Nishat Energy Limited

NISHAT

19.05.2016

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

SUBJECT: Application for a Generation License for Nishat Energy Limited

I, Norez Abdullah (the Chief Financial Officer), being the duly authorized representative of Nishat Energy Limited by virtue of Board Resolution dated 30th April, 2016, hereby apply to the National Electric Power Regulatory Authority for the grant of a Generation License to Nishat Energy Limited pursuant to Section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

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

A Pay Order in the sum of Pak Rupees **659, 272**, being the non-refundable license application fee calculated in accordance with Schedule II of the AMPR, is also attached herewith. Further, additional documents/information, pursuant to the AMPR, are attached herewith.

Norez Abdullah
Chief Financial Officer
Nishat Energy Limited

APPLICATION FOR THE GRANT OF A GENERATION LICENSE UNDER SECTION 15 OF THE ACT AND REGULATION 3 OF THE AMP REGULATIONS

1. NEPRA's Participation in the Process

1.1. Section 15 of the Regulation of Generation, Transmission, and Distribution of Electric Power Act, 1997 (the "**Act**") provides, *inter alia,* that:

> *"(1) No person except under the authority of a license issued by the Authority under this Act and subject to the conditions specified in this Act and as may be imposed by the Authority, construct own or operate a generation facility.*
>
> *(2) An application for the grant of a license for a generation facility shall specify-*
>
> *(i) the type of facility for which the license is applied;*
>
> *(ii) the location of the generation facility; and*
>
> *(iii) the expected life of the generation facility."*

1.2. Furthermore, Regulation 3 of the National Electric Power Regulatory Authority (Application and Modification Procedure) Regulations, 1999 (the "**AMP Regulations**") provides that an application for a license shall be made in the form specified in the AMP Regulations and further enumerates the documents required to be submitted to the Authority along with the requisite application.

1.3. This Application for the grant of a generation license is made pursuant to Section 15 of the Act and Regulation 3 of the AMP Regulations (this "**Application**").

2. Introduction of the Applicant/Sponsor

2.1. As required under the Section 24 of Act, Nishat Energy Limited (the "**Applicant**" or the "**Company**" or the "**Project Company**") is an entity incorporated under the Companies Ordinance, 1984, to act as a special purpose vehicle (the "**SPV**") and develop a 1x660 MW coal fired power plant at Tehsil Liaqatpur, District Rahimyar Khan, Punjab (the "**Project**"). The constitutive documents and latest audited financial statements and tax return of the Applicant are annexed herewith as **Annex- A** hereto.

2.2. By way of background and introduction, M/S TBEA Xinjiang SunOasis Co., Limited (the "**Sponsors**" or "**TBEA**") has shown interest in participating in the Project as a co- sponsor to provide technical and project financing proficiencies. TBEA is a well-known and upcoming thermal power project developers in China with a proven track record of developing, financing, constructing, and operating coal fired projects in China. TBEA has signed a consortium agreement on 16th December 2015 which lays out the understanding and broad framework for future cooperation on the Project wherein TBEA, *inter alia*, has taken up the lead role in arranging the financing from china and also doing the EPC works on turnkey basis. A copy of the consortium agreement is annexed as **Annex-B** hereto.

After having signed the understanding as encompassed in the agreement appended as **Annex-B** to this Application, the board of LOI issuing agency, M/S Punjab Power Development Board ('**PPDB**') has approved the change in consortium members and their sponsorship interests through their letter appended as **Annex-C**. Therefore subject to satisfaction of the conditions precedents in the Consortium Agreement, the following shall be the revised shareholding:

Nishat Power Limited	Main Sponsor	25%
Nishat Mills Limited	Initial Sponsor	5%
TBEA		70%

2.3. TBEA's parent company was established in 1993 and since then it has diversified itself into wide variety of businesses including manufacturing of transformers, reactors, inductors, cables, high purity aluminum, solar silicon wafers, coal mining, gold mining, grid operations, thermal power engineering and O&M. With vastly varied experience and expertise, the group is now becoming one of the frontline OEM and EPC contractors in Western China which is eyeing to further

expand its presence overseas by developing power projects itself. Their existing overseas portfolio includes development in Central Asia, India, East Africa and lately Pakistan.

2.4. TBEA as a turnkey EPC contractor, Coal miner and OEM for heavy duty electrical equipment compliments Nishat Group's (the "**Nishat**") strength in the consortium who enjoys rich local O&M and development experience in Pakistan power sector on both liquid fuel (HFO) and solid fuel (coal) consumption. The Sponsors has undertaken to provide foreign non-existent man power and expertise in coal plant operations which is lacked by Nishat for large coal fired operations. All local personnel is to be provided/hired by Nishat based on its strong O&M reputation in the Pakistan power industry. The financial strength and developing/operating ability of Nishat in power industry is amply demonstrated in the Statement of Qualification document filed with PPDB under a competitive qualification process as a result of which Nishat was awarded the Letter of Intent by PPDB.

2.5. TBEA, as per the consortium agreement, has taken a lead role in procuring Chinese financing which will also ease the burden on Nishat from seeking project financing from local banking channel with visible Foreign Exchange liquidity constraints imposed by State Bank of Pakistan.

2.6. Nishat Power Limited (the "**Main Sponsors**") is a public limited company incorporated in February 2007, formed under the Power Policy 2002 as an independent Power Producer (the "**IPP**"). The company is a subsidiary of Nishat Mills Limited. The principal activity of the company is to build, own, operate, establish and maintain a fuel fired power station having gross capacity of 200 MW in Jamber Kalan, Tehsil Pattoki, and District Kasur Punjab.

2.7. Nishat Mills Limited (the "**Initial Sponsor**") is the flagship company of Nishat Group. It was established in 1951. It is one of the most modern, largest vertically integrated textile companies in Pakistan. The Initial Sponsor has 227,640 spindles, 789 Toyota air jet looms. The Company also has the most modern textile dyeing and processing units, 2 stitching units for home textile, two stitching units for garments and Power Generation facilities with a captive power capacity of 120 MW. The Company's total export for the year 2015 was Rs. 39.868 billion (US$ 393.683 million). Due to the application of prudent management policies, consolidation of operations, a strong balance sheet and an effective marketing strategy, the growth trend is expected to continue in the years to come. The Company's production facilities comprise of spinning, weaving, processing, stitching and power generation.

2.8. The latest available Credit Ratings, Financial History and Thermal Power Projects Experience of Nishat Power Limited, Nishat Mills Limited and TBEA is attached as **Annex-D** hereto.

2.9. The Project Company have further collaborated with professional firms that are highly qualified and committed to developing and commissioning the Project on a fast track basis. Collectively, the sponsors along with their professional alliances, presents a vastly experienced team of power sector professionals of international repute. The Main Sponsor has entered into agreement with ENERGEN Infra (Mauritius) Limited for latter to act as an advisor in negotiating the EPC contract with potential EPC contractor from China. The agreement is enclosed as **Annex-E** hereto.

2.10. A preliminary EPC proposal was also gathered by Nishat from SEPCO to set up 1x660MW project to assess the interests of EPC players and budgeted EPC costs, timelines and financing support from the Chinese banks before entering into a consortium agreement with TBEA. The preliminary EPC proposal and SEPCO's introduction is enclosed as **Annex-F** hereto.

3. The Project Overview

3.1 Project Company

3.1.1 The Company is developing its Project under the NEPRA Upfront Tariff regime. The Letter Of Intent (the "**LOI**") has been awarded by Punjab Power Development Board (the "**PPDB**") to the Sponsors wherein Nishat Power Limited was nominated as the Main Sponsors. The Project Company is diligently working towards the early implementation of the Project, on a Build Own and Operate (BOO) basis. The construction of 660 MW power plant on super-critical technology will take approximately forty-eight (48) months or less from the issuance of notice to proceed to the EPC contractor. The plant commissioning is expected in the fourth quarter of 2020.

The original LOI dated 15th October, 2014 (appended in **Annex – C**) was awarded to Nishat Group and Associates with the following composition of shareholding:

Nishat Power Limited	Main Sponsor	25%
Lalpir Power Limited	Initial Sponsor	25%
Pakgen Power Limited		25%
Nishat Mills Limited		25%

3.1.2 However, Nishat Group and Associates requested for change in consortium members for LOI. The change of consortium was necessitated after engaging with multiple large banks that emphasized the need for a Chinese sponsor in order to prioritize and fast track the financial close process with Chinese financial institutes. The sheer size of debt financing (>600 M USD) required to fund the project was not possible to manage from local banking channels. Therefore, the need for induction of a capable Chinese partner to drive the financing process forward. It is strongly believed that the current Sponsor's experience and balance sheet strength, the new consortium would become more formidable and capable.

3.1.3 After having secured the approval from PPDB on the induction of the Chinese equity partner, significant progress have been made in completing the feasibility study, securing LOI from China Development Bank and finalization of a detailed Joint Venture Agreement between Nishat Group companies and TBEA.

The LOI from China Development Bank is annexed as **Annex-G** hereto.

3.2 Issuance of "Letter of Intent"

3.2.1 On October 15th, 2014 the LOI was awarded by PPDB, Government of the Punjab (the "**GOPb**") to the Sponsors of the Project for the development of a 660MW imported coal power project situated at Tehsil Liaqatpur near, Rahimyar Khan, Punjab.

3.2.2 Although the Applicant will opt for the Upfront Tariff and as such all risks associated with the Project are to be borne by the Applicant, nevertheless, the Company has undertaken to conduct the following studies / investigations:

a. Social & Environmental Impact Assessment;
b. Interconnection Study to include load flow, short circuit and transient stability studies;
c. GeoTech investigations;
d. Hydrological survey including bathymetry of the area;
e. Seismic survey;
f. Topographical survey;
g. Technical layout configuration;
h. Heat balance, Process flow, Electrical Single Line, Piping and Instrumentation Diagrams;
i. Coal Spec availability and Long term coal supply agreement term sheets;

j. Assurance from Pakistan Railways to transport coal from Port to Site upto 2 Million tons per annum on long terms contract basis;
k. Options and evaluation of Port availability and handling capacities at Port Qasim;
l. Irrigation water availability for cooling, underground water quality and effluent discharge channel availability;
m. Land allocation and access thereto
n. Merits of Project Site
o. Preliminary EPC Proposal

A detailed feasibility study was conducted with the assistance of Shanghai Electric and East China Electric Power Design Institute which is annexed as **Annex-H** hereto. The minutes of the 'Panel of Experts' appointed by PPDB under the Punjab Power Policy 2006 (Revised in 2009) approving the feasibility study is also annexed as **Annex-I** hereto.

4. Power Purchaser

4.1. The electricity generated from this Project would be supplied to the grid system of NTDC through 500 KV grid available in the vicinity of this Project. The power generated by the Project will be sold for the term of 30 years under the standard PPA starting from commencement of commercial operations.

4.2. The 30 year concession period is in line with the design life of the turbines, as they are designed to have a very low probability of failure within 30 years' life. Although, the turbines may have a better design life span but local climatic conditions and operating regime may affect the expected life of the assets. The Grid and Transmission Lines to evacuate power will be made available by the Power Purchaser.

4.3. The grid evacuation scheme proposed by the grid study consultant after consultation with NTDC on the basis of NTDC's projections of demand supply data is annexed as **Annex- J** hereto.

5. Site

5.1. The proposed Project site is located in Cholistan Development Authority's jurisdiction, Tehsil Liaquat Pur District Rahim Yar Khan. The site is situated above around 6-KM from main Jetha Butta- Khan Pur Grand Trunk road at barren land of Cholistan Development Authority and 4-KM away from Jetha Bhutta Railway Station. The entire Site land is owned by the Government without any private lease or encumbrance or occupation. The Company has already been issued a

recommendation letter by the energy department by the Government of Punjab to the board of revenue Punjab for the allocation of land for the subject power project, annexed herewith as **Annex -K** hereto. According to the requirements of the Statement of Conditions (also appended in **Annex-K)** applicable in respect of the Site, the Project Company is required to execute a land lease agreement or a land purchase agreement immediately upon the issuance of Letter of Support by PPDB, which shall immediately follow once the Company has successfully obtained the generation license and tariff determination from NEPRA.

5.2. The Company has already obtained access for the conduct of geo tech and environmental studies of a total land measuring 527 Acres in one piece. The land coordinates are attached as part of the feasibility study appendix **Annex-H**.

5.3. Since the site is in an undeveloped area, there is adequate room for construction laydown. Construction lay down is the area used to store equipment and material transported to the site before it is installed in the plant. Depending on the final arrangement, the coal storage can be part of the construction laydown area. Some temporary warehouse and fabrication shops will be built for the storage of equipment that requires protection from the weather. The fabrication shops will be used for fabrication of piping and other assemblies before installation into the plant. One or more tree plantations will be made near the plant at the end of construction. This will provide a pleasant area and contribute to the environment.

6. NTDC Interconnection Arrangement and Study

6.1. The Company appreciates that the grid interconnection study is one of the important consents which is required by the project before the issuance of upfront tariff for development of the project. In this regard the Company is already in the advanced stages of procuring NTDC's approval of its interconnection study. The Company having collected the data from NTDC has completed the interconnection and load flow study which was submitted to NTDC for approval in the month of October 2015. Later on, based on NTDC's review comments/observations on the aforesaid study dated March 21, 2016 clarification was made to address the concerns of NTDC. During the recent communication with NTDC, it has been apprised that the approval of the aforesaid study is in advance stage and the Company expects the same to be ready in few weeks, a copy of which will be submitted by NTDC to NEPRA directly. The Company would also submit the approval upon its receipt without delay. Copy of the document evidencing the submission of the interconnection study in the month of October 2015 together with the document evidencing the deposit of review fee required by NTDC are appended herewith as **Annex-L** hereto. Also

attached are the comments of NTDC which is being addressed by the designated technical adviser namely PPI to whom the study has been outsourced (also appended in **Annex- L).**

7. Operations & Maintenance Arrangement

7.1. The Company intends to self-undertake the Operation and Maintenance (O&M) of the plant as the sponsors has the wherewithal, capacity and capability to undertake such task. The EPC contractor shall be engaged well in time to enable it to participate and provide vital inputs in design reviews, staff training, pre-commissioning and commissioning activities.

The operational experience of the sponsors on coal power plant operations are already appended as part of **Annex-D.**

8. Financing

8.1. The Project is intended to be financed from the Chinese banks under CPEC Govt to Govt. agreed framework as provided in the CPEC Agreement wherein project Rahimyarkhan is listed at no. 12 in the designated projects list. The target Debt Equity ratio is 80:20.

8.2. A Letter of Intent appended as **Annex-G** is also procured by a potential Chinese equity partner in favor of the project expressing willingness to finance the project subject to customary lenders' due diligence.

8.3. The sponsors intends to procure 100% of project debt from Chinese banks with support from a reputable Chinese equity partner as an Overseas Investment Loan or an ECA tied financing package or any other financing program which the sponsors deem fit.

9. Selection of Technology

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

The following is the major technical data for the plant design which was compiled by East China Electrical Power Design Institute (ECEPDI) and formed part of the

feasibility study approved by the Panel of Experts appointed by PPDB pursuant to the terms of the LOI.

Parameter	Value
Thermal Cycle Information – Gross Capacity	660 MW at guarantee conditions
Thermal Cycle Information – Net Capacity	625MW (target) at design conditions
Net Plant Heat Rate	8359 kJ/kWh at design guarantee conditions (i.e 43%)
Main Steam Flow (VWO) Main Steam Pressure Main Steam Temperature	1,934,200 kg/h 27MPa 600°C
Hot Reheat Flow Hot Reheat Pressure Hot Reheat Temperature	1,518,988 kg/h 4.987 MPa 600°C
Cold Reheat Flow Cold Reheat Pressure Cold Reheat Temperature	1,687,651 kg/h 5.42 MPa 347.2°C
Feed water Pressure	33.1MPa
Coal Burn Rate	242 t/h for the design coal, BMCR load

Water Flow to the Plant Circulating Water Flow Circulating Water Temperature Rise in Condenser	1653m^3/h 83,448 m^3/h to condenser per unit (closed cooling) 9.9°C
Waste Water Flow	10 m^3/h approximate
Potable Water Supply to Plant	10 m^3/h

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

The design parameters have yet to be verified and adopted under a binding EPC contract which would certify the pragmatism of the feasibility assumptions based on ambient, ground and other relevant conditions.

10. Health and Safety

10.1. During the construction and operation of the Project, the guideline of "safety first, (accident) prevention foremost" will be practiced. Comprehensive management and supervision will be applied to all staff members and the whole operation process, in order to ensure safe operation of the equipment and personal safety of workers. A detailed organogram reflecting the project team Structure, along with key personnel resumes, is appended as **Annex-O** hereto.

10.2. The Company shall ensure that the EPC Contractor shall take all due precautions to ensure the safety of its employees, agents and subcontractors and, in collaboration with and to the requirements of the local health authorities, to ensure that suitable arrangements such as medical staff, first aid equipment and stores, sick bay and suitable ambulance services are available at all times throughout the period of the construction period as necessary and that suitable arrangements are made for all necessary welfare and hygiene requirements..

10.3. The EPC Contractor shall maintain records concerning safety, health and welfare of persons and damage to property, and make such reports, as are consistent with Good Utility Practice and shall report details of any accident to the Company as soon as possible after its occurrence.

10.4. All measures suitable and necessary in accordance with Good Utility Practice and all applicable legal requirements shall be taken to ensure the protection, security and the safety of the site and personnel.

10.5. The Company shall ensure that the EPC Contractor shall prepare and implement a comprehensive Health, Safety and Environment (HSE) policy and associated procedures, that will govern the EPC Contractor's actions at all times during the design preparation and construction of the Project as well as during the operating phase. In addition to the other requirements of EPC relating to the standards to be adopted by the EPC Contractor in the overall design of the Project, the EPC Contractor shall submit a detailed construction safety plan, that will demonstrate EPC Contractor's commitment to the highest standards of personal and general safety standards during construction of the Project, as well as the concept of an accident and injury free Project.

11. Environmental Impact

11.1. The Environmental Impact Assessment (EIA) study for the project has been completed. The power plant and coal spec is configured in conformity with the National Environmental Quality Standard (NEQS) applicable for new power plant projects. National Environmental Quality Standard (NEQS) requirements is being followed also for emissions, effluents, workplace air quality, noise, worker health, safety and training requirements for design configuration purposes of this project. Original Environmental NOC for construction of the Power Project issued by Punjab Environmental Protection Agency along with executive summary of the Environmental Impact and Social Soundness Assessment Study report is annexed as **Annex-M** hereto.

12. Evidence/relevant correspondence:

12.1. Copies of the pertinent correspondence are enclosed herewith for the learned Authority's assistance and consideration.

12.2. The Applicant would be pleased to provide any other assistance that the learned Authority may require in the matter of grant of Generation License.

12.3. This Application and its Annexures are being submitted in triplicate, with certain documents certified as necessary, each in accordance with Regulation 3(4) of the AMP Regulations.

13. Additional Grounds

13.1. The Applicant seeks to raise further additional grounds in support of this Application at the hearing stage.

PRAYER

It is most humbly prayed to the esteemed Authority as follows:

A. That the Applicant be granted a Generation License for the development of the Project.

B. That the terms of the Generation License may kindly be made consistent with the terms of the GoP concession documents.

C. That the Authority may be pleased to treat the Applicant's request for the grant of Generation License on a non-discriminatory basis and any concession offered to comparable projects on the date of filing of this Applicant and at any stage subsequent to the grant of license may kindly be granted to the Applicant as well.

D. Any further and better relief that the Authority may deem appropriate in the circumstances may kindly be granted to the Applicant.

We hope the information/explanation provided above meets your requirements, and remain available to assist you if you have any further queries.

Respectfully submitted for and on behalf of the Applicant:

Sincerely,
Nishat Energy Limited
19 May, 2016

Nishat Energy Limited

NISHAT

RESOLUTION NO. 7 DATED APRIL 30, 2016 PASSED BY THE BOARD OF DIRECTORS OF NISHAT ENERGY LIMITED

RESOLVED that an application for Generation License ("**GL Application**") be filed by and on behalf of Nishat Energy Limited ("**the Company**") with National Electric Power Regulatory Authority ("**NEPRA**"), in respect of the Company's 1 x 660 MW coal fired power plant near Rahimyar Khan (the "**Project**").

RESOLVED FURTHER that any of Chief Executive and or Chief Financial Officer and or Company Secretary of the Company, be and are hereby authorized singly to sign the GL Application, and any other documentation ancillary thereto, pay all filing fees, and provide any information required by NEPRA in respect of the Project, and to do all acts, deeds and things necessary for the processing, completion and finalization of the GL Application.

Certified True Copy issued on 2nd day of May 2016.

KHALID MAHMOOD CHOHAN
COMPANY SECRETARY

HEAD OFFICE : 1-B AZIZ AVENUE, CANAL BANK, GULBERG V, LAHORE. TEL: +92-42-35717090-96, 35717159~63, FAX: +92-42-35717239
REGISTERED OFFICE : NISHAT HOUSE, 53/A, LAWRENCE ROAD, LAHORE TEL: 111-113-333, FAX: +92-42-36367414

SCHEDULE-IV

[Regulation 4(3) (x)]

Thermal Power Generation Facility – Information Summary

Name of Applicant	Nishat Energy Limited
Registered Office	1-B, Aziz Avenue, Canal Bank Road, Gulberg-V, Lahore
Business Office	1-B, Aziz Avenue, Canal Bank Road, Gulberg-V, Lahore
Project Location	Tahsil Liaqatpur, District Rahimyar Khan (refer annexure for further details of coordinates)
Plant Details (Optional)	Please refer annexure for details
Manufacturer	To be determined by the EPC Contractor (for options please refer annexure for details)
Make & Model	To be determined by the EPC Contractor
Technology	Super Critical Pulverized Coal Power Plant -
Plant Configuration	1 Steam Generator + 1 Steam Turbine + 1 Generator
Plant Capacity (MW) Gross	660 MW
Plant Capacity (MW) Net	607 MW (subject to true-up on IDC test at COD)
Details of Auxiliary Load (MW)	53 MW (subject to true-up on IDC test at COD)
Plant Capacity (MW) Net (at Mean Site Conditions)	As Above
Fuel	Sub Bituminous Imported and/or Local Coal
Net Thermal Efficiency at full load	39% (subject to true-up on Heat Rate test at COD)
Reference Site Conditions (Optional)	[Left Blank]
Electricity Load	85% annual capacity factor
Ambient dry bulb temperature	26.4° C
Relative humidity (%)	60%
Atmospheric pressure ($mbar_a$)	Elevation: ~90 meters, Pressure: 1006.5(mbar)
Power Factor at Generator Terminal	0.85 (lagging) and 0.90 (leading)
Grid Frequency	50Hz
Evaporation Cooler	Not Applicable as these are relevant to Combined Cycle Power Plants
HRSG Blow down	
Hours of CC'PP degradation	
Expected Date of Financial Close	Q4 2016
Expected COD	Q4 2020

NISHAT ENERGY LIMITED

SCHEDULE-I

The location, Size (i.e. Capacity in MW), Type of Technology, Interconnection Arrangements, Technical Limits, Technical/Functional Specifications and other details specific to the Generation Facilities of the Licensee are described in this Schedule.

Detail of the Generation Facility/Thermal Power Plant

(A). General Information

(i)	Name of Company/ Licensee	Nishat Energy Limited
(ii)	Registered Office	1-B, Aziz Avenue, Canal Bank, Gulberg-V, Lahore, Pakistan
(iii)	Business Office	1-B, Aziz Avenue, Canal Bank, Gulberg-V, Lahore, Pakistan
(iv)	Location of the Generation Facility/ Power Plant	East of Dhoop Sarhi, Jetha Bhutta Town, Khanpur City, Tehsil Liaqat Pur, Dist. Rahim Yar Khan, Province of Punjab
(v)	Type of Generation Facility/ Power Plant	Thermal Generation Facility

(B). Configuration of Generation Facility

(i)	Installed Capacity/Size of the Generation Facility/ Power Plant	660 MW	
(ii)	Type of Technology	Conventional Thermal Power Generation Facility with Super Critical PC Boiler and Steam Turbine	
(iii)	Number of Units/Size (MW)	1 x 660 MW	
(iv)	Unit Make/Model/Type & Year of Manufacture etc.	Steam Turbine	PC Boiler
		Super-critical, condensing Steam. *Please refer Annexure for Manufacturer's Options*	Supercritical thermal power unit, single reheat, balanced draft radiant furnace, dry bottom. *Please refer Annexure for Manufacturer's Options*
(v)	COD of the Generation Facility/Power Plant (Anticipated)	31st December, 2020	

NISHAT ENERGY LIMITED

(vi)	Expected Useful Life of the Generation Facility/Power Plant from COD	30 Years

(C). Fuel/Raw Material Details

(i)	Primary Fuel	Imported Bituminous/Sub-Bituminous Coal	
(ii)	Start-Up Fuel	Light Diesel Oil (LDO) / High Speed Diesel (HSD)	
(iii)	Fuel Source for each of the above (i.e. Imported/Indigenous)	Primary Fuel	Start-Up Fuel
		Bituminous/Sub-Bituminous Coal from Indonesia, South Africa, Botswana, Ukraine, Australia, Columbia, USA and others	Indigenous
(iv)	Fuel Supplier for each of the above	Primary Fuel	Start-Up Fuel
		Nishat Commodities International Coal Traders and Miners	Shell Pakistan / Pakistan State Oil / any other OMC
(v)	Supply Arrangement for each of the above	Primary Fuel	Start-Up Fuel
		Through Ships docked at Karachi Port Jetty or of Pakistan International Bulk Terminal (PIBT) and to Site through Pakistan Railway / Trucks	Through Oil Tankers
(vi)	No. of Storage Bunkers/Tanks/ Open Yard	Primary Fuel	Start-Up Fuel
		1 x Coal Yard	2 x Storage Tanks
(vii)	Storage Capacity of each Bunkers/Tanks/ Open Yard	Primary Fuel	Start-Up Fuel
		162,000 Tons	2 x 500 m^3
(viii)	Gross Storage	Primary Fuel	Start-Up Fuel
		162,000 Tons	1,000 m^3

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(D). Emission Values

		Primary Fuel	Start-Up Fuel
(i)	SO_x (mg/Nm^3)	≤ 1053	As per NEQS
(ii)	NO_x (mg/Nm^3)	≤ 300	-do-
(iii)	PM(mg/Nm^3)	≤ 36	-do-

(E). Cooling System

(i)	Cooling Water Source/Cycle	Natural draft cooing tower having recirculation rate of 83,448 m^3/hr. Raw water will be taken from nearby irrigation perennial canal (Abbasia Canal) which originates from Head Punjnad.

(F). Plant Characteristics

(i)	Generation Voltage	22 kV ±5%
(ii)	Frequency	50 Hz
(iii)	Power Factor	0.85 (lagging), 0.90 (leading)
(iv)	Auxiliary Voltage System	MV : 6 kV ±5% LV : 400/220V
(v)	Generator Capacity	776 MVA (TMCR) Hydrogen Cooled
(vi)	Generator Step-up Transformer	780 MVA (ODAF) HV: 500kV
(vii)	Ramping Rate (MW/min)	The typical value is 0.5-1% of rated load (3.3-6.6 MW/min). This is indicative and will be confirmed after detailed engineering design of the plant. Power plant will not be operated below 30% continuously.
(viii)	Length of Shutdown	Notice required before synchronizing (minutes)
	No more than 2 hours	80
	More than 2 hours but < 8 hours	150
	More than 8 hours but < 32 hours	190
	More than 32 hours but < 150 hours	495
	More than 150 hours	610
(ix)	Hydrogen Generation Facility	Capacity: 5 Nm^3 / hr Storage: 840 Nm^3
(x)	Switch Yard	Air Insulated Switchyard (AIS)

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SCHEDULE-II

The Installed Capacity (MW) at Reference Conditions, Auxiliary Consumption (MW) and the Net Capacity at Reference Conditions (MW) of the Generation Facilities of Licensee is given in this Schedule.

1	Total Gross Installed Capacity of the Generation Facility/Power Plant at Reference Condition	660 MW
2	Auxiliary Consumption of the Generation Facility/Power Plant	53 MW
3	Total Installed Net Capacity of Generation Facility/Power Plant at Reference Site Condition	607 MW

Note

All the above figures are indicative as provided by the Licensee. The Net Capacity available to Power Purchaser for dispatch will be determined through procedure(s) contained in the Power Purchase Agreement (PPA) or any other applicable document(s).

Annexure to SCHEDULE-I

The location, Size (i.e. Capacity in MW), Type of Technology, Interconnection Arrangements, Technical Limits, Technical/Functional Specifications and other details specific to the Generation Facilities of the Licensee are described in this Schedule.

Detail of the Generation Facility/Thermal Power Plant

(B). Configuration of Generation Facility

*Manufacturer Options for Key Equipment**

S. No.	Equipment	Vendor	Place of Manufacture
1.	Boiler	Alstom Amec Foster Wheeler Harbin Shanghai Electric	Wuhan Guangdong Harbin Shanghai
2.	Turbine	SIEMENS Shanghai Electric DongFang Harbin	China Shanghai Deyang Harbin
3.	Generator	GE Electric DongFang Shanghai Electric Harbin	China Chengdu Shanghai Harbin
4.	ESP	Fujian Longking Zhejiang Feida Zhejiang Xinyada	Fujian Zhuji Zhejiang

**Or any other options of equivalence and repute in addition to above*

ENERGY LIMITED

Sojitz Corporation
1-1,Uchisaiwaicho, 2-chome,
Chiyoda-ku, Tokyo
100-8691, Japan

July, 3, 2015

To: Nishat Energy Limited
Attn to: Norez Abdullah, CFO

REQUEST FOR PROPOSAL

Dear Sirs,

Thanks for inviting us to your Request for Proposal for the coal supply to your 660MW Nishat Coal Power Project in Pakistan. We, Sojitz Corporation, are hereby pleased to send you our Non-Binding term sheet as follows.

Items	Contents
1) General interest in coal supplier to receive firm RFP	We are pleased to receive firm RFP and interested in long term coal supply to Nishat Coal Power Project
2) Offered coal specifications and ash properties	As per Appendix I
3) Indicative FOB price as on May 31, 2015	globalCOAL RB1* minus US$2.00/MT, FOB RBCT, 5500NAR basis
4) Benchmark Index for FOB and Pricing Formula	*where globalCOAL RB1 means monthly average of RB1 index issued by globalCOAL in the month of loading laycan.
5) Pricing formula for adjustment for spec variation (esp. for ash, moisture, and Sulphur)	Total moisture: no price adjustment Ash(ar): US$0.20/MT per 1%, pro-rata for over 21% (ar) Sulphur (ar): US$0.20/MT per 0.1%, pro-rata for over 0.7% (ar)
6) Indicative shipping prices as on May 31, 2015	US$15.00/MT for the delivery of 50,000MT +/-10% at Seller's option
7) Vessel type, draft, beam, size and cargo capacity	VESSEL TYPE: Dry bulk ship DWT/DRAFT: 55,569 MT / 12.868 M GRT/NRT: 32,672 / 18,529 LOA/BEAM: 187.88 M / 32.26 M GRAIN CAPA: 70,733 M3 GEARS: 30 CRANE X 4 CRANE OUTREACH: 9.87M HATCH SIZE : NO.1 16.40M X 18.40M NO.2-5 21.32m X 18.40M
8) Benchmark (s) to be used for	Fixed freight with BAF (Bunker Adjustment Factor)

NISHAT ENERGY LIMITED

Sojitz Corporation
1-1,Uchisaiwaicho, 2-chome,
Chiyoda-ku, Tokyo
100-8691, Japan

shipping freights	
9) Commitments required from IPP	Terms and conditions as per SCoTA (Standard Coal Trading Agreement) issued by globalCOAL
10) Commitments offered to IPP	Terms and conditions as per SCoTA (Standard Coal Trading Agreement) issued by globalCOAL
11) Credit instrument or escrow reserve requirement against take or pay	To be discussed
12) Liquidated Damages and Delayed Payment Interest Rate	To be discussed
13) Credit Terms available and terms of premium for credit	Buyer's payment shall be made 100% by Letter of Credit At Sight issued by a first class Pakistani bank confirmed by international first class bank acceptable to Seller. In case Buyer needs shipper's usance, the interest rate shall be discussed.
14) Guarantees and counter guarantees offered and required	To be discussed
15) Tenor of contract and terms or renewal	Frame coal supply agreement is made for 5 years. Terms and conditions to be discussed and agreed every year for next 12 months.
16) General procedures to be followed from order booking to delivery	a) Notice of plant commissioning and request of trial b) Agreement on spot terms and conditions c) Trial delivery of coal for commissioning d) Quality and performance test/meeting e) Agreement on annual coal supply agreement f) Commencement of commercial delivery of coal
17) Governing Laws of the CSA	Singapore

Sojitz Corporation

Katsunori Okada
General Manager
Coal & Iron Ore Department

NISHAT ENERGY LIMITED

Sojitz Corporation
1-1,Uchisaiwaicho, 2-chome,
Chiyoda-ku, Tokyo
100-8691, Japan

<Appendix-I>

Typical Specification of RB3 Type Coal (as per ISO standard)

General Analysis	Units	As received	Air dried	Dry	Dry ash free
Total Moisture	%	7.8			
Moisture	%		2.8		
Ash	%	19.9	21.0	21.6	
Volatile Matter	%	21.8	23.0	23.7	30.2
Fixed Carbon	%	50.5	53.2	54.7	69.8
Total Sulfur	%	0.56	0.59	0.61	0.77
Gross Calorific Value	kcal/kg	5,703	6,010	6,185	7,890
	Mj/kg	23.87	25.16	25.89	33.03
	Btu/lb	10,262	10,816	11,131	14,199
Net Calorific Value	kcal/kg	5,500			
(Constant Volume)	Mj/kg	23.03			

Ultimate Analysis	Units	As received	Air dried	Dry	Dry ash free
Carbon (total)	%	60.9	64.2	66.1	84.3
Hydrogen	%	3.26	3.44	3.54	4.52
Nitrogen	%	1.44	1.52	1.56	1.99
Total Sulfur	%	0.56	0.59	0.61	0.77
Oxygen (by diff.)	%	6.1	6.4	6.6	8.4

Ash Analysis	Units	Dry
SiO_2	%	52.0
Al_2O_3	%	30.2
Fe_2O_3	%	4.6
CaO	%	6.0
MgO	%	1.3
Na_2O	%	0.1
K_2O	%	0.6
TiO_2	%	1.7
Mn_3O_4	%	0.0
SO_3	%	2.2
P_2O_5	%	1.3
Total	%	100

Fusibility of Ash	Units	Red. Atm.
Deformation	Deg.C	1,430
Sphere	Deg.C	1,450
Hemisphere	Deg.C	1,460
Flow	Deg.C	1,480

Other Analysis	Units	
Light Transmittance	%	90
HGI		56
Fuel Ratio		2.31
Fouling Index		0.02
Slagging Index		0.09
Phosphorus in Coal (db)	%	0.12

Trace Analysis	Units	Dry
Chlorine	%	0.004
Antimony	mg/kg	0.2
Arsenic	mg/kg	3.0
Cadmium	mg/kg	0.05
Boron	mg/kg	30
Fluorine	mg/kg	160
Lead	mg/kg	8
Mercury	mg/kg	0.13
Selenium	mg/kg	0.6

Size Analysis	Units	Air dried
50 x 0 mm	%	98
40 x 0 mm	%	92
31.5 x 0 mm	%	86
16 x 0 mm	%	68
8 x 0 mm	%	46
5 x 0 mm	%	33
4 x 0 mm	%	29
2 x 0 mm	%	16
1 x 0 mm	%	9
0.5 x 0 mm	%	5

NISHAT ENERGY LIMITED

TRAFIGURA

TRAFIGURA PTE. LTD.

10 COLLYER QUAY #29-00 OCEAN FINANCIAL CENTRE SINGAPORE 049315 TEL: +(65) 6319 2960- FAX: +(65) 6 734 9448

COAL SUPPLY PROPOSAL

Proposal:	Trafigura pte ltd to supply Nishat Energy Limited (NEL) with steam coal for their power plant project of 1x660MW in Rahimyar Khan in Punjab Pakistan
Seller:	Trafigura Pte Ltd Singapore, Branch Office Geneva or its subsidiary
Buyer:	Nishat Energy Limited (NEL)
Commodity:	[illegible] Indonesian origin as per below specifications

South African Origin

Specifications	
Calorific Value Basis	5,500 kcal/kg NCV
Calorific Value Min	5,300 kcal/kg NCV
Total Moisture (ARB)	14.0% max
Volatile Matter (ARB)	20.0% min
Ash (ARB)	23.0% max
Sulphur (ARB)	1.0% max
HGI	45 – 70
Nominal Topsize	50 mm
IDT	Min 1,150 degrees Celsius in a reducing atmosphere

Indonesian origin

5,300 GAR

Specification	Basis	Typical	Rejection	Unit
Total Moisture	ARB	25.0		%
Inherent Moisture	ADB	12.0		%
Ash Content	ADB	6.0	>8.0	%
Volatile Matter	ADB	40.0		%
Total Sulphur	ARB	0.6	>0.8	%
Fixed Carbon	ADB	42.0		%
Gross Calorific Value	ARB	5,300	<5,100	Kcal/kg
Gross Calorific Value	ADB	6,200		Kcal/kg
HGI		50		
Size		90%		Mm
Ash Fusion Temp (IDT)		1,450		°C

Loading points:

- For south African coal, loading shall take place from **Richards Bay Coal Terminal in South Africa**
- For Indonesian coal, loading shall take place from **Palembank Coal Jetty in Sumatra, Indonesia**

Duration of the coal supply: Trafigura to supply NEL starting from the year of operations of the project and for a minimum period of 5 years. This can be extended to 10 or 20 years supply period.

Quantity: Trafigura would supply NEL with 50% of their yearly requirement (1.8Mt) and that for the [illegible]

Delivery: CFR Bin Qasim port Pakistan, where buyer guarantees a min draft of 12.5 meters

Price: price of coal shall be based on FOB + Ocean freight. The FOB part shall be reference to RB1 Or RB3 index and this, to be mutually agreed with buyer and seller. The ocean freight part shall be based on the below formula

Freight from Indonesia BF + TCA + BAF + PCA + PIR

Where:
BF =Base freight that will be determined at the day pf price negotiations
TCA=(Y – 10000)*0.00065 where Y is the Baltic S6TC assessment on the day of the final vessel nomination for a lifting.
BAF= (Z – 520)*0.0178 where Z is the Singapore Platts bunker price on the day of the final vessel nomination for a lifting
PCA=Port cost adjustment: This applies only if there is an increase in port costs at either load and/or discharge ports(s) of more than 10% of the current costs. If such an increase happens then the extra cost above the 10 pct increase to be included into the freight.

PIR-Piracy Cost adjustment: This applies only if there is an increase in piracy costs in the arabian sea of more than 10% of the current costs. If such an increase happens then the extra cost above the 10 pct increase to be included into the freight.

For the freight from South Africa a similar formula shall be applied.

As a reference today (July 2015), the delivered price of RB3 coal into Ben Qasim would be: 48.5$ (FOB) + 11.00$ (Freight)

Vessel to be fitted for Ben Qasim limits, rules and regulation.

Price adjustment: Price of FOB and Freight shall be discussed on a regular/quarterly basis between buyer and supplier to be adjusted and reflected of the market conditions.

Payment terms: Buyer and seller shall agree on payment terms before signing the contract. Seller can look into providing the buyer with extended payment terms.

Incoterms: the contract shall be based on CFR- Ben Qasim basis (incoterms 2010)

Market Research and intelligence:

- **Monthly reports** prepared by Trafigura to be provided to NEL: Delivered prices for all quality coals into Pakistan. Also volume traded in the region (Pakistan and Indian Ocean area).
- **Quarterly meetings between the parties** (NEL and Trafigura) to include comprehensive presentations and covering: changes in forward pricing, Energy5 consumption, freight market, purchase strategies, supply and demand fundamentals, optimisation opportunities.

No. PPDB/ 191 /2016

PUNJAB POWER DEVELOPMENT BOARD
ENERGY DEPARTMENT
1st Floor, Central Design Building, Irrigation Secretariat,
Old Anarkali, Lahore
(Ph: 042-99213886 Fax: 042-99212796)

Date 08-02 /2016

M/s Nishat Energy Limited
1.B AZIZ AVENUE, CANAL BANK
GULBERG V, Lahore

Subject: **CHANGE OF CONSORTIUM MEMBERS FOR RAHIMYAR KHAN PROJECT (1 X 660 MW) BY NISHAT GROUP AND ASSOCIATES**

With reference to your office letter dated December 21, 2015 and letter January 19, 2015 regarding captioned subject. This is to apprise that your company request for change of consortium members for development of 1x660 MW Rahim Yar Khan Project has been taken up in the 35th PPDB Board meeting and after detailed deliberations the proposed change, as tabulated below (Requested / Revised Shareholding), has been approved;

Requested/ Revised Shareholding			
a)	Nishat Power Ltd	25%	Main Sponsor
b)	Nishat Mills Ltd	5%	Member
c)	TBEA Xinjiang Sunoasis Co Ltd	70%	Member

2. It is therefore advised that further project activities including the required regulatory approvals may please me taken up with the concerned forums.

Best Regards,

MANAGING DIRECTOR
Punjab Power Development Board

CC:

PS TO Additional Chief Secretary (Energy), Energy Department

A000916

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE, LAHORE

Company Registration Office Lahore
Securities and Exchange Commission of Pakistan
SECP

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No. 0088349

I hereby certify that **NISHAT ENERGY (PRIVATE) LIMITED** is this day incorporated under the Companies Ordinance, 1984 (XLVII of 1984) and that the company is **Limited by Shares**.

Given under my hand at **Lahore** this **Nineteenth** day of **May**, Two **Thousand** and **Fourteen**.

Fee Rs. 332,000/-

CERTIFIED TO BE TRUE COPY

JOINT REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.

(LIAQAT ALI DOLLA)
Additional Registrar of Companies

No.ARL/ 25225 DATED: 19/5/2014

NISHAT ENERGY LIMITED

020227

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN
LAHORE

Company Registration Office Lahore
Securities and Exchange Commission of Pakistan
SECP

CERTIFICATE ON CONVERSION OF PRIVATE COMPANY INTO PUBLIC COMPANY

[See regulation 6(c)]

[Under Section 41 (3) of the Companies Ordinance, 1984 (XLVII of 1984)]

Corporate Universal Identification No. 0088349

I hereby certify that pursuant to the provisions of Section 45 read with sub-section (3) of Section 41 of the Companies Ordinance, 1984 (XLVII of 1984), **NISHAT ENERGY (PRIVATE) LIMITED** has complied with the requirements precedent and incidental to the conversion of a Private Company into a Public Company. The said company stands converted into a Public Company with effect from **18-07-2014.**

Given under my hand at **Lahore** this 8th day of **August, 2014** (Two Thousand and Fourteen).

Fee Rs.500/-

(LIAQAT ALI DOLLA)
Additional Registrar of Companies

CERTIFIED TO BE TRUE COPY

JOINT REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.

No.ARL/ 3363 Dated: 11/8/2014

NISHAT ENERGY LIMITED

The Companies Ordinance, 1984

(Company Limited by Shares)

MEMORANDUM OF ASSOCIATION

OF

Nishat Energy Limited

I. NAME:

The name of the Company is "**Nishat Energy Limited**"

II. REGISTERED OFFICE:

The Registered Office of the Company will be situated in the Province of Punjab.

III. OBJECTS:

The objects for which the Company is established are:

1. To develop, design, construct, build, own, operate, maintain, and acquire coal fired power generation complexes and thermal, hydel, solar and wind energy projects in any part of Pakistan subject to permission from NEPRA / other regulatory authorities.

2. To carry on the business of electricity generation, transmission, sale and distribution of the same in any part of Pakistan subject to permission from NEPRA / other regulatory authorities and to do all and everything necessary, suitable, proper, incidental or conducive to the accomplishment of this object and to do every other act or thing incidental or appurtenant to or arising out of or connected with this object.

3. To establish and maintain housing, transportation, communication and utility lines and other requisite logistic facilities for the construction, operation and maintenance of power plant(s).

4. To obtain, subject to applicable laws, foreign equity and technical collaboration for the development, ownership, construction, operation and management of power plant(s).

5. To develop and/or transfer technology and to acquire or pass on technical know-how incidental or conducive to the attainment of its objects.

6. To enter into any arrangement or agreement to purchase power from any

NISHAT ENERGY LIMITED

other power seller, whether local, foreign, private or government.

7. To provide advisory, consultancy, operations and maintenance (O & M) services, whatsoever in nature, including but not limited to operational, technical services etc. to coal, thermal, hydro, solar or wind power projects, .

8. To set up undertakings for electricity/power generation plant(s) and to generate, accumulate, distribute, sell and supply electricity/power for all purposes and to sell electricity to WAPDA/NTDC/CPPA (or any other Government institution under agreement with Government of Pakistan or to any other consumer or power purchaser as permitted under the law.

9. For the purpose of achieving the above objects, the Company is authorized:-

   i) To borrow or raise money by means of local and/or foreign currency loans or other financing arrangements from banks, investors, directors, private equity and financial institutions including Non-Banking Finance Companies ("**NBFC**") and other specialized institutions, for the purpose of purchase, manufacture, market, supply, export and import of machinery, development of real estates, construction activities and improvements, repair and renovations of buildings, warehouses, factories, sheds, offices, hospitals, ports, parks, clubs, entertainment and recreation areas, industrial zones, bridges, flyovers and subways, roads, highways and motorways, high rise residential and commercial complexes, residential towns, building and for the purpose of working capital or for any other purpose.

   ii) To arrange money by issue of shares, participation term certificates, TFC, SUKUK, musharaka certificates, unit trust certificates, mutual fund certificates, debentures, debenture stock, bonds, perpetual or otherwise convertible into shares and to mortgage, assign or charge the whole or any part of the property, rights, revenue or assets of the Company, present or future, by special assignment or to transfer or convey the same absolutely or in trust as may seem expedient and to purchase, redeem or payoff any such securities.

   iii) To purchase/import raw materials, machinery, equipment and allied items required in connection thereto in any manner the company may think fit;

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

NISHAT ENERGY LIMITED

acquired, subject to any permission required under the law.

v) To open accounts with any Bank(s) or any other financial institution(s) and to draw, make, accept, endorse, execute, issue, negotiate and discount cheques, promissory notes, bills of exchange, bills of lading, warrants, deposit notes, debentures, letter of credit and other negotiable instruments and securities, and to withdraw money therefrom.

vi) To own, establish or have and maintain, offices, branches and agencies all over Pakistan for the purpose of the company but not to act as managing agency.

vii) To acquire by concession, grant, purchase, barter, licence either absolutely or conditionally and either solely or jointly with others any lands, buildings, machinery, plants, equipment, privileges, rights, licences, trademarks, patents, and other movable and immovable property of any description which the Company may deem necessary or which may seem to the Company capable of being turned to account, subject to any permission as required under the law.

viii) To invest surplus money of the Company in shares, stocks or securities of any company, debentures, debenture stocks or in any investments, short term and long term participation, term finance certificates or any other securities (including government securities) in such manner as may from time to time be decided as per law, without indulging NBFCs, banking business or an investment company or any other unlawful business.

ix) To guarantee the performance of contracts, agreements, obligations or discharge of any debt of the company subject to the provisions of Section 195 of the Companies Ordinance, 1984 ("Ordinance") in relation to the payment of any financial facility including but not limited to loans, advances, letters of credit or other obligations through creation of any or all types of mortgages, charges, pledges, hypothecations, on execution of the usual banking documents or instruments or otherwise encumbrance on any or all of the movable and immovable properties of the company, either present or future or both and issuance of any other securities or sureties by any mean in favour of banks, NBFCs or any financial institutions and to borrow money for purpose of the company on such terms and conditions as may be considered proper.

x) To purchase, hold and get redeemed, debentures, bonds of any company, financial institution or any Government institutions;

xi) To enter into arrangements with the 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 of them and to

NISHAT ENERGY LIMITED

obtain from any such government, authority, corporation, company or person any charters, contracts, rights, privileges and commission which the Company may think desirable and to carry on and comply with any such charters, contracts, decrees, rights, privileges and concessions.

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

xiii) To sell, transfer, mortgage, pledge, exchange or otherwise dispose of the whole or any part of the property or the undertaking of the Company, either together or in portions for such consideration as the Company may think fit and in particular, for shares, debenture-stock or securities of any Company purchasing the same or to any other legal entity or person, by other means, permissible under the law.

xiv) To conduct, encourage, promote, support, arrange and organize seminars, symposiums, exhibitions, fairs, conferences, lectures, demonstrations and other similar activities for promotion of sales or other business interests of any person, companies, firms, individuals, associations, local or government bodies, foreign governments, and international agencies, in Pakistan and in any part of the world for, and on behalf of, customers and for that purpose, to carry out market surveys, researches, training programs and other activities.

xv) To carry out joint venture agreements with technology suppliers, other companies or countries within the scope of the objects of the company.

xvi) To make known and give publicity to the business and products of the company by means the company may think fit.

xvii) To pay all costs, charges and expenses, if any, incidental to the promotion, formation, registration and establishment of the company;

xviii) To go in for, buy or otherwise acquire and use any patent design, copyright, license, concession, innovation, invention, trademarks, rights, privileges, real estates, plants, tools or machinery and the like in Pakistan or elsewhere, which may for the time being appear to be useful or valuable for adding to the efficiency or productivity of the Company's work or business, as permissible under the law.

xix) To establish, promote or assist in establishing or promoting and subscribe to or become a member of any other company, association or club whose

NISHAT ENERGY LIMITED

objects are conducive to the objects of this Company or the establishment or promotion of which may be beneficial to the Company, as permissible under the law.

xx) To give commission on the sale of the products and for that purpose to enter into any agreement or scheme of arrangement as the Company may deem fit and to get any employee of the Company insured against risk of accident in the course of their employment.

xxi) To establish and support or aid in the establishment and support of associations, institutions, funds and calculated to benefit the directors, employees and ex-employees of the Company, and any dependent thereof, and to grant pensions, gratuities, allowances, relief and payments in any manner calculated to benefit the persons described herein.

xxii) To apply for and obtain necessary consents, permissions and licenses from any government, state, local and other authorities for enabling the Company to carry on, initiate and further any of the Company's objects as and when required by law.

xxiii) To cause the Company to be registered or recognized in any foreign country and carry on its business activities in any part of the world.

xxiv) To amalgamate or merge with any other company having objects conducive to those of this Company.

xxv) To distribute any of the properties of the Company amongst the members in specie or in kind at the time of winding up of the company.

xxvi) To, subject to the approval of the competent authority, make, amend and modify Articles of Association and rules and regulations not inconsistent with this Memorandum of Association to provide for all matters for which provision is necessary or expedient for the purpose of giving effect to the provisions of this Memorandum of Association and the efficient conduct of its objects.

xxvii) To appoint agents, sub-agents, attorneys, consultants, and contractors or to act as agent, sub-agent, attorney, consultant, and contractor in connection with the objects of the Company but not to act as managing agents.

xxviii) To sell, improve, manage, develop, exchange, lease, mortgage, enfranchise, dispose of or otherwise deal with, all or any part of the property, assets or undertaking of the Company for such consideration as the Company may think fit and to distribute among the members in specie

NISHAT ENERGY LIMITED

any property of the Company, or any proceeds of sale or disposal of any property of the Company on winding up of the Company.

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

(xxx) To establish laboratories, research and development centers to perform such research and development as the Company may deem advisable or feasible, and to expend money on experimenting upon and testing and improving or securing any process, or processes, patent or protecting any invention or inventions which the Company may acquire or propose to acquire or deal with in furtherance of its objects.

(xxxi) To undertake and execute any trust or trusts which the Company may deem to be desirable, expedient or necessary and to act as trustees of any deeds constituting or securing any debentures, debenture stock, or other securities or obligations and to undertake and execute any other trust and also to undertake the office of executor, administrator and to keep for any company, Government, authority or body, any register relating to any stocks, funds, shares or securities, to undertake any duties in relation to the registration of transfers, the issue of certificates or otherwise.

(xxxii) To subscribe or contribute or otherwise to assist or to guarantee money to charitable, benevolent, religious, literary, scientific, technical, national, public or any other institutions or for any exhibition or purpose.

(xxxiii) To do all such other things as may be deemed incidental or conducive to the attainment and/or furtherance of any or all of the objects.

10. It is hereby declared that:

a. It is, hereby, undertaken that the Company shall not engage in banking business or Forex, illegal brokerage, or any business of investment company or NBFC or insurance or leasing or business of managing agency or in any unlawful business and that nothing contained in the object clauses shall be so construed to entitle it to engage in such business directly or indirectly and the Company shall not launch multi-level marketing (MLM), Pyramid and Ponzi schemes.

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

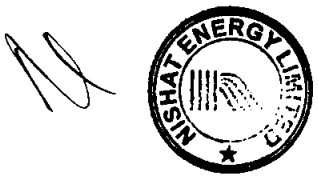
NISHAT ENERGY LIMITED

IV. LIABILITY

The liability of the members is limited.

V. CAPITAL

The authorized share capital of the Company is Rs. 100,000,000 (Rupees One Hundred Million Only) divided into 10,000,000 ordinary shares of Rs. 10/- (Rupees Ten) each with the power to increase or reduce the capital, to divide the shares for time being into several classes and subject to Section 90 of the Ordinance, to attach thereto such rights, privileges and conditions in such manner as many, for the time being provided by the Articles of Association of the Company. The Company further reserves to itself the right to increase authorized capital in accordance with the regulations for the time being in force, and in accordance with law.



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

Name and Surname in Full	Father's Surname in Full	Nationality with any former	Occupation	CNIC Number	Residential address in full	No. of Shares	Signature
Mushtaq Ahmad	Muhammad Ahmad	Pakistani	Service	35201-1301833-7	House # 32-B, Punjab Cooperative Housing Society, Lahore.	1	
Inayat Ullah Niazi	Chaudry Muhammad Deen	Pakistani	Service	35202-2732121-1	House # 102-AIII, Gulberg III, Lahore.	1	
Lalpir Power Limited Through nominee Khalid Qadeer Qureshi	Subscriber s o Mazhar Qadeer Qureshi	Pakistani Pakistani	Service	0032510 35202-8191856-7	Nishat House, 53-A, Lawrence Road, Lahore Punjab House # 128-III, Model Town, F Block, Lahore.	250,000	
Nishat Power Limited Through nominee Tanvir Khalid	Subscriber s o Khalid Saeed	Pakistani Pakistani	Service	0059637 35202-2881915-3	Nishat House, 53-A, Lawrence Road, Lahore Punjab House # 1240 I, Rang Mehal Lahore.	250,000	
Pakgen Power Limited Through nominee Khalid Mahmood Chohan	Subscriber s oAbdul Rasheed	Pakistani Pakistani	Service	0035039 33100-0985638-5	Nishat House, 53-A, Lawrence Road, Lahore Punjab Defense Road House #16-E Punjab Cooperative Housing Society, Lahore	249,999	
Nishat Mills Limited Through nominee Badar Ul Hassan	Subscriber s o Israr Ul Hassan	Pakistani Pakistani	Service	0001053 35202-[illegible]-9	Nishat House, 53-A, Lawrence Road, Lahore Punjab House # 74-C, New Muslim Town, Lahore, Lahore.	249,999	

Total Shares Taken: 1,000,000

Dated this14th May 2014

Witness to the above Signatures:

Signature: _____

Occupation: NIFT

Full Name: National Institutional Facilitation Technologies (Pvt) Ltd

Full Address: 5th Floor, AWT Plaza, I. I. Chundrigar Road, Karachi.

CERTIFIED TO BE TRUE COPY

JOINT REGISTRAR OF COMPANIES

COMPANY REGISTRATION OFFICE

NISHAT ENERGY LIMITED

THE COMPANIES ORDINANCE, 1984

(Company Limited by Shares)

ARTICLES OF ASSOCIATION

of

NISHAT ENERGY LIMITED

PRELIMINARY

1. TABLE "A" NOT TO APPLY

The regulations in Table 'A' in the First Schedule to the Companies Ordinance, 1984 shall not apply to the Company except so far as the same are reproduced herein.

2. DEFINITIONS

Unless the context or the subject matter otherwise requires, the terms used in these articles shall have the meanings set out below:

(a) **"Articles"** mean these Articles of Association as originally framed or as from time to time altered by special resolution.

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

(c) **"Book and paper"**, "book or paper" or "books of account" mean accounts, deeds, vouchers, writings and documents, maintained on paper or computer network, floppy, diskette, magnetic cartridge tape, CD-Rom or any other computer readable media;

(d) **"Chairman"** means the Chairman of the Board of Directors of the Company;

(e) **"Chief Executive"** means an individual who subject to the control and directions of the Directors, is entrusted with the whole, or substantially the whole, of the powers of the management of the affairs of the Company and includes a Director or any other person occupying the position of a Chief Executive, by whatever name called, and whether under a contract of service or otherwise."

(f) **"Company"** means **Nishat Energy Limited**

(g) **"Commission"** means the Securities and Exchange Commission of Pakistan established under Section 3 of the Securities and Exchange Commission of Pakistan Act, 1997.

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(h) **"Directors"** mean the directors of the Company including alternate directors appointed and elected from time pursuant to Companies Ordinance, 1984.

(i) **"Dividend"** includes cash dividend, dividend in species and bonus shares.

(j) **"In Person"** includes attendance and/or voting at a meeting, personally or by video or telephone-conference or other facility whereby all the participants of the meeting can hear and / or see each other unless expressly stated otherwise by the directors.

(k) **"Member"** means a person whose name is for the time being entered in the register of members by virtue of his holding by allotment or otherwise any share, scrip or other security which gives him a voting right in the company including an accountholder of central depository.

(l) **"Memorandum"** means the Memorandum of Association of the Company as originally framed or as from time to time altered in accordance with the Companies Ordinance, 1984.

(m) **"Month"** means calendar month according to the English calendar.

(n) **"Office"** means the registered office for the time being of the company.

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

(p) **"Ordinary Resolution"** means a resolution passed at a general meeting when the votes cast (whether on a show of hands or on poll, as the case may be) in favour of the resolution by members present in person or by proxy exceeds the votes if any cast against the resolution.

(q) **"Proxy"** includes an attorney duly constituted under a power of attorney.

(r) **"Record"** includes, in addition to a written or printed form, any disc, tape, sound-track, film or other device in which sounds and / or other data is embodied so as to be capable (with or without the aid of some other instrument or machine) of being reproduced there from in audible, legible or visual form.

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

(t) **"Registrar"** means a Registrar, defined in Section 2 (1) (31) of the Ordinance performing the duty of registration of companies under the Ordinance.

(u) **"Regulations"** mean the rules of governance of the Company made by the board from time to time.

(v) **"Seal"** means the common or official seal of the Company.

(w) **"Section"** means Section of the Ordinance.

(x) **"Share"** means share in the share capital of the company.

(y) **"Sign" and "Signature"** unless otherwise provided in these articles, include respectively lithography, printing facsimile, "advanced electronic signature" which

is capable of establishing the authenticity and integrity of an electronic document, as defined by Section 2(e) of the Electronic Transactions Ordinance, and names impressed with a rubber or other kind of stamp.

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

INTERPRETATION

3. In these articles, unless the context otherwise requires:

(a) the singular includes the plural and vice versa and words denoting any gender shall include all genders;

(b) references to any Act, Ordinance, Legislation, Rules or regulations or any provision of the same shall be a reference to that Act, Ordinance, Legislation, rules or regulations or provisions, as amended, re-promulgated or superseded from time to time;

(c) the terms "include" or "Including" shall mean include or including without limitation;

(d) expression referring to writing shall, unless the contrary intention appears, be construed as including references to printing, lithography, photography, and other modes of representing or reproducing words in a visible form, including but not limited to, electronic transmission such as facsimile, and electronic mail or any other electronic process, as prescribed by section 3 of the Electronic Transactions Ordinance.;

(e) words importing persons shall include bodies corporate; and

(f) words importing singular number include the plural number or vice versa;

(g) words and expressions contained in these articles shall bear the same meaning as in the Ordinance.

(h) The head notes are inserted for convenience and shall not affect the construction of these Articles.

REGISTERED OFFICE

4. The Registered office of the Company shall be at a place in the Province of Punjab as the directors shall from time to time determine.

PUBIC LIMITED COMPANY

5. The Company is a public limited company within the meanings of Section 2 (1) (30) of the Companies Ordinance, 1984.

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BUSINESS

6. DIRECTORS MAY UNDERTAKE ANY BUSINESS

The business of the Company shall include the several objects expressed in its Memorandum of Association or any of them. All branches 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 allowed 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

7. POWER TO ISSUE SHARES OF DIFFERENT CLASSES AND KINDS

Subject to Section 90 of the Ordinance and Rules framed there under and without prejudice to any special rights previously conferred on the holders of any existing shares or class of shares, any share in the Company may be issued with different rights, restrictions and privileges, including but not limited to the following as may be approved by the Company by special resolution:

(1) different voting rights; voting rights disproportionate to the paid-up value of share held; voting rights for specific purposes only; or no voting rights at all;

(2) different rights for entitlement of dividend, right shares or bonus shares or entitlement to receive the notices and to attend the general meetings;

(3) rights and privileges for indefinite period, for a limited specified period or for such periods as may from time to time be determined by the Company; and

(4) different manner and mode of redemption, including redemption in accordance with the provisions of these articles, including but not limited to, by way of conversion into shares with such rights and privileges as determined by the Company in the manner and mode provided in these articles.

8. POWER TO ISSUE REDEEMABLE CAPITAL

Subject to the provisions of the Ordinance and any rules in that regard made under the Ordinance, the Company may issue shares which are to be redeemed or any other redeemable security, on such terms and in such manner as may be provided in the Ordinance and rules.

9. POWER TO ISSUE SHARES AT PAR, PREMIUM OR DISCOUNT

Subject to provisions of the Ordinance and these Articles, the shares in the share capital of the Company may be issued and allotted as the directors shall determine and at such times and in such manner as the directors think fit, either at par or at a premium or subject to Section 84 of the Ordinance at a discount.

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10. ONLY FULLY PAID SHARES TO BE ISSUED

The shares in the capital of the Company shall always be issued as fully paid shares and no shares shall be issued as partly paid shares.

11. ISSUE OF SHARES FOR CONSIDERTAION OTHERWISE THAN IN CASH

The directors may allot and issue shares in the capital of the Company as payment or part payment for any asset or property sold or transferred, or for services rendered, to the Company in the ordinary course of its business, and shares so allotted shall be issued as and shall be deemed to be fully paid shares subject to the fulfilment of requirement of Section 73 of the Ordinance and applicable rules.

12. ALLOTMENT OF SHARES

The board shall, as regards any allotment of shares, duly comply with such provisions of the Ordinance and rules as may be applicable.

13. PURCHASE OF COMPANY'S SHARES

Except as permitted by the Ordinance or any other rules in that regard made under the Ordinance, no part of the funds of the Company shall be employed in the purchase of its own shares or in giving, whether directly or indirectly and whether by means of a loan, guarantee, security or otherwise, any financial assistance for the purpose of or in connection with a purchase made or to be made by any person of any shares in the Company.

14. TRUST NOT TO BE RECOGNIZED

Save as herein otherwise provided or as permitted by law, the Company shall be entitled to treat the registered holder of any share as the absolute owner thereof and accordingly shall not, except as ordered by a court of competent jurisdiction or as required by statute, be bound by or be compelled in any way to recognize (even when having notice thereof) any *benami*, equitable, contingent, future, partial or other claim or right to or interest in such share on the part of any other person.

15. WHO MAY BE REGISSTERED AS MEMBER

Shares may be registered in the name of individuals, any limited company or other corporate body. Not more than four (4) persons shall be registered as joint-holders of any share.

16. JOINT MEMBERS

If any share or shares stand in the name of two or more persons, the person first 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 of such shares.

17. COMMISSION FOR PLACING SHARES, ETC.

The Company may at any time pay a commission to any person for subscribing or agreeing to subscribe (whether absolutely or conditionally) for any shares or debentures or redeemable capital of the Company or producing or agreeing to procure subscriptions (whether absolute or conditional) for any shares or debentures or redeemable capital of the Company. In case any commission shall be paid the Company shall comply with the provisions of Section 82 of the

Ordinance. The Company may also pay expenses on any issue of shares or debentures or redeemable capital.

CERTIFICATES

18. SHARE CERTIFICATES TO BE ISSUED UNDER SIGNATURES AND SEAL

The Certificates of title to shares and duplicate thereof shall be issued under the seal of the Company and signed by two of the directors or by one such director and the secretary provided that such signatures may if necessary be printed lithographed or stamped subject to the approval of the directors.

19. TIME FOR ISSUE OF SHARES CERTIFICATES

The Company shall within ninety days after the allotment of any shares, debentures or debenture stock 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.

20. ISSUE OF DUPLICATE SHARE CERTIFICATES

If a certificate of shares, debenture or debenture stock is proved to the satisfaction of the Company to have been lost 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 as may be determined by the Board of Directors) 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.

21. ISSUE OF CERTIFICATES TO JOINT HOLDERS

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

TRANSFER AND TRANSMISSION

22. DIRECTORS MAY DECLINE TO REGISTER TRANFER OF SHARES

The directors shall not refuse to register the transfer of fully paid shares unless the Instrument of Transfer is defective or invalid or is not duly stamped or accompanied by the certificate of the share(s) to which it relates or otherwise there are specific restrictions on the transferability of the shares imposed by the Commission or any Court. The directors may also decline to register the instrument of transfer if it is not accompanied by a certified copy of the computerized national identity card of the transferee. If the directors refuse to register a transfer

of any shares they shall, within thirty (30) days from the date on which the Instrument of Transfer was lodged with the company, send to the transferee and the transferor the notice of refusal indicating the defect or invalidity; provided that the transferee shall be entitled, after removal of such defect or invalidity, to re-lodge the Instrument of Transfer with the Company.

23. FORM OF TRANSFER

The Instrument of Transfer of any share shall be in writing in the usual common form, or in the following form, or as near thereto as circumstances will admit:

"I/We ..... of ..... son/daughter/wife of being a national(s) of in consideration of the sum of Rupees ..... only (Rs. .....) paid to me/us by ---------- of ..... son/daughter/wife of being a national(s) of (hereinafter called the 'said transferee(s)') do hereby transfer to the said transferee(s) share(s) numbered standing in my/our name(s) in the books of **NISHAT ENERGY LIMITED**, to hold unto the said transferee(s) his/her/their executors, administrators and as signs, subject to the several conditions on which I/we hold the same at the time of execution hereof, and I/we the said transferee(s) do hereby agree to take the said share(s) subject to the conditions aforesaid.

As witness our hands the ..... day of .....thousand and .....".

Signed by the said transferor in the presence of	Transferor's signature ..... Transferor's occupation ....
Witness ..... Occupation ..... Address ..... CNIC #..... Signed by the said transferee in the presence of	Witness ..... Occupation ..... Address ..... CNIC # ..... Transferee's signature ..... Transferee's occupation .....
Witness ..... Occupation ..... Address ..... CNIC #	Witness ..... Occupation ..... Address ..... CNIC # .....

24. RESTRICTION ON TRANSFER OF SHARES

No transfer shall be made to an individual if the instrument of transfer is not accompanied by a certified copy of the computerized national identity card of the transferee.

25. INSTRUMENT OF TRANSFERS TO BE PRESERVED

All registered instruments of transfers shall be retained by the Company for a period of not less than 10 years, but any Instrument of Transfer which the directors may decline to register shall be returned to the person depositing the same.

26. TRANSFEROR TO REMAIN HOLDER OF SHARE(S)

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(s) until the name of the transferee is entered in the register in respect thereof.

27. CLOSURE OF REGISTER(S)

On giving seven days previous notice by advertisement in some newspaper circulating in the areas specified in Section 151 of the Ordinance or as per requirement of the stock exchange(s) where the shares of the Company are listed, the transfer books and register(s) 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 days (30) at a time.

28. NOMINATION

Any Member may make and deposit with the Company a nomination in writing specifying one or more eligible person who or each of whom, in the event of 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 of the Member nominating him and 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.

29. PERSONS ENTITLED ON DEATH OF MEMBER

In the case of the death of a Member who was a joint holder of shares, the survivor or survivors shall be the only person 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 nomine or nominees of the deceased where a nomination is effective and legal personal representatives of the deceased where no such nomination has been made and deposited with the Company, shall be the only persons recognised by the Company as having any title to his interest in the shares.

30. PERSON ENTITLED ON DEATH OR INSOLVENCY MAY ELECT TO BE REGISTERED OR TO TRANSFER

Any person becoming entitled to a share in consequence of the death or insolvency of a Member may upon such evidence being produce 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 shares as the deceased or insolvent person could have made, but the Directors shall, in either case, have the same right to decline or suspend registration as they would have had in the case of a transfer of the shares by that Member before his death or insolvency as the case may be.

31. EFFECT OF ELECTION

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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 a 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 notice or transfer signed by that Member.

32. RIGHT OF PERSON ENTITLED BY TRANSMISSION

A person becoming entitled to a share by reason of the death or insolvency of the holder shall be entitled to the same dividends and other advantages to which he would be entitled if he 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

CAPITAL

33. INCREASE, CONSOLIDATION, SUB-DIVISION AND CANCELLATION

The Company may by ordinary resolution and subject to compliance with the requirements of Section 92 of the Ordinance

(a) increase the authorized share capital by such sum, to be divided into shares of such amount, as the resolution shall prescribe.

(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 shares which, at the date of the passing of the resolution, have not been taken or agreed to be taken by any person.

34. FURTHER ISSUE OF CAPITAL

The directors may from time to time increase the issued share capital by such sum as they think fit. Except as otherwise permitted by Section 86 of the Ordinance, and subject to any special rights or privileges for the time being attached to any issued shares, all shares intended to be issued by the directors shall, before issue, be offered to the members strictly in 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 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.

35. NEW SHARES TO RANK WITH EXISTING CAPITAL

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 and transmission and otherwise.

36. REDUCTION OF CAPITAL

The Company may, by special resolution, reduce its share capital in any manner, with and subject to, any incident authorized and consent required by law.

37. SHARE PREMIUM ACCOUNT

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 to 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.

VARIATION OF SHAREHOLDERS RIGHTS

38. MODIFICATION OF RIGHTS OF DIFFERENT CLASES OF SHARES

Whenever the capital is divided into different classes of shares, all or any of the rights and privileges attached to each class may, subject to the provisions of section 108 of the Ordinance, be modified, commuted, affected, abrogated or dealt with by agreement between the Company and any person purporting to contract on behalf of that class provided such agreement is (a) ratified in writing by the holders of at least three-fourths in nominal value of the issued shares of the class or (b) confirmed by a special resolution passed at an extraordinary general meeting of the holders of shares of that class and all the provisions hereinafter contained as to general meetings, shall, mutatis mutandis, apply to every such meeting.

MEETINGS

39. ANNUAL GENERAL MEETING

Except as may be allowed under Section 158(1) of the Ordinance, the Company shall hold a general meeting once at least in every calendar year within a period of four months following the close of its financial year at such time as may be determined by the directors, provided that no greater interval than fifteen months shall be allowed to elapse between two such general meetings. The Company may, for any special reason and with permission of the Commission, extend the time within which any annual general meeting, not being the first such meeting, shall be held.

40. WHERE TO HOLD ANNAUL GENERAL MEETING

The Company shall hold its annual general meeting in the town in which the registered office is situate; provided that, it may, for any special reason and with permission of the Commission, hold the said meeting at any other place. Save as aforesaid, the Company may hold its general meeting at two (2) or more venues using any technology that gives the members as a whole a reasonable opportunity to participate in the meetings.

41. EXTRORDINARY GENERAL MEETINGS

All general meetings of the Company, other than annual general meeting, shall be called extraordinary general meetings.

42. CONVENING OF EXTRORDINARY GENERAL MEETINGS

The directors may, whenever they think fit, and they shall, on the requisition of the holders of not less than one-tenth of the issued capital of the Company, forthwith proceed to convene an extraordinary general meeting of the Company. If at any time there are not within Pakistan sufficient directors capable of acting to form a quorum, any director of the Company may call an extraordinary general meeting in the same manner as nearly as possible as that in which meetings may be called by the directors, and in the case of such requisition the following provisions shall have effect:

(i) The requisition must state the objects of the meeting and must be signed by the requisitionists and deposited at the office and may consist of several documents in like form each signed by one or more requisitionists.

(ii) If the directors do not proceed within twenty-one days from the date of the requisition being so deposited to cause a meeting to be called, the requisitionists or a majority of them in value may themselves convene the meeting, but any meeting so convened shall not be held after three months from the date of the deposit.

(iii) Any meeting convened under this article by the requisitionists shall be convened in the same manner as nearly as possible as that in which meetings are to be convened by the directors but shall be held at the office.

(iv) A requisition by joint-holders of shares must be signed by all such holders.

43. NOTICE OF MEETINGS

(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 above as the Registrar 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, where the notice convening the meeting provides for the election of directors, 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

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interest (whether 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 at 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 at which an election of directors is to take place 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 or join in demanding a poll 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.

(8) The Company shall comply with the provisions of section 160(1) and section 50 of the Ordinance with regard to giving notices of general meetings.

44. ACCIDENTAL OMISSION TO GIVE NOTICE

The accidental omission to give any such notice to or the non-receipt of notice by, any of the members shall not invalidate the proceedings at any such meeting.

PROCEEDINGS AT GENERAL MEETINGS

45. QUORUM

No business shall be transacted at any general meeting unless a quorum of members is present at the time when the meeting proceeds to business.jm Not less than three (3) members present in person representing at least twenty five percent (25%) of the total voting power either of their own account or as proxies shall be a quorum.

46. CHAIRMAN OF GENERAL MEETINGS

The Chairman 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 in person within fifteen minutes after the time appointed for the holding of the meeting or is unwilling to act, the Chief Executive shall preside as Chairman of the meeting, or if the Chief Executive is absent or unwilling to act, any one of the directors present may be elected to be Chairman of the meeting, or if no director is present, or if all the directors present decline to take the chair, the members present in person shall choose one of their member to be Chairman of the meeting.

47. EFFECT OF QUORUM BEING NOT PRESENT

If within half-an-hour from the time appointed for the meeting, a quorum is not present, the meeting if convened upon such requisition as aforesaid shall be dissolved, but 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 such adjourned meeting a quorum is not present within half an hour from the time appointed for it, the members present being not less than Two shall be a quorum.

48. ADJOURNMENT OF MEETINGS

The Chairman may adjourn the meeting from time to time and from place to place, but no business shall be transacted at any adjourned meeting other than the business left unfinished at the meeting from which the adjournment took place. When a meeting is adjourned for more than seven days, notice of the adjourned meeting shall be given as in the case of an original meeting. Save as aforesaid it shall not be necessary to give any notice of an adjournment or of the business to be transacted at an adjourned meeting.

49. CASTING VOTE OF CHAIRMAN

In the case of an equality of votes the Chairman shall, both on a show of hands and at the poll have a casting vote in addition to the vote or votes to which he may be entitled as a member.

50. RESOLUTION TO BE VOTED BY SHOW OF HANDS OR BY POLL

(1) At any general meeting a resolution put to the vote of the meeting shall be decided on a show of hands, unless a poll is (before or on the declaration of the result of the show of hands) demanded in accordance with paragraph (2) of this article, and unless a poll is so demanded, a declaration by the Chairman of the meeting that a resolution has, on a show of hands, been carried, or carried unanimously, or by a particular majority, or lost, and an entry to that effect in the book or electronic record of the proceeding of the Company shall be conclusive evidence of the fact, without proof of the number or proportion of the votes recorded in favour of, or against, the resolution.

(2) A Poll may be ordered to be taken by the Chairman of the meeting of his own motion and shall be ordered to be taken by him on a demand made by the following persons;

(a) Five members having the right to vote on the resolution and present in person or by proxy; or

(b) Any member or members present in person or by proxy having not less than one-tenth of the total voting power in respect of the resolution.

51. MANNER OF TAKING POLL

If a poll is demanded, as aforesaid, it shall be taken (subject to Section 168 of the Ordinance) in such manner and at such time and place as the Chairman of the meeting directs, and either at once or after an interval or adjournment of not more than fourteen days from the day on which the poll is demanded, and the result of the poll shall be deemed to be the resolution of the meeting at which the poll was held. The demand for a poll may be withdrawn at any time by the person or persons who made the demand. In case of any dispute as to the admission or rejection of a vote, the Chairman of the meeting shall determine the same, and such determination made in good faith shall be final and conclusive. On a Poll the chairman or his nominee and representative of the members demanding the poll shall scrutinize the votes given on the Poll and the result shall be announced by the Chairman subject to provision of the Ordinance and these articles, the Chairman shall have power to regulate the manner in which a Poll shall be taken.

52. TIME FOR TAKING POLL

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Any poll duly demanded on the election of a Chairman of a meeting or on a question of adjournment shall be taken forthwith at the meeting and without adjournment. A poll demanded on any other question shall be taken at such time, not being more than 14 days from the day on which the poll is demanded as the Chairman of the meeting directs.

53. MEETING TO CONTINUE

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

VOTES OF MEMBERS

54. RIGHT TO VOTE

Subject to Section 160 and any rights or restrictions for the time being attached to any class or classes of shares, every member present in person (where all the participants of a general meeting can see each other) shall have votes proportionate to the paid up value of the shares or other securities carrying voting rights held by him according to the entitlement of the class of such shares or securities, as the case may be provided that the provisions of Section 178 shall apply in the case of the election of directors.

55. VOTING BY SHOW OF HANDS, POLL AND FOR ELECTION /REMOVAL OF DIRECTORS

On a show of hands, every member present in person shall have one vote and upon 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 Section 178 shall apply.

56. VOTING ON POLL

On a poll a member entitled to more than one vote need not, if he votes, use all his votes or cast all the votes he uses in the same way.

57. VOTING BY CORPORATIONS AND COMAPNIES

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 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 such representative.

58. RIGHT TO VOTE

Any person entitled under article 34 to any shares may vote at any general meeting in respect thereof in the same manner as if he were the registered holder of such shares, provided that forty-eight hours at least before the time of holding the meeting or adjourned meeting, as the case may be, at which he proposes to vote he shall satisfy the directors of his right to such shares, or the directors shall have previously admitted his right to vote at such meeting in respect thereof. If any member be a lunatic, idiot or non compos mentis, he may vote, whether by a

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show of hands or at a poll, by his committee, curator bonis or other legal curator and such last mentioned persons may give their votes by proxy.

59. **VOTING BY JOINT HOLDERS**

Where there are jointly registered holders of any share, any one of such persons may vote at any meeting either in person or by proxy in respect of such share as if he were solely entitled thereto; and if more than one of such joint-holders be present at any meeting, either in person or by proxy, that one of the said persons so present whose name stands first in the register in respect of such share shall alone be entitled to vote in respect thereof. Several executors or administrators of a deceased member in whose name any share stands shall for the purposes of this article be deemed joint holders thereof.

60. **VOTE MAY BE GIVEN IN PERSON OR BY PROXY ON POLL**

On a poll votes may be given either in person (including without limitation an authorized representative of a company or corporation) or by proxy.

61. **OBJECTIONS ON VOTING**

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.

62. **PROXY TO BE IN WRITING**

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 such appointer is a corporation under its common seal or signed by an officer or an attorney duly authorised by. No person shall be appointed a proxy who is not a member of the Company.

63. **INSTRUMENT APPOINTING PROXIES TO BE DEPOSITED**

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

64. **REVOCATION OF PROXY**

A vote given in accordance with the terms of an instrument appointing a proxy shall be valid notwithstanding the previous death or insanity of the principal or revocation of the instrument or transfer of the share in respect of which the vote is given, provided no intimation in writing of the death, insanity, revocation or transfer of the share shall have been received at the office before the meeting. Provided nevertheless that the Chairman of any meeting shall be entitled to require such evidence as he may in his discretion think fit of the due execution of an instrument of proxy and that the same has not been revoked.

65. **FORM OF PROXY**

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Every instrument appointing a proxy shall. as nearly as circumstances will admit, be in the following form or in the form set out in Regulation 39 of Table A of the First Schedule to the Ordinance and shall be retained by the Company:

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I, _____ of _____, being a member of **NISHAT ENERGY LIMITED**, hereby appoint _____ of _____ (or failing him _____ of _____ or failing him _ of _____) as my proxy in my absence to attend and 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.

As witness my hand this _____ day of _____.

Signed by the said
In the presence of

DIRECTORS

66. MINIMUM NUMBER OF ELECTED DIRECTORS

The Company shall have not less than three directors to be elected in a general meeting in the manner provided in Section 178 of the Companies Ordinance.

67. DIRECTORS TO FIX NUMBER OF ELECTED DIRECTORS

Subject to Article 72 and the provisions of the Ordinance, the directors shall fix the number of elected directors 35 days before the convening of the general meeting at which the directors are to be elected. The number of elected directors so fixed by the directors shall not be changed except with the prior approval of the Company in general meeting.

ALTERNATE DIRECTORS

68. APPOINTMENT OF ALTERNATE DIRECTORS

When any director intends to be, or is living outside Pakistan or otherwise he may with the approval of the directors appoint any person to be his alternate director, and such alternate director during the absence of the appointer from Pakistan, shall be entitled to receive notice of and to attend and vote at meeting of directors and shall be subject to and entitled to the provisions contained in these articles with reference to directors and may exercise and perform all such powers, directions and duties as his appointer could have exercised or performed including the power of appointing another alternate director. Such appointment shall be recorded in the directors minute book. A director may at any time by notice in writing to the Company remove an alternate director appointed by him. The alternate director shall cease to be such provided that if any director retires but is re-elected at the meeting at which such retirement took effect any appointment made by him pursuant to this article which was in force immediately prior to this retirement and re-election and which has not otherwise ceased to be effectively shall continue to operate after his re-election as if he had not so retired. All appointments and removals of alternate directors shall be effected by writing under the hand of

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the director making or revoking such appointment and left at the office. For the purpose of assessing a quorum, an alternate director shall be deemed to be a director. An alternate director may resign as such upon giving thirty (30) days prior notice to the board to this effect.

69. RIGHT OF ALTERNATE DIRECTORS TO RECEIVE NOTICES ETC

An alternate director shall, in the absence of a direction to the contrary in the instrument appointing him, be entitled to notice of general meetings of the Company on behalf of his appointer.

CHIEF EXECUTIVE

70. APPOINTMENT OF CHIEF EXECUTIVE

The Company shall have an office of Chief Executive which shall be filled from time to time by the directors who may appoint a director or (subject to Section 201 of the Ordinance) any other person to be the Chief Executive of the Company for a period not exceeding three years and on such terms 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. If the Chief Executive 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 shall thereby be increased and he shall be entitled to all the rights and privileges and shall be subject to all liabilities of the office of director. Upon the expiry of his period of office, a Chief Executive shall be eligible for re-appointment. The Chief Executive may be removed from office in accordance with the provisions of Section 202 of the Ordinance notwithstanding anything contained in these articles or in any agreement between the Company and the Chief Executive.

71. REMUNERATION OF CHIEF EXECUTIVE

A Chief Executive of the Company shall receive such remuneration as the directors may determine.

72. POWERS OF CHIEF EXECUTIVE

The directors may from time to time entrust to and confer upon the Chief Executive for the time being such of the powers exercisable under these articles by the directors as they may think fit, and may confer such powers for such time, and to be exercised for such objects and purposes, and upon such terms and conditions, and with such restrictions as they think expedient; and they may confer such powers, either collaterally with, or to the exclusion of, and in substitution for all or any of the powers of the directors in that behalf; and may from time to time revoke, withdraw, alter or vary all or any of such powers. Directors may also appoint the Chief Executive as general attorney of the company and execute a power of attorney in his favour.

REMUNERATION OF DIRECTORS

73. REMUNERATION FOR EXTRA SERVICES

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 from time to time. The remuneration of a director for attending meetings of the board shall from time to time be determined by the directors.

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74. **EXPENSES OF MEETINGS**

Each director of the Company may, in addition to any remuneration receivable by him, be reimbursed his reasonable travelling and hotel expenses incurred in attending meetings of the directors.

75. **DIRECTOR TO BE MEMBER**

Save as provided in Section 187 (1) (h) of the Ordinance, no person shall be appointed as a director of the company unless he is a member of the company.

76. **DIRECTORS MAY ACT NOTWITHSTANDING ANY VACANCY**

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.

77. **VACATION OF OFFICE OF DIRECTOR**

The office of a director shall ipso facto be vacated if:

(a) he ceased to hold the share qualification, if any, necessary for his appointment; or

(b) he is found to be a unsound mind by a court of competent jurisdiction; or

(c) he is adjudged an solvent; or has applied to be adjudicated as an insolvent and his application is pending or is an un discharged insolvent; or

(d) he has been convicted by a court of law for an offence involving moral turpitude;

(e) 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 legal or technical adviser or a banker in contravention of the provisions of section 188 (i) (e) of the Ordinance;

(f) 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 absence from the board of directors; or

(g) 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 Company in contravention of section 195 of the Ordinance; or

(i) by notice in writing to the Company he resigns his office; or

(j) he is removed from office by resolution of the Company in general meeting in accordance with section 181 of the Ordinance;

(k) his appointment is withdrawn by the Authority nominating him as director;

78. **INTEREST OF DIRECTORS**

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Subject to authorisation being given by the directors in accordance with section 196(2)(g) of the Ordinance, a director shall not be 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 realised by any such contract or arrangement by reason of such director holding that office or of the fiduciary relationship so established. A director who, or whose spouse or minor child, is in any way, whether directly or indirectly, concerned or interested in any contract or arrangement or proposed contract or arrangement with the Company shall disclose the nature of such concern or interest in accordance with section 214 of the Ordinance that is to say:

(a) in the case of a contract or arrangement to be entered into, at the meeting of the directors at which the question of entering into the contract or arrangement is first taken into consideration or, if the director was not, on the date of that meeting, concerned or interested in the contract or arrangement, at the first meeting of the directors held after he becomes so concerned or interested; and

(b) in the case of any other contract or arrangement, at the first meeting of the directors held after the director becomes concerned or interested in the contract or arrangement.

79. GENERAL NOTICE OF INTEREST BY DIRECTOR

A general notice that any director of the Company is a director or a member of any other named company or is a member of any named firm and is to be regarded as interested in any subsequent transaction with such company or firm shall, as regards any such transaction, be sufficient disclosure under this article. Provided, however, that any such general notice shall expire at the end of the financial year in which it was given and may be renewed for a further period of one financial year at a time by giving fresh notice in the last month of the financial year in which it would otherwise expire.

80. DISCLOSURE TO MEMBERS OF DIRECTORS INTEREST IN APPOINTMENT OF CHIEF EXECUTIVE, DIRCTORS ETC

Whereby 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 of any director of the Company is, or after the contract or resolution becomes, in any way, whether directly or indirectly, concerned or interested, or whereby any contract or resolution of the directors, an appointment or a variation in the terms of appointment is made (whether effective immediately or in the future) of a Chief Executive, 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 there from and otherwise.

81. REGISTER OF CONTRACTS AND APPOINTMENTS

In accordance with section 219, the Company shall maintain at its office a register or electronic record, in which shall be entered separately particulars of all contracts, arrangements or appointments in which the directors are interested. Such register or electronic record shall be open to inspection to the members during business hours, subject to any reasonable restriction that may be imposed by the Company in general meeting.

82. DIRECTOR MAY BECOME DIRECTOR OF ANOTHER COMAPNY

A director of the Company may be or become a director of any other 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.

ELECTION OF DIRECTORS

83. PROCEDURE FOR ELECTION OF DIRECTORS

The number of directors determined by the directors under Section 178 shall be elected to office by the members in general meeting in the following manner, namely:

(a) a member present in person or by proxy shall have such number of votes as is equal to the product of voting shares held by him and the number of directors to be elected

(b) a member may give all his votes to a single candidate or divide them between more than one of the candidates in such manner as he 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 the total number of directors to be elected has been so elected.

If the number of persons who offer themselves to be elected as directors is not more than the number of vacancies for which elections are being held, such persons being otherwise eligible shall be deemed to have been elected as directors from the date on which the election was proposed to be effective.

84. TENURE FOR OFFICE OF DIRECTORS

A director elected under Section 178 shall hold office for a period of three years unless he earlier resigns or becomes disqualified from being a director, or otherwise ceases to hold office.

85. ELEGIBILITY OF RETIRING DIRECTOR

A retiring director of the Company shall be eligible for re-election.

86. REMOVAL OF DIRECTORS

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.

87. CASUAL VACANCY

Any casual vacancy occurring among the directors may be filled up by the directors not later than ninety (90) days thereof and the person so appointed shall hold office for the remaining period of the director in whose place he is appointed provided that the directors may not fill a casual vacancy by appointing any person who has been removed from the office of a director of the Company.

88. NOTICE OF INTENTION TO BE FILED

No person including a retiring director of the Company shall be eligible for election to the office of director of the Company at any general meeting unless he has, not less than fourteen days before the date of the meeting, left at the office, a notice in writing, duly signed, signifying his candidature for the office.

89. REGISTER OF DIRECTORS AND OFFICERS

The Company shall keep at the office a register of the directors and officers, containing the particulars required by Section 205 of the Ordinance and the Company shall otherwise comply with the provisions of that Section as regards furnishing returns to the Registrar and giving inspection of the register.

PROCEEDINGS OF DIRECTORS

90. DECISION BY MAJORITY AND CASTING VOTE

The directors shall meet together for the despatch of business, adjourn and otherwise regulate their meetings and proceedings as they may think fit In accordance with the Ordinance. Questions arising at any meeting shall be decided by a majority of votes and in case of an equality of votes the Chairman shall have a second or casting vote.

91. QUORUM FOR DIRECTORS MEETINGS

The quorum necessary for the transaction of the business of the directors shall not be less two directors. An alternate director whose appointment is effective shall be counted in a quorum. In case directors qualified to vote are less than the minimum quorum, the matter should be decided in general meeting.

92. CONVENING OF DIRECTORS MEETINGS

A director may, and the secretary on the requisition of a director shall, at any time summon a meeting of the directors. Such meetings may be held using any technology consented to by all the directors, including but not limited to telephone and video conferencing. The consent may be a standing one, withdrawable by a director only within a reasonable period of time before the meeting. It shall not be necessary to give notice of a meeting of directors to any director for the time being absent from Pakistan.

93 CHAIRMAN BOARD OF DIRECTORS

The board of directors of the Company shall from time to time elect one of the directors as Chairman of the board of directors of the Company and determine the period for which he is to hold office, his role, remuneration and other terms and conditions, if any. The Chairman shall preside over all meetings of the board of directors, but if at any meeting neither the Chairman is present in person within half an hour of the time appointed for holding the same, the directors present in person may choose one of their number to be Chairman of the meeting.

94. EXCERCISE OF POWERS BY THE DIRECTORS

A meeting of the directors at which a quorum is present shall be competent to exercise all or

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any of the authorities, powers and discretion by or under these articles for the time being vested in or exercisable by the directors generally.

95. DELEGATION OF POWERS

The directors may from time to time delegate of their powers to committees consisting of such members or members of their body as they think fit, and may from time to time revoke such delegation. Any committee so formed shall, in the exercise of the powers so delegated, conform to any regulations that may from time to time be imposed upon it by the directors.

96. MEETING OF COMMITTES

The meeting and proceedings of any such committee consisting of two or more members shall be governed by the provisions herein contained for regulating the meetings and proceedings of the directors, so far as the same are applicable thereto.

97. WHEN ACTS OF DIRECTORS OR COMMITTEE VALID

All acts done by any meeting of the directors or by a committee of the directors or by any person acting as a director of the Company shall, notwithstanding that is shall afterwards be discovered that there was some defect in the appointment or continuance in office of any such directors or person acting as aforesaid, or that they or any of them were disqualified or had vacated office, or were not entitled to vote, be as valid as if every such person had been duly appointed or had duly continued in office and was qualified and had continued to be a director and had been entitled to be a director. Provided that nothing in this article shall be deemed to give validity to acts done by any such director after the appointment of such director has been shown to be invalid.

98. RESOLUTION BY CIRCULATION

A resolution circulated through fax or email or any form of electronic transmission to all the directors for the time being entitled to receive notice of a meeting of the directors, passed without any meeting of the directors or of a committee of directors and signed or affirmed through fax or email or any form of electronic transmission, by a majority of all directors in writing under the hands of all directors (or in their absence their alternate directors) for the time being in Pakistan, being not less than the quorum required for meetings of the directors, or as the case may be of the members of the committee, shall be valid and effectual as if it had been passed at the meeting of the directors, or as the case may be of such committee, duly called or constituted. The resolution in writing of the Company may consist of several copies of a document signed by one or more director(s) and takes effect at the date and time on which the last director, necessary for the resolution to be passed, signs a copy of the resolution; or a record of several signed electronic messages each indicating the identity of the sender, the text of the resolution and the sender's agreement or disagreement to the resolution, as the case may be and such a resolution takes effect on the date on which the last director's message, necessary for the resolution to be passed, is received.

99. REMUNERATION FOR EXTRA SERVICES

If any director of the Company, being willing, shall be called upon to perform extra services or to make any special exertions in going or residing away from his place of business for the time being for any of the purposes of the Company or in giving special attention to the business of the Company as a member of a committee of the directors, the Company may remunerate such director so doing either by a fixed sum or by a percentage of profits or otherwise as may be determined by the directors.

MINUTES

100. MINUTES OF MEETINGS

The directors shall cause minutes to be duly entered in books provided for the purpose of or as an electronic record, of:

(a) all appointments of officers;

(b) the names of the directors present in person at each meeting of the directors and of any committee of the directors;

(c) all decisions, directions and orders made by the directors and committees of the directors;

(d) all resolutions and proceedings of general meeting and of meetings of the directors and of the committees of the directors;

and any such minutes of any meeting of the directors or of any such committee or of the Company, if purporting to be signed by the Chairman of such meeting or by the Chairman of the next succeeding meeting, shall be prima facie evidence of the matter stated in such minutes.

POWER AND DUTIES OF DIRECTORS

101. DIRECTORS TO COMPLY WITH THE LAW

The directors shall duly comply with the provisions of the Ordinance, Insurance Ordinance, the Code as modified or amended or substituted from time to time and rules, regulations, guidelines framed there under.

102. DIRECTORS TO CONTROL AND MANAGE COMPANY AFFAIRS

The control of the Company shall be vested in the directors, and the business of the Company shall be managed by the directors who may exercise all such powers of the Company as are not by the Ordinance or by these articles or by a special resolution expressly directed or required to be exercised or done by the Company in general meeting.

103. POWER OF THE DIRECTORS

Without prejudice to the general powers conferred by Ordinance and to any other powers or authorities conferred by these articles on the directors, it is hereby expressly declared that the directors shall subject to the exercise in accordance with the Ordinance have the following powers, that is to say, power:

(1) To purchase or otherwise acquire for the Company any property, rights or privileges which the Company is authorised to acquire at such price and generally on such terms and conditions as they think fit, and to sell, let, exchange or otherwise dispose of absolutely or conditionally any part of the property, privileges and undertaking of the Company upon such terms and conditions, and for such consideration, as they may think fit.

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(2) At their discretion to pay for any property, rights, privileges acquired by or services rendered to the Company either wholly or partially in cash or in shares (subject to the provisions of section 86 of the Ordinance) bonds, debentures or other securities of the Company. Any such bonds, debentures or other securities may be either specifically charged upon all or any part of the property of the Company or not so charged.

(3) To open account with any bank or financial institution and deposit into and withdraw money from such accounts from time to time.

(4) To make, draw, endorse, sign, accept, negotiate and give all cheques, bills of lading, drafts, orders, bills of exchange, and other promissory notes and negotiable instruments required in the business of the Company.

(5) To secure the fulfilment of any contracts, agreements or engagements entered into by the Company by mortgage or charge of all or any of the property of the Company for the time being or in such other manner as they may think fit.

(6) Subject to the provisions of the Ordinance, to appoint and at their discretion remove or suspend such agents (other than Managing Agents), managers, secretaries, officers, employees for permanent, temporary or special services as they may from time to time think fit, and to determine their powers and duties and fix their salaries or emoluments and to require security in such instances and to such amount as they think fit.

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

(8) To institute, conduct, defend, compound or abandon any legal proceedings by or against the Company or its officers or otherwise concerning the affairs of the Company and also to compound and allow time for payment or satisfaction of any debts due and of any claims or demands by or against the Company.

(9) To refer claims or demands by or against the Company to arbitration and observe and perform the awards.

(10) To make and give receipts, releases and other discharges for money payable to the Company and for the claims and demands of the Company.

(11) To determine who shall be entitled to sign on the Company's behalf bills, notes, receipts, acceptances, endorsements, cheques, releases, contracts and documents.

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

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(13) To invest and deal with any of the moneys of the Company not immediately required for the purposes thereof upon such securities and in such manner as they may think fit, and from time to time to vary or realise such investments.

(14) From time to time to make, vary and repeal bye-laws for the regulation of the business of the Company, its employees.

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

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

(17) Subject to the provisions of section 227 of the Ordinance, before recommending any dividends, to set aside portions of the profits of the Company to form a fund to provide for such pensions, gratuities, or compensation; or to create any provident or benefit fund in such or any other manner as to the directors may seem fit.

(18) Subject to the provision of the Ordinance to accept from any member on such terms and conditions as shall be agreed a surrender of his shares or any part thereof.

(19) To make advances and loans without security or on such security as they may deem proper and as permissible under the law.

(20) To delegate all or any of the powers hereby conferred upon them to such person or persons as they may from time to time think fit subject to the provision of Section 196 of the Ordinance.

(21) To approve appointment of alternate director/directors.

POWER OF ATTORNEY

104. APPOINTMENT OF ATTORNEY

The directors may from time to time and at any time by power of attorney appoint any company, firm or person (including any director or officer of the Company) or body of persons, whether nominated directly or indirectly by the directors, to be the attorney or attorneys of the Company for such purposes and with such powers, authorities and discretions 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 to delegate all or any of the powers, authorities and discretions vested in him; and without prejudice to the

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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.

BORROWING POWERS

105. DIRECTORS POWERS TO BORROW

(1) The directors may exercise all the powers of the company to borrow money and to mortgage or charge its undertaking, property and assets (both present and future), and to issue debentures, debenture stocks, and other securities, weather outright or as collateral security for any debt, liability or obligation of the company or of any third 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 the mark up on price, musharika, modaraba or any other permitted mode of financing.

(3) In regard to the issue of securities the directors may exercise all or any of the powers of the Company arising under Sections 87 and 120 of the Ordinance and in particular the directors may issue any security as defined in Section 2(1) (34) of the Ordinance or may issue any instrument or certificate representing redeemable capital as defined in section 2(1) (30A) of the Ordinance or participatory redeemable capital as defined in section 2(1) (25) of the Ordinance.

(4) Any debentures, debenture-stock, bonds or other securities may be issued at a discount, premium or otherwise and with any special privileges as to redemption, surrender, drawing, allotment of shares, attending and voting at general meetings of the Company, appointment of directors of the Company or otherwise.

106. REGISTER OF MORGAGES AND CHARGES

The directors shall cause a proper register to be kept in accordance with the provisions of Section 135 of the Ordinance, of all mortgages and charges specifically affecting the property of the Company, and shall duly comply with the provisions of the sections of the Ordinance, namely, Sections 121 and 122 (Registration of mortgages and charges), Section 128 (Endorsement of certificates), Section 129 (Filing of prescribed particulars), Section 130 (Keeping of a copy of every instrument creating any mortgage or charge by the Company at the office) and Section 132 (Giving of intimation of the payment or satisfaction of any charge or mortgage created by the Company).

BOOKS OF ACCOUNTS

107. DIRECTORS TO KEEP BOOKS OF ACCOUNTS

The directors shall cause to be kept proper books of account as required under section 230.

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108. **WHERE TO KEEP BOOKS OF ACCOUNTS**

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

109. **INSPECTION BY MEMBERS**

The directors shall from time to time determine whether and to what extent and at what time and places and under what conditions or regulations the accounts and books or papers of the company or any of them shall be open to the inspection of members not being directors, and no member (not being a director) shall have any right of inspecting any account and books or papers of the company except as conferred by law or authorised by the directors or by the company in general meeting.

110. **PREPARATION OF ACCOUNTS**

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

111. **ACCOUNTS TO BE LAID BEFORE THE MEMBERS**

A balance sheet, profit and loss account, and other reports referred to in the preceding Article shall be made out in every year and laid before the company in the annual general meeting made up to a date not more than three months before such meeting. The balance sheet and profit and loss account shall be accompanied by a report of the auditors of the company.

112. **ACCOUNTS AND REPORTS TO BE SENT TO MEMBERS**

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

113. **ERRORS DISCOVERED AFTER APPROVAL OF ACCOUNTS**

Every account of the company when audited and approved by a general meeting shall be conclusive except as regards any errors discovered therein within three months next after the approval hereof. Whenever any such error is discovered within that period the account shall forthwith be corrected and henceforth shall be conclusive.

114. **DIRECTORS TO COMPLY SECTION 230 AND 236**

The directors shall in all respects comply with the provisions of sections 230 to 236.

ANNUAL RETURNS

115. **FILING OF FORM A**

The Company shall make the requisite annual returns in accordance with the provisions of section 156 of the Ordinance.

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DIVIDENDS AND RESERVES

116. The company in general meeting may declare dividend but no dividend shall exceed the amount recommended by the board.

117. 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.

118. No dividend shall be paid otherwise than out of profits of the year or any other undistributed profits. No unpaid dividend shall bear interest against the company.

119. The dividend warrants shall be sent by the company by registered post unless the shareholder entitled to receive the dividend requires otherwise.

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

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

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

123. Any general meeting may resolve that any moneys, investments, or other assets forming part of the undivided profits of the company standing to the credit of any reserve or other fund or in the hands of the company and available for dividend (or representing premium received on the issue of shares and standing to the credit of the shares premium account) be capitalized and distributed amongst such of the shareholders as would be entitled to receive the same if distributed by way of dividend and in the same proportions on the footing that they become entitled hereto as capital and that all or any part of such capitalized fund be applied on behalf of such shareholders in paying up in full, any unissued shares, debentures or debenture-stock of the company which shall be distributed accordingly and that such distribution of payment shall be accepted by such shareholders in full satisfaction of their interest in the said capitalized sum.

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

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

126. Notice of any dividend that may have been declared shall be given in the manner hereinafter mentioned to the persons entitled to share therein.

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

128. 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 all dividends unclaimed for three years after having been declared may be forfeited by the directors for the benefit of the company, but the directors may annul the forfeiture wherever they may think proper.

AUDIT

129. APPOINTMENT OF AUDITORS

Auditors shall be appointed and their duties regulated in accordance with Sections 252 to 255 of the Ordinance or any statutory modification thereof for the time being in force.

SEAL

130. COMMON SEAL OF THE COMAPNY

The directors shall provide a common seal of the Company which shall not be affixed to any instrument except by the authority of a resolution of the board or by a committee of directors authorised in that behalf by the directors, and two (2) directors, or one (1) director and the secretary of the Company, shall sign every instrument to which the common seal is affixed.

131. USE OF OFFICIAL SEAL OUTSIDE PAKISTAN

The directors may provide for the use in any territory, district or place not situated in Pakistan, of an official seal which shall be a facsimile of the common seal of the Company, with the addition on its face of the name of every territory, district or place where it is to be used. The official seal shall not be affixed to any instrument except by the authority of a resolution of the board or by a committee of directors authorised in that behalf by the directors, and two (2) directors, or one (1) director and the secretary of the Company, or such other person as the directors may appoint for the purpose, shall sign every instrument to which the official seal is affixed. The provisions of section 213 shall apply to the use of the official seal.

NOTICES

132. NOTICES TO MEMBERS

Notice shall be given by the company to members and auditors of the company and other persons entitled to receive notice in accordance with section 50 and will include electronic form as may apply to the manner in which notices are to be issued, served and/or received by the company.

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AMALGAMATION, DIVISION AND RECONSTRUCTION

133. MERGER, DE-MERGER AND RECONSTRUCTION OF THE COMPANY

Subject to and in accordance with the provisions of section 287, the Company may reconstruct, amalgamate into another Company or divide into two (2) or more companies in the process of which the whole or any part of the undertaking, property or liabilities of the Company or any other company, may be transferred to any other Company or the Company, respectively, as the case may be. Provided that any sale of the undertaking of the Company, the directors, or the liquidator on a winding up, may, if authorised by a special resolution, accept fully paid shares, debentures or securities of any other company, whether incorporated in Pakistan or not, either then existing or to be formed, for the purchase in whole or in part of the property of the Company, and the directors (if the profits of the Company permit) or the liquidator (in a winding up) may distribute such shares, or securities, or any other property of the Company amongst the members without realisation, or vest the same in trustees for them, and any special resolution may provide for the distribution or appropriation of the cash, shares or other securities, benefits or property, otherwise than in accordance with the strict legal rights of the members or contributories of the Company, and for valuation of any such securities or property at such price in such manner as the meeting may approve, and all holders of shares shall be bound to accept and shall be bound by any valuation or distribution so authorised, and waive all rights in relation thereto, save only in case the Company is proposed to be or is in the course of being wound up, such statutory rights (if any) under section 367 of the Ordinance as are incapable of being varied or excluded by these articles.

SECRECY

134. DECLARATION TO OBSERVE SECRACY

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

135. NO MEMBER TO ENTER THE PREMISES OF THE COMPANY

No member or other person (not being a director) shall be entitled to enter upon the property of the Company or to inspect or examine the Company's premises or properties of the Company without the permission of the directors for the time being or, subject to the provisions of article 122, to require discovery of or any information respecting any detail of the Company's trading or any matter which is or may be in the nature of a trade secret, mystery of trade, or secret process or of any matter whatsoever which may relate to the conduct of the business of the Company and which in the opinion of the directors it will be inexpedient in the interest of the members of the Company to communicate.

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ARBITRATION

136. APPOINTMENT OF ARBITRATOR

Whenever a difference arises between the Company on the one hand and any of the members, their executors, administrators, or assignees on the other hand touching the true intent or construction or the incident or consequences of these presents, or of the status of enactment's of the legislature, or touching anything then or thereafter done, executed, omitted or suffered in pursuance of these presents or of the status of enactment's touching any breach or alleged breach or otherwise relating to the premises or to these presents, or to the status or to any of the affairs or officers of the Company, the Company by written agreement refer to arbitration in accordance with the Arbitration Act 1940 (X of 1940) and every such difference shall be referred to the decision of an arbitrator to be appointed by the parties in difference or if they cannot agree upon a single arbitrator, to the decision of two arbitrators, one appointed by such party, or in the event of disagreement of the arbitrators, to that of an umpire appointed by arbitrators themselves. The provisions of Arbitration Act 1940 (X of 1940) shall apply to all arbitrations between the Company and persons having such difference.

137. FAILURE TO APPOINT ARBITRATOR BY ONE PARTY

If either party to the difference makes default in appointing the arbitrator for fifteen days after the other party has given to him notice to appoint the same, such other party may appoint an arbitrator to act in the place of the arbitrators of the defaulting party.

138. COST OF ARBITRATION

The costs of, or incidental to any such reference and award shall be in the discretion of the arbitrator/arbitrators or umpire as the case may be who may determine the amount there of an may award by whom, and to whom, and in what manner the same shall be borne and paid.

WINDING UP

139. DISTRIBUTION OF ASSETS ON WINDING UP

If the Company shall be wound up and the assets available for distribution among the members, subject to the rights attached to any preference share capital, as such shall be insufficient to repay the whole of the paid-up capital, such assets shall be distributed so that as nearly as may be the losses shall be borne by the members in proportion to the capital paid up on the shares held by them respectively. And if in a winding up the assets available for distribution among the members shall be more than sufficient to repay the whole of the capital paid up at the commencement of the winding up, the excess shall be distributed amongst the members in proportion to the capital at the commencement of the winding up, paid up on the shares held by them respectively. But this article is to be without prejudice to the rights of the holders of shares issued upon special terms and conditions.

140. DISTRIBUTION OF ASSETS IN SPECIE OR KIND

If the Company shall be wound, whether voluntarily or otherwise, the liquidator may with the sanction of a special resolution divide among the members in specie or kind any part of the assets of the Company, and may with the like section vest any part of

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the assets of the Company 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.

INDEMNITY

141. 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 judgement 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.

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

Name and Surname in Full	Father's Surname in Full	Nationality with any former	Occupation	CNIC Number	Residential address in full	No. of Shares	Signature
Mushtaq Ahmad	Muhammad Ahmad	Pakistani	Service	35201-1301833-7	House # 32-B Punjab Cooperative Housing Society, Lahore	1	
Inayat Ullah Niazi	Chaudry Muhammad Deen	Pakistani	Service	35202-2732121-1	House # 102-AIII, Gulberg III, Lahore.	1	
Lalpir Power Limited Through nominee Khalid Qadeer Qureshi	Subscriber s/o Mazhar Qadeer Qureshi	Pakistani Pakistani	 Service	0032510 35202-8191856-7	Nishat House, 53-A, Lawrence Road, Lahore Punjab House # 128-III, Model Town, F Block, Lahore.	250,000	
Nishat Power Limited Through nominee Tanvir Khalid	Subscriber s/o Khalid Saeed	Pakistani Pakistani	 Service	0059633 35202-2881915-3	Nishat House, 53-A, Lawrence Road, Lahore Punjab House # 1240-I, Rang Mehal Lahore.	250,000	
Pakgen Power Limited Through nominee Khalid Mahmood Chohan	Subscriber s/o Abdul Rasheed	Pakistani Pakistani	 Service	0035039 35100-0985638-5	Nishat House, 53-A, Lawrence Road, Lahore Punjab Defense Road House #16-E Punjab Cooperative Housing Society Lahore	249,999	
Nishat Mills Limited Through nominee Badar Ul Hassan	Subscriber s/o Israr Ul Hassan	Pakistani Pakistani	 Service	0001053 35202-[illegible]	Nishat House, 53-A, Lawrence Road, Lahore Punjab House # 74-C, New Muslim Town, Lahore.	249,999	

Total Shares Taken: 1,000,000

Dated this 14th May 2014

Witness to the above Signatures

Signature: _____

Occupation: NIFT

Full Name: National Institutional Facilitation Technologies (Pvt) Ltd

Full Address: 5th Floor, AWT Plaza, I. I. Chundrigar Road, Karachi.

CERTIFIED TO BE TRUE COPY

JOINT REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE

NISHAT ENERGY LIMITED

PUNJAB POWER DEVELOPMENT BOARD
ENERGY DEPARTMENT

MINUTES OF PANEL OF EXPERTS (POEs) MEETING REGARDING APPROVAL OF FEASIBILITY STUDY OF 1X660 MW COAL FIRED POWER PROJECT AT RAHIM YAR KHAN BY M/S NISHAT ENERGY LIMITED.

A meeting of Panel of Experts (POE) was held on October, 26, 2015 in the Committee Room of Punjab Power Development Board, Energy Department, Government of the Punjab. Managing Director Punjab Power Development Board, being convener of the POE chaired proceedings of the meeting. Following were the participants of meeting:

PRESENT:

Sr. #	Name	Designation	Department
1	Mrs. Samya Awais	Managing Director	Punjab Power Development Board
2	Mr Zafar Ranjha	Chief Executive Officer	PRTC, Pakistan Railway
3	Dr. Shahid Munir	Director Coal Technologies	Punjab University
4	Mr. Muhammad Yousaf Khan	Director Technical	WPPO, NTDC/CPPA
5	Mr. Muhammad Amin	Chief Financial Officer	Punjab Mineral Company

IN ATTENDANCE:

Sr. #	Name	Designation	Department
1	Mr. Abdul Rauf	Director Finance	Punjab Power Development Board (PPDB)
2	Mr. Ahmad Salman	Director Technical Coordination	Punjab Power Development Board (PPDB)
3	Mr. Shahzeb Ahmad	Manager Thermal	Punjab Power Development Board (PPDB)
4	Mr. Saqib Rasul	Manager planning	Punjab Power Development Board (PPDB)
5	Mr. Mahmood Subhani	Manager Legal	Punjab Power Development Board (PPDB)
6	Mr. Adnan Ghafoor	Manger Hydro	Punjab Power Development Board (PPDB)
7	Mr. Abu Bakar	Associate Thermal	Punjab Power Development Board (PPDB)

8	Mr. M Yasin Ali	Managing Director	Nishat Energy Limited
9	Mr. M Yunas	GM	Nishat Power

The subject meeting was conducted to discuss and review the Feasibility Study Report (the "Report") of 2x660MW imported coal fired power project at Rahim Yar Khan (the "Project") forwarded to PPDB by Nishat Energy Limited (the "Sponsor"). Managing Director PPDB briefed members of POE and other participants of the meeting that the Sponsor received LOI, from PPDB, on October 15, 2014 to conduct the Feasibility Study (FS) of the Project within nine months. The Sponsor has submitted the Draft Report of the Project, within its due time and presented in POE. The Sponsor demanded three month time extension from POE in its meeting held on July 01, 2015 as per the allowance given in Punjab Power Generation Policy 2006 revised 2009 to complete the FS in all respects. The Sponsor has also intimated PPDB about its willingness to accept the applicable Upfront Tariff with its terms & conditions, notified by NEPRA through "Determination of National Electric Power Regulatory Authority in the Matter of Upfront Tariff for the Projects on Imported/Local Coal (Other than Thar Coal) dated 6.26.2014"

MD PPDB invited the team of experts from the Sponsor to present major components of the report with justification of the findings of the feasibility report. The Sponsor presented the Report before the POE and highlighted the following key areas.

- Site and Merits
- Plants Technical Configuration
- Power Evacuation
- Environmental and Social Impact
- Geotechnical & Geophysical
- Coal Supply and Logistics
- Permits & Consents
- Risks & Economics
- Financing Plan
- Current Status & Project Plan
- Challenges

- Support from Government particularly for Coal Transportation

During discussion, Director Technical, NTDC pointed out that plant configuration layout to be reviewed again particularly the distance of H2 plant to coal settlement pond and coal yard. It was also found that coal storage area as mentioned in report is sufficient to store 36 days coal requirement of the Project. This storage area needs to expand to hold 45 days coal to meet the power purchaser requirement. Director Technical, NTDC also showed concerns about the uninterrupted coal supply to power plant and in response CEO PRTFC provided the detailed briefing on how PRTFC will be able to ensure the uninterrupted coal supply to the Project. M/s NEL.

The Sponsor explained that the Environment Impact Assessment (EIA) Report of the project has been prepared and submitted to Environment Protection Agency (EPA) for its approval. Public Hearing has been conducted in this regard. Interconnection study of the project has also been submitted to NTDC and the approval is in progress at the Planning Department.

In light of the above and subject to acceptance of Upfront Tariff, the POI approved the feasibility study of the project subject to the following.

i. Project Sponsor Company will get the EPA approval of EIA and ensure compliance of EPA standards throughout the term of the project.
ii. Project Sponsor Company will submit Interconnection Study approved by NTDC Planning to PPDB.
iii. If there is any change in the identified land coordinates, the Feasibility Study will be updated accordingly.

Meeting ended with vote of thanks from and to the Chair.

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Volume Reference No.
30–FR0098K

RAHIMYAR KHAN 1x660MW COAL FIRED POWER PLANT

Feasibility Study

Volume I - Main Feasibility

Prepared by

Shanghai Electric Corporation's Power Generation Group

(SEC)

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Nishat Energy Limited (Nishat)

October, 2015

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1. EXECUTIVE SUMMARY

This Coal-Fired Power Plant Project includes the building of a 660 MW in the premises of Cholistan, Dist. Rahim Yar Khan (RYK) using Supercritical Pulverized Coal (PC) boiler. The proposed project site is located at 28° 41' 22.14 " North Latitude and 70° 47' 23.09" East Longitude however its confirmation is to be received. The total land requirement for this power project is likely to extend upto 560 acres which has been identified due to its proximity to load center, rail track, national highway, 500KV transmission substation and ample water resource. This project will bring a huge area of barren land in productive utilization which comes under the jurisdiction of Cholistan Development Authority, District Rahimyar Khan, Govt. of Punjab.

1.1 Project Fundamentals

The location of this project is very near to the sweet water source "Abbasia Canal" and is located at its right bank. The Abbasia canal is a perennial irrigation canal which is operational 11 months in a year with a capacity of 2,200 cusec with its origin from Punjnad barrage. The project site lies along the seepage water drain channel on the west and very close to Main Railway Line. These make it the best location for setting up such big coal power project. The railway link to the project site by laying new rail track of about 4 km long will be established by Pakistan Railways / Punjab Government. Railway siding will be beyond the Jetha Bhutta station while coming from Karachi. This makes an added advantage to the site location as the distance of Site's Station to Port Qasim is around ~660Kms. Hence the location provides a good combination for its proximity to load center of central Punjab and sea port for coal logistics.

The Project includes a completely developed project including the complete engineering, design, procurement, construction, commissioning, and operation of the plant, including a pulverized coal (PC) generating plant, supercritical thermal cycle, cooling water system, single concrete chimney, air and water quality controls (flue gas desulfurization, electrostatic precipitator), coal unloading and coal storage facilities, ash disposal, balance-of-plant equipment including all buildings and internal roads and including other facilities to provide a complete power generation facility.

The power plant will be connected with 500kV Grid Station which is located around 32 km away from project site and is under-construction. In accordance with the latest information available from NTDC, this Grid Station will be completed before end of 2016. Power will be evacuated at 500kV from the power station through its switchyard to the 500kV Grid Station.

The general trend in recent coal-fired power plants is to build larger size units and most of the new coal-fired units built in the last five years have been in the rage range of 600 MW ~ 1,000 MW size. Some smaller units (200 MW to 500 MW) have been built, but in most of those cases, the small size was selected due to grid or transmission limits. The economies of scale, including lower capital cost and lower operating costs favor the larger sizes. This power project is based on fast track and has nameplate capacity of 660MW. This output figure is derived on site parameters, design configuration and site ambient conditions. Net output is estimated ~625 MW.

The fuel sources for the project will be sourced from Indonesia, South Africa and Pakistan. The blends of coal based on fuel performance and characteristics will be used at this power project. The rate of blend will be determined at the next stage for once comprehensive local coal analysis is available. Subbituminous coal also called black lignite having low moisture contents will be used for this project. The imported coal will be transported to the jetty at Port Qasim, Karachi by sea and then transported to the power plant by railways.

Access road and relevant infrastructure for all new plant shall be included in the development. The living area for the power plant employees will be adjacent to the plant site and will be equipped with all necessary facilities.

The plant will have Coal Handling, Unloading and Storage Facilities. A conveyor belt will deliver the coal for operational use. There will be coal stock yards sufficient for 30 days of coal consumption at full load operations.

Limestone supply will be from a local supplier for wet scrubbers with whom a supply agreement will

be concluded. The quality of this supply will be analyzed for its suitability to be used for power plant.

Electrical power during construction will be provided from 132 kV Grid Station (20km away from project site). The overhead conductor line is very near to the project site though. The transmission line will be established by the NTDC. The maximum capacity required by the construction site will be approximate 4 ~ 5 MW in peak times.

The raw water supply will be made from deep wells during construction. A water treatment plant will be constructed at the beginning of the construction period to supply potable water for the power plant construction site. The water quality of Abbasia Canal has been analyzed and is of irrigation quality and will be used as the potential primary source of raw water for make-up and cooling purposes. Abbasia Canal will supply raw water during most of time of the year (11 months) during normal operation of the plant with a capacity of 2,200 cusecs. A comprehensive study for underground water will be conducted for well water quality and usage which will act as a back-up source during canal outage periods post COD and as primary source for most part of construction period.

1.2 Environmental Impact and Social Soundness Assessment

The Environmental Impact Assessment (EIA) study for the project has been completed. The power plant and coal spec is configured in conformity with the National Environmental Quality Standard (NEQS) applicable for new power plant projects. National Environmental Quality Standard (NEQS) requirements is being followed also for emissions, effluents, workplace air quality, noise, worker health, safety and training requirements for design configuration purposes of this project.

Environmental Impact Assessment and Social Soundness Report (EIASSR) is being submitted to the Environmental Protection Agency (EPA), Government of the Punjab, Lahore in compliance with the legal requirement for Punjab Environment Protection Act-2012 (amended act), Section-12 for obtaining the No Objection Certificate (NOC) before commencement of the project work at the proposed project site. This is in line with the stipulations of the LOI issued by the PPDB for the project.

Different environmental aspects like social, physical, biological and other related features of the project both during construction and its regular occupancy have been studied. The purpose of the study was the identification of key environmental and social issues which will likely arise during construction and operation of the power plant along with the assessment of the significant negative impacts (if any) and mitigation measures to be adopted for their minimization.

There are no sensitive elements/segments of environment around the project site. The project has the privilege to be sited in the "unpolluted" air shed, which in turn means that baseline environmental indicators are within national limits and there is less expenditure required to achieve desired environmental standards even with the introduction of the project. The project has inbuilt efficient, state of the art and reliable mechanisms to control all type of pollutants like PM, gaseous emissions (like SOx, NOx) and noise in compliance levels very well within the NEQS limits. The proposed power plant is designed to meet the NEQS for environmental protection. Hence, the implementation of plant will lead to overall sustainable development in the area in specific and at the national level in general.

Based on the input data of the emissions provided by the design engineers for the boiler, the results of the air dispersion modelling using various ambient temperatures is presented in the table below

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Season	Pollutants	500	1000	1500	2000	2500	3000	6000	NEQS* for Coal Power Projects	NAAQS* (24 h average)
		1.95	2.10	1.74	1.48	1.27	1.10	0.63	**50**	**120**
		0.28	0.39	0.34	0.29	0.25	0.22	0.13	**100**	**80**
		0.73	1.05	0.90	0.78	0.67	0.58	0.33	**---**	**5 (mg/m^3)**
		5.83	17.84	15.5	13.38	11.43	9.94	5.66	**---**	**150**
		2.95	2.54	2.60	2.55	2.45	2.30	1.56	**50**	**120**
		0.32	0.45	0.49	0.48	0.47	0.45	0.30	**100**	**80**
		1.35	1.12	1.31	1.30	1.25	1.18	0.80	**—**	**5 (mg/m^3)**
		22.54	18.83	21.98	21.76	20.98	19.86	13.56	**—**	**150**

**NEQS refers to National Environmental Quality Standards and NAAQS refers to National Ambient Air Quality Standards*

1.3 Seismicity

The project site lies in the low seismic hazard area with Minor to No damage zone, with intensity <6 and g-factor <0.03 as per Geological Survey of Pakistan Earthquake Zone Map published in 2006.

1.4 Geo Tech Investigations

Since the project is at feasibility stage, preliminary geo technical investigations were undertaken. Six (06) boreholes were drilled. Scope of work included drilling of boreholes, carrying out field test including standard penetration tests, collection of soil and ground water samples, lab testing, performance of electrical and thermal resistivity tests, plate load test, downhole seismic test, topography and recommendations for foundation design and earth works.

The deposition of area mainly consists of medium dense to very dense fine to coarse grained sand with traces of gravels, medium stiff to very hard silt, and medium stiff to hard clay. Ground water table was encountered at a depth of 9-12 meters below the existing ground level.

For foundation design purposes, keeping in view the sub soil conditions and the loads expected to be borne, shallow foundations including isolated and raft foundations are recommended. The settlement of shallow foundations due to net allowable pressure has been estimates within allowable limit of 25mm and 50mm for islolated and raft foundation, respectively. Parameters for vibration control were also determined at depths of 1,5,10 and 15 meters which ranges from 255MPa to 1,630MPa.

The exposure of underground concrete to aggressive chemicals is found to be negligible for ground water, for sulphates and chlorides which have influenced the selection of cement for underground concreting and it is recommended to use Ordinary Portland Cement.

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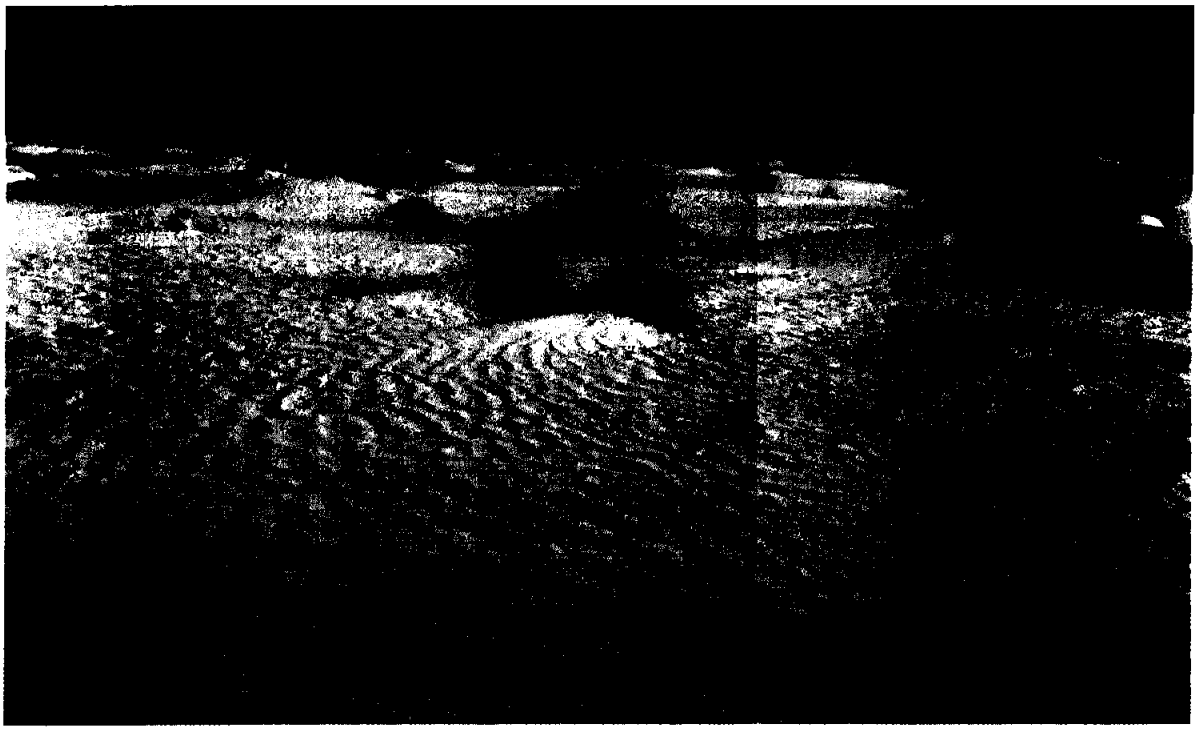
General topography was conducted as the land did not require a detailed analysis. The proposed plant site is located at app. 19 kms from Khanpur city. The site of the proposed development lies in an undulating terrain. Sand dunes in the desert and some old bushes may also be observed across the site.



1.5 Grid Inter Connect

One (1) sets of 660MW Coal Fired Generator unit will be built. The generator will be directly connected to its three-phase two-winding Generator Step-Up transformer (GSU). The power of the generator will be stepped up from 22kV by GSU and be transmitted to the 500kV switchyard. Generator transformers shall be rated to continuously export the maximum output at the generator terminals, at rated power factor, less the minimum auxiliary load. The rated capacity of GSU transformer shall be about 800MVA (three phase).

The nearest grid facility is R.Y.Khan 500/220/132 kV Grid Station near Pir Zahir Shah. Keeping in view the Nishat Energy Power Plant location, two alternatives have been proposed for the interconnection of the said plant with the 500 kV network of NTDC.

1. In the first alternative, a direct double circuit from Nishat Energy Plant to R.Y.Khan 500 kV Grid has been proposed. The length of this double circuit would be 42 km. The conductor used would be 500 kV Drake.
2. In the second alternative, the 500 kV 292 km circuit running from R.Y.Khan to Multan would be looped in out at Nishat Energy Plant using 500 kV Drake conductor. The distance from the power plant to the looping point (immediately after the line take-off from the Grid Station) would be 42 km.

Although, alternative-I would require two line bays at R.Y.Khan 500/220/132 kV Grid station whereas alternative-II would not require additional line bay at R.Y.Khan G/S, yet the length of 500 kV transmission line between Nishat Energy Power Plant to Multan, as a result of looping, would become 292 + 42 = 334 kM which is considerably long and might compromise the loadability of line. Hence, alternative-II may not be a more likeable alternative.

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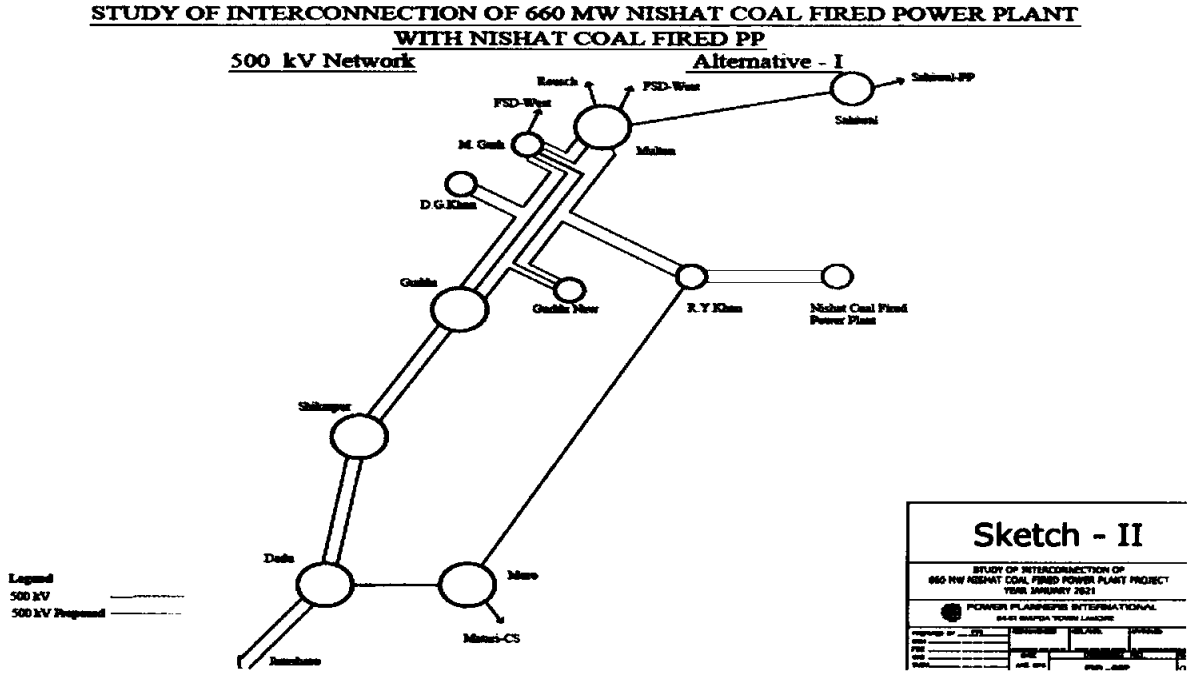
In view of planned COD of the Nishat Energy Plant in the fourth quarter of 2018, the base case of studies have been assumed as of January 2019 because maximum power flow occurs on Southern grid of NTDC due to concentration of thermal power plants in the South. Therefore both the above proposed interconnection alternatives have been tested for steady state conditions through detailed load flow studies for the peak low water conditions of January 2019. The system conditions of normal and N-1 contingency have been studied to meet the reliability criteria of NEPRA Grid Code.
The proposed interconnection scheme has also been tested in the extended scenarios of the year 2021

by carrying out detail studies for low water (January) and high water (September) seasons.

Detailed analysis of load flow under steady state, maximum short circuit levels, dynamic and transient stability analysis were conducted with the conclusion that no technical constraints or problems persists in the adoption of alternative 1 interconnection scheme as it fulfills all the criterion of reliability, stability, contingency load flows, short circuit currents and dynamic/transient conditions and is therefore recommended to be adopted.



1.6 Coal Requirement & Specifications

Annual Coal Requirement:

- Gross Capacity: 660MW
- Calorific Value (LHV) of coal: 5,371 kCal/kg
- Annual coal requirement is less than 1.8 million tons while operating with 43% efficiency and at 85% capacity factor.
- The design coal spec for the complex has been carefully selected after soliciting proposals from the renowned coal traders, both international and local. An RFP was floated to solicit proposals of coal supply (along with an abridged terms sheet of long term supply contract) based on the coal spec selected after preliminary research of the coal industry primarily of South African and Indonesian origin. The overarching principle laid out in the RFP and followed in selecting the coal was cost effectiveness (on site delivery basis) and reliability of supply over the PPA term. The proposals received from two international suppliers have confirmed their interest, pricing mechanism and availability of coal on a long term basis. The proximate analysis of the selected coal spec is given in the following table which resembles with the RB3 Index coal spec (5,500kcal NAR).

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PARAMETER	UNITS	WORST COAL	PERFORMANCE COAL
Total Moisture (arb)	%	25.1	9.27
Proximate Analysis			
Inherent Moisture (adb)	%	14.9	4.44
Ash (adb)	%	5.61	18.5
Total Sulphur (adb)	%	1.43	1.09
Volatile Matter (adb)	%	39.03	24.98
Fixed Carbon (adb)	%	40.46	52.08
GCV (adb)	kcal/kg	5715	5889
GCV (arb)	kcal/kg	5030	5591
NCV (arb)	kcal/kg	4731	5371
HGI		48	53
Size	0 - 50 mm	90%	99.20%

1.7 Technical Configuration and Design Parameters

Following are the salient features of the project;

- Gross Capacity: 660MW
- Auxiliary Load: 35MW (5.3%)
- Net Output: 625MW
- Annual Energy Export at a Capacity Factor of 85%: 4,654 GWh
- Working Principle: Single Reheat, Regenerative, Rankine Cycle
- Pulverized Coal Super Critical Boiler: 275 kg/cm^2, 600 °C
- Main Steam Flow (Valve Wide Open): 1,934,200 kg/h
- Steam Turbine Generator (STG) of nominal gross output rating of 660MW with bleed steam ports for HP Heaters, De-aerator, and LP Heater
- Natural draught cooling Tower having a circulation rate of 83,448 m^3/hr with range of 10 °C for Condenser and auxiliary cooling requirement.
- Water pretreatment for water requirement by the entire power plant like Demineralized Water for Boiler and water cycle make-up, Cooling Tower make-up, ash water and utilities.
- Coal unloading and storage facilities 194,000 tons sufficient to cater plant operation requirements for a period of 36 days at full load on design coal.
- Dense phase pneumatic conveying system for fly ash from Electrostatic Static Precipitator (ESP) to ash silos; Bed ash shall be conveyed in slurry form to ash pond through wet ash system.
- Wet Limestone Flue Gas Desulphurization (FGD) with all auxiliaries to reduce SOx emissions
- Flue gas stack with a height of 210 m enabling to through away flue gases
- Treated water discharge will be kept at a rate of 50m^3 an hour with a storage pond of 2,000m^3
- Powerhouse building for STG, its auxiliaries, Switchgears/MCCs and plant control equipment and panels.
- Adequate raw water system having a capacity of 1,800 m^3/hr, comprehensive fire water system consisting of storage tank/pond and pumping system, potable and service water system
- Air-Insulated Substation (AIS) 500kV Switchyard enabling the power plant connection with national transmission line consisting of necessary equipment, equipped with protections, and including the metering station.
- Storage tank for High Speed Diesel (HSD) to be used as start-up fuel.
- Suitable hydrogen generation, storage and distribution system with control stations; the capacity of generators is 1×5Nm3/h.
- Dust Collection system to restrict emission level upto 80mg/Nm^3
- Ash silos to store 4,000m^3 (3 days) of fly ash at BMCR condition. Ash yard in complex to store ash for about 5 years of generation and covers an area of 20 Hectares (~50 Acres) to be located

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at the south of power island. Lifespan of Ash pond to increase with reclamation options discussed as under.

1.8 Ash Disposal

Annual coal requirement of the plant is estimated at 1.8 million tons. The maximum ash generation considering the coal with an ash content of 18.5% is ~ 324,000 tons per annum (with 90% being fly ash and 10% being wet ash) at 85% load factor. The fly ash has high pozzolanic properties and when mixed with lime and water, it is suitable for following commercial purposes;

- Cement Industry
- Brick making industry
- Light weight aggregates
- Road sub-base
- Grouting material
- Roads/Paving as filler in asphalt mix for road
- Road enlargement

1.9 Coal Logistics

At the present time, the dominant transportation mode for coal at power plants is the dumping of trucks that have been loaded by front-end loaders. This is the widely used method currently available for the quick unloading at the coal yards. Trucking charges vary with the season, destination and fuel prices. In some cases, there is no cargo available for the return journey, thus increasing coal freight charges. Government of Pakistan claims to have a plan to develop the railway transportation in several years, tendering is in process of heavy duty locomotives (>4,000 HP) and Wagons (60 tons cargo capacity). Plans/Tenders are also under preparation for augmentation of railway tracks, development of sidings for Project sites and introduction of signaling system (from Kotri to Lodhran in the first phase). Government assured railway transportation will be available and meet the time schedule of Rahim Yar Khar 1x660MW Coal Fired Power Plant through a Letter of Comfort addressed to Nishat Energy Limited (Copy Annexed in the Appendices). Several meetings have been held with Pakistan Railways officials however, a detailed transportation plan laying out the specifics for coal logistics feasibility e.g loading point, time of turnaround, freight charges, provision of storage yard at loading stations, time to implement augmentation, capacity to carry freight cargoes post augmentation, etc. is yet to be delivered and hence pose serious issues for bankability.

1.10 Port Handling

A number of facilities are being planned and under construction for the coal handling at port with a combined capacity of 6-10 million tons per annum. A fully mechanized under construction facility is located at Port Qasim and developed by Marine Group by the name of Pakistan International Bulk Terminal (PIBT). The facility is planned to be commissioned in later half of 2016 with initial coal handling capacity of 4 million tons and another 4 million tons for the export of cement and clinker. However the facility is fraught with two main issues which are yet to be resolved a) The evacuation mode (i.e through conveyor belts or a direct rail link) and hence point of loading of rail wagons is yet to be determined (i.e whether the loading would occur in the area of terminal's storage yard or a nearby railway station or where another storage area may need to be provided, or both) and b) The current draught for berthing at PIBT provides for berthing of smaller Handymax vessels only. The dredging of the channel for another 2 meters needs to be provided for the navigation of Panamax vessels, hence a sub-optimal handymax vessels may have to be used in the initial phase which would limit the handling capacity of the terminal to 4 Million tons of coal per annum. The extra dredging has to be undertaken by PQA.

Another port is being planned to set up a hybrid coal handling facility by extending the existing Quay (Jetty) of the FAP Grain and Fertilizer Terminal operating at Port Qasim, the proposed development is planned to be carried out in phases corresponding to the throughput requirements of the coal fired

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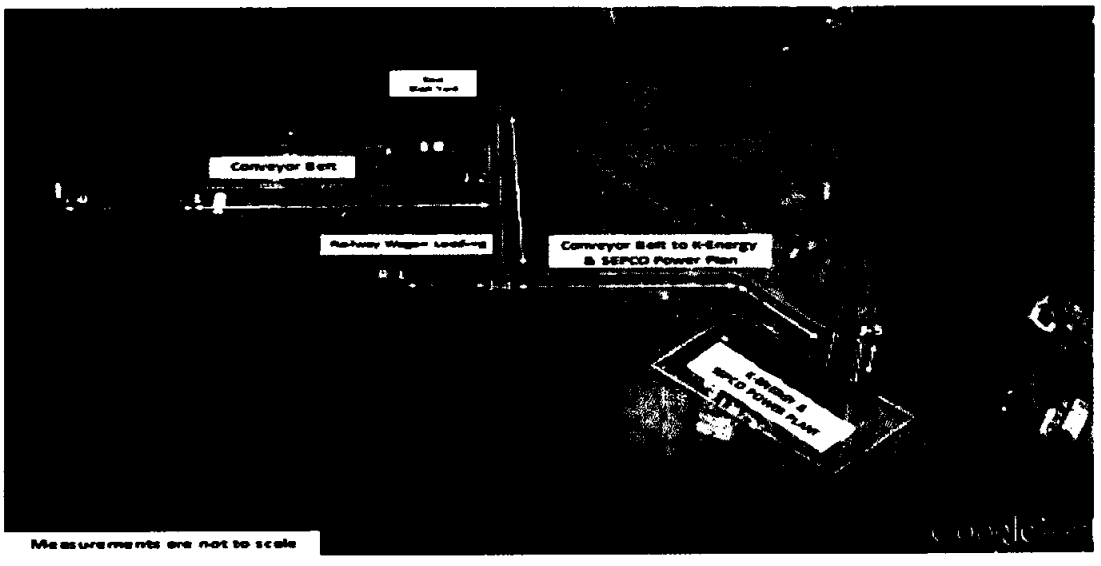
power plants being implemented at Port Qasim. It is envisaged that a minimum of annual throughput of 2 million tons will be used to commission the port required for the power plants. This option has the advantage of laying the conveyor belt to the loading point of railways through ROW at QICT as shown below.



The owners of FAP grain terminal intends to commence development and construction of the terminal expansion/modification for coal handling only under a binding offtake arrangement with the power producers/other customers which can ensure bankability of the expansion. However the sponsors and financiers are awaiting a detailed transportation plan before committing an offtake arrangement with the Terminal Owners which has been promised under the Letter of Comfort from Pakistan Railways. With other Projects of coal e.g at Sahiwal, Jamshoro, Port Qasim and K Energy (with combined coal demand of >12 million tons per annum) likely getting commissioned earlier, RYK project could be at a risk of facing a short handling capacity at Port Qasim if the evacuation hurdles and rail transportation are not addressed. KPT could not be considered as a viable alternative due to limitation of current storage capacity and congestion of current cargo traffic on the evacuation link of both rail and road. The storage yard is also limited in space even in the present circumstances and faces existential threat for environmental reasons and deep sea port expansions in the neighborhood.

A holistic 'Time and Motion' study needs to be undertaken once the above gaps on port handling and rail logistics are bridged to determine an end to end mainstream transportation plan via rail and trucking as a back-up or for spill overs.

1.11 Economics

For tariff purposes, Nishat intends to undertake adoption of upfront tariff as announced by NEPRA on 26.06.14 for 1x660MW category, post acceptance of feasibility by PPDB. The upfront tariff has already been adopted by other investors which practically has set a standard benchmark for the regulator in respect of CAPEX, efficiency, financing, construction timeline and O&M. Hence practically any of the tariff parameters on cost plus basis differing from the upfront tariff (beyond what has been granted and accepted by the upfront tariff adopters) is unlikely to be favored and granted by the Regulator. Therefore finance and economics of the project would not be any different from the declared upfront tariff. CAPEX cost, construction time, efficiency and O&M would be optimized within the upfront tariff limits at the detailed engineering phase.

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1.12 Financing Issues

Project's feasibility ultimately rests on the bankability of the security package. The Govt. needs to discern and redress the following issues to inspire confidence amongst the financiers and investors for the project to be declared as bankable.

1.12.1 Circular Debt

According to estimates, the circular debt (as defined below) at the end of FY 2012 was Rs872.416 billion, representing approximately 4% of the national nominal GDP, this position more or less still continues. The DISCOs' inability to make full payments to the CPPA results in cash flow problems for power producing companies. The result is a shortage of fuel supply to generating companies, a diminished power generation capacity and limited investment to maintain the plant in the required manner. The problem has become so acute that Finance Ministry has to come for the bail out of power sector every other month. This risk of non-payments by Power Purchaser has a severe impact on the viability and bankability of the project. The bankers always, as a first question, raise the issue of circular debt and so far bankers are not satisfied with the performance of Power Purchaser.

1.12.2 Non-Payment or Delayed Payments

Another problem that affects bankability of this project is the Power Purchaser's inability to pay the Delayed Payment invoices, which not only affects the ROE of the power producer since no interest is allowed on delayed payments. Further, a clear violation of already implemented Power Purchase Agreements which defines the payment mechanism on the basis of First in First Out basis, whereas, Power Purchaser follows entirely a different mechanism that is against the terms of PPA. This factor further alienates the financiers.

1.12.3 Guarantees

Another problem in this regard is that Power Producers have more than once called the GoP backed Guarantees, and the results were appalling, which led to the filing of petitions by IPPs in the Supreme Court of Pakistan. This matter was highlighted in media repeatedly with the international coverage. If this state of affairs persists, the bankability of the project will remain under severe pressure, as prospective financiers are aware that a default in Guarantee is an event of default in financing agreements and can lead to termination and eventual liquidation of the Power Producer.

1.12.4 Cross Default

In 2013, a situation arose where Power Purchaser refused to pay certain due Capacity Payments to IPP's, as plants were not fully available for power generation. However, the sole reason for this under-utilization of plant capacity was non-availability of fuel owing to non-payment of huge amounts of overdue Capacity and Fuel payments by Power Purchaser. The case has long been pending with the Expert as appointed under the PPAs, and the matter is expected to be forwarded to Arbitrator. In this scenario we believe that payment defaults by the Power Purchaser should be treated as an event of default in the security package and a merit order be devised to prioritize payment of revenue streams which are acceptable to the financiers besides other kinds of default of Power Purchaser and State Institutions which are usually covered in the IA. These clauses could really provide the comfort to the prospective financiers, in the absence of which their will be doubts about the bankability of the Projects.

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1.INTRODUCTION

1.1 Project Background and Memorandum of Understanding

Pakistan has been facing substantial shortages in the power sector and the province of Punjab is no exception.

Punjab with 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 units. There is a growing un-met demand of energy which offers an opportunity in power generation projects

With deepening energy crisis over the last few years and growing gap between the demand and the supply, the Punjab provinces have also decided to look for ways and means to assist the Federal Government in its efforts to address the challenge of growing energy shortages.

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.

Therefore NISHAT has a plan to built 1x660MW coal fired power plant in Cholistan, near Rahimyar Khan City, Pakistan, based on imported coal and fast track basis.

In preparation of this Feasibility Study, Nishat Energy Limited and Shanghai Electric Power Generation Group and its consultants have liaised with the related departments to study on the plant site, fuel transportation, transmission line and interconnection arrangements, water resource, etc and other critical factor of the project.

1.2 Project Feasibility Basis

This feasibility study is for 1x660MW coal fired fast track project as base case and reserve the possibility for future expansion.

1.3 Power Development in Punjab/Pakistan and Role of the Project

1.3.1 Current Energy-Power

The Pakistan Economy has been growing at an average rate of 7.6% over the past several years. 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

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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.

Highly expensive generation of electricity due to an increased dependence on expensive thermal fuel sources (44% of total generation). RFO, HSD, and Mixed are the biggest sources of thermal electricity generation in Pakistan and range in price from ~Rs 12 / unit for mixed, to ~Rs 17 / unit for RFO, and a tremendously expensive ~Rs 23 / unit for HSD. 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 increase cost, which currently records losses of 23-25% due to poor infrastructure, mismanagement, and theft of electricity.

Currently total installed capacity is indicated as following table.

Table 1-1 Total Installed Capacity (MW, by June. 2013)

Producer Name	Installed Capacity	Percent Share
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%

Note: Source from NTDC.

1.3.2 Power Development Plan

According to the data provided by NTDC, by Apr.2013, total installation capacity is 20,841MW (refer to table 1-1). Due to delivery loss and a lack of gas and oil, actual capacity was about 14,600MW, peak load was 18,800MW, gap between demand and supply was about 4,200MW.

The government has encouraged the private and public sector to meet this additional demand and have a plan to reform power structure and reducing delivery cost.

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Pakistan has set key targets in terms of the demand-supply gap, affordability, efficiency, financial viability and governance of the system. The below will be descript the target related to electricity from Government.

- Decrease supply demand gap from 4,200 MW today to 0.
- Decrease transmission and distribution losses from ~23-25% to ~16%.
- Decrease decision making processing time at the Ministry, related departments and regulators from long to short durations.

Pakistan has formulated the Power Generation Addition Plan and Power Generation Mix Plan. The Power Generation Addition Plan set the goal of capacity planned to install, which categorized by producer , by the year of 2020 as table 1-2 shows. To 2020, totally 26041MW capacity is installed, by Producer Name, Hydel WAPDA 6138MW (23.6%), Gencos 2372MW (9.1%), Thermal IPP 9524 MW (36.6%), Hydel IPP 2577MW (9.9%), Nuclear 1780 MW (6.8%), Wind 1650 MW (6.3%), import power 1000MW (3.8%)，Solar 1000 (3.8%) .

The Power Generation Mix Plan set the goal of capacity planned to install, which categorized by energy source, by the year of 2029(2030) as table 1-3 shows. To 2029(2030), totally 112638MW capacity is installed, by Type of energy, Thermal coal 37875MW (33%), Thermal oil 6855MW (6%), Thermal gas 12015 MW (11%), Hydro 41546MW (37%), Imports 2000 MW (2%), Wind 5400 MW (5%), Nuclear 6947MW (6%) .

Table 1-2 Power Generation Addition Plan (MW, by 2020)

Producer Name	Installed Capacity	Percent Share
Hydel WAPDA	6138	23.6%
Gencos	2372	9.1%
Thermal IPP	9524	36.6%
Hydel IPP	2577	9.9%
Nuclear	1780	6.8%
Wind	1650	6.3%
Import	1000	3.8%
Solar	1000	3.8%
Sum	26041	100%

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Note: Source from NTDC.

Table 1-3 Power Generation Mix Plan (MW) by the Year of 2029-30-NTDC

Type of energy	Installed Capacity	Percent Share
Thermal coal	37875	33%
Thermal oil	6855	6%
Thermal gas	12015	11%
Hydro	41546	37%
Imports	2000	2%
Wind	5400	5%
Nuclear	6947	6%

Note: Source from NTDC.

1.3.3 Power Balance

The followings table 1-4 and figruel-1 indicated balance of demand and supply from 2015 to 2019.Trough implementing the power plan mentioned above, the gap between demand and supply will decrease substantially as described as follows.

Table 1-4 Power Balance Forecast of Demand and Supply from 2015 to2019 (MW)

Year	2015	2016	2017	2018	2019
demand	24361	25521	26755	28058	29423
supply	19534	20304	24259	26588	29895

Note: Source from NTDC.

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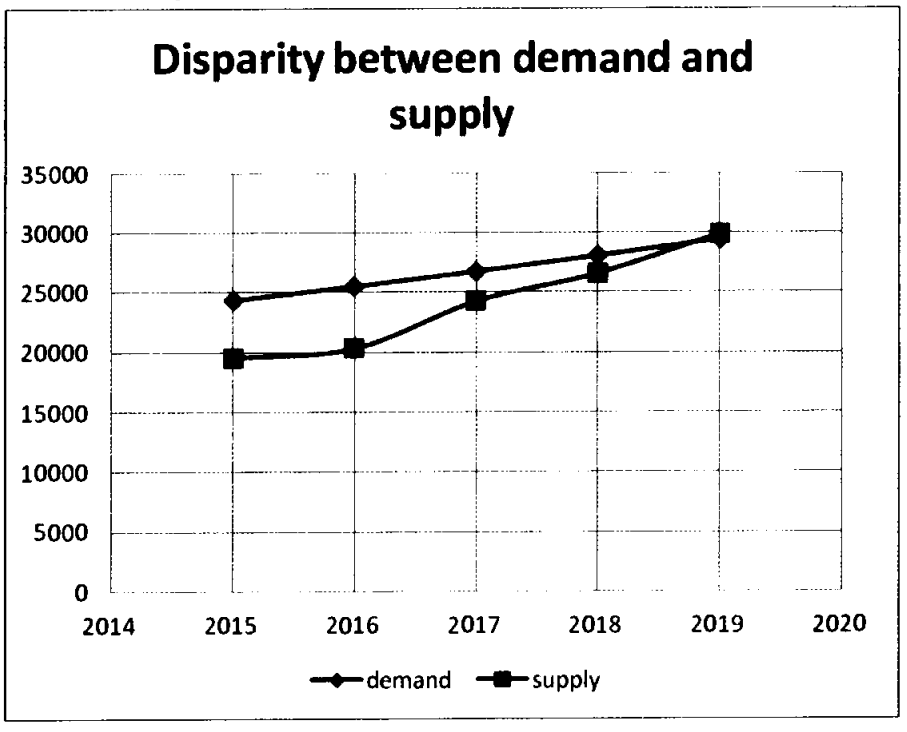
Figure 1-1 Disparity between demand and supply



Note: Source from NTDC.

1.3.4 The Role of RYK Project

Until about 1997, there was an equilibrium between the demand and supply, and with the advent of the 1994 Policy IPPs, it was expected then that the planned supply would meet demand until year 2020. For a variety of reasons, including better-than-expected economic growth, rising levels of disposable income, and availability of consumer finance, the demand started to outpace supply. As of January 2014, demand growth and other factors have resulted in some parts of Pakistan now being subjected to up to several hours of load shedding daily, which greatly disrupts the social and economic fabric of the society.

Since demand suppression is currently so acute, with practically no reserves and with the results of power conservation measures being negligible, practically the entire burden of meeting the gap falls on policy instruments and their appeal to investors for fresh addition to power generation capacity.

To bridge the demand and supply gap and to address the long-term consequences of depending on costly imports, the GoP has now taken major steps to open up the coal sector for power generation. According to Table 1-3, coal fired power generation will be increased almost to 33% by 2030.

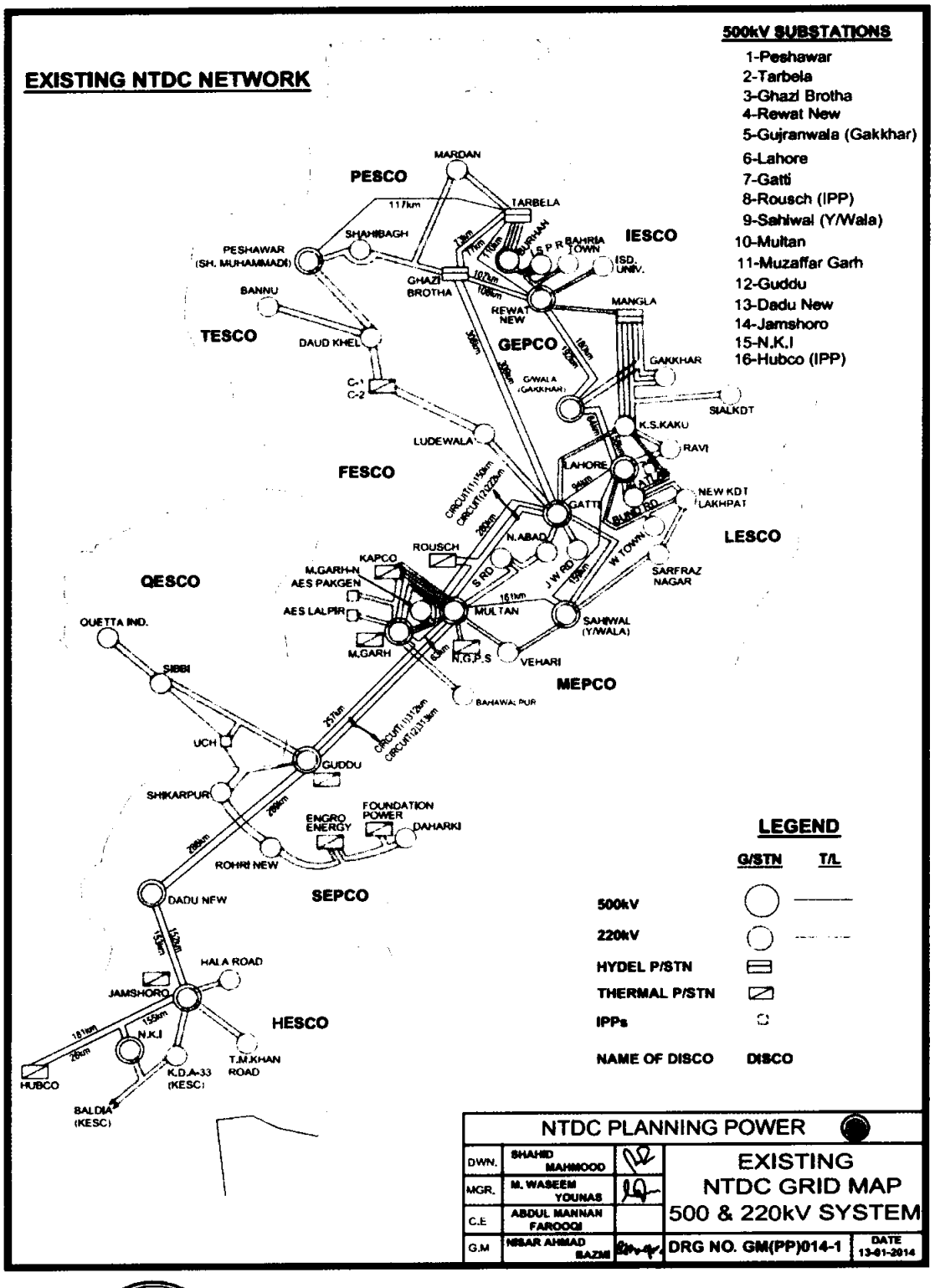
In a word, the proposed RYK project can right resolve shorten of power supply and meet load demand of MEPCO.

1.3.5 Connection with GRID

The power geographical connecting diagram is illustrated in figure1-2.

The location of the coal-fired power plant is Rahim Yar Khan, which is about 6km away from JethaBhutta town & 18km away from Khanpur City. The nearest 132kV line distance (back feed power) is 2km. The nearest railway station is 4km away (Jetha Bhutta Railway Station) and the nearest Canal is about 2km away (Abbasia Canal). For the Grid interconnection, Rahim Yar Khar 1×660MW Coal Fired Power Plant will be connected at voltage of 500 kV with two line bays to Rahimyar Khan 500/220/132KV substation expected to be commissioned by middle of 2016,.

Figure 1-2 The power geographical connecting diagram of Pakistan in 2013



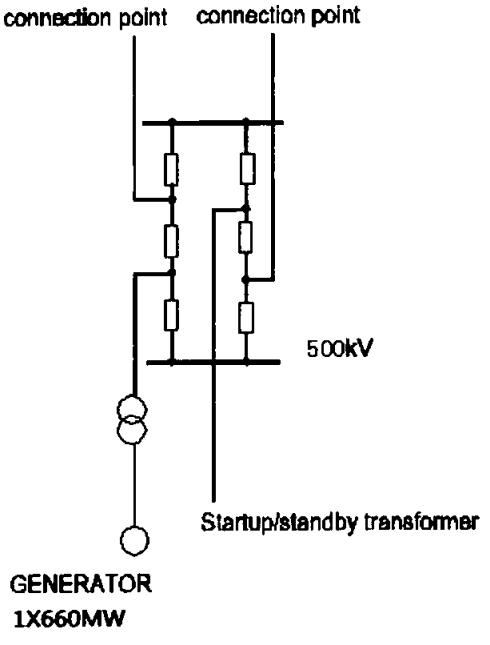
1.3.6 The single line diagram of this power plant substation

Due to the lack of specific materials describing the system, we assume the switchyard scheme temporarily as follows.

One (1) sets of 660MW Coal Fired Generator unit will be built. The generator will be directly connected to its three-phase two-winding Generator Step-up transformer (GSU). The power of the generator will be stepped up by GSU and be transmitted to the 500kV switchyard. The power plant will connect to the GRID at 500kV voltage Class.

The power plant is adopted double bus bar with one and half scheme. 500kV switchyard is newly built in this phase of the power plant and has two (2) outlet lines, one (1) main transformer lines and one(1) start-up/standby transformer line. Reservation of bay is considered for future expansion. The single line diagram of this power plant substation is illustrated as figure 1-3.

Figure 1-3 the single line diagram of this power plant substation



1.3.7 The grid system demands for the main equipments in the power plant:

Details are provided by the completed grid interconnection study. Preliminary grid demand is as follows:

(1) The rated power factor of per generator unit shall be 0.85 (lagging), and it also can be 0.90 leading.

(2) Generator transformers shall be rated to continuously export the maximum output at the generator terminals, at rated power factor, less the minimum auxiliary load. The Generator transformers' rated capacity shall be about 800MVA (three phase), and its' reactance (Uk) is around 13%-14%.

(3)The mode of main transformers neutral grounding is solidly grounded, provisions shall be made for connection to a future-grounding reactor.

2.PROJECT DETAILS

The potential site is located at east of RahimYar Khan city, Punjab, Pakistan. The site is situated on right side of main dual track road network from RahimYar Khan to Lahore and is accessible through single track road which needs to be upgraded. Dual railway track also exists near site. There is no issue of water availability as ABBASIA Canal is passing near the site. Water can be availed from ABBASIA by constructing an open channel or through underground pipes. The evacuation of power is proposed through 500 KV double circuit Transmission Line(s) and will be connected with existing 500kV transmission line. The potential site fall within the sand land which is flat and owned by Government.

This feasibility study is based on fast track and 1x600MW (Net) project. These output figures are based on Design condition for motor driven boiler feed pump configuration, where the gross output is approximately 660 MW.

Since an engineering, procurement, and construction (EPC) contractor has not been committed at this time, the Project design details may change when an EPC contractor is selected and specific equipment suppliers are determined. However, the final design will meet all the general design features to meet the operating capacity and the environmental requirements as described.

The Project includes a completely developed project including the complete engineering, design, procurement, construction, commissioning, and operation of the plant, including a pulverized coal (PC) generating plant, supercritical thermal cycle, cooling water system, single concrete chimney, air and water quality controls (flue gas desulfurization, electrostatic precipitators or baghouse), coal unloading and coal storage facilities, ash disposal, balance-of-plant equipment including all buildings and internal roads and including others to provide a complete power generation facility.

The Pakistan requirements for emissions enacted as NEQS, workplace air quality and noise, and worker health, safety, and training requirements will be implemented in the design of the Project.

The fuel sources for the project will be expected from Australia, Indonesia, Pakistan, and South Africa. Blends of coal based on fuel performance and characteristics will be used at the Project. The rate of blend will be determined at the next stage for incomplete local coal analysis.

2.1 Project Site and Site Selection

2.1.1 Site Selection Criteria

The site is about 3.5km east of the town DHOOP SARHI. The coal power project will supply electricity to existing high-voltage transmission lines supplying power to National Grid.

A systematic evaluation process is implemented to identify the site. Key evaluation considerations included land acquisition, meeting fast track project time schedule, fuel transportation, power evacuation and water source, etc. The site is evaluated to determine the lowest and shortest time for land acquisition and demolition and resettlement.

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The site is evaluated to determine potential sites suitable for a 1x660MW coal project.
To determine the site, the following approach was taken:

- Meetings and communications with Punjab Government and local Government, Railway department of Punjab, Irrigation department of Punjab and local, other related department of Punjab and local.
- Site visits and satellite imagery survey by Google Earth for potential site.
- Determination of key aspects (pro and con evaluation) for the site (Seepage canal, canal water, transmission line for back feed power, railway station, land ownership and resettlement issues etc.)
- Information necessary for the site screening study should be obtained for the site based on site visits.
- Preliminary gird study for determining proximity to load center and power plans of NTDC

2.1.2. Land Acquisitions

The site selection process identified the site on land property owned by Government of Punjab Province and some acres of private occupation. The land acquisition would be facilitated by PPDB. The site initially will be reserved for conduct of Site studies and shall be transferred/leased at the stage of financial Close of the Project.

Nishat has committed itself to the Project since 27 June 2014 when it first issued the bank guarantee in favor of PPDB for the LOI of the Project located at Haveli Bahadur Shah, Jhang. However, the site location proposed by PPDB was rendered unsuitable owing to logistical challenges of coal transportation through railways. After having discussed the issue with PPDB, Nishat decided to file for substitution of the site from Jhang to Rahimyar Khan to which the Board of PPDB accorded its approval in 19 September 2014 and LOI reissued on 30October 2014. This essentially became the starting point for development but unfortunately Rahimyar Khan too was fraught with issues of its location.

The original land marked and proposed by PPDB for the Project was inaccessible for reason of agitation caused by the local inhabitants. The issue was conveyed to PPDB in writing and a process for new site selection began which ultimately culminated in selection of the current site which has recently been endorsed by PPDB to Revenue Board of Punjab for allocation. The process will take time as NOC from other govt departments would also be required.

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2.1.3. Site Location and Characteristics

2.1.3.1 Features of the Site

This site falls 3.5km east of the town DHOOP SARHI and is located adjacent to see page. Available land is 1030 acres.

2.1.3.2 Access to the Site

The site is accessible through Shahi road.

2.1.3.3 Water Source

There is no issue of water availability as ABBASIA Canal of 2,200 cusecs is passing near the site 11 months in a year. Water can be availed from ABBASIA by constructing an open channel or through underground pipes. Effluents discharge will be made into the west border of the site in a separate seepage canal.

2.1.3.4 Power Evacuation

The evacuation of power is proposed through 500 KV double circuit Transmission Line(s). The detailed study in this regard is being carried out by the consultants, Power Planners International. A 132 KV line also crosses overhead very near to the site area which could be used for back feed power requirements during construction.

2.1.3.5 Fuel Delivery

The imported coal will be transported to the jetty at Port Qasim near the Karachi by sea and then transported to the power plant by railways.

2.1.3.6 Environmental

The suitability of the site from environmental considerations has been examined and its impacts determined in detail in the detailed environmental study by Integrated Environment Consultants.

2.1.4 Not used

2.1.5 Site Area Requirements

The Project is feasible at the site. It is similar in size and technology to other plants in the region and has been confirmed to be technically, socially, and environmentally acceptable.

2.1.6 Plant Layout

The plant layout proposed is typical for large coal-fired plants.

The fuel coal will be delivered from port in Karachi to Plant by railway. The access railway will be connected with existing railway, located 3.5km distance at west of the site. The detailed scheme will be implemented by local Railway Department.

The access road will be connected with existing Shahi road, located 2.7km distance at north-west of the site.

The ABBASIA Canal and the seepage canal is close to the site and canal water will be adopted as water source.
The evacuation of power is proposed through 500 KV double circuit Transmission Line(s) .
The ash will be trucked to the ash disposal area located in the south of Plant.

2.2 Design Codes and Standards

In general, the project will be designed, manufactured, erected and commissioned to Chinese standards. It shall also comply with the compulsory standards on seismic design, fire protection, safety and environmental protection of Pakistan, etc.

2.3 Technical Data

The following are the major technical data for the plant design. These data are not repeated in the individual system descriptions. The data are per unit. The source of most of the data is the heat balances and the water balance.

Table 2-6 — Key Technical Data

Parameter	**Value**
ThermalCycleInformation–Gross Capacity	660 MW at guarantee conditions
Thermal Cycle Information – Net Capacity	625MW (target) at design conditions
Net Plant Heat Rate	8359 kJ/kWh at design guarantee conditions (i.e 43%)
Main Steam Flow (VWO) Main Steam Pressure Main Steam Temperature	1,934,200 kg/h 27MPa 600°C
Hot Reheat Flow Hot Reheat Pressure Hot Reheat Temperature	1,518,988 kg/h 4.987 MPa 600°C

Cold Reheat Flow Cold Reheat Pressure Cold Reheat Temperature	1,687,651 kg/h 5.42 MPa 347.2°C
Feed water Pressure	33.1MPa
Coal Burn Rate	242 t/h for the design coal, BMCR load
Water Flow to the Plant Circulating Water Flow Circulating Water Temperature Rise in Condenser	1653m^3/h 83,448 m^3/h to condenser per unit (closed cooling) 9.9°C
Waste Water Flow	10 m^3/h approximate
Potable Water Supply to Plant	10 m^3/h

The data above is based on steam temperatures of 600°C and turbine driven boiler feed water pump.

2.4 Technology Selection

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

2.4.1 Supercritical vs. Subcritical Technology

The technology selection includes determining whether subcritical or supercritical boilers should be used. The selection of the technology will determine the boiler and turbine suppliers as they have definite preferences for either subcritical or supercritical designs.

The terms subcritical and supercritical refer to main steam operation conditions being either below or above the critical pressure of water (22.12MPa). The significance of the critical point is the difference in density between steam and water. Above the critical pressure, there is no step increase in the density between water and steam.

The higher pressure of a supercritical cycle results in a higher efficiency than a subcritical cycle. A typical subcritical cycle has a maximum turbine throttle pressure of 17.38 MPa, and a typical throttle

pressure for a supercritical cycle is 27MPa. This difference in pressure results in a heat rate difference of is up to approximately 6%.

There are currently over 400 supercritical units in operation in the China, United States, Europe, Korea, Japan and a few in the developing countries. The Chinese, European, Japanese suppliers have standardized on supercritical designs for units larger than 600MW. Most recent coal plants now under design and construction are supercritical. With the high price of coal, the higher efficiency of the supercritical design justifies the higher capital cost.

The selection of the technology also considers the capital cost of a supercritical versus a subcritical plant. The capital cost of a supercritical plant is generally approximately the same as, or 2% higher than, a subcritical plant. This cost difference, however, is well within the spread of prices expected in a competitive bid situation, depending on the selection of the EPC Contractor.

Based on the above, Rahim Yar Khar Project will be based on a supercritical cycle to realize the benefit of higher efficiencies and, thereby, reduced fuel costs over the life of the Project.

2.4.2 Unit Size Selection

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

Based on 1,000 to 1,200 MW net generation, the following alternatives for the number and size of units (net generation) were considered:

- 1 x 660 MW
- 1 x 450 MW
- 2 x 330 MW

Based on the current maximum generator size and the NTDC grid, it was determined to exclude the 660 MW single unit both on the basis of generator impact to the grid and effect due to loss of generation due to scheduled maintenance.

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

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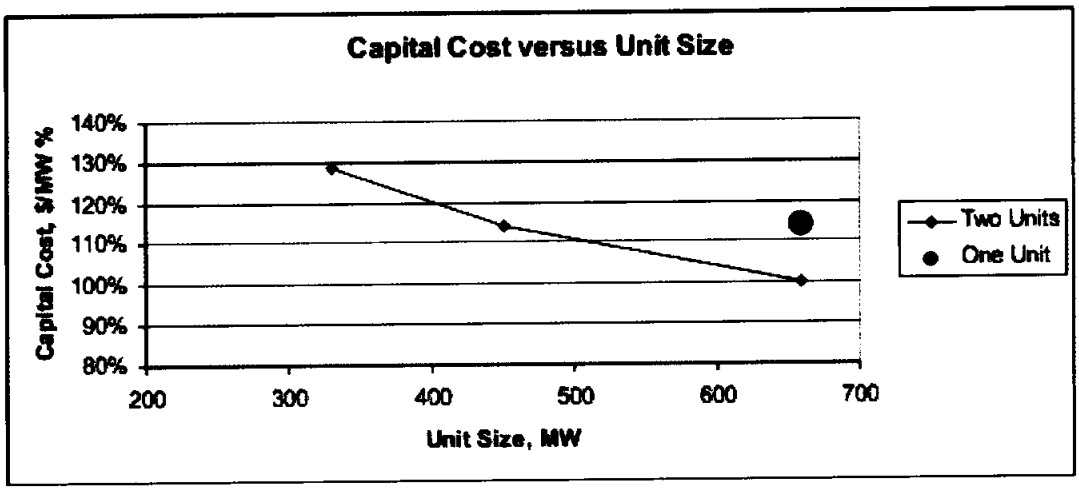
Figure 2-5 - Indicative Relative Cost Relationship (Unit size is gross MW)



The typical capital costs are based on a new site, with site development costs, administration buildings, warehouse, etc. included.

There are no significant break points where the unit cost experiences either a step increase or step decrease change in cost. There will be small step changes for individual suppliers, but when considered across available suppliers, those step changes disappear. For example, there will be a step increase in capital cost of approximately $10/kW at approximately 660

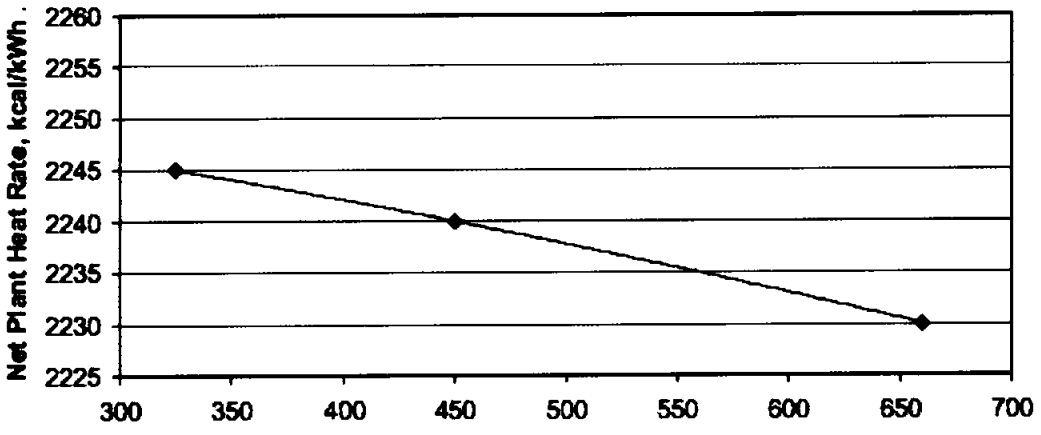
MW when there is a change from five to six pulverizers. However, this change will not occur at the same size for all boiler suppliers. Therefore, there is no cost advantage to any specific unit size.

Competitive pricing is a significant factor in the cost of a unit. In the size range of 330

MW to 1,000 MW, there are several suppliers of all major equipment, with the most competition in the 600 MW to 660 MW size range. Most boiler and turbine suppliers have standard or reference designs that they prefer to offer. If they can duplicate an existing design, they can reduce costs and can be more competitive. For this reason, the most competitive prices can be obtained by specifying a size range (e.g. 650 MW to 700 MW) rather than a specific size.

The efficiency of a coal-fired unit increases slightly with size due to improvements in turbine efficiency, boiler efficiency, and auxiliary power consumption. Larger turbines are more thermally efficient, and one factor contributing that the higher efficiency is that as turbine blades increase in length, leakage past the end of the blades becomes a smaller percentage of the total flow. Boiler efficiency increases slightly with unit size because the heat loss from the boiler casing becomes a smaller percentage of total heat generated. The auxiliary power, as a percentage of gross output, also decreases with unit size. The overall impact can be seen by comparing the heat rate of the 330 MW, 450 MW, and 660 MW sizes in the following figure.

Figure 2-6 - Indicative Heat Rates for Unit Sizes



On the basis of lower capital cost and improved heat rate, only units of approximately 660 MW (gross) were considered in this feasibility study.

2.4.3 Equipment Redundancy

2.4.3.1 Function

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

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

2.4.3.2 Design Basis

The equipment excluding the power train (boiler, steam turbine, and main power transformer) will be designed with an N+1 criteria except noted. Where exceptions are taken, it is due to sufficient reliability and that the effect failure of a single component being out of service is deemed acceptable. The systems designed for this plant will have the following:

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Table 2-8 -Equipment Redundancy

Equipment	**Number / % size**	**Notes**
Circulating Water Pumps	3 / 33 %	
Condensate Pumps	2 / 100% or 3 /50%	
Boiler Feed Pumps	2 / 50% turbine driven plus 35% motor driven startup Or 3x35% motor driven	
Vacuum Pumps/ SJAE	2 / 100%	
6 KV Buses	2	Redundant motors fed from different buses
Main Power Transformers	1	
Aux Transformers	1	
Standby Transformers Coal Handling	1	Note – repair can be performed to enable continuous operation
Stack Out Belts	1/2	1x660 MW
Stacker-reclaimers	1/2	1x660 MW
Reclaim Belts	1/2	1x660 MW
Reclaimers	1/2	1x660 MW

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Crushers	1/2	1x660 MW
Dust Collectors	2/50%	High reliability item
Wagon tippler	1/2	1x660 MW

2.4.4 Flue Gas Desulfurization System Selection

A wet limestone flue gas desulfurization (FGD) system was selected for this project because this project location is far from sea. No other FGD system can be the choice.

2.4.5 Cooling Water System Selection

Normally, there is three type cooling type for turbine condenser ,one is once through ,one is recirculation with cooling tower, the other is air cooling.

The water source for the power plant is Abbasia Canal, then through a irrigation canal which will be closed for renovations for a month every winter dry season is pumped to plant, and considering the groundwater pumped to meet plant water during renovation time.

According to the channel function, water flow, distance between plant and water source and water quantity requirement ,recirculation cooling system is the best option.

2.4.6 Not used

2.5 Plant Material and Energy Balance

2.5.1 Heat Balance

The heat balances for the proposed supercritical cycle are included in Appendix E.4. The data shown include turbine heat rate and gross output.

2.5.2 Water balance

Water Balance can be found in Appendix D.14 Water Balance Diagram. The water consumption was estimated and will cover water requirements for the following:

- Plant uses including boiler makeup
- Coal dust suppression
- Potable and service water

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2.6 Systems and Equipment

The final generation capability of the unit is targeted for net 625 MW and will depend on the vendors selected for the steam turbine and steam generator. Vendors have units or building blocks that are optimized for their design. To maximize the capacity and reduce costs, the final design needs to remain flexible until the final vendor selection is made. The scope of the Project will include all work to develop the site including

- Generating unit
  - Turbine generators
  - Steam generators
  - Raw water intake and reservoir
  - Water treatment system for plant cycle makeup and domestic water for the plant
  - Emission control systems
  - 500-kV Air-insulated substation (AIS) switchyard
  - Auxiliary power system
    - Auxiliary boiler, fuel oil fired
    - Coal handling systems
    - Wagon tippler
    - Conveyors
    - Stock system
- Civil works
  - Site development
  - Roads
  - Drainage
  - Foundations
  - Buildings
    - Offices
    - Warehouses
    - Maintenance shops
    - Camp for construction workers
    - Ash storage area

2.6.1 Mechanical systems

2.6.1.1 Boiler

2.6.1.1.1 Function

The boiler converts the energy in the coal to high pressure steam. The steam is then discharged to the turbine.

2.6.1.1.2 Design Basis

The boiler is a high parameter, supercritical, balanced draft, outdoor, coal-fired design.

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The warm-up and ignition fuel will be High Speed Diesel (HSD).This fuel will provide initial firing and will stabilize the combustion until the coal flames are stable, about 30% to 35% load. Details of the design depend on the specific suppler chosen for the Project.

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

The steam design conditions are shown in the Technical Data section.

The life of boiler main pressure parts is expected to 30 years.

The following major components are supplied:

- Boiler
- Forced draft fans
- Primary air fans
- Induced draft fans
- Pulverizers

There will be a minimum of two 50% air heaters, forced draft, primary air, and induced draft fans.

The following discussion is general; many of the details will vary depending on the manufacturer selected.

The modern large supercritical boiler has the following major components:

- Furnace
- Superheaters
- Reheaters
- Economizer
- Air preheater
- Mix bottles or leveling vessels (depending on the specific vendor)
- Water collection tank
- Circulation pumps
- Burners
- Pulverizers

The components are discussed individually below.

The characteristics of the design coal are shown below.

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Table 2-11 - Proximate and Ultimate Analysis of Design Coal Spec

PARAMETER	UNITS	WORST COAL	PERFORMANCE COAL
Total Moisture (arb)	%	25.1	9.27
Proximate Analysis			
Inherent Moisture (adb)	%	14.9	4.44
Ash (adb)	%	5.61	18.5
Total Sulphur (adb)	%	1.43	1.09
Volatile Matter (adb)	%	39.03	24.98
Fixed Carbon (adb)	%	40.46	52.08
GCV (adb)	kcal/kg	5715	5889
GCV (arb)	kcal/kg	5030	5591
NCV (arb)	kcal/kg	4731	5371
HGI		48	53
Size	0 - 50 mm	90%	99.20%
Ultimate Analysis			
Carbon (daf)	%	74.78	81.33
Hydrogen (daf)	%	4.15	4.62
Nitrogen (daf)	%	1.39	1.99
Sulphur (daf)	%	1.80	1.38
Oxygen (daf)	%	17.88	10.68
Ash Fusion Temperature			
IDT	deg C	1140	1240
Spherical	deg C	1160	1270
Hemispherical	deg C	1170	1290
Flow	deg C	1240	1310
Ash Analysis			
SiO2 (db)	%	42.70	53.39
Al2O3 (db)	%	14.20	22.65
Fe2O3 (db)	%	14.40	6.56
CaO (db)	%	14.00	6.92
MgO (db)	%	6.70	2.23
TiO2 (db)	%	0.67	1.06
Na2O (db)	%	2.30	0.19
K2O (db)	%	1.32	0.66
P2O5 (db)	%	0.18	0.62
SO3 (db)	%	2.08	5.22
Others (db)	%	1.45	0.50

2.6.1.1.2.1 Furnace

The furnace is an enclosure to provide space for fuel combustion and cooling of the combustion gasses before the gases enter the convection pass. In the furnace area the fuel and combustion air are injected in a controlled manner to efficiently control the combustion. In the furnace walls the water is converted to steam. High parameter supercritical units have no drum to separate the water and steam. Modern furnaces are formed by spiral water tube walls. The spiral

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design insures a more even distribution of heat to each of the circuits.
The heat transfer in the furnace is largely radiant. At the top of the furnace, the tube arrangement changes to a vertical arrangement. The gases then rise to the convection pass, named because the heat transfer is by convection.

2.6.1.1.2.2 Superheaters and Reheaters

The superheaters, reheaters, and economizer are in the convection pass. Superheaters and reheaters are in-line tube bundles that increase the temperature of the saturated steam. There may be several superheater sections. These may be arranged as platen, intermediate, final, and primary superheaters.
Reheaters are designed similar to the superheaters except they operate at lower temperatures. The gas flow is from the final to the primary reheater. The steam temperature from the exit of the final superheater and the final reheater is the steam temperature entering the turbine high pressure and intermediate pressure turbines respectively.

2.6.1.1.2.3 Economizer

The economizer is a counter-flow heat exchanger for recovery of the heat remaining in the flue gasses at the exit of the primary reheater and/or superheater. The tube bundle is usually a serpentine arrangement of parallel tubes with the water flow opposite to the gas flow. Water enters the economizer from the feedwater system and discharges to the furnace walls. Tube spacing is critical. Close spacing has better heat transfer but can result in plugging of the spaces with ash.

2.6.1.1.2.4 Mix Bottles, Water Collection Tank, and Circulation Pumps

The mix bottles, water collection tank, and circulation pumps are part of the startup system used to control the initial generation of steam.

2.6.1.1.2.5 Air Preheater

There are several air preheater designs. One of the common designs is a Lungstrom which uses a metallic heat transfer surface that rotates at 1 to 3 revolutions per minute (rpm). Other designs use rotating hoods with a stationary metallic heat transfer surface. Radial and axial seals are required to control leakage between the air and gas sides. These seals must accommodate axial and radial growth in a difficult environment. Some new designs include automatic seal adjustments depending on temperatures.
The air preheater uses hot gases from the outlet of the boiler economizer to warm the inlet air discharged from the forced draft fans. The size of the air heater depends on the evaluation of the manufacturer to balance the size of the economizer and the size of the air heater. The air inlet to the air heater is typically 27°C, and it is heated to about 300°C. The hot gases from the boiler enter the air heater at about 400°Cand exit at about 120°C. Air heaters are usually the regenerative type.
Cleaning of the air preheater is done regularly on-line with sootblowers and off-line loads with water wash.

2.6.1.1.2.6 Sootblowers

Sootblowers are designed to clean soot and slag from the heat transfer surfaces of the boiler and air preheater. The number and location of the soot blowers will be determined by the boiler supplier based on his experience with his boiler design and similar coals. Steam is supplied at a constant pressure usually from the cold reheat pipe.

There are three general types of sootblowers: wall, retractable, and water cannon. Wall blowers use a stream of high-pressure steam to remove slag from furnace walls. They are inserted into the furnace and rotate in a circular pattern; typically 20 to 30 per furnace. Retractable sootblowers are used to clean convection passes using a long lance that is rotated in to the sectionto be cleaned; typically 30 to 40 per furnace. Water cannons direct a stream of water across the furnace to the opposite wall and part of the side walls. There are typically two when used to clean furnace walls: one on the front wall and one on the rear wall. Their control systems have become increasingly sophisticated in recent years, and they are commonly used for difficult coals.

2.6.1.1.2.7 Pulverizers

Coal pulverizers are required to crush the coal to a uniform fineness and to evaporate moisture to ensure efficient combustion. Modern coal-firing systems are direct-fire systems; that is, they move the coal and hot air directly from the pulverizer to the burners with no intermediate storage. There are typically six to eight pulverizers per boiler. Based on the design coal, one spare pulverizer will be included in the design.

Modern pulverizers are of the air-swept, vertical-shaft, roller type. They are low speed, the table rotates at 20 to 35 rpm. The table is driven by an electric motor, typically 375 to 650 kW (500 to 900 horsepower [hp]) through a reduction gear. The coal is crushed between the table and the rollers. A classifier at the top of the pulverizer separates oversized particles and returns them to the grinding area.

The hot primary air enters the pulverizer from the air preheater, it dries the coal and moves the coal through the pulverizer and pipes to the individual burners.

2.6.1.1.2.8 Burners

Burners combine secondary air from the air preheater with the coal and primary air from the pulverizer in a manner to sustain ignition and produce a stable flame. There are typically six to eight burners per pulverizer.

Burners are critical to achieving combustion and controlling boiler emissions. NOX, CO, and unburned carbon are controlled by good burner design.

2.6.1.1.3 System Operation

In normal operation, the fuel is gravity fed to the feeders from the coal silos. The feeders regulate the coal flow to maintain the steam generation required by the turbine. The coal then drops into the pulverizers where it is crushed to a controlled fineness, and then blown into the furnace by primary air where it is combined with secondary air and combustion occurs. The radiant heat and hot gases then cause the water in the furnace to be heated to steam.

The combustion air is supplied by forced draft fans, through the air heaters and into the furnace. The gases are then drawn through the superheaters and back passes the air heater and precipitator. The flue gas is routed through the flue

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gas desulfurization (FGD) scrubber and then to the chimney.

2.6.1.1.4 Main Material Specifications

Main steam piping: SA335-P92
Hot reheat piping: SA335-P92
Cold reheat piping: A691Cr1-1/4CL22
HP feedwater piping: WB36
Boiler Downcomer: SA-106C
Boiler Waterwall spiral pipe: SA-213T12
Boiler Waterwall vertical pipe: SA-213T12
Boiler SH I outlet header: SA-335P12
Boiler Final SH outlet header: SA-335P92
Boiler Low-temp RH inlet header: SA-106C
Boiler Low-temp RH outlet header: SA-335P12
Boiler High-temp RH inlet header: SA-335P92
Boiler High-temp RH outlet header: SA-335P91

2.6.1.2 Turbine Generator

2.6.1.2.1 Function

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

The steam turbine is a tandem-compound three- or four-casing design, depending on the manufacturer.

2.6.1.2.2 Design Basis

The steam turbine is designed to accept the steam flows as defined in the Technical Data section. The turbine-generator will operate at 3,000 rpm.

Extraction steam is routed from various sections of the turbine and routed to the feedwater heaters. The cycle is based on eight feedwater heaters, four low-pressure heaters, one deaerator heater, and three high-pressure heaters. The first one or two heaters will be installed in the condenser neck.

The following major components are supplied with the turbine:

- High-pressure turbine
- Intermediate-pressure turbine
- Low-pressure turbine
- Lubricating oil reservoir, pumps and piping
- Digital Electro hydraulic control (DEHC) oil system
- Generator
- Hydrogen seal oil system
- Exciter

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• Control system

These components are discussed individually below.

2.6.1.2.2.1 High-Pressure Turbine

The high-pressure turbine (HP) receives steam from the main steam pipe and expands it through several stages of blades. The steam that exits the HP turbine returns to the boiler through the cold reheat pipe. In the boiler, the steam is heated to the design reheat temperature and returned to the intermediate-pressure (IP) turbine.

2.6.1.2.2.2 Intermediate-Pressure Turbine

The steam is further expanded in the IP section. It is then brought to the low-pressure (LP) turbines by the crossover pipe at a temperate of about 285°C.

2.6.1.2.2.3 Low-Pressure Turbine

The steam is split between the two LP turbines because it is technically impractical to build 660 MW or larger LP turbines large enough to pass the high volume of low-pressure steam. Each LP turbine is double flow, meaning that the steam enters at the center and flows out axially towards both the turbine end and the generator end. This is called a four-flow machine. Large steam turbines have last-stage blades that are about 1.1 to 1.2 meters (42 to 48 inches) long.
All turbine sections have benefited in the past decades by improved blade designs that have improved efficiency and reliability. The most significant part of the power plant performance improvement is the turbine improvement.

2.6.1.2.2.4 Lubricating Oil System

The lubricating oil system includes the oil tank, pumps, coolers, piping and controls the supply of clean oil to the turbine and generator bearings. The oil tank contains 7.5 m3 (2,000 gallons) or more of lubricating oil, pumps, and piping. The pumps are usually vertical pumps with the suction below the low oil level and the electric motors above the tank.
The main, auxiliary, and emergency pumps discharge to a header, where the oil is cooled to the design supply temperature, filtered, and distributed to each of the turbine and generator bearings. The oil discharged from the bearings is collected and drained by gravity to the tank.

2.6.1.2.2.5 Digital Electrohydraulic Control Oil System

The DEHC oil is a high-pressure oil system used to control the stop and control valves that regulate the admission of steam to the turbines. The system is constructed of mostly stainless steel components to maintain the required high level of cleanliness required. A fine filtering system also helps achieve the cleanliness.

2.6.1.2.2.6 Generator

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

2.6.1.2.2.7 Hydrogen Seal Oil System

The hydrogen seal oil system seals the shaft ends of the generator rotor to reduce the escape of hydrogen from the generator. This system supplies a constant flow of lubricating oil from its tank to the seals at each end of the generator stator. This oil is collected and drained to degassing systems and the seal oil tank. It is also cooled in a similar manner to the lubricating oil system. Hydrogen gas is explosive, so this system is critical to the safe operation of the plant.

2.6.1.2.2.8 Static Exciter

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

2.6.1.2.2.9 Control System

The turbine control system is supplied by the turbine manufacturer to interface with all parts of the turbine generator. Among the items controlled are the steam stop and control valves.

2.6.1.2.3 System Operation

In normal operation, the steam is admitted to the HP turbine through the stop and control valves. After the steam is expanded through the HP turbine, it is returned to the boiler to be heated to the design temperature in the reheater section. The reheated steam then expands through the IP turbine and the LP turbines.

The control valves limit the steam flow to achieve the load required. Steam is extracted from the turbine at several points for use in the feedwater heaters, which improves cycle efficiency. The amount of steam extracted will not be regulated with a control valve and is therefore termed uncontrolled.

The lubricating oil system contains the oil for the bearings of the turbine and generator. Pumps take suction from the tank and after-coolers deliver the oil to each of the bearings to lubricate the surfaces and remove heat. The oil then returns to the main tank.

The EHC system is a separate high-pressure oil system that is used to open and close the stop and control valves as needed. The valves are opened to add more steam as load is increased and closed to reduce load. The valves also close quickly to prevent over-speed in case load is reduced quickly or tripped.

The hydrogen seal oil system is a hydraulic seal between the generator stator and rotor to contain the hydrogen gas inside the generator.

2.6.1.3 Main Steam and Reheat Piping

2.6.1.3.1 Function

The major steam systems include the main steam, cold reheat, hot reheat, and extraction steam pipes.

2.6.1.3.2 Design Basis

2.6.1.3.2.1 Main Steam

The main steam pipe will carry the steam from the boiler superheater outlet to the steam turbine stop and control valves.

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Due to the operating temperature, this pipe is typically made of P92.

2.6.1.3.2.2 Cold Reheat

The cold reheat pipe will transport the steam from the HP turbine outlet to the inlet of the boiler reheater. Due to the operating temperature, this pipe is typically made of A691Cr1-1/4CL22.

2.6.1.3.2.3 Hot Reheat

The hot reheat pipe will carry the steam from the reheater outlet to the IP turbine inlet stop valves. Due to the operating temperature, this pipe is typically made of P92 material.

These pipe systems will be designed for the steam conditions established on the heat balances for the specific boiler and steam turbines selected. The reheat pipes are sized to result in a low pressure drop that is set by the turbine designer. The main steam pipe for supercritical units is typically designed for a maximum of 1.2 MPa pressure drop, and a maximum velocity of 100 m/s.

2.6.1.3.2.4 Extraction Steam

The extraction steam systems carry the steam from the individual turbine connections to the feedwater heaters. The pressure drop is set by the instructions of the turbine manufacturer and is usually 5% of the stage pressure.

The extraction pipes will have shut-off valves and air-assisted check valves as required by code and turbine manufacturer requirements.

The condensed steam in the feedwater heaters is termed heater drains. These drains are cascaded from the higher pressure heaters to the next lowest operating pressure heater. The lowest-pressure HP heater is drained to the deaerator. The lowest pressure LP heater is drained to the condenser. All feedwater heaters are also provided with emergency heater drains, which can drain any heater to the condenser. This capability is needed when heaters are out of service, if leaks occur in the heater tubes, and at startup.

All the steam systems will have drain systems. These include drain pots, drain pipes, level detectors, and drain valves. The deaerator heater is a direct contact heater; it has no tubes. Also it has no heater drain;
the drain is the suction connection to the feedwater pumps.

2.6.1.3.3 System Operation

During normal operation, the steam will flow through the main steam line to the HP turbine inlet. Steam exhausted from the HP turbine will flow through the cold reheat line to the steam generator reheater inlet. The steam is reheated in the steam generator and will flow through the hot reheat line to the IP turbine inlet.

The cold reheat line generally supplies steam to the seventh feedwater heater (depends on the turbine design). This, like all extractions, will be uncontrolled.

The extraction steam pipes will carry the steam from the individual turbine connections to the feedwater heaters. The isolation and check valves are designed to isolate the feedwater heaters from the turbine during a turbine trip. This capability will prevent turbine overspeeding due to the energy stored in the heaters. Feedwater heaters installed in the

condenser neck do not require this isolation because of the relatively low energy stored.
The heater drains will normally drain to the lower pressure heater. During startup, however, there is commonly inadequate pressure to accomplish this, so the heater is drained to the condenser. Also, if a tube leak occurs in a heater, the higher pressure water will leak into the shell. This will increase the flow of the heater drain. If a high level occurs in the heater shell, the emergency drain will open to the condenser. Relief valves will open to protect the heater shell from overpressure if the pressure exceeds the design pressure.
When heaters are out of service, the maximum load of the turbine may be reduced due to the increased steam flow through the LP turbine. This criterion is set by the turbine supplier and will depend on the project requirements and the supplier's design specifics.

2.6.1.4 Condensate

2.6.1.4.1 Function

The condensate system transfers the condensed steam from the condenser hotwell, through the low-pressure feedwater heaters, and into the deaerator heater.

2.6.1.4.2 Design Basis

The condensate system will be designed to provide a continuous supply of water from the condenser to maintain a constant level in the deaerator heater.
There will be three 50% capacity, or two 100% capacity, motor-driven condensate pumps, which will take suction through strainers from the condenser hotwell. These pumps are typically vertical can-type pumps with the cans mounted in the concrete substructure. There will be a margin of 3% in flow and 10% in head in the pump design to account for wear and unknowns. A bypass system, with an automatic control valve, will be provided to ensure the required minimum flow through the pumps.
The system transfers the water through the condensate polisher, gland steam condenser, and three low-pressure feedwater heaters. The temperature of the water is increased in each of the feedwater heaters. Also, water is supplied to the turbine hood sprays and other uses as required. The condensate will also be pumped through the steam jet air ejector if that is the system selected by the EPC contractor; rotary vacuum pumps may be used.
The condensate is heated and deaerated in the deaerator. The deaerator is elevated to provide adequate net positive suction head for the boiler feed pumps. Drains from the gland steam condenser and feedwater heaters will be returned to the condenser.

2.6.1.4.3 System Operation

The condensate pumps take suction from the condenser hot well and discharge to a common header. During normal operation, makeup water will be delivered to the condenser from the condensate storage tank to maintain the normal water level in the hot well. This flow is normally accomplished by the elevation in the condensate tank and the negative pressure in the condenser. Pumps will be provided to deliver the required water in cases of low water level in the tank or high demand.

Normally, one pump will operate at startup, and up to 60% load. Above 60% load, a second pump will be started. If a pump trips or if header pressure is below a predetermined level, then the third pump will be started automatically.
The bypass system will be controlled by the DCS system. It is typically wide open at initial startup, gradually closes as flow through the system increases, and is closed when the unit load approaches full load.

2.6.1.5 Feedwater

2.6.1.5.1 Function

The feedwater system transfers the water from the deaerator, through the high-pressure feedwater heaters, and to the boiler.

2.6.1.5.2 Design Basis

The feedwater system will be designed to provide a continuous supply of water from the deaerator heater to the boiler. There will be two turbine-driven 50% capacity and one 35% motor-driven startup pump, or three motor-driven, 35% capacity, feedwater pumps. The final decision on turbine-driven pumps or motor-driven pumps will be up to the EPC contractor. In general, the studies done comparing these designs indicate that there is little or no difference in the total evaluated cost. The capital cost will be higher for the turbine-driven option but operating costs will be reduced. In either case, the net plant output will not be changed.
These pumps are typically barrel-type pumps with the barrel supported on a steel base. There will be a margin of 3% in flow and 10% in head in the pump design to account for wear and unknowns. A bypass system, with automatic control valve, will be provided to ensure the required minimum flow through the pumps.
These pumps typically use a variable-speed drive. The variable speed may be achieved by variable speed motors or fluid couplings. The variable speed allows the pump to operate at close to the minimum speed required for the load at any particular time. This capability reduces the power requirements, recirculation flow, and wear of the pump. The wear on the pump is a particularly significant factor during startup if variable speed is not provided.
The system transfers the water through the high-pressure feedwater heaters. The temperature of the water is increased in each of the feedwaterheaters. Also, water is supplied to attemperators and other uses as required. The water to the reheat attemperators is supplied from an interstage connection on the pumps.
If three motor-driven feedwater pumps will be selected by the EPC contractor, the pumps shall be started singly during boiler operating.

2.6.1.5.3 System Operation

The feedwater pumps take suction from the deaerator and discharge to a common header. The header is the main feedwater line which connects to the HP feedwater heaters. The discharge from the last heater connects to the boiler economizer inlet.
The pump speed and the bypass system will be controlled by the DCS system. The bypass is typically wide open at initial startup, gradually closes as flow through the system increases, and is closed when the unit load approaches full load.

2.6.1.6 Not used

2.6.1.7 Closed Cooling Water System

2.6.1.7.1 Function

The closed cooling water (CCW) system will cool all water-cooled equipment in the plant except the main condenser. The system will use opened cooling water to cool a closed-loop freshwater system.

2.6.1.7.2 Design Basis

The system will use demineralized water for initial filling and makeup as needed. The water will be treated with corrosion inhibitors to minimize corrosion in the piping and heat exchangers. Two 100% capacity pumps will pump the fresh water through the two 100% capacity heat exchangers and the cooled equipment, through a closed system, and return to the pump suction. An expansion tank will be provided to accommodate the thermal expansion and provide a supply of water for makeup required by small leaks.

The system will provide cooling water to the following equipment:

- Main turbine oil coolers
- Generator hydrogen coolers
- Exciter coolers
- Generator stator oil coolers
- Boiler auxiliaries (as needed)
- Feedwater pump coolers
- Water and steam sample coolers
- Large motor coolers (if required)
- Air compressors (if required)

The closed cooling water pump design will include at least 5% flow margin. The heat exchangers will include at least 10% heat duty margin.

A means of chemical addition will be provided without the expansion tank being opened. The unit will have a completely independent system.

2.6.1.7.3 System Operation

In normal operation, one of the two closed cooling water pumps will circulate water continuously through the loop. The second pump will be in standby. The second pump will start automatically on low header pressure or a trip of the first pump.

A low water level in the expansion tank will be alarmed in the control room. Water will be added through a manual valve from the demineralized water system.

A grab sample valve will be used to periodically obtain a sample for testing.

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Equipment temperature will be controlled by automatic temperature control valves at each of the major coolers. Small coolers may be manually controlled.

2.6.1.8 Demineralized Water Processing System

2.6.1.8.1 System Function

The demineralized water processing system provides demineralization treatment for the clarified water from the pretreatment system and produces ultrapure water as cycle makeup to the high-parameter supercritical coal-fired unit.

2.6.1.8.2 Water Quality Data

The raw water is pumped from the Abbasia Canal which flows on the north of the site area. The flow of the canal is plentiful enough for the unit operating for 11 months of the year. And the other one month, as the canal is dammed up due to the drought period, the well water will be used to ensure the water demand for the unit normal operating. There is only one canal water quality data temporarily which is listed as follow:

TABLE2.6.1.8-2Abbasia Canal Water Quality

#	ITEM	UNIT	CANAL
1	pH	-	8.25
2	Conductivity	μS/cm	300
3	Total Dissolved Solid (TDS)	ppm	210
4	Total Suspended Solid (TSS)	ppm	424
5	Calcium as $CaCO_3$	ppm	73
6	Magnesium as $CaCO_3$	ppm	29
7	Total Hardness	ppm	103
8	Alkalinity (Total)	ppm	90
9	Chloride	ppm	24
10	Sulphate	ppm	26
11	Iron	ppm	0.048
12	Silicon as SiO_2	ppm	6.6

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13	Copper	ppb	4

The well water quality data is still wanted, we suppose the TDS of the well water is not more than 800 mg/L. Usually, to design an optimizational system, we need to get the last 12 months water quality data of the surface water, or 4 water quality data of the ground water of each season. So the system will be checked and optimized when we get more water quality data.

2.6.1.8.3 The quality criterion of water and steam for power plant

A coal fired steam power plant with the capacity of 1×660MW will be designed. And the high-parameter supercritical pressure boiler will be used in this project. The boiler maximal continuous evaporation capacity(BMCR) is 1934.2 t/h, and the steam pressure of superheater outlet is 28.25 MPa(g). Based on GB/T 12145-2008 Quality criterion of water and steam for generating unit and steam power equipment, the water quality criterion of water and steam for power plant is listed as below:

TABLE2.6.1.8-3 Quality Criterion of Water and Steam

		Steam		Feed water for boiler		Condensate water		makeup water
		Standard	expectation	Standard	expectation	Standard	expectation	Standard
Na	μg/kg	≤3	≤2	≤3	≤2	≤3	≤1	—
CC(25 °C)	μS/cm	≤0.15	≤0.10	≤0.15	≤0.10	≤0.15	≤0.10	≤0.40 (Tank outlet)
SiO_2	μg/kg	≤10	≤5	≤10	≤5	≤10	≤5	≤10
Fe	μg/kg	≤5	≤3	≤5	≤3	≤5	≤3	—
Cu	μg/kg	≤2	≤1	≤2	≤1	≤2	≤1	—

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TABLE2.6.1.8-3 Quality Criterion of Water and Steam								
		Steam		Feed water for boiler		Condensate water		makeup water
		Standard	expectation	Standard	expectation	Standard	expectation	Standard
DO	μg/kg	—	—	30~150	—	≤30	—	—
pH(25℃)		—	—	8.0~9.0	—	—	—	—
TOC	μg/kg	—	—	≤200	—	—	—	≤200

2.6.1.8.4 System Selection

The demineralized water processing system will supply enough demineralized water for boiler and the closed cooling water system, etc. Based on the canal water quality and the quality criterion of water and steam, the main demineralized water processing system flow diagram is as follow:

Clean water from Pretreatment Device → UF Feed Water Pump →UF Safety Filter → Ultra Filter Unit → UF Water Tank → UF Water Pump → RO Safety Filter → RO HP Pump →RO Membrane Unit → RO Water Tank → RO Water Boosting Pump → Cation Bed → Decarbonator →Anion Bed → Mixed bed → DM Water Tank → DM Water Pump → Main Building

The quality of the produced demineralized water will be listed as followed:

SiO_2 ≤10 μg/L

Conductivity ≤0.15 μs/cm (25℃)

2.6.1.8.5 System Capacity

According to the rules of GB 50660-2011 *Code for design of fossil fired power plant,* the water and steam losses of the plant operating process is as follow:

TABLE 2.6.1.8-3
Minimum Sizing Criteria for Facility Water Usage and Flow

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#	Item	m^3/h
1	Normal Loss of water-steam Cycle	29
2	Self Water Usage of demineralization water treatment system	0.6
3	Total DM Water Demand	29.6
Note: The boiler maximal continuous evaporation capacity(BMCR) is 1934.2 t/h.		

Based on the data in table 2.6.1.8-1 and taking some other factors into account, such as the water requirement as the boiler commissioning into account, the normal capacity of the system will be designed as 50 m^3/h, the maximum will be 100 m^3/h. The system configuration is as follow:

The Ultra Filter device will be used to remove suspended solids, to meet the turbidity and Silt Density Index requirements for feed water to RO devices. The capacity of the Ultra Filters is 2×67 m^3/h (one for operating and the other for standby).

RO device is one pass two stages type. The capacity of RO devices is 2×50 m^3/h (one for operating and the other for standby).

The capacity of ion exchangers is 2×100m^3/h (one for operating and the other for standby).

As a large quantity of demineralized water is needed for the unit commissioning, the inlet water of the ion excharger system can mix with the clean water from pretreatment device.

Demineralized water processing system will be arranged in demineralized water plant which consists of indoor part and outdoor part. The UF unit, RO unit, Desalted water tank, cation bed, anion bed, mixed bed, chemical dosing equipments, chemical cleaning equipments and pumps will be arranged indoors, while the UF tanks, DM water tanks, ponds and Acid & Caustic Storage will be arranged outdoors.

2.6.1.9 Condensate Polishing System

2.6.1.9.1 System Function

The function of condensate polishing system is removing the contamination of steam and water.

2.6.1.9.2 System Selection

To meet the demand of the water and steam quality of the high-parameter supercritical pressure unit, the 100% output mid-pressure condensate polishing system will be provided for the unit. The main condensate polishing system flow diagram is as follow:

Condensate Water from Condensate Pump ➔ Prefilter ➔ Mixed Bed ➔ Resin Trap ➔ Back to Thermal System

The quality of the condensate water after polishing will be listed as followed:

TABLE 2.6.1.9-1 Quality criterion of polished condensate water

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Item	Unit	Guarantee Value under normal operating
SiO_2	μg/L	≤10
Na^+	μg/L	≤3
Fe	μg/L	≤5
Cu	μg/L	≤2
CC（25℃）	μs/cm	≤0.15

Under normal operating, there will be 1290 m^3/h condensate water from the unit needed to be sent to condensate polishing system. There are 2×50% prefilters with no spare. And there are 3×50% mixed beds for the unit, 2 for operating and the other for standby.

One set of regeneration device will be provided to the system to regenerate the exhausted resin.

2.6.1.10 Chemical Dosing System for Steam/water Cycle

The dosing system is designed to maintain the steam/water circuit chemistry under all operating conditions and control the water chemistry of condensate-feed water-steam cycle to minimize deposition and corrosion.

The chemical dosing system will be provided to the unit. The chemical dosing system includes ammonia dosing system (for condensate water, feed water and closed cooling water), and the oxygen dosing system (for condensate water and feed water).

2.6.1.11 Steam/Water Sampling and Monitoring System

Steam and water sampling system is designed to sample and monitor the normal and abnormal operation of the unit. The function of the sampling system is as follows:

1) Provide representative process stream samples for analysis to monitor and measure the performance of thermal systems and equipment.
2) Provide a means to obtain samples for routine and special laboratory tests.
3) Provide control signal for chemical dosing system.

The sampling system will provide effective sampling, analyzing and indicating facilities for water & steam cycle, closed cooling water.

2.6.1.12 Circulating Cooling Water Treatment System

The indirect open circulating cooling water system is designed with natural draft cooling tower in this project, and the make-up water is from the Abbasia Canal.

To prevent the cooling equipment from scaling and maintain the cycles of concentration, the scale inhibitor dosing system will be provided.

To control the microbial propagation in circulating cooling water, and further more to prevent the cooling equipment

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from clogging and corrosion, the chlorination system will be needed.
We suggest using the sodium hypochlorite bought locally. But if the sodium hypochlorite cannot be bought, the chlorine dioxide generator system will be provided. The system output is 2×10kg/h.
The circulating cooling water treatment plant will be arranged near the circulating water pump station.

2.6.1.13 Wastewater Treatment System

The wastewater treatment system will be designed to collect and treat all kinds of industrial wastewater, which includes wastewater from demineralized water plant, wastewater from condensate polishing system etc. 3×2000m^3 wastewater storage ponds will be arranged for the collection and storage of wastewater. The capacity of waste water treatment system is 50m^3/h.
The industrial wastewater treatment system flow is as follows:
Industrial wastewater→storage and being mixed→pH adjustment→oxidation→
→flocculation→clarification→neutralization→reuse or discharge to the drain
↓
sludge concentration→dehydration→dehydrated sludge being carried away
Through this process, the pH of treated water will be in the range of 6~9, and most of the metal ion in the boiler acid cleaning drain will be oxidated to hydroxide that can hardly dissolve in water. The treated wastewater will be sent to reuse or discharge to the drain out of the site area (TDS of the treated wastewater is around 4000~5000mg/L).
One unit drain pit for the unit is used to collect the main building drainage, which includes boiler chemical cleaning drain, regenerative waste water from condensate polishing system etc.

2.6.1.14 Hydrogen Generation System

The Generators is cooled by hydrogen. If the hydrogen which meet the demand of the unit cannot be bought locally, a suitable hydrogen generator, storage and distribution system with control stations will be provided.
The capacity of generators is 1×5Nm^3/h.
Considering over the gas volume of the unit normal operating when the hydrogen generators are overhauled and the volume of one power generator's starting requirement, 3 hydrogen storage vessels will be needed, the vessels total volume is 840 Nm^3.

2.6.1.15 FGD wastewater treatment system

The impurities contained in the wastewater from limestone-gypsum flue gas desulfurization system is mainly from flue gas, desulfurizer and wastewater. Since the impurity of flue gas is mainly from the coal combustion and the one of desulfurizer is mainly from the limestone dissolution, the impurities contained in the FGD wastewater consist of suspended solid, supersaturated sulfite, sulfate and heavy metal ion, which make the quality of FGD wastewater particular and difficult to treat. There will be an independent treatment system for FGD wastewater.
FGD wastewater will be treated by means of oxidation, flocculation, sediment settling and pH adjustment. The quality of the treated wastewater will meet the requirement of local rules to discharge to the drain out of the site area (TDS of

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treated FGD wastewater is around 20000~30000mg/L).

2.6.1.16 Chemical Laboratory

An appropriate laboratory will be designed to perform all necessary analysis work on all kinds of water (condensate, feed-water, raw water, cooling water, waste water, etc.), steam, chemicals used for water conditioning, as well as the tests and analyses of fuels, transformer oils according to the requirements. Laboratory equipments will meet the need of routine operation.

2.6.1.17 Emission Controls

2.6.1.17.1 Low NO_X Burners

2.6.1.17.1.1 Function

When air is used as the source of oxygen for combustion, the heat of combustion causes significant conversion of nitrogen and oxygen to various oxides of nitrogen (NO_X). The Project will be fitted with low-NO_X burners, designed to keep NOX generation to a minimum. A space will be reserved for further SCR system in the boiler for further strict emission control law.

2.6.1.17.1.2 Design Basis

The burners are expected to operate at an emission rate of 300 mg/Nm3. A guarantee lower than this value will be requested from the supplier.

2.6.1.17.1.3 System Operation

Low-NO_X burners achieve their objective by measuring and controlling fuel flow and air flow at each individual burner, rather than relying only on a single overall mixture. Also, the burners contain spin vanes and other aerodynamic devices to obtain the best possible mixing of the fuel and air as they enter the furnace. In this way, zones of imperfect fuel/air mixture are minimized. Zones of imperfect mixing typically run too hot, which causes NO_X to form.

2.6.1.17.2 FGD

2.6.1.17.2.1 Function

When combusting coal, virtually all (about 90%) the sulfur is converted to sulfur dioxide (SO_2) gas. The Project will be equipped with a flue gas desulfurization (FGD) system for use when burning a coal that would produce emissions in excess of the limit.

2.6.1.17.2.2 Design Basis

The FGD system is expected to operate at an emission rate of 2224 mg/Nm^3 (design coal), 3252 mg/Nm^3 (worst coal). An FGD by pass will be installed for use when burning coals that produce less than that emission rate. About 30 percent gas of the design coal and about 55 percent gas of the worst coal will anticipate the FGD system. After the FGD system, the SO_2 emission rate of the stack is less more 1600 mg/Nm^3.

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2.6.1.17.2.3 System Operation

The FGD system will be the limestone-gypsum wet desulphurization process. Wet FGD technology, which is based on using limestone as a reagent, is a wet scrubbing process and has been the FGD technology most frequently selected for sulfur dioxide (SO_2) reduction from coal-fired utility boilers. The wet FGD flue gas treatment system is located after removal of particulate matter from flue gas by the electrostatic precipitator. The cleaned gas is discharged to the stack. This type of FGD system removes SO_2 by scrubbing the flue gas with limestone slurry.

Flue gas is treated in an absorber by passing the flue gas stream through a limestone slurry spray. In absorber, the gas flows upward through the absorber countercurrent to the spray liquor flowing downward through the absorber. Slurry is pumped through banks of spray nozzles to atomize it to fine droplets and uniformly contact the gas. The droplets absorb SO2 from the gas, facilitating the reaction of the SO_2 with reagent in the slurry. Hydrogen chloride present in the flue gas is also absorbed and neutralized with reagent, causing an accumulation of chloride ions in the process liquid. The desulfurized flue gas passes through mist eliminators to remove entrained droplets before the flue gas is sent to the stack.

After contacting the gas, the slurry collects in the bottom of the absorber in a reaction tank. The slurry is agitated to prevent settling. Limestone consumed in the process is replenished by adding fresh limestone slurry to the reaction tank.

The slurry is also aerated in the reaction tank to oxidize calcium sulfite hemihydrate ($CaSO3 \cdot \frac{1}{2} H_2O$) to calcium sulfate dihydrate ($CaSO4 \cdot 2H_2O$), or gypsum, which precipitates. A portion of the slurry is withdrawn to remove the precipitated gypsum. This slurry is dewatered in a two-stage process involving a hydroclone and vacuum filter system to produce a gypsum cake for disposal or sale. Water removed from the gypsum slurry is returned to the process. A portion of this water is removed from the system as wastewater to limit accumulation of corrosive chloride salts in the process liquid.

The gypsum quantity will be about 3.9 t/h based on design coal.

2.6.1.17.3 Electrostatic Precipitator

2.6.1.17.3.1 Function

Coal is impure, containing significant quantities of non-combustible material. Non-combustible material is known as ash. A portion of the ash forms large particles and falls to the bottom of the furnace. This is known as bottom ash. The rest of the ash (typically 90% of the ash in a pulverized coal boiler) forms fine, lighter particles that are carried out of the furnace by the flue gas. This is called fly ash. The Project will be fitted with a particulate control system to remove nearly all the particulates form the flue gas.

2.6.1.17.3.2 Design Basis

The particulate collector is expected to operate at an emission rate of 19.86 g/Nm^{3}ADD Conventional means of collecting the particulate matter include electrostatic precipitation (ESP) or a fabric filter baghouse. In this case, either is fully capable of meeting the operating point, as well as a guarantee lower than that. Due to the fabric filter leads to high cost, more pressure loss, and more maintenance working, ESP will be considered for this project.

2.6.1.17.3.3 System Operation

The ESP consists of a box that is an enlarged section of duct, to slow the gas velocity down. Metal plates hang in the box parallel to flow, such that the flow is channeled between them. Also between them are hanging electrodes, either solid ones or weighted wires. Transformer/rectifier (T/R) sets step up the power to high voltage and convert the current to dc. The voltage is applied between the plates and the electrodes, such that the operating point, as well as a guarantee lower than that. Due to the fabric filter leads to high cost, more pressure loss, and more maintenance working, ESP will be considered for this project.

2.6.1.17.3.3 System Operation

The ESP consists of a box that is an enlarged section of duct, to slow the gas velocity down. Metal plates hang in the box parallel to flow, such that the flow is channeled between them. Also between them are hanging electrodes, either solid ones or weighted wires. Transformer/rectifier (T/R) sets step up the power to high voltage and convert the current to DC. The voltage is applied between the plates and the electrodes, such that the electrodes charge the particles, then the particles are attracted to the oppositely-charged plates.

Periodically, the plates are rapped with automatic hammer assembles which causes the ash to fall into hoppers below the plates.

2.6.1.17.4 Thermal Discharge

The thermal discharge is primarily the indirect dry air cooling system with surface condenser and natural draught cooling tower system.

2.6.1.17.5 Noise

The plant will be designed to control the noise generated to meet international and Pakistan regulations within the plant and at the fence line.

2.6.1.18 HVAC

2.6.1.18.1 Function

The function of the HVAC systems is to provide safe and appropriate conditions in all rooms, enclosures, and buildings that are part of the plant. This will include heating (if any), cooling, and ventilating all enclosed spaces for personnel comfort and equipment protection. Functions will include the required number of air changes, relative humidity control, temperature control, and pressurization.

Air conditioning is required for the switchgear and electrical equipment areas/ rooms to ensure equipment reliability. Dust suppression and collection will be provided for the coal handling areas.

2.6.1.18.2 Design Basis

The systems will be designed to meet the intent and specific requirements of the ASHRAE handbooks and Chinese standards. If heating is required, electric heating will be used. If Pakistan requirements are more stringent in any aspect, they must be followed. In addition, the following specific considerations will apply.

2.6.1.18.2.1 Outdoor design conditions

For all general cases the HVAC systems the outdoor design conditions will be as follows.

Table 2-14 Outdoor Design Conditions

The 0.4% outdoor design dry-bulb temperature and mean coincident wet-bulb temperature	43.2℃/23.2℃
The 1% outdoor design dry-bulb temperature and mean coincident wet-bulb temperature	41.8℃/23.5℃
Winter design 99.6% dry-bulb temperature	3.9℃
Winter design 99.0% dry-bulb temperature	5.0℃
Extreme maximum dry-bulb temperature	45.6 ℃
Extreme minimum dry-bulb temperature	-0.1℃

2.6.1.18.2.2 Indoor design conditions

The basic internal temperature will be as follows.

Table 2-15 Indoor Design Conditions

Building	Type of the HVAC system	Indoor Temperature℃		Relative Humidity %		Room Ventilation Rate	
		winter	summer	winter	summer	air changes per hour	fresh air volume(m^3/h)
Turbine house							
Steam turbine hall	EV	None	≤40	None	None	≥10	
6kVswitch gear room	EV + VE	None	≤35	None	None	≥12	
380Vswitch gear room	EV + VE	None	≤35	None	None	≥12	

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Building	Type of the HVAC system	Indoor Temperature℃		Relative Humidity %		Room Ventilation Rate	
		winter	summer	winter	summer	air changes per hour	fresh air volume(m^3/h)
Start Boiler PC room	VE+AC	None	≤35	None	None	≥12	
Control Building							
Control room	VE+AC	22±1	24±1	50±10	50±10	≥12	10% the total air supply
Battery room	VE+ AC	20	≤30	None	None	≥12	
UPS room	VE+ AC	20	≤30	None	None	≥12	
Electronic equipment room	VE+AC	20±1	24±1	50±10	50±10	≥12	5% the total air supply
Engineer room	VE+AC	21	23	50±10	50±10	≥5	10% the total air supply
Relay room	VE+AC	20±1	24±1	50±10	50±10	≥12	5% the total air supply
380kV GIS	V	None	None	None	None	normal≥4;emergency≥12	
Air compressor house	V	None	None	None	None	≥6	
Pump house	V	None	None	None	None	≥30	
Local MCC room	VE+ EV	None	≤35	None	None	≥12	
Chemical Dosing room	V	None	None	None	None	≥15	
Electrochlorination room	V	None	None	None	None	≥15	

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Building	Type of the HVAC system	Indoor Temperature℃		Relative Humidity %		Room Ventilation Rate	
		winter	summer	winter	summer	air changes per hour	fresh air volume(m^3/h)
Workshop	V	None	None	None	None	≥5	
Auxiliary buildings							
Offices	AC	21	26	None	≤60		30 per person
Ware room	AC	21	26	None	≤60		30 per person
Canteen room	AC	21	26	None	≤60		30 per person
Meeting room	AC	21	26	None	≤60		20 per person
Pray room	AC	21	26	None	≤60		30 per person
Guard room	AC	21	26	None	≤60		/
Local electrical control rooms	VE+ AC	21	26	<50	<50	≥12	

Note: V ---- Natural supply, Mechanical exhaust

EV---- Evaporative cooling ventilation

VE---- Emergency ventilation (running when the room is at an emergency situation, such as smoke, gas leak)

AC-----Air conditioning

2.6.1.18.2.3 Air Conditioning system

1）According to the local climate conditions, evaporative cooling ventilation system will be provided for the turbine house.

2）The condensers of air conditioners will be air cooling type.

3）Central air conditioning system

A central air conditioning system(s) will be installed for rooms requiring air conditioning, including the main control room, electronic equipment room etc. The air conditioner will be direct expansion type. The system(s) will be a constant-volume air conditioning system, the fresh air rate shall be 10% or 100% of total supply air . When outdoor air

temperature and humidity conditions permit, the system will use outside air instead of refrigerant for cooling. 100% fresh air operating model is economic to achieve energy conservation. Each air handling unit will include a mixing section with fresh air, exhaust air, and return air dampers, filter section (including re-filter and final filter), electric pre-heating coil section, cooling coil section, supply fan section, and return/exhaust fan section. The air conditioning system final filter will meet the requirements of 80% atmospheric dust spot efficiency based on ASHRAE Standard 52.1 or approved equivalent international standard. The HVAC system will continuously operate the year round. For the main control room and electronic equipment room two 100% capacity HVAC systems will be provided: one operating and one as standby.

4）Packaged air conditioner will be provided for the following areas:

i) ESP control room.

ii) Switchyard control room.

iii) Ash handling control rooms.

iv) Coal handling complex building.

v) Any other control rooms.

5）Evaporative cooling ventilation systems will be provided for switch gear rooms.

6）Split AC units (5 star rating) shall be provided for offices, meeting room areas and control rooms where the cooling load is less than 5 TR.

7) Careful consideration will be taken for locating outdoor air intakes and air-cooled condensers away from prevailing wind direction and from airborne sand, coal dust, and dust.

2.6.1.18.2.4 Ventilation system

1）Mechanical ventilation shall be provided where necessary to remove heat released by equipment or hazardous fumes.

2）Natural ventilation to buildings/areas shall take the form of louvers bank as required at low level and mechanical extract fans at roof level. The extract fans shall be suitable protected against the corrosive marine environment and located such that ease of maintenance is achieved.

3）The number of air changes/hour in evaporative/mechanically ventilated areas shall be as follows:

Table 2-16 Number of Air Changes per Hours

No.	Area	Air Changes
i	General areas	15
ii	Various pump houses	30
iii	Switch gear / MCC rooms.	12

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iv	Areas where gaseous fumes are generated	30
v	Water treatment building	15
vi	D G set room	30

4）Evaporative cooling ventilation systems will be provided for turbine house.

2.6.1.18.2.5 Air Distribution System (common for both air conditioning and ventilation Ductwork
Duct work for all HVAC systems will be designed per ASHRAE guidelines, for a maximum air velocity of 10 m/s (2,000 fpm), to ensure reasonable noise levels.

2.6.1.18.2.6 Dust collection and Dust Suppression for coal handling system
Dust extraction system with pulse jet bag dust collector shall be provided to extract dust laden air from all dust generating points in coal bunker, transfer towers, crusher house etc. Dust emission level shall not exceed 80mg / Nm^3. The exhaust fans will be explosive proof type.
Spray water dust suppressing system also shall be considered to improve working site conditions at all transfer areas.

2.6.1.19 Compressed Air
2.6.1.19.1 Function
The compressed air system provides a continuous supply of 0.85 MPa air for station use. The air is used for maintenance to operate air tools, for air movers, and for cleaning. Asecond piping system provides the instrument air to all instruments, including air-operated valves.

2.6.1.19.2 Design Basis
The compressed air system will be designed to provide a continuous supply of air to all air users at the site. The same compressors supply the service air and the instrument air.
There will be four motor-driven 50% capacity, micro-oil compressors installed with Unit. These compressors will be packaged units with all controls, coolers, and sound reduction enclosures. They will be water cooled and not require cooling water.
The compressors will discharge to a common header that connects to an air receiver. Air dryers will be provided for instrument air.
The piping for the service air system will be carbon steel. The piping for the instrument air system will be stainless steel. Service air will be piped to all areas of the power block area where maintenance work with air tools is anticipated. A loop will be provided around the turbine and boiler areas with isolation valves to allow maintenance on sections of the

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system without removing the entire system from operation. Valved hose connections will be provided at each location. These locations will include the grade, mezzanine, and operating floors of the turbine room, all levels of the boiler room, and all shops and coal handling buildings.

The instrument air system will have a similar design for all areas where air-operated valves or instruments are anticipated.

2.6.1.19.3 System Operation

The operating compressor will maintain the operating pressure preset for its receiver. If the pressure drops below that level, the second compressor will automatically start.

The air dryers will automatically switch desiccant towers as needed to maintain the required dew point. The inactive tower will be purged with a portion of the dry air to return the desiccant to its original effectiveness.

2.6.1.20 Fire Protection

2.6.1.20.1 General

The design and construction of fire detection and protection equipment will be in compliance with NFPA (National Fire Protection Association, USA) or Chinese relevant fire protection standards and codes, while the fire protection requirements from the local authority will also be fully taken into consideration in the detailed design stage. However, it would be owner's duty to help designers get these local standards and codes if necessary.

A comprehensive fire detection & alarm system and fire protection system will be designed for the power plant to provide a high degree of protection for plant buildings and employees.

The main functions of the Fire Fighting System encompass the fire water supply and storage, fire pumps and pressure maintenance devices, fire water distribution system, fire suppression systems, fire detection & alarm system, mobile fire extinguishers and other necessary system, to extinguish and suppress fires.

Two fire-fighting pumps, one (1) motor driven and one (1) diesel engine driven as standby will be provided for hydrant system and spray system of the power plant. These two pumps will be installed in the Firefighting Pump House to provide water for the firewater ring. Also the fire fighting system will be pressurized by two (2) electric motor driven jockey pumps and one (1).air pressure vessel.

2.6.1.20.2 Scope of Work

The fire fighting system of this power plant will include;

(1) Two (2) Service&Fire-fighting Water Pond with a capacity of 800m^3;

(2) One (1)×100% electric motor driven fire-fighting pump;

(3) One (1)×100% diesel engine driven fire-fighting pump;

(4) One (1) fire pneumatic water supply device (including a pneumatic tank, two (2)×100% makeup water pumps, two (2)×100% makeup air pumps if necessary) for maintain the system pressure;

(5) Firefighting water supply ring pipes and Valves, Hydrants, Nozzles of selected types and other ancillary facilities.

(6) Two (2) Service&Fire-fighting Water Pond with a capacity of 800m^3 will be provided to serve as the source of the

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firewater. This reinforced concrete reservoir is fed from the freshwater pre-treatment station.

2.6.1.20.3 Fire Alarm System

Fire protection and detection systems will include remote indication or alarm facilities, zoning of fire protection and detection installations, and facilities for the containment/removal of smoke and the containment/removal of spray water. Based on these requirements and the features of the power plant, a complete control and instrumentation system will be provided to ensure a safe, efficient and reliable system complete with necessary redundancy. The actuation of any fire detection device will be audibly and visibly displayed at the central fire alarm control panel and relevant local annunciation panels.

To ensure that fires are detected at an early stage, areas at risk are monitored with automatic and manual fire detectors. The following types of detectors will be installed:

- Smoke detectors
- Heat detectors
- Gas detectors
- Manual fire detectors (push buttons)

All initiating signals from fire and gas detectors, push button stations, and flow indicators in fire waterlines will be announced at the main fire control panel to be installed in the central control room. A parallel indicator panel will show the status of the various areas under surveillance by the detection and alarm system and it will be installed in the gate house. It will also show the status of the fixed fire extinguishing systems and the fire pumps.

2.6.1.20.4 Fire Protection

The fire protection installations shall include all systems and equipment for an adequate protection of the buildings. The design of fire fighting systems shall consider the effectiveness of the following individual extinguishing agents:

- Water: Fire extinguishing, exposure protection and cooling, fire intensity control, ignition prevention and prevention of vapour cloud formation.
- CO_2 gas: Fire extinguishing by means of oxygen reduction inside enclosures.
- Dry Chemical Powder: Control and extinguishing of small flammable liquid spill fires and gas flash fires.

Fire protection shall be provided by automatic and manually operated fixed systems in conjunction with portable and mobile firefighting equipment. The determination of design fire resistance time, the material requirements and fire resistance of all buildings shall be designed in accordance with the above international standards mentioned in this document. In addition, adequate and safe escape routes shall be provided for all buildings according to those standards.

Each carbon dioxide system consists mainly of: standard storage rechargeable CO_2 cylinders of nominal size of 45 kg, which must be safety rated for the maximum ambient temperature. Distribution and discharge manifolds and nozzles. Pressure switches for signaling; Cylinders weighting switches.

Fire and gas detection systems shall, via instrumentation, continuously monitor all building and process areas for abnormal conditions. In the event of a hazardous situation being detected the system shall initiate protective actions and pre-determined alarms to warn personnel within a zone of a fire or gas incident in that zone or in its vicinity. The

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Contractor shall install the Main Fire Protection panel in the Central Control Room and a duplicate panel at Gatehouse.

2.6.1.20.5 Fire Hydrant System

Entire hydrant system will be designed as per Chinese codes or standards to meet the owner's requirements.

An underground fire hydrant ring main facility will be introduced. Strategically placed hydrant connections will be provided in the system to suit the Site/Plant/building configuration.

Risers will be provided for internal protection to boiler galleries and turbine houses at various levels. All hose connection points will be fitted with landing type valves with instantaneous flexible connections. Top landing valves will terminate at the boiler house/turbine house roof levels. Generally, the space between the adjacent outdoor hydrants will be less than 120m, and that between the two nearest internal hydrants/land valves 30m at most. Pressure break-down orifice will be introduced as necessary to restrict active pressure of indoor hydrant points at said value.

2.6.1.20.6 Fixed Water Sprinkle/Spray Systems

Entire sprinkle/spray water system will be designed as per the guidelines of Chinese codes or standards to meet owner's requirements.

The water sprinkle/spray nozzles will be arranged in the form of ring to all protected areas or equipment, such as Conveyor belt, transformers, cable vaults and cable spreader rooms. Length of each protected zone will be so selected that water requirement of each zone will be met. Placing of nozzles will be such that spray cones overlap each other.

2.6.1.20.7 Foam System

Fuel oil storage tanks, if there is any, will be protected with automatically operated fixed foam injection system to ensure safe operation, together with outdoor hydrants around the tank. The firewater will be supplied by the hydrant firewater ring system.

2.6.1.20.8 Gas Type System

If there is any, all gas type fire protection will be designed for high pressure CO2.fire protection and detection systems will include remote indication/alarm facilities, zoning of fire protection and detection installations, and facilities for the containment/removal of smoke and the containment/removal of spray water.

2.6.1.20.9 Other Requirements

For the steam turbine hall, mobile fire extinguishers will be provided.

For the switchgear building, mobile fire extinguishers will be provided.

For all other buildings, rooms, equipment and relevant plant areas of the power plant, mobile fire extinguishers will, if necessary, be provided and located along escape routes and at the exits of rooms and buildings.

The fire service main ring pipes will be laid underground and will be made of steel.

All the above mentioned installation and arrangement will be in accordance with Chinese standards, NFPA or local codes.

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2.6.1.21 Fuel Oil Storage and Transfer

2.6.1.21.1 Function

The fuel oil storage and transfer system will store the fuel oil and transfer that oil to the main boiler for ignition and warm-up of the main boiler and the auxiliary boiler. The system will include truck unloading facilities.

2.6.1.21.2 Design Basis

The system will include two identical 500-m^3 welded-steel vertical tanks to store the oil. The oil is commonly known as light diesel. It does not require heating. The tanks will be inside a berm designed to contain any oil leaks, including complete failure of the tanks. Provisions will be included to remove the rain water that accumulates inside the berm and to provide treatment before discharge.

Floating suction will be provided in each tank. The suction will be designed for the oil specifications for the Project. The float will be designed such that the suction is submerged between 50 and 300 mm below the oil surface during all modes of operation. Suction will be capable of drawing down to 450 mm from the tank bottom. A low-level stop will be provided to prevent drawdown below 450 mm.

Truck delivery of this oil is expected. A truck unloading station will be included to unload two trucks simultaneously, contain any spills, and measure the quantity of oil from the trucks. Two screw pumps will transfer the fuel to the tanks. The pumps will be designed for at least 25 m^3/h.

Pumps will be provided to supply the oil to the burner levels of the boilers, at which point the system will be the responsibility of the boiler supplier.

Two 100% capacity transfer pumps will pump the oil from the storage tanks to the boiler. Each pump will be designed to provide the maximum fuel required for the igniters and warm-up burners of the boiler and the auxiliary boiler.

2.6.1.21.3 System Operation

The tanks will normally be kept full to provide the capacity required to attempt multiple startups of the boiler if there is a forced outage. As oil is used for startup, it will be replaced within a few days to ensure that an adequate supply is available.

Drains will be checked periodically for signs of water and other contaminants. Appropriate filtering draining and additives will be used as required to maintain the quality of the oil.

As trucks are unloaded, any oil spilled will be contained and recovered or disposed of in accordance with the environment regulations.

2.6.1.22 Coal Unloading and Handling System

2.6.1.22.1 Function

This discussion includes the coal handling systems in the plant. The coal handling system will receive coal from the railway station, transport it to the coal yard, reclaim coal from storage, and transport it to the coal bunkers in the main power house, including coal crushing, screening, iron separating, measuring, sampling and so on. The coal receive jetty, rail way transportation and related equipment are covered in other sections.

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2.6.1.22.2 Design Basis

The coal consumption is listed in table below.

TABLE 2-17 Coal Consumption

	1×660MW Unit	
	Design Coal	Worst Coal
Hourly (t/h)	242	275
Daily (t/d)	5324	6050
Annual (10^4t/a) (5000 hours)	121.0	137.5
Annual (10^4t/a) (7446 hours)	180.19	204.77

Note: The coal system is designed on the basis of 22 hours daily and 7446 hours yearly coal consumption and all the equipment is chosen according to this situation.

2.6.1.22.3 Description

Coal flow diagram of the coal receiving and storage system are provided in the drawings. One underground conveyor will receive coal from the wagon tippler, 100% capacity conveyor will be provided to transport the coal to the stock yard.

Coal for the project will be received in wagon that arrive the national railway beside the plant and connection into the wagon tippler room. The transport capacity of the national railway should be confirmed by the government.

One (1) set of single-dumper with capacity of 1500t/h will be set in this system to receive the coal come from the railway. There are two (2) sets of feeder under the wagon tippler to load the coal from the wagon tippler hopper to the C1 belt with 100% capacity for the 1x660MW unit, every feeder with capacity of 0~750t/h. Totally two (2) sets of feeder will be set in the wagon tippler room. And the dynamic railway scale and the train coal sampling device are not in this scope, which will not be mentioned in the equipment list.

The unloaded coal shall be conveyed to transfer station in plant by single-way belt conveyors, and the specification of the belt conveyors are: B=1400mm, V=2.5m/s, Q=1500t/h.

One (1) turn-back coal yard will build in this project. It has two (2) coal stacks. The width of each coal stack is 47 meters, and the height is 12 meters. These coal yards have the capacity of 162,000 tons for 30 days coal consumption when using the design coal and for 26 days coal consumption when using the worst coal. The length is about 285 meters; the width is about 106 meters; the area is 30210m2. Dry coal shed with the capacity of 32,000 tons is set to store coal for 6

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days coal consumption when using the design coal and for 5 days coal consumption when using the worst coal. The dry coal shed will be about 80 meters in length and 106 meters in width. Wind-prof and dust suppressing walls are set around the coal yards.

One (1) set of rail type bucket wheel stacker / reclaimer will be installed in the coal yard, and the stacking capacity is 1500t/h, the reclaiming capacity is 600t/h. The boom length is 40m. At the same time, one (1) set of rail type bucket wheel reclaimer will be installed in the coal yard, and the reclaiming capacity is 600t/h. The boom length is 40m.

From the coal yard to the boiler bunker bay, double line belt conveyors system will be installed, one line for operation, one line for standby. And the two lines of belt conveyors will also be operated at the same time. The rated capacity of reclaiming system is 600t/h as well. The specification of the belt conveyors in coal reclaiming system is: B=1000mm, V=2.0m/s, Q=600t/h.

Two sets of crusher with capacity of 400 t/h and two sets of screen with capacity of 600t/h will be equipped in the system. The outlet coal size will be ≤30mm. All the crusher and screen will be double settled with one for running and one for standby.

The conveyors of the coal yard need water wipers, and all the conveyors are equipped with cleaner equipment.

Electric driven two side plough unloader will be equipped on bunker conveyor and will be used to unload coal to the coal bunkers.

Two (2) sets of coal sampling device, belt scale and circle chain will be installed on the belt conveyor after the crusher house.

There are seven (7) sets magnetic separators will be equipped on the coal handling system. The magnetic separator will be respectively set once before the coal yard, and will be set twice before the crusher house and once again after the crusher house.

Cranes or hoists will be set in all kinds of coal handling system buildings, which will be used to maintain all kinds of equipment.

2.6.1.23 Ash and slag handling system

2.6.1.23.1 Ash Amount

		1×660MW			
		t/h	t/d	$\times 10^4$ t/a(5000hrs)	$\times 10^4$ t/a(7446hrs)
Design Coal	Fly Ash	39.13	782.60	19.565	29.136
	Bottom Ash	4.35	87.0	2.175	3.239
	Total Ash	43.48	869.60	21.74	32.375
Check Coal	Fly Ash	13.08	261.6	6.54	9.740

	Bottom Ash	1.45	29.0	0.725	1.08
	Total Ash	14.53	290.6	7.265	10.819

Note: 1. The runtime of the boiler is calculated as 20 hours per day (on average).
2. The runtime of the boiler is calculated as 5000 or 7446 hours per year.
3. The quantity of fly ash is calculated as 90% of the total ash while the bottom ash is 10%。

2.6.1.23.2 Ash& Slag Handling System Selection

2.6.1.23.2.1 Bottom slag handling system selection

The bottom ash will drop from the ash well of the boiler to the dry ash extractor and the big ash will be crushed first. The bottom ash will be burned and cooled with the cool air in the dry ash extractor. The bottom ash will be discharged to the ash crusher and then the ash crushed will be transported by the bucket elevator to the bottom ash bin. The bottom ash from the bottom ash hopper will be transported to the ash yard or the comprehensive utilization point.

The emergency discharge point is installed in the ash crusher. When the ash crushed is in failure, the bottom ash will be discharged directly from the emergency discharge point and be transported away by trucks.

There is 1 set of dry ash extractor for the boiler and the normal capacity of the dry ash extractor of the boiler is 1.5~4.5t/h; the max capacity of the dry ash extractor is 11t/h. For the boiler one set of bottom ash hopper which volume is 200m3 will be furnished to store about 35 hours bottom ash generation when the max ash generation coal is burned in BMCR. There is 1 wash water pit in each bottom ash hopper area. The wash water will flow to the pit through the ditch and pumped to the coal settling basin. There are 2 wash water pumps for the boiler, one is at operation, and the other is for standby.

2.6.1.23.2.2 Fly Ash handling system selection

The fly ash handling system will adopt the positive pressure pneumatic conveying system for approximately 150% of the ash amount of the design coal or the 120% of the check coal ash amount. The fly ash from ESP hoppers and economizer hoppers will be collected in their respective pressure vessels by gravity and then will be conveyed to fly ash silos by positive pressure pneumatic conveying system. There are totally 3 ash pipes for the unit. Each fine ash pipe will be able to go into any fly ash silo and the each coarse ash pipe will be able to go into the coarse ash silo. The conveying capacity of the unit will be 59t/h. There are 3 plant air compressors recommended for the unit, two in operation and one in standby will supply the conveying air. For ash fluidity in the ESP hoppers when unloading ash, 2 fluidizing blowers and one fluidizing air heaters will be provided.

Two ash silos, one silo for coarse ash and the other silo for coarse and fine ash respectively will be provided. Each silo shall have effective capacity about 2000m3 for storing 72 hours fly ash burning the design coal at BMCR condition. Each ash silo shall be of concrete construction (Φ13m) having 3 discharging outlets. For the coarse ash silo: one outlet will be connected with a double paddle mixer (Q=100t/h), which will be used for unloading wet ash; the other two outlet will be connected with a dry ash telescopic spout (Q=100t/h), which will be used for dry ash. For coarse & fine

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ash silo: two outlets will be connected with a dry ash telescopic spout (100t/h) and one double paddle mixer for unloading wet ash. To guarantee smooth and average unloading ash, three fluidizing blowers will be installed at the silo area to supply air for the fluidizing devices at the bottom of the silos, 2 in operation and 1 in standby. 2 fluidizing air heaters will be provided for heating the fluidizing air. On the roof of each silo a bag filter and a pressure/vacuum relief valve will be provided.

There is one wash water pit in fly ash silos area. The wash water will flow to the pit through the ditch and pumped to the coal settling basin. There are 2 wash water pit pumps provided.

Ash pipes will be laid on the pipe rack. The diameter of the ash pipe will be determined in the detail design with the ash handling system manufactory.

The electrical hoist will be installed at air compressor house for ash handling system and electrical hoists will be installed at the maintenance floor and the roof of fly ash silos which are for the convenience of maintenance.

2.6.1.24 Ash yard

2.6.1.24.1 Facility Function

The objective of this section is to describe the Ash Yard designed for the Rahim Yar Khar 1X660MW coal fired power plant.

One (1) ash yard which near the plant will be constructed to store ashes for this power plant for about five (4.8) years. It is highly recommended that Owner to consider the reclamation of ashes (such as the production of concrete or bricks) to increase the life span of the Ash Yard. In addition, the ash yard will also be taken to prevent the dry ash solids from polluting the air and underground water during ash yard operation and administration.

2.6.1.24.2 Ash Amount

The calculation of ash amount for this power plant is based on the assumption of 5,000 consecutive annual operating hours.

The ash amount for this power plant is shown in the following table 9.2-1.

Table 9.2-1 Ash Amount

	1×660MW	
	Hourly (t/h)	Yearly ($\times 10^4$t/a)
Fly Ash	39.13	19.565
Bottom Ash	4.35	2.175

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Total	43.48	21.74

Both fly ashes、bottom ashes produced in the power plant will be transported by trucks to store in the ash yard.

2.6.1.24.3 Ash Yard

One ash yard with an area of twenty (20) hectares with a capacity of $104\times10^4m^3$ will be constructed which is capable of storing ashes for about five (4.8) years in a row.

If the Annual utilization hours increased, the storing lifes of the ash yard is corresponding shortened.

The ash yard will covered an area of 482m×416m, and the will be 3.5 meters above ground and 3 meters underground which makes its total height be 6.5 meters. The design ash height will be 6 meters with a 0.5 meter safety over height.

One (1) Ash Yard Administration Area will be set in the entrance of the ash yard, which will be composed of Administration Room, Parking Lots and Water supply facilities. One (1) road with a slope of 8% leading from ash yard administration area to the bottom of the ash yard will be constructed for the transportation of vehicles. One (1) Ash Water Collection Pond (25m×15m×4m) will be set at the bottom of ash yard to collect ash water and rainwater. Pumps will also be set in this collection for the reuse of ash water.

As is required by Environmental protection, the ash yard will be covered with one layer of High Density Polyethylene (HDPE) liner for the protection of underground water. Around the ash yard as well as inside the bottom of ash yard, a total of five (5) underground water monitoring wells will be provided for the survey of underground water near the ash yard. The monitoring well will be one (1) meter in diameter and their depth will be decided by the actual underground water level. Padlocks will be used to protect these wells.

2.6.2 Electrical

2.6.2.1 General of Electrical Connection

2.6.2.1.1 Generator and Main Transformer system

One (1) sets of 660MW Coal Fired Steam Turbine-Generator unit will be built. The generator will be directly connected to its three-phase two-winding Generator Step-up transformer (GSU). The power of the generator will be stepped up by GSU and be transmitted to the 500kV switchyard. The power plant will connect to the GRID at 500kV voltage Class.

There is no Generator Circuit Breaker (GCB) for the generator. The Isolated Phase Bus (IPB) is used for the connection between generator and GSU. The generator is excited by a terminal-fed static excitation system.

2.6.2.1.2 500kV Switchyard

The power plant is adopted double bus bar with one and half scheme.500kV outdoor switchyard is newly built in this phase of the power plant which has two(2) outlet lines, one(1) main transformer lines and one(1) start-up/standby transformer line.

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2.6.2.1.3 System Voltage and Grounding type

Table 2.1.3-1

System	Nominal volt.	Volt. variation	Neutral point Grounding type	Number of phase	Number of wire
500kV	500kV	Per the Grid Code	effectively earthed	3	3
Generator	22kV	±5%	Earthed via distribution type transformer	3	3
Medium voltage system	6kV	±5%	Earthed via Medium resistance	3	3
Low voltage system	380/220 V	±5%	Solidly earthed	3	4

2.6.2.2 Main Equipment Criterion & Parameter

2.6.2.2.1 Generator System

2.6.2.2.1.1 Generator

(1) Parameter (estimate)

· Rated Capacity: 776MVA (Under rated conditions and matching the TMCR operation)

· Rated Power: 660MW (Under rated conditions and matching the TMCR operation and subtracted the Excitation system power consume)

·Rated voltage: 22kV

·Rated power factor: 0.85（lagging）

·Frequency: 50Hz

·Rated speed: 3000r/min

·Phase number: 3

·Pole number: 2

(the above datum shall be confirmed by manufacture)

(2) Generator neutral grounding shall adopt high resistance grounding via a single phase grounding transformer (secondary side connecting with resistance)

2.6.2.2.1.2 GSU

The capacity of the GSU shall be sized by the larger one of following design criteria:

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To carry generator rated capacity subtracting the UAT, the temperature rise of windings not exceeding 55K under +40°C the ambient temperature or the cooling water temperature.

To carry generator maximum continuous capacity subtracting the UAT, the temperature rise of windings not exceeding the 65K.

Therefore the capacity of GSU shall be 780MVA with the ODAF cooling type (65K temperature rise).

Rated ratio is 525±4×2.5%/22kV, YNd11 wiring.

Water spray fire protection system will be used for GSU.

2.6.2.2.1.3 Generator Isolated Phase Bus (IPB)

IPB main circuit specification

·Rated current:	25000A
·Rated Voltage:	22kV
·Basic insulation level（BIL）:	125kV
·Dynamic stability current:	200kA（peak）
·Thermal stability current:	100kA（r.m.s）/2s

IPB branch circuit specification

·Rated current:	3000A
· Rated Voltage:	22kV
·Basic insulation level（BIL）:	125kV
·Dynamic stability current:	400kA（peak）
· Thermal stability current:	200kA（r.m.s）/2s

Cooling method of IPB shall be slightly pressurized natural self-cooling.

The IPB contractor shall also supply the PT&SA cabinet, neutral point device(including the CT), capacitor and so on.

2.6.2.2.2 UAT

2.6.2.2.2.1 UAT

One UAT, three phase split-transformer is used for the generator unit, specification as follows:

Rated capacity: 56/38-38MVA

Rated ratio: 22±2x2.5/6.3-6.3kV, Ud=10.5%（based on 38MVA）

Wiring type: Dyn1yn1

Cooling type: ONAF

2.6.2.2.3Non-Segregated Phase Metal Busduct

Non-Segregated Phase metal busduct with rated voltage 6kV, rated current 3150A, aluminum enclosure, rectangle copper conductor is used at the LV side of UAT.

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2.6.2.3 Unit auxiliary power system wiring and arrangement

2.6.2.3.1 Unit Auxiliary Power System Voltage and Neutral Point Grounding Type

MV auxiliary system voltage is 6kV. LV auxiliary system is 380/220V. Motors of 200kW and above shall be rated at 6 kV. Motors less than 200kW shall be rated at 380V.

UAT 6kV neutral point is grounding via medium resistance, tripping when single-phase grounding current above 600A. 380V system is grounded solidly.

2.6.2.3.2 MV Auxiliary System Wiring

There is one UAT, two 6kV buses named Unit 6kV bus A and B are set for the the turbine-generator unit loads, connecting to the two secondary windings of split-transformer (UAT). The 6kV bus A and B supply power to the loads of boiler, turbine, electrical precipitator, lighting system, maintenance system, raw water treatment and chemical water area, circulation water pump house area and so on.

There is a dedicated 6 kV plant area distribution system, which is located at the inside of coal handling control building, and including some 380V substations being constructed to feed the loads in the vicinity of this area (the details shall be adjusted on detailed design stage). Two 6kV feeds shall come from Unit 6kV bus A and B to feed coal handling 6kV bus A and B respectively.

2.6.2.3.3 LV Auxiliary System Wiring Principle

Two LV transformers are powered by 6kV bus A and B respectively and standby for each other.

All the LV transformers located indoor are dry type transformers.

2.6.2.3.4 Auxiliary Power system wiring and arrangement in Turbine Building

UATs are located outside the Turbine Building row A. The distance from the transformers outline to row A is more than 10m, the distance between the UAT and GSU is less than 10m, not satisfying the requirements of Fire Protection Code. The wall of row A will take the fire precautions.

The 6kV switchgears are arranged on the 6.3m level of Turbine Building.

The 380V switchgears including PCs and transformers are arranged in the Turbine Building or the Central Control Building.

2.6.2.3.5 Switchgear type

6kV switchgear shall be high quality, metal clad, middle-placed barrow, withdrawable Type. The 6kV incoming CB of UAT will be equipped with two tripping coils. 380V PC and MCC shall be high quality, metal clad, withdrawable MNS type cubicles for saving the space.

2.6.2.4 380V Emergency AC Power and UPS

2.6.2.4.1 380V Emergency AC Power

One air cooled diesel generator is used to supply the 380V emergency AC power for turbine-generator unit. The diesel generator auxiliary system shall include control and protection device, start-up battery, fuel oil daily tank and so on. The fuel oil daily tank shall contain enough oil for 8 hours full load continuous running. The diesel generator with the capacity 630kW can satisfy all the emergency loads. The diesel generator can start by remote/local control or manually/automatically and achieve full speed in 10s and prepare to supply power to the loads. Times from receiving the start signal to supply the full loads shall be less than 15s.

2.6.2.4.1.1 Two 380V emergency MCCs are set for the turbine-generator unit. Normally each MCC is powered by 380V auxiliary PC. When both of the two power lost, the diesel generator will start automatically and supply power to it. The MCCs are arranged in Central Control Building.

2.6.2.4.1.2 The diesel generator is three phases, 50Hz, Y wiring, neutral point solidly grounding, static excitation and equipped with the meters for current, voltage, frequency, active power, reactive power and kilowatt hour.

2.6.2.4.1.3 One set of protection relaying including following items as a minimum:

Differential protection
Over current protection (instantaneous and inverse time characteristic)
Reverse power protection
Earth fault protection
Low frequency protection
Over voltage protection
Loss excitation protection

2.6.2.4.1.4 One set of meter instrumentation and control switches which have the functions to select fully automatic or manually controlled operation.

2.6.2.4.1.5 380V emergency PC, MCC is arranged in the central control building.

2.6.2.4.2 Uninterrupted AC system（UPS）

The unit configures Two (2) set of UPS, which is supplied by external DC power, single-phase output. The UPS shall have a minimum output rating of 80kVA（the final capacity determined by loads at the stage of construction design）. UPS AC input voltage is 380V/220V; The 220V DC source is supplied from the unit DC system (DC power capacity can support 1 hour); UPS rated output voltage: Single-phase230V±1%, Two-wire system, Ground-Insulated system, Rated Frequency: 50Hz, Changes within the range of ± 0.1%. Unit UPS devices are located in the 5.3m floor of DC-UPS room of Central Control Building (CCB).

2.6.2.5 Unit 220V DC system

One (1) 220V battery group shall be provided for the generator unit, with Single-bus connection. The batteries will be seal valve-regulated lead-acid type, and the chargers will be high-frequency switching type. The battery shall be 1800Ah(the final capacity determined by loads at the stage of construction design).Two (2) high-frequency switching type chargers will be provided for each battery. 220V DC bus voltage ranges of 193 ~ 248V, DC bus short-circuit

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current is considered by 20kA. 220V DC system battery is arranged in the battery room of CCB, DC system configures microprocessor-based insulation monitoring devices to detect ground fault of feeder and bus.
220V DC power supply for the following load: 220VDC motor of urgent oil pumps, 220VDC power of UPS, the Emergency lighting in the Central Control Room and Diesel Engine Room.

2.6.2.6 Unit 110V DC system

Two (2) 110V battery group shall be provided for the generator unit, with Single-bus connection. The batteries will be seal valve-regulated lead-acid type, and the chargers will be high-frequency switching type. The battery shall be 800Ah(the final capacity determined by loads at the stage of construction design).Three (3) high-frequency switching type chargers will be provided for each battery. 110V DC bus voltage ranges of 93.5 ~121V, DC bus short-circuit current is considered by 10kA. 110V DC system battery is arranged in the battery room in CCB, Unit 110V DC system configures microprocessor-based insulation monitoring devices to detect ground fault of feeder and bus.
110V DC power supply for the following load: Control and protection.

2.6.2.7 110V DC system for 500kV switchyard

Two (2) 110V battery group shall be provided for the 500kV switchyard, with Single-bus connection. The batteries will be seal valve-regulated lead-acid type, and the chargers will be high-frequency switching type. The battery shall be 600Ah(the final capacity determined by loads at the stage of construction design).Three (3) high-frequency switching type chargers will be provided for each battery. 110V DC bus voltage ranges of 93.5 ~121V, DC bus short-circuit current is considered by 10kA.

2.6.2.8 Control, Measurement, Protection and Automatic devices

2.6.2.8.1 Control

Control locations
This project mainly control locations are follows:
1) Unit DCS, Operator Station is set in CCR.
2) Auxiliary control system, including ESP, Ash handling, desulfurization and water treatment systems. Operator Station is set in CCR.
3) Ash / slag control system， Backup Operator Station is set in ash handing control room of Air compressor building.
4) About Water Treatment Control System, See description of I&C Discipline.
Mainly control sites of Electrical equipment
Except 500kV circuit breaker associated with generator step-up transformer will be controlled by DCS, 500kV switchyard equipment including circuit breakers, Disconnect switches, earthing-switches are all controlled by NCS.
AVR will be controlled by the DCS. DCS will perform the normal control command such as start/stop AVR, PSS on/off, and so on.
All power source of 6kV CB and 380V PC incoming CB will be controlled by Unit DCS;

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All power source of other 380V CB including feeder breakers that serve MCC in MPB(main plant building),CCB(central control building) will be monitored by Unit DCS and controlled in switchboard;
In plant area, 6kV incoming CB & coupling CB, LV transformer and its HV side CB, LV side CB, 380V bus tie breakers will be controlled by corresponding control system, feeder breakers that serve MCC will be controlled locally. All breakers shall have "closed/tripped" status indicated locally and at the corresponding control system.
Generator, Generator step-up transformer , UAT protection, shutting-down/ maintenance transformer protection, the act status of the protective lockout relays shall be directly hard-wired to the sequence of events (SOE) in unit DCS .
DC and UPS system, measuring and alarm signal will be transmitted to the corresponding control system.
Main control system
1）Unit control
One central control building will be set for unit 3 in this project, One central control room for the unit and the unit control method will be adopted.
The central control room located in central control building. Protecting panels, 6kV bus transfer panel, the transducer & metering panels and fault recorder etc. all locate at 5.3m level of the central control building, the electrical relay room. No electrical control panel will be supplied in the central control room, and the electrical equipment's sequential control and real-time surveillance will be realized in DCS.
a. The following electrical equipment will be controlled and monitor in the unit DCS.

- 500kV CB of GSUT(Generator step-up transformer) HV side.
- Generator exciting system (including the field CB, AVR)
- 6kV incoming breaker
- 6kV standby incoming breaker
- 6kV feed breakers
- Unit LV auxiliary transformer, the HV side CB, the LV side CB and 380V bus tie breakers
- Unit 380V feed breakers (PC to MCC breakers)
- Motors for unit
- Diesel generator system

b. The following electrical equipment will be monitor in the unit DCS.

- 500kV disconnector switches, earthing-switches of GSUT(Generator step-up transformer) HV side.
- GSUT temperature and signal system
- UAT temperature and signal system
- Unit UPS
- Unit 220V DC system
- Tripping and alarm signals of protective relays, synchronize device(ASS), 6kV bus transfer device（ATS）etc.
- 6kV bus voltage for 6kV unit auxiliary power
- 380V bus voltage for 6kV unit auxiliary power

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c. The generator set's normal operation will be controlled by DCS. Moreover the emergency trip button of the generator will be mounted on the control desk, and the button will directly act to the generator protection's output relay.
d. The PT of generator and the 6kV auxiliary system will select the "N phase grounding" method in the second wiring side.
e. The unit will provide one micro automatic synchronization system (ASS); apply to synchronize for 500kV CB.

2) Ash net control system

Ash net control system consists of Fly Ash Handling control System, slag handling control system and bottom ash control system. A set of Fly Ash Handling control System, a set of slag handling control system and a set of bottom ash control system will be provided by corresponding process manufactories. The control system uses the dedicated PLC, PLC uses the redundancy, hot standby mode. The PLC's main cabinets and Backup Operator Station is set in the Ash Handling Control building. Ash net control system has the communication interface with the auxiliary control system, All system information and monitoring will be provided to the DCS via data link.

3) Electrostatic precipitators (ESP) control system

Electrostatic precipitators (ESP) control system shall be provided for the unit, supply by ESP manufactory. The control system uses the dedicated PLC, PLC uses the redundancy, hot standby mode. It can operate individually. The PLC's main cabinets and Backup Operator Station is set in the Ash Handling Control building. The control system has the communication interface with the auxiliary control system.

4) Water treatment control system

Water treatment control system refers to description of I&C discipline.

2.6.2.8.2 Metering

This project voltage transformer secondary winding use N-phase grounding, and secondary-side line voltage is AC110V.

This project current transformer secondary side current is 1A.

2.6.2.8.3 Protection relay

The main principles of protection

(1) Protection relay shall be configured according to the electrical one line diagram, meet the technical code for protection and contract requirements.

(2) Generator protection, Generator Step-up Transformer(GSUT) protection and UAT protection is use of microprocessor-based protection devices.

(3) Dual Protection shall be supplied for Generator, GSUT and UAT protection. Current and voltage circuits, DC power, protection output relays and cables shall be separate and distinct for redundancy.

(4) The protection lockout put relays for Generator, GSUT and UAT protection shall be hand reset type with mechanical target and a white pilot light for supervising the trip coil. After the protection act, the relative circuit breaker closing circuit shall be locked, the closing operation can't be execute until hand reset.

(5) The overcurrent protection of UAT shall not allow to start 10kV ATS(Automatic Transfer System).

Generation protection:

Two sets of protection have the same function:

（1）Generator differential protection

（2）Negative sequence overcurrent protection

（3）Loss of excitation protection

（4）Reverse Power Protection

（5）Generator overload protection

（6）95% and 100% stator ground protection

（7）Over/under Frequency Protection

（8）Volts per Hertz protection

（9）Generator Over Voltage Protection

（10）Generator Inadvertant Energization protection

（11）out of step protection

（12）GCB breaker failure protection

Excitation transformer protection:

Two sets of protection have the same function:

(1) Excitation transformer overcurrent protection

(2) Excitation transformer winding temperature protection (Manufacturers supporting)

Generator step-up transformer protection

Two sets of protection have the same function:

(1) Generator step-up transformer differential protection

(2) Generator step-up transformer Neutral overcurrent protection

(4) 500kV circuit breaker flashover protection

(5) 500kV circuit breaker Pole Discrepancy protection

Generator step-up transformer non-electricity protection:

Generator step-up transformer Bochholz protection

Generator step-up transformer Sudden pressure protection

Generator step-up transformer winding temperature protection

Generator step-up transformer Oil Temperature Protection

Generator step-up transformer Abnormal Oil level

Generator step-up transformer coolers stopping

on-load-tap-changer (OLTC) Bochholz protection

on-load-tap-changer (OLTC) pressure release protection

UAT protection

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Two sets of protection have the same function:.
UAT differential protection
UAT Overcurrent protection
UAT Negative sequence overcurrent protection
UAT 6kV Winding 1,2 Neutral overcurrent protection.
UAT Non-electricity protection:
Bochholz protection
Sudden pressure protection
widing temperature protection
Oil Temperature Protection
Abnormal Oil level
6kV incoming circuit breaker protection (Microprocessor-based integrated protection device in switchgear)
Instantaneous overcurrent with time delay protection
zero sequence overcurrent protection
LV auxiliary power protection
Protection and Measuring Device shall be supplied for 6kV incoming line, outgoing line and bus bar, which is set in the 6kV switchgear cabinet. Less than 2000kVA transformer feeder circuits shall be installed transformer protection and measuring device. The main protection: Instantaneous/Timed overcurrent, Ground Fault Overcurrent, low voltage side neutral overcurrent. Less than 2000kW motor feeder circuits shall be equipped with motor circuit protector (MCP) device. The main protection: Instantaneous/Timed overcurrent, Thermal Overload, Ground Fault Overcurrent, Locked Rotor/Stall/Jam, Under-voltage, Phase Unbalance/Phase Loss. For transformer applications equal or greater than 2000kVA, motor applications equal or greater than 2000kW, except above protections, the device shall also include differential over-current (3-phase) protection.
In principle, Protection and Measuring Device shall be supplied for 380V PC incoming &outgoing line, the digital-type trip devices equipped with circuit breakers, it will provide independently adjustable over-current, short circuit, and ground fault protection. Motors rated less than 75kW shall be fed by 380V MCC, the short circuit protective by main breakers, overload protective by thermal relay.

2.6.2.8.4 Automatic device configure and Auxiliary power transfer principle

(1) One set of ATS(automatic transfer system) device shall be supplied for each 6kV bus section, used for synchronizing check and block scheme of corresponding 6kV bus section, accident transfer from UAT to the Standup/Standby transformer(fast transfer mode).
(2) Logic switching of diesel 380V section circuit breakers is achieved by diesel PLC. When diesel generator periodic test to start, the synchronization judgment is achieved by synchronize device supplied by DG manufacturers.

2.6.2.8.5 GPS time synchronizing system

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2.6.2.8.5.1 A set of GPS system will be supplied for apparatus requiring time synchronizing in the whole power plant such as DCS, Protective relays, other control system PLCs, etc. The supplied GPS system shall include at least, a GPS-based system, interfaces with IRIG-B code, pulse, message with time stamp, NTP, etc. to be synchronized, outdoor antenna with cable, lighting protection, power supply, etc.
2.6.2.8.5.2 The accuracy of this master clock shall be, at least, 0.1 sec/day.
2.6.2.8.5.3 The time-receiving component configured by redundant criteria of GPS system will receive signals emitted by GPS satellite as external datum signal.
2.6.2.8.5.4 The GPS system has the function of time signals expansion to increase output signals easily according to different requirements.
2.6.2.8.5.5 The GPS system can synchronize time by message or by pulse. The message way of time synchronizing can also allow several communication rules.
2.6.2.8.5.6 The GPS system has multiplex time signal outputs with each one insulated from each other electrically regardless of interface type.

2.6.2.9 Over-voltage protection and grounding
2.6.2.9.1 Over-Voltage Protection
2.6.2.9.1.1 Lightning Protection
(1) Lightning line shall be installed between the both 500kV over head conductor gantries. The line can protect not only the over head conductor but also the GSU and UAT.
(2) Lightning rod shall be installed on top of the chimney.
(3) Independent lightning rod shall be installed at the oil tank area. Lightning protection net shall be installed on top of high structure.
2.6.2.9.1.2 Lightning Invasion Wave and Switching Surge Protection
(1) ZnO surge arresters shall be installed at the GSU HV side.

2.6.2.9.2 Grounding
2.6.2.9.2.1 Neutral Point Grounding Type
Refer to table 12.1.3-1.
2.6.2.9.2.2 Grounding Grid
(1) The underground grounding grid is combined with the copper rods(vertical grounding pole) and the stranded copper wire(horizontal grounding conductor).
(2) The electronic devices in control room shall be grounded together at the special grounding plate and then via two single-wire shield cables connecting to the same point of underground grounding grid.

2.6.2.10 Cable and Cable raceway
2.6.2.10.1 Cable

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2.6.2.10.1.1 Except for special requirement, the conductor of cables shall be copper. The cable flame retardant character shall according to the GB 12666.5-90, equal to IEC-332-3.
2.6.2.10.1.2 Power cables for the 6kV system shall have an insulation rating of 6/10 kV and for the 380 V system as 0.6/1 kV and shall be shielded. Multi-conductor control cables shall have an insulation rating of 750V. Instrumentation cables shall have a voltage rating of 500V.
2.6.2.10.1.3 In general, power cables shall be three conductors. Large power cables may be triplex or single conductor to facilitate easier cable installation.
2.6.2.10.1.4 Important circuit such as DC system, fire fighting pump motor and fire alarm system shall use the flame-resistant cable.

2.6.2.10.2 Cable Raceway

2.6.2.10.2.1 Cable raceway in Main Building will mainly consist of cable tray and cables to the equipment will be installed in the conduit.
2.6.2.10.2.2 Cable trench and cable tray may be installed in plant auxiliary workshop. But for the water and waste water workshop, only cable tray is used.
2.6.2.10.2.3 Cable routing from Main building to plant auxiliary workshop will consider use the Combined Piping Support and the cable trench.
2.6.2.10.2.4 In cable routing design, when cable trays are multiple stacks, the MV cables, LV cables, Control cables and Low level signal cables shall be arranged from top to bottom. Cable of deferent system shall be arranged in deferent cable raceway. MV and LV cables shall be arranged in deferent cable ducts. Low level signal cables shall be arrange in special steel conduit or in the steel cable tray with cover and bottom to prevent them from jammed.
2.6.2.10.2.5 Cable tray and steel conduit shall be Hot-dip zinc coated steel and grounded reliably.

2.6.2.11 Lighting and maintenance system

2.6.2.11.1 Lighting

2.6.2.11.1.1 Lighting system

Three lighting subsystems are utilized in the power plant:

Normal AC Lighting System
Normal/Emergency (N/E) AC Lighting System (only in turbine house and boiler house)
DC Emergency Lighting System

One 400/230V lighting PC is set for supplying the normal lighting loads of generator unit. There is a voltage compensation device used to guarantee the bus voltage variation in the rated. For auxiliary system outside the Turbine Building, the lighting power will be supplied by associated PC/MCC locally.
The Normal/Emergency AC lighting system is connected to the 380V E/MCC. The load of N/E system is 15~20% of all the lighting loads.
Emergency lamp with chargeable battery shall be installed at the exits, corridors, coal handling control room, E.P

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control room, switchgear room and so on.
DC emergency lamp shall be installed in the control room and the diesel generator room.

2.6.2.11.1.2 Lighting Voltage
Voltage of Normal Lighting system and N/E lighting system is 220V.Safety lighting voltage is 24V or 12V.Lighting device lower than 2.4m adopt the 24V voltage. Boiler lighting and maintenance system voltage is 12V, powered by 230/12V transformer in maintenance power box.

2.6.2.11.1.3 Mean illumination level:
street lighting: 15 lux
outdoor technical areas cable ducts: 50 lux
outdoor operating areas: 150 lux
staircases, toilets, ...: 300 lux
indoor operating areas (switchgear and electronic rooms, ...): 300 lux
offices, control room: 500 lux

2.6.2.11.2 Maintenance system
2.6.2.11.2.1 Maintenance Power
One 400/230V maintenance PC is set for supplying the normal maintenance loads via distribution panel.
For auxiliary system outside the Main Building, the maintenance power will be supplied by associated PC/MCC locally.
2.6.2.11.2.2 Maintenance power box
The incoming breaker of all the maintenance power boxes shall have the Leakage protection.
2.6.2.11.2.3 AC Socket System
There are some single phase/three phase safety sockets in the turbine and boiler area. There is 12V AC safety power source near the steam drum.

2.6.2.12 Plant communication and time display system
The communication and time display system, an integral part of the Power Station, functions as a system that:
Telephone system
Public address system

2.6.2.13 Cathodic Protection System
The cathodic protection system will prevent from the electrochemical corrosion of the followings:
- Metal piping buried in the earth
- The bottoms of above-ground, pad-mounted steel tanks

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• The wetted metal surfaces of the jetty
• The interior surfaces of designed, steel water-storage tanks

Cathodic protection systems are generally classified as an "impressed-current" and "galvanic-anode (sacrifice anode)". Impressed-current systems use rectifiers to drive protective DC current from anodes to the protected structure, while galvanic anode systems use only the natural difference in potential between the anode metal and the structure metal to drive the protective dc current.

2.6.2.14 Coal Handling System

Programmable logic controller ("PLC") will apply to the coal handling system of the plant, with industrial television and its associated sensors to realize automatic coal distribution, coal handling and monitoring and control for each equipment of the coal handling system.

2.6.2.15 Fire Alarm System

Fire protection and detection systems will include remote indication or alarm facilities, zoning of fire protection and detection installations, and facilities for the containment/removal of smoke and the containment/removal of spray water. Based on these requirements and the features of the power plant, a complete control and instrumentation system will be provided to ensure a safe, efficient and reliable system complete with necessary redundancy.

2.6.3 Instrumentation and Controls

The control and instrumentation systems will be upwardly compatible, the state-of-the-art systems that have been installed and have been operating in power plants for at least three years.

2.6.3.1 Distributed Controls and Monitoring Systems

The control and monitoring functions will be implemented in a microprocessor-based distributed control system (DCS) that encompass the following subsystems:

• Boiler combustion and miscellaneous modulating control systems (BCS)
• Burner management system (BMS)
• Data acquisition system (DAS)
• Modulating control system (MCS)
• Sequence control system (SCS)
• Sequence-of-events recording system (SER)
• Electrical auxiliary power circuit breakers control system (EPCS)
• Motor control system
• Human-Machine LCD-based operator consoles (MMI)

The control and monitoring functions for each of the above systems will be configured in dedicated redundant controllers located in system cabinets that interface with each other and with the MMI via redundant data highways.

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The DCS cabinets will be either geographically distributed throughout the plant and will be located in environmentally controlled enclosures.

A conceptual DCS architecture/overview block diagram, please refer to Appendix D.2.

It should be pointed out that this diagram will be revised for the EPC specification.

The DCS will provide scanning, controlling, alarming, and logging functions. All DCS subsystems will operate in parallel and all system functions will occur in real-time operations.

The monitoring and management functions will be highly centralized by means of a monitor and keyboard. The functions of control, protection, and interlock will be extensively distributed to individual microprocessors or programmable controllers.

The sequence-of-events (SOE) system will have one millisecond resolution covering critical boiler, turbine, generator inputs and the protection system. The SOE will be an integral part of the DCS, the SOE I/O point will be distributed all related redundant controllers, the dedicated controller of SOE will not be used.

The DCS will be time synchronized with GPS clock.

The DCS will have self-diagnosing abilities, so that internal faults can be detected within the system before the resulting disturbance to the process and so that measures can be taken to prevent spreading of the fault. Alarming of the fault will also occur simultaneously.

The important protection and interlock systems will be provided with redundant channels and multipoint measurement, as well as self-diagnosing functions and adequate test facilities to meet the following criteria against failure.

- No single fault will cause the complete failure of any system.
- Redundancy in the control system structure will be provided so that no single fault within a control system can cause failure of the controlled equipment or cause the standby equipment to be unavailable. In case of a failure of in-service equipment, the standby equipment will start up automatically without any system interference.

For critical parameters, three independent measurements will be provided. Control and direct indication will be derived from the median value of measurements. High deviation from the median value will be alarmed and removed from the median signal.

The DCS will be designed to maintain the control variable limits within the values specifically by the boilers and turbine manufacturers.

A historical data collection, storage, and presentation (historian) system will be supplied that will fully automate the collection, storage, and presentation of plant data. The historian will provide a centralized collection of information, a real-time database, and a historical data archive. The historian will interface with all of the plant real-time systems simultaneously and will be capable of reading and writing to these systems. The system will store data to an adequately sized storage medium with a printer and necessary software.

2.6.3.2 Central Control Room (CCR) layout

There will be one CCR for the power plant. The CCR will be located on the operation floor of central control building, The Electronic Equipment Room (EER) and engineer room will be located adjacent to the CCR.

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The operator control console in the CCR will include the following:

- Furniture, material, and design based on human factor engineering
- Four operator workstations, each with one (22-inch) monitor with keyboard for unit DCS
- One operator workstation with one (22-inch) monitor for the Digital-electronic hydraulic governor (DEH) of the unit
- PC/PLC network control workstations for plant BOP system with three (22-inch) workstations and one engineer workstation
- Emergency trip push buttons for boiler shutdown and turbine trip that will be mounted on the operator console

One operator workstation with monitor and keyboard for monitoring only will be provided for the shift supervision in the CCR.

Two engineering workstations (respectively for DCS and DEH), each with a monitor, will be provided. The engineering workstations will include all functions and capabilities available for the operator consoles plus the necessary enhancements for the performance of the required DCS/DEH engineering/programming functions. Two printers each for one engineering workstation will be provided. There will be networked printers, driven from common drivers, to perform the following functionalities:

- Screen copy printer (color)
- Report and SOE printer
- Alarm printer

One historical station and one vibration monitoring and analysis workstation also will be provided in the engineer room.

In addition to above, the following equipment also will be located in the CCR:

Auxiliary panel, the large video screen (65 inch), furnace flame TV (65 inch) and CCTV (65 inch) monitor will be mounted in the auxiliary panel, fire detection and alarm panel etc.

The Conventional instrument panel in CCR for this project will not be considered, all the monitoring and controlling will be realized on the LCD monitors by the operators.

2.6.3.3 Boiler Control System

2.6.3.3.1 General

Boiler control system (BCS) of the unit will be a part of the DCS.

The BCS design will include redundant distributed processors that are physically and functionally segregated from processors in the other systems. Critical signals between the BCS and the other systems will be hard-wired. The controls will be partitioned such that the control logic for equipment companion pairs is not implemented in the same processor.

2.6.3.3.2 System Description

Controlled parameters will not exceed permissible limits along the range from lowest coal-fired load (30% to 35%) up to 100% MCR load. For parameters required to be controlled throughout the whole range of load variation, full range control will be implemented in the DCS so as to lessen the intermediate intervention of the operator.

For adaptation of the unit to the network load and frequency regulation, the turbine-boiler coordination control system

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will be employed as the unit main controller. The main controller will meet the need under all operating conditions of the unit, and control the load variation according to permissible thermal stress value of boiler and turbine, to get the shortest possible ramp time. The unit target load may set by the operator or by the load-dispatching center.
Self-diagnostic, interlock, and protection will be provided for the control system. Alarm signals will be sent to the DCS monitors during initiation of these functions and be logged by the printer. The control system will not transfer to the auto mode, if the necessary conditions are not satisfied. In auto mode, the system will automatically and smoothly transfer to manual mode if necessary control input is lost or if the system fails. The interlock and protection system will allow on line testing and maintenance.
The BCS will include the following:

- Boiler-turbine coordination control (boiler follow, turbine follow, and coordinated or integrated control modes)
- Fuel control
- Draft air control
- Furnace pressure control
- Feed water flow control
- Primary air flow control
- Primary draft fan outlet pressure control
- Superheater, reheater steam temperature control
- Air heater discharge temperature control, etc.

2.6.3.4 Burner Control and Furnace Safety System

2.6.3.4.1 General

The burner management system (BMS) will be designed using redundant distributed processors that are physically and functionally segregated from processors in the other systems. Critical signals between the BMS and the other systems will be hard-wired. The control services will be partitioned such that the control logic for equipment companion pairs is not implemented in the same processor.

2.6.3.4.2 System Description

The system will provide control of startup/shutdown, fuel feeders, burners and igniters, and provide furnace monitoring and protection.
The system will provide the following functions:

- Furnace purge and ignition system leak test before boiler ignition
- Automatic or manual ignition and shutoff of igniters and main flame
- Igniter and burner startup/shutdown monitoring
- Coal feeder and igniter trips (main fuel trip)
- Operating interface for the monitoring and control of fuel feeders and igniters
- Interface for boiler control system and protection system

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• Flame detection
• Igniter fuel leak test
• Implosion protection of furnace and flue gas ducts

2.6.3.4.3 Flame Scanners

The BMS will be complete with the proper type and quantity of flame scanners for main flame and ignition fuel flame for the circulating fluidized bed boiler. Each scanner will be connected to a flame monitor via individually shielded and armored cable.

2.6.3.5 Turbine Control System

2.6.3.5.1 General

The turbine control system (TCS) that also be called Steam Turbine Digital Electro-Hydraulic Control System (DEH) will be provided and configured by the turbine manufacturer. TCS will be designed using redundant distributed processors that are physically and functionally segregated from processors in the other systems. Critical signals between the TCS and the other systems will be hard-wired. Hardwired signals between the TCS and other systems will be reviewed and finalized during detail design. The control services will be partitioned such that the control logic for equipment companion pairs is not implemented in the same processor. The DEH may use the same hardware as that of DCS otherwise DEH will be data-linked with DCS.

2.6.3.5.2 System Description

The TCS system will provide the following functions, but not limited to:

1) Turbine speed regulating function

2) Load control function

The turbine generator output will be automatically regulated according to a target load demand. The system will have maximum and minimum adjustable load limits and a rate limit of changing load. The system will monitor the process variables and equipment status that restricts the output of the turbine generator set. When such conditions occur, the system will limit the load signal and initiate an alarm.

3) Automatic turbine startup or shutdown control function (ATC)

4) Performance monitoring

The TCS system will monitor the main steam parameters, status of turbine and auxiliaries, and turbine thermal stresses; and it will provide the DAS with input for calculation of turbine performance.

5) Valves management function

6) On-line testing, the TCS system will facilitate on line testing of turbine valves and high-speed trip.

7) Monitoring and operation functions of startup & shutdown, normal operation

8) Over speed protection function etc.

2.6.3.5.3 Turbine Supervisory Instruments (TSI)

TSI will be provided and configured by the turbine manufacturer. TSI will be used for monitoring important parameters of turbine, and send out alarm and trip signals when parameters are over limit. As per the turbine manufacturer's design standard, TSI will include the following functions:

1) Speed measurement
2) Zero speed measurement
3) Axial displacement measurement
4) Shaft & bearing vibration
5) Eccentricity
6) Thermal expansion
7) Differential expansion
8) Key phase etc.

2.6.3.5.4 Emergency Trip System of Steam Turbine (ETS)

ETS will be provided and configured by the turbine manufacturer. ETS will perform the safety functions of the turbine protection system. It will be connected to DCS and TCS through hardwires and can be tested online. When one of the following trip signals occurs, ETS will be initiated and main steam stop valve will be closed immediately.

1) Turbine over speed
2) Axial displacement extra high
3) Loss of condenser vacuum
4) Low bearing lube oil pressure
5) Low control oil pressure
6) Bearing vibration extra high
7) Generator inner fault
8) Generator main protection initiating
9) Boiler master fuel trip (MFT)
10) DEH power supply failure
11) Operation of emergency turbine trip pushbutton in CCR etc.

2.6.3.6 Vibration Monitoring

All important large rotating machinery which are driven by medium-voltage motors will have shaft or/and bearing vibration monitoring and analysis. The application of monitoring equipment will be to the size and type of rotating equipment. Adequate vibration monitoring sensors will be provided based on equipment manufacturers. The arrangement of the vibration probes will be as per the ISO 7919 and ISO 80816 or the equivalent Chinese GB.

2.6.3.7 Closed Circuit Television System (CCTV)

CCTV system will be designed for plant security and vigilance monitoring. The menus of CCTV will be displayed on LCD monitor in CCR and the safe guarding room. The CCTV system will include security CCTV and CCTV used

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for production area. The security CCTV will include warehouse, plant main entry gate, administration building and plant fence etc. The production area CCTV system will include boiler, turbine hall, water area, ash area, fuel oil area, coal area etc. And the detailed number and location of cameras will be submitted during detailed design stage.

2.6.3.8 Balance of Plant (BOP) control systems

The following table lists out main BOP packages of this project and their control mode:

Table 2-20 Control Mode of BOP

S. No.	BOP system	Control mode	Control location	Interface with DCS
1	Demineralized water system	PLC	Local control room (LCR) and CCR	No Interface
2	Condenser polishing system	PLC	LCR and CCR	No Interface
3	Steam and water sampling & chemical dosing system	PLC in No.2	LCR and CCR	No Interface
4	Unit drain tank	PLC in No.2	LCR and CCR	No Interface
5	Waste water treatment plant	PLC	LCR and CCR	No Interface
6	Hydrogen generation system	PLC	LCR and CCR	No Interface
7	Circulating water treatment system	PLC	LCR and CCR	No Interface
8	Circulating water pump	DCS remote I/O	CCR	
9	Supply water pump	PLC	LCR and CCR	No Interface
10	Raw water pretreatment system	PLC	LCR and CCR	No Interface
11	Rainwater pump	PLC	LCR and CCR	No Interface
12	Fuel oil system	DCS remote I/O	CCR	
13	Compressed air system	PLC	CCR	Hardwire for several important

				signals
14	HVAC & Chilling system	PLC	LCR and CCR	No Interface
15	Ash handling system	PLC	LCR and CCR	No Interface
16	Coal handling system	PLC	LCR and CCR	No Interface
17	ESP filter system	PLC	LCR and CCR	Hardwire for several important signals
18	Auxiliary Boiler	PLC	LCR and CCR	No Interface

If the controlled system is far from control room, the remote I/O cabinets will be used and will be laid in the respective local electronic room.

PLC centralized control network will be provided in the CCR, all PLC based BOP systems will be communicated with the centralized control network so that the PLC based BOP systems can be monitored and controlled through the operator stations of the PLC centralized control network in the CCR under the normal operation condition.

2.6.3.9 Back-up Operation Pushbutton

When serious accident of DCS happens (for example loss of power supply, communication interrupt, all operator stations fault, important controller fault etc.), the unit can be shut down safely through the several hardwire 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.

As preliminary, the following hardwired back-up emergency operation push buttons will be furnished on the operator console:

a) Turbine emergency trip
b) Master Fuel Trip (MFT)
c) Generator-transformer emergency trip
d) PRV (Pressure relief valve)
e) Condenser vacuum breaking valve
f) DC lube oil pump
g) AC lube oil pump
h) Emergency starting button for diesel generator.
I) Others if required.

2.6.3.10 Programmable Logic Controller (PLC)

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The hardware of PLC will be endeavored to limit the choice one supplier as possible.
PLC will include processor, I/O cards, memory modules, racks, mounting accessories. The system will have self-diagnosis function.

2.6.3.11 Power Supply & Air Supply for I&C

2.6.3.11.1 Power supplies for I&C

Two (2) loop 230V AC 50Hz power supplies derived from main plant UPS and emergency power supply will be designed to meet electric power requirements of important instruments and control systems such as DCS, DEH, ETS, TSI etc.
Two (2) loop 220V DC power supplies used for important protection and control will be derived from the main plant storage battery sets. Power used for motor-operated valves in main building will be two (2) loop power supplies of 400V AC 50Hz derived from low voltage auxiliary power bus and emergency power supply feeders.
Power used for I&C in BOP will be offered by low voltage electric switchboard of corresponding plant.

2.6.3.11.2 Air supply for I&C

Air supply for instrument will be special compressed air. It will be oil-less, water-less, dust-less. And it will meet the instrument air quality requirement. The air supply will be from the instrument air compressors.

2.6.3.12 Laboratory Equipments for I&C

One set of general test and maintenance equipment for fulfilling maintenance and checkout of I&C equipments will be supplied.

2.6.4 Civil

2.6.4.1 Site General Information

2.6.4.1.1Description and Location

The distance from the project site to the nearest city (Jetha Bhutta Town) is 6km. The site is situated on the side of main railway track from Lahore to Karachi at a distance of 4km. There is a canal 2km away near the project site. Available land for this project is around 500 acres.

2.6.4.1.2Seismicity

According to the Pakistan seismic ground motion parameter zonation map, Peak Ground Acceleration (PGA) of the planned sites is 0.08~0.12g with 10% probability of exceedance in 50 years.

2.6.4.2 Site Preparation and Drainage

2.6.4.2.1Grade Elevation and Plant Drainage

Plant finished grade elevation may be approximately +90 meters above sea Level. This will be based on the balance of

excavation and fill volume of earth works due to the lack of Highest Flood Level of once-in-a-century. The finished grade surface will be sloped away from the buildings to provide surface drainage.
The site will graded to drain rainwater using storm drain. Storm water runoff will be discharged out of the plant.
The rainwater runoff from the coal pile area will be collected in a lined retention pond for settlement of coal particles and this water will be discharged to the storm drainage system.

2.6.4.2.2 Drainage of Other Wastes

All oily waste from floor wash, transformer areas, the diesel generator area, equipment drain areas, and other areas will be collected in oil separators provided at strategic locations.
A sanitary sewer system will be provided to collect sanitary waste from sources of sanitary waste and will be treated and then reused.

2.6.4.3 Foundation and Substructure

Due to the lack of Geotechnical Investigation Report, it is assumed that pile foundations in groups with pile cap are recommended for main power building structures, TG foundation, boiler foundation, chimney foundation etc. Piles shall be bored cast-in-situ. Square/strip foundations interconnected by tie beams in both of the orthogonal directions are recommended for other building structures supporting lighter load.

2.6.4.4 Water Intake System and Drainage System

2.6.4.4.1Cooling Water System（CWS）

2.6.4.4.1.1General Description

A cooling water system will be provided which is capable of providing the cooling duty necessary to meet the rated plant performance requirements, see the Appendix D.13 Circulating Water System Flow Diagram.
The principal criteria for the design of the system will be to ensure the supply of cooling water to the condenser at all times, as well as under any operation circumstances.
The contractor, if necessary, will show, by suitable analysis, that our proposed design of cooling water system will meet the cooling system requirements of the power plant and environmental requests under all operation circumstances, taking into account the conditions when plant heat rejection is the largest.
The design of the cooling system is fundamental to the normal operation of the whole power plant. The Contractor promises to consider water quality, local climate and hydrographical studies while determining the system design. All design values presented hereinafter are estimated and is subject to changes based on actual and more detailed site data after the award of contract.

2.6.4.4.1.2Circulating Water（CW）System

Based on such current available site conditions as geographical, hydrological and meteorological features, etc, as well

as the cement price, the circulating water（CW） system is recycled circulating water system with natural draft cooling tower.

The unit has an independent CW system. For the unit, one natural draft cooling tower, two vertical diagonal-flow 2×50% CW pumps, one pressure CW supply main pipe and one pressure CW return main pipe will be installed. CW system of the 1×660MW unit has a common CW pump house which situated around cooling tower. The CW Pump House and the cooling tower are connected by channel. Diameter of the CW pressure supply main pipe and return main pipe is DN3000. Diameter of inlet and outlet pipe of the main condenser is DN2200.

CW system of the 1x660MW unit has a common Circulating Water Pump House. Two (2) vertical diagonal-flow pumps will be arranged in the CW pump house. The underground plan size of the CW pump house is 27.7mx14.3 m. In the Forebay, each CW pump will be equipped with two filtration screen and a steel gate.

The outlet of each circulating water pump shall be equipped with a DN2200 two stage hydraulic operated butterfly valve. This butterfly valve could be closed by two stages to avoid the damage of water hammer occurred in accident. Before start the circulating water pump, the butterfly valve should be opened by 15% approx and at this time, the reverse rotate speed of the pump could be reach to about 10% of the rated normal rotate speed. Under above-mentioned condition, the circulating water pump can start and operate safely.

An portal crane with a capacity of 50/10t (operated on floor) will be installed in the CW Pump House for installation and maintenance of circulating water pumps, motors, butterfly valves, double flange power delivery joint, the Filtration Screen and Steel Gate and so on.

Four drainage pumps will be equipped for CW Pump House. Function of drainage pumps is to discharge the water collected in the sump pit during equipment operation and maintenance. The pump will be interlocked with the water level in the sump pit, running/stopping automatically. Two drainage pumps will be installed in the sump pit, one in operation and one on standby. The other two drainage pumps will be installed in the sump pit under butterfly valve, one in operation and one on standby.

2.6.4.4.1.3Natural Draft Cooling Tower

One unit (1x660MW) is equipped with one 9000m^2 natural draft cooling tower .Main design parameter of cooling tower is as follows:

Model: natural draft cooling tower;

Cooling water flow: 83448 m^3/h;

Air inlet height:9.8m;

Water drenching area: 9000m^2;

The inner diameter of the collecting tank for tower: 115.73m;

Tower height: 150m

Material of filling: PVC;

Depth of the water basin: 2.0m;

Designed temperature of the outlet water:

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Designed temperature of the outlet water: According to local climatic information , the calculation of cooling tower is tentatively based on the following conditions： Dry bulb temperature: θ=26.4 ℃,Wet bulb temperature: τ=24.3℃,Atmosphere pressure： P= 1006.5hPa, Relative humidity: 84%.Under the above condition, in the summer, the outlet of cooling tower water temperature will not be higher than 30.0 ℃.Cooling Tower System is designed for 24.3 ℃ （tentative） Wet bulb temperature and Approach of 9.8 ℃.

The Contractor will describe the main operating features of the system in normal operation, shutdown and starting-up including priming of the pumps if applicable.

To facilitate safe maintenance within the cooling water system, the pipe work will incorporate appropriate isolation and man access points. Any specific corrosion control system will be fully described and the Contractor will demonstrate that the plant offered is suitable for the power plant design life, the water quality and the anticipated duty.

2.6.4.4.2Potable & Service Water Supply System

2.6.4.4.2.1 Raw water supply

The Contractor will, considering the normal operation of the power plant as well as the owner's requirements, provide sufficient eligible quality water for the plant. All these water will be supplied to the necessary sections of the plant after being processed. The Contractor will provide all necessary equipment, facilities, reservoirs, pumps and valves etc. to process freshwater.

Raw water supply will be from Abbasia Canal river, which is freshwater in nature. Through the booster pump installed in the first raw water pump house near the Abbasia Canal river， raw water will be pumped to a irrigation canal and along the canal flow into the forebay of the second raw water pump house through gravity. Then through the booster pump installed in the second raw water pump house near the plant ,raw water will be pumped to the water pre-treated station. Because the irrigation canal in the north side of plant will be closed for renovations for a month every winter dry season, considering the groundwater pumped to meet plant water during this time.

The Power supply for booster pumps will be covered from power plant, and 12 Million m^3/annum of Ground water is available for 1x660MW Thermal power plant's use.

The freshwater including the deep well water outside power plant will be pumped to Two (2) 900m^3 Reaction and Sedimentation Tanks for pre-treating.

2.6.4.4.2.2 Main process of raw water pre-treatment system

(1) Make-up water

Abbasia Canal river→first raw water pump house→irrigation canal→second raw water pump house→ Pressure Steel pipes→900 m^3/h Reaction and Sedimentation

↑

deep well water

Tanks→cooling tower water basin

(2) Chemical water

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Abbasia Canal river→first raw water pump house→irrigation canal→second raw water pump house→ Pressure Steel pipes→900 m3/h Reaction and Sedimentation

↑

deep well water

Tanks→60m^3/h Air backwashing filter→Water treatment plant.

(3) Potable water

Abbasia Canal river→first raw water pump house→irrigation canal→second raw water pump house→ Pressure Steel pipes→900 m^3/h Reaction and Sedimentation

↑

deep well water

Tanks→60m^3/h Air backwashing filter→200 m^3 Potable Water Basin.→Potable water pumps→Potable water pipe network→Potable water users.

(4) Service water

Abbasia Canal river→first raw water pump house→irrigation canal→second raw water pump house→ Pressure Steel pipes→900 m3/h Reaction and Sedimentation

↑

deep well water

Tanks→60m^3/h Air backwashing filter→800m^3 Service&Fire-fighting Water Pond.→Service water pumps→Service water pipe network→Service water users.

(5) Fire fighting water

Cooling tower Blowdown losses→Reused Water Pond →users

↑

Industrial waste water treatment& R.O.Drainage

(6) Fire fighting water

Abbasia Canal river→first raw water pump house→irrigation canal→second raw water pump house→ Pressure Steel pipes→900 m^3/h Reaction and Sedimentation

↑

deep well water

Tanks→60m^3/h Air backwashing filter→800m^3 Service&Fire-fighting Water Pond→Fire fighting pumps→Fire fighting water pipe network.

2.6.4.4.2.3 Facilities of raw water pre-treatment system

All necessary plants, equipment and works necessary to meet the Raw Water Pre-treatment requirements in the Contractor's design will be provided; the major items include:

(1)Two (2) 900m^3/h Reaction and Sedimentation Tanks;

(2)Two (2) 60m^3/h Air backwashing filter;

(3)Two (2) 800m^3 Concrete Service&Fire-fighting Water Pond, One (1) 200m^3 Concrete Potable Water Basin, One(1) 800m^3 Concrete Reuse Water Basin and

Two (2) 200m^3 Concrete Chemical Water Basin;

(4)One (1) Multi-Function Pump House and One (1) Chemical Dosing Room;

(5)All pumps, piping, valves etc. required for the aforementioned water systems.

2.6.4.4.3 Water Usage for the Power Plant

For the 1x660MW Power Plant, the whole freshwater consumption is about 0.45 m^3/s (1617m^3/h), which include the service water, potable water and chemical water, etc. (Note: water for ash deposit system is not included.)

The normal service water consumption will be range from 45m3/h to 150m^3/h (estimated, the max. flow happens while Air Preheater is flushed.), we suppose that necessary water demand can be provided by the filtered water.

The normal potable water consumption will be range from 10m3/h to 20m^3/h (estimated), we suppose that necessary water demand can be provided by the filtered water.

Item	Water Usage	Water Quantity (m^3/h)	Water Source
1	Cooling tower make-up water	1501	Clarify water
2	Chemical Water System Make-up Water	48	filtered water
3	Potable Water System Make-up Water	10	filtered water
4	FGD Cooling Water	10	Service Water
5	Wet water for double-shaft pug mill in ash storage	30	Service Water
6	Wet water for double-shaft pug mill in ash storage	30	Service Water
7	Miscellaneous water	202	Reused Water
8	Ash Silo Washing Water	8	Reused Water

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9	Desulfuration Water	110	Reused Water
10	Coal Yard Spray & Wash Water	50	Reused Water

Note: 1. All the data in the above table is subject to changes after the award of contract.

2.6.4.4.4 Other Water Drainage

2.6.4.4.4.1 Domestic waste water sewage system

2×10m^3/h domestic wastewater treatment facility will be equiped. Domestic wastewater after the treatment to meet the standard of <The reuse of urban recycling water-Water quality standard for urban miscellaneous water consumptiom> will be reused to plant greening or ground sprinkling.

Sewage and rain water separate drainage system is adopted. The domestic waste water from buildings is collected by domestic sewage pipes and flows to the domestic wastewater treatment plant.

UPVC reinforced pipes are used as the domestic sewage pipes which are laid out as branch type and directly buried. The diameter of main pipe is 300mm, i≥0.004,laid out from buildings to the domestic wastewater treatment plant, and wastewater examination wells are set on the way. In addition, an outlet with measure facility to the rain water sewage pipes system is set for emergency.

2.6.4.4.4.2 Rain water Drainage System

One (1) rain water pump house shall be need in this project.

Storm water coming from roofs, roads and buildings such as washing water of normal stain areas will be drained away directly to the main discharge collector via the plant storm water collection and diversion system, and then, through the rain water pump, it shall be lifted to discharge into the nearby drain. Storm water coming from the outside of the power plant fence will not go into the plant drainage system.

Waste water coming from fuel oil storage grounds will be drained to the main discharge collector after going through a suitable oil-water separators or pit allowing the oil recovery.

2.6.4.4.4.3 Coal Yard Drainage Water Treatment System

Coal yard spray and Coal Handling System wash water flows into the coal containing wastewater sedimentation pond which is set near the coal yard. Coal slurry precipitated in the bottom of the pond shall be cleaned up by automatic grab bucket or hand work. Two set of 20m3/h coal containing wastewater treatment facility is introduced beside the sedimentation pond, which are used for treating with the coal yard spray sewage and wash water. The sediment of coal particles are collected back to the coal yard. The cleared water will be reused for coal yard spray and gallery washing. A chemical dosing room is needed for the treatment facility, which is equipped with two chemical unloading pumps, one set of coagulant dosing device, one set of flocculants dosing device.

2.6.4.5 Buildings

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2.6.4.5.1 Main plant building

Main Plant Building comprises of TG bay, deaerator bay, bunker bay, boilers and all other auxiliary facilities / structures located there in. This building will contain turbine generator and auxiliary equipment.

The main plant building will be of steel framed structure. The roof and external-wall above 1.00m of main plant TG bay will be insulated double skin sandwich panel metal sheeting, and that below 1.00m will be masonry wall.

Boiler will be supported on steel structures.

2.6.4.5.2 Central Control Building

The central control building is steel framed building attached to the TG hall. Cladding will be of masonry wall with plastering on both sides. Roof w ill be provided with roof water proofing treatment and Insulated.

All air conditioned areas will be provided double glazing. Adequate aluminum doors and windows will be provided for natural lighting, ventilation and view.

2.6.4.5.3 Miscellaneous Buildings

2.6.4.5.3.1Administration Building

Administration building contains offices for the management and administration of the plant. Other facilities are lobby, meeting rooms, toilets for men and women, first-aid room, laboratory, etc. The entire building is air conditioned.

2.6.4.5.3.2 Workshop

It will be of steel framed structure with metal cladding. The workshop includes separate shops for mechanical and electrical equipment repair. The maintenance space will include welding areas, and offices and toilets etc.. The shops will be ventilated to maintain air quality. The offices will be air conditioned.

2.6.4.5.3.3 Permanent store building

Permanent store building will be of steel framed structure with metal cladding. The building will protect all the spare parts required. The building will be ventilated. The offices and some areas for sensitive parts will be air conditioned.

2.6.4.5.3.4 Garage

The structure will be reinforced concrete framed. The external-wall will be masonry wall. The building includes office area, tool room, maintenance area etc.

2.6.4.5.3.5 Gate House

It will be of single storied reinforced concrete framed structure with in filled masonry wall consisting of mainly security room, reception; visitor's waiting area, toilet and office area.

The entire building is air conditioned.

2.6.4.5.3.6 Fire Station

Fire Station building will be single storied reinforced concrete framed building. There will be offices and store room, workshop and toilet etc.

2.6.4.5.3.7 Water Treatment Building

The water treatment building contains all the water treatment equipment, including demineralizers, required to produce the water for drinking and boiler makeup. The equipment will include some switchgear and a control panel. The control

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panel will be in an air-conditioned room. This building will be constructed of concrete blocks or it will be a steel structure with uninsulated metal wall cladding except around the air-conditioned room.

2.6.4.5.3.8 Coal Transfer Houses

The coal transfer houses will support the conveyors and dust suppression/control equipment for each of the changes in direction of the coal conveyors. They will be reinforced concrete structures, and the sides of the structures may be enclosed or open depending on the final design.

2.6.4.5.3.9 Coal Crusher House

The coal crusher house will support conveyors, crushers, dust collectors and related equipment. This building will be reinforced concrete framed.

2.6.4.5.3.10 Coal Handling Control Building

The coal handling control building will house the controls for all coal handling conveyers. The building will include areas for an office, switchgear, locker room, and lunch room. The office and control room will be air-conditioned. This building will be of steel structure with an insulated metal wall cladding or it will be constructed of concrete blocks with concrete roof slab and built-up roofing.

2.7 Plant Support Facilities

2.7.1 Construction

A summary of these works follows below.

The access road from existing asphalt road to plant will require improvement to a level suitable for the transport of power plant equipment, materials, and construction machinery.

The trains and railway from existing railway to plant will be arranged for the transport

The plant site requires grading and preparation by cutting and filling as appropriate.

All necessary governmental approvals will be arranged.

•Areas totaling approximately 13 hectares need to be made available for lay down and staff accommodation during the construction phase.

•Completion of the water intake and discharge.

•Adequate capacity of temporary power and water for construction purposes for the entire duration of construction phase to be arranged.

•Ash pond or other suitable arrangement will be provided with enough capacity to accommodate all ashes generated from the Project.

•Permanent electrical interconnect will be provided at the plant boundary to deliver power generated from the Project to the national grid. Facilities will also be included to import power necessary for start-up power.

•Land for permanent colony housing will be made available for construction of permanent operations staff accommodation. But for feasibility study stage, colony housing has not been considered for cost and at next stage, the project company provide the specification for permanent colony, cost will be considered individually.

•A 500-kV interconnecting transmission line from the Project outgoing gantry to the grid system needs to be built, for

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timely and successful evacuation of the electricity generated in the Project. This will also provide the start-up auxiliary power to the power plant.

2.7.2 Construction Camp

Separate from the colony will be a construction camp. The design of the construction camp will be the responsibility of the EPC Contractor. There will be three general areas:

- Container-based housing for the management. These will be removed at the completion of construction.
- Cement block / concrete housing for lower management and supervisors. These buildings will be designed as permanent buildings and will be used for the outage workers after the plant is in operation.
- Hall style housing for the workers. These will be removed at the completion of construction.

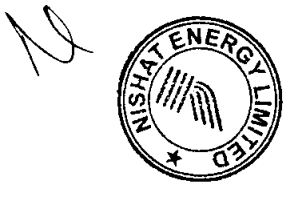
2.7.3 Land Use

Since the site is in an undeveloped area, there is adequate room for construction laydown.

Construction lay down is the area used to store equipment and material transported to the site before it is installed in the plant. Depending on the final arrangement, the coal storage can be part of the construction laydown area.

Some temporary warehouse and fabrication shops will be built for the storage of equipment that requires protection from the weather. The fabrication shops will be used for fabrication of piping and other assemblies before installation into the plant.

One or more tree plantations will be made near the plant at the end of construction. This will provide a pleasant area and contribute to the environment.



3. FUEL SUPPLY

Rahim Yar Khar Project site is located 6KM from JethaBhutta Town & 18KM from Khanpur City, Pakistan. The Rahim Yar Khar Power Plant will have a design rating of 660MW and an annual coal consumption of up to 180.19×10^4 tonnes per year (Mtpy) at full load operation of the plant depending on the calorific value of coal. The range of available coal qualities and prices will guide in selecting the boiler specification and the type of coal preferred.

The objectives of the coal supply plan are to evaluate the most reliable and economic sources of coal for the power plant. The study includes an evaluation of the world coal market, the availability of a range of coals, the quality of the coals, and the indicative FOB and delivered price of the range of coals. For the coal sources considered, information is provided including coal sources, coal quality, current and future production capacity and demand, and other relevant information. The coal procurement plan must be acceptable to the project company.

The recommended primary sources of coal supply are Australia, Indonesia, Pakistan, and South Africa. The coal suitable for the Project should be sourced from all primary supply countries. Midrank Indonesian coal (5000-5,500kcal/kg gross as-received) and higher ash Australia and South African coal (proximate to RB3 spec) should be considered if coal price discounts improve the overall economics. Pakistani coal will be used if it meets the quality, quantity, and cost requirements. Any further reduction in coal CV would make it unviable on $/MMBBTU basis as the add-on of inland transportation cost would outweigh the benefit of the price discount for lower CV coal.

Prudent approach towards coal procurement relies heavily on fixing an arrangement with common understanding between the key stakeholders of the project. The key stakeholders and their perceived role is as follows:

1) NEPRA (Regulator): responsible for tariff of the IPP
2) PPIB (Power Purchaser's Rep): responsible for approving the overall terms of PPA and CSA
3) Technical Stakeholders (Power Plant Operator, Port Handlers and Inland Transporters)
4) Coal suppliers

The following steps are conceived in achieving the above:

1) Finalization of coal specifications through a mutual discussion process involving technical stakeholders of the project
2) Fixing the revenue model and key commercial terms of PPA related to coal procurement through proper component-wise benchmarking
3) Receiving non-binding term sheet from shortlisted coal suppliers to feed into finalization of design parameters of the power complex
4) Adjustment of coal specifications and key commercial terms of the CSA after review
5) Launch of formal RFP for binding proposals
6) Finalization of CSA

As on July 2015, step 1 to 3 are partially completed. Initial rounds of discussion have taken place with only a few coal traders and this document is for formally indulging with coal suppliers in compliance with step 4.

Coal should be purchased with a mix of contracts — short-term (one year), medium-term (up to five years), and long-

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term (longer than five years) — to allow the Project to respond to market variations. Coal prices should be discounted for heat content and moisture content for high-moisture, mid rank Indonesian coal. In the current market, discounts for other components, such as ash or sulfur, are minimal. Penalties may be negotiated for out-of-specification coal in the coal supply agreements.

Terms should be staggered; that is, different contracts should expire and be renewed at different times. The portfolio should change with market circumstances. In general, during times of low prices, the longest possible terms should be negotiated. As prices increase, terms should be decreased. Over the past 10 years, Pacific coal market prices have shifted significantly. Properly implemented, the portfolio strategy should ensure that this project coal purchases allow the plant to remain competitive over the long term.

Coal should be transported to the site in the most economical manner, which will likely be in Capesize vessels (i.e., cargo ships too large for either the Suez or Panama Canal) and railway, under long-term contracts, which are currently significantly lower than spot rates. Pakistani coal can be received by dumper at the project site. Pakistani coal could be delivered to the plant by rail.

3.1 Coal Source

3.1.1 Supply

Coal Supply Plan is to identify the most economical, reliable, available coal supply and to determine an indicative CIF and delivered price of various coals to allow the most reliable coal supply to be selected. This information includes coal quality parameters to estimate the costs incurred at the power plant due to the quality of the coal.

Based on logistics and coal availability, the most likely sources of competitive coal supply to the Rahim Yar Khar Coal Fired Power Plant are Australian, Indonesian, South African, and Pakistani coal. Due to relatively shorter shipping distances, Indonesia, South Africa, and, to a lesser extent, Australia enjoy a delivered cost advantage to Pakistan over more distant coal-exporting countries such as Colombia, Venezuela, and Russia.

Indigenous coal supply from Pakistan is currently being evaluated and will be used provided it meets the quality, quantity, and cost requirements of the Rahim Yar Khar project.

3.1.2 World Production-Thermal Coal

The following Figure indicated Supply and demand of Seaborne Traded Thermal Coal.

Figure 3-1 Supply and demand of Seaborne Traded Thermal Coal (MT)

Supply and demand for seaborne traded thermal coal *(mt)*

	2012E	2013F		2014F		2015F	
	mt	mt	% y/y	mt	% y/y	mt	% y/y
Euro-area demand	153	145	-4.9%	145	-0.4%	144	-0.4%
Total Asia-Pacific demand	612	675	10.3%	707	4.7%	728	3.0%
of which:							
China	203	259	27.4%	278	7.6%	295	5.8%
India	123	131	6.1%	134	2.6%	143	7.0%
Japan	126	126	-0.2%	129	2.6%	122	-5.5%
South Korea	100	100	0.5%	103	2.6%	105	2.0%
Taiwan	60	60	-0.2%	63	4.4%	63	1.0%
Total demand	917	966	5.4%	1,001	3.6%	1,026	2.5%
Pacific/total demand	67%	70%		71%		71%	
Total supply	914	969	6.0%	1004	3.7%	1030	2.5%
of which:							
Australia	171	181	5.7%	189	4.6%	201	6.4%
Colombia	79	74	-6.3%	79	6.7%	84	6.3%
Indonesia	382	404	5.8%	424	4.9%	434	2.4%
Russia	96	112	16.9%	111	-0.8%	110	-0.8%
South Africa	80	81	1.2%	83	1.5%	84	1.5%
Notional balance	-3	3		3		4	

Indonesia is currently the world's leading exporter of steam coal with 2012 seaborne steam coal exporter in excess 382 million tonnes (Mt). Australia is the second largest steam coal exporting country with 2012 shipments of 171 Mt, the fourth is South Africa of 80 Mt.

There is a possibility that coal can be sourced from other country, at a later date.

3.1.2.1 Potential Coal Supply Sources

It is evident based on logistics and coal availability that the most likely sources of competitive coal supply to the Karachi in Pakistan are Australian, Indonesian, Pakistan, and South African coal. Due to relatively shorter shipping distances, Indonesia, South Africa, and, to a lesser extent, Australia enjoy a delivered cost advantage to Pakistan over more distant coal-exporting countries such as Colombia, and Russia. The locations of major steam coal exporting countries supplying Indian Ocean markets and primary shipping routes to the Karachi are shown on Figure 3-2. Distances are given in nautical miles (N.M.).

Russia is not considered a potential supplier because of its location. It supplies export thermal coal primarily to Europe and does not have economic access to Asia. China is not considered because, due to its domestic requirements, China's export coal tonnages have declined in the last several years. Due to many uncertainties with China's coal exports, it is not considered to be a reliable source of export coal.

Pakistan itself has identified coal and lignite resources of coal. However, the coal quality is low with heating values of 2,800 to 4,000 kcal/kg (GAR) and high sulfur values of 1.25% to 5% on an as-received basis (arb). Some of the deposits are mined, and the coal is used locally. However, it would be quite open to purchasing Pakistani indigenous coal that could be delivered at an acceptable quality, quantity, and price. Indigenous Pakistani coal supply sources need to be evaluated further.

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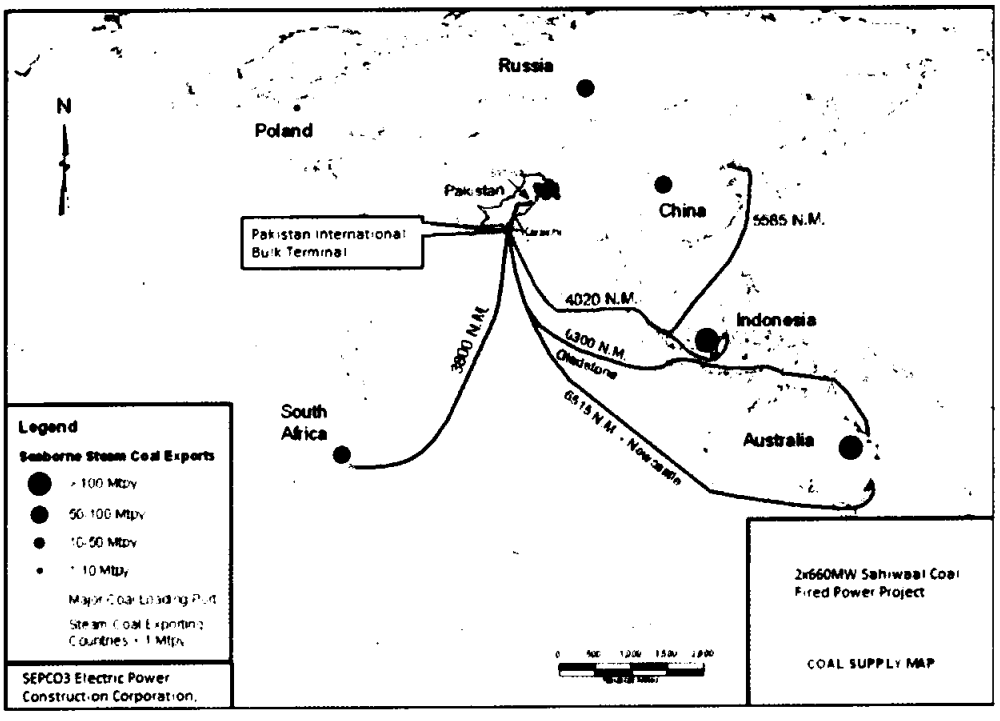
Figure 3-2 Coal Supply Map



3.1.2.1.1 Australia – New SouthWales

New South Wales (NSW) coal mining industry has enjoyed a period of great prosperity over the past few years. The industry produced a record 188.8 million tonnes (Mt) of raw coal, yielding 145.4 Mt of saleable coal in 2009-10. This accounted for $13.2 billion in income, or 80% of the total value of the NSW mining sector. Exports of 109.9 Mt of thermal and metallurgical coal totalled approximately $14.1 billion in value, while domestic consumption of 34 Mt of coal by the power, steel and other industries totaled $1.8 billion in value. The remaining saleable coal was placed into mining stocks.

NSW currently exports steam coal from approximately 30 different mines distributed throughout five of the state's six active coal-producing regions. Almost 80% of the state's total steam coal exports are derived from 17 mines in the Hunter Coalfield, which is also referred to as the Hunter Valley. Seven coal mines located in the Western Coalfield account for an additional 11% of NSW's steam coal exports; while five mines in the Newcastle Coalfield contribute another 6.5%. Two mines each in the Gloucester Basin and the Gnnedah Coalfield account for the remaining exports. The steam coals currently exported from NSW are bituminous in rank with as-received heat contents varying from 6,100 kcal/kg to 6,800 kcal/kg (GAR), ash contents typically between 11% and 16%, as-received volatile matter contents ranging from 23% to more than 34% and total moisture contents varying from 7% to 11%. NSW export steam coals are generally low-sulfur products with as-received sulfur contents of less than 0.9%; however, some higher (almost 2%) sulfur steam coals are exported from the Gloucester Basin.

Due to the recent increase in demand for coal, NSW mines are exporting higher ash content coal, up to and above 18% ash on an air-dried basis (adb). Currently 10 different producing-companies or joint venture partnerships export steam

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coal from NSW.

NSW coals bound for export markets move by rail to the state's coal export terminals. Pacific National rails 93% of NSW's export coal, with the remainder handled by Queensland Rail (QR), which recently successfully tendered for the transport of coal from BHP Billiton's Mount Arthur Mine and a few other smaller operations.

The rail network servicing the NSW coal industry currently consists of over 1,050 km of track and 26 rail loading terminals, most of which are equipped with balloon loops and rapid discharge overhead bins capable of loading 8,600-tonne unit trains. Export coal from mines in the Hunter, Gunnedah, Newcastle, and Gloucester coalfields and the northern portion of the Western Coalfield is transported to the two coal terminals at Newcastle. Export coal from the southern part of the Western Coalfield moves by rail to Port Kembla.

3.1.2.1.2 Australia – Queensland

Over the past few years, roughly 65% of QLD steam coal production has been exported to international customers with the remainder consumed primarily by the domestic power generation sector. Japan is the single largest export market for QLD steam coals consuming almost 50% of the state's total steam coal exports in 2006. Other major export markets include South Korea, Europe, Taiwan, and India. QLD exported approximately 43Mt of thermal coal in 2006. Steam coal is currently exported from more than a do zen mines in QLD's Bowen Basin and three mines in the Moreton-Surat Basin. The mines in the Bowen Basin presently account for almost 90% of the state's steam coal exports with the remainder produced from the operations in the Moreton-Surat Basin.

QLD's export steam coals are bituminous with heat contents varying from 5,750 kcal/kg to 6,800 kcal/kg, ash contents typically varying between 9% and 14%, as-received volatile matter contents ranging from 19% to more than 35%, sulfur contents ranging from less than 0.3% to almost 0.7%, and total moisture contents varying from 6% to 16%.

QLD steam coals destined for export markets are transported to the state's loading ports via rail. Rail service for all QLD coal mines is provided by QR, the state-owned railway system operator. QR operates five coal-hauling rail systems: one serving the northern Bowen Basin (Newlands System); two serving the central Bowen Basin mines (Goonyella and Blackwater system s); one serving the southern Bowen Basin (Moura System); and another system serving the Moreton Basin mines (Moreton System). The Goonyella and Blackwater rail systems are electrified; the other networks operate diesel-powered trains.

3.1.2.1.3 Indonesia

Since the early 1990's Indonesian coal mining in Indonesia has grown dramatically. The World Coal Institute estimates that in 2008 Indonesia mined 246 million tonnes of coal with just over 200 million tonnes of this exported. 2008 coal exports comprised 173 million tonnes of steam coal and 30 million tonnes of coking coal. In 2009, Indonesia was the world's second largest coal exporter behind Australia and is a major supplier to Asian countries.

According to the 2010 BP Statistical Energy Survey, Indonesia had 2009 coal reserves of 4.3 billion tons. Almost a quarter (22%) of its production is exported to international markets. There are a number of companies eyeing coal reserve in Indonesia, including BHP Billiton, China Investment Corp, Coal India, Reliance Power, and the Shenhua Group, among others.

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In December 2010, Indonesia's government said it forecasts coal output to increase by 19 percent in 2011. Zacks investment research estimates that more than 90% of the estimated 3.5 billion metric ton coal demand growth in Asia is expected to come from Indonesia in the next 20 years.

In April 2011, Coal Age reported that Indonesian coal miners expect to dig up 340 million metric tons (mt) of coal in 2011, an increase of 23% from 275 million mt in 2010. Of the planned 340 million mt of coal produced in 2011, the association estimates 20% of it—around 70 million mt—will be allocated to domestic market demand, while the remaining 80% will be exported, primarily to Japan, China and South Korea, which are estimated to remain the largest importers of Indonesia's coal.

ABARE, an Australian government economic modelling and statistics agency, stated that in 2009, Indonesia exported approximately 200 million tonnes of thermal coal with the recovery in Asian economies likely to "support an increase in exports to around 210 million tonnes". ABARE estimates that in the period to 2015, Indonesia thermal coalexports could increase to approximately 250 million tonnes.

In a 2005 presentation, RubiantoIndrayuda from the Ministry of Energy and Mineral Resources estimated that Indonesian coal exports would be approximately 124 million tonnes in 2010 and peak at 128 million tonnes in 2015.That exports were far far higher within a few years. ABARE stated that "key expansion projects supporting increased exports include Bumi Resources' plan to expand its KPC and Arutmin mines from 53 million tonnes in 2009 to 111 million tonnes by 2013 and PT Adaro Energy's plan to increase its mine capacity to 80 million tonnes by 2014."

In an earlier review on the global coal trade, ABARE analyst Alan Copeland noted that thermal coal exports from Indonesia were estimated to have grown by approximately 33% in 2004, 2005 and 2006: "The growth in Indonesia's exports reflects the ability of its coal industry to respond to the rapid growth in Asian demand for thermal coal, supported by unconstrained transport and port capacity. A significant proportion of coal transport in Indonesia is water based, which allows for coal to be transported along rivers via barges to the open sea for loading on to larger vessels." The first 11 months saw Indonesia's coal exports for power stations rose to 283.7 million tonnes, reported by the trade ministry of Indonesia.

There has also been a rise in illegal mining. In September 2005, the Washington Post reported on coal-laden trucks – which are notionally banned from public roads – going all-night from "from scores of often-illegal mines" on their way to a local port.

In June 2006 ABARE listed the main destinations for Indonesian thermal coal as being:

- **Japan (approximately 25%);**
- **Chinese Taipei (17%)**
- **India (15%); and**
- **Republic of Korea (13%).**

Copeland notes that India imports Indonesian low-ash coal for blending with its higher-ash content domestic coals. Chairman of Indonesian Coal Mining Association predicted India's coal imports will rise from 40 million tonnes to 70 million tonnes, most likely to surpass Japan as Indonesia's biggest coal export customer by 2011.

In 2008, nearly one million tons of Indonesian coal was burned at the Bridgeport Harbor power plant in Bridgeport, Connecticut.

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It was reported in September 2011 that a ban was to be issued on the export of low-quality coal from Indonesia. Investment bank Dahlman, Rose & Company reported that Indonesia's Energy and Mineral Resources Ministry drafted a decree, which would halt the export of coal with a heating content below 5,700 kcal/kg, or roughly 10,300 Btu/lb. Indonesia's Energy Ministry denied the report and said that the ban was only in the discussion stage and no implementation date had been set.

3.1.2.1.4 South Africa

South Africa is the fifth largest hard coal producer in the world and a major exporter of coal into the world market. It is also heavily dependent on coal for power generation and is aiming to rapidly expand its coal-based generation capacity. It is also a major exporter of power to utilities in neighboring countries and directly to some major individual customers in Mozambique and Namibia.

South Africa, which is estimated to have produced 244 million tonnes of coal in 2006, is ranked as the world's fifth largest hard coal producer, behind China, the USA, India and Australia. In 2005 it was estimated that coal-fired power stations accounted for approximately 93% of South Africa's electricity production and were the dominant domestic coal consumer. Approximately one-third of domestic coal consumption is used by Sasol as the source for synthetic fuel and chemicals production. South Africa has also become a major player in the global coal trade, exporting an estimated 69 million tonnes in 2006. The bulk of this is exported to Germany, Spain and Japan.

According to Eskom, the publicly owned electricity utility, 53% of domestic consumption is used for electricity generation with a further "12% for metallurgical industries (Iscor) and 2% for domestic heating and cooking."In a brief review of alternatives to coal, Eskom confines its considerations to major centralised power station options of gas, hydro and nuclear. It argues that domestic gas and hydro resources are limited, importing hydro power from the Zaire River basin could be unreliable due to political instability but is a little more up-beat about its as yet unproven pebble-bed nuclear reactors. No other options were considered. Instead it places its faith in "clean coal" technologies. "There are many existing and emerging clean coal technologies that will enable the production, processing, conveyance and utilisation of coal in a more environmentally compatible manner," it states.

South Africa is also a significant exporter of power to neighbouring countries and a small number of major consumers. In March 2010 the Minister for Public Enterprises, Barbara Hogan, told parliament that South Africa exported approximately 1200GWh of power per month, representing 5.95% for 2009. She also explained that power is also imported and that the net exports was 0.73% of the total electricity available for distribution. Power is exported under contracts with national electricity utilities in Botswana (Botswana Power Corporation, Namibia (NamPower), Lesotho (the Lesotho Electricity Company LEC), Swaziland (Swaziland Electricity Company - SEC) and occasionally to Zimbabwe (Zimbabwe Electricity Supply Authority - ZESA) and Zambia (Zambia Electricity Supply Corporation ZESCO). These exports are done as part of the South African Power Pool agreement and their "non-firm agreements with Eskom", she said. Hogan also explained that electricity is also supplied to the Motracoaluminium smelter in Mozambique, Skorpion Zinc for its zinc mine in Namibia and Namdeb for its diamond mine in Namibia.

As of 2011, South Africa accounts for over 40 percent of Africa's CO_2 emissions from fossil fuel burning, and about 1% of the world's total. Most of South Africa's CO_2 emissions are from use of coal, and overall, CO_2 emissions have

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increased by about 30% over the past decade.

3.1.3 Factors Affecting World Deep-Sea Shipping

Ocean freight prices have been subject to similar volatility and increases as coal prices. The changes in spot coal prices and freight prices have followed a similar path. The price increases are both driven by the increased demand for commodities in China, particularly, and in India. In 2007, enormous gains were made in the shipping industry as a whole as steel production and demand for raw materials in China soared. Right now freight rates have been declining.

3.1.3.1 Size of Ship and Availability of Coal Carriers

The ocean-going vessels used in the seaborne trade of coal and other dry bulk commodities are referred to as dry bulk carriers. Bulk carriers are classified by deadweight tonnage (dwt), which refers to a vessel's carrying capacity of cargo, bunker fuel, fresh water, and stores, into four general size categories: Handysize, Handymax, Panamax, and Capesize. The distribution of bulk carriers by size class is summarized in the following tabulation:

Figure 3-3 Summary of World Bulk Carrier Fleets

WORLD BULK CARRIER FLEET (*) PROFILE AS OF JANUARY 1, 2013

SIZE GROUP BY DWT	AVERAGE DIMENSIONS, SPEED				IN SERVICE			ON ORDER		
	LENGTH (Feet)	BEAM (Feet)	DRAFT (Feet)	SPEED (Knots)	SHIPS	DWT (000s)	Average DWT	SHIPS	DWT (000s)	Average DWT
Handy Size (10,000-39,999 dwt)										
10,000-19,999	463.6	71.2	28.9	13.6	513	7,884	15,368	19	236	12,368
20,000-29,999	522.3	80.4	31.5	13.8	1,184	31,047	n/a	58	1,519	
Handymax (30,000-59,999 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	56,395	303	16,928	55,869
Panamax (60,000-79,999 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 Size (80,000 dwt and over)										
80,000 - 99,999	757.6	117.5	46.6	14.3	776	67,145	86,527	356	30,024	84,368
100,000-119,000	833.0	142.4	47.6	14.3	106	11,963	112,282	33	3,625	109,843
120,000-159,999	882.1	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	246,828	195,426	211	45,844	217,269
TOTALS	676.8	107.6	41.9	14.2	9,490	679,169	71,567	1,711	136,214	79,616

(*) Excludes vessels confined to the Great Lakes

Source: Clarkson Research, *The Bulk Carrier Register 2013*.

Bulk carriers of less than 35,000 dwt constitute the Handysize vessel category. Vessels with carrying capacities ranging from 35,000 to 60,000 dwt comprise the Handymax class. Recently, a new vessel subclass dubbed the Supramax, has emerged between traditional Handymax vessel sizes and Panamax vessels.Traditionally, most Handymax vessels were less than 50,000 dwt, but the aging Handymax fleet is being increasingly replaced with Supramax vessels in the 50,000 to 60,000 dwt range.

Bulk carriers in the 60,000 to 80,000 dwt size class are termed Panamax vessels. Panamax vessels are the largest bulk carriers that can transit the Panama Canal, which has a maximum beam restriction of 32.2 m. Ocean-going vessels exceeding 80,000 dwt fall into the Capesize class.

Care must be taken with defining the size and tonnage of ships, as they are constantly changing designs, which changes the required berthing depths and dock dimensions.

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3.1.3.2 Handling Capacity of Coal Loading Ports

Coal for Rahim Yar Khar Project is expected to be sourced from Indonesia, South Africa, and perhaps Australia in distant future. All of the coal loadout ports from which coal would be sourced in these countries can load up to Capesize vessels.

In Australia, Port Kembla can load up to Panamax vessels, and Brisbane can handle Panamax and small Capes; all the other ports in NSW and QLD can load Capesize vessels. It is not expected that coal will be loaded at Port Kembla or Brisbane.

South African coal would be out-loaded at Richard's Bay, which can load Capesize vessels.

Indonesian coal can be loaded in Capesize vessels by sea cranes or floating loading facilities. The Balikpapan Coal Terminal can light-load Capesize vessels and top them up with sea cranes. KPC can load Capesize vessels. The International Bulk Terminal (IBT, Adaro) can only load up to Panamax size, but Adaro can load Capesize vessels at Taboneo by sea crane.

3.1.3.3 Voyage Distance and Frequency of Transportation

Assuming that the 660 MW plant will consume 1.8 Mtpy, if Capesize vessels are used exclusively, then there will be two vessel arrivals per month. If Panamax vessels are used exclusively, there will be three vessel arrivals per month. A bulk carrier traveling at 14 knots will take 19 days to travel from Newcastle, NSW, to Karachi; from Richards Bay, South Africa, it will take 11 days; and from Balikpapan, Indonesia, it will take approximately 12 days.

3.1.3.4 Handling Capacity of Coal Discharge Port

A number of facilities are being planned and under construction for the coal handling at port with a combined capacity of 6-10 million tons per annum. A fully mechanized under construction facility is located at Port Qasim and developed by Marine Group and co-sponsorship of IFC by the name of Pakistan International Bulk Terminal (PIBT). The facility is planned to be commissioned in later half of 2016 with initial coal handling capacity of 4 million tons and another 4 million tons for the export of cement and clinker. However the facility is fraught with issues on a number of fronts. First and foremost being the evacuation plan from the storage yard. The evacuation mode (i.e conveyor belts or a rail link) and point of loading of rail wagons is yet to be decided (i.e whether the loading would be occur in the area of terminal's storage yard or a nearby railway station where another storage area may need to be provided for such heavy volume handling). In the absence of an evacuation link establishment (rail link or conveying belt), the only evacuation option left is trucking which cannot reliably be undertaken and impractical for such heavy volume handling. For trucking, the evacuation rate of dry bulk is undetermined which could not ensure storage area sufficiency at the Port. A holistic 'Time and Motion' study needs to be undertaken to determine the base transportation plan via railways and trucking as a back-up or for spill overs. The secondary issue is though less intense in nature. The current draught for berthing at PIBT provides for berthing of smaller Handymax vessels only. The dredging of the channel for another 2 meters needs to be provided for the navigation of Panamax vessels, hence a sub-optimal handymax vessels may have to be used in the initial phase which would limit the handling capacity of the terminal to ~4 Million tons of coal per annum

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The sponsors of grain terminal intends to commence development and construction of the terminal expansion/modification for coal handling only under a binding offtake arrangement with the power producers/other customers which can ensure bankability of the expansion. However the sponsors and financiers are awaiting a detailed transportation plan before committing an offtake arrangement with the Terminal Owners in writing which has been promised under the Letter of Comfort from Pakistan Railways.

With other Projects of coal e.g at Sahiwal, Port Qasim, Jamshoro & K Energy (with combined coal demand of 8 million tons per annum) likely to get commissioned earlier, RYK project could be at a risk of facing a short handling capacity at Port Qasim if the evacuation hurdles and rail transportation are not addressed. KPT could not be considered as a viable alternative due to limitation of current handling capacity and congestion of current cargo traffic on the evacuation link of both rail and road. The storage yard is also limited in space even in the present circumstances and faces existential threat for environmental reasons being nearer to city and in the wake of deep sea port expansions in the vicinity.

3.1.4 Indigenous Coal

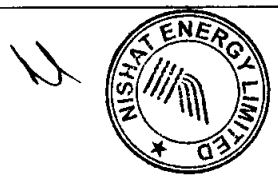
It is not possible to determine at this time whether indigenous coal in Pakistan can be used to provide fuel to the Rahim Yar Khar Project. The project company is willing to consider the purchase of indigenous coal if the delivered quality and price are acceptable. The indigenous coal would either replace contracted coal, which could be reduced to minimum tonnage, or replace other spot coal.
The use of indigenous coal for the Rahim Yar Khar Project will be evaluated.

3.1.5 Procurement Policies and Coal Supply

The coal suitable for the Project should be sourced from all primary supply countries. Low-rank Indonesian coal (4,100 kcal/kg gross as-received [GAR]) and higher ash Australia and South African coal should be considered if coal price discounts improve the overall economics. Pakistani coal will be used if it meets the quality, quantity, and cost requirements.
Several coal supply options—including bituminous coals from Australia, Indonesia, and South Africa and sub bituminous coals from Indonesia—have been considered for Rahim Yar Khar Project, as described below:

• All low-rank Indonesian coal. This would likely be the lowest price coal option. This would consist of, for example, PT Adaro Wara ultra-low sulfur coal, which has offered 1.0 Mtpyat 4,100 kcal/kg (GAR). Adaro may also offer a 4,500-kcal/kg (GAR) blend of Tutupan and Wara coals. Other possibilities are PT ArutminEcocoal ultra-low sulfur, tonnage negotiable, at 4,200 kcal/kg and Kideco, which verbally o ffered up to 2.0 Mtpy at 4,700 kcal/kg (GAR).
-These coals would be the lowest priced on a FOB basis.

-The option of using sub bituminous (+6,000 kcal/kg [GAR]) coal is stated by suppliers to be limited because this coal



in Indonesia and South Africa is becoming depleted and is largely committed to customers. However, this coal would likely be available at market price with little or no discount.

- All Australian or all South African.
- A mix of low-rank Australia, Indonesian, and South African.
- A mix of low-rank Indonesian and Australian coal.
- A mix of medium-rank (5,000 – 5,500 kcal/kg [NAR]) South African with Indonesian and Australian coal.

Given the state of the coal market and the risk implied in over-reliance on one country (whether Australia, Indonesia, or South Africa), the current recommendation is that coal be sourced from all three of these primary supply sources or at least two. It is recognized that coal resources are present in Pakistan and that it would be of interest to the government of Pakistan to use indigenous coal as a domestic supply. The Project would consider use of such coal if it is offered at economic price and useable quality and quantity.

The risk will be reduced by being able to burn coals from as broad a range of heat values as possible within economic constraints. Ideally, the plant would be able to burn from 4,000 to 6,500 kcal/kg GAR coals sourced from the most economic suppliers. If the coal yard is designed to blend a wide range of heat values to a narrower and acceptable range, then more opportunities may present themselves to buy lower-cost coal.

It is difficult to see in the current market that long-term indexed contracts provide any significant cost advantage over short-term market prices. Long-term contracts may provide more security of supply, especially in Indonesia. There should be an economic incentive for the Project to sign up significant long-term tonnages; however, this incentive may be difficult to negotiate in the sellers' market that exists today.

Depending on the final calculation of the costs of coal, including the cost impact on power plant capital and operating costs, the largest amount of coal should be sourced from the most cost-effective and reliable source. This stipulation will likely result in a substantial amount of coal, both low and medium rank, being sourced from South Africa and Indonesia. The next coal to be selected would be from the most economical coal from Australia. In the future, given the expansion in NSW and Queensland, and the very large domestic requirement Australia is expected to be a more reliable supplier than South Africa. If the price of coal from Australia is competitive with South Africa at the time of coal acquisition, then the next largest portion of coal should be purchased from Australia. The remainder will come from South Africa and Indonesia.

Coal should be purchased with a mix of contracts — short-term (one year), medium-term (up to five years), and long-term (longer than five years). Coal prices should be discounted for heat content and moisture content for high-moisture, low-rank Indonesian coal. In the current market, discounts for other components, such as ash or sulfur, are minimal. Penalties may be negotiated for out-of-specification coal in the coal supply agreements.

Terms should be staggered; that is, different contracts should expire and be renewed at different times. The portfolio should change with market circumstances. In general, during times of low prices, the longest possible terms should be negotiated. As prices increase, terms should be decreased. Over the past 10 years, Pacific coal market prices have shifted significantly. Properly implemented, the portfolio strategy should ensure that coal purchases allow the plant to remain competitive over the long term.

Terms should be staggered to mitigate market exposure over time. Short-term prices should be fixed; longer term prices

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may be based on a market index or fixed if reasonably discounted. Contracts should provide flexibility to reduce and increase the base tonnage as much as possible. At all times, power plant's anticipated requirements should be fully covered under contracts at least one or two quarters forward.

It is generally expected that future coal prices will be volatile, but will remain high unless a major economic recession reduces demand. As Australian mines and infrastructure begin to catch up with demand, prices may soften to a degree, but this is unpredictable and is unlikely to cause prices to fall back to the levels experienced in the 2006–2007 time frame.

At this time of high demand, with coal supply continuing to be constrained by production capacity for some time into the future until suppliers respond. It is impossible to predict coal prices with any certainty.

Consequently, it is recommended that FOB coal price be based on a reported Index Price and that the coal price at the time of purchase and beyond be directly linked to a published index, not on any attempt to forecast a market price, which would be at best an educated guess. It is possible that some discount against an index, or coal price caps and floors, would be agreed to by a coal supplier, but this will not be known until the Terms of Reference for a Coal Supply Agreement have been negotiated between respective authority and the coal supplier.

3.1.6 Coal Spec Selection

In view of the above, a Request for Proposal for Non-Binding term sheets were floated by NEL amongst key coal traders sourcing from South Africa and Indonesia, both International and Local. The objective was to finalize the most optimal coal spec for the design of the boiler given the underlying principles of cost effectiveness and reliability are not compromised. The RFP mentioned to propose business interest and pricing structure for the envisaged design coal of RB3 Spec on a broad basis. RB3 Index is the next best CV coal range to higher CV bituminous which can ensure better economy on a $/MMBTU basis on the delivered price at the Site. Since the Site is located inland the combined freight costs of sea and rail/road would have the potential of outweighing the benefit of discounted price for lower CV range. The RFP also left it open to the suppliers to propose alternatives of higher/lower grade which can ensure overall economy (in terms of generation, handling, maintenance and capital costs) and continuity of supply over the life of the plant. NEL hitherto have received two term sheets from its suppliers who have both shown interest in the supply and neither of them challenged our apprehension of going for a high CV (>6000kcal) coal in the wake of depleting reserves from sourcing destinations. Both suppliers have confirmed the availability of RB3 spec coal for design and offered pricing structure with reference to widely published index (i.e RB1 and RB3) with discount factors for exceedances on Sulphur, Moisture and Ash. The performance and check coal proximate, ultimate and ash fusion analysis chosen for boiler and complex configuration is given in the table below:

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PARAMETER	UNITS	WORST COAL	PERFORMANCE COAL
Total Moisture (arb)	%	25.1	9.27
Proximate Analysis			
Inherent Moisture (adb)	%	14.9	4.44
Ash (adb)	%	5.61	18.5
Total Sulphur (adb)	%	1.43	1.09
Volatile Matter (adb)	%	39.03	24.98
Fixed Carbon (adb)	%	40.46	52.08
GCV (adb)	kcal/kg	5715	5889
GCV (arb)	kcal/kg	5030	5591
NCV (arb)	kcal/kg	4731	5371
HGI		48	53
Size	0 - 50 mm	90%	99.20%

Ultimate Analysis			
Carbon (daf)	%	74.78	81.33
Hydrogen (daf)	%	4.15	4.62
Nitrogen (daf)	%	1.39	1.99
Sulphur (daf)	%	1.80	1.38
Oxygen (daf)	%	17.88	10.68

Ash Fusion Temperature			
IDT	deg C	1140	1240
Spherical	deg C	1160	1270
Hemispherical	deg C	1170	1290
Flow	deg C	1240	1310

Economics: The recent FOB price at RBCT for API4 was recorded at $57/MT and Freight cost from RBCT to Karachi was $15/MT. This makes a total CFR cost of $72/MT which after inclusion of estimated port clearing dues ($4/MT) and inland transportation ($20/MT) would work out to be $96/MT as against the reference coal price of $129/MT provided in the upfront tariff. The $/MMBTU price at this price level would equate to $4.5/MMBTU. This augurs well when compared against competing fuels in the energy mix Pakistan. At current RFO price of Rs 45,000/ton, the $/MMBTU equates to ~$11 a unit. The local gas field to gas fired plants is being delivered at close to ~$5/MMBTU. Given the economics of fuel above the plant is expected to run at base load with high ranking position in the merit order.

3.1.7 Coal Handling, Storage and Evacuation at Port

A number of facilities are being planned and under construction for the coal handling at port with a combined capacity of 6-10 million tons per annum. A fully mechanized under construction facility is located at Port Qasim and developed by Marine Group under the co-sponsorship of IFC by the name of Pakistan International Bulk Terminal (PIBT). The facility is planned to be commissioned in later half of 2016 with initial coal handling capacity of 4 million tons and

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another 4 million tons for the export of cement and clinker. However the facility is fraught with issues on a number of fronts. First and foremost being the evacuation plan from the storage yard. The evacuation mode (i.e conveyor belts or a rail link) and point of loading of rail wagons is yet to be decided (i.e whether the loading would be occur in the area of terminal's storage yard or a nearby railway station where another storage area may need to be provided for such heavy volume handling). In the absence of an evacuation link establishment (rail link or conveying belt), the only evacuation option left is trucking. For trucking, the evacuation rate of dry bulk is undetermined which could not ensure storage area sufficiency at the Port. A holistic 'Time and Motion' study needs to be undertaken to determine the base transportation plan via railways and trucking as a back-up or for spill overs. The secondary issue is though less intense in nature. The current draught for berthing at PIBT provides for berthing of smaller Handymax vessels only. The dredging of the channel for another 2 meters needs to be provided for the navigation of Panamax vessels, hence a sub-optimal handymax vessels may have to be used in the initial phase which would limit the handling capacity of the terminal to ~4 Million tons of coal per annum.

Another port is being planned to set up a hybrid coal handling facility by extending the existing Quay (Jetty) of the FAP Grain and Fertilizer Terminal operating at Port Qasim, the proposed development is planned to be carried out in phases corresponding to the throughput requirements of the coal fired power plants being implemented at Port Qasim. It is envisaged that a minimum of annual throughput of 2 million tons will be used to commission the port required for the power plants.

The existing 300 meters long quay of FAP terminal shall be extended by an additional 175 meters towards the western side, which will provide sufficient quay length for simultaneous berthing of two Panamax class vessels. It is anticipated that a cargo parcel of 75,000 tons will be imported through each delivery shipment, which shall translate to up to 3 deliveries per month during the 1st phase (1st year) of operation. An average unloading rate (through vessel) of 1000 tons per hour will be required to turn around one ship within 96 hours (4 days). For the purpose to achieve the said average through vessel rate of 1000 TPH, it is proposed to install 2× 800 TPH capacity grab cranes of double luffing type with self-installed receiving hoppers dispensing the coal to the quay conveyer.

The unloaded coal will be transported to the stack yard through 2×transfer conveyors of 1500 TPH capacity each, which will be designed upfront to cater for the ultimate handling capacity of 12 million per annum at the terminal. These conveyors will be installed on overhead gantry structure with a span of 30 meters along the conveyor length of approximately 4 KM, through a Right of Way (ROW) corridor up to the coal stack yard.

OVERALL LAYOUT CONFIGURATION

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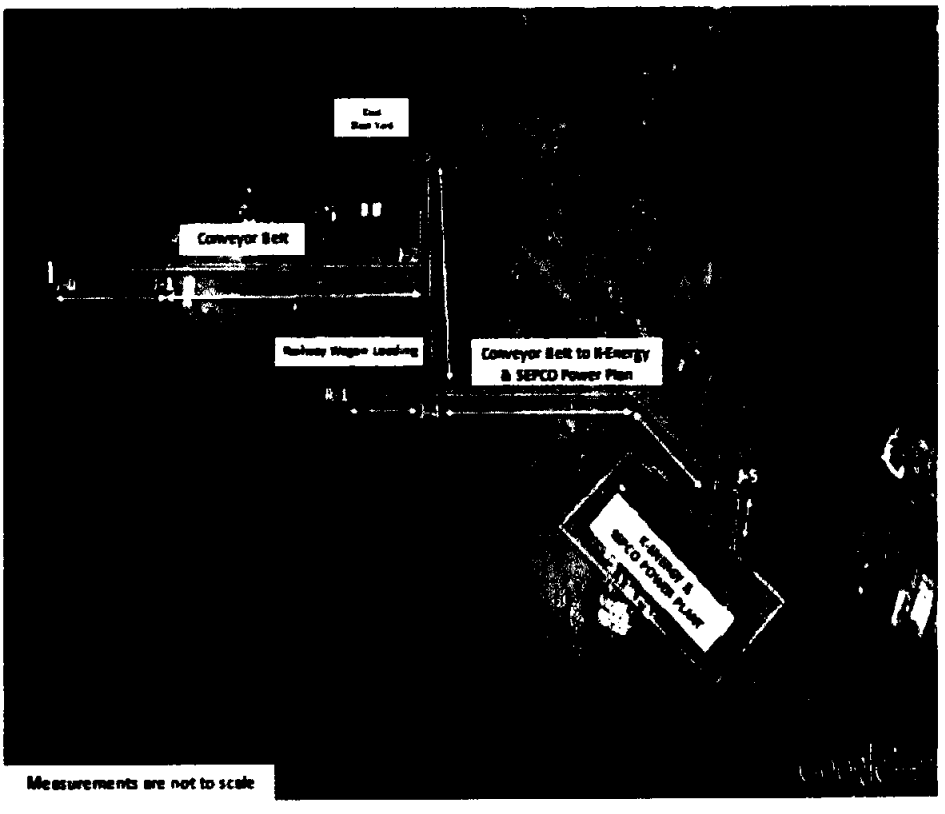

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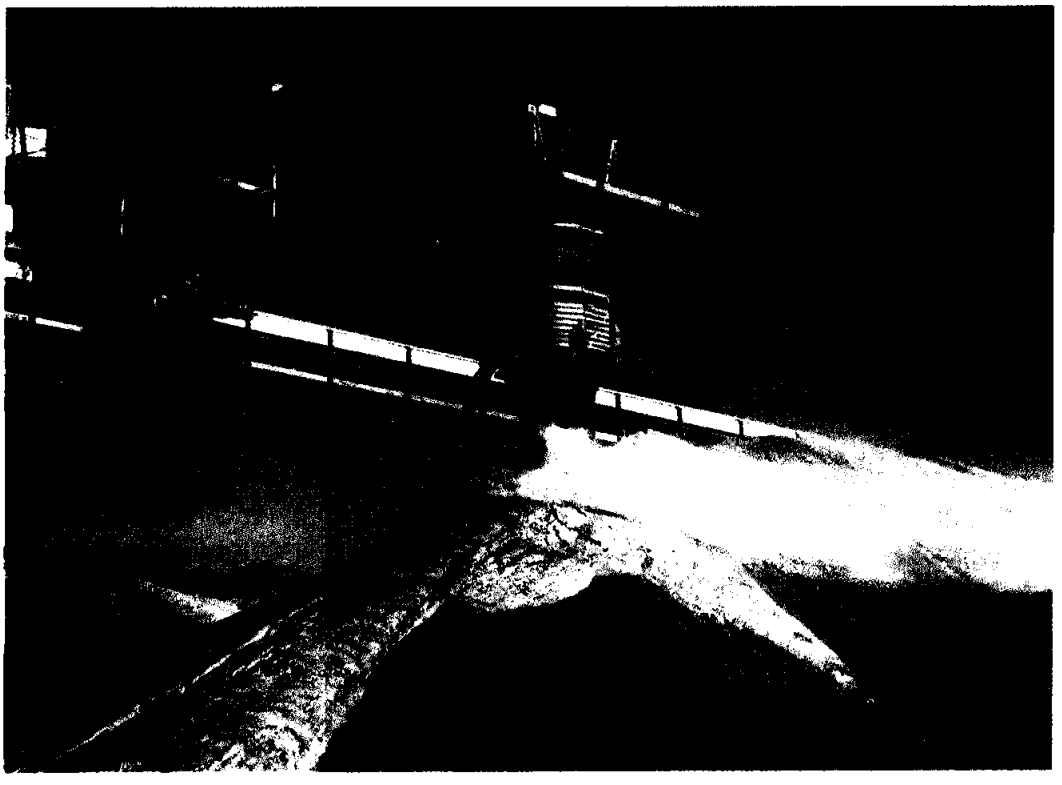

The total stack yard area of about 100 acres is also to be developed in phases corresponding to the annual throughputs and the minimum inventory requirements of the power plants being fed and maintained from the proposed terminal and the common stack yard. In the 1st Phase it is planned to develop a stack yard of 500,000 to 600,000 tons capacity to cater a 60 to 90 days inventory for annual throughput of 2 MTPA. The coal stacking will be carried out through 4×overhead butterfly type stacking conveyors of 300 meters in length, installed with tripper trolley and 20 meters extension chain conveyors at an elevation of 15 meters, while utilizing telescopic shuts to minimize coal dust generation.

The reclamation of the stacked coal will be carried out through 8×heavy duty front loaders (20 tons bucket capacity), delivering the coal to the 5×reclaim conveyors with hoppers arranged at suitable spans to ensure minimum cycle time of the front loaders. It is required to achieve a minimum reclamation rate of 600 TPH to feed the day bunkers of 6,000 tons capacity at the power plant.

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The proposed configuration of the stack yard is being considered in view of the geotechnical composition of the soil, which is mainly the dredged material freshly dumped at the proposed location and as such will remain exposed to settlement over an extended period of time, particularly under the weight of the coal stacks acting as surcharge materials, which shall facilitate the natural compaction process overtime. The overhead stacking conveyors proposed above will require piled foundation with a span of 30 meters for the 4×300 meter lengths in the 1st phase, these conveyors will be further extended by 600 meters over the subsequent development phases. Once adequate soil compaction levels have been achieved, which are anticipated within one year of the start of stacking operations, it is intended to install 3×dedicated Reclaimers of 600 TPH capacity each. Identical arrangements will be replicated in the subsequent development phases. The ultimate stack yard capacity is planned to be 1.8 Million tons

Environmental protect, particularly against the coal dust is one of the prime considerations for the sponsors. It is intended to employ the state of the art environmental control measures like erection of wind wall at appropriate location at the stack yard and water sprinkling / fogging at the stack yard and the quay unloading areas.

Transportation from storage area to national railway for Nishat project depends on Pakistan Railways which should provide assurance that they would upgrade their capacity by the time the power plant is commissioned.

The owners of FAP grain terminal intends to commence development and construction of the terminal expansion/modification for coal handling only under a binding offtake arrangement with the power producers/other customers which can ensure bankability of the expansion. However the sponsors and financiers are awaiting a detailed transportation plan before committing an offtake arrangement with the Terminal Owners which has been promised under the Letter of Comfort from Pakistan Railways. A request letter for the delivery of a detailed transportation plan, key aspects of the plan and project's nearest station with site coordinates has already been delivered to Pakistan Railways.

With other Projects of coal e.g at Sahiwal and Jamshoro (with combined coal demand of 8 million tons per annum) getting commissioned earlier, RYK project could be at a risk of facing a short handling capacity at Port Qasim if the evacuation hurdles and rail transportation are not addressed. KPT could not be considered as a viable alternative due to limitation of current storage capacity and congestion of current cargo traffic on the evacuation link of both rail and road. The storage yard is also limited in space even in the present circumstances and faces existential threat for being nearer to city for environmental reasons and deep sea port expansions in the neighbourhood.

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4. INDIGENOUS COAL

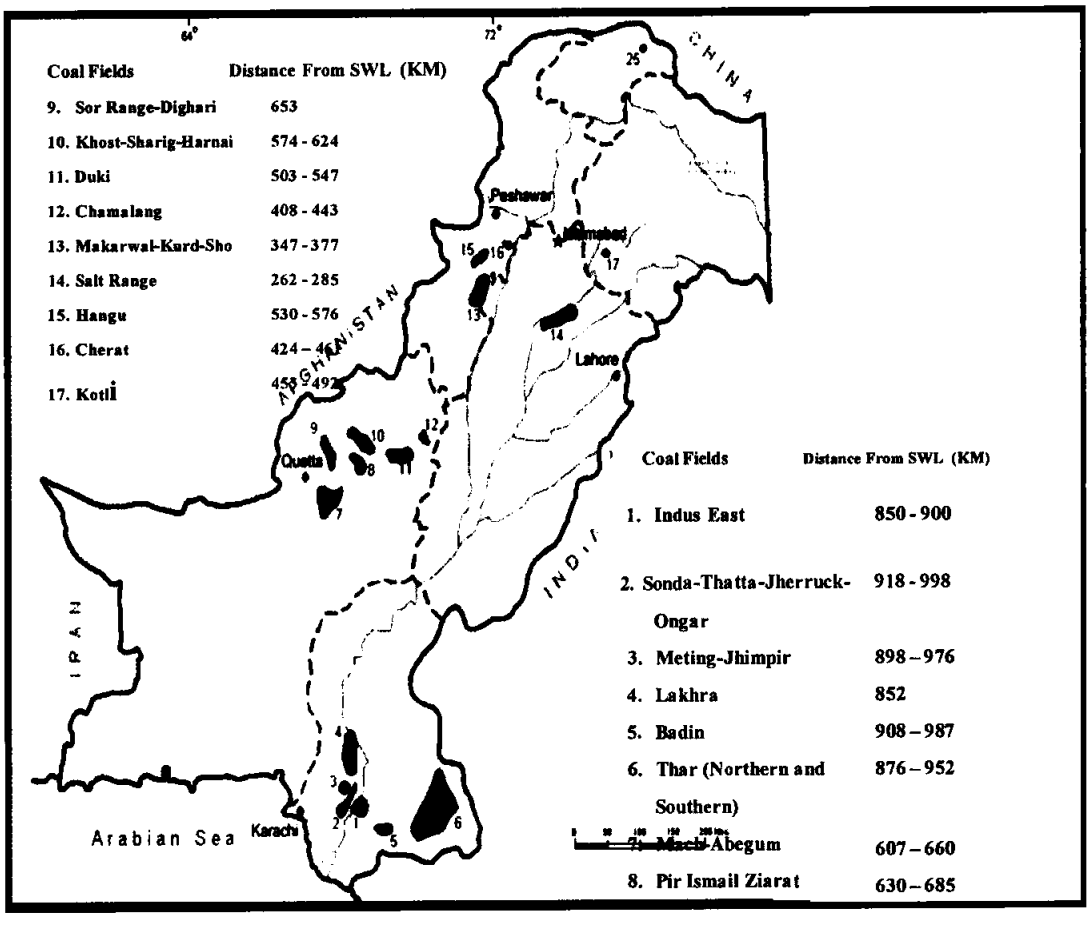
4.1 Pakistan Coal Resources

Pakistan's coal resources are primarily located in four areas: Sindh Province, Balochistan, and Punjab, KPK, each of which contains several major deposits. Figure 4-1 on the following presents a location map of Pakistan coal resources and distance from coal field to Rahim Yar Khar Project site, each of which is briefly described below.

Figure 4-1-Major Coal Fields of Pakistan and Distance to Project Site

[redacted]

Pakistan



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4.1.1 Sindh Province

The Sindh Province has total coal resources currently estimated to be approximately 185 billion tonnes (Bt).The quality of coal is mostly lignite-B to subbituminous A-C. Three of the major Sindh deposits are the Thar deposit, the Lakhra coalfield, and the Sonda-Jherruck coalfield.

4.1.1.1 Thar

Thar is a large coalfield in the eastern part of the Province about 400 km southeast of Karachi, having aresource potential of about 175 Bt. The coalfield extends over 9,000 sq. km, out of which 356 sq. km areahas been studied in detail by the Geological Survey of Pakistan proving 9 Bt of coal in four blocks. The area is accessible by a 410km metalled road from Karachi via Hyderabad to Islamkot, the sizable townnearest the Thar resource. A road network has been developed connectingall major towns with Thar coalfield. A rail link exists from Hyderabad to Naukot, about 100km from Islamkot, and the feasibility study and route for a railroad extension to the Thar coal field has been approved by the Chief Minister, Sindh. A planhas been sponsored by Islamkot for resettlement/rehabilitation of villages that may be displaced by miningin Thar.

The main coal bed thickness ranges from 12 to 21 meters at an average depth of 170 meters, the upper 50 meters being loose sand. The quality of coal has been determined on the basis of chemical analyses of more than 2,000 samples. The rank of the coal ranges from lignite-B to subbituminous-A. Coalfield highlights are as follows:

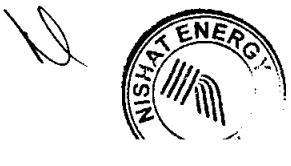
•Thar Desert Area - (approx.) 22,000 sq. km.
•Coalfield Area 9,100 sq. km.
•Total Drill Holes 217
•Coal Deposit 175,506 Mt
•Coal Reserves (Bt) 9,000 Mt
•Coal Quality Lignite A-B:
–Moisture (AR) 46.77%
–Ash (AR) 6.24%
–Volatile Matter (AR)23.42%
–Fixed Carbon (AR) 16.66%
–Sulfur (AR) 1.16%
–Heating Value (Av.) 5,774 Btu/lb

4.1.1.2Lakhra

The Lakhra Coalfield in Dadu District lies 16 km to the west of Khanot Railway Station on the Kotri-Dadu section of the Pakistan Railways. It covers an area of approximately 200 sq. km. It is well connected with Karachi and Hyderabad through roads and railways. Mining in the area is currently done by underground methods.

Three coal seams are established in the field, but generally only the middle seam known as the Lailian Bed possesses the necessary persistence and thickness for consideration in large-scale mining. It shows a variation in thickness from 0.75 meter to 2.5 meters, with average thickness of 1.5 meters.

Coal from Lakhra has an apparent rank of lignite-A to subbituminous C. The coal is dull black and contains amber resin flakes and about 30% moisture. Although it can be extracted in large lumps, it dries to a moisture content of about 8% when brought to surface, and tends to crumble on longer



exposure to atmosphere. It is often susceptible to spontaneous combustion.

The total reserves of the deposit have been estimated to be 1,328 million tonnes (Mt) with 244 Mt measured, 629 Mt indicated, and 455 tonnes inferred. Current average annual production of coal from Lakhra is over 1 Mt. Most of this production is used in the WAPDA Power Plant at Khanote, Sindh, and in the brick kiln industry. Coalfield highlights are as follows:

Area 1309 sq. km

Coal Reserves 1,328 Mt

Chemical Analysis of Coal:

–Moisture (AR) 28.9%

– Ash (AR) 18.0%

–Volatile Matter (AR) 27.9%

–Fixed Carbon (AR) 25.2%

–Sulfur (AR) 4.7% to 7.0%

–Heating Value (Av.) 4,622-7,554 Btu/lb

4.1.1.3 Sonda–Jherruck

Over 1 Bt reserves of lignite quality coal have been assessed in the Sonda–Jherruck Coalfield. Owing to favorable location and developed infrastructure, interest has been expressed by a Chinese consortium to determine the feasibility of commissioning power generation unit at the site.

In case the feasibility study justifies commissioning of a project, a quantity of 2 Mt of coal annually would be mined to cater to the requirements of the power generation unit. Highlights of the Thatta–Sonda– Jherruck coalfield are as follows:

- Identified Area 1206 sq. km
- Shallowest Coal Bed 37.8 m
- Deepest Coal Bed 265.28 m
- Coal Reserves (Billion Tonnes) 7.112
- Chemical Analysis

– Moisture (AR) 31.23-34.72%

– Volatile Matter 27.9% – Fixed Carbon 25.2%

– Ash (AR) 7.69-14.7%

–Sulfur (AR) 1.38-2.82%

– Heating Value (AR) Btu/lb 6,780 - 11,029

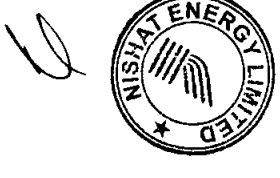
4.1.2 Balochistan

The coal seams in Balochistan are found in the Ghazig Formation of Eocene age. The quality of the coal is subbituminous A to high volatile B bituminous. The coalfields mostly lie around Quetta in Balochistan; however, the Sor-Range Degari Coalfield and the Chamalang are significant.

4.1.2.1 Sor-Range, Degari, Sinjidi

The Sor-Range Degari Coalfield lies 13 to 25 km southeast of Quetta covering an area of about 50 sq. km and is easily accessible through metalled road from Quetta.

The northern half of the field is known as Sor Range, Degari and is situated at the southern end of the field. The thickness of the coal seam varies from 1.0 meter to 2.0 meters, but in the Sor-Range Seam, sections up to 5.0 meters have been encountered. The coal is of better quality with low ash and sulfur



content. The quality of the coal is high subbituminous A to high volatile B bituminous.

4.1.2.2 Chamalang

The Chamalang coalfields are newly discovered and need development. Preliminary work done by GSP in these areas has indicated that it has a good potential.

The quality of coal is also better as compared to the rest of Balochistan. The rank of the coal ranges from high volatile C bituminous to high Volatile A bituminous with a total resource of 6 Mt. Its heating value is +12,000 Btu/lb.

4.1.3 Punjab

The Punjab's coalfields comprise the eastern, central and western Salt Range between Khushab, Dandot and Khewra while the Makerwal Coalfield lies in Trans-Indus Range (Sanghar Range). The rank of the coal is sub bituminous A to high volatile bituminous. The highlights of the Indus East Coalfield are as follows:

Thickest coal bed 2.40 meters

- Fixed Carbon (AR) 23.9%
- Volatile Matter (AR) 27.7%
- Sulfur (AR) 2.6%
- Moisture (AR) 33.1%
- Calorific Value (AR) 6,300 to 8,000 Btu/lb
- Ash (AR) 15.2%

The Government of Punjab can make use of indigenous coal in the coal based power plant by establishing coal washing plant to lower the content of Sulfur and Ash.

4.1.3.1 Salt Range

The Salt Range Coalfield covers an area of about 260 sq. km between Khushab, Dandot and Khewra. The entire coal producing area is well connected with roads and railways.

The top seam varies in thickness from 0.22 meter to 0.30 meter while the middle seam is up to 0.60 meter thick. The lower seam is up to 1 meter thick and is relatively of better quality. Salt Range coal is being mined in Dandot, Choa-Saiden Shah and adjoining areas. The Punjab Mineral Development Corporation and several private companies are operating the mines in the area. Reserve of the deposit is estimated at about 235 Mt.

4.1.3.2 Makerwal/Gullakhel

Makerwal/Gullakhel Coalfield is situated in Sarghar Range (Trans-Indus Range). The coalfield extends from about 3.2 km west of Makerwal to about 13 km west of Kalabagh, covering an area of about 75 sq. km in the Mianwali district. The quality of Makerwal/Gullakhel coal is better than that of Salt Range coal and is preferred by the consumers. Total reserves of the deposit are estimated to be about 22 Mt.

4.1.4 Coal Resources Summary

Pakistan's coal resources are summarized in the following tables.

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Table 4-1 Coal estimates-Pakistan

Province	Estimates(Million Tonnes)	Estimation by
Punjab	597	Mines and Minerals Department, Govt. of the Punjab through SNOWDEN Australian Consulting Firm
Sindh	185,450	Geological Survey of Pakistan
KPK	90	Geological Survey of Pakistan
Balochistan	281	Geological Survey of Pakistan
AJK	9	Geological Survey of Pakistan

Note: Source from Mines & Minerals Department Government of the Punjab

4.2 Coal Production

Coal production for last several years is summarized in following Table. Over 80% of coal was consumed by the brick kiln industry, thus reducing the supply available for power generation. Indigenous coal is blended with imported coal in small proportion, which is necessary for smooth operation of the cement plant.

Table 4-2 Average Annual Coal Production ("000" Tons) of Pakistan

Sr. No	Province	2008-09	2009-10	2010-11	2011-12	2012-13
1	Baluchistan	2,125	1,731	1,388	1,335	1,364
2	K.P.K	61	74	88	91	70
3	Sindh	827	1,242	1,118	1,258	1,109
4	Punjab	571	591	620	624	605
5	FATA	204	305	206	192	198
6	AJK	4	4	7	6	4
Total Production		3,792	3,947	3,427	3,596	3,350

Note: Source from Mines & Minerals Department Government of the Punjab

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Table 4-3 Coal Production of Different Coal Type

		Coal Production			
Interval	Unit	Punjab	Sindh	Balushistan	K.P.K
Interval		Bituminour/ Sub-Bituminous	Lignite	Bituminous	Bituminous
2008-09	("000" Tons)	571	827	2,125	61
2009-10	("000" Tons)	591	1,242	1,731	74
2010-11	("000" Tons)	620	1,118	1,388	88
2011-12	("000" Tons)	624	1,258	1,335	91
2012-13	("000" Tons)	605	1,109	1,364	70

Note: Source from Mines & Minerals Department Government of the Punjab

Pakistan has been importing 4 to 5 million tons of coal (pre-dominantly bituminous with NCV 5800-6000 Kcal/Kg) this shows that the total existing production in Pakistan is not sufficient to meet its industrial requirements. However in next 5 to 7 years, with development of rail links (from mines to power project sites) and with introduction of mechanized mining in coal sector there is high probability that local coal (up to 20%) also be blended with imported coal for its utilization in forthcoming power plants in Punjab and other provinces of Pakistan

4.3 Coal Mining and Transportation

4.3.1 Coal Mining

Generally, coal mining in Pakistan is not mechanized. While a general area can produce many thousand tons of coal, this is an aggregate amount of production from several coal lease operators in one particular area.

Trucking charges vary with the season and destination. In some cases, there is no cargo available for the return journey, thus increasing coal freight charges.

These companies and others operate additional mines, for which data is not readily available, in Balochistan near Quetta, and in the Punjab. Thus Pakistan has a widespread coal mining industry, sitting amidst substantial resources. For further development, these resource areas await only a market for coal that will support development of mechanized mines, and investment in modern coal transportation infrastructure.

4.3.2 Transportation

At the present time, the dominant transportation mode for coal at power plants is the dumping of trucks that have been loaded by front-end loaders. This is the widely used method currently available for the quick unloading at the coal yards. Trucking charges vary with the season, destination and fuel prices.

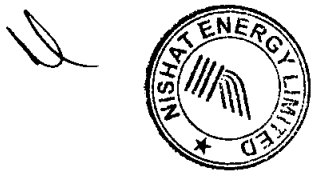
In some cases, there is no cargo available for the return journey, thus increasing coal freight charges. Government already has a plan to develop the railway transportation in several years, tendering is in process of heavy duty locomotives (4,800 HP) and Wagons (60 tons cargo capacity). Plans/Tenders are also under preparation for augmentation of railway tracks, development of sidings for Project sites and introduction of signaling system (from Kotri to Lodhran in the first phase). Government assured railway transportation will be available and meet the time schedule of Rahim Yar Khar 1x660MW Coal Fired Power Plant through a Letter of Comfort addressed to Nishat Energy Limited (Copy Annexed in the Appendices).

The uncertainty about the PR's capacity for coal transportation from Port to Plant is major threat about the bankability of the Project. This situation was exacerbated by reports in the media quoting high powered Ministry Officials statements that the coal projects in Punjab have been shelved, with the exception of Sahiwal Project, at a stakeholder's discussion forum held in Islamabad for RLNG and coal projects to discuss and address among other things PR's lack of coal transportation capacity. The reports stayed in the air for a considerable number of days until it got addressed in the Pakistan Railway's (**PR**) letter dated 9 March 2015.

Nishat has shared their concerns as well as the concern of their foreign partners, *inter alia*, among others, on the ability of PR in the absence of a viable infrastructure enhancement and transportation plan from the PR. We understand that the comfort/commitment as per the letters dated 9 March, 2015from PR would in any case be a part of Inland Coal Transportation Agreement (the "**ICTA**") and that such letters of comfort/commitment are not sufficient to ensure bankability. Bankers and equity partners will certainly ask for the issuance of a bankable transportation plan from PR as committed in the letter dated 9 March 2015. Such uncertainties collectively added to serious doubts regarding the development of the coal projects.

Further, the unconditional guarantee should be provided by GoP, against default of PR both during the time of construction and once the operations starts, as a simple Letter of Comfort is not strong enough to win over the confidence of sponsors or the prospective financiers.

The latest draft of ICTA is yet to be shared by PPDB and Pakistan Railways, hence its commercial terms are yet to be assessed for financing purposes.



5. TRANSMISSON INTERCONNECTION

5.1 General System Description

The location of the coal-fired power plant is Rahim Yar Khan, which is about 6km away from JethaBhutta & 18km away from Khanpur City. The nearest 132kV line distance (back feed power) is 2km. The nearest 500kV grid station (SardarGarh) is 32 km. The nearest railway station is ~4km away (JethaBhutta Railway Station) and the nearest Canal is about 1km away (Abbasia Canal). The information of the system has been described in detail in Chapter 2.

5.2 Transmission Voltage and Transmission Scheme

Transmission Voltage: Rahim Yar Khan 1×660MW Coal Fired Power plant will be connected at voltage of 500 kV.

Because of the lack of specific materials containing content of system connecting, the connection scheme is temporarily assumed as follows: Connect to the 500kV station nearby through two 500kV lines.

5.3 Not used

5.4 Not used

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6. IMPLEMENTATION

6.1 Not used

6.2 Project Company Management

6.2.1 Project Company

The Chief Executive Officer will provide primary oversight for the duration of the Project.

Each box beneath the Chief Executive Officer represents a distinct capability area that requires the attention of dedicated staff.

The Security team is responsible for overall site security.

The Commercial and Finance organization manages all contracts required to conduct business, with the exception of those pertaining to fuel supply. They are responsible for reviewing the budgets established by the contractors and approving any expenditure outside the limits of the capital and operating budgets. They review contractor compliance and take whatever corrective action necessary to ensure meeting the terms of all agreements. They are also responsible for preparing all financial statements and maintaining the books of the Project Company. Finally, they are responsible for maintaining banking relations and all bank accounts and preparation/filing of all tax related documentation.

•The Environmental, Health and Safety group addresses environmental issues during the construction and operations phases. They help to ensure that the facility remains in compliance with applicable regulations.

•Fuel supply for the facility is handled by another team, including its transport and all terms within the governing purchase agreements

•An Administrative organization manages the office, including reception, general accounting, and clerical duties.

A separate Project Management team has responsibility over both EPC and O&M efforts. The O&M organization is ultimately responsible for the operations of the facility. This organization is discussed in more detail in a separate section below. The EPC organization exists during the implementation phase of the Project. Once they have fulfilled their contractual obligations and the O&M team has assumed operations, the EPC is completed.

6.2.2 EPC Organization

The project will be implemented on a lump-sum, date-certain turnkey basis. Current plans are to have the EPC Agreement contract include the boilers, steam turbines and generators, balance-of-plant, water intake, and all other associated facilities for a complete project. The Project Company will coordinate any interfaces with Pakistani governmental agencies and obtain necessary permits associated with the execution of the project, and the EPC Contractor will supply the necessary document to the Project Company to obtain any permits. In addition, the EPC Contractor will be responsible for remaining in full compliance with existing environmental regulations.

The role of the EPC organization per the EPC Agreement is to complete four phases of work: engineer, procure, install, and commission the facility. While the organization of the actual EPC team is left to the contractor, key roles will be established to ensure appropriate coverage in each of those areas.

The Project Company monitors the execution of the EPC Agreement through an Owner's Engineer, either a self-performed function or contracted through a reputable company with relevant experience.

A key aspect of the EPC Contractor's responsibilities is the transition of facility operations to the O&M organization, including all necessary training and knowledge transition.

6.2.3 O&M Organization

General operations and maintenance of the Project, once put into commercial operation, will be managed by a team comprised of experienced individuals with the goal of operational efficiency. Before the completion of the construction phase, the O&M organization will begin the process of transitioning ownership of the plant from the EPC team. Training will be conducted on all aspects of the facility until all aspects of plant operation have been adequately transitioned, as identified in the O&M Agreement.

6.3 Not used

6.4 Land Acquisition

Land acquisition will be response for Government of Punjab. The proposed site falls 3.5km east of the town DHOOP SARHI. The proposed project site and conceptual general layout refer to Appendix D.1 General Layout. The Site coordinates have been finalized and advised to PPDB and lies completely in the jurisdiction of Cholistan Development Authority meaning private occupants replacement and resettlements would be minimal if at all. The land is >90% barren and not under any agricultural use.

6.5 Project Execution

Throughout the duration of the Project, basic management practices will be followed to ensure a high level of quality. Project objectives will be defined, work plans established, and controls implemented. The Project Company's responsibility is to ensure safe and effective execution during both the construction and operational phases.

6.5.1 Construction

6.5.1.1Construction site planning

The construction land for this project refers to the related provisions in the Notice about the Regulations on Outline Design of fossil-fired Power Plant Construction Organizations (Trial) numbered as Diandiangui [1997]274 and the Notice about Issuing the Design Guidelines for fossil-fired Power Project Construction Organizations numbered as Guodiandianyuan [2002]849 issued by the former ministry of electric power industry, in combination with the practical situation of this project, as well as the construction experience and construction site arrangement for similar domestic unit sets, with the construction production land of this project planned to be about 13 hm^2 and the construction domestic land to be about 2 hm^2.

6.5.1.2 Power and gases supply for construction

(1)Temporary power supply during construction

The determination of construction power supply is based on the load statistics of construction equipment, domestic facilities, and on-site office facilities during the power supply peak hours. according to the provisions of Design Guidelines for fossil-fired Power Project Construction Organizations, the reference of similar thermal power unit, on the basis of referring to the construction experience of in similar power unit , combined with the actual situation of this project, the temporary

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power supply maximum load of this project is preliminarily determined to 5000 kW. The construction site is equipped with a number of diesel generator engines as power source, for construction use.

(2)Temporary water supply during construction

In accordance with the provisions in the Guidelines for Construction Organizations' Design of fossil-fired Power Projects, combined with the actual situation of this project, the maximum production water consumption(including fire protection water) for construction is preliminarily determined to about 250 t/h, and the maximum domestic water consumption for construction is about 70 t/h, which makes the total maximum water consumption of this project be 320 t/h. The water supply for construction is considered to draw underground water by setting up a water pump room on site, and meanwhile laying a water pipe to draw water from a reservoir in the north of the site, with water purification device installed to satisfy the quality requirement of construction water.

(3)Temporary communication during construction

The temporary communication for the construction of this project adopts multi-unit construction combination, with a total of 15 pairs of telephony trunks (including supervision units), as the main means of external liaison during construction, which is to be provided by the Owner. The switchboard inside the construction unit should be solved by the unit itself.

(4)Temporary gas supply during construction

Oxygen, acetylene, argon, and compressed air for construction should be purchased by the construction contractor itself as needed, but the safety of using various gas cylinders and gases should be considered, and the relevant unit should formulate specific measures and report for approval and record.

The oxygen and acetylene needed during the civil engineering construction are advisable to be supplied in form of bottles in principle. It's forbidden to use acetylene generators on site. During the installation and construction, as oxygen and acetylene demands are large and the using conditions are complex, it's also allowable to use the centralized supply of gas by setting up centralized supply stations of oxygen and acetylene which are sent to the construction site through the underground pipeline.

Oxygen pipes and acetylene pipes should be chosen from seamless carbon steel pipes; Connection between air supply pipes and connection between air supply pipes and air supply valves should be welded. The flashback arrestors should be set in front of the outlets of all the newly-cut air supply valves. After the air supply pipeline is installed, airtight test must be carried out.

Upon construction, compressed air is dispersed for supply portable air compressors.

As the schedule of this project is tight, the Owner should obtain the construction-related power supply, water supply and communication agreements as soon as possible, and arrange construction access to the site to create conditions for this project to start early.

6.5.1.3 Oversize and large component transportation

6.5.1.3.1Shipping dimensions and weight of oversize and large equipment

Overall dimensions and shipping weight of large equipment (length x width x height)

Item	Weight	Dimension (length x width x height)
Single-phase main transformer	140t	5.6m×3.85m×4.1m

Generator stator	345t	10.52m×4.02m×4.35m
Boiler girder	120t	34m×1.35m×3.9m
Deaerator	125t	31.66m×φ4.0m

As it's currently at the feasibility study phase, the equipment supplier has not been knocked down, the overall dimensions and weight of the above equipment are referred to the equipment of the same type and level. The detailed data is to be determined upon equipment ordering at the next stage.

6.5.1.3.2Transportation feasibility analysis

The selection of cargo transportation routes mainly depends on the characteristics of the goods (including dimension and weight); handling and transferring conditions on the way; transportation restrictions of the routes (such as restrictions on bridges and tunnel). The constraints on different modes of transportation of this project are as follows:

1) Railway transportation

There is a railway around the plant site of this project, which can meet the demand on navigation and transportation.

2) road transportation

The conditions of roads from Karachi Port of Pakistan to the plant site are poor, and so only after some renovation measures are taken can the roads meet the requirements for large equipment transportation.

3) waterway transportation

The nearby rivers of the project site cannot meet the navigation transport requirement of this project.

6.5.1.3.3Assumptions on transportation schemes

This project is to construct 660MW large coal-fired unit set, and the transportation scheme mainly considers the large equipment such as the main transformer and stator of the generator.

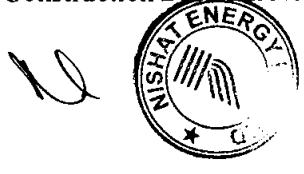
Comprehensively considering the transportation conditions of power plants, as the alternative sites of this project do not have waterway transportation conditions, it's decided to transport the large equipment of this project through railway and then transfer to the plant area by land transportation. As the road condition is poor, it's necessary to plan the transportation routes in advance and to take effective transformation and reinforcement measures.

To ensure the transportation safety, it is suggested to request professional and qualified heavy-cargo transport units to verify and test run the large equipment wharfs in which the large equipment transportation passes, the bearing capacity, turning radius and limited height of the alongside roads of the actual transportation sections. If necessary, some renovation reinforcement measures should be taken, so as to meet the needs of large equipment transportation for this project.

The transportation of large equipment must follow the schedule according to the requirements of construction, and meanwhile notification should be done in advance before the shipment of equipment, and the construction site should be ready for receipt as well.

6.5.1.4 Implementation scheduling

This project constructs large coal-fired unit sets, with reference to the related provisions in the Construction Duration Norm for Power Projects numbered as Dianjian [1997] 253 issued by the former



ministry of electric power industry, based on the construction duration experience of similar unit sets which are put into production in China. After rationally selecting the construction tools and optimizing the construction sequence, it is planned to arrange the period from civil work to unit 1 operation to be 30 months*. The specific preparation is as follows:

(1) Construction preparation is 6 months.

(2) From civil work to installation is 14 months

(3) From installation to unit 1 operation is 16 months

**If detailed engineering works and pre-erection ground preparation work is accomplished 6 months prior to financial close then COD can be planned by end of 2018. This however shall depend upon the state of preparedness on the part Govt. interfaces to enable Chinese financing documents closure. Key issues that may create impedances in the FC process could be port handling capacity, rail logistics capacity, govt. assurances for Pak Railways and resolution of point of intersection between port and railways for coal offloading on the rolling stock.*

7. ENVIRONMENTAL PROTECTION

Special institutions must be entrusted to investigate into the assessment of environmental impacts (EIA), also the permission of local environmental protection department must be attained. The final data subjects to the assessment of environmental impacts.

7.1 Environment standards and criteria

In this phase of the Project, environmental protection design shall carried out based on National Environmental Quality Standards (NEQS).

7.1.1 Emission Standards of Air pollutants

The emission standards listed in the following tables will be adopted for the project.

Table 7.1-1 National Environmental Quality Standards for Gaseous Emissions (unit: mg/m^3)

S/N	Pollutant	Pakistan (revised standard)
1	PM	500
2	SO_2	1700(1)
3	NO_X	1200(1)

Note: (1) For emission of SO_2 and NOX of from coal-fired power plant and oil-fired power plant, the emission standards of air pollutants in the NEQS will be followed. Furthermore, the standards in Table 7.1-2 shall also be followed.

Table7.1-2 SO2 and NOX Standards for Power Plants Operating on Oil and Coal

SO_2 Background Levels ($\mu g/m^3$)				Criterion I	Criterion II
Pollutant	Background Air Quality (SO_2 basis)	Annual Average	Maximum 24-Hour Interval	Maximum SO_2 emission (ton / day • plant)	Max. Allowable 1-Year Average Ground Level Increment to Ambient (ug/m^3)
SO_2	Unpolluted area	<50	<200	500	50
	Mildly polluted area	50	200	500	50
	Highly polluted area	100	400	100	10

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	Severely polluted area	>100	>400	100	10
NO_X	300mg/J of heat input				

7.1.2 Discharge Standards of Water Pollutants

For the discharge standards of water pollutants of Pakistan, please refer to Table 7.1-3.

Table 7.1-3 NEQS for Municipal and Liquid Industrial Effluents (unit: mg/L)

S/N	Pollutant	Pakistan (revised standard, discharged into inland water areas)
1	Temperature rise	≤3℃
2	pH	6-9
3	BOD_5	80
4	COD	150
5	TSS	200
6	TDS	3500
7	Oil	10
8	Phenolic compound (such as phenol)	0.1
9	Chloride (Cl^-)	1000
10	Fluoride (F^-)	10
11	Total cyanide (such as CN^-)	1
12	Anionic detergent (such as suchmethylene blue active substance)	20
13	SO_4^{2-}	600
14	S^{2-}	1.0
15	NH_3	40
16	Pesticide	0.15

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17	Cd	0.1
18	Cr (trivalent and hexavalent)	1.0
19	Cu	1.0
20	Pd	0.5
21	Hg	0.01
22	Se	0.5
23	Ni	1.0
24	Ag	1.0
25	Total toxic metals	2.0
26	Zn	5.0
27	As	1.0
28	Ba	1.5
29	Fe	8.0
30	Mn	1.5
31	B	6.0
32	Cl	1.0

7.1.3 Standards for Ambient Noise

Table 7.1-4 Standards for Ambient Noise Unit : dB(A)

Category of Area/Zone	Day time (6.00a.m.~10.00p.m.)	Night time (10.00p.m.~6.00a.m.)
Industrial area	75	65

7.2Relevant pollutants

7.2.1 Air Pollutants Emission

Air Pollutants emissions of this project are shown in table 7.2-1.

7.2-1 Air pollutants emission

Parameter		Unit	Design coal	Check coal	Control method
SO_2	Emission concentration	mg/m^3	1053	1524	The limestone wet desulfurization, 55% flue gas

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	Emission within 1 hour	kg/h	2088	2960	go through the FGD, desulfurization efficiency is 95%
	Daily emission*	t/d	50.112	71.04	
NOx	Emission within 1 hour	kg/h	578	561	Low-nitrogen combustion
	Emission concentration	mg/m^3	≤300	≤300	
	Maximum emission levels	ng/J	≤107	≤103	
Fume & dust	Emission within 1 hour	kg/h	71	24	Electrostatic precipitator, efficiency of dust collection ≥99.75%,
	Emission concentration	mg/m^3	36	12	

*:24 hours are taken as the daily operation hours.

7.2.2 Water Body Pollution Sources and Other Pollutants

The waste water generated in the process of production mainly includes the acid and alkali waste water, desulphurization wastewater and sewage, etc.

7.2.3 Solid Waste

The main solid waste generated from the power plant is ash. The amount of them listed in Table 7.2-2.

Table 7.2-2 Amount of Slag and Fly Ash of the Power Plant

	1x660MW					
	Design coal			Check coal		
	t/h	$\times 10^4$t/a (5000h)	x10^4t/a (7446h)	t/h	$\times 10^4$t/a (5000h)	x10^4t/a (7446h)
Amount of fly ash	39.13	19.565	29.136	13.08	6.54	9.740
Amount of slag	4.35	2.175	3.239	1.45	0.725	1.08
Total amount of slag and fly ash	43.48	21.74	32.375	14.53	7.265	10.819

Notes: The amount of fly ash and the amount of slag are calculated as per 90% and 10% of the total amount of fly ash and slag respectively.

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7.2.4 Major Noise Sources

The noise during operation of the power plant is made up of many different frequencies. It is a broadband noise. According to the nature of the noise, the noise can be divided into the following types: mechanical power noise, gas dynamic noise, electromagnetic noise, traffic noise and noise from daily life of the people.

The plant building and the cooling tower will be the main noise source of the power plant. The environmental noise of the power plant will be mainly resulted in outgoing radiation of all interfaces of the plant building and the cooling tower. The noise generated by auxiliary plant will degenerate very soon within a short distance because of its small energy. Therefore, the environmental noise of the power plant will be mainly distributed around the main power house and the cooling tower. With increase of distance, the noise level will decrease progressively.

7.3Main control measures

7.3.1 Air pollutants emission and control measures

(1)Dust control measures

The Project will use electrostatic precipitator with an efficiency of dust collection of more than 99.75%, the FGD system could eliminate more than 50% of dust. At the outlet of chimney the concentration of fume & dust will be lee than 36mg/Nm^3. The requirement of the allowable emission concentration (500mg/m^3) will be met.

(2)SO2 control measures

The Project will use the technique of flue gas desulphurization (FGD) by limstone, the efficiency of desulphurization is considered no less than 95%, 55% flue gas go through the FGD, 45% go through the Stack. The emission concentration of SO2 in flue gas will be less than 1524 mg/Nm3. This meets the requirement of the allowable emission concentration (1700mg/m3). The emission of SO2 will be 71.04t/d, less than the maximum emission values for different polluted areas listed in Table 7.1-2.

(3)NOx control measures

The Project will use low-nitrogen combustion system. The emission concentration of NOx will be controlled under 300mg/m3. This meets the requirement of the allowable emission concentration (1200mg/m^3). Maximum emission levels of the NOx will be controlled under 107 ng/J of heat input.

7.3.2 Water discharge control measures

(1)Wastewater of chemical water treatment system

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

The industrial wastewater generated by the project will be recycled after certain treatment measures are taken for the wastewater. A small amount of such water will be discharged when it meets the discharge standards after being treated. All cooling tower water will be recycled or discharged.

(2)Domestic wastewater

Domestic wastewater will be treated in the domestic wastewater treatment station. When such water meets the discharge standards after being treated, it will be used in the green spray system.

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7.3.3 Solid waste control measures

The ash yard is about 20.05hm^2, ash storage volume is 104.2×104m^3, the ash heap is 6.5m high, 3.5m is over ground, and 3m is underground.

7.3.4 Measures to Control Noise Pollution

To control the noise sources is the most effective method to reduce environmental impact of noise of the power plant. In this phase of the Project, when ordering equipment with a high noise level, noise control requirements will be sent to the supplier(s). Generally, noise shall be no more than 85dB (A). In addition, noise level will also be taken as an important factor for assessing the equipment.

At the place where noise can have a rather big impact on the workshop and workplace, sound insulation materials can be used and sound insulation work cell and working room can be provided to reduce impact of noise on the operation personnel.

When carrying out architectural design, the area of windows can be controlled for the main power house and other workshops with a high noise level. In addition, sound insulation doors and windows can be provided to effectively reduce escape of noise of the main power house and reduce the environmental impact of noise.

On the atmospheric exhaust steam pipes and exhaust steam pipes with safety valves, exhaust steam micropole diffusers will be provided.

In the boiler room of the power plant, on the force draft fans, silencers will be provided to reduce pneumatic noise at the outlets of the force draft fans.

For all kinds of pumps, vibration insulating foundations shall be provided to prevent vibration of the pump bodies. For the windows of the pump room, materials that have a good airtightness and sound insulation performance will be used.

The general layout of the power plant will be optimized. The equipment that has a high noise level will be provided in a concentrated place that has a low elevation and far away from the noise sensitive spots. Around the main power house, the production area, the office area, a large number of trees will be planted. In addition, trees with good noise reduction function will be considered preferably.

7.4Conclusions

The Project will use limestone desulphurization system with a desulphurization efficiency of 95%. Electric dust collector with an efficiency of dust collection ≥99.75% will be used. Low-nitrogen combustion will be used. The emission concentration of pollutants shall meet the requirements of the emission limits.

The industrial wastewater and domestic wastewater generated by the Project will be recycled after certain treatment measures are taken for the wastewater. A small amount of such water will be discharged when it meets the discharge standards after being treated.

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8. CONSENTS AND PERMITS

8.1 Project Company Permits

The following permits are required to be obtained at various stages of the project development. The permits below are laid out in the order of their procurement.

1. Project Company Incorporation - SECP (Companies Regulator)
2. Letter of Intent for Feasibility Conduct – PPDB (Facilitator, Punjab Govt.)
3. Land Reservation for Site Studies – Cholistan Development Authority (Punjab Govt.) and PPDB
4. Letter of Comfort and Consent from Pakistan Railways – Pak Railways (Federal Govt.) and PPDB
5. Environmental Clearance – Environmental Protection Agency (Punjab Govt.)
6. Canal Water Use and Effluents Discharge – Irrigation Department (Punjab Govt.)
7. Grid Inter Connect – NTDC, the Power Purchaser (Federal Govt.)
8. Approval of Feasibility by Panel of Experts – PPDB
9. Generation License – NEPRA (Regulator)
10. Tariff Application and Approval – NEPRA
11. Tripartite Letter of Support to enter into PPA– PPIB (Facilitator of Federal Govt.) and PPDB
12. Land Lease / Acquisition – PPDB and Revenue Board (Punjab Govt.)

8.2 Foreign Equity Ownership Permits

The following permits are additionally required if the sponsors intend to bring in foreign equity

1. Board of Investment – Foreign Investment (Federal Govt.)
2. Security Clearance of the Company and Personnel – Ministry of Interior (Federal Govt.)
3. Local office incorporation as liaison or branch office – SECP (Federal Govt.)
4. Feasibility Approval from NDRC, Chinese Govt.
5. Foreign investment approval from Ministry of Commerce and NEA, Chinese Govt.

8.3 EPC Contractor/Pre COD Permits

The following permits are required for an EPC contractor to commence its Site work.

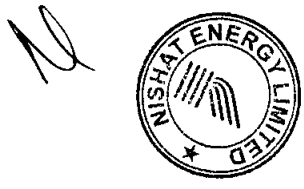
1. Pakistan Engineering Council Certification – Federal Govt. Agency
2. Heavy Equipment Transportation – National Highway Authority, Federal Govt.
3. Boiler Certification – Boiler Inspectorate, Punjab Govt.
4. Electrical Inspection – Electrical Inspection, Punjab Govt.
5. Weigh Bridge Verification – Directorate of Labor Welfare, Punjab Govt.
6. Storage of Petroleum Products – Ministry of Industries, Department of Explosives, Fed. Govt.
7. Storage of Prohibited Chemicals– Anti Narcotics Department, Federal Govt.
8. Wireless Communications License – Pakistan Telecommunication Authority, Federal Govt.
9. Radiation Facility License – Pakistan Nuclear Regulatory Authority, Federal Govt.
10. Weapons Use License– Ministry of Interior, Punjab Govt.
11. Clearance letter or documents from CAA-Federal Govt. Agency

9. UNIT COSTING AND ECONOMIC FEASIBILITY

Nishat Intends to undertake adoption of upfront tariff as announced by NEPRA on 26.06.14 vide Order No. NEPRA/TRF-ITTC/2013/7195-7197 for 1x660MW category, post acceptance of feasibility by PPDB. The upfront tariff has already been adopted by other investors which practically has set a standard benchmark for the regulator in respect of CAPEX, efficiency, financing, construction timeline and O&M. Hence practically any of the tariff parameters on cost plus basis differing from the upfront tariff (beyond what has been granted and accepted by the upfront tariff adopters) is unlikely to be favored and granted by the Regulator. Therefore finance and economics of the project would not be any different from the declared upfront tariff. CAPEX cost, construction time, efficiency and O&M would be optimized within the upfront tariff limits at the detailed engineering phase.

Salient Features of Upfront Tariff provides as following for the above mentioned parameters:

Key Parameters	**Benchmarks**
Project Cost	$956M ($1.45M/MW – Gross Cap.)
ROE	27.20% p.a.
Efficiency	39% Net LHV basis
Construction Time	48 months (from FC)
Debt Tenor	10 years Post COD
Amortization	Mortgage Style Annuity
Variable O&M	0.44 cents per Kwh
Fixed O&M	0.30 cents per Kwh
Working Capital Cost basis	90 days of Inventory and 30 days AR
Levellized Tariff	**8.4 cents/kwh**



10. FINANCING ISSUES

Project's feasibility ultimately rests on the bankability of the security package. The Govt. needs to discern and redress the following issues to inspire confidence amongst the financiers and investors for the project to be declared as bankable.

Circular Debt

According to estimates, the circular debt (as defined below) at the end of FY 2012 was Rs872.416 billion, representing approximately 4% of the national nominal GDP, this position more or less still continues. The DISCOs' inability to make full payments to the CPPA results in cash flow problems for power producing companies. The result is a shortage of fuel supply to generating companies, a diminished power generation capacity and limited investment to maintain the plant in the required manner. The problem has become so acute that Finance Ministry has to come for the bail out of power sector every other month. This risk of non-payments by Power Purchaser has a severe impact on the viability and bankability of the project. The bankers always, as a first question, raise the issue of circular debt and so far bankers are not satisfied with the performance of Power Purchaser.

"Circular Debt" means, among others, the debt towards the IPPs due to non-payments/short payments to IPPs by CPPA of their due amounts under their respective power purchase agreements. For avoidance of doubt, this non-payment/short payment is primarily because of the insufficient payments by DISCOs to CPPA out of the revenue realized by DISCOs, inter alia, on the basis of inefficiency of DISCOs in minimizing the line losses and theft of electricity, which creates the difference between the actual cost of providing electricity and the revenue realized by DISCOs from sales to customers and, therefore, the said gap is then subsidized by the Government of Pakistan.

Non-Payment or Delayed Payments

Another problem that affects bankability of this project is the Power Purchaser's inability to pay the Delayed Payment invoices, which not only affects the ROE of the power producer since no interest is allowed on delayed payments. Further, a clear violation of already implemented Power Purchase Agreements which defines the payment mechanism on the basis of First in First Out basis, whereas, Power Purchaser follows entirely a different mechanism that is against the terms of PPA. This factor further alienates the financiers.

Guarantees

Another problem in this regard is that Power Producers have more than once called the GoP backed Guarantees, and the results were appalling, which led to the filing of petitions by IPPs in the Supreme Court of Pakistan. This matter was highlighted in media repeatedly with the international coverage. If this state of affairs persists, the bankability of the project will remain under severe pressure, as prospective financiers are aware that a default in Guarantee is an event of default in financing agreements and can lead to termination and eventual liquidation of the Power Producer.

Cross Default

In 2013, a situation arose where Power Purchaser refused to pay certain due Capacity Payments to IPP's, as plants were not fully available for power generation. However, the sole reason for this under-utilization of plant capacity was non-availability of fuel owing to non-payment of huge amounts of overdue Capacity and Fuel payments by Power Purchaser. The case has long been pending with the Expert as appointed under the PPAs, and the matter is expected to be forwarded to Arbitrator.
In this scenario we believe that payment defaults by the Power Purchaser should be treated as an event of default in the security package and a merit order be devised to prioritize payment of revenue streams which are acceptable to the financiers besides other kinds of default of Power Purchaser and State

Institutions which are usually covered in the IA. These clauses could really provide the comfort to the prospective financiers, in the absence of which their will be doubts about the bankability of the Projects.

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Installation of 660-MW Coal Power Plant
At Cholistan, Tehsil Liaqatpur
District Rahimyar Khan

ENVIRONMENTAL IMPACT ASSESSMENT & SOCIAL SOUNDNESS REPORT

Prepared by:

INTEGRATED ENVIRONMENT CONSULTANTS
2nd Floor, Office # 7, Anwar Tower, 99-Shadman, Lahore, Pakistan
E-mail: inenvconsultants@yahoo.com
Tel: + 92 42 35960091
July – 2015

EXECUTIVE SUMMARY

- This report deals with the Environmental Impact Assessment and Social Soundness pertaining to proposed 660-MWp coal fired power project. Considering the strong correlation between economic growth and energy demand, there is an imperative need for sustained increase in energy supply not only to maintain the growth momentum but also to protect the economy from disruptions, caused by energy deficiency during the past years up to date. The Government of Pakistan is making concerted efforts to ensure development of energy resources by encouraging private sector to meet energy demand and has liberalized investment policies. The policy has resulted not only in investments in power production sector from local resources, but also foreign investments are pouring in large amounts. A worsening power crisis, problem of circular debt and the discovery of approximately 175 Billion tonnes coal reserves in Thar has offered an impetus to the federal and provincial governments to develop coal as a source of energy and power generation. Reports on the power sector in Pakistan all point towards the under-utilization of its coal reserves. By conservative estimates, these reserves can generate up to 100,000 MW of power. According to the 2011-2016 strategic business plan of the Central Power Generation Company, the projected aggregate energy supply contribution of coal will go up to 13,331 MW by 2015. Consequently, keeping in view the available resources of coal in country and government policy for power generation from coal M/S Nishat Energy Limited intends to install a 660 Mega Watt (MW) coal fired power plant using flue gas desulphurization technology at Cholistan, Tehsil Liaqatpur, District Rahimyar Khan. The site is situated about 7-Km from main Jhatha Bhutha - Khanpur Grand Trunk road at barren land of Cholistan.

- The main object of the proposed project is to generate cleaner, economical and reliable energy from indigenous and where required imported fuel which will

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not only provide a better source of energy but also cause a compensatory role in reducing the shortage of energy demand.

- In accordance with the Pakistan Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations, 2000, SRO # 339 (1)/2000, the project falls in Schedule –II, Part-A 'Energy' Serial 2 'Thermal power generation over 200 MW; therefore, requires the detail Environmental Impact Assessment study for sustainable development.

- Currently the proposed land for installation of power project is barren land of Cholistan. About ninety percent of the proposed land is entirely desert while about five percent land to be acquired for access road is partially cultivated by the farmer. This part of land is falls in Cholistan but leased by the private farmer for cultivation. The nearest 132-KV overhead line is available at a distance of about 2-km while nearest 500-KV Grid Station (Sardar Garh) is about 33-km from the main site.

- The project site and its vicinity have some sort of shrubs with no significant importance. The land is barren and non-cultivated except some land which is far away from the proposed project site.

- The project cost has been estimated at One Billion US$. The quantities have been worked out from the design drawings and project feasibility. The rates for cost estimates are based on construction work, contractor cost, and cost of the equipments with 10% escalation for the year 2015. The proposed activities to be carried out within a period of four years from the starting date.

- The project will require makeup boiler feed water and cooling water for the operation. Water requirement (both during construction and operation phases) of the proposed 660-MW project will be met from the Abbasia Canal which is perennial in nature and has 2200 cusec of water flow.

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- The construction will also sometimes go round the clock, therefore, during all activities the followings will be the major pollutants/wastes or project related pollution aspects:
  - Soil erosion
  - Particulate matter/dust and gaseous emissions from construction machinery and vehicles transporting materials.
  - Noise from construction machinery and vehicles transporting materials
  - Garbage as construction waste including clay, sand, crush stones, paper, plastic, wood pieces, iron and steel as scarp, wires, rags, ropes etc
  - Dust during raw materials unloading and its use in construction
  - Sewage and solid wastes from construction camp
  - Some social impacts due to accumulation of workers may arise
  - Some problems to utilities infrastructure of the area may occur especially due to labor negligence

  A number of machinery and equipment is in operation for the construction which includes:

  - Excavators
  - Truck
  - Transport vehicles
  - Concrete mixers
  - Vibrators
  - Welding plants
  - Rigging
  - Generators etc.

  Most of these are using diesel engines that generate noise and exhaust emissions. The possibility of exhaust emissions increases when old vehicles/plants are utilized for the execution purposes. Generally, the above activity is generating particulate- matter (PM_{10}), smoke, dust, CO and NO_x in the ambient air, which is deteriorating the air quality and resulting in potential

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impacts on human health. The movement of heavy machinery and vehicles on the dirt tracks is also causing fugitive dust emissions. Source of air pollution for this project activities are unpaved roads. Dust plumes behind vehicles moving along unpaved roads represent a typical occurrence, since as the vehicle travels over an unpaved road, the force of the wheels on the road surface causes pulverization of the surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. As an approximation, fugitive dust (dust generated from unpaved roads is termed "fugitive dust" because it is not discharged into the atmosphere in a confined-flow stream) from unpaved roads can be considered to average. This dust would be a problem for the nearest communities.

- ❖ The following mitigation measures will be adopted to overcome the impacts on resources;
  - Tuning of vehicles should be made mandatory to reduce the emissions of NOx, SO_x, CO and PM_{10}. Emissions from the batching plants will be controlled with appropriate control equipment (such as fabric filters or cyclone separators). Equipment and vehicles powered with diesel should be well maintained to minimize particulate emissions. Trucks carrying, sand, aggregate and other materials should be kept covered during transportation of materials and during storage at site, with tarpaulin. For the construction machinery generating noise level in excess of that prescribed in NEQS, Contractor will make arrangements to bring the noise level within applicable limits (including proper tuning of vehicles and mufflers/silencers). Movements of the trucks and other construction machinery causing high noise levels must be restricted at night time to avoid disturbance to the nearby locality. Truck drivers should be instructed not to play loud music at night and stop use of horn. It is suggested that noise barriers should be installed at construction site during the construction phase of the project. The fugitive dust emission

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will be a problem for the nearby communities which will be mitigated by sprinkling of water.

- During the operation phase of the project to the control the air pollution the following mitigation measures will be adopted;
  - To control the particulates from the stack Electrostatic precipitators will be installed.
  - The gaseous emissions will be controlled by installing the flue gas desulphurization facility and low NOx burners to make the emissions up to NEQS levels.
  - Ash will be landfill with proper lining in the land or will be sold to the bricks manufacturing unit or cement units.
  - The effluents will be treated till the NEQS levels.

- The Environmental Management Plan (EMP) aims to provide:
  - An integrated plan for the comprehensive monitoring and control of impacts.
  - Auditable commitments displaying practical achievable strategies for management to ensure that environmental requirements are specified and complied with.

  For this purpose, an outline of EMP has been developed which includes;
  - what has to be managed and monitored, how and why
  - when and where
  - by whom
  - whom to report and who to follow up if there is any problem
  - The monitoring program is designed to ensure that the requirements of the NEQS compliance. Monitoring Program (MP) provides important information that allows for more effective planning and an adaptive response based on the assessment of the effectiveness of mitigation measures. The monitoring of various parameters will help to determine

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the extent to which project construction/operation activities will cause environmental disturbance.

- The cost for environmental management and monitoring will be the part of contract of Contractor and Consultants respectively. However, a lump sum amount of Rs. 2.5 million will be allocated by the project proponent as cost for environmental training and monitoring for a period of two years during construction and operation of the project.

❖ Public Discussions were held with the inhabitant of the surrounding area and the farmer of the land to e acquired. They are quite positive to the project and see the project as growing business and accomplishing towards the positive development in the area at local and in country as whole. The people observe strong positive impacts regarding employment, business and structural development due to this project. Social assessments findings depict that people perceive overall positive social and economic impacts by the project. Their attitude towards the project installation is highly optimistic. Majority of the people are convinced for development in the area and they correlate this progress with the pace of their social mobility.

❖ Resettlement Action Plan (RAP) has been prepared and incorporated in the EIA report for providing a framework for addressing the resettlement issues, if resettlement is unavoidable.

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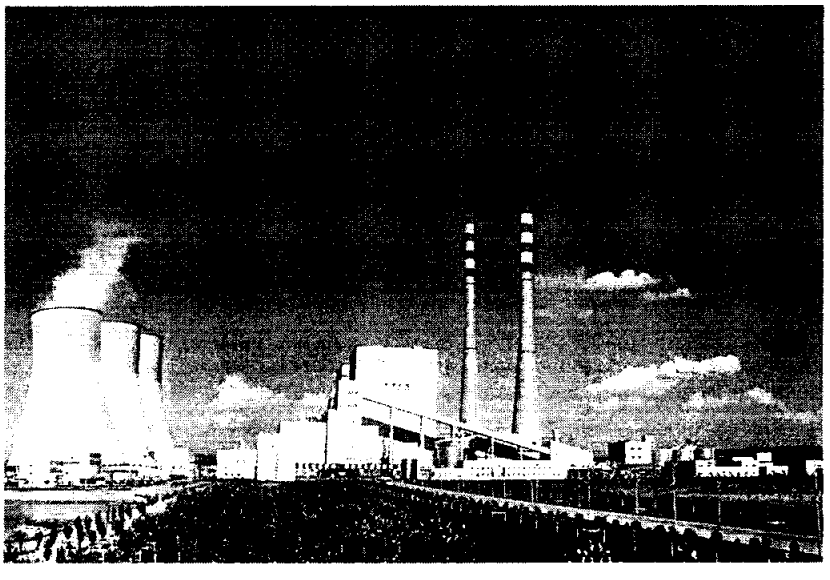
Report No. PPI-168.1-Draft/15

INTERCONNECTION STUDY

For

660 MW Nishat Coal Fired Power Plant near Rahim Yar Khan, Punjab



Draft Report
(October 2015)

POWER PLANNERS INTERNATIONAL

UK Office:
3-Sylvester Road,
Sudbury Town, Middlesex,
HA0 3AQ, UK
Phone & Fax:+44-(0)208-9223219

Pakistan Office:
64-F/1, Wapda Town,
Lahore, Pakistan
Phone: +92-42-35968118;
Fax: + 92-42-35183166

Email: info@powerplannersint.com
www.powerplannersint.com

Executive Summary

- The Draft Report of interconnection of the 660 MW Nishat Coal Fired Power Plant with NTDC grid system is submitted herewith. The installed capacity of the plant would comprise of one coal fired unit of 660 MW which would deliver maximum net power of 625 MW to the grid.
- The study objective, approach and methodology have been described and the plant's data received from the Client is validated. The network of Nishat Power Plant has been modeled at 500 kV.
- The system data of NTDC has been used as per permission granted by NTDC vide their letter no. GMPP/CEMP/TRP-300/3768-69 dated 01/09/2015 attached in Appendix-A.
- The nearest grid facility is R.Y.Khan 500/220/132 kV Grid Station as shown in Sketch-1 in Appendix-B.
- Taking the location of Nishat Power Plant in consideration, two alternatives have been proposed for the interconnection of the said plant with the 500 kV network of NTDC.
    - In the first alternative, a direct double circuit from Nishat Power Plant to R.Y.Khan 500 kV Grid has been proposed. The length of this double circuit would be 42 km which has been confirmed thorough a site visit by PPI team of engineers. The conductor used would be 500 kV Drake.
    - In the second alternative, the 500 kV 292 km circuit running from R.Y.Khan to Multan would be looped in out at Nishat Power Plant using 500 kV Drake conductor. The distance from the power plant to the looping point (immediately after the line take-off from the Grid Station) would be 42 km.
- Although, alternative-I would require two line bays at R.Y.Khan 500/220/132 kV Grid Station whereas alternative-II would not require additional line bay at R.Y.Khan G/S, yet the length of 500 kV transmission line between Nishat PP to Multan, as a result of looping, would become 292 + 42 = 334 kM which is

considerably long and might compromise the loadability of line. Hence, alternative-II may not be a more likeable alternative.

- In view of planned COD of the Nishat Power Plant in the fourth quarter of 2018, the base case of studies have been assumed as of January 2019 because maximum power flow occurs on Southern grid of NTDC due to concentration of thermal power plants in the South. Therefore both the above proposed interconnection alternatives have been tested for steady state conditions through detailed load flow studies for the peak low water conditions of January 2019. The system conditions of normal and N-1 contingency have been studied to meet the reliability criteria of NEPRA Grid Code.
- In addition, peak high water condition of September 2019 has also been studied for alternative-I only, as alternative-II is not a likeable alternative.
- The proposed interconnection scheme has also been tested in the extended-term scenario of the year 2021 by carrying out detailed studies for Low Water (January) and High Water (September) seasons.
- Steady state analysis by load flow for peak load of January 2019, September 2019, January 2021 and September 2021 reveals that the proposed scheme is adequate to evacuate the maximum net power of 625 MW of the Plant under normal as well as contingency conditions.
- The short circuit analysis has been carried out for alternative-I to calculate maximum fault levels at Nishat Power Plant and the substations of 500 kV and 220 kV in its vicinity for 2019 and 2021. We find that the fault currents for the proposed scheme are within the rated short circuit capacities of switchgear installed at these substations. There are no violations of exceeding the rating of the equipment due to contribution of fault current from Nishat Power Plant.
- The maximum short circuit level of Nishat Power Plant 500 kV is 13.13 kA and 11.73 kA for 3-phase and 1-phase faults respectively for January 2019. The short circuit level of the Nishat Power Plant 500 kV is 13.64 kA and 12.28 kA for 3-phase and 1-phase faults respectively for January 2021. Similarly these values for September 2021 are 14.52 kA and 12.05 kA. Therefore industry standard switchgear of the short circuit rating of 40 kA would be fine to be installed at 500

kV switchyard of Nishat Power Plant taking care of any future generation additions and system reinforcements in its electrical vicinity and also fulfill the NEPRA Grid Code requirements specified for 500 kV switchgear.

- The dynamic stability analysis of proposed alternative-I of interconnection has been carried out for January 2019, January 2021 and September 2021. The stability check for the worst case of three phase fault right on the 500 kV bus bar of Nishat Power Plant followed by the final trip of one 500 kV circuit emanating from this substation, has been performed for fault clearing of 5 (100 ms) as understood to be the normal fault clearing time of 500 kV protection system, and for fault clearing of 9 cycles (180 ms) in case of stuck breaker as specified in the Grid Code. The system is found strong enough to stay stable and recovered with fast damping. The stability of system for far end faults of 3-phase occurring at R.Y.Khan 500 kV bus bar have also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults for the most stringent cases.
- The proposed alternative-I of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.

Contents

Appendices

Appendix –A:

- NTDC Generation Program
- Transmission Expansion Plan
- NTDC Load Forecast

Appendix –B: Sketches for Chapter-4

Appendix –C: Plotted Results of Load Flow for Chapter – 5

Appendix –D: Results of Short Circuit Analysis for Chapter – 6

Appendix –E: Plotted Results of Stability Analysis for Chapter – 7

1. Stability Plots for the Year 2018-19
2. Stability Plots for the Year 2020-21

Appendix –F: Generator Data Used for Stability Analysis

1. Introduction

1.1 Background

Nishat Power Plant is a coal fired power project which is located at a direct distance of about 35 km (42 km through line route) from the under-construction R.Y.Khan 500/220/132 kV Grid Station of NTDC.

The electricity generated from this project would be supplied to the grid system of NTDC through 500 kV grid available in the vicinity of this project. The nearest grid facility is a R.Y.Khan 500/220/132 kV Grid Station as shown in Sketch-1 in Appendix-B

1.2 Objectives

The overall objective of the Study is to evolve an interconnection scheme between Nishat Power Plant and NTDC network, for stable and reliable evacuation of the electrical power generated from this plant, fulfilling N-1 reliability criteria. The specific objectives of this report are:

1. To develop scheme of interconnections at 500 kV for which right of way (ROW) and space at the terminal substations would be available.
2. To determine the performance of interconnection scheme during steady state conditions of system, normal and N-1 contingency, through load-flow analysis.
3. To check if the contribution of fault current from this new plant increases the fault levels at the adjoining substations at 500 kV voltage levels to be within the rating of equipment of these substations, and also determine the short circuit ratings of the proposed equipment of the substation at Nishat Power Plant.
4. To check if the interconnection withstands dynamic stability criteria of post fault recovery with good damping.

1.3 Planning Criteria

The planning criteria required to be fulfilled by the proposed interconnection is as follows:

Steady State:

Voltage	± 5 %, Normal Operating Condition (+ 8 % is permitted for 500 kV only)
	± 10 %, Contingency Conditions
Frequency	50 Hz Nominal
	49.8 Hz to 50.2 Hz variation in steady state
	49.4 - 50.5 Hz, Min/Max Contingency Freq. Band
Power Factor	0.8 to 0.85 Lagging; 0.9 to o.95 Leading

Short Circuit:

Substation Equipment Rating for 500 kV should be 40 kA or 50 kA (if desired)

Dynamic/Transient:

The system should revert back to normal condition after dying out of transients without loosing synchronism with good damping after permanent three-phase fault on any primary transmission element; including: transmission circuit, substation bus section, transformer, or circuit breaker. It is assumed that such a fault shall be cleared by the associated circuit breaker action in 5 cycles.

In case of failure of primary protection (stuck breaker case), the total fault clearing time from the instant of initiation of fault current to the complete interruption of current to isolate the faulted element, including the primary protection plus the backup protection to operate and isolate the fault, is equal to 180 ms (9 cycles).

2. Assumptions of Data

The number of generating units at Nishat Power Plant is one. As per the data provided by the Client the following assumptions have been made:

2.1 Nishat Power Plant data

Generator data:

Installed capacity of power plant	= 660 MW
Net Generation to be Delivered to the Grid	= 625 MW
Power factor	= 0.85 lagging, 0.95 leading
Lump sum MVA capacity	= 776 MVA
Combined Inertia Constant, H (Both Generator + Turbine)	= 3.9 MW-sec/MVA
Generating Voltage	= 22 kV

2.2 Network data

The 500 kV network in the area near Nishat Power Plant is as shown in Sketches in Appendix-A. The system data of NTDC has been used as attached in Appendix-A as per permission granted by NTDC vide their letter no. GMPP/CEMP/TRP-300/3768-69 dated 01/09/2015.

Apart from other network additions/reinforcements in NTDC network, there are two HVDC Bipoles ± 600 kV that have been included in the study as per Transmission Plan of NTDC as follows:

- ± 600 kV HVDC Bipole from Matiari to Lahore South
- ± 600 kV HVDC Bipole from Bin Qasim to Faisalabad West

3. Study Approach and Methodology

3.1 Understanding of the Problem

Nishat Power Plant is a coal fired power project which is located at a direct distance of about 35 km (42 km through line route) from the under-construction R.Y.Khan 500/220/132 kV Grid Station of NTDC. Therefore the proposed Power Project is going to be embedded in the transmission network of NTDC through this grid station.

Due to the location of Nishat Power Plant, two alternatives have been proposed for the interconnection of the said plant with the 500 kV network of NTDC.

- In the first alternative, a direct double circuit from Nishat Power Plant to R.Y.Khan 500 kV Grid has been proposed. The length of this double circuit would be 42 km which has been confirmed thorough a site visit by PPI team of engineers. The conductor used would be 500 kV Drake.
- In the second alternative, the 500 kV 292 km circuit running from R.Y.Khan to Multan would be looped in out at Nishat Power Plant using 500 kV Drake conductor. The distance from the power plant to the looping point (immediately after the line take-off from the Grid Station) would be 42 km.

The adequacy of NTDC network of 500 kV and 220 kV in and around the proposed site of Nishat Power Plant has been investigated in this study for absorbing and transmitting this power fulfilling the reliability criteria.

3.2 Approach to the problem

The consultant has applied the following approaches to the problem:

- A base case network model has been prepared for January 2019 after the commissioning of Nishat Power Plant by the 4th quarter of 2018, comprising all 500 kV, 220 kV and 132 kV system, envisaging the load forecast, the generation additions and transmission expansions for that year.

- Month of January 2019 has been selected for the study because it represents the maximum thermal dispatch conditions after the COD of Nishat Power Plant in 4th quarter of 2018. Thus the loading on the lines in the vicinity of Nishat Power Plant will be maximum allowing us to judge the maximum impact of the plant on the transmission system in its vicinity.
- The proposed interconnection scheme has also been tested in the extended-term scenario of the year 2021 by carrying out detailed studies for Low Water (January) and High Water (September) seasons.
- Interconnection scheme without any physical constraints, like right of way or availability of space in the terminal substations, have been identified.
- Perform technical system studies for peak load conditions to confirm technical feasibility of the interconnections. The scheme will be subjected to standard analysis such as load flow, short circuit, and transient stability study to check the adequacy of transmission network and strength of the machines for the proposed interconnection scheme under normal and disturbed conditions.
- Determine the relevant equipment for the proposed technically feasible scheme.
- Recommend the technically most feasible scheme of interconnection.

4. Development of Scheme of Interconnection

4.1 The Existing and Ongoing Network

The existing 500 kV network available around Nishat Power Plant is shown in Sketch-1 in Appendix-B. The existing and ongoing 500 kV network in the vicinity of the proposed power plant consists of as follows:

- 500/220/132 kV grid station of Rahim Yar Khan
- 500 kV circuit between Guddu-New to RY Khan
- 500 kV circuit between RY Khan to Multan
- 500 kV circuit between Moro and RY Khan (ongoing)

4.2 The Scheme of Interconnection of Nishat Power Plant

Keeping in view of the above mentioned 500 kV network available in the vicinity of the site of the Nishat Power Plant, two alternatives have been proposed for the interconnection of the said plant with the 500 kV network of NTDC. Both alternatives have been shown in Sketch 2 and 3 of Appendix A.

- In the first alternative, a direct double circuit from Nishat Power Plant to R.Y.Khan 500 kV Grid has been proposed. The length of this double circuit would be 42 km which has been confirmed thorough a site visit by our team of engineers. The conductor used would be 500 kV Drake.
- In the second alternative, the 500 kV 292 km circuit running from R.Y.Khan to Multan would be looped in out at Nishat Power Plant using 500 kV Drake conductor. The distance from the power plant to the looping point (immediately after the line take-off from the Grid Station) would be 42 km.

4.3 The Scope of work at Switching Station of Nishat Power Plant

The schemes showing the scope of work at Nisshat Power Plant for alternative-1 and alternative-2 have been attached in Appendix-B:

Alt-1: (SLD-I)

One and half breaker scheme would be required as shown in SLD-1 as follows:

- Two breaker bays (one dia) to connect two 500 kV circuits to connect to RY Khan 500 kV grid station
- One breaker bay to connect 660 MW Generating Units
- One spare breaker bay for future addition of 660 MW unit

Alt-2: (SLD-III)

Same scheme as of Alternative-I but the termination of outgoing 500 kV circuits would change as follows to loop in-out RY Khan-Multan 500 kV circuit

- One circuit to Multan
- One circuit to RY Khan

4.4 The Scope of work at RY Khan 500 kV grid station

The schemes showing the scope of work at RY Khan 500 kV grid station for alternative-1 and alternative-2 have been attached in Appendix-B:

Alt-1: (SLD-II)

One and half breaker scheme would be required as shown in SLD-II as follows:

- Two breaker bays (one dia) to connect two 500 kV circuits to connect to

Alt-2: (SLD-IV)

No additional bays would be required. Only protection and control schemes would be changed for looping in-out RY Khan-Multan 500 kV circuit at Nishat Power Plant

5. Detailed Load Flow Studies

5.1 Base Case Load Flow January Peak 2021, Without Nishat Power Plant

A base case has been developed for the peak load of January 2019 using the network data of NTDC, after updating with latest load forecast and expansion plan of NTDC. Demand forecast obtained from NTDC have been incorporated into the base case.

The results of load flow for this base case are plotted in Exhibit 0.0 of Appendix-C. The system plotted in this Exhibit comprises of 500 kV network around the proposed power plant including 500 kV Grid Stations of R.Y.Khan, Guddu, Guddu-New, Moro, Dadu, Jamshoro, Muzaffargarh, Multan and Sahiwal etc. In addition 220 kV network including and around R.Y.Khan, Guddu, Dadu, Shikarpur, Muzaffargarh, Rohri etc. have also been shown.

The load flow results show that the power flows on all the circuits are within their normal rating. The voltage profile of these surrounding substations is also within normal limits.

For N-1 contingency conditions we have performed the simulation cases with results plotted as follows:

Exhibit 0.1	R.Y Khan to Multan 500kV Single Circuit Out
Exhibit 0.2	Moro to R.Y Khan 500kV Single Circuit Out
Exhibit 0.3	Dadu to Moro 500kV Single Circuit Out
Exhibit 0.4	Multan to Sahiwal 500kV Single Circuit Out
Exhibit 0.5	Guddu-New to R.Y Khan 500kV Single Circuit Out
Exhibit 0.6	Guddu to Guddu-New 500kV Single Circuit Out
Exhibit 0.7	Guddu-New to M. Garh 500kV Single Circuit Out
Exhibit 0.8	Guddu to D.G. Khan 500kV Single Circuit Out
Exhibit 0.9	Guddu to M. Garh 500kV Single Circuit Out
Exhibit 0.10	Shikarpur to Guddu 500kV Single Circuit Out

We see that in all the cases the power flows on all circuits remain within their rated limits. Also the bus voltages are within the acceptable operating range.

5.2 Load Flow Peak January 2019 with Nishat Power Plant

For the interconnection of Nishat Power Plant with the 500 kV network of NTDC, two alternatives have been proposed. Both alternatives have been shown in Sketch 2 and 3 of Appendix B.

- In the first alternative, a direct double circuit from Nishat Power Plant to R.Y.Khan 500 kV Grid has been proposed. The length of this double circuit would be 42 km which has been confirmed thorough a site visit by our team of engineers. The conductor used would be 500 kV Drake.
- In the second alternative, the 500 kV 292 km circuit running from R.Y.Khan to Multan would be looped in out at Nishat Power Plant using 500 kV Drake conductor. The distance from the power plant to the looping point (immediately after the line take-off from the Grid Station) would be 42 km

Load flow studies have been carried out for January 2019 because it represents the maximum thermal dispatch conditions in the grid after the COD of Nishat Power Plant in the third quarter of 2018. Thus the loading on the lines in the vicinity of Nishat Power Plant will be maximum, allowing us to judge the maximum impact of the plant on the transmission system in its vicinity. The results of load flow with Nishat Power Plant interconnected as per proposed alternative-I and alternative-II are shown in Appendix-C.

5.2.1 Load Flow with Nishat Power Plant – Alternative-I

The results of Normal case of Peak January 2019 are plotted in Exhibit 1.0 for alternative-I. We find no capacity constraints on 500 kV circuits under normal conditions i.e. without any outages of circuits.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of +8/-5 % off the nominal.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – C as follows;

Exhibit 1.1	Nishat Power to R.Y Khan 500kV Single Circuit Out
Exhibit 1.2	R. Y. Khan to Multan 500kV Single Circuit Out
Exhibit 1.3	Moro to R.Y Khan 500kV Single Circuit Out
Exhibit 1.4	Dadu to Moro 500kV Single Circuit Out
Exhibit 1.5	Multan to Sahiwal 500kV Single Circuit Out
Exhibit 1.6	Guddu-New to R.Y Khan 500kV Single Circuit Out
Exhibit 1.7	Guddu-New to Guddu 500kV Single Circuit Out
Exhibit 1.8	Guddu-New to M. Garh 500kV Single Circuit Out
Exhibit 1.9	Guddu to D.G.Khan 500kV Single Circuit Out
Exhibit 1.10	Guddu to M.Garh 500kV Single Circuit Out
Exhibit 1.11	Shikarpur to Guddu 500kV Single Circuit Out

We see that in all the contingency cases, in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the permissible limits in all the contingency events.

5.2.2 Load Flow with Nishat Power Plant – Alternative-II

The results of Normal case of Peak January 2019 are plotted in Exhibit 2.0 for alternative-I. We find no capacity constraints on 500 kV circuits under normal conditions i.e. without any outages of circuits.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of +8/-5 % off the nominal.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – C as follows;

Exhibit 2.1	Nishat Power to R.Y Khan 500kV Single Circuit Out
Exhibit 2.2	Nishat Power to Multan 500kV Single Circuit Out
Exhibit 2.3	Moro to R.Y Khan 500kV Single Circuit Out

Exhibit 2.4 Dadu to Moro 500kV Single Circuit Out

Exhibit 2.5 Multan to Sahiwal 500kV Single Circuit Out

Exhibit 2.6 R.Y Khan to Guddu-New 500kV Single Circuit Out

Exhibit 2.7 Guddu-New to Guddu 500kV Single Circuit Out

Exhibit 2.8 Guddu-New to M. Garh 500kV Single Circuit Out

Exhibit 2.9 Guddu to D.G.Khan 500kV Single Circuit Out

Exhibit 2.10 Guddu to M.Garh 500kV Single Circuit Out

Exhibit 2.11 Shikarpur to Guddu 500kV Single Circuit Out

We see that in all the contingency cases, in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the permissible limits in all the contingency events.

5.3 Load Flow Peak September 2019 with Nishat Power Plant

The results of Normal case of Peak September 2019 are plotted in Exhibit 3.0 for alternative-I. We find no capacity constraints on 500 kV circuits under normal conditions i.e. without any outages of circuits.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of +8/-5 % off the nominal.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – C as follows;

Exhibit 3.1 Nishat Power to R.Y Khan 500kV Single Circuit Out

Exhibit 3.2 Multan to R. Y. Khan 500kV Single Circuit Out

Exhibit 3.3 R.Y Khan to Moro 500kV Single Circuit Out

Exhibit 3.4 Moro to Dadu 500kV Single Circuit Out

Exhibit 3.5 Multan to Sahiwal 500kV Single Circuit Out

Exhibit 3.6 Guddu-New to R.Y Khan 500kV Single Circuit Out

Exhibit 3.7 Guddu-New to Guddu 500kV Single Circuit Out

Exhibit 3.8 Guddu-New to M. Garh 500kV Single Circuit Out

Exhibit 3.9 Guddu to D.G.Khan 500kV Single Circuit Out

Exhibit 3.10 Guddu to M.Garh 500kV Single Circuit Out

Exhibit 3.11 Guddu to Shikarpur 500kV Single Circuit Out

We see that in all the contingency cases, in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the permissible limits in all the contingency events.

5.4 Load Flow for Extended Term Scenario of January 2021

Extended term scenario of January 2021 has also been studied for the selected alternative-I.

The results of Normal case of Peak January 2021 are plotted in Exhibit 4.0 for alternative-I. We find no capacity constraints on 500 kV circuits under normal conditions i.e. without any outages of circuits.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of +8/-5 % off the nominal.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – C as follows;

Exhibit 4.1 Nishat Power to R.Y Khan 500kV Single Circuit Out

Exhibit 4.2 R. Y. Khan to Multan 500kV Single Circuit Out

Exhibit 4.3 Moro to R.Y Khan S00kV Single Circuit Out

Exhibit 4.4 Dadu to Moro 500kV Single Circuit Out

Exhibit 4.5 Multan to Sahiwal 500kV Single Circuit Out

Exhibit 4.6 Guddu-New to R.Y Khan 500kV Single Circuit Out

Exhibit 4.7 Guddu-New to Guddu 500kV Single Circuit Out

Exhibit 4.8 Guddu-New to M. Garh 500kV Single Circuit Out

Exhibit 4.9 Guddu to D.G.Khan 500kV Single Circuit Out

Exhibit 4.10 Guddu to M.Garh 500kV Single Circuit Out

Exhibit 4.11 Shikarpur to Guddu 500kV Single Circuit Out

We see that in all the contingency cases, in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the permissible limits in all the contingency events.

5.5 Load Flow for Extended Term Scenario of September 2021

Extended term scenario of September 2021 has also been studied for the selected alternative-I.

The results of Normal case of Peak January 2021 are plotted in Exhibit 5.0 for alternative-I. We find no capacity constraints on 500 kV circuits under normal conditions i.e. without any outages of circuits.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of +8/-5 % off the nominal.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – C as follows;

Exhibit 5.1 Nishat Power to R.Y Khan 500kV Single Circuit Out

Exhibit 5.2 R. Y. Khan to Multan 500kV Single Circuit Out

Exhibit 5.3 Moro to R.Y Khan 500kV Single Circuit Out

Exhibit 5.4 Moro to Dadu 500kV Single Circuit Out

Exhibit 5.5 Multan to Vehari 500kV Single Circuit Out

Exhibit 5.6 Guddu-New to R.Y Khan 500kV Single Circuit Out

Exhibit 5.7 Guddu-New to Guddu 500kV Single Circuit Out

Exhibit 5.8 Guddu-New to M. Garh 500kV Single Circuit Out

Exhibit 5.9 Guddu to D.G.Khan 500kV Single Circuit Out

Exhibit 5.10 Guddu to M.Garh 500kV Single Circuit Out

Exhibit 5.11 Shikarpur to Guddu 500kV Single Circuit Out

We see that in all the contingency cases, in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the permissible limits in all the contingency events.

Conclusion of Load Flow Analysis

Two alternatives proposed for the interconnection of Nishat Power Plant have been tested under normal and contingency conditions for peak load conditions of January 2019. In all the normal and contingency cases, we find that the loading on the circuits remain within the rated capacity. Also the bus bar voltages are well within the permissible limits in all the normal and contingency events.

Although, alternative-I would require two line bays at R.Y.Khan 500/220/132 kV Grid Station whereas alternative-II would not require additional line bay at R.Y.Khan G/S, yet the length of 500 kV transmission line between Nishat PP to Multan, as a result of looping, would become 292 + 42 = 334 kM which is considerably long line and might compromise the loadability of line. Hence, alternative-II may not be a more likeable alternative.

The selected alternative-I has been tested for High Water conditions of September, 2019 and for extended term scenario of January 2021 and September 2021. It is found that the loading on the circuits remain within the rated capacity and the bus bar voltages are well within the permissible limits in all the normal and contingency events.

The selected alternative-I fulfils all the required criteria under normal and contingency conditions and recommended to be adopted.

6. Short Circuit Analysis

6.1 Methodology and Assumptions

The methodology of IEC 909 has been applied in all short circuit analyses in this report for which provision is available in the PSS/E software used for these studies.

The maximum fault currents have been calculated with the following assumptions under IEC 909:

- Set tap ratios to unity
- Set line charging to zero
- Set shunts to zero in positive sequence
- Desired voltage magnitude at bus bars set equal to 1.10 P.U. i.e. 10 % higher than nominal, which is the maximum permissible voltage under contingency condition.

For evaluation of maximum short circuit levels we have assumed contribution in the fault currents from all the installed generation capacity of hydel, thermal and nuclear plants in the system in the year 2018-19 i.e. all the generating units have been assumed on-bar in fault calculation's simulations.

The assumptions about the generator and the transformers data are the same as mentioned in Ch.2 of this report.

6.2 Fault Current Calculations without Nishat Power Plant

In order to assess the short circuit strength of the network of 500 kV without Nishat Power Plant, fault currents have been calculated for balanced three-phase and unbalanced single-phase short circuit conditions. These levels will give us the idea of the fault levels without Nishat Power Plant and later on how much the contribution of fault current from Nishat Power Plant may add to the existing levels,.

The results are attached in Appendix – D.

The short circuit levels have been calculated and plotted on the bus bars of 500 kV of substations lying in the electrical vicinity of our area of interest i.e. R.Y.Khan, Guddu, Guddu-New, Muzaffargarh, Multan and surrounding bus bars and are shown plotted

in the Exhibit 6.0 attached in Appendix-D. Both 3-phase and 1-phase fault currents are indicated in the Exhibit which are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the bus bar.

Table-6.1
Maximum Short Circuit Levels without Nishat Power Plant

Substation	3-Phase fault current, kA	1-Phase fault current, kA
R.Y.Khan 500kV	12.88	7.20
Guddu-New 500kV	22.66	20.35
M.Garh 500kV	24.84	19.15
H.B. Shah 500kV	22.52	18.54
Multan 500kV	25.87	19.52
Sahiwal 500kV	17.22	14.11
D.G.Khan 500kV	13.15	8.21
Guddu 500kV	23.12	20.71
Shikarpur 500kV	18.1	11.77
Dadu 500kV	20.5	10.92
Jamshoro 500kV	26.33	19.34
Moro 500kV	15.21	6.66
M.Garh-1 220kV	31.04	32.12
M.Garh-2 220kV	24.37	22.86
Guddu 220kV	35.71	39.47
Shikarpur 220kV	28.26	23.27

The tabular output of the short circuit calculations is also attached in Appendix-D for the 500 kV and 220 kV bus bars of our interest i.e. the substations connecting in the 500 kV circuits lying close to R.Y.Khan, Guddu-New and Multan. The total maximum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 6.1. We see that the maximum fault currents do not exceed the short circuit ratings of the equipment at these 500 kV substations which normally are 40 kA for older substations and 50 kA for new substations.

6.3 Fault Current Calculations January 2019 with Nishat Power Plant interconnected – Alternative-I

Fault currents have been calculated for the electrical interconnection of proposed alternative-I for base case of January 2019. Fault types applied are three phase and single-phase at 500 kV bus bars of Nishat Power Plant itself and other bus bars of the 500 kV substations in the electrical vicinity of Rahim Yar Khan, Guddu-New and Multan. The graphic results showing maximum 3-phase and 1-phase fault levels are indicated in Exhibit 6.1. Both 3-phase and 1-phase fault currents are indicated in the Exhibit which are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the bus bar.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 500 kV bus bars of the network in the electrical vicinity of Nishat Power Plant are placed in Appendix-D. Brief summary of fault currents at significant bus bars of our interest are tabulated in Table 6.2 on the next page.

Comparison of Tables 6.1 and 6.2 show slight increase in short circuit levels for three-phase and single- phase faults due to connection of Nishat Power Plant on the 500 kV bus bars in its vicinity. We find that even after some increase, these fault levels are below the rated short circuit values of the equipment installed on these substations. The maximum short circuit level of Nishat Power Plant 500 kV is 13.13 kA and 11.73 kA for 3-phase and 1-phase faults respectively. It would be advisable to go for standard size switchgear of short circuit rating of 40 kA. It would provide large margin for any future increase in short circuit levels due to future generation additions and network reinforcements in this area.

Table-6.2

Maximum Short Circuit Levels with Nishat Power Plant – January 2019

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Nishat Power 500kV	13.13	11.73
R.Y.Khan 500kV	15.24	12.06
Guddu-New 500kV	22.95	20.28
M.Garh 500kV	25.09	19.22
H.B. Shah 500kV	22.59	18.55
Multan 500kV	26.22	19.66
Sahiwal 500kV	17.05	14.11
D.G.Khan 500kV	13.18	8.2
Guddu 500kV	23.28	20.3
Shikarpur 500kV	18.0	11.66
Dadu 500kV	20.3	10.83
Jamshoro 500kV	25.5	18.14
Moro 500kV	15.22	6.69
M.Garh-1 220kV	31.08	32.12
M.Garh-2 220kV	24.4	22.83
Guddu 220kV	32.3	34.24
Shikarpur 220kV	27.91	23.0
Nishat Power 500kV	13.13	11.73

6.3 Fault Current Calculations January 2021 with Nishat Power Plant interconnected – Alternative-I

Fault currents have been calculated for the electrical interconnection of proposed alternative-I for extended term scenario of January 2021. Fault types applied are three phase and single-phase at 500 kV bus bars of Nishat Power Plant itself and other bus bars of the 500 kV substations in the electrical vicinity of Rahim Yar Khan, Guddu-New and Multan. The graphic results showing maximum 3-phase and 1-phase fault levels are indicated in Exhibit 6.2. Both 3-phase and 1-phase fault currents are indicated in the Exhibit which are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the bus bar.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 500 kV bus bars of the network in the electrical vicinity of Nishat Power Plant are placed in Appendix-D. Brief summary of fault currents at significant bus bars of our interest are tabulated in Table 6.4 on the next page.

Comparison of Tables 6.2 and 6.4 show slight increase in short circuit levels for three-phase and single- phase faults due to connection of Nishat Power Plant on the 500 kV bus bars in its vicinity. We find that even after some increase, these fault levels are below the rated short circuit values of the equipment installed on these substations. The maximum short circuit level of Nishat Power Plant 500 kV is 13.64 kA and 12.28 kA for 3-phase and 1-phase faults respectively. Therefore the selected rating of switchgear as 40 kA holds good in the extended year scenario of 2021 and still it would provide large margin for any future increase in short circuit levels due to future generation additions and network reinforcements in this area.

Table-6.4

Maximum Short Circuit Levels with Nishat Power Plant – January 2021

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Nishat Power 500kV	13.64	12.28
R.Y.Khan 500kV	15.84	12.44
Guddu-New 500kV	23.63	20.63
M.Garh 500kV	25.66	19.28
H.B. Shah 500kV	23.44	19.86
Multan 500kV	27.05	20.05
Sahiwal 500kV	18.21	14.92
D.G.Khan 500kV	13.62	8.12
Guddu 500kV	23.95	20.50
Shikarpur 500kV	18.85	11.79
Dadu 500kV	22.84	11.97
Jamshoro 500kV	32.12	28.96
Moro 500kV	16.70	7.16
R.Y.Khan 220kV	16.80	15.81
M.Garh-1 220kV	30.07	30.18
M.Garh-2 220kV	24.51	22.49
Guddu 220kV	31.91	33.30
Shikarpur 220kV	28.69	23.35

6.4 Fault Current Calculations September 2021 with Nishat Power Plant interconnected – Alternative-I

Fault currents have been calculated for the electrical interconnection of proposed alternative-I for extended term scenario of September 2021. Fault types applied are three phase and single-phase at 500 kV bus bars of Nishat Power Plant itself and other bus bars of the 500 kV substations in the electrical vicinity of Rahim Yar Khan, Guddu-New and Multan. The graphic results showing maximum 3-phase and 1-phase fault levels are indicated in Exhibit 6.3. Both 3-phase and 1-phase fault currents are indicated in the Exhibit which are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the bus bar.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 500 kV bus bars of the network in the electrical vicinity of Nishat Power Plant are placed in Appendix-D. Brief summary of fault currents at significant bus bars of our interest are tabulated in Table 6.3 on the next page.

Comparison of Tables 6.3 and 6.5 show slight increase in short circuit levels for three-phase and single – phase faults due to connection of Nishat Power Plant on the 500 kV bus bars in its vicinity. We find that even after some increase, these fault levels are below the rated short circuit values of the equipment installed on these substations. The maximum short circuit level of Nishat Power Plant 500 kV is 14.52 kA and 12.05 kA for 3-phase and 1-phase faults respectively. Therefore the selected rating of switchgear as 40 kA holds good in the extended year scenario of 2021 and still it would provide large margin for any future increase in short circuit levels due to future generation additions and network reinforcements in this area.

Table-6.5
Maximum Short Circuit Levels September 2021 with Nishat Power Plant

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Nishat Power 500kV	13.64	12.28
R.Y.Khan 500kV	15.84	12.44
Guddu-New 500kV	23.63	20.63
M.Garh 500kV	25.66	19.28
H.B. Shah 500kV	23.44	19.86
Multan 500kV	27.05	20.05
Sahiwal 500kV	18.21	14.92
D.G.Khan 500kV	13.62	8.12
Guddu 500kV	23.95	20.50
Shikarpur 500kV	18.85	11.79
Dadu 500kV	22.84	11.97
Jamshoro 500kV	32.12	28.96
Moro 500kV	16.70	7.16
R.Y.Khan 220kV	16.80	15.81
M.Garh-1 220kV	30.07	30.18
M.Garh-2 220kV	24.51	22.49
Guddu 220kV	31.91	33.30
Shikarpur 220kV	28.69	23.35

6.4 Conclusion of Short Circuit Analysis

The short circuit analysis results show that for the proposed scheme of interconnection of Nishat Power Plant there is no problem of violations of short circuit ratings of the already installed equipment on the 500 kV equipment of substations in the vicinity of Nishat Power Plant due to fault current contributions from this power house under three-phase faults as well as single phase faults.

The maximum short circuit level of Nishat Power Plant 500 kV is 13.13 kA and 11.73 kA for 3-phase and 1-phase faults respectively for January 2019. The short circuit

level of the Nishat Power Plant 500 kV is 13.64 kA and 12.28 kA for 3-phase and 1-phase faults respectively for extended year scenario of January 2021. Similarly these values for September 2021 are 14.52 kA and 12.05 kA. Therefore industry standard switchgear of the short circuit rating of 40 kA would be fine to be installed at 500 kV switchyard of Nishat Power Plant taking care of any future generation additions and system reinforcements in its electrical vicinity.

7. Dynamic Stability Analysis

7.1 Assumptions & Methodology

7.1.1 Dynamic Models

The assumptions about the generator and its parameters are the same as mentioned in Ch.2 of this report.

We have employed the generic dynamic models available in the PSS/E model library for dynamic modeling of the generator, exciter and the governor as follows;

Generator	GENROU
Excitation System	EXST1
Speed Governing System	TGOV1
Inertia Constant (Supplied by Client),	H = 3.9 MW-sec/MVA

7.1.2 System Conditions

The proposed scheme of lying a direct double circuit from Nishat Power Plant to R.Y.Khan 500 kV Grid has been modeled in the dynamic simulation. The length of this double circuit would be 42 km which has been confirmed thorough a site visit by PPI team of engineers. The conductor used would be 500 kV Drake.

All the power plants of WAPDA/GENCOs and IPPs from Tarbela to Hub have been dynamically represented in the simulation model.

7.1.3 Presentation of Results

The plotted results of the simulations runs are placed in Appendix-E. Each simulation is run for its first one second for the steady state conditions of the system prior to fault or disturbance. This is to establish the pre fault/disturbance conditions of the network under study were smooth and steady. Post fault recovery has been monitored for nine seconds. Usually all the transients due to non-linearity die out within 2-3 seconds after disturbance is cleared in the system.

7.1.4 Worst Fault Cases

Three phase faults are considered as the worst disturbance in the system. We have considered 3-phase fault in the closest vicinity of Nishat Power Plant i.e. right at the

500 kV bus bar of Nishat Power Plant substation, cleared in 5 cycles, as normal clearing time for 500 kV i.e. 100 ms, followed by a permanent trip of single 500 kV circuit emanating from the substation.

7.2 Dynamic Stability Simulations' Results January 2019

7.2.1 Fault at 500 kV Near Nishat Power Plant

We applied three-phase fault on Nishat Power Plant 500 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of a 500 kV single circuit between Nishat Power Plant and Rahim Yar khan 500 kV substation. We monitored different quantities for one second pre-fault and nine cycles after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 1.1 Bus Voltages

The bus voltages of 500 kV bus bars of Nishat Power Plant, R.Y.Khan, Guddu-New, Multan, Moro and Jamshoro are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 1.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 1.3 MW/MVAR Output of Generator of Nishat Power Plant

The pre-fault output of Nishat Power Plant is 625 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 1.4 Speed and Mechanical Power of Generators at Nishat Power Plant

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 1.5 MW Flow on Nishat Power Plant to Rahim Yar Khan 500 kV circuit

Followed by clearing of fault, the trip of a 500 kV single circuit from Nishat Power Plant to Rahim Yar Khan causes the entire output of Nishat Power Plant to flow on the intact 500 kV circuit between Nishat Power Plant to Rahim Yar Khan. We plotted

the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 1.6 Rotor Angles

The rotor angles of the generators of Nishat Power Plant 500 kV, Guddu-New 500 kV, Guddu 220 kV and H.B. Shah 500 kV are plotted relative to machines at Jamshoro 500 kV. The results show that the rotor angle of Nishat Power Plant gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.2.2 Fault at 500 kV Near Nishat Power Plant (Stuck Breaker)

We applied three-phase fault on Nishat Power Plant 500 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of a 500 kV single circuit between Nishat Power Plant and Rahim Yar khan 500 kV substation. We monitored different quantities for one second pre-fault and nine cycles after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 2.1 Bus Voltages

The bus voltages of 500 kV bus bars of Nishat Power Plant, R.Y.Khan, Guddu-New, Multan, Moro and Jamshoro are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 2.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 2.3 MW/MVAR Output of Generator of Nishat Power Plant

The pre-fault output of Nishat Power Plant is 625 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 2.4 Speed and Mechanical Power of Generators at Nishat Power Plant

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 2.5 MW Flow on Nishat Power Plant to Rahim Yar Khan 500 kV circuit

Followed by clearing of fault, the trip of a 500 kV single circuit from Nishat Power Plant to Rahim Yar Khan causes the entire output of Nishat Power Plant to flow on the intact 500 kV circuit between Nishat Power Plant to Rahim Yar Khan. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 2.6 Rotor Angles

The rotor angles of the generators of Nishat Power Plant 500 kV, Guddu-New 500 kV, Guddu 220 kV and H.B. Shah 500 kV are plotted relative to machines at Jamshoro 500 kV. The results show that the rotor angle of Nishat Power Plant gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.2.3 Fault at 500 kV R.Y.Khan (Far-End Fault)

We applied three-phase fault on far 500 kV bus bar of R.Y.Khan to study the impact of a disturbance in the grid on the performance of the plant. The fault is cleared in 5 cycles (100 ms) as standard clearing time for 500 kV systems, followed by trip of 500 kV single circuit between R.Y.Khan to Multan. We monitored different quantities for one second pre-fault and nine cycles after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 3.1 Bus Voltages

The bus voltages of 500 kV bus bars of Nishat Power Plant, R.Y.Khan, Guddu-New, Multan, Moro and Jamshoro are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 3.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 3.3 MW/MVAR Output of Generator of Nishat Power Plant

The pre-fault output of Nishat Power Plant is 625 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 3.4 Speed and Mechanical Power of Generators at Nishat Power Plant

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 3.5 MW Flow on Rahim Yar Khan to Guddu-New 500 kV circuit

Followed by clearing of fault, the trip of a 500 kV single circuit from Rahim Yar Khan to Multan causes a significant increase in the flow on the intact 500 kV circuit between Rahim Yar Khan and Guddu-New. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 3.6 Rotor Angles

The rotor angles of the generators of Nishat Power Plant 500 kV, Guddu-New 500 kV, Guddu 220 kV and H.B. Shah 500 kV are plotted relative to machines at Jamshoro 500 kV. The results show that the rotor angle of Nishat Power Plant gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.3 Dynamic Stability Simulations' Results Year 2020-21

7.3.1 January 2021

7.3.1.1 Fault at 500 kV Near Nishat Power Plant

We applied three-phase fault on Nishat Power Plant 500 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of a 500 kV single circuit between Nishat Power Plant and Rahim Yar khan 500 kV substation. We monitored different quantities for one second pre-fault and nine cycles after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 1.1 Bus Voltages

The bus voltages of 500 kV bus bars of Nishat Power Plant, R.Y.Khan, Guddu-New, Multan, Moro and Jamshoro are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 1.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 1.3 MW/MVAR Output of Generator of Nishat Power Plant

The pre-fault output of Nishat Power Plant is 625 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 1.4 Speed and Mechanical Power of Generators at Nishat Power Plant

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 1.5 MW Flow on Nishat Power Plant to Rahim Yar Khan 500 kV circuit

Followed by clearing of fault, the trip of a 500 kV single circuit from Nishat Power Plant to Rahim Yar Khan causes the entire output of Nishat Power Plant to flow on the intact 500 kV circuit between Nishat Power Plant to Rahim Yar Khan. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 1.6 Rotor Angles

The rotor angles of the generators of Nishat Power Plant 500 kV, Guddu-New 500 kV, Guddu 220 kV and H.B. Shah 500 kV are plotted relative to machines at Jamshoro 500 kV. The results show that the rotor angle of Nishat Power Plant gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.3.1.2 Fault at 500 kV Near Nishat Power Plant(Stuck Breaker)

We applied three-phase fault on Nishat Power Plant 500 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of a 500 kV single circuit between Nishat Power Plant and Rahim Yar khan 500 kV substation. We monitored different quantities for one second pre-fault and nine cycles after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 2.1 Bus Voltages

The bus voltages of 500 kV bus bars of Nishat Power Plant, R.Y.Khan, Guddu-New, Multan, Moro and Jamshoro are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 2.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 2.3 MW/MVAR Output of Generator of Nishat Power Plant

The pre-fault output of Nishat Power Plant is 625 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 2.4 Speed and Mechanical Power of Generators at Nishat Power Plant

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 2.5 MW Flow on Nishat Power Plant to Rahim Yar Khan 500 kV circuit

Followed by clearing of fault, the trip of a 500 kV single circuit from Nishat Power Plant to Rahim Yar Khan causes the entire output of Nishat Power Plant to flow on the intact 500 kV circuit between Nishat Power Plant to Rahim Yar Khan. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 2.6 Rotor Angles

The rotor angles of the generators of Nishat Power Plant 500 kV, Guddu-New 500 kV, Guddu 220 kV and H.B. Shah 500 kV are plotted relative to machines at Jamshoro 500 kV. The results show that the rotor angle of Nishat Power Plant gets back after

the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.3.1.3 Fault at 500 kV R.Y.Khan (Far-End Fault)

We applied three-phase fault on far 500 kV bus bar of R.Y.Khan to study the impact of a disturbance in the grid on the performance of the plant. The fault is cleared in 5 cycles (100 ms) as standard clearing time for 500 kV systems, followed by trip of 500 kV single circuit between R.Y.Khan to Multan. We monitored different quantities for one second pre-fault and nine cycles after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 3.1 Bus Voltages

The bus voltages of 500 kV bus bars of Nishat Power Plant, R.Y.Khan, Guddu-New, Multan, Moro and Jamshoro are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 3.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 3.3 MW/MVAR Output of Generator of Nishat Power Plant

The pre-fault output of Nishat Power Plant is 625 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 3.4 Speed and Mechanical Power of Generators at Nishat Power Plant

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 3.5 MW Flow on Rahim Yar Khan to Guddu-New 500 kV circuit

Followed by clearing of fault, the trip of a 500 kV single circuit from Rahim Yar Khan to Multan causes a significant increase in the flow on the intact 500 kV circuit between Rahim Yar Khan and Guddu-New. We plotted the flows of MW and MVAR

on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 3.6 Rotor Angles

The rotor angles of the generators of Nishat Power Plant 500 kV, Guddu-New 500 kV, Guddu 220 kV and H.B. Shah 500 kV are plotted relative to machines at Jamshoro 500 kV. The results show that the rotor angle of Nishat Power Plant gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.3.2 September 2021

7.3.2.1 Fault at 500 kV Near Nishat Power Plant

We applied three-phase fault on Nishat Power Plant 500 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of a 500 kV single circuit between Nishat Power Plant and Rahim Yar khan 500 kV substation. We monitored different quantities for one second pre-fault and nine cycles after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 4.1 Bus Voltages

The bus voltages of 500 kV bus bars of Nishat Power Plant, R.Y.Khan, Guddu-New, Multan, Moro and Jamshoro are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 4.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 4.3 MW/MVAR Output of Generator of Nishat Power Plant

The pre-fault output of Nishat Power Plant is 625 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 4.4 Speed and Mechanical Power of Generators at Nishat Power Plant

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 4.5 MW Flow on Nishat Power Plant to Rahim Yar Khan 500 kV circuit

Followed by clearing of fault, the trip of a 500 kV single circuit from Nishat Power Plant to Rahim Yar Khan causes the entire output of Nishat Power Plant to flow on the intact 500 kV circuit between Nishat Power Plant to Rahim Yar Khan. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 4.6 Rotor Angles

The rotor angles of the generators of Nishat Power Plant 500 kV, Guddu-New 500 kV, Guddu 220 kV and H.B. Shah 500 kV are plotted relative to machines at Jamshoro 500 kV. The results show that the rotor angle of Nishat Power Plant gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.3.2.2 Fault at 500 kV Near Nishat Power Plant(Stuck Breaker)

We applied three-phase fault on Nishat Power Plant 500 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of a 500 kV single circuit between Nishat Power Plant and Rahim Yar khan 500 kV substation. We monitored different quantities for one second pre-fault and nine cycles after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 5.1 Bus Voltages

The bus voltages of 500 kV bus bars of Nishat Power Plant, R.Y.Khan, Guddu-New, Multan, Moro and Jamshoro are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 5.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 5.3 MW/MVAR Output of Generator of Nishat Power Plant

The pre-fault output of Nishat Power Plant is 625 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 5.4 Speed and Mechanical Power of Generators at Nishat Power Plant

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 5.5 MW Flow on Nishat Power Plant to Rahim Yar Khan 500 kV circuit

Followed by clearing of fault, the trip of a 500 kV single circuit from Nishat Power Plant to Rahim Yar Khan causes the entire output of Nishat Power Plant to flow on the intact 500 kV circuit between Nishat Power Plant to Rahim Yar Khan. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 5.6 Rotor Angles

The rotor angles of the generators of Nishat Power Plant 500 kV, Guddu-New 500 kV, Guddu 220 kV and H.B. Shah 500 kV are plotted relative to machines at Jamshoro 500 kV. The results show that the rotor angle of Nishat Power Plant gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.3.2.3 Fault at 500 kV R.Y.Khan (Far-End Fault)

We applied three-phase fault on far 500 kV bus bar of R.Y.Khan to study the impact of a disturbance in the grid on the performance of the plant. The fault is cleared in 5 cycles (100 ms) as standard clearing time for 500 kV systems, followed by trip of 500 kV single circuit between R.Y.Khan to Multan. We monitored different quantities for one second pre-fault and nine cycles after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 6.1 Bus Voltages

The bus voltages of 500 kV bus barsof Nishat Power Plant, R.Y.Khan, Guddu-New, Multan, Moro and Jamshoro are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 6.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 6.3 MW/MVAR Output of Generator of Nishat Power Plant

The pre-fault output of Nishat Power Plant is 625 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 6.4 Speed and Mechanical Power of Generators at Nishat Power Plant

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 6.5 MW Flow on Rahim Yar Khan to Guddu-New 500 kV circuit

Followed by clearing of fault, the trip of a 500 kV single circuit from Rahim Yar Khan to Multan causes a significant increase in the flow on the intact 500 kV circuit between Rahim Yar Khan and Guddu-New. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 6.6 Rotor Angles

The rotor angles of the generators of Nishat Power Plant 500 kV, Guddu-New 500 kV, Guddu 220 kV and H.B. Shah 500 kV are plotted relative to machines at Jamshoro 500 kV. The results show that the rotor angle of Nishat Power Plant gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.4 Conclusion of Dynamic Stability Analysis

The results of dynamic stability show that the system is very strong and stable for the proposed scheme for the severest possible faults of 500 kV systems near to and far of Nishat Power Plant. Therefore there is no problem of dynamic stability for interconnection of Nishat Power Plant; it fulfills all the criteria of dynamic stability.

8. Conclusions

- The proposed plant is going to be connected to the nearest grid facility of NTDC which is R.Y.Khan 500/220/132 kV Grid Station as shown in Sketch-1 in Appendix-B.
- Taking the location of Nishat Power Plant in consideration, two alternatives have been proposed for the interconnection of the said plant with the 500 kV network of NTDC.
    - In the first alternative, a direct double circuit from Nishat Power Plant to R.Y.Khan 500 kV Grid has been proposed. The length of this double circuit would be 42 km which has been confirmed thorough a site visit by PPI team of engineers. The conductor used would be 500 kV Drake.
    - In the second alternative, the 500 kV 292 km circuit running from R.Y.Khan to Multan would be looped in out at Nishat Power Plant using 500 kV Drake conductor. The distance from the power plant to the looping point (immediately after the line take-off from the Grid Station) would be 42 km.
- Although, alternative-I would require two line bays at R.Y.Khan 500/220/132 kV Grid Station whereas alternative-II would not require additional line bay at R.Y.Khan G/S, yet the length of 500 kV transmission line between Nishat PP to Multan, as a result of looping, would become 292 + 42 = 334 kM which is considerably long and might compromise the loadability of line. Hence, alternative-II may not be a more likeable alternative.
- In view of planned COD of the Nishat Power Plant in the fourth quarter of 2018, the base case of studies have been assumed as of January 2019 because maximum power flow occurs on Southern grid of NTDC due to concentration of thermal power plants in the South. Therefore both the above proposed interconnection alternatives have been tested for steady state conditions through detailed load flow studies for the peak low water conditions of January 2019. The system conditions of normal and N-1 contingency have been studied to meet the reliability criteria of NEPRA Grid Code.

- In addition, peak high water condition of September 2019 has also been studied for alternative-I only, as alternative-II is not a likeable alternative.
- The proposed interconnection scheme has also been tested in the extended-term scenario of the year 2021 by carrying out detailed studies for Low Water (January) and High Water (September) seasons.
- Steady state analysis by load flow for peak load of January 2019, September 2019, January 2021 and September 2021 reveals that the proposed scheme is adequate to evacuate the maximum net power of 625 MW of the Plant under normal as well as contingency conditions.
- The short circuit analysis has been carried out for alternative-I to calculate maximum fault levels at Nishat Power Plant and the substations of 500 kV and 220 kV in its vicinity for 2019 and 2021. We find that the fault currents for the proposed scheme are within the rated short circuit capacities of switchgear installed at these substations. There are no violations of exceeding the rating of the equipment due to contribution of fault current from Nishat Power Plant.
- The maximum short circuit level of Nishat Power Plant 500 kV is 13.13 kA and 11.73 kA for 3-phase and 1-phase faults respectively for January 2019. The short circuit level of the Nishat Power Plant 500 kV is 13.64 kA and 12.28 kA for 3-phase and 1-phase faults respectively for January 2021. Similarly these values for September 2021 are 14.52 kA and 12.05 kA. Therefore industry standard switchgear of the short circuit rating of 40 kA would be fine to be installed at 500 kV switchyard of Nishat Power Plant taking care of any future generation additions and system reinforcements in its electrical vicinity and also fulfill the NEPRA Grid Code requirements specified for 500 kV switchgear.
- The dynamic stability analysis of proposed alternative-I of interconnection has been carried out for January 2019, January 2021 and September 2021. The stability check for the worst case of three phase fault right on the 500 kV bus bar of Nishat Power Plant followed by the final trip of one 500 kV circuit emanating from this substation, has been performed for fault clearing of 5 (100 ms) as understood to be the normal fault clearing time of 500 kV protection system, and for fault clearing of 9 cycles (180 ms) in case of stuck breaker as specified in the

Grid Code. The system is found strong enough to stay stable and recovered with fast damping. The stability of system for far end faults of 3-phase occurring at R.Y.Khan 500 kV bus bar have also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults for the most stringent cases.

- The proposed alternative-I of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.