

Ref. No.: AGJV/NEPRA/01/2021

Dated: 05 - April, 2021

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

**Subject: APPLICATION OF AGJV (PRIVATE) LIMITED FOR GRANT OF GENERATION LICENSE
IN RESPECT OF 10 MW COAL POWER PLANT LOCATE AT THAR**

I, Syed Faysal Hussain Naqvi, CEO being the duly authorize representative of M/S AGJV (Private) Limited by virtue of Board Resolution dated 25th March, 2020, hereby apply to the National Electric Power Regulatory Authority for the grant of a Generation License to the AGJV (Private) 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, and undertake to abide by the terms and provisions of the above-said regulations 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 Bank Al-Habib No.08048239 dated 26th March, 2021 amounting PKR 186,944/- (Rupee One Lac Eighty six thousand nine hundred & forty four only), being the non-refundable license application fee calculated in accordance with Schedule II to the National Electric Power Regulation Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

Yours sincerely,
AGJV (Pvt) Limited



S. Faysal Hussain Naqvi
CEO





**EXTRACTS OF RESOLUTION PASSED IN THE MEETING OF THE BOARD OF DIRECTORS OF
M/S AGJV (Pvt.) LTD. HELD AT THEIR OFFICE, LS-30 BLOCK # 13, F.B. AREA, KARACHI
ON [25th March, 2021**

"Resolved that Mr. Syed Faysal Hussain Naqvi, having CNIC No. 42101-5637920-1, CEO of the Company singly be and hereby authorized to do any or all of the following acts, deeds and things, on behalf of the company, in connection with Generation License Application to be filed with National Electric Power Regulatory Authority ("NEPRA") under the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 and The National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulation, 1999:

- a. Represent the Company before NEPRA, and in doing so perform all lawful acts, deeds and things which shall be entitled or permitted to do ourselves, including but not limited to filing, signing, presenting, modifying, amending, withdrawing applications and other documents, responding to any queries and meeting any objections, receiving notices and documents; and
- b. Finalize all agreements in his respect and other documents as may be required and do all acts, deeds and things, which are ancillary and incidental to the aforesaid purpose and issuance of Generation License."

Further resolved that a certified true copy of resolution be furnished to the department for its records.



CERTIFIED TO BE TRUE COPY

AGJV (PVT) LIMITED

[Nasir Raza]

Company Secretary

LS-30 Block 13,
Federal "B" Area,
Karachi, Pakistan.
T +9221-38801488-91,
38801574
F +9221-38378888
info@agjv.com



A Joint Venture of Amcorp & Gasco



GASCO
GASCO Engineering (Pvt) Limited
INNOVATIVE ENERGY SOLUTIONS

Ref. No.: AGJV/NEPRA/01/2021

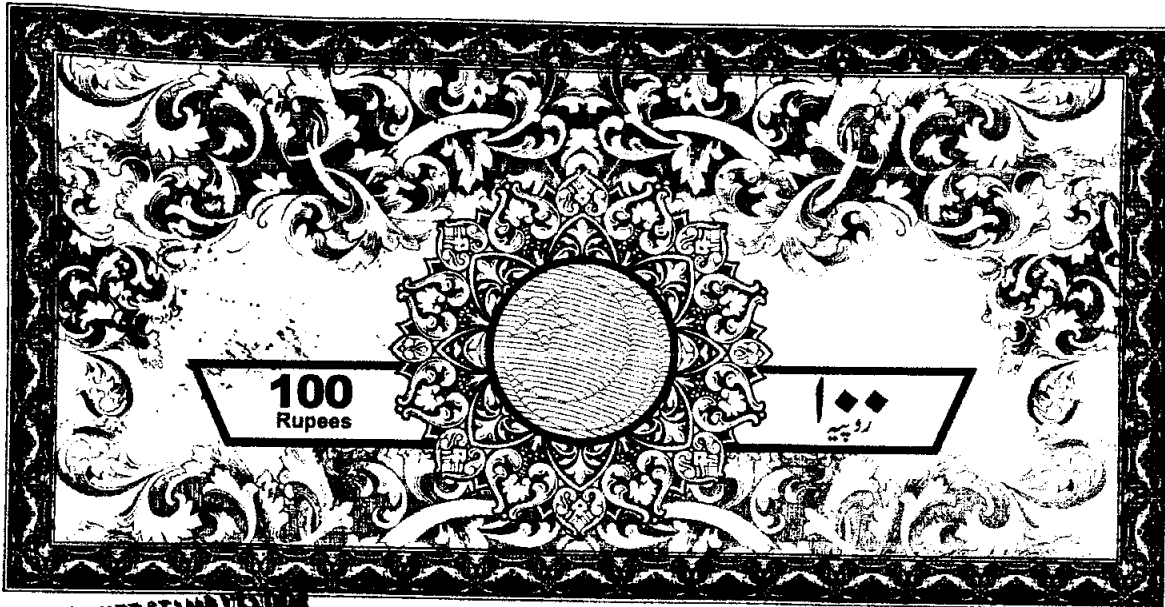
Dated: 26th March, 2021

AUTHORITY LETTER

It is to authorize M/S Spire Consilium (Pvt.) Ltd. formerly Nasir Absar Consulting (Pvt.) Ltd. through its Chief Executive, Syed Ibrahim Ahmad, to represent the company, for the purposes of preparation and submission of Generation License Application for its 10 MW Coal Power Plant before NEPRA. The representative is authorized to correspond with all stakeholders, attend any/all meeting(s) and discussion related to any matter of the project in this regard.




S. Faysal Hussain Naqvi
CEO



M. SULAIMAN BUTT STAMP VENDOR
Lic. No. 21, 22-A, UK Stamp & Stationery, P.O. Box 1000, KARACHI

S. NO.
DATE

043561
04 MAR 2022
ISSUED TO WITH ADDRESS
THROUGH WITH ADDRESS
PURPOSE

Value Rs.
Stamp Vendor Signature

RUPEES ONE HUNDRED ONLY

**BEFORE NATIONAL ELECTRIC POWER REGULATORY AUTHORITY
AFFIDAVIT OF MR. SYED FAYSAL HUSSAIN NAQVI CNIC NO. 42101-5637920-1,
CHIEF EXECUTIVE OF M/S AG JV (PRIVATE) LIMITED**

I, the above-named deponent, in relation to the approval for Generation License for development of 10 MW coal power plant before NEPRA do hereby solemnly declare and affirm on oath as under:

- I am Chief Executive Officer of the AG JV (Pvt.) Ltd. ("Company") and authorized representative of the Company duly authorized by its Board of Directors.
- That I have filed application grant of generation license together with supporting documents before the NEPRA and the contents of the same may kindly be read as an integral part of this affidavit.
- That the contents of the accompanying application for grant of generation license and further documentation and/or information to be provided by me in connection the accompanying generation license application shall, are true to the best of my knowledge and belief of and according to the information received by the deponent.

Deponent Verification

Verified on oath this [date] at [place] that the contents of this affidavit are true and correct to the best of my knowledge and belief and that nothing has been concealed therein.



Deponent Signature



S. FAYSAL HUSSAIN NAQVI

CEO

42101-5637920-1

PROSPECTUS

1. The Applicant

Company Name: M/S AGJV (Private) Limited
Incorporation: Incorporated with SECP under Companies Act, 2017
Contact Details: Syed Faysal Hussain Naqvi
LS-30, Block-13, Federal B Area, Karachi, Pakistan
faysal.naqvi@gascoengineering.com.pk & info@agjv.com
Project: 10 MW Coal Power Plant located at Block-II, Tharparker, Sindh, Pakistan

2. Brief Introduction

Sindh Engro Coal Mining Company Limited ("SECMC") is a joint venture of Engro Energy Limited & Affiliates and Government of Sindh. SECMC is working on the development of an Open Cast Lignite Mine and in Thar Block-II to support future energy needs of Pakistan.

SECMC has been granted a 30 years Mining Lease for Thar Block-II by Mines & Minerals Development Department, Government of Sindh. SECMC needs electricity to meet its own requirement for operations. SECMC issued Request for Proposal document, on November 2019, with the objective to invite proposals for Power Developer to install, commission and manage O&M of Coal Power Plant based on Thar Coal on BOO (Build, Own, Operate) basis. Following the examination of the bids submitted in response to the RFP, SECMC was pleased to accept our bid, submitted in **Joint Venture of M/S AMCORP-GASCO**. The Joint Venture has been issued Letter of Intent on January 28, 2021 to undertake Installation, Commissioning, Operation & Maintenance of a 10MW Coal Power Plant. Later the Special Purpose Company with the name of **AGJV (Private) Limited ("Company")** has been incorporated in between the shareholder of AMCORP and GASCO. M/S AGJV, being the Sponsors, will develop and maintain the Project and will supply electricity to SECMC under a Power Purchase Agreement between the parties.

Amcorp Engineering & Construction (Pvt) Ltd., established in 1965 as Al-Mumtaz Corporation, is providing construction and engineering services in the areas of institutional and office buildings, road works & bridges, Plant Construction and Erection of Plant Equipment's, Factories, Industrial Buildings and Warehouses.

M/S Gasco Engineering (Pvt.) Ltd. was established as independent-equipment supplier in Karachi, Pakistan in 1990. Services rendered by GASCO are very broad base and multi-faceted. The services includes Pipeline Construction, Outsource Warehouse, Detail & Design Engineering, Supplies, Construction, Fabrication, Procurement, Venture Capitals/Development and Rental Equipment.

3. Salient Features of Project

The Generation Facility of 10 MW is based on Thar Coal having one generating unit.

Installed Capacity: 10 MW
Auxiliary Consumption: 1.2 MW
Net Capacity: 8.8 MW
Boiler: 1 (100% Operational)
Availability: 95%

4. Proposed Investment

The total Project Cost is USD 14 Million with the debt-to-equity ratio of 70:30. The debt is to be financed through local banks while equity is to be injected by the Sponsors M/S AGJV (Pvt.) Ltd. The Letter of Support for financing of the Project is provided with the Application.

5. Social and Environmental Impact of the Project

The Environmental Study of the Project has been conducted by the renowned Consultant that has been submitted to Environmental Protection Agency and expected to be approved shortly.

The consultants reported that project has no major adverse impacts, and all impacts could easily be mitigated.

2. Technology, Size of Plant, Number of Units

The configuration will be 1 x 10 MW steam turbine and 1 Boilers (100 % operational). A minimum system availability of 95% has to be ensured. The power installation capacity of 10000kW in according with this thermal and electrical load to build a co-generate power plant in order to save energy, improve the environment, enhance the quality of power supply. Boiler will be of fluidized bed technique, Main steam maximum continuous rating 50 t/h, Superheater outlet steam temperature 450°C , Superheater outlet steam pressure 3.82MPa(g), Feedwater temperature 150°C, Flue gas temperature at A/H outlet 140°C, Boiler design efficiency 91.±1%, Minimum stable combustion load 60% MCR(without oil supporting). The steam turbine will be a standard multistage, single-cylinder, non-reheat, condensing unit. The turbine will exhaust against condenser pressure of 6kPa (0.06ata) at the design condenser cooling water temperature.

The project life would be 25 years.

3. Capacity

Installed capacity (10 MW), de-rated capacity / auxiliary consumption (1.2 MW), Net capacity (8.8 MW)

4. Fuel

Power Plant is design for lignite coal type and source is available within radius of 1 km. SECMC is responsible for provision of coal at its stockyard.

5. Emission Values

The emission values will be maintained as per SEQS / NEQS.

6. Cooling Water Source

Underground water will be provided by SECMC at source. RO plant will be installed.

7. Interconnection

Interconnection arrangement is already available on-site. The integration will be as follows:

- Integration of 11kV output of the coal plant with the centralized 11kV distribution switchgear.
- Integration of turbine power control system with existing diesel engine-controllers and solar power plant controllers (existing controllers are Deif AGC-200 and ASC-200 for generators and solar plants respectively).

8. Infrastructure

Some Infrastructure facilities are already available on site e.g. road. However, staff colony and other amenities would be constructed on site by the Contractor.

9. Project Cost

The total Project Cost is USD 14 Million. The cost is to be finance through debt and equity with the ratio of 70:30. The debt is to be financed through local banks while equity is to be injected by the Sponsors M/S AGJV (Pvt.) Ltd.

10. Project Commencement

The overall project completion period is 24 months:

- Design & engineering: 4-6 months
- Manufacturing of Equipment: 10-12 months
- Site Construction: 10-12 months

11. ESSA

Detailed environmental study has been conducted and submitted to EPA for approval. Copy of submission letter is provided.

12. Safety Plans

- Firefighting, fire water tank, pumps sprinklers/ hydrants/suppression, as required in complete compliance with NFPA requirements.
- Fire detection and alarm system and evacuation system
- Emergency lighting
- Security surveillance through the power plant
- Access control system for physical and software access
- Central security control room

13. System Studies

Single line Diagram is attached.

14. Plant Characteristics: generation voltage, frequency, power factor

The turbine will be connected to electric generator operating at 3000 rpm. Electric power is generated at 11kV, 3 phases, 50 Hz. Light diesel oil is used for boiler start-up and flame stabilization. The light diesel oil is stored in a 20m³ tank. There are two light diesel oil feed pumps with 100 percent capacity, one working one standby. Ramping rates are not available at this point of time.

15. Control, metering, instrumentation and protection

The metering, instrumentation, control and protection will be installed that comply with the prudent electrical practices for captive generation facilities.

A single line diagram is provided.

16. Training and development

Training and Development is part of the project and details are provided in the environmental report.

17. Project Consumers

Sindh Engro Coal Mining Company Limited, will be the main consumer of the electricity.

TECHNICAL INFORMATION AS PER REGULATIONS

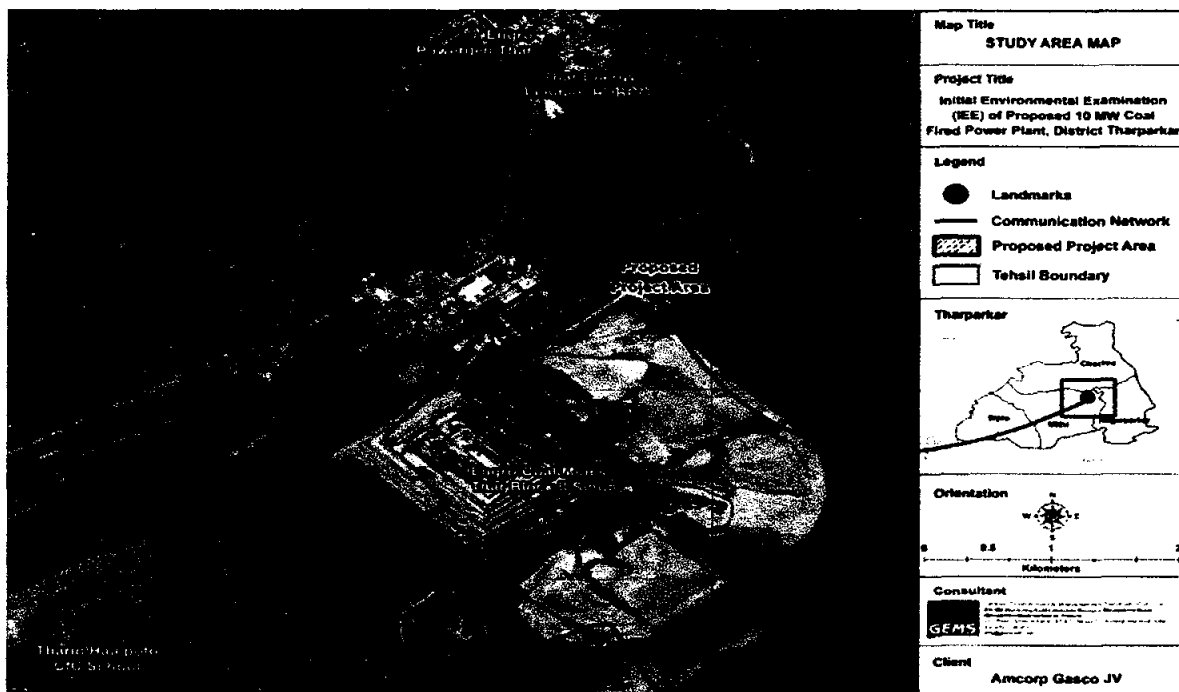
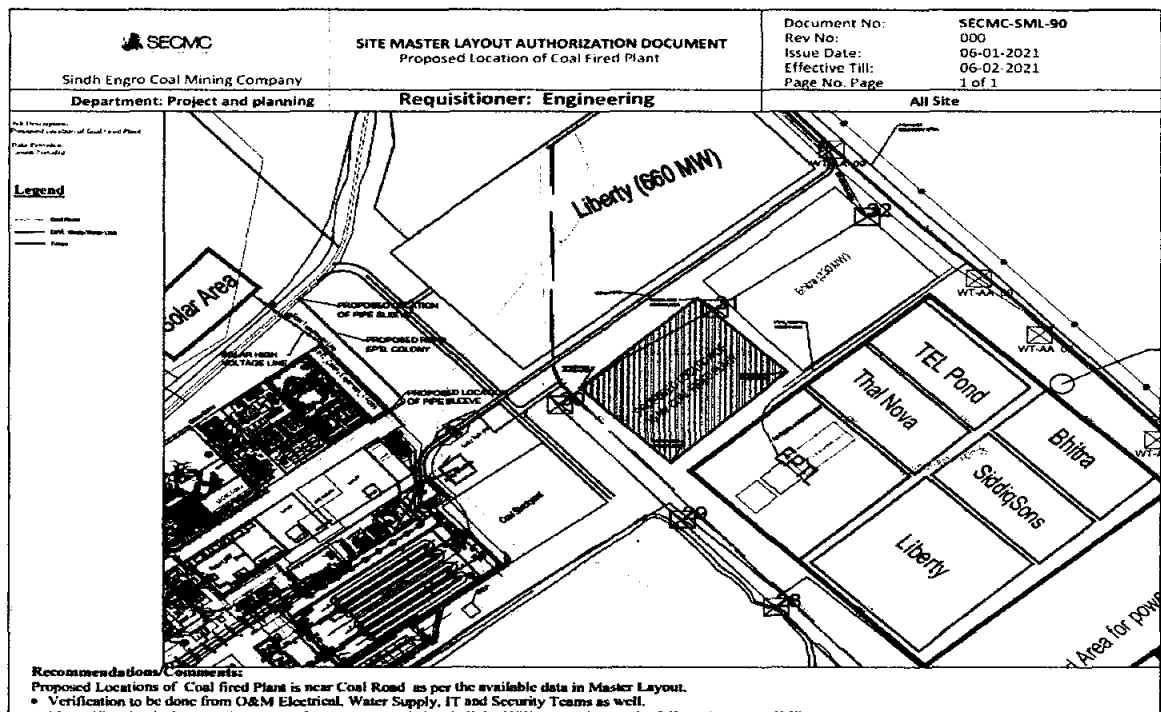
1. Location

The project is located at Block-II, Thar, Sindh, Pakistan

Thar block-II covers an area of 95.5 km² and is located in District Tharparker approx. 380 kms from Karachi, 65 kms from Mithi and 20 kms from Islamkot. The project area is around 20,000 m² (100m x 200m)

The area can be approached by road, using either the southern road via Badin / Naukot or the northern via Hyderabad / Mirpur Khas / Naukot.

Coordinates of Project boundary are: 24°47'50.03"N 70°23'22.95"E



Efficiency Figures

Proposed SECMC 10 MW Coal Fired Power Plant

Boiler Efficiency		88%
Turbine Heat Rate		11753 kJ/ kWh
Turbine Efficiency		30.63 %
Gross Efficiency		26.45%
Net Efficiency		23.2%

Remarks: LHV of coal as provided by Owners: 8.70~14.69 MJ/kg

Reference value for calculation of fuel consumption is taken as 10 MJ/kg as a conservative consideration

Net Efficiency will improve on better quality fuel (LHV > 10 MJ/kg) is used

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

Company Registration Office

CERTIFICATE OF INCORPORATION

[Under section 16 of the Companies Act, 2017 (XIX of 2017)]

Corporate Unique Identification No. 0167161

I hereby certify that **AGJV (PRIVATE) LIMITED** is this day incorporated under the Companies Act, 2017 (XIX of 2017) and that the company is **limited by shares.**

Given at **Karachi** this **Twenty Sixth** day of **January**, Two **Thousand**
and **Twenty One**

Muhammad Nasir Khan
Additional Joint Registrar



[https://eservices.secp.gov.pk/eServices/ControllerServlet?request_id=V
ERIFY_ONLINE_INCORP_CERT&id=0167161](https://eservices.secp.gov.pk/eServices/ControllerServlet?request_id=VERIFY_ONLINE_INCORP_CERT&id=0167161)

Certified to be True Copy
Additional Joint Registrar of Companies

FREE OF COST COPY

THE COMPANIES ACT, 2017
(PRIVATE COMPANY LIMITED BY SHARES)
ARTICLES OF ASSOCIATION
OF
AGJV (PRIVATE) LIMITED

1. The regulations contained in Table 'A' to the First Schedule to the Companies Act, 2017 (the "Act") shall be the regulation of **AGJV (PRIVATE) LIMITED** (the "Company") so far as these are applicable to a private company.

PRIVATE COMPANY

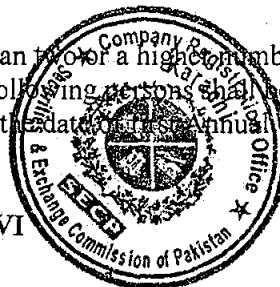
2. The company is a "Private Company" within the meaning of Section 2(1)(49) of the Act and accordingly:
- (1) No invitation shall be made to the public to subscribe for the shares or debentures of the company.
 - (2) The number of the members of the company (exclusive of persons in the employment of the company), shall be limited to fifty, provided that for the purpose of this provision, where two or more persons hold one or more shares in the company jointly, they shall be treated as single member; and
 - (3) The right to transfer shares of the company is restricted in the manner and to the extent herein appearing.

TRANSFER OF SHARES

3. A member desirous to transfer any of his shares shall first offer such shares for sale or gift to the existing members and in case of their refusal to accept the offer, such shares may be transferred to any other person, as proposed by the transferor members, with the approval of the Board of Directors.

DIRECTORS

4. The number of directors shall not be less than two or a higher number as fixed under the provisions of Section 154 of the Act. The following persons shall be the first directors of the company and shall hold the office upto the date of the first Annual General Meeting:
- a). **ARIF RAZA KAZMI**
 - b). **SYED FAYSAL HUSSAIN NAQVI**
 - c). **ALI RAZA KAZMI**
 - d). **SYED RAZA HUSSAIN NAQVI**



We, the several persons whose names and addresses are subscribed below, are desirous of being formed into a company, in pursuance of this articles of association and respectively agree to take the number of shares in the capital of the company set opposite our respective names.

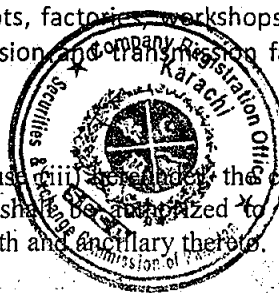
S. No.	Name & Surname (present & former) in full (in block letters) including N.I.C. /Passport Nos.	Father's/ Husband's Name in full	Nationality with any former Nationality	Occupation	Residential address in full	Number of shares taken by each subscriber	Signature
01	ARIF RAZA KAZMI 42101-1566874-7	SYED MUHAMMAD RAZA KAZMI	PAKISTANI	BUSINESS EXECUTIVE	HOUSE NO. 214, STREET NO. 18, KHAYABAN-E-IQBAL, PHASE 8, DHA, KARACHI	12,500 (TWELVE THOUSAND FIVE HUNDRED ONLY)	
02	SYED FAYSAL HUSSAIN NAQVI 42101-5637920-1	SYED HUSSAIN HADI NAQVI	PAKISTANI	BUSINESS EXECUTIVE	HOUSE NO. 212, STREET NO. 21, KHAYABAN-E-IQBAL, PHASE 8, DHA, KARACHI	12,500 (TWELVE THOUSAND FIVE HUNDRED ONLY)	
03	ALI RAZA KAZMI 42101-1566873-9	SYED MUHAMMAD RAZA KAZMI	PAKISTANI	BUSINESS EXECUTIVE	HOUSE NO. 214, STREET NO. 18, KHAYABAN-E-IQBAL, PHASE 8, DHA, KARACHI	12,500 (TWELVE THOUSAND FIVE HUNDRED ONLY)	
04	SYED RAZA HUSSAIN NAQVI 42101-5637825-1	SYED HUSSAIN HADI NAQVI	PAKISTANI	BUSINESS EXECUTIVE	HOUSE NO. 212, STREET NO. 21, KHAYABAN-E-IQBAL, PHASE 8, DHA, KARACHI	12,500 (TWELVE THOUSAND FIVE HUNDRED ONLY)	
					TOTAL	50,000 (FIFTY THOUSAND ONLY)	

Dated: 23rd day of January, 2021

Certified to be True Copy
Additional Joint Registrar of Companies

FREE OF COST COPY

THE COMPANIES ACT, 2017
(PRIVATE COMPANY LIMITED BY SHARES)
MEMORANDUM OF ASSOCIATION
OF
AGJV (PRIVATE) LIMITED.

1. The name of the company is **AGJV (PRIVATE) LIMITED.**
2. The registered office of the company will be situated in the Province of Sindh.
3. (i) The principal line of business of the company shall be to carry on all or any of the businesses of generating, purchasing, importing, transforming, converting, distributing, supplying, exporting and dealing in all forms of energy be it electricity, gas, solar and products or services associated therewith and of promoting the conservation and efficient use of energy and to perform all other acts which are necessary or incidental to the business of electricity generation, transmission, distribution and supply, subject to permission of concerned authorities; and to locate, establish, construct, equip, operate, use, manage and maintain thermal power plants, coal fired power plants, hydel power plants, wind mills, power grid station, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, compression system, gas process plants, well head facilities, refining facilities, cable bridges, link boxes, heat pumps, plant and equipment for combined heat and power schemes, offices, computer centres, shops and necessary devices, showrooms, depots, factories, workshops, plants and to provide transforming, switching, conversion and transmission facilities, subject to permission of relevant authorities.

(ii) Except for the businesses mentioned in sub-clause (i) hereof, the company may engage in all the lawful businesses and shall be authorized to take all necessary steps and actions in connection therewith and ancillary thereto.

(iii) Notwithstanding anything contained in the foregoing sub-clauses of this clause nothing contained herein shall be construed as empowering the company to

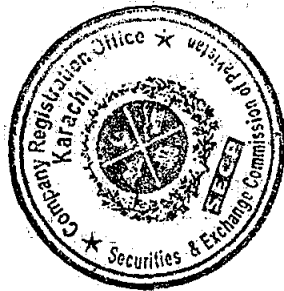
undertake or indulge, directly or indirectly in the business of a Banking Company, Non-banking Finance Company (Mutual Fund, Leasing, Investment Company, Investment Advisor, Real Estate Investment Trust Management Company, Housing Finance Company, Venture Capital Company, Discounting Services, Microfinance or Microcredit business), Insurance Business, Modaraba Management Company, Stock Brokerage Business, Forex, Real Estate Business, Managing Agency, Business of providing the services of Security Guards or any other business restricted under any law for the time being in force or as may be specified by the Commission.

(iv) It is hereby undertaken that the company shall not:

- (a) engage in any of the business mentioned in sub-clause (iii) above or any unlawful operation;
- (b) launch multi-level marketing (MLM), Pyramid and Ponzi Schemes, or other related activities/businesses or any lottery business;
- (c) engage in any of the permissible business unless the requisite approval, permission, consent or license is obtained from competent authority as may be required under any law for the time being in force.

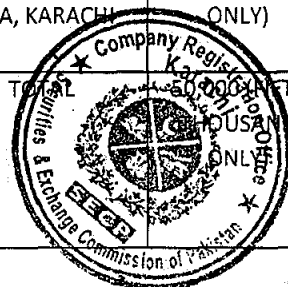
4. The liability of the members is limited.

5. The authorized capital of the company is Rs. 100,000,000/- (Rupees hundred million only) divided into 1,000,000 (one million) ordinary shares of Rs. 100/- (Rupees hundred only) each.



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

S. No.	Name & Surname (present & former) in full (in block letters) including N.I.C. /Passport Nos.	Father's/ Husband's Name in full	Nationality with any former Nationality	Occupation	Residential address in full	Number of shares taken by each subscriber	Signature
01	ARIF RAZA KAZMI 42101-1566874-7	SYED MUHAMMAD RAZA KAZMI	PAKISTANI	BUSINESS EXECUTIVE	HOUSE NO. 214, STREET NO. 18, KHAYABAN-E-IQBAL, PHASE 8, DHA, KARACHI	12,500 (TWELVE THOUSAND FIVE HUNDRED ONLY)	
02	SYED FAYSAL HUSSAIN NAQVI 42101-5637920-1	SYED HUSSAIN HADI NAQVI	PAKISTANI	BUSINESS EXECUTIVE	HOUSE NO. 212, STREET NO. 21, KHAYABAN-E-IQBAL, PHASE 8, DHA, KARACHI	12,500 (TWELVE THOUSAND FIVE HUNDRED ONLY)	
03	ALI RAZA KAZMI 42101-1566873-9	SYED MUHAMMAD RAZA KAZMI	PAKISTANI	BUSINESS EXECUTIVE	HOUSE NO. 214, STREET NO. 18, KHAYABAN-E-IQBAL, PHASE 8, DHA, KARACHI	12,500 (TWELVE THOUSAND FIVE HUNDRED ONLY)	
04	SYED RAZA HUSSAIN NAQVI 42101-5637825-1	SYED HUSSAIN HADI NAQVI	PAKISTANI	BUSINESS EXECUTIVE	HOUSE NO. 212, STREET NO. 21, KHAYABAN-E-IQBAL, PHASE 8, DHA, KARACHI	12,500 (TWELVE THOUSAND FIVE HUNDRED ONLY)	
					TOTAL 50,000 SHARES	50,000 (FIFTY THOUSAND ONLY)	



Dated: 23rd day of January, 2021

Page 3 of 3

Certified to be True Copy
Additional Joint Registrar of Companies

FREE OF COST COPY



Online NTN/STRN Inquiry

Printed On: 1/27/2021 5:52:23 PM

Registration No 8646347
Reference No 8646347-2
STRN
Name AGJV (PRIVATE) LIMITED
Category Company - Company formed and registered under the Companies Ordinance, 1984 or any other law repealed thereunder.
PP/REG/INC No. 0167161
Email fay****naq***gascoengineering.com.pk
Cell 00923**826**15
Address LS 30, BLOCK 13,, FEDERAL B AREA, KARACHI, Pakistan
Registered On 26-JAN-2021
Tax Office CTO KARACHI
Registration Status Income Tax: Active

Sr.	Business/ Branch Name	Business/ Branch Address	Principal Activity
1	AGJV (PRIVATE) LIMITED	LS 30, BLOCK 13,, FEDERAL B AREA, KARACHI, Pakistan	351002-Electricity, gas, steam and air conditioning supply/Electric power generation, transmission and distribution/Electric power transmission and distribution

Inc. Form - II

COMPANIES (INCORPORATION) REGULATIONS, 2017
[See Section 16 of the Act and Regulation 5]

APPLICATION FOR COMPANY INCORPORATION

PART - I

1.1 Name of the Company	AG JV (PRIVATE) LIMITED	
1.2 Fee Payment Details	1.2.1 Challan No	E-2021-335193
	1.2.2. Challan Amount (Rs.)	500,0

PART - II

Section - A - Company Information

2.1 Correspondence Address*	LS 30, BLOCK 13,, FEDERAL B AREA, KARACHI, Karachi Gulberg Town, KARACHI CENTRAL, Sindh				
City	Gulberg Town	District	KARACHI CENTRAL	Province	Sindh
Telephone Number	03008264815	Email Address	faysal.naqvi@gascoengineering.com.pk		
Mobile Number	03008264815				

* Information regarding Correspondence address is to be provided only if company does not have a place at its registered office at the time of incorporation of the company

2.2 Registered office Address, if any					
City		District		Province	
Telephone Number		Website (if any)			
Mobile Number		Email Address			

2.3 Principal line of business. (Brief object as per clause 3(i) of the Memorandum may be mentioned)	--POWER GENERATION - ALLIED (OTHER)
---	-------------------------------------

Section - B - Capital Structure

	Class / Kind	Face Value	No of Shares	Total Amount
2.4 Authorised Capital	ORDINARY	100	1000000	100000000
2.5 Paid Up Capital	ORDINARY	100	50000	5000000

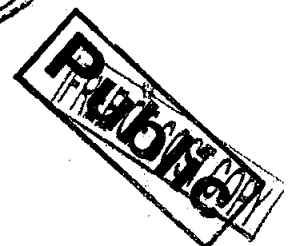
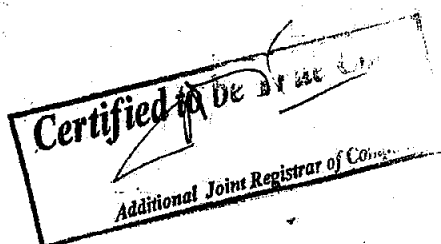
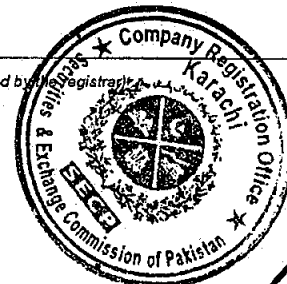
Section - C - Special Business Information*

(Applicable in case of Banking Company, Non-banking Finance Company, Insurance company, Modaraba management company, Stock Brokerage business, forex, real estate business, managing agency, business of providing the services of security guards and any other business restricted under any other law or as may be notified by the commission)

2.6 Nature of business in case of specialized business requiring licence / permission / approval (please specify and also attach NOC / approval of the relevant authority)

N.A.

*(Additional documents will be required by the Registrar)



Section - D - Company subscribers, directors, chief executive officer and in case of single member company, nominee**2.7 State Number of directors fixed by subscribers:**

(Please note that as per law a company must have minimum director as follows:)

Kind of company	Minimum number of directors required by law	No. of proposed directors
Single Member Company	01	
Private Limited Company	02	4
Public Limited Company	03	

2.8 Details of subscribers, directors and chief executive officer *

Name	Father/Husband Name	NIC/Passport No/NICOP	**Incorporation/Registration No	Nationality	***Occupation	Residential/Registered office address	NTN	Designation (Director/Subscriber/CEO) Please specify	No of shares subscribed (for subscriber)	****Signatures
SYED FAYSAL HUSSAIN NAQVI	S/O SYED HUSSAIN HADI NAQVI	4210156379201		Pakistan		HOUSE NO. 212, STREET NO. 21, KHAYABAN-E-IQBAL, PHASE 8 DHA		Chief Executive		
SYED FAYSAL HUSSAIN NAQVI	S/O SYED HUSSAIN HADI NAQVI	4210156379201		Pakistan		HOUSE NO. 212, STREET NO. 21, KHAYABAN-E-IQBAL, PHASE 8 DHA		Director And Subscriber	12500	Electronically signed by SYED FAYSAL NAQVI
ARIF RAZA KAZMI	S/O SYED MUHAMMAD RAZA KAZMI	4210115668747		Pakistan		HOUSE NO. 214, STREET NO. 18, KHAYABAN-E-IQBAL, PHASE 8 DHA	0285537	Director And Subscriber	12500	Electronically signed by ARIF RAZA KAZMI
ALI RAZA KAZMI	S/O SYED MUHAMMAD RAZA KAZMI	4210115668747		Pakistan		HOUSE NO. 214, STREET NO. 18, KHAYABAN-E-IQBAL, PHASE 8 DHA	0285537	Director And Subscriber	12500	Electronically signed by ALI RAZA KAZMI
SYED RAZA HUSSAIN NAQVI	S/O SYED HUSSAIN HADI NAQVI	4210156378251		Pakistan		HOUSE NO. 212, STREET NO. 21, KHAYABAN-E-IQBAL, PHASE 8 DHA	2307435	Director And Subscriber	12500	Electronically signed by SYED RAZA NAQVI

*Add details as applicable

** Applicable on subscribers other than natural persons

***Please also mention names of other companies where directorship is held.

**** Signature of subscribers and consent to act as director or chief executive as the case may be. In case of online submission, the document will be signed electronically

2.9 Details of Nominee (only in case of single member company- Nominee shall not be a person other than relatives of the member- namely, a spouse, father, mother, brother, sister and son or daughter)

Name of Nominee	
NIC of Nominee	
Residential address of Nominee	
Telephone number of Nominee	
Email address of Nominee	



Section - E - If the company intends to adopt tables contained in First Schedule to the Companies Act, 2017 (XIX of 2017) as its articles of association

- ☐ Table A- Part I (Articles of association of company limited by shares)
- ☐ Table A- Part II (Articles of association of single member company limited by shares)

Section - F - The company limited by shares in case it has not adopted articles contained in First Schedule to the Act company limited by guarantee and unlimited company shall attach the articles of association.

PART - III

Declaration under section 16

3.1 Declarant's Name

Mr SYED FAYSAL HUSSAIN NAQVI

3.2 Declarant Profession / Designation

- ☐ Authorized Intermediary
- ☒ a person named in the articles as Director of the proposed company

3.3 Declaration

I do hereby solemnly and sincerely declare that:

- a) I have been authorized as declarant by the subscribers;
- b) all the requirements of the Companies Act, 2017, and the regulations made there under in respect of matters precedent to the registration of the said Company and incidental thereto have been complied with
- c) I make this solemn declaration conscientiously believing the same to be true.

3.4 Declarant Signature

3.5 Registration No of authorized Intermediary, if applicable

3.6 Date(dd/mm/yyyy)

24/01/2021

ENCLOSURES

- (i) Original paid bank challan evidencing payment of fee;
- (ii) Memorandum of Association;
- (iii) Articles of Association, where applicable;
- (iv) Copies of valid CNIC/NICOP of the subscribers/directors/chief executive officer or copy of Passport in case of a foreigner;
- (v) Copy of valid CNIC/NICOP of Nominee only in case of single member company or copy of Passport in case of a foreigner;
- (vi) Copy of valid CNIC of witness in case of physical filing;
- (vii) NOC/Letter of Intent/ License (if any) of the relevant regulatory authority in case of specialized business;
- (viii) Authority letter for filing of documents for the proposed company on behalf of the subscribers as per requirement of clause (vi) of sub-regulation (2) of regulation 5.
- (ix) Copy of valid CNIC/Passport of person duly authorized by the Board of directors of a body corporate which is a subscriber. Further, along with copy of Board resolution along with attendance sheet duly authorizing the representative. In case of a subscriber which is a limited liability partnership, copy of valid NIC/ Passport of designated partner empowered to act as such, along with copy of instrument empowering him;
- (x) In case the subscriber is a foreign company or a foreign body corporate, the profile of the company, detail of its directors, their nationality and country of origin, certified copy of its charter, statute or memorandum and articles etc.
- (xi) In case of foreign subscriber/ officer, an undertaking on stamp paper of requisite value duly signed, notarized and witnessed to the effect that in case name of subscriber/officer is not security cleared by MoI, the subscriber/officer and the company, shall take immediate steps for replacement and shall transfer shares if any, held by the subscriber.



THE COMPANIES ACT, 2017
THE COMPANIES (GENERAL PROVISIONS AND FORMS) REGULATIONS, 2018
[Section 70 and Regulations 4 & 12]

RETURN OF ALLOTMENTS OF SHARES

PART - I

Shareholder's name in company's or in bold block capitals

1.1 GUIN (Registration)	0167161
1.2 Name of the Company	AGJV (PRIVATE) LIMITED
1.3 Fee Payment Details 1.3.1.	E-2021-401821
1.3.2. Challan Amount	0.00

PART - II

2. Share Capital

2.1 Authorized Capital	100,000,000.00
2.2 Paid up Capital	9,000,000.00

2.3 Kind of Shares

2.3 Kind of Shares	☒ Ordinary
	☐ Preference
2.4 Class of Shares	☐ Ordinary Class A
	☐ Ordinary Class B
	☐ Preferred: Participatory: Redeemable at company's option
	☐ Preferred: Non Participatory: Non Redeemable
	☐ Preferred: Non Participatory: Redeemable at company's option
	☐ Preferred: Non Participatory: Redeemable at Shareholder's option
	☐ Preferred: Participatory: Redeemable at Shareholder's option

Day Month Year

2.5 Date of Allotment *	15/03/2021
-------------------------	------------

* If shares are allotted on different dates, the date of first allotment shall be mentioned.

2.6 SECTION A - SHARES ALLOTTED AGAINST CASH CONSIDERATION

	No of Shares	Indicating class, if any
2.6.1	40000	Ordinary
	Per share (Rs.)	Total Amount (Rs.)
2.6.2 Nominal Amount	100.00	4,000,000.00
2.6.3 Premium		
2.6.4 Discount		0.00
2.6.5 Total (Amount paid on each share 2.6.2 to 2.6.4)	100.00	4,000,000.00
2.6.6 Consideration received against	Specify Currency	Total Amount of Foreign Currency



22520
Certified to be True Copy
Assistant Registrar of Companies

against
allotment in foreign current
(equivalent amount in PKR included in total amount mentioned at 2.6.5)



2.7 SECTION B: SHARES ALLOTTED FOR CONSIDERATION OTHERWISE THAN IN CASH

No of Shares	indicating class if any
2.7.1 No. of Shares (indicating class, if any)	Ordinary
Per Share (Rs)	Total Amount (Rs)
2.7.2 Nominal Amount	0.00
2.7.3 Premium	
2.7.4 Discount	0.00
2.7.5 Total (2.7.2 to 2.7.4)	0.00
2.7.6 The consideration for which shares have been allotted is	Amount (Rs)
a) Property and Assets Acquired (give details)	
b) Goodwill	
c) Services (give nature of services)	
d) Other items (to be specified)	
e) Total (a to d)	0.00

2.8 SECTION C: ALLOTMENT OF BONUS SHARES

No of Shares	indicating class if any
2.8.1 No. of Shares (indicating class, if any)	Ordinary
Allotment ratio (existing)	Total Amount (Rs)
2.8.2 Details of Bonus Shares	0.00
2.8.3 Particulars of Resolution of Board of Directors /	Day Month Year

2.9 SECTION D: NAMES, ADDRESSES, OCCUPATIONS, ETC. OF THE ALLOTTEES

Date of Allotment	Name of the Allottee in Full	Father/Husband's Name	Nationality	Country of origin in case of foreign national	Occupation of the Allottee	Address of the Allottee	No of Shares	CNIC
15/03/2021	AMCORP ENGINEERING AND CONSTRUCTION (PRIVATE) LIMITED	NA	PAKISTAN	PAKISTAN	COMPANY	LS 30 BLOCK 13, FEDERAL B AREA,	20000	
15/03/2021	AMCORP ENGINEERING (PRIVATE) LIMITED	NA	PAKISTAN	PAKISTAN	COMPANY	OFFICE 301 AMBER ESTATE, SHAHRA-E-	20000	

PART III

3.1 I do hereby solemnly, and sincerely declare that the information provided in the form is:
(a) true and correct to the best of my knowledge, in consonance with the record as maintained by the Company and nothing has been concealed, and
(b) hereby reported after complying with and fulfilling all requirements under the relevant provisions of law, rules, regulations, directives, circulars and notifications whichever is applicable

3.2 Name of Authorized Officer with Designation/ Authorized

SYED FAYSAL HUSSAIN NAOVI Chief Executive

3.3 Signature

Electronically sign by SYED FAYSAL HUSSAIN NAOVI

3.4 Rights of Authorized intermediary (a)

Day Month Year

3.5 Date

17/03/2021

3.6 I hereby declare that I have read and understood the provisions of the Securities and Exchange Commission of Pakistan (SECP) Act, 2015 and the Securities and Exchange Commission of Pakistan (SECP) Regulations, 2015 and I have complied with the provisions of the Act and the Regulations and I have taken all necessary steps to ensure that the information provided in the form is true and correct to the best of my knowledge, in consonance with the record as maintained by the Company and nothing has been concealed, and I have hereby reported after complying with and fulfilling all requirements under the relevant provisions of law, rules, regulations, directives, circulars and notifications whichever is applicable.







Sindh Engro Coal Mining Company

Department: Project and planning

SITE MASTER LAYOUT AUTHORIZATION DOCUMENT
Proposed Location of Coal Fired Plant

Requisitioner: Engineering

Document No:
Rev No:
Issue Date:
Effective Till:
Page No. Page

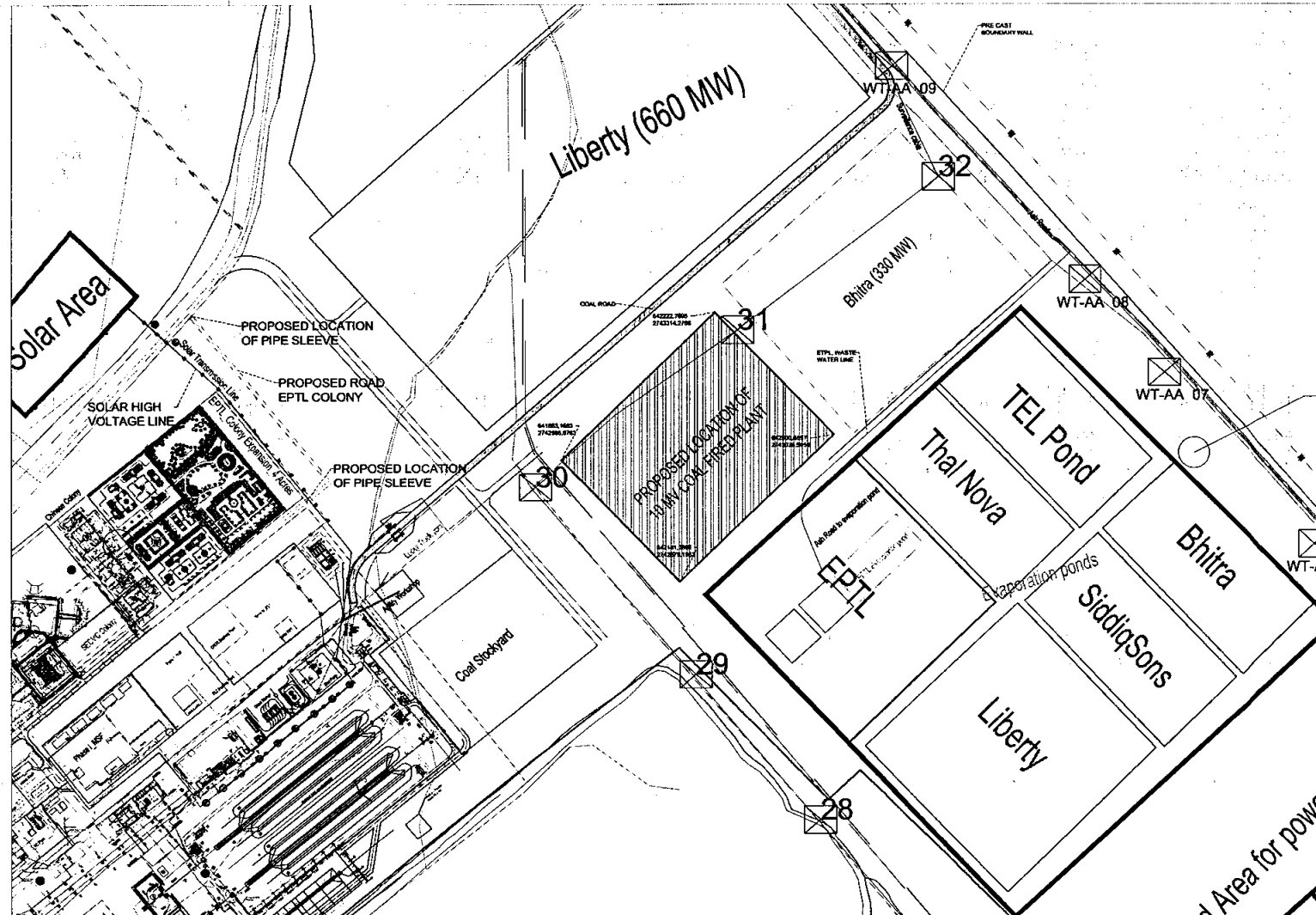
SECMC-SML-90
000
06-01-2021
06-02-2021
1 of 1

All Site

Job Description:
Proposed Location of Coal Fired Plant
Data Provided:
Layout Provided

Legend

Coal Road
EPTL Waste Water Line
Fence



Recommendations/Comments:

Proposed Locations of Coal fired Plant is near Coal Road as per the available data in Master Layout,

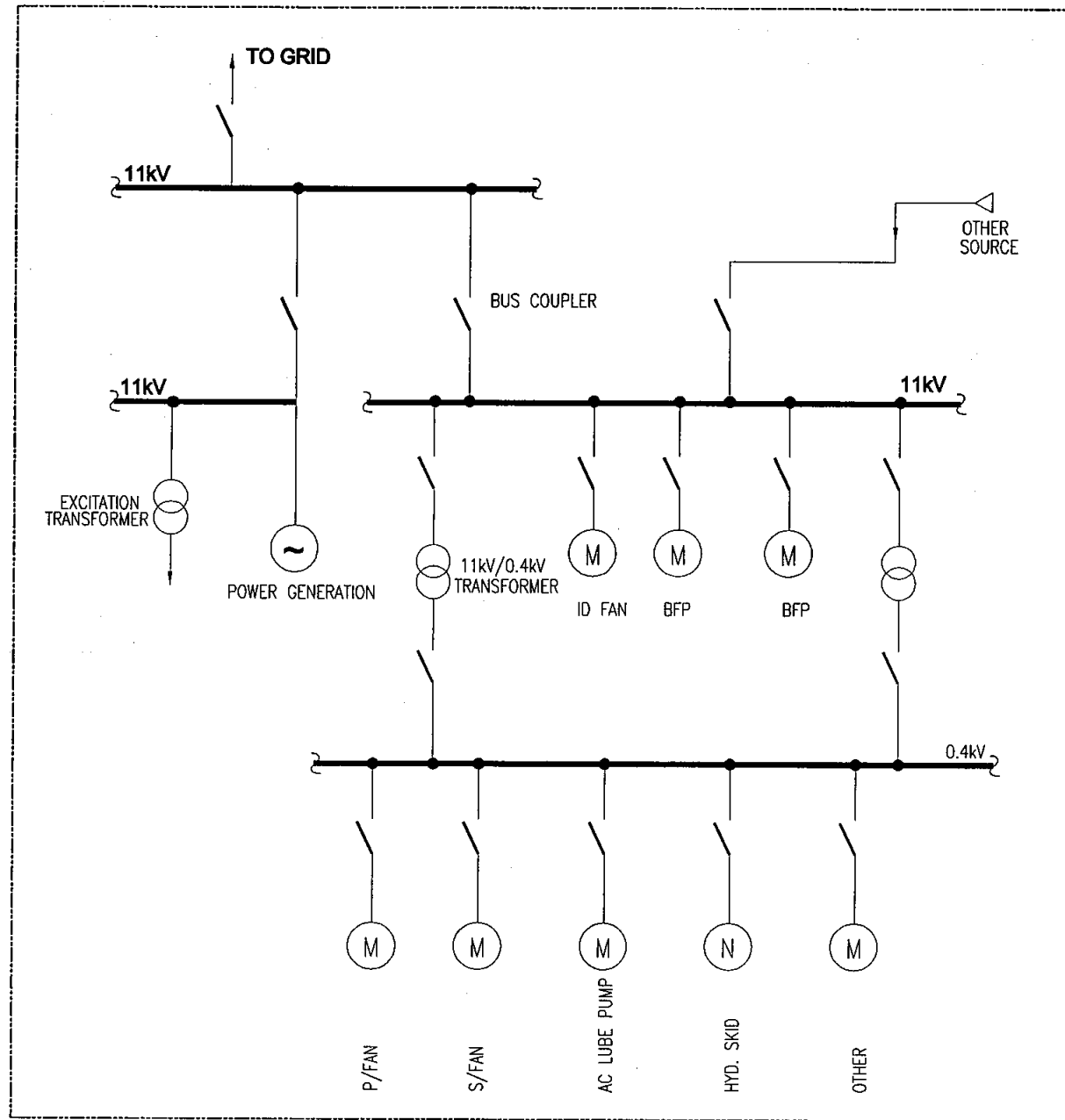
- Verification to be done from O&M Electrical, Water Supply, IT and Security Teams as well.
- Manual/Mechanical excavation Protocol are recommended and all the HSE protocols must be followed as per SHMS.

Requested By:

Irtiza
Engineering

Authorized By:

Fahim Bozdar/Deep Kumar
Site Master Layout Custodian





SECMC

Sindh Engro Coal Mining Company

16th Floor, The Harbor Front Building, U 00 92 (21) 111-211-211
HC#3, Marine Drive, Block 4, Clifton, T 00 92 (21) 35297875-84
Karachi-75600, Pakistan F 00 92 (21) 35293665

January 28, 2021

Attn: Mr. Arif Kazmi
M/s. AMCORP-GASCO JOINT VENTURE
LS-30, Block – 13, Federal B Area, Karachi.
Pakistan

Subject: Letter of Intent for Installation, Commissioning, Operation and Maintenance of a Coal Power Plant at SECMC Site, Islamkot, Tharparkar, Sindh

Dear Sir:

Following the examination/review of the bids/tenders submitted in response to our invitation for bids floated on 14th November 2019, Sindh Engro Coal Mining Company (the "COMPANY"), are pleased to inform you that your bid/tender proposal against the bid has been accepted. With this Letter of Intent, the COMPANY hereby expresses its intention to negotiate, finalize and award M/s. AMCORP-GASCO JOINT VENTURE (the "CONTRACTOR"), the contract to undertake "Installation, Commissioning, Operations and Maintenance of a 10MW Coal Power Plant" (the "WORKS") at Thar Block-II Tharparkar, Sindh (the "Site"), subject to the following terms and conditions:

1. The Parties shall, in good faith, negotiate and execute a definitive agreement ("AGREEMENT") which shall upon execution supersede this Letter of Intent.
2. The rights and obligations of the parties hereto, prior to the execution of AGREEMENT, shall be governed by this Letter of Intent and following documents, in the form as issued by the COMPANY along with its RFP.
 - 2.1 CONTRACTOR'S revised proposal (Attachment 1)
 - 2.2 RFP & Addendum (Attachment 4)
 - 2.3 Comprehensive Document (Attachment 2)
 - 2.4 Any additional Technical Scope sign off via email (Attachment 3)
 - 2.5 Contractor HSE Guidelines (Attachment 5)

Until the execution of Agreement, should there be any conflict between this Letter of Intent and the documents cited above, the terms of this Letter of Intent shall prevail, and the cited documents shall take precedence after this Letter of Intent. The AGREEMENT shall consist of the documents cited in paragraph including all agreed modifications and revisions to these documents.

3. The Agreement shall be for a Fifteen-year period on Build Own Operate basis.
4. CONTRACTOR's Original Equipment Manufacturer (OEM) will be present on Site for the first three years of Operations & Maintenance (O&M). The OEM not being present on Site during the first three years of O&M shall be considered as a default of the Agreement leading to termination.
5. The CONTRACTOR will be obligated to achieve Financial Close (FC) by 30th June 2021. The failure to do so shall be considered as a default of the Agreement leading to termination.
6. CONTRACTOR will be responsible for obtaining all permits required for the execution of the Works, including but not limited to procurement of Generation License or any other licenses required for generation and supply of electricity from the plant as and when needed.

Sindh Engro Coal Mining Company

 secmc.com.pk
 [SECMC_Thar](#)
 [SECMC_Thar](#)

 [secmc](#)
 [SECMC Thar](#)



SECMC

Sindh Engro Coal Mining Company

16th Floor, The Harbor Front Building U 00 92 (21) 111-211-211
HC#3, Marine Drive, Block 4, Clifton, T 00 92 (21) 35297875-84
Karachi-75600, Pakistan F 00 92 (21) 35293665

7. The Construction Period shall be Twenty-Four Months from the achievement of FC the CONTRACTOR shall be liable to pay the alternate energy cost (cost of producing power via the existing power supply system for the COMPANY i.e. Diesel Genset based production) in the event the Coal plant is not commissioned within 24 months from achievement of FC.
8. The applicable tariff shall be as per Attachment 1. No additional indexations or price increases shall be applicable other than the applicable Custom Duties on import of equipment. CONTRACTOR shall share a detailed breakdown of all applicable duties on import of equipment and the Parties will give their best efforts to ensure minimum exposure of custom duties.
9. The award of the LOI does not mean acceptance of any design by COMPANY and the detailed design developed by CONTRACTOR shall be reviewed by COMPANY and Process Hazard Analysis will be jointly conducted. CONTRACTOR will demonstrate best engineering practices, will oblige to recommendations by the COMPANY after any cost and performance assessment before proceeding further. Any recommendation made by the COMPANY aligned with the details shared with ITB & details shared / agreed within the bid evaluation period should be incorporated in the final design. The COMPANY, CONTRACTOR and OEM shall conduct a kickoff meeting after the award of the Letter Of Intent to discuss the detailed design parameters, after which the CONTRACTOR shall submit the detailed design as per the COMPANY's requirements. The detailed design shall be finalized within 6 months of the awarding of the LOI.
10. The CONTRACTOR shall make available a battery for back up storage of power. The storage capacity of the battery shall contain at least forty minutes of back up of power as per requirement.
11. The CONTRACTOR will submit a performance guarantee worth USD Five Hundred Thousand (500,000), issued by bank having long-term rating of "AA (double A)" by a Pakistani rating agency viz PACRA and JCR-VIS in the format acceptable to the Owner. The performance bank guarantee shall remain valid for the duration of the contract except when a change order is given, the amount shall be subject to an increase or decrease. Only after the issuance of the performance guarantee, the owner shall release the earnest money for the successful CONTRACTOR. The performance guarantee will remain valid throughout the contract.

The Performance Guarantee is required to be submitted within two weeks of the award of Contract and shall remain in full force for the duration of the contract and up till one year after commissioning of the plant.

The CONTRACTOR will not be allowed to sell the plant within the first three years of Operations & Maintenance, in case the CONTRACTOR sells the plant to any other company, the CONTRACTOR is required to maintain its performance guarantee for at least twelve months period after the sale transaction has been executed while the procuring company shall also submit a performance guarantee of USD 500,000. The terms of both the guarantee shall remain the same and SECMC's rights under the contract shall be applicable on both the guarantees for such 12-month period.

Until the CONTRACTOR doesn't submit the performance guarantee, the CONTRACTOR shall maintain the bid bond of USD 225,000 submitted as part of the bidding process. COMPANY will return the bid bond within seven days of the submission of the performance guarantee.

12. CONTRACTOR shall strictly adhere to and cause his employees to strictly adhere to all safety rules, safety practices, WORKS procedures, required engineering specifications, security policies and general guidelines given in safety manual of the COMPANY and other safety instructions issued by the COMPANY from time to time.
13. This Letter of Intent shall govern the relationship between the parties and serve as an interim AGREEMENT until such time as the parties execute AGREEMENT. This Letter of Intent and the documents referred to in paragraph 2.0 above shall constitute the entire AGREEMENT between



SECMC

Sindh Engro Coal Mining Company

16th Floor, The Harbor Front Building, U 00 92 (21) 111-211-211
HC#3, Marine Drive, Block 4, Clifton, T 00 92 (21) 35297875-84
Karachi-75600, Pakistan F 00 92 (21) 35293665

the parties hereto and supersedes all prior negotiations, representations, correspondence, undertakings, promises, covenants, arrangements, communications, warranties or agreements whether written or oral, except to the extent they are expressly referred to and incorporated in this Letter of Intent or in the documents referred above.

14. Notwithstanding any other term of this Letter of Intent, COMPANY has the right to terminate this Letter of Intent without assigning any reason whatsoever, by giving Fifteen (15) days written notice to the CONTRACTOR.
15. In the event the Letter of Intent is terminated for any reason whatsoever, the Company shall have no liability for any loss or damage whatsoever caused or suffered by the Contractor or its subcontractors or its agent or any third party and shall not be liable for any expense or cost whatsoever incurred by the Contractor and the Contractor hereby releases and discharges the Company from any liability, claim or demand which it may have.
16. The COMPANY shall provide the draft agreement within two weeks from the issuance of this LOI, after which the Parties shall in good faith negotiate and execute the AGREEMENT within two months of issuance of this LOI.
17. The Contractor shall be responsible to manage at its own expense, indemnify and hold harmless the Company and its, respective officers, directors, employees, representatives and agents from and against and in respect of any and all claims, liabilities, allegations, suits, actions, investigations, judgments, deficiencies, settlements, inquiries, demands or other proceedings of whatever nature or kind, whether formal or informal, brought against the Company or any of its respective officers, directors, employees, representatives, licensees or agents, by any third person or party against and in respect of any and all damages, liabilities, losses, costs, charges, fees and expenses, including without limitation reasonable legal fees and expenses, as and when incurred, relating to, based upon, incident to, arising from, or in connection with any claim or allegation with regard to the Contractor's performance or non-performance of the Letter of Intent, any misrepresentation by the Contractor, breach of any provision of this Letter of Intent, negligence or willful misconduct of the Contractor and/or any matter, connected and/or ancillary thereto. Any issue arising because of such disputes shall not be reason for excuse for any delay in the deliveries and the Contractor shall be liable for the same.
18. The Contractor shall comply with all applicable Laws of Pakistan. Any disputes or disagreements which cannot be amicably settled amongst the parties shall be submitted to the arbitration of two arbitrators, one to be appointed by each party. In case of a difference between the two arbitrators, the dispute will be referred to an umpire to be appointed by the arbitrators before entering upon the reference and the unanimous decision of the two arbitrators or in the case of difference between them the decision of the umpire, shall be final and binding on both the parties. The arbitration shall be held at Karachi in accordance with provision of the Arbitration Act 1940 and amendment or re-enactment thereof.

Subject to the Paragraph above, should any recourse to the Courts of Law become necessary, the parties hereto submit to the jurisdiction of the Courts of Law at Karachi which courts shall have exclusive jurisdiction to settle any claims and/or dispute arising out of this Agreement or any acts done in pursuance thereof regardless of the location of place of business of parties hereto or the place where the Project is to be undertaken or arbitration proceedings held.

19. The parties have caused this Letter of Intent to be executed in their respective corporate names by their respective officers, hereunto duly authorized.

Sindh Engro Coal Mining Company

secmc.com.pk
SEC MC_Thar
SEC MC_Thar

secmc
SEC MC_Thar



SECMC
Sindh Engro Coal Mining Company

16th Floor, The Harbor Front Building, U 00 92 (21) 111-211-211
HC#3, Marine Drive, Block 4, Clifton, T 00 92 (21) 35297875-84
Karachi-75600, Pakistan F 00 92 (21) 35293665

SIGNED FOR AND ON BEHALF OF "COMPANY"
(SINDH ENGRO COAL MINING COMPANY LIMITED)

Name: Talha Bin Zahid Lodhi
Designation: General Manager Commercial

IN THE PRESENCE OF:

1.
Signature of Witness

C/O SECMC
Address of Witness

2.
Signature of Witness

C/O SECMC
Address of Witness

SIGNED FOR AND ON BEHALF OF "CONTRACTOR"
(AMCORP-GASCO JOINT VENTURE)



Name: **ARIF RAZA KAZMI**
Designation: **DIRECTOR**

IN THE PRESENCE OF:

1.
Signature of Witness
NASIR RAZA

AMCORP, LS 30/13 F.B. AREA,
Address of Witness **KARACHI**

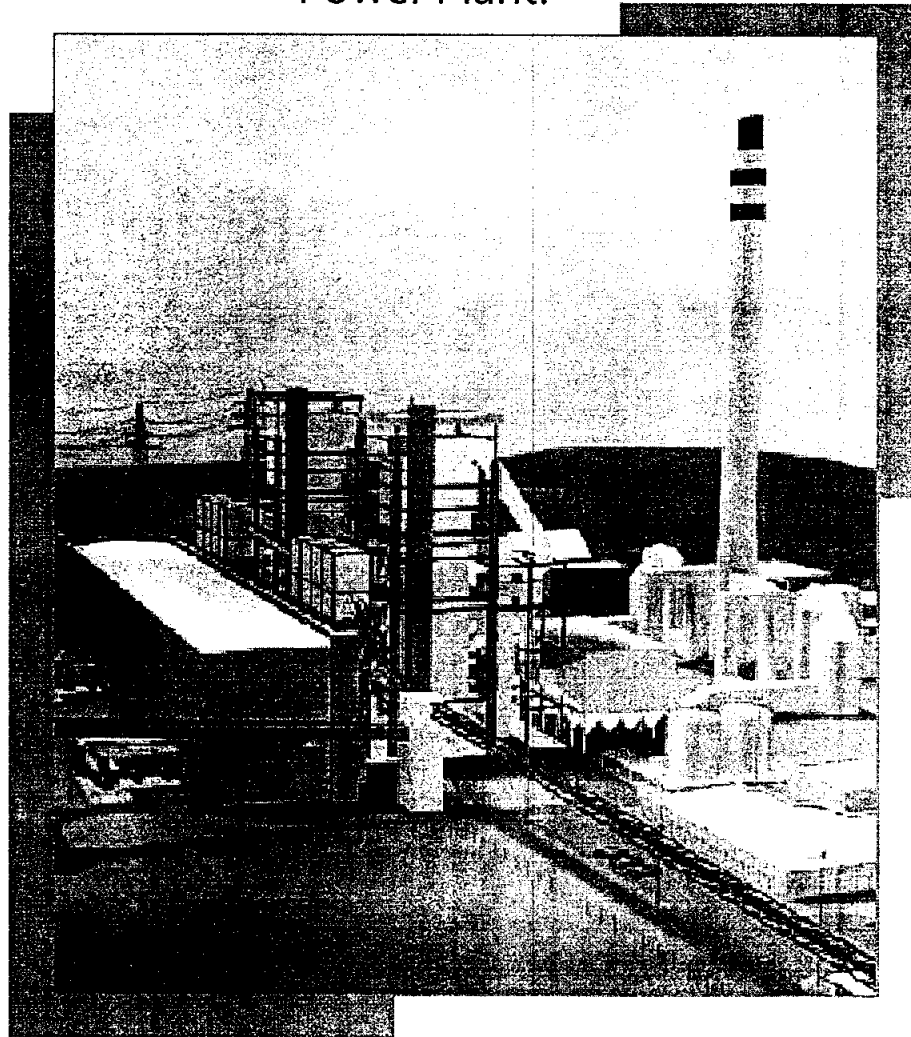
2.
Signature of Witness
ASIF AHMED

AMCORP, LS 30/13 F.B. AREA,
Address of Witness **KARACHI**

AGJV
(Pvt.) Limited

Initial Environmental Examination (IEE)

Construction and Installation of
10MW Coal Fired (1 X 10 MW Steam Turbine & Boiler)
Power Plant.



Global Environmental Management Services (Pvt) Ltd.

2nd Floor, Aiwan-e-Sanat, ST-4/2, Sector 23, Korangi Industrial Area, Karachi
Ph: (92-21) 35113804-5; Fax: (92-21) 35113806; Email: info@gems-intl.com

AGJV

(Pvt.) Limited

Initial Environmental Examination (IEE)

**Construction and Installation of
10MW Coal Fired (1 X 10 MW Steam Turbine & Boiler)
Power Plant.**

Final Report

February, 2021



Global Environmental Management Services (Pvt.) Ltd
2nd Floor, Aiwan-e-Sanat, ST-4/2, Sector 23, Korangi Industrial Area, Karachi
Ph: (92-21) 35113804-5; Fax: (92-21) 35113806; Email: info@gems-intl.com

LIST OF CONTENTS

EXECUTIVE SUMMARY

1.0 INTRODUCTION

1.1	OVERVIEW	1-1
1.2	PROPONENT'S INTRODUCTION	1-2
1.3	NEED OF THE PROJECT	1-2
1.4	PROJECT OUTLINE	1-3
1.5	CONSULTANT'S PROFILE	1-3
1.5.1	Consultancy Division	1-3
1.5.2	Laboratory Division	1-4
1.5.3	Waste Management Division	1-4
1.6	IEE STUDY TEAM	1-4
1.7	LEGISLATIVE REQUIREMENT	1-5
1.8	PURPOSE OF THE STUDY	1-5
1.9	SCOPE OF THE IEE	1-5
1.10	APPROACH AND METHODOLOGY	1-6
1.10.1	Scoping	1-6
1.10.2	Baseline Studies	1-6
1.10.3	Impact Assessment	1-7
1.10.4	Documentation	1-7

2.0 PROJECT DESCRIPTION

2.1	GENERAL OUTLINE	2-1
2.2	THE ENERGY CRISIS IN PAKISTAN	2-1
2.3	PROPONENT ADDRESS & LOCATION MAP	2-2
2.4	PROJECT DESCRIPTION	2-3
2.4.1	Construction Activities	2-3
2.4.2	Project Timeframe	2-4
2.4.3	Process Description of Power Plant	2-4
2.4.4	Proposed Technology for Boiler Combustion	2-6
2.4.5	Coal Quality	2-6
2.4.6	List of chemicals and its usage	2-7
2.4.7	Coal handling and storage	2-7
2.4.8	Ash Handling and Disposal System	2-7
2.4.9	Cooling System	2-7
2.4.10	Domestic Water	2-8
2.5	HAZARDOUS WASTE MANAGEMENT	2-8
2.5.1	Solid and Liquid Waste Treatment or Management	2-8
2.6	ENVIRONMENTAL MANAGEMENT AND CONTROLS EQUIPMENT	2-8
2.6.1	Flue Gas Treatment System (FGTS)	2-8
2.6.2	Health Safety Environment	2-9

2.6.3	Groundwater Treatment System	2-9
2.6.4	Dust Suppression and Temperature Monitoring	2-9
2.6.5	Project Synopsis	2-10

3.0 INSTITUTIONAL, LEGISLATION AND POLICY FRAMEWORK

3.1	GENERAL OUTLINE AND SCOPE	3-1
3.2	NATIONAL ENVIRONMENTAL POLICY, LEGISLATION AND GUIDELINES	3-1
3.2.1	Sindh Environmental Protection Act 2014	3-1
3.2.2	The Sindh Environmental Quality Standards	3-2
3.2.3	Approval from Sindh Environment Protection Agency (SEPA)	3-2
3.2.4	Sindh Environmental Protection Agency Review of IEE and EIA Regulations, 2014	3-3
3.2.5	National Conservation Strategy (NCS)	3-3
3.3	OTHER RELEVANT LEGISLATION	3-5

4.0 PHYSICAL ENVIRONMENT

4.1	GENERAL OUTLINE AND SCOPE	4-1
4.2	TOPOGRAPHY AND LAND USE	4-1
4.3	GEOLOGY AND SOIL	4-2
4.4	CLIMATE	4-3
4.5	RAINFALL	4-5
4.6	RELATIVE HUMIDITY	4-5
4.7	WIND SPEED	4-6
4.8	AMBIENT AIR QUALITY & NOISE LEVELS	4-7
4.9	WATER RESOURCES	4-9
4.9.1	Surface Water Resources	4-9
4.9.2	Groundwater Resources	4-10
4.10	DISASTER RISKS	4-11
4.10.1	Flooding	4-12
4.10.2	Faults, Earthquakes and Seismic Hazards	4-12

5.0 ECOLOGICAL ENVIRONMENT

5.1	GENERAL OUTLINE AND SCOPE	5-1
5.2	GENERAL HABITAT OF AREA UNDER FOCUS	5-1
5.3	SAMPLING METHODOLOGIES	5-3
5.3.1	Sampling Methodology for Terrestrial Flora	5-3
5.3.2	Survey/Sampling Methodology for Endemic Birds:	5-3
5.3.3	Survey/Sampling Methodology for Mammalian:	5-3
5.3.4	Survey/Sampling Methodology for Wildlife (Reptiles/Amphibians)	5-3
5.4	TERRESTRIAL FLORA OF THE PROPOSED PROJECT AREA	5-3
5.5	FAUNA OF THE PROPOSED PROJECT AREA	5-5
5.5.1	Endemic Birds Species Findings	5-5
5.5.2	Mammalian Species Findings	5-6
5.5.3	Reptiles/Amphibians Species Findings	5-6

6.0 SOCIO-ECONOMICS & CULTURAL ENVIRONMENT

6.1	GENERAL OUTLINE AND SCOPE	6-1
6.2	DEMOGRAPHICS	6-2
6.3	LIVELIHOOD AND EMPLOYMENT	6-2
6.4	INFRASTRUCTURE AND SERVICES	6-3
6.5	POWER SUPPLY AND FUEL WOOD CONSUMPTION	6-3
6.6	WATER SUPPLY AND SANITATION	6-3
6.7	EDUCATION AND LITERACY	6-4
6.8	HEALTH CARE FACILITIES	6-4
6.9	CULTURE, ETHNICITY AND RELIGION	6-5
6.10	ARCHEOLOGICAL HERITAGE	6-5
6.11	ROLE OF WOMEN	6-5

7.0 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

7.1	SCREENING OF POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES	7-1
7.2	IMPACT ASSESSMENT METHODOLOGY	7-1
7.3	ENVIRONMENTAL IMPACTS ASSOCIATED WITH CONSTRUCTION AND OPERATION	7-1
7.4	WASTE GENERATION AND MANAGEMENT	7-5
7.5	SOCIOECONOMIC IMPACTS	7-7
7.6	HEALTH AND SAFETY	7-8

8.0 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

8.1	OVERVIEW AND SCOPE	8-1
8.2	MITIGATION PLAN	8-1
8.3	MONITORING MECHANISM	8-10

9.0 CONCLUSION

Annexure

I- IEE Study Team

LIST OF EXHIBITS

CHAPTER 2: PROJECT DESCRIPTION

Exhibit 2. 1:	Project Area Location Map	2-2
Exhibit 2. 2:	Proposed Project Setup Layout Plan	2-3
Exhibit 2. 3:	Lignite specifications	2-6
Exhibit 2. 4:	Coal Fired Power Plant's Features	2-10

CHAPTER 3: INSTITUTIONAL, LEGISLATION AND POLICY FRAMEWORK

Exhibit 3. 1:	Relevant Legislation	3-5
---------------	----------------------	-----

CHAPTER 4: PHYSICAL ENVIRONMENT

Exhibit 4. 1:	The Topographic Elevation Map of the Proposed Project Area	4-2
Exhibit 4. 2:	Geological Map of Thar	4-3
Exhibit 4. 3:	Average yearly High and Low Temperature	4-4
Exhibit 4. 4:	Average Monthly Rainfall	4-5
Exhibit 4. 5:	Relative Humidity	4-6
Exhibit 4. 6:	Average Wind Speed	4-7
Exhibit 4. 7:	Ambient Air Sampling Point Map	4-8
Exhibit 4. 8:	Ambient air monitoring results	4-8
Exhibit 4. 9:	Chemical Analysis of Groundwater	4-10
Exhibit 4. 10:	Classification of multi-hazard zoning map	4-11
Exhibit 4. 11:	Hazard Map of Tharparkar	4-13

CHAPTER 5: ECOLOGICAL ENVIRONMENT

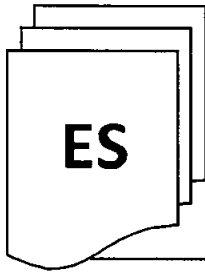
Exhibit 5. 1:	Detailed list of floral species observed at project surrounding	5-4
Exhibit 5. 2:	List of Endemic Birds Species Observed	5-5
Exhibit 5. 3:	List of observed Mammalian species in proposed project area surrounding	5-6
Exhibit 5. 4:	observed species in the premises of proposed area	5-7

CHAPTER 6: SOCIO-ECONOMIC & CULTURAL ENVIRONMENT

Exhibit 6. 1:	District Tharparkar Administrative Map	6-2
Exhibit 6. 2:	Population Literacy Rate of District Tharparkar	6-4
Exhibit 6. 3:	Caste distribution of the Study Area	6-5
Exhibit 6. 4:	Project Area Surrounding Environment	6-6
Exhibit 6. 5:	Pictorial view of study area	6-7

CHAPTER 8: ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

Exhibit 8. 1:	Environmental Management Plan	8-2
Exhibit 8. 2:	Environmental Monitoring Plan during Construction and Operation	8-11



EXECUTIVE SUMMARY

This Initial Environmental Examination (IEE) study was carried out by GEMS, for the proposed Construction and Installation of 10MW Coal Fired (1X10MW Steam Turbine & Boiler) Power Plant. Which is located at Thar coal field in the southeast corner of the Sindh Province of Pakistan, the proposed covered area of the project is about 20,000m² (100m x 200m), as per legislative requirement under Sindh Environmental Protection Agency (SEPA) Act 2014. This IEE report is consolidation of the finding and assessment carried out during the IEE process. This IEE was guided by the provincial practices and conducted accordingly for the proposed project.

This IEE study has been undertaken to conform to the requirements of the SEPA Act 2014; Initial Environmental Examination; Environmental Impact Assessment Review Regulations 2014. Furthermore, it has incorporated the provincial best practices, the company's social and environmental policies and compliance and contextual realities to integrate the philosophy and processes of sustainable development.

THE PROPONENT

AGJV Private Limited (AMCORP-GASCO JV) is a Joint Venture between AMCORP Engineering and GASCO Engineering. AGJV is a full cycle EPCC company working actively in Pakistan for the last 5 years and have executed number of significant projects during this period.

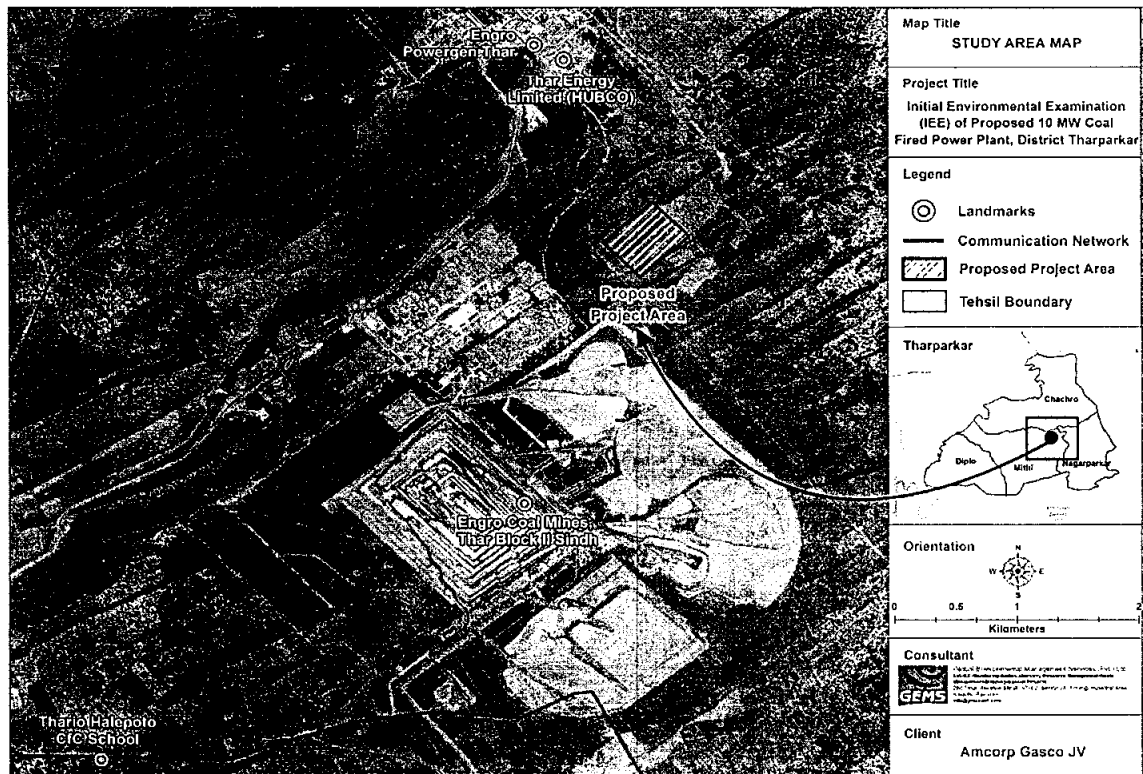
Need and significance

SECMC is the operating company & responsible for the coal mining in the energy capital of Thar, unlocking indigenous energy potential of Pakistan. Currently, SECMC is operating a 10MW diesel fueled genset operated power station to supply auxiliary power to SECMC operations. 10MW power plant is envisaged by SECMC for their auxiliary power requirements. As a natural conversion and the mining operator of Pakistan indigenous coal, SECMC is planning to convert their auxiliary power requirements from diesel fueled genset station to coal operated power plant. This conversion and switch to locally available indigenous fuel presenting advantages not limited to,

- Low fuel cost to SECMC for their auxiliary power;
- Any savings made in the operational cost at SECMC would be passed onto the users in the form of low fuel cost.

PROPOSED LOCATION OF POWER PLANT

The proposed Project site is located in the Thar coal field, southeast corner of the Sindh Province of Pakistan in the Thar Desert. The proposed covered area of the project is about 20,000 m² (100m x 200m), project Location map can be seen below.



PROJECT DESCRIPTION

The proposed Project will consist of a lignite fired power plant capable of generating 10MW electricity, circulating fluidized bed (CFB) boiler will be installed at the plant. The boiler will provide steam for a steam turbine/generator.

The proposed power plant will be connected to the existing grid of the project site, ignite as a fuel will be supplied to the power plant from the SECMC coal yard through dump trucks. The proposed power plant will burn around 10,000 Ton Per month of coal monthly, more or less 300 kg bottom ashes per hour and around 10 ton per hour fly ash may be produced. Along with the proposed power plant, coal storage and handling facilities, ash handling and disposal facilities, and cooling water intake and outfall channels will also be constructed in the vicinity of the power plant.

The configuration will be 1 x 10 MW steam turbine and 1 Boilers (100 % operational). A minimum system availability of 95% has to be ensured. The power installation capacity of 10000kW in according with this thermal and electrical load to build a co-generate power plant in order to save energy, improve the environment, enhance the quality of power supply. Boiler will be of fluidized

bed technique, Main steam maximum continuous rating 50t/h, Superheater outlet steam temperature 450°C, Superheater outlet steam pressure 3.82MPa(g), Feed water temperature 150°C, Flue gas temperature at A/H outlet 140°C, Boiler design efficiency 91.±1%, Minimum stable combustion load 60% MCR (without oil supporting). The steam turbine will be a standard multistage, single-cylinder, non-reheat, condensing unit. The turbine will exhaust against condenser pressure of 6kPa (0.06ata) at the design condenser cooling water temperature.

S. No.	Description	
Construction Material usage		
1.	Cement, Crush, Sand, Water	
2.	Grout & chemicals (additives)	
3.	250kVA electricity will be required during construction phase	
4.	250 average manpower for the period of 12 months	
Operation Phase Usage		
1	Coal type	Lignite
2	Power plant capacity	10MW
3	Lignite burning capacity per month	10,000 Ton
4	Bottom ash production capacity	300 kg per hour
5	Fly ash production capacity	10 ton per hour
6	Make up water requirement	120 ton per hour
7	Gaseous emissions	CO2, CO, NOx, SO2, Particulate Matter.
8	Chimney	40 meter
9	Steam turbine temperature	450°C
10	Feed water temperature	150°C
11	Generator	50MMKWH

PHYSICAL ENVIRONMENT

The proposed project is located at taluka Islamkot of district Tharparkar in Sindh province of Pakistan. This district is bounded by India on the East, Rann of Kuch on the South, district Umerkot

and Mirpurkhas on the north and district Badin on the west¹. The topography of Islamkot is typical of the Thar Desert and consists of barren tracts of sand dunes covered with thorny shrubs. The modest variations in elevation is observed, with a maximum elevation change of 233 feet, and an average elevation above sea level of 241 feet². It has an undulating relief with areas of higher ground consisting of elongate and parabolic sand dunes, running parallel to the prevailing northeasterly winds. Dunes are interspersed with areas of very flat plain being approximately 90 m amsl³. The proposed project area can be divided into two major parts with respect of surface undulation, this includes desert portion and agricultural land.

The Thar Desert lies in the southeastern part of Pakistan, on the western edge of the stable Indian Peninsula. Thar coalfield rests directly on relatively shallow, rifted basement rocks of late Pre-Cambrian age. The whole area is covered with extensive & thick cover of sand dunes, extending down to an average depth of 80m. The dune is brown to yellowish grey, very fine to fine grained, slightly silty and clayey. The almost barren sand is locally enriched with higher clay/silt in some areas especially in inter-dune valleys, where flood waters accumulate the silt. There the soil is favorable for crop production relative to sand dune both because of some enrichment in potassium and calcium within these silty materials and the increased water bearing capacity of these strata. At the bottom, hard bands of sandstone occur which are slightly calcareous and argillaceous (Khan et al., 1993). Surface rock exposures are almost absent, except limited outcrops of granitic basement in Nagarparkar. A few scattered outcrops of Mesozoic and Tertiary strata are exposed across the Indo-Pakistan border in the Jaisalmer and Rann of Kutch areas of India. On the basis of drill whole data, four sub-surface litho-stratigraphic units have been identified. The units are dune sand (recent), Alluvial deposits (sub-recent), Bara formation (Paleocene) and Basement Complex (Pre-Cambrian).

BIOLOGICAL ENVIRONMENT

The Thar Desert is a large ecoregion lying to the west of the Aravalli Mountain Range in northwestern India. The relief in the Thar Desert varies between near sea level to more than 150 meters. The sand dunes defining the topography are mostly longitudinal forming a NE-SW trend and are stabilized by shrubs and grass. In the inter-dunal valleys, the alluvial soil brought by rainwater is deposited in the depressions. The vegetation in Thar Desert is desertic and semi-desertic.

Habitat Classification and Distribution

Habitats within the Study Area were classified relying primarily upon geomorphology and soil texture, with consideration of variations within habitat types. The Study Area was classified by geomorphological characteristics into agricultural fields, sand dunes and plains. Agriculture fields are the dominant habitat, constituting 56% of habitats of the Study Area. There is only one cropping season in the summer (called kharif season) in which a variety of summer crops are grown. Sand dunes are the second dominant habitat, constituting 35% of the total habitat. They vary in height, ranging

¹ <http://reliefweb.int/sites/reliefweb.int/files/resources/PESA-DP-Tharparkar-Sindh.pdf>

² www.weatherspark.com

³ [http://shehri.org/eia-reports/EIA%20report-vol 1%20330MW%20Thar%20Energy%20HubPower%20Company%20\(2\).pdf](http://shehri.org/eia-reports/EIA%20report-vol%201%20330MW%20Thar%20Energy%20HubPower%20Company%20(2).pdf)

from a few meters to over a hundred meters. Plains constitute 9% (including 2% of the area covered by settlements) of the total habitat of the Study Area. An established tradition of preservation of trees contributes to maintaining the vegetation cover in the Thar Desert. Grazing pressure, however, is significant and the ground vegetation in terms of grasses, scrubs and bushes can be considered as uniformly degraded.

Vegetation

A total of 137 plant species have been reported from the Tharparkar area. These plant species are the base for the animal and human life in the desert. The plants are used for a variety of purposes, including production of medicines, resins, dyes and fibers, and for construction, forage and fodder making. The habitat in the Thar Desert is influenced by the extreme climate. The vegetation consists of xerophilious grasslands. Scrub vegetation consists of low trees and shrubs. None of the plant species found during the survey is listed under either the IUCN Red List 2010.

SOICAL ENVIRONMENT

The inhabitants of the area, like that of Thar Desert, belong to different religions, sects and castes which gives the area a rich multifaceted culture. The population of the area is estimated to be in excess of 6,000. Most of the living structures in the villages are chaunras, mud huts with thatched roof. The area has a weak infrastructure when compared to other districts provincially and nationally. Water supply is one of the major problems faced by villages in the area. Most of the underground water is brackish. The villagers travel to the nearby towns of Mithi and Islamkot for health facilities. The literacy rate in the surveyed population of ages 10 years and above in the area was 21%. Primary school facilities for boys exist in seven of the ten villages, while primary school for girls is present in only one of the villages. The unemployment rate for males is 28%. All ten villages in the potential impact zone were surveyed.

IMPACT AND MITIGATION MEASURES

After a comprehensive assessment of the existing environmental and socio-economic conditions and review of technical data, a team of environmental professionals analyzed the significant environmental impacts and suggested the necessary mitigating measure to mitigate the adverse environmental and social impacts of the proposed project. During the initial construction phase there can be considerable environmental impacts mainly due to civil works such as site preparation, lying of foundation, vehicle movement etc. Construction phase impacts are usually temporary and localized phenomenon, the potentially significant issues identified are discussed below.

Construction Impact

Some of the environmental and social impacts of construction activities relate to activities at the construction site whereas others relate to the setting up and operation of the construction crew camp. Typical issues include:

- Site clearance leading to dust emission

- Removal of vegetation leading to loss of vegetation cover
- Air quality impact from operation of construction machinery and earthwork
- Noise and vibration from machinery and construction work
- Generation of waste and its disposal
- Off-site impacts such as those related to borrow pits

Operation Phase

The 10MW Coal Fired (1X10MW Steam Turbine & Boiler) Power Plant are modeled with the following assumptions:

- Thar Lignite as fuel source;
- Control efficiencies: PM10 (99.9%), SO (90%), and NOx (based on EPA emission factor);

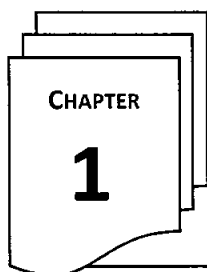
Major sources in the project area and predict air quality impact for SO and PM_{2.5}, NO.

There are no major schools or hospitals in Study Area.

The wastewater from the project includes the blowdown from cooling tower, blowdown from boilers and other sources most of which will be reused. However, the waste generated from the desalination has to be disposed separately. For some of the low volume waste, an evaporation pond will be constructed at the site.

ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

The Environmental Management & Monitoring Plan (EMMP) has been designed to address how the proposed measures will be implemented. It defines the responsibilities of the project developer and contractor; develops a system of checks and balances; proposes actions that are to be taken by each role player; and lays down the required documentation, communication, and monitoring procedures. The purpose of this EMMP is not only to address the expected environmental impacts of the proposed project, but also to enhance project benefits and to introduce standards of good practice to be adopted for the proposed project.



INTRODUCTION

1.1 OVERVIEW

Study Type	Initial Environmental Examination (IEE)
Study Title	Construction and Installation of 10MW Coal Fired (1 X 10 MW Steam Turbine & Boiler) Power Plant.
Project Location	Sindh Engro Coal Mining Company (SECMC) Thar.
Project Proponent	AGJV (Pvt.) Limited
Project Consultant	Global Environmental Management Services (Pvt.) Ltd. (GEMS);

Pakistan currently imports much of its fuel for the production of electricity to power homes and businesses. Electricity demand outweighs supply within the country, as such the Government of Sindh is considering options for power generation. The Government of Sindh is pursuing coal to power generation since the identification of the Thar Coalfield and as it is believed to be one of the least costly energy generation options for Pakistan.

The Thar Coalfield which is located in the southeast of Sindh Province was discovered in 1980 and cover an area of 9,100km² with total lignite coal resources estimated to be in excess of 175 billion tones. The development of the Thar Coalfield and the associated establishment of coal to power projects are major objectives of the Government of Sindh, to achieve increased power production, with associated economic growth to ultimately reduce poverty in the country. The Thar Desert has one of the largest coal reserves in the world.

The AMCORP-GASCO JV is planning to install a new 10MW coal-fired power plant at Thar Block-II. In order to comply with environmental regulations, the proponent acquired the services of Global Environmental Management Services Pvt. Ltd (GEMS) to carry out the initial environmental examination of the proposed Project.

This IEE report discusses the potential environmental impacts which may result from Project-related activities and suggests recommendations to mitigate adverse impacts. The IEE process and report meets national and provincial regulatory standards enforced by the Sindh Environmental Protection Agency (SEPA). The Environmental assessment has been undertaken to conform the requirements of the SEP, Act 2014; Initial environmental examination; Environmental impact assessment review regulations 2014.

1.2 PROPONENT'S INTRODUCTION

AMCORP-GASCO JV is a Joint Venture between AMCORP Engineering and GASCO Engineering. AGJV is a full cycle EPCC company working actively in Pakistan for the last 5 years and have executed number of significant projects during this period.

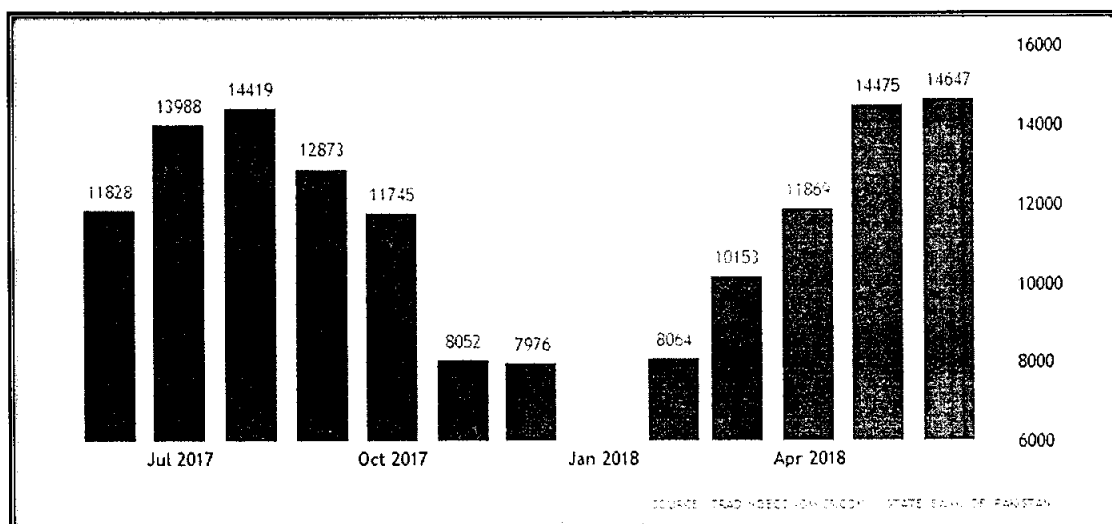
1.3 NEED OF THE PROJECT

SECMC is the operating company & responsible for the coal mining in the energy capital of Thar, unlocking indigenous energy potential of Pakistan. Currently, SECMC is operating a 10MW diesel fueled genset operated power station to supply auxiliary power to SECMC operations 10MW power plant is envisaged by SECMC for their auxiliary power requirements. As a natural conversion and the mining operator of Pakistan indigenous coal, SECMC is planning to convert their auxiliary power requirements from diesel fueled genset station to coal operated power plant. This conversion and switch to locally available indigenous fuel presenting advantages not limited to, 1) Low fuel cost to SECMC for their auxiliary power; 2) Any savings made in the operational cost at SECMC would be passed onto the users in the form of low fuel cost.

Pakistan is among some countries which has a lot of potential to produce electricity. The country is geographically very rich in terms of various renewable resources which are low costing to produce electricity and at the same time more environment friendly. But still from last 15 years Pakistan has a series of bottlenecks in power sector and there is a shortfall because electricity demand is growing day by day and the resources to produce electricity are not used efficiently.

With the view of such constraint, AMCORP-GASCO JV, one of the reputed Company of the Pakistan, the proponent has initiated to install 10MW Coal Fired plants to the existing facility of Sindh Engro Coal Mining Company (SECMC) Thar.

Exhibit 1. 1: Pakistan Electric Production



1.4 PROJECT OUTLINE

The proposed Project is a 10 MW (gross) coal-fired power plant which will utilize the lignite coal from SECMC coal yard. The Project will incorporate state of the art air pollution control system to minimize and treat gaseous emissions generated from the operation activities.

The Project will comprise of a steam turbine with CFB boiler to generate 10MW (net) electric power to feed to the existing grid, boiler typically emit gases containing NOX, SO₂, CO and Particulate Matter (PM) which are harmful for both humans and the environment. Using emission control systems, the Project will emit these pollutants at rates which comply with the limits prescribed by the Sindh Environmental Quality Standards (SEQS) and the International Financial Corporation's (IFC) limits for emissions from coal-fired boilers. This will help ensure that the concentrations of these pollutants in ambient air will be within the ambient air quality levels prescribed by the NEQS.

Effluents generated from the power plant will be treated and monitored for compliance with SEQS before being discharged into the sea. All other industrial effluents such as those from the boiler make-up water treatment system; oily waste and sanitary waste will be treated to comply with SEQS and re-used as far as possible. Water will also be used to mix with ash to form ash slurry and for washing coal. Here too, water will be retreated and re-used.

1.5 CONSULTANT'S PROFILE



Global Environmental Management Services (Pvt.) Ltd. (GEMS) is an Environmental Consultancy which provides broad range of Environmental Solutions which are and not limited to Environmental Audits, Initial Environmental Examinations (IEE), Environmental Impact Assessments (EIA), Baseline studies and Training & Capacity building. GEMS is one of the few environmental firm having its own renowned ISO 17025 Certified Environmental Laboratory by the name of Global Environmental Laboratory (Pvt.) Ltd.

GEMS have several divisions at work which provides core quality services. They are as follows:

1.5.1 Consultancy Division:

GEMS offer the following services to various industries, government institutions and international development organizations:

- ❖ Environmental impact assessments
- ❖ Initial Environmental Examination
- ❖ Environmental audits and management plans
- ❖ Baseline studies and habitat mapping
- ❖ Capacity building and trainings
- ❖ Cleaner production for industries

1.5.2 Laboratory Division:

GEMS Laboratory, Global Environmental Lab (Pvt.) Ltd. is the leading source of environmental solutions. It is providing 24 hours sampling and monitoring services to various sectors including:

- ❖ Liquid Effluent Analysis
- ❖ Drinking Water Analysis
- ❖ Soil and Sludge Analysis
- ❖ Microbiological Analysis
- ❖ Gaseous Emissions and Particulate Matter Analysis
- ❖ Ambient Air Monitoring
- ❖ Noise Level Measurements
- ❖ Light Intensity Measurements
- ❖ Complete Monitoring as per NEQS and SEQS

1.5.3 Waste Management Division

Waste Management Division has the following services:

- ❖ Incineration
- ❖ Bio-remediation
- ❖ Research and Division facility for disposal
- ❖ Waste minimization
- ❖ Waste recycling
- ❖ Integrated Waste Management

For over a decade GEMS have conducted IEEs in an expanding range of Energy sector (oil and gas industry, power plants etc.), Manufacturing industries (e.g. pharmaceutical, mineral fertilizers, textile, paper, food processing etc.), Infrastructure projects (roads, highway's buildings etc.), ports and harbors, tourism, aquaculture and fisheries.

1.6 IEE STUDY TEAM

GEMS personnel have professional environmental and social experience extending throughout Pakistan and UAE. They are all qualified environmental and social scientists with complementary multi-disciplinary skills covering all major biomes of the environment. As a result GEMS is able to offer accurate, independent and appropriate services to its clients and to regulatory bodies.

The IEE study team profile for the proposed project has been attached as **Annexure I** of the report.

1.7 LEGISLATIVE REQUIREMENT

The IEE of the proposed Project activity will be subjected to the pertinent legislative and regulatory requirements of the Government of Sindh including State laws. Legislation presents a synopsis of environmental policies, legislation and other guidelines that have relevance to the proposed project. The proposed project falls under the project category of B (Energy) Schedule I. as per EIA/IEE review Regulations, 2014.

1.8 PURPOSE OF THE STUDY

The purpose of this IEE study is to evaluate the significant Environmental aspects of the proposed project and identify requirements and standards that need to be complied specifically with SEP, Act 2014.

The specific objectives of this IEE are to:

1. Identify the relevant stakeholders that need to be consulted to evaluate Environmental aspects of the project.
2. Assess the existing environmental conditions in the proposed project area, including identification of environmentally sensitive areas and significant receptors;
3. Assess various project related activities to identify potential impacts on environment baseline settings and determine their significance;
4. Propose appropriate mitigation measures that can be incorporated into the project design, commissioning and operating phases to minimize damaging effects or lasting negative consequences identified by the environmental assessment;
5. Assess the proposed activities and ensure their compliance with the relevant environmental regulations of the province;
6. Prepare an IEE report for submission to the Sindh EPA in compliance with EIA, IEE Regulations 2014.

1.9 SCOPE OF THE IEE

For the IEE study, the scope of work is as under:

1. Description of physical, environmental, socio-economic and cultural setting and baseline conditions in the proposed project area;
2. Identification and prediction of proposed project impacts and their significance relating to the proposed project activities;
3. Identification and assessment of the applicability and effectiveness of mitigation measures to offset or minimize adverse impacts on environment.

1.10 APPROACH AND METHODOLOGY

The IEE was performed in five main phases, which are described below.

1.10.1 Scoping

The key activities of this phase included:

Project Data Compilation: A generic description of the proposed project (i.e. construction and operation), within the proposed project area relevant to environmental assessment, was compiled with the help of EPA guidelines and proponent.

Literature Review: Secondary data and information related to weather, soil, water resources, coastal and marine ecology, and wildlife was reviewed and compiled.

Legislative Review: Information on relevant legislation, regulations, guidelines, and standards was reviewed and compiled.

Identification of Potential Impacts: The information collected in the previous steps was reviewed, and potential environmental issues were identified.

1.10.2 Baseline Studies

Following the scoping exercise, the project area was surveyed to collect primary data. During the field visits, information was collected on ecologically important areas, surface and groundwater resources, soils, local communities' livelihood, culture and developmental needs, public services, and sites of archaeological or cultural importance. The following specific studies were conducted as part of the IEE.

Vegetation: A botanist conducted the vegetation study, which consisted of a thorough literature review and field data collection. As a part of the vegetation study, quadrant sampling was conducted and area's floral species were documented. Vegetation communities were identified and vegetation cover was determined.

Wildlife Study: A wildlife biologist conducted a wildlife study, which was based on a thorough literature review and field data collection. During the fieldwork, the faunal species of the area were documented. The diversity of avian, large and small mammals, and reptile species was also determined. Information was collected on the species of concern in the area.

Physical Environment: An Environmental Assessment Specialist conducted a physical environmental study which included, soil sampling, water sampling of surface water resources of the area, and groundwater resources of the area. The impact of the project on soil and water resources was also assessed.

Socioeconomic Study: A team of experts including social assessment and gender specialist conducted a socioeconomic and cultural study of the project area. The study team collected data through participatory technique from the community of the project area. As a part of this, Locals were consulted about the project. The profile included livelihood, culture, leadership, gender issues, spiritual and

temporal leadership, demographic information based on field data and published sources, the existing use of land resources, community structure, employment, distribution of income, goods and services, public health, local religious and cultural values, and local customs, aspirations and attitudes.

1.10.3 Impact Assessment

The environmental, socioeconomic and cultural, gender and project information collected in previous phases was used to assess the potential impacts of the proposed activities. The issues studied included potential proposed project impacts on:

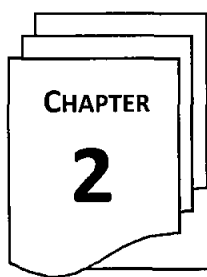
- ❖ Groundwater and surface water quality;
- ❖ Ecology of the area, including flora and fauna;
- ❖ Local communities;
- ❖ Socioeconomic and gender environment.

Wherever possible and applicable, the discussion covered the following aspects:

- ❖ The present baseline conditions;
- ❖ The change in environmental parameters likely to be affected by proposed project related activities;
- ❖ Identification of potential impacts;
- ❖ Mitigation measures to reduce impacts to as low as possible;
- ❖ Prediction of impacts;
- ❖ Evaluation of the importance or significance of impacts;
- ❖ Implementation of mitigation measures (i.e. Environmental management).

1.10.4 Documentation

At the end of the assessment, a report was prepared according to the relevant guidelines of the EPA, This report includes the findings of the assessment, project impacts, and mitigation measures to be implemented during the execution of the proposed activities.



PROJECT DESCRIPTION

2.1 GENERAL OUTLINE

This section gives the technical details of a construction, installation and operation activities, wastes and its handling or services that can interact with the environment. The purpose of this section is to find and evaluate the risk associated with the operation activities and intended to reduce significant impacts, leading to improved environmental performance. The detailed environmental monitoring and site audit findings are presented in proceeding sections of this IEE report.

2.2 THE ENERGY CRISIS IN PAKISTAN

The growing Pakistani economy has been brought to a virtual stand-still due to the Country's acute power shortage in the recent years. Many industries (including the very significant textile industry) have been forced to shut down entirely or slow down their industrial production; and households in cities and villages alike are facing load-shedding of 12 hours per day in summer months. The power shortage that was estimated to be between 1,000 and 2,000 megawatt (MW) in 2007 is estimated to be in excess of 6,000 MW in 2013 (HBP, 2013); and electricity shortfalls reached a peak of 8,500 megawatts (MW) in June 2012 - more than 40% of national demand (NBR, 2013).

There are multiple reasons for the current energy problems in the country. In addition to actual supply shortfall, there are issues of financial mismanagement and governance weaknesses. There is no comprehensive and integrated energy strategy and an insufficient level of funding is available for investment in energy projects (NBR, 2013). In 2012, the figure for circular debt (induced by financial mismanagement) exceeded PKR 872 Billion (IPRI, 2013).

Prevailing power shortages present a serious constraint to economic growth in Pakistan. Power outages of the order of six to eight hours can be attributed to growth in demand for power; poor condition of thermal power plants in the public sector; shortfall in supply of natural gas to the combined cycle independent power producers (IPP); and, the circular debt arising out of withholding of payments by the government for fuel as well as power produced by the generating units.

Peak summer shortfall in 2012 touched 6,000 MW, corresponding to 32% of the demand in the country. In 2013, the estimated shortfall stayed at the same figure¹ and according to recent estimates, the summer shortfall in 2014 is expected to stand between 4,000 to 5,000 MW².

¹ Kazmi, Shabbir. "Pakistan's Energy Crisis." The Diplomat. <http://thediplomat.com/2013/08/pakistansenergy-crisis/> (accessed September 29, 2014).

² Ahmadani, Ahmad. "Unannounced load shedding starts paralysing industry, life." Daily Times. <http://www.dailytimes.com.pk/islamabad/28-Apr-2014/unannounced-load-shedding-starts-paralysingindustry-life> (accessed September 29, 2014).

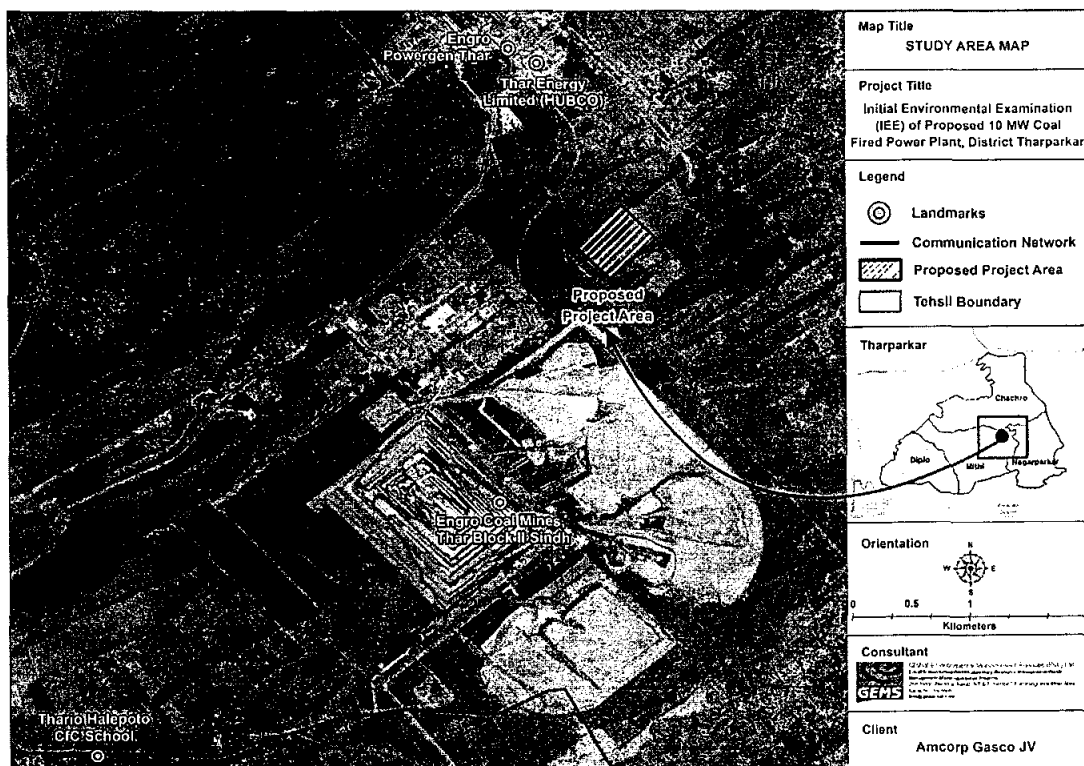
Pakistan, therefore, has an urgent requirement to generate additional power to feed into the national grid. Any slippage in the addition of new generation capacity or fuel availability will further widen the gap between supply and demand.

Closing the gap in the energy shortfall is also a high-priority matter for elected governments in Pakistan. In 2013, the Ministry of Water and Power (MoWP) of the Government of Pakistan developed a power policy³ to support the current and future energy needs of the country. The policy aimed at addressing key challenges facing the power sector in order to provide much needed relief to the citizens of Pakistan.

2.3 PROPONENT ADDRESS & LOCATION MAP

The proposed Project site is located in the southeast corner of the Sindh Province of Pakistan in the Thar Desert, southern part of the Thar Coalfield. The proposed covered area of the project is about 20,000 m² (100m x 200m), project Location map can be seen in Exhibit: 2.1 and layout plan is given as Exhibit 2.2.

Exhibit 2. 1: Project Location map



³ Government of Pakistan, National Power Policy, 2013,
<http://pakistan.gov.pk/gop/index.php?q=aHR0cDovL3d3dy5tb3dwLmdvdi5way9nb3AvaW5kZXgucGhwP3E9YUhsMGNEb3ZMekU1TWk0eE5qZ3VOekF1TVRNMcWwMXZkM0F2>

The diagram is a detailed architectural floor plan of a power plant layout. It shows various rooms and equipment, including a fuel storage area (燃料仓库), a fly ash silo (灰库), a dust collector (除尘器), a boiler room (锅炉房), a turbine house (汽机房), and a condenser (凝汽器). It also includes a cooling water pool (冷却水池) and a condenser water pump house (凝结水泵房). The layout is organized into several sections, with a central corridor and various service areas. The plan is labeled with both Chinese and English text.

2.4.1 Construction Activities

- Site clearance
- Vegetation removal
- Earthworks
- Water supply, waste disposal and wastewater treatment
- Site access, traffic and transport.

GEMSIEE2020221AGJVPL

2.4.2 Project Timeframe

S. No.	Detail
1.	24 months from June 2021
2.	FC scheduled to complete by June 2021
3.	Engineering work to complete by June 2021
4.	Construction will be start in July, August 2021 and commissioning to complete 24 months from FC.

2.4.3 Process Description of Power Plant

The configuration will be 1 x 10 MW steam turbine and 1 Boilers (100 % operational). A minimum system availability of 95% has to be ensured. The power installation capacity of 10000kW in according with this thermal and electrical load to build a co-generate power plant in order to save energy, improve the environment, enhance the quality of power supply. Boiler will be of fluidized bed technique, Main steam maximum continuous rating 50 t/h, Superheater outlet steam temperature 450°C, Superheater outlet steam pressure 3.82MPa(g), Feed water temperature 150°C, Flue gas temperature at A/H outlet 140°C, Boiler design efficiency 91.±1%, Minimum stable combustion load 60% MCR(without oil supporting). The steam turbine will be a standard multistage, single-cylinder, non-reheat, condensing unit. The turbine will exhaust against condenser pressure of 6kPa (0.06ata) at the design condenser cooling water temperature.

The proposed Project will consist of a lignite fired power plant capable of generating 10MW electricity, circulating fluidized bed (CFB) boiler will be installed at the plant. The boiler will provide steam for a steam turbine/generator.

The proposed power plant will be connected to the existing grid of the project site, Coal as a fuel will be supplied to the power plant from the SECMC coal yard through dump trucks. The proposed power plant will burn around 10,000 Ton Per month of coal monthly, more or less 300kg bottom ashes per hour and around 10 ton per hour fly ash may be produced.

Along with the proposed power plant, coal storage and handling facilities, ash handling and disposal facilities, and cooling water intake and outfall channels will also be constructed in the vicinity of the power plant.

Boilers typically emit gases containing NO_x, SO_x, CO, CO₂ and Particulate Matter (PM) which are harmful for both humans and the environment. Using emission control systems, the Project will emit these pollutants at rates which comply with the limits prescribed by the Sindh Environmental Quality Standards (SEQS) and the International Financial Corporation's (IFC) limits for emissions from coal-fired boilers. This will help ensure that the concentrations of these pollutants in ambient air will be within the ambient air quality levels prescribed by the SEQS.

Effluents from the plant will be treated and monitored for compliance with SEQS before being discharged into the sea. All other industrial effluents such as those from the boiler make-up water treatment system; oily waste and sanitary waste will be treated to comply with SEQS and re-used as far as possible. Water will also be used to mix with ash to form ash slurry and for washing coal. Here too, water will be treated and re-used.

The major components of the power plant include;

1. Steam Generating Unit

The boiler shall be designed according to MCR condition and can provide reliable superheated steam as well as to ensure the normal operation of turbo-generator, therefore the following functional specification will be required for the boiler.

2. Combustion system

When cold start, fill in thickness of 300mm ~400mm start-up inert material, the inert material shall be in size of 0-6mm, average in 2mm and total volume in 6 cubic meters, then start under bed igniter to burn and generate 870 °C high temperature gas.

1. Startup Firing Devices
2. Cyclone Separator
3. Loop-seal device
4. Air-driven fuel feeding device
5. Superheaters and Attemperator
6. Economizer
7. Air preheater
8. Boiler Auxiliary Equipment
9. Boiler Feed Water Pump
10. Deaerating Heater
11. Electrostatic Precipitators
12. Stack

- 15) Turbine Generation unit

- 16) Condenser

The major activities with regards to the operation of the power plant include the following.

- ✓ Coal for the power plant will be received at the coal supplied by SECMC coal yard, it will be processed before feeding into the boiler. Heat from the combustion of coal in the boiler will be used to generate steam at high pressure. The steam will then be fed into a steam turbine, where it will rotate the turbine to generate mechanical energy.
- ✓ Flue gas from the boiler is normally laden with pollutants such as NO, PM and SO. The gas will be passed through a series of treatment units to remove the pollutants before being discharged into the atmosphere.

- ✓ Cooling water is required to condense the steam exiting the turbine for reuse as water into the boiler. Cooling water for the proposed Project will be obtained from the existing water storage area of SECMC.
- ✓ Bottom ash from the boiler and fly ash from the flue gas treatment system will be collected and disposed into ash yard through the ash handling system.

The configuration will be 1 x 10 MW having steam turbine and a Boiler, below are the details:

• Gross Capacity	• 10MW
• Fuel Type	• Lignite (coal)
• Plant Type /Model	• Steam Turbine with CFB boiler Type
• Gaseous Emission	• CO ₂ , Co, SO _x , NO _x , Particulate matter, etc.

2.4.4 Proposed Technology for Boiler Combustion

The main reason for selecting CFB boiler is fuel flexibility, low SO₂ and NO emissions and its combustion efficiency. CFB has several advantages compared to Pulverized Fuel (PF) especially because it promises to be a cost effective to PF while at the same time allowing sulfur capture without the use of add-on scrubbers. Moreover, the technology is suitable for high ash, variable quality, high moisture and high sulfur fuels. Its ability to effectively control gaseous emission without the need to install additional SO_x treatment system. In addition, CFB combustion has significantly lower power consumption compared to PF system. Therefore, the selected combustion technology is the best available technology for the proposed Project.

Boiler will be of fluidized bed technique, Main steam maximum continuous rating 50t/h, Superheater outlet steam temperature 450°C, Superheater outlet steam pressure 3.82MPa(g), Feed water temperature 150°C, Flue gas temperature at A/H outlet 140°C, Boiler design efficiency 91.±1%, Minimum stable combustion load 60% MCR(without oil supporting)

2.4.5 Coal Quality

Lignite will be used for the proposed power plant. The specifications of lignite is given in **Exhibit 3.4**.

Exhibit 2. 3: Lignite specifications

Parameters	Range
• Moisture (%)	• 37.40-57.73
• Ash (%)	• 4.34- 13.23
• Volatiles (%)	• 20.06 -29.33

• Fixed Carbon (%)	• 14.03 -22.66
• Total Sulphur (%)	• 0.61- 1.93
• Lower Heating value (Mi/kg)	• 8.70- 14.69

2.4.6 List of chemicals and its usage

The chemical feed system, consisting of ammonia and phosphate dosing, is required to control the water and steam chemistry of the cycle and to minimize scaling and corrosion. Ammonia will be injected into the feed water for maintaining pH value in the proper range to minimize cycle corrosion. Phosphate dosing equipment will be sized to feed phosphate into boiler drum in order to prevent boiler from scaling and corrosion. Exact quantities of ammonia and phosphate to be identified during detailed engineering. Moreover, Sulphur in fuel is 1.3 percent Ca/S ratio 2.0 to 3.0 on this basis 600 to 700 kg/hr of limestone will feed.

2.4.7 Coal handling and storage

The function of the coal handling system is to receive, store and deliver to the boiler silos. Lignite Coal will be supplied from the SECMC coal yard to the proposed project site through dump trucks, fly ash and coal dust will be controlled by water sprinkling on daily basis. The coal stocking area is concreted and will be uncovered. Water drainage, collection and subsequent treatment will be provided.

2.4.8 Ash Handling and Disposal System

Coal combustion residuals commonly referred to as coal ash, are the materials that remain after burning coal for electricity. Combustion residuals to be produced at the Project include, Fly ash and Bottom ash. All the waste including fly ash and bottom ash will be collected and disposed of through the ash handling system, as informed by the management, ash will be disposed off within 1 km radius of proposed site.

2.4.9 Cooling System

2.4.9.1 System Description

The circulating water system, the main heat rejection system, consists of structures and mechanical equipment which serve the main condensers and cooling water systems to reject plant heat to the atmosphere. The makeup water to the system will be taken from the mine ground water and treated by reverse osmosis with the addition of chemicals to reduce hardness. The main components of the circulating water system are cooling towers, circulating water pumps, condenser and its associated valves, and instrumentation and controls.

2.4.9.2 Cooling Tower

The cooling towers cool the heated circulating water by evaporation process that occurs when water droplets are brought into direct contact with the upwards-flowing ambient air, i.e., the wet-type cooling tower process. The required raw water to be provided by SECMC, which is about 110 ton per hour.

2.4.10 Domestic Water

Domestic water tank is for storing plant domestic water, the domestic water is pumped to users of the power plant.

2.5 HAZARDOUS WASTE MANAGEMENT

Hazardous Waste Storage Facility (HWSF) will be constructed at site to store and handle hazardous wastes generated at facility during all phase of Project. All the liquid effluent would be produced from the plant boundary will be treated though the wastewater NEQS/SEQS compliant; the emissions will also be NEQS/SEQS compliant. The Reject from RO plants, will be disposed with continuous reinjection or in the evaporation ponds near dewatering disposal site.

2.5.1 Solid and Liquid Waste Treatment or Management

For solid waste proper waste segregation process to be followed at site during construction and plant operation and their disposal shall be made as per HSE guideline. Moreover, soak pit will be constructed at site for human waste and its cleaning to be performed by vacuum bowser as and when required basis. Further, for normal plant operation (including blow down of cooling water) a dedicated evaporation pond will be constructed to handle liquid disposal.

2.6 ENVIRONMENTAL MANAGEMENT AND CONTROLS EQUIPMENT

2.6.1 Flue Gas Treatment System (FGTS)

The particulate emission level standard calls for 100 mg/Nm³ of gas effluent, which level is technically feasible and reasonable cost with regard to present state of the art in ash collection. The electrostatic precipitator will be provided for the ash/particulate countermeasures. The coal proposed has an average sulfur content of 1.3 %. Because of high sulfur content, it use spouting limestone powder for desulphuration in boiler. Desulphuration efficiency between 85~90%, limestone consumption is about 600-750kg/h, the requirement of particle size is between 0-1mm, and the particle size smaller than 0.5mm should more than 50%. Because this sulfur content is higher, no special treatment for reducing SO₂ in the flue gas is proposed. All SO₂ emissions will pass through the stacks. The stack height will ensure that the ground level concentration of SO₂ remains within the acceptable limits. The height of the stack, in conjunction with the proper boiler burner design with low combustion temperature, will ensure that the ground level concentration of NO_x also remains within the acceptable limits.

2.6.1.1 Electrostatic Precipitators (ESP)

ESP will be located downstream of the air preheater. The ESP will have one set of single chamber three-electric-field type ESP, the model of which is SWB-30, flue gas flow area is about 30m², for the design coal, the ESP efficiency shall be not less than 99.5% at boiler MCR. ESPs are the most economical technology for removal of this percentage of particulate. The main components of the ESP will include carbon steel casings and baffles, stainless steel discharge electrodes, carbon steel collecting plates, high-voltage transformer and rectifier sets, controls, and a rapping system. Staggered rapping hammers will minimize dust entrainment, because adjacent hammers do not hit simultaneously.

2.6.2 Health Safety Environment

For the Environmental Management and Control the proponent has already a dedicated team of Health, Safety, Environment (HSE) professionals for the proposed project, HSE department shall perform following functions during the entire life cycle (from construction till operations) of the proposed project:

- To devise, implement and amend (if required) HSE and Quality Policy.
- To implement Environmental Management and Monitoring Plan (EMMP).
- To monitor the progress of IEMC (Independent Environmental Monitoring Consultant) and comment on IEMC reports as well as ensure effective, timely and concrete implementation of EMMP in true spirit.

2.6.3 Groundwater Treatment System

Raw water supply will be from groundwater, which is brackish in nature and will be supplied from adjacent mining area dewatering facility. The treatment facility will be located near the mine stockyard and Service facilities. The treated water will be pumped to the power plant, the anticipated power plant normal demand of makeup raw water is about 120 ton per hour.

The source of water used for the power plant will be from groundwater, which is brackish in nature and will be supplied from adjacent SECMC facility. The water will be treated for meeting the power plant requirement according to water quality analysis. The raw water treatment capacity is 110 ton per hour.

2.6.4 Dust Suppression and Temperature Monitoring

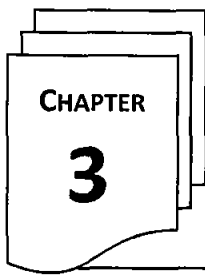
To prevent contamination of the atmosphere with coal dust, a water spray system will be located at strategic locations at the coal yard for use by yard personnel, as needed. Coal piles will be inspected daily for visible signs of hot spots. Temperature monitoring probes will be strategically located at the coal piles.

2.6.5 Project Synopsis

Project synopsis can be seen in **Exhibit: 2.6.**

Exhibit 2. 4: Coal Fired Power Plant's Features

S. No.	Description	
Construction Material usage		
1.	Cement, Crush, Sand, Water	
2.	Grout & chemicals (additives)	
3.	250kVA electricity will be required during construction phase	
4.	250 average manpower for the period of 12 months	
Operation Phase Usage		
1.	Coal type	Lignite
2.	Power plant capacity	10MW
3.	Lignite burning capacity per month	10,000 Ton
4.	Bottom ash production capacity	300 kg per hour
5.	Fly ash production capacity	10 ton per hour
6.	Make up water requirement	120 ton per hour
7.	Gaseous emissions	CO2, CO, NOx, SO2, Particulate Matter.
8.	Chimney	40 meter
9.	Steam turbine temperature	450°C
10.	Feed water temperature	150°C
11.	Generator	50MMKWH



INSTITUTIONAL, LEGISLATION AND POLICY FRAMEWORK

3.1 GENERAL OUTLINE AND SCOPE

There are a number of national and regional requirements that the project will have to comply with in addition to appropriate international standards. This section provides a brief overview of the applicable legislation, associated regulations and relevant standards that will be applied to the Project. As this chapter presents a synopsis of environmental policies, legislation and other guidelines that have relevance to the proposed project.

The environmental study primarily includes review of EIA/IEE regulations 2014 of Sindh Environmental Protection Act. All other laws and guidelines relevant to the proposed project have also been reviewed.

3.2 NATIONAL ENVIRONMENTAL POLICY, LEGISLATION AND GUIDELINES

The enactment of comprehensive legislation on the environment, covering multiple areas of concern, is a relatively new and ongoing phenomenon in Pakistan. Whereas, a basic policy and legislative framework for the protection of the environment and overall biodiversity in the country is now in place, detailed rules, regulations and guidelines required for the implementation of the policies and enforcement of legislation are still in various stages of formulation and discussion. The following section presents a brief overview of the existing national policies, legislation and guidelines.

3.2.1 Sindh Environmental Protection Act 2014

The Sindh Environmental Protection Act, 2014 (SEPA 2014) is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The SEPA 2014 is broadly applicable to air, water, soil, marine and noise pollution. Penalties have been prescribed for those contravening the provisions of the Act.

The two primary deliberations of the Act are the conduct of projects only after approval of environmental assessments from the SEPA and adherence with Sindh Environmental Quality Standards (SEQS). For administrative purposes, it is part of the Forest, Environment and Wildlife Department of the Government of Sindh. SEPA is a regulatory agency with the following main functions:

- ✓ Enforcement of Sindh Act 2014
- ✓ Implement environmental policies
- ✓ Ensure implementation of Sindh Environmental Quality Standards (SEQS)

- ✓ Establish systems and procedures for environmental management
- ✓ Issue license for handling of hazardous substance
- ✓ Specify safeguards for the prevention of accidents which may cause pollution
- ✓ Review and approve mitigation plans and give guidance for clean-up operations
- ✓ Carry out any other task related to the environment assigned by the government

3.2.2 The Sindh Environmental Quality Standards

With the SEPA Act, 2014 the Sindh EPA revised the Environmental Quality Standards (EQS) with full consultation of the private sector, industrialist, trade and business associations and NGOs and approval of Sindh Environmental Protection Council has developed Sindh Environmental Industrial Wastewater, Effluent, Domestic Sewerage, Industrial Air Emission, Ambient Air, Noise for vehicles, Air Emissions for Vehicles and Drinking Water Quality Standards 2015 vide Notification No. EPA/TECH/739/2014. During the construction and post development phase of the project SEQS will apply to all effluents and emissions.

3.2.3 Approval from Sindh Environment Protection Agency (SEPA)

As per the 2014 Regulations, Proponent will submit an IEE report for their proposed project activities to SEPA, and seek approval on the same from the Agency. Ten (10) hard copies and two (02) soft copies of the IEE report will be need to be submitted to SEPA. It will then grant its decision on the IEE as per the rules and procedures set out in the 2014 Regulations. The following rules will apply:

- ❖ A fee is payable to SEPA for review of the EIA& IEE;
- ❖ The IEE submission is to be accompanied by an application in the format prescribed in Schedule V of the 2014 Regulations;
- ❖ SEPA is to conduct a preliminary scrutiny and reply within fifteen (15) days of the submission of the report a) confirming completeness, or b) asking for additional information, if needed;
- ❖ In the review process SEPA may consult a Committee of Experts, which maybe constituted on the request of the DG SEPA;
- ❖ On completion of the review process, the decision of SEPA will be communicated to the proponent in the form prescribed in Schedule V;
- ❖ Where an IEE is approved, SEPA can impose additional controls as part of the conditions of approval;
- ❖ SEPA is required to make every effort to complete the IEE review process within sixty (60) days of the issue of confirmation of completeness. However, SEPA can take up to four(4) months for communication of final decision;

- ❖ The approval will remain valid for the project duration mentioned in the IEE but on the condition that the project commences within a period of three (03) years from the date of approval. If the project is initiated after three years from approval date, the proponent will have to apply for an extension in the validity period. The SEPA on receiving such request grant extension (not exceeding 3 years at a time) or require the proponent to submit a fresh IEE if in the opinion of SEPA changes in baseline conditions or the project so warrant;
- ❖ After receiving approval from SEPA the proponent will acknowledge acceptance of the conditions of approval by executing an undertaking in the form prescribed in Schedule VI of the 2014 Regulations;
- ❖ The 2014 Regulations also require proponents to obtain from SEPA, after completion of the project, a confirmation that the requirements of the IEE and the conditions of approval have been duly complied with;
- ❖ The SEPA in granting the confirmation of compliance may impose any additional control regarding the environmental management of the project or the operation, as it deems necessary.

3.2.4 Sindh Environmental Protection Agency Review of IEE and EIA Regulations, 2014

The SEPA Review of IEE and EIA Regulations, 2014 (The 2014 Regulations) promulgated under SEPA 2014 were enforced on December, 2014. The 2014 Regulations define the applicability and procedures for preparation, submission and review of IEEs and EIAs. These Regulations also give legal status to the Pakistan Environmental Assessment Procedures prepared by SEPA in 2014.

The Regulation classifies projects on the basis of expected degree of adverse environmental impacts and lists them in two separate schedules. Schedule I lists projects that may not have significant environmental impacts and therefore require an IEE. Schedule II lists projects of potentially significant environmental impacts requiring preparation of an EIA. The Regulations also require that all projects located in environmentally sensitive areas require preparation of an EIA.

The proposed project falls under the review of IEE/EIA regulation 2014:

Category B of Schedule I (IEE):

3.2.5 National Conservation Strategy (NCS)

The National Conservation Strategy (NCS) is the primary Policy document of the Government of Pakistan on national environmental issues. The Policy was approved by the Federal Cabinet in March 1992. The Strategy also attained recognition by international donor agencies, principally the World Bank. The NCS identifies 14 core areas including conservation of biodiversity, pollution prevention and abatement, soil and water conservation and preservation of cultural heritage and recommends immediate attention to these core areas in order to preserve the country's environment.

A midterm review of the achievements of the NCS in 2000 concluded that achievements under the NCS have been primarily awareness raising and institutional building rather than actual improvement to environment and natural resources and that the NCS was not designed and is not adequately focused as a national sustainable development strategy¹. The need therefore arose for a more focused National Environmental Action Plan (NEAP) required to bring about actual improvements in the state of the national environment with greater emphasis on poverty reduction and economic development in addition to environmental sustainability.

The NEAP was approved by the Pakistan Environmental Protection Council under the chairmanship of the President/Chief Executive of Pakistan in February 2001. NEAP now constitutes the national environmental agenda and its core objective is to initiate actions that safeguard public health, promote sustainable livelihoods, and enhance the quality of life of the people of Pakistan.

A National Environmental Policy has been approved by the Federal Cabinet in its meeting held during June 2005². This policy has already been endorsed by the Pakistan Environmental Protection Council during 2004. The new policy has total 171 guidelines on sectoral and cross-sectoral issues. The objectives of new policy include assurance of sustainable development and safeguard of the natural wealth of country. The following are the approved Sectoral Guidelines;

- ❖ Water Supply and Management;
- ❖ Air Quality and Noise;
- ❖ Waste Management;
- ❖ Forestry;
- ❖ Biodiversity and Protected Areas;
- ❖ Climate Change and Ozone Depletion;
- ❖ Energy Efficiency and Renewable;
- ❖ Agriculture and Livestock;
- ❖ Multilateral Environmental Agreements.

¹Arthur J. Hanson et al, *Pakistan's National Conservation Strategy Renewing Commitment to Action, Report of the Mid-Term Review, 2000*

²National Environmental Policy, GoP, 2005

3.3 OTHER RELEVANT LEGISLATION

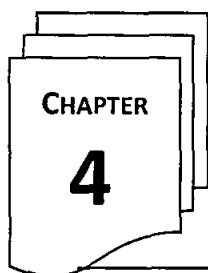
In addition to the environmental and social legislation presented in the previous sections, there is a range of further sectorial legislation that is relevant to the Project. This is summarised in **Exhibit 3.1**.

Exhibit 3. 1: Relevant Legislation

S. No.	Legislation (year of Issuance)	Brief Description
1.	Thar Coal and Energy Board Act, 2011	Thar Coal and Energy Board Act, 2011 was passed by the Provincial Assembly of Sindh on 8 June, 2011 and assented to by the Government of Sindh on 28 June, 2011 and is published as an act in the Legislature of Sindh. Under this act a board is required to be set up, and the membership of the board is made up of representatives from multiple government agencies with an interest in the Thar region or in the development of coal mining and power production. The Thar Coal and Energy Board (TCEB) will have a central role with its mandate for inter-agency support for Thar coal development especially related to policy formulation, programme/project monitoring and project facilitation at every stage of Thar coal projects.
2.	Pakistan Penal Code 1860	The Pakistan Penal Code deals with offences where public or private property and/or human lives are affected, due to intentional or accidental misconduct of an individual or body of people. In context of the environment, the penal code empowers local authorities to control noise, noxious emissions and disposal of effluents.
3.	Factories Act 1934	The Factories Act provides regulations for handling and disposal of toxic and hazardous materials. As construction activity is classified as 'industry', these regulations will be applicable.
4.	Sindh Wildlife Ordinance 1972 and Amendments 2001	Sindh Wildlife Ordinance 1972 and Amendments 2001 details the rules, regulations and permits for hunting, trapping, capturing of game animals; conservation of national parks, game reserves; and the laws and guidelines of working in protected area and sanctuaries.

S. No.	Legislation (year of Issuance)	Brief Description
5.	The Antiquities Act, 1975 and Sindh Cultural Heritage Act 1994	These acts deal with protection, preservation and conservation of archaeological/historical sites and monuments. It binds project proponents to notify the department if anything of archaeological value is discovered during project construction.
6.	The National Mineral Policy (NMP), 1995	This policy aims at promoting and developing the mining sector in Pakistan mainly through private investment. It includes environmental safeguards and compensation for injury.
7.	Sindh Coal Act 2012	The Sindh Coal Act 2012 has been designed to provide for regulation and development of coal in the Province of Sindh. Sections 6 and 7 of the Act stipulate that an environmental impact assessment, social assessment and environmental management plan are required for all projects engaged in exploration and exploitation of coal. Coal-based power generation or any other use of coal shall comply with the resettlement policy of the Government of Sindh.
8.	National Resettlement Policy 2002 and Interim Resettlement Framework Guidelines 2011	The National Resettlement Policy 2002 was developed to ensure equitable and uniform treatment of resettlement issues across Pakistan and applies to all development projects involving adverse social impacts, land acquisition, loss of assets, income and businesses. The Interim Resettlement Framework Guidelines 2010 set out the institutional, legal, and implementation framework to guide the resettlement and rehabilitation of project affected people (PAP) who will be adversely affected by the development of a project.
9.	Electricity Act, 1910	The Act provides a legal base for power distribution. A licensee under this Act is enabled to operate supply of electricity. This Act obligate licensee to pay compensation for any damages caused during the constructions and maintenance of any power distribution facilities.

S. No.	Legislation (year of Issuance)	Brief Description
10.	International standards and guidelines	Substantial information/data exists from previous assessments and studies undertaken in the area. As such, the air quality and waste and materials management chapters were able to be prepared in accordance with the International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability 2012 (IFC PS).
11.	The Pakistan Environmental Assessment Procedures, 1997	The Pakistan Environmental Protection Agency prepared the Pakistan Environmental Assessment Procedures in 1997. They are based on much of the existing work done by international donor agencies and Non-Governmental Organizations (NGO's). The package of regulations prepared by PEPA includes: ❖ Policy and Procedures for Filing, Review and Approval of Environmental Assessments; ❖ Guidelines for the Preparation and Review of Environmental Reports; ❖ Guidelines for Public Consultation; ❖ Guidelines for Sensitive and Critical Areas; and ❖ Sectoral Guidelines for various types of projects.



PHYSICAL ENVIRONMENT

4.1 GENERAL OUTLINE AND SCOPE

This section gives the detailed description of the physical environmental conditions of the study area. The data collection techniques is combination of both primary and secondary means by field verifications, observations, sampling and monitoring which was supplemented by review of published literature and previous studies conducted in the proposed project surrounding areas. The baseline data defines and elaborates present physical environmental quality within the project surrounding.

KEY FEATURES OF PHYSICAL BASELINE

- ✓ Topography and land use
- ✓ Geology
- ✓ Climate
- ✓ Air Quality
- ✓ Water Resources
- ✓ Water Quality

4.2 TOPOGRAPHY AND LAND USE

The proposed project is located at taluka Islamkot of district Tharparkar in Sindh province of Pakistan. This district is bounded by India on the East, Rann of Kuch on the South, district Umerkot and Mirpurkhas on the north and district Badin on the west¹. The topography of Islamkot is typical of the Thar Desert and consists of barren tracts of sand dunes covered with thorny shrubs. The modest variations in elevation is observed, with a maximum elevation change of 233 feet, and an average elevation above sea level of 241 feet². A topographical elevation map of the proposed project area is shown in **Exhibit 4.1**³. It has an undulating relief with areas of higher ground consisting of elongate and parabolic sand dunes, running parallel to the prevailing northeasterly winds. Dunes are interspersed with areas of very flat plain being approximately 90 m amsl⁴. The proposed project area can be divided into two major parts with respect of surface undulation, this includes desert portion and agricultural land.

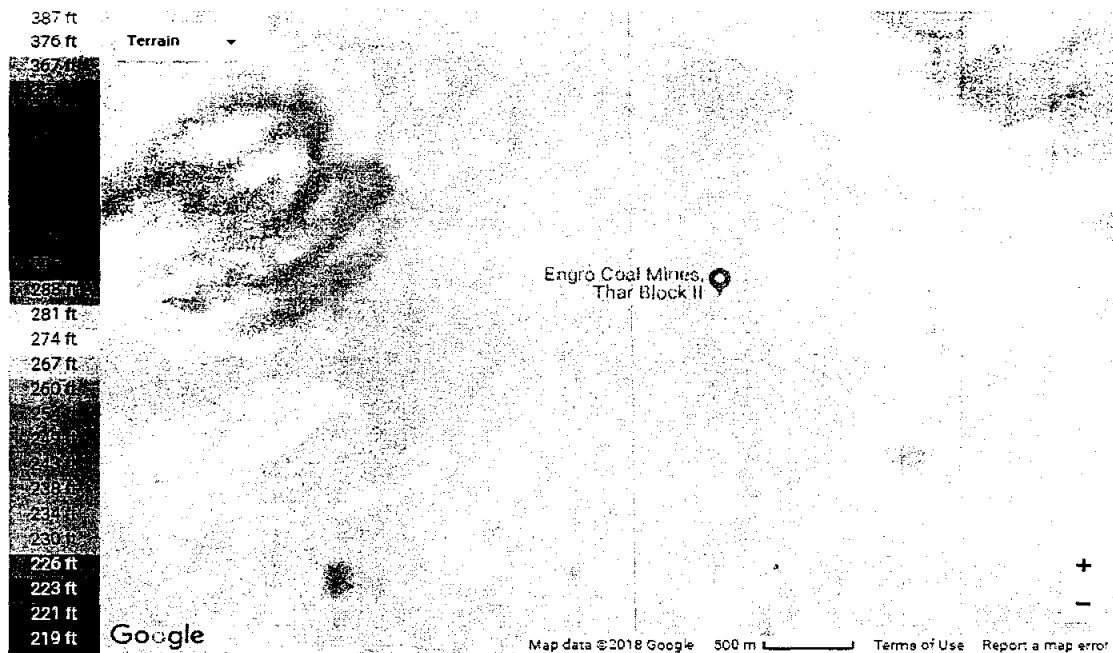
¹ <http://reliefweb.int/sites/reliefweb.int/files/resources/PESA-DP-Tharparkar-Sindh.pdf>

² www.weatherspark.com

³ <http://en-gb.topographic-map.com>

⁴ [http://shehri.org/eia-reports/EIA%20report-vol 1%20330MW%20Thar%20Energy%20HubPower%20Company%20\(2\).pdf](http://shehri.org/eia-reports/EIA%20report-vol%201%20330MW%20Thar%20Energy%20HubPower%20Company%20(2).pdf)

Exhibit 4. 1: The Topographic Elevation Map of the Proposed Project Area



4.3 GEOLOGY AND SOIL

The Thar Desert lies in the southeastern part of Pakistan, on the western edge of the stable Indian Peninsula. Thar coalfield rests directly on relatively shallow, rifted basement rocks of late Pre-Cambrian age. The whole area is covered with extensive & thick cover of sand dunes, extending down to an average depth of 80m⁵. The dune is brown to yellowish grey, very fine to fine grained, slightly silty and clayey. The almost barren sand is locally enriched with higher clay/silt in some areas especially in interdune valleys, where flood waters accumulate the silt. There the soil is favorable for crop production relative to sand dune both because of some enrichment in potassium and calcium within these silty materials and the increased water bearing capacity of these strata. At the bottom, hard bands of sandstone occur which are slightly calcareous and argillaceous (Khan et al., 1993). Surface rock exposures are almost absent, except limited outcrops of granitic basement in Nagarparkar. A few scattered outcrops of Mesozoic and Tertiary strata are exposed across the Indo-Pakistan border in the Jaisalmer and Rann of Kutch areas of India. On the basis of drill whole data, four sub-surface litho-stratigraphic units have been identified. The units are dune sand (recent), Alluvial deposits (sub-recent), Bara formation (Paleocene) and Basement Complex (Pre-Cambrian)⁶.

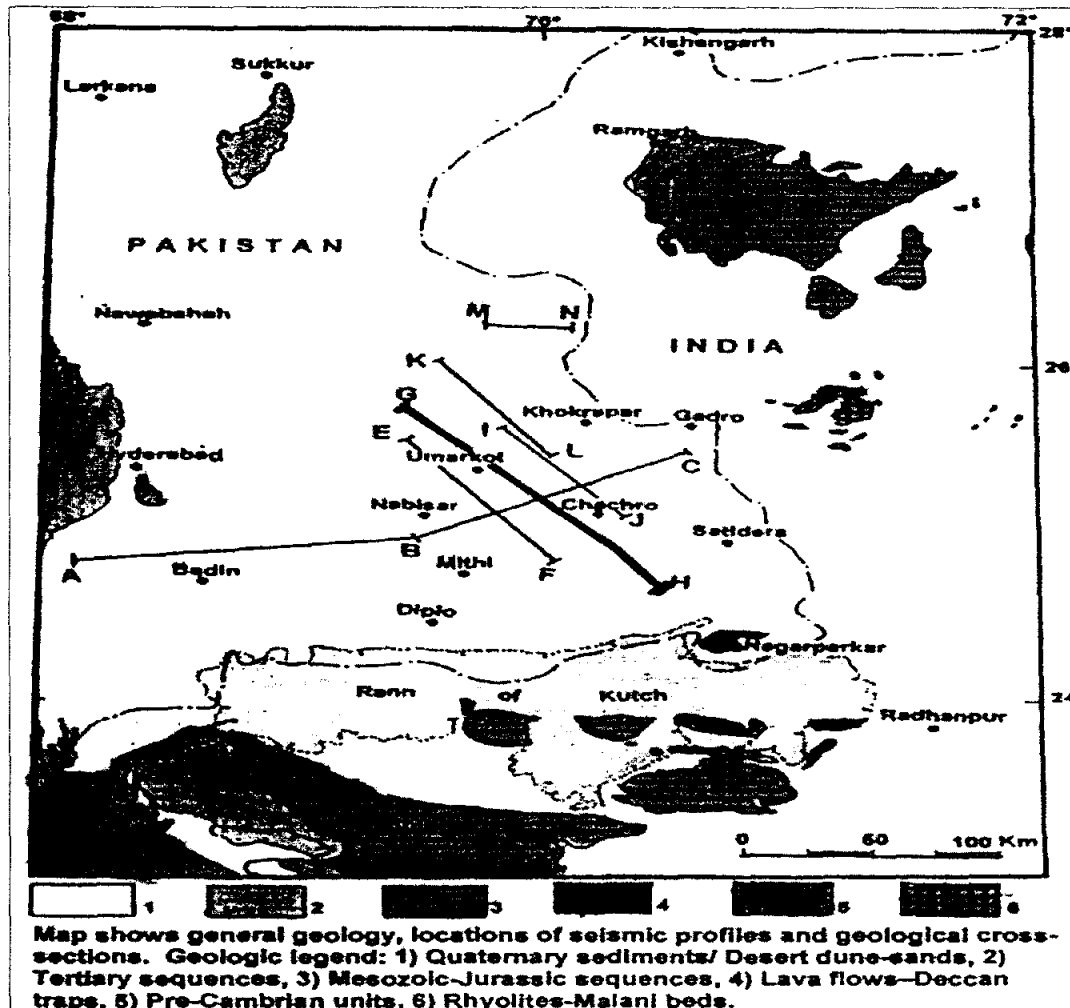
Most parts of Sindh are covered either by recent alluvium or wind-borne sand. The principal features of geological significance are to be found in the hilly portions of the province, towards the west of the Indus. Outlying extensions of this hilly tract occur east of the Indus as well, near Sukkur, Hyderabad

⁵http://www.sciencevision.org.pk/BackIssues/Vol7/Vol7No34/Vol7No34_4_6_Strategic_Sustainable_NayyarAlam.df

⁶https://www.academia.edu/8052739/Environmental_and_Social_Baseline_of_Thar_Coalfield_Block_-11

and Jerruck. The isolated hills of Nagarparkar on the northern border of the Rann of Kutch belong to quite a different system both geographically and geologically. The geological map of Thar is presented as Exhibit 4.2.

Exhibit 4. 2: Geological Map of Thar



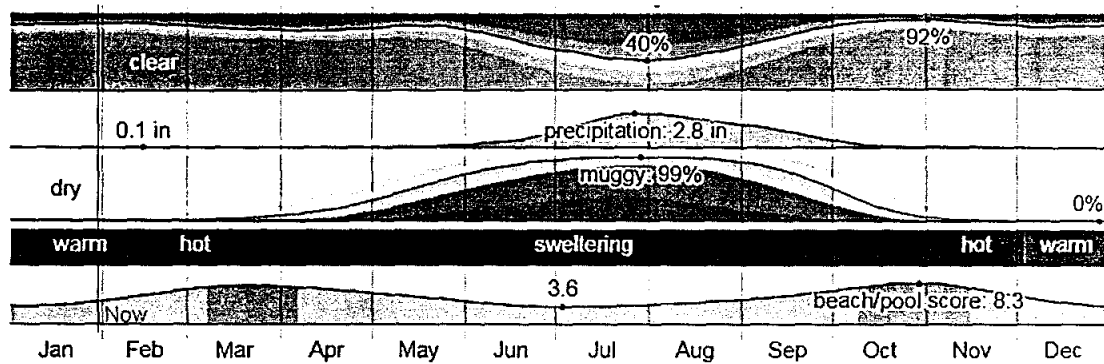
Source: Strategic Sustainable Development of Groundwater in Thar Desert of Pakistan⁷

4.4 CLIMATE

In Islāmkot, the summers are short, sweltering, muggy, and windy; the winters are short and comfortable; and it is dry and mostly clear year round. Over the course of the year, the temperature typically varies from 52°F to 108°F and is rarely below 45°F or above 113°F.

Based on the beach/pool score, the best times of year to visit Islāmkot for hot-weather activities are from early March to early April and from early October to mid-November.

⁷http://www.sciencevision.org.pk/BackIssues/Vol7/Vol7No34/Vol7No3&4_6_Strategic_Sustainable_NayyerAlam.pdf

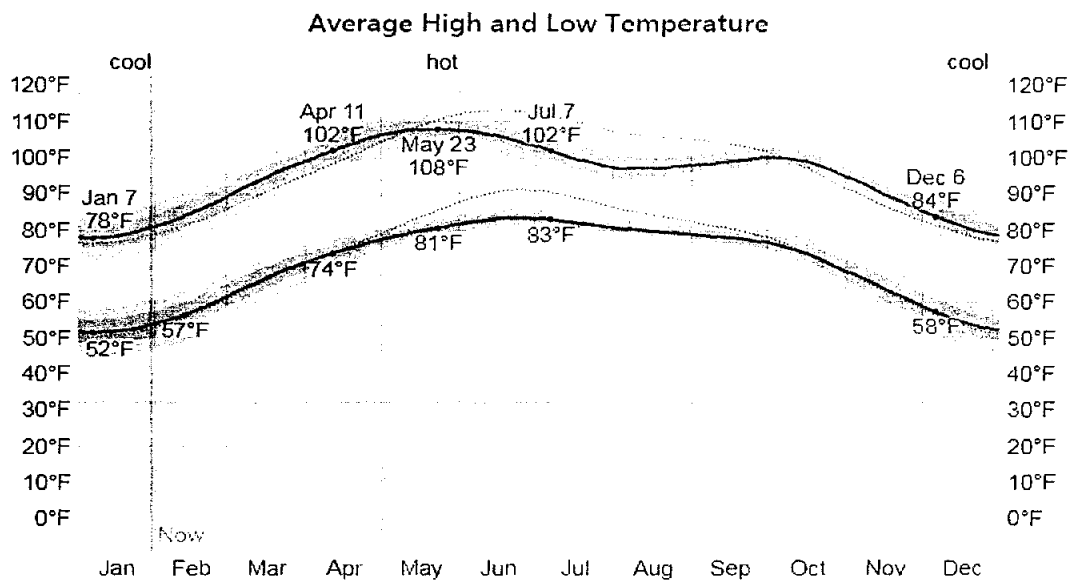


Thar Desert has semi-arid to arid climate. The present climatic situation in Pakistan is mainly influenced by the circulation of the monsoons, which depends on the movement of the intertropical convergence zone. Strong, humid and cold southwest monsoons prevail in the summer months from May to September. The strength of the southwest monsoon depends mainly on the pressure gradient between the low air pressure in Central Asia and high air pressure above the Indian Ocean. In Islamabad, the summers are short, sweltering, muggy, and windy; the winters are short and comfortable and it is dry and mostly clear round the year.

Temperature

The hot season lasts for 2.9 months, from April 11 to July 7, with an average daily high temperature above 102°F. The hottest day of the year is May 23, with an average high of 108°F and low of 81°F. The cool season lasts for 2.2 months, from December 6 to February 12, with an average daily high temperature below 84°F. The coldest day of the year is January 7, with an average low of 52°F and high of 78°F.

Exhibit 4. 3: Average yearly High and Low Temperature



Source: WeatherSpark.Com

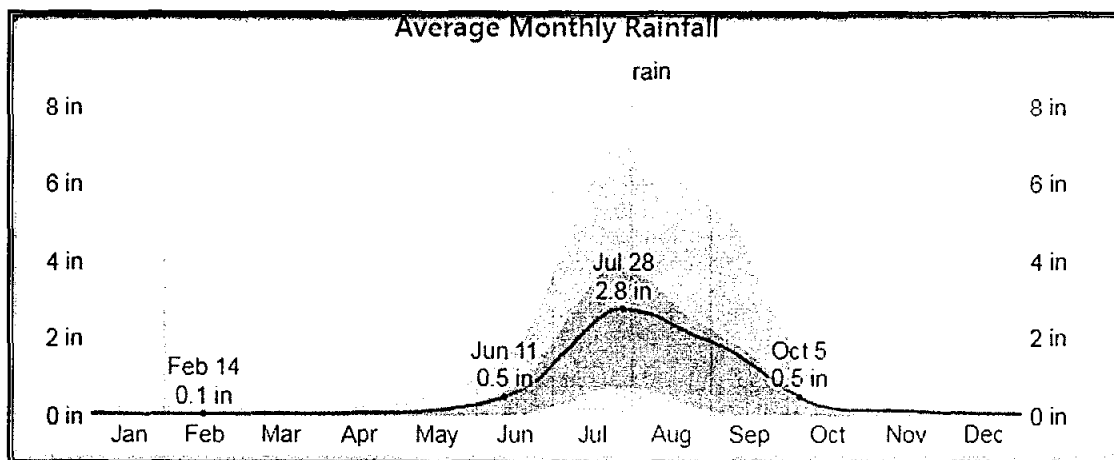
4.5 RAINFALL

The present climatic conditions of district Tharparkar is semi-arid to arid mostly influenced by the rainfall pattern of Thar Desert. Rainfall varies from north to south. Although the rain occurs in the form of heavy showers, it creates no run off. All the rain fall is absorbed by the dehydrated sandy soil. The monsoon enters in lower Sindh by the 22nd of July and lasts up to 1st week of September. The yearly average rainfall pattern of Islamkot from January 1, 1980 to December 31, 2016 shows some seasonal variation.

To show variation within the months and not just the monthly totals, we show the rainfall accumulated over a sliding 31-day period centered on each day of the year. Islāmkot experiences significant seasonal variation in monthly rainfall. The rainy period of the year lasts for 3.8 months, from June 11 to October 5, with a sliding 31-day rainfall of at least 0.5 inches. The most rain falls during the 31 days centered around July 28, with an average total accumulation of 2.8 inches.

The rainless period of the year lasts for 8.2 months, from October 5 to June 11. The least rain falls around February 14, with an average total accumulation of 0.1 inches. **Exhibit 4.4** represents the mean monthly rainfall pattern of Islamkot.

Exhibit 4. 4: Average Monthly Rainfall



Source: WeatherSpark.Com

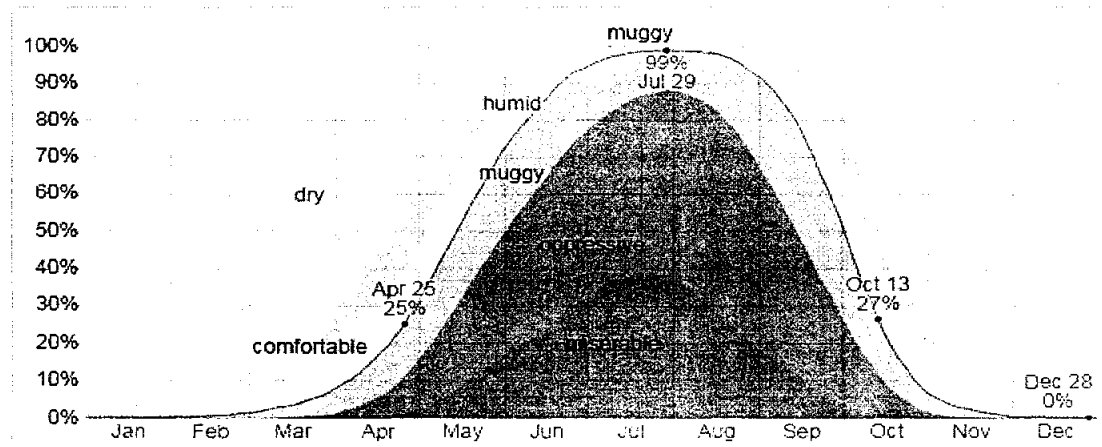
4.6 RELATIVE HUMIDITY

Islamkot experiences very significant seasonal variation in the perceived humidity. The humidity comfort level is based on the dew point, as it determines whether perspiration will evaporate from the skin, thereby cooling the body. Lower dew points feel drier and higher dew points feel more humid. Unlike temperature, which typically varies significantly between day and night, dew point tends to change more slowly, so while the temperature may drop at night, a muggy day is typically followed by a muggy night.

The muggier period of the year lasts for 5 months and 17 days, from April 25 to October 13, during which time the comfort level is muggy, oppressive, or miserable at least 25% of the time. The muggiest day of the year is July 29, with muggy conditions 99% of the time.

The least muggy day of the year is December 28, with muggy conditions are essentially unheard. The mean monthly relative humidity for Islamabad can be seen in **Exhibit 4.5**.

Exhibit 4. 5: Relative Humidity



Source: WeatherSpark.Com

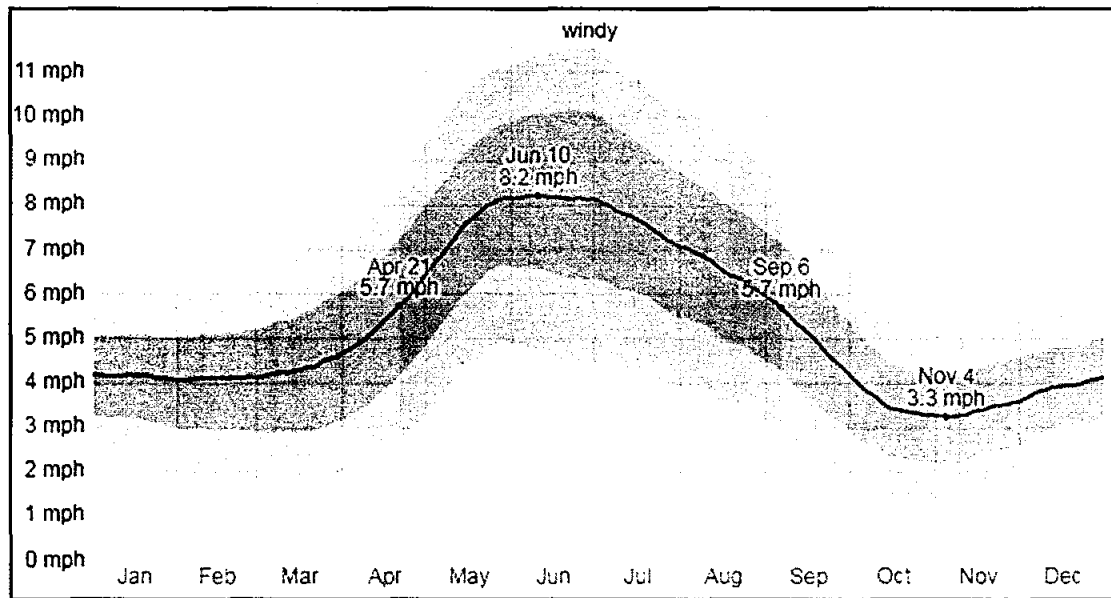
4.7 WIND SPEED

The average hourly wind speed and wind direction in Islamabad experiences significant seasonal variation over the course of the year. The wind usually carries sand and salt with it resulting in severe corrosion and erosion. The wind direction and speed in between the two monsoon seasons, summer and winter are rather unsettled and large variations are noted in term of speed and direction. The windier part of the year lasts for 4 months and 15 days, from April 21 to September 6, with average wind speeds of more than 5.7 miles per hour. The calmer time of year lasts for 7 months and 15 days, from September 6 to April 21.

The wind is most often from the west for more or less 8 months, from February 24 to October 29, with a peak percentage of 84% on May 13. The wind is most often from the north for 4 months, from October 29 to February 24, with a peak percentage of 58% on January 1.

The maximum recorded sustained wind speed and wind direction for each month in the district Tharparkar is presented as **Exhibit 4.6**.

Exhibit 4. 6: Average Wind Speed



Source: WeatherSpark.Com

4.8 AMBIENT AIR QUALITY & NOISE LEVELS

Air pollution has a direct impact on human health and the environment. The following pollutants were selected for the monitoring program based on the expected emissions from the plant operations and the level of risk to human health posed by these pollutants: Sulfur Dioxide, Nitrogen Dioxide, Particulate matter.

Some data on noise quality levels was obtained from secondary sources, however, the proposed project area and its surroundings does not have any large scale industrial activities. The population density is low, and number of vehicles is very small compared to other parts of the country, it is expected that ambient noise levels are likely to be low. Ambient air and noise quality sampling results can be seen in **Exhibit 4.7**.

*BASELINE COMPONENTS

Establishment of air quality baseline involves a number of components, including:

- ✓ On spot collection and validating air quality data for the proposed project

Ambient Air Quality Parameters Measured

- ✓ SPM
- ✓ PM_{2.5}
- ✓ PM₁₀
- ✓ CO
- ✓ NO_x
- ✓ Sox
- ✓ Noise Levels

Exhibit 4. 7: Ambient Air Sampling Point Map

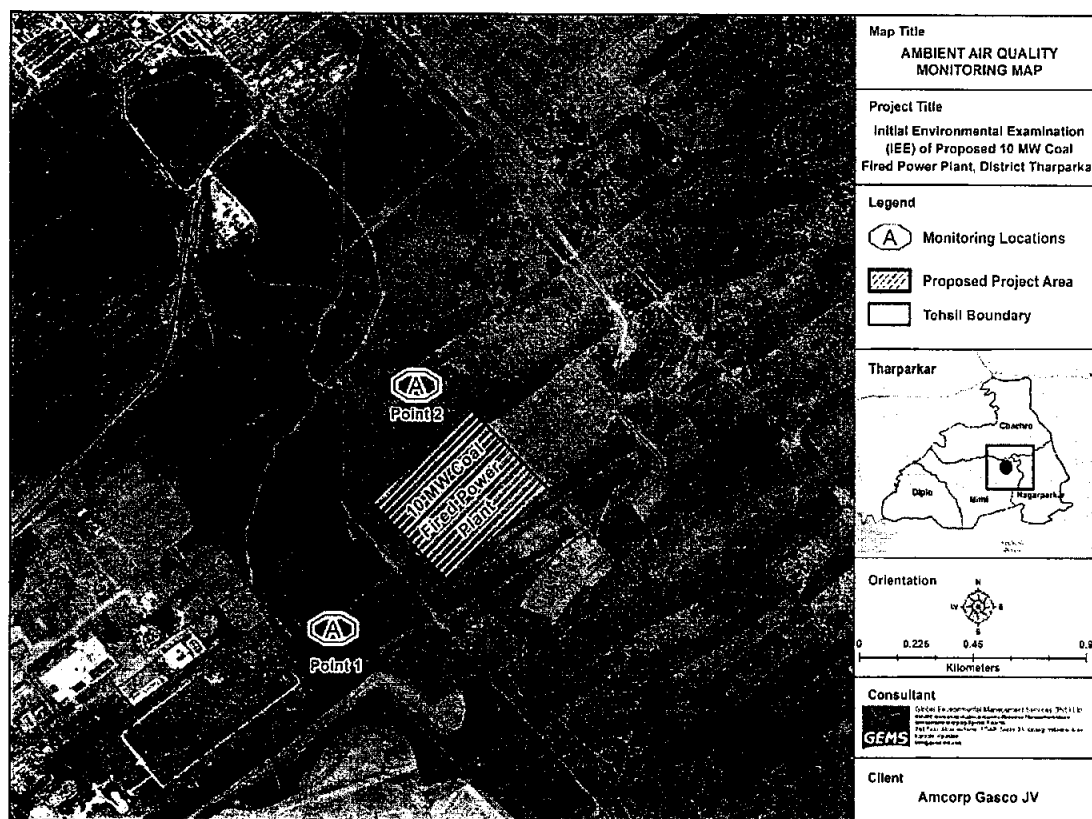


Exhibit 4. 8: Ambient air monitoring results

S. No	Parameters	Units	SEQS Limits	Concentration	
				Location-1	Location-2
1.	Carbon Monoxide (CO)	ug/m ³	10	0.10	0.20
2.	Oxides of Nitrogen (NOx)	ug/m ³	40	<1	<1
3.	Sulphur Dioxide (SO ₂)	ug/m ³	120	0.15	0.22
4.	Particulate Matter (PM)	ug/m ³	500	199	185
5.	Particulate Matter (PM ₁₀)	ug/m ³	150	115	112
6.	Particulate Matter (PM _{2.5})	ug/m ³	75	38	42
7.	Noise	dB	85	59.5	55.5

SEQS=Sindh Environmental Quality Standards

4.9 WATER RESOURCES

This section details the water resources of the proposed project area. Both, surface and ground water resources have been summarized in this section of the report. Data was obtained from secondary sources and through field observation (field survey).

The communities residing in the Thar area rely on rainfall and groundwater aquifers to meet their water needs. As the evaporation rate is high, very little moisture is retained in the soil. There are no perennial surface flows and hence no system of natural drainage lines and streams is found in the Thar region. Rainwater either seeps through the soil or flows to the nearest dhand or playa where it accumulates and is used by the community while it lasts. Water for domestic use is acquired from wells tapping the rain-fed top or quaternary aquifer. The thickness of the top aquifer varies between 4 m to 18 m and the aquifers are 30 m to 80 m below the ground level. The Monsoon rain feeding the aquifer occurs from July to September. By February or March, the shallower parts of the aquifer get depleted and the wells become saline. An indigenous method of water storage is called the Tarai. These are water storages built in natural depressions. Often communities develop these to increase the water holding capacity. Although the ponds are unlined, one or more tanks are constructed at the lowest part of the pond. These tanks are lined and covered, and are constructed below the ground surface. Through small openings near the top water accumulates in the tanks and lasts much longer than the water in the pond. Water from the Tarai is used by humans and livestock for drinking purposes. It is also used for cooking and washing by the community.

4.9.1 Surface Water Resources

Water supply is the major problem faced by the communities residing in the Thar area. There are no rivers and perennial springs are rare. Thar coalfields are located in a remote region with no surface water supply. Villagers mostly rely on rainfall and groundwater aquifers to meet their water needs. As the evaporation rate is high, very little moisture is retained in the soil. There are no perennial surface flows and hence no system of natural drainage lines and streams is found in the Thar region. Rainwater either seeps through the soil or flows to the nearest dhand where it accumulates and is used by the community⁸. Rainwater is collected in large open channels called tarais, and small underground tanks called tankas.

The main sources of drinking water for humans and livestock is from dug wells, which is supplemented by rainwater for a few months after the rainy season⁹. Water supply to Mithi, the district head quarter of Tharparkar District, and few other villages and towns of the district is through a 12 inch pipeline from one of the Naukot tributary of the Mithrao Branch and multiple booster pumping stations. Being at the tail-end of the distribution system, water supply is inadequate and is unable to meet the demand of growing population that is now converging on Mithi and Islamkot¹⁰.

⁸ <http://www.engropowergen.com/wp-content/uploads/2012/08/Environmental-Social-Impact-Assessment-of-Thar-Coal-Block-II-Power-Project-Volume-I.pdf>

⁹ [http://shehri.org/eia-reports/EIA%20report-vol%20330MW%20Thar%20Energy%20HubPower%20Company%20\(2\).pdf](http://shehri.org/eia-reports/EIA%20report-vol%20330MW%20Thar%20Energy%20HubPower%20Company%20(2).pdf)

¹⁰ https://www.academia.edu/8052739/Environmental_and_Social_Baseline_of_Thar_Coalfield_Block_-1

4.9.2 Groundwater Resources

The region faces acute shortage of potable water. There are no major rivers within the Thar Desert. Rainwater flows to the nearest topographic low, and either evaporates there or infiltrates. The main source of water in the area is groundwater but most underground water is brackish and saline. The wells are open dug wells; no mechanically drilled boreholes were found in the proposed project area. Most of the wells are brick-lined. The minimum, maximum and average depths of the well with respect to ground are 48.0 m, 86.4 m, and 60.9 m, respectively; 90% of the wells are between 50 and 70 m in depth. Three main aquifers and two aquitards have been identified in the Thar region. This includes¹¹:

- Upper aquifer (Top Aquifer), which is located in the base of the sand dunes
- Fine grained siltstone aquitard
- Middle alluvial sand aquifer (Middle Aquifer) of sub-recent age
- Claystone and lignite aquitard in the top part of the Bara Formation
- Deep aquifer (Deep Aquifer or Bottom Aquifer) of marine sands belonging to the bottom part of the Bara Formation

To establish the baseline of the proposed project area, a sample of groundwater was collected from the proposed project area and subjected to chemical analysis. The laboratory result of groundwater is presented below as **Exhibit 4.9**.

Exhibit 4. 9: Chemical Analysis of Groundwater

S. No.	Parameters	Units	SSDWQ	Sample-1
1	pH		6.5-8.5	7.25
2	Total Hardness	mg/l	<500	346.37
3	Total Dissolved Solids	mg/l	<1000	3560
4	Total Suspended Solids	mg/l		<5
5	Iron	mg/l		ND
6	Magnesium	mg/l		58.09
7	Chloride	mg/l	<250	1404.27
8	Arsenic	mg/l	<0.05	ND
9	Manganese	mg/l	<0.5	ND
10	Calcium	mg/l		43.45
11	Bicarbonate	mg/l		0.05
12	Chromium	mg/l	<0.05	ND
13	Nickel	mg/l	<0.02	ND
14	Silver	mg/l		ND
15	Cadmium	mg/l	0.01	ND

¹¹ [http://shehri.org/eia-reports/EIA%20report-vol 1%20330MW%20Thar%20Energy%20HubPower%20Company%20\(2\).pdf](http://shehri.org/eia-reports/EIA%20report-vol%201%20330MW%20Thar%20Energy%20HubPower%20Company%20(2).pdf)

S. No.	Parameters	Units	SSDWQ	Sample-1
16	Nitrate	mg/l	<50	12.4
17	Nitrite	mg/l	<3	0.108
18	Phenol	mg/l		<0.10
19	Residual Chloride	mg/l	0.5	0.05
20	Cyanide	mg/l	<0.05	ND
21	Zinc	mg/l	5.0	ND
22	Copper	mg/l	2.0	ND

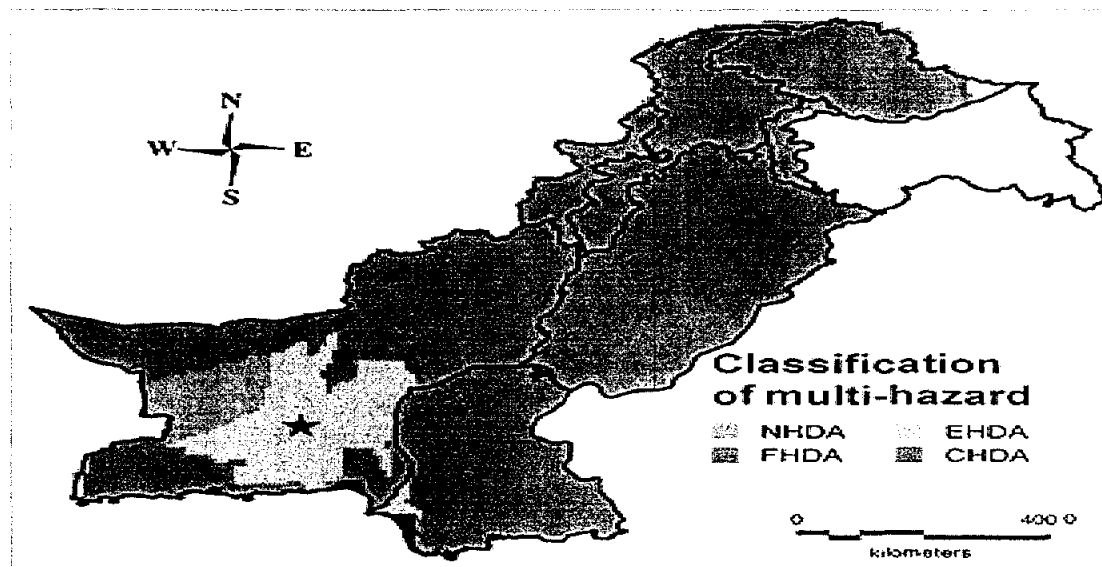
SSDWQ=Sindh Environmental Quality Standards for Drinking Water Quality

4.10 DISASTER RISKS

The province of Sindh has historically suffered from both natural and human induced disasters. The high level of risk is mainly from floods/heavy rains, cyclones in coastal area, sea intrusion, droughts, earthquakes, epidemics etc.

The multi-hazard map that takes into account various natural hazards identifies this area as earthquake dominant. Hence it verifies that the probability of occurrence of a specific natural hazard is correctly shown in the Exhibit 4.10.

Exhibit 4. 10: Classification of multi-hazard zoning map



NHDA : No Hazard Dominated Areas

EHDA: Earthquake Hazard Dominated Areas

FHDA : Flood Hazard Dominated Areas

CHDA : Combined Hazard Dominated Areas

Source: Siddique, M.S. and Schwarz, J. (2012): Multi-hazard approach to assess vulnerability of the building stock in Pakistan

4.10.1 Flooding

Urban flooding is caused by heavy rainfall overwhelming drainage capacity. Cities have been growing with alarming rate. This problem is important both in developed and under developed cities. Like other mega cities of the world, flooding has become a serious hazard in the mega cities of Pakistan. River Indus, after receiving water from 5 of its tributary rivers, causes floods in the northern and southern parts of Sindh province. The length of River Indus along the province is 750 kms long. The districts, on the right and left banks of River Indus, are prone to severe threat when River Indus is in high flood. The districts in the lower Sindh are prone to riverine flooding and include Dadu, Jamshoro and Thatta on the right bank of River Indus and Tando Muhammad Khan, Matiari and Hyderabad. District Tharparkar is adjacent to district Badin, which is highly prone to the flooding in the Left Bank Outfall Drainage (LBOD). According to PDMA Sindh, district Tharparkar has one vulnerable point with respect to LBOD and that is Spinal Drain. Dhoru Puran is also a vulnerable point of the district which can cause flooding. Floods of 2011 and recent droughts of 2014 affected almost all the population of the district¹².

4.10.2 Faults, Earthquakes and Seismic Hazards

District Tharparkar is one of the oldest districts of Sindh. In 2001, the district along with the bordering district of Badin was hit by an earthquake. Due to this earthquake, 12 people lost their lives and 115 persons were injured. Besides, 1,989 houses were destroyed and 43,643 houses were partially damaged. The public infrastructural loss was counted up to 1,406 buildings. The financial value of the overall loss was 2.4 billion rupees¹³.

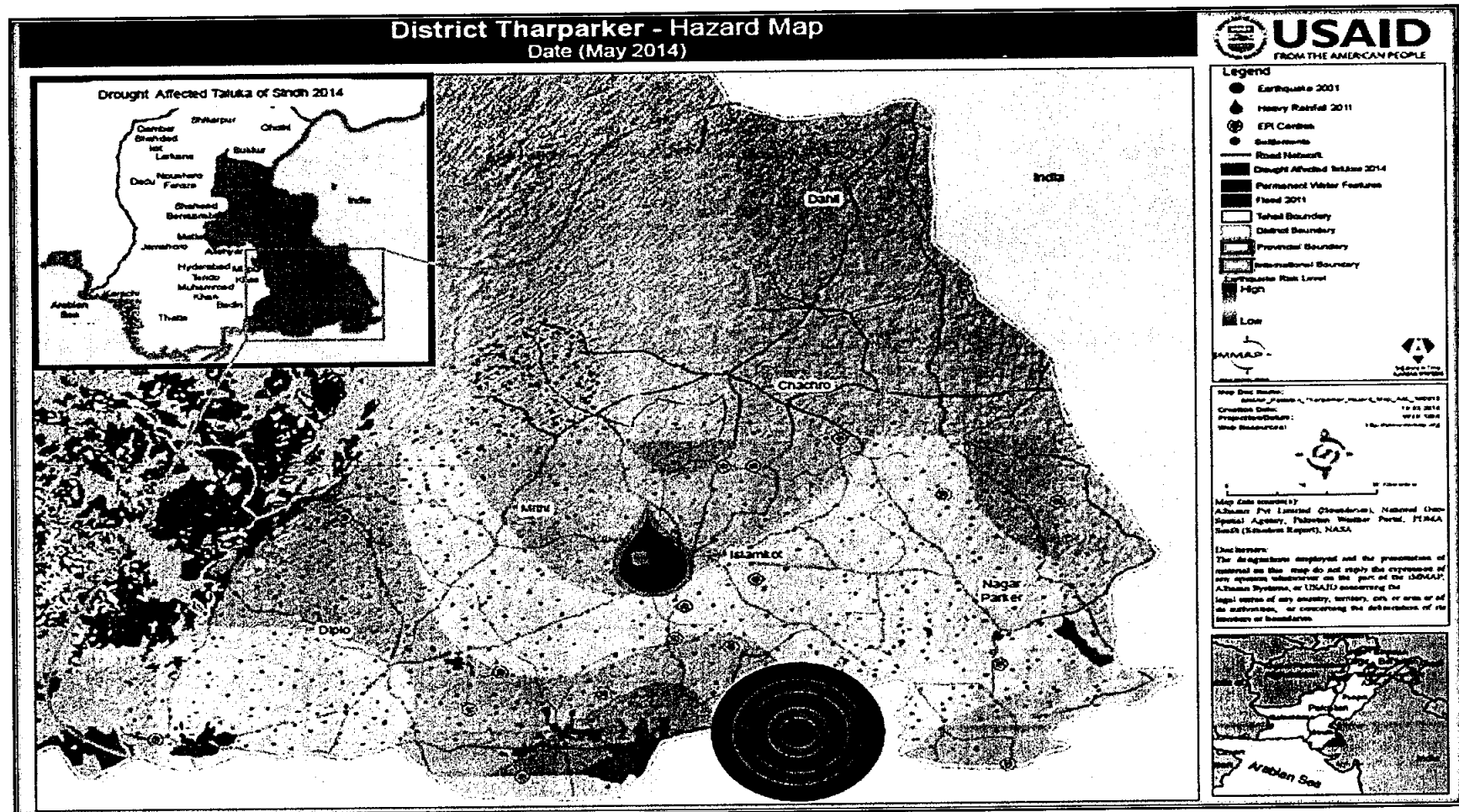
Pakistan lies in a seismically active zone. Pakistan is located in the Indus-Tsangpo Suture Zone, which is roughly 200 km north of the Himalaya Front and is defined by an exposed ophiolite chain along its southern margin. This region has the highest rates of seismicity and largest earthquakes in the Himalaya region, caused mainly by movement on thrust faults. Seismic zone mapping of Pakistan has divided the country into four seismic zones ranging in term of major, moderate, minor and negligible zones with respect to ground acceleration values. According to seismic zoning of Mirpurkhas division, it is identified on the edge of moderate to high hazard zone. This zone has minor to moderate damaging affect. The latest massive earthquake that affected Sindh desert area was recorded in Gujrat, which occurred on January 26, 2001 and Tharparkar and the neighboring Badin District was also badly affected. A geological tectonic line that passes from Karachi through Khirthar Hills / Mountains to north-west of Sindh and Thar Desert, due to which Sindh has risk of a major earthquake in the future¹⁴. Exhibit 4.11 represents hazard map of district Tharparkar.

¹² <http://reliefweb.int/sites/reliefweb.int/files/resources/PESA-DP-Tharparkar-Sindh.pdf>

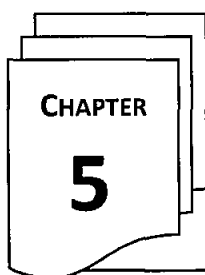
¹³ <http://reliefweb.int/sites/reliefweb.int/files/resources/PESA-DP-Tharparkar-Sindh.pdf>

¹⁴ <http://www.econ-envirom-geol.org/pdf/jul2014/01.pdf>

Exhibit 4. 11: Hazard Map of Tharparkar



Source: <http://reliefweb.int/sites/reliefweb.int/files/resources/PESA-DP-Tharparkar-Sindh.pdf>



ECOLOGICAL ENVIRONMENT

5.1 GENERAL OUTLINE AND SCOPE

This section gives the detailed description of the ecological environmental conditions of the study area. The proposed project area under review was assessed for its potential impact on Biodiversity, and ecosystem in short term and long term. The data collection techniques are combination of both primary and secondary. Primary means by field verifications and observations. Experts in the field of terrestrial ecology were engaged in the area of interest from GEMS. The floral and faunal diversity was also determined by observations in and around for the area under focus. The objective of the study was to establish terrestrial ecological baseline of the proposed project site and its vicinity. A hand-held GPS was used to document changes in the ecological assemblages. Data was also supplemented by secondary means, which included review of published literature and previous IEE/EIA studies, conducted in the proposed project surrounding areas. The base line data defines and elaborates the present ecological environmental quality and features of the proposed project surrounding.

KEY FEATURES OF ECOLOGICAL BASELINE

- ✓ General Habitation of Study Area under Focus
- ✓ Flora of The Study Area under Focus (Desert Biome)
- ✓ Fauna of The Study Area under Focus (Mammals, Avifauna, Reptiles)

5.2 GENERAL HABITAT OF AREA UNDER FOCUS

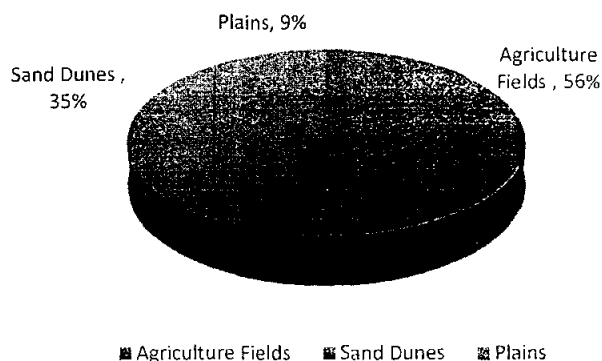
The Thar Desert is a large ecoregion lying to the west of the Aravalli Mountain Range in northwestern India. The relief in the Thar varies between near sea level to more than 150 meters. The climate of the Thar Desert is arid to semi-arid and extremely hot in summer and relatively mild in winter. Rainfall in the Study Area (Block II) averages at 200 mm, and is associated with the July-September southwest monsoon that brings in precipitation. Long dry spells persists in the area and drought conditions affect human life and the biodiversity. The sand dunes defining the topography are mostly longitudinal forming a NE-SW trend and are stabilized by shrubs and grass as reported in earlier documents.

The flora and fauna defined the ecological behavior of Thar Desert: vegetation is mainly thorny dominated by shrubs, mammals, birds and reptiles represented the major faunal composition. The project area contains resident populations of wildlife, and reported visits of migratory species as well. Some species vary in activity patterns between one time of the year and another; for example, many reptiles are particularly active during the summer months.

Habitats within the Study Area were classified relying primarily upon geomorphology and soil texture, with consideration of variations within habitat types. The Study Area was classified by geomorphological characteristics into agricultural fields, sand dunes and plains.

Agriculture fields are the dominant habitat, constituting **56%** of habitats of the Study Area. There is only one cropping season in the summer (called kharif season) in which a variety of summer crops are grown. The natural scrub vegetation in the agricultural fields and harvested agricultural lands serve as grazing grounds for the large animal herds for most of the year. The plants communities dominating this habitat, and which mostly grow on the edge of agricultural fields, are *Salvadora oleoides*, *Aerva javanica*, *Leptadenia pyrotechnica*, *Calotropis procera*, *Ziziphus nummularia* and *Crotalaria burhia*.

Graphical Representation of Habitats



Sand dunes are the second dominant habitat, constituting **35%** of the total habitat. They vary in height, ranging from a few meters to over a hundred meters. The common and dominant plants of this habitat include *Aerva javanica*, *Acacia senegal*, *Crotalaria burhia*, *Calligonum pollygonoides*, *Leptadenia pyrotechnica*, and *Salvadora oleoides*.

Plains constitute **9%** (including 2% of the area covered by settlements) of the total habitat of the Study Area. An established tradition of preservation of trees contributes to maintaining the vegetation cover in the Thar Desert. Grazing pressure, however, is

As discussed previously in chapter-2 of this report that the proposed project will be located in Block-II Islamkot, Tharparkar. Tharparkar is located on the eastern edge of Sindh Thar Desert and the name itself reflects that the general habitat of the proposed project area is mainly associated with desert ecological system which mainly sustains the species able to survive under high stress, hot, dry and harsh weather conditions. The area under focus sustains a number of nocturnal life form, of desert origin. None of the species reported from the focused area, are protected, threatened, and vulnerable or endangered under IUCN red list and or SWPO Sindh Wildlife Protection ordinance 1972-1978. However, presence of vulture in the surrounding area was reported.

5.3 SAMPLING METHODOLOGIES

This section discuss the methods and techniques which has been used for the proposed study, in order to estimate and observed the floral, faunal and mammalian diversity.

5.3.1 Sampling Methodology for Terrestrial Flora

Plot less methodology based on ocular observations and verifications of the reported floral species was specifically adopted for this IEE Study which was supplemented by review of literature and IEE/EIA studies previously carried out in the study area.

5.3.2 Survey/Sampling Methodology for Endemic Birds:

The data collection technique is combination of both primary and secondary. To estimate avifaunal diversity of the proposed project area individual count technique was used by using Praktica Telescope with maximum zooming capacity of about 60-80 X. Identified species were immediately recorded and documented accordingly wherever possible, furthermore review of literature as well as previous IEE/EIA studies in the project surrounding further supplemented the baseline for documenting Endemic Birds in the study area.

5.3.3 Survey/Sampling Methodology for Mammalian:

The data collection techniques is combination of both primary and secondary. To estimate mammalian diversity of the proposed project area which is based on ocular observations.

5.3.4 Survey/Sampling Methodology for Wildlife (Reptiles/Amphibians):

The data collection techniques are combination of both primary and secondary. To estimate wildlife diversity of the proposed project area which is based on ocular observations.

5.4 TERRESTRIAL FLORA OF THE PROPOSED PROJECT AREA

A list of 137 plant species has been reported from the Tharparkar area. Some 30 plus species were spotted in current floristic list. The life in Thar greatly depends on indigenous natural resources. The plants are used for a variety of purposes, including production of medicines, resins, dyes and fibers, and for construction, forage and fodder making. The habitat in the Thar Desert is influenced by the extreme climate. The vegetation consists of xerophytic grasslands of *Eragrostis* sp. *Aristida adscensionis*, *Cenchrus biflorus*, *Cymbopogon* sp., *Cyperus* sp., *Eleusine* sp., *Panicum turjidum*, *Lasiurus scindicus*, *Aeluropus lagopoides*, and *Sporobolus* sp. Scrub vegetation consists of low trees such as *Acacia nilotica*, *Prosopis cineraria*, *Prosopis juliflora*, *Tamrix aphylla*, *Zizyphus mauritiana*, and shrubs such as *Capparis decidua*, *Calligonum polygonoides*, *Calotropis procera*. *Aerva pseudotomentosa*. *Crotalaria* sp. *Haloxylon salicornicum* and *Haloxylon recurvum* were also present.

The vegetation is dominated mostly by shrubs; however variations in vegetation composition were observed with varying microhabitats. The terrestrial species thriving at the area under focus has already adapted to the harsh natural environment and extreme temperature variations of the given area and are observed to have been most successful in the difficult environment. It is important for plants to have capacity of water storage to be able to utilize stored water during the dry season.

Exhibit 5. 1: Detailed List of Floral Species Observed at Project Surrounding

S. No.	Plant species*	Family	Life form	Life span
1	<i>Abutilon fruticosum</i> Guill. & Perr. Kapanh wal	Malvaceae	Shrub	Perennial
2	<i>Abutilon indicum</i> (L.) Delile. Kapanh wal	Malvaceae	Shrub	Perennial
3	<i>Acacia jacquemontii</i> Benth. Chhota Babur	Mimosaceae	Shrub	Perennial
4	<i>Acacia nilotica</i> (L.) Delile. Babur	Mimosaceae	Tree	Perennial
5	<i>Acacia nilotica</i> ssp. <i>Cupressiformis</i> (J.L. Stewart) Ali & Faruqi Babur	Mimosaceae	Tree	Perennial
6	<i>Acacia senegal</i> (L.) Willd. Khonr	Mimosaceae	Tree	Perennial
7	<i>Aeluropus lagopoides</i> (L.) Trin.	Poaceae	Grass	Perennial
8	<i>Aerva javanica</i> (Burm. f.) Juss ex J. A. Shultes. Booh	Amaranthaceae	Shrub	Perennial
9	<i>Alternanthera sessilis</i> (L.) R. Br.	Amaranthaceae	Herb	Annual
10	<i>Amaranthus graecizans</i> subsp. <i>Thellungianus</i> (Nevski) Gusev. Saag	Amaranthaceae	Herb	Annual
11	<i>Amaranthus viridis</i> L. Saag, Mariro	Amaranthaceae	Herb	Annual
12	<i>Amberboa ramosa</i> (Roxb.) Jafri. Lubh	Asteraceae	Herb	Annual
13	<i>Ammania baccifera</i> L.	Lathyraceae	Herb	Biennial
14	<i>Argyrolobium roseum</i> ssp. <i>Ornithopodioides</i> (Jaub. & Spach) Jafri & Ali	Fabaceae	Herb	Annual
15	<i>Aristida adscensionis</i> Hk. f.	Poaceae	Grass	Annual
16	<i>Aristida funiculata</i> T. & P.	Poaceae	Grass	Annual
17	<i>Arnebia hispidissima</i> Khari	Boraginaceae	Herb	Annual
18	<i>Asparagus</i> sp.		Herb	Perennial
19	<i>Asphodelus tenuifolius</i> Cavan Basri	Liliaceae	Herb	Annual
20	<i>Avena fatua</i> L.	Poaceae	Grass	Annual
21	<i>Azadirachta indica</i> A. Juss. Nim	Meliaceae	Tree	Perennial

Note: *Plants having medicinal value are highlighted in Blue; Local names are provided in Red

5.5 FAUNA OF THE PROPOSED PROJECT AREA

5.5.1 Endemic Birds Species Findings

The Thar Desert ecological system provide food and shelter to a number of endemic species of birds. Some of these birds are also migratory. There is no permanent wetland close to the Study Area radius; therefore avifauna of the area predominantly consists of terrestrial birds. During the surveys most of the resident species were observed. House sparrow *Passer domestics* was most abundant followed by Eurasian collard dove, and common babbler *Turdoides caudatus*. The birds list which includes common birds in premises of the proposed project area is shown as per **Exhibit 5.2**.

Exhibit 5. 2: List of Endemic Birds Species Observed

S. No.	Scientific Name	Family	Status
1	<i>Tachybaptus ruficollis</i>	<i>Podicipedidae</i>	Common
2	<i>Phalacrocorax niger</i>	<i>Phalacrocoracidae</i>	Common
3	<i>Ardea cinerea</i>	<i>Ardeidae</i>	Common
4	<i>Ardeola grayii</i>		Common
5	<i>Bubulcus ibis</i>		Common
6	<i>Egretta alba</i>		Common
7	<i>Egretta garzetta</i>		Common
8	<i>Anas crecca</i>	<i>Anatidae</i>	Common
9	<i>Marmaronetta angustirostris</i>		Common
10	<i>Anas clypeata</i>		Common
11	<i>Apis affinis</i>	<i>Apodidae</i>	Common
12	<i>Milvus migrans</i>	<i>Accipitridae</i>	Common
13	<i>Pavo cristatus</i>	<i>Phasianidae</i>	Common
14	<i>Partridge, Perdix</i>	<i>Perdicinae</i>	Common

5.5.1.1 Conservation Status

The avifauna listed above are not listed as threatened near threatened, or declining populations under the IUCN Red list of 2016. Tharparkar district serves an important nesting and breeding ground for white-backed and long-billed vultures. Though vultures as one Endangered and three Critically Endangered species of vultures are breeding in the Thar Desert. The white-backed vultures make their nests on trees, whereas long-billed make them on hills.

5.5.2 Mammalian Species Findings

Thar Desert supports a fair population of the mammalian. It is observed that the thari cattle's are abundant found in the surrounding of the proposed project area. These animals can thrive well on small bushy vegetation during drought and fodder scarcity condition. The observed mammals are listed in **Exhibit. 5.3**.

Exhibit 5. 3: List of observed Mammalian species in proposed project area surrounding

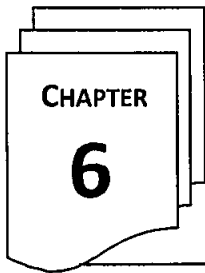
S. No	Common Name	Family/ Scientific Name	Status
1	<i>Asiatic Jackal</i>	<i>Canis Aureus</i>	Common
2	<i>Jungle Cat</i>	<i>Felis species</i>	Common
3	<i>Wild Hare</i>	<i>Lepus Nigricollis</i>	Frequent
4	<i>Long eared Desert Hedgehog</i>	Hemiechinus Collaris	Common
5	<i>Indian Hedgehog</i>	<i>Paraechinus micropus</i>	Common
6	<i>Five stripped, Palm Squirrel</i>	<i>Funambulus Pennantii</i>	Common
7	<i>Asian Mongoose</i>	<i>Herpestes Javanicus</i>	Rare
8	<i>Camel</i>	<i>Camelidae</i>	Common

5.5.3 Reptiles/Amphibians Species Findings

Thar Desert ecological system is fortunate in the sense that it is rich in diverse wildlife species. Proposed project area surroundings provides a good habitat for a variety of reptiles. Monitor lizard, Indian monitor was observed at the proposed project area. According to different literature review other species like Ground Lizard, Desert monitor, Sand Lizard, Garden Lizard, Bark Gecko, Yellow tailed Gecko, Three Toed Snake Skink, Saw Scaled Viper, Black Cobra, and Common Sand Boa are present in surroundings. None of the species observed or reported in the area are on the IUCN Red List 2010. Observed species are listed in **Exhibit.5.4**.

Exhibit 5. 4: Observed species in the premises of proposed area

S. No	Zoological Name	Family	Status
1	<i>Bufo stomaticus</i>	<i>Bufonidae</i>	Common
2	<i>Euphlyctis cyanophlyctis</i>	<i>TrionychidaeRanidae</i>	Common
3	<i>Calotes versicolor</i>	<i>Agamidae</i>	Common
4	<i>Trapelus megalonyx</i>		Common
5	<i>Uromastyx hardwickii</i>		Common
6	<i>Hemidactylus flaviviridis</i>	<i>Geckonidae</i>	Common
7	<i>Hemidactylus leschenaultii</i>		Common
8	<i>Acanthodactylus cantoris</i>	<i>Lacertidae</i>	Common
8	<i>Varanus griseus</i>	<i>Varanidae</i>	Common
9	<i>Lycodon striatus</i>	<i>Colubridae</i>	Common
10	<i>Psammophis schokari</i>		Common
11	<i>Naja naja</i>	<i>Elapidae</i>	Rare
12	<i>Daboia russelii</i>	<i>Viperidae</i>	Rare



SOCIO-ECONOMIC & CULTURAL ENVIRONMENT

6.1 GENERAL OUTLINE AND SCOPE

A team of experts comprising of a sociologist and an environmental assessment specialist carried out a comprehensive study of socio-economic and cultural environment of the proposed project surrounding. The approach and methodology was a combination of qualitative as well as quantitative data gathering techniques, which was supplemented by secondary data, wherever required was extracted from previous studies and research projects conducted in the project surrounding. This section of the report represents the assessment of the socio-economic baseline of the proposed project surrounding based on social surveys. The assessment also includes a focus on the gender aspects

The key socioeconomic features under focus for baseline investigations included:

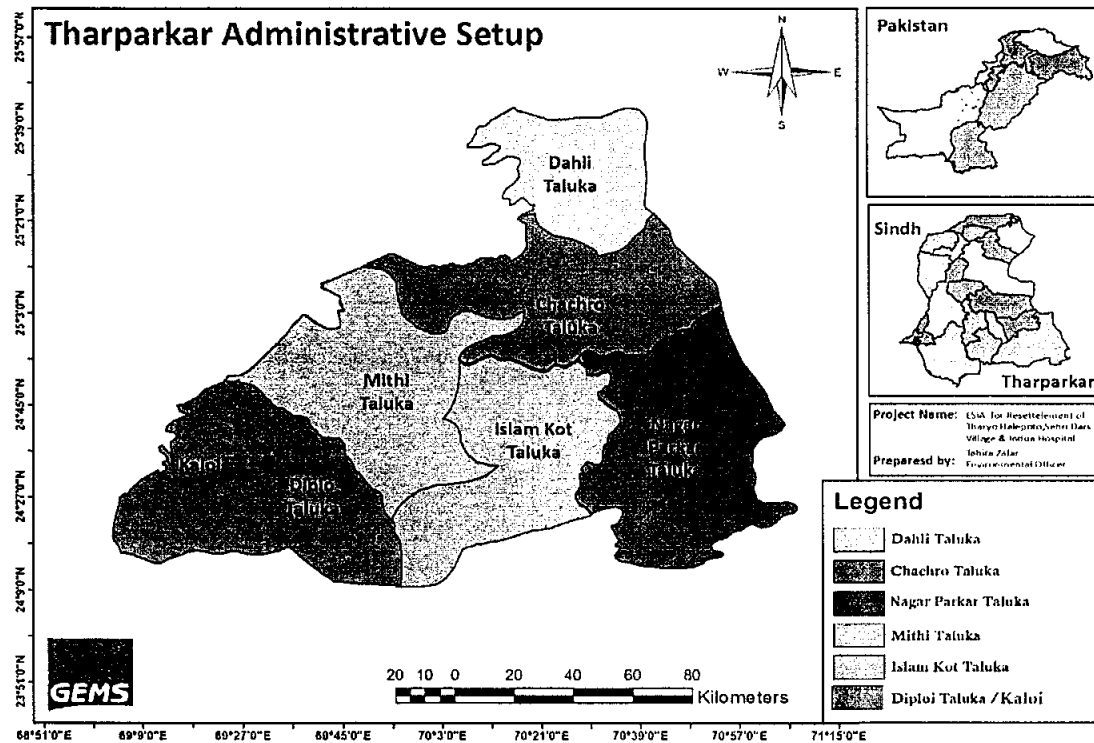
- a) Administrative Setup, Demography
- b) Livelihood, Water Supply And Sanitation
- c) Education And Literacy, Health Care Facilities
- d) Archeological Heritage

a) Administrative Setup

District Tharparkar is administratively subdivided into seven talukas (tehsils or sub-district) which includes Chhachro, Diplo, Mithi, Islamkot, Kaloi, Dahli and Nagar Parkar. The proposed project is located near Thar Coal Field Block II of Taluka Islamkot. The following considerable major access routes to the project area are National Highway (N5), Badin-Sujawal Road, Islamkot Bypass, Mitthi Road, Nagarparkar Road

The prominent places within the project surrounding includes; Kumbharo Village and Thar Coal Field Block II, refer **Exhibit 6.1** to review Tharparkar District Administrative Map.

Exhibit 6. 1: District Tharparkar Administrative Map



6.2 DEMOGRAPHICS

Tharparkar district has been spreaded over an area of 47, 91,025 acres (19,638 Square Kms) with 1,649,661 souls (according to census 2017)¹. Average annual growth rate is 3.15 from 1998 to 2017. Sex ratio in district Tharparkar is 121 male per 100 females, which is far more than the ratio at the national level that is 106². Like other districts of Sindh about 96 percent of population of this district is rural by its characteristics³.

6.3 LIVELIHOOD AND EMPLOYMENT

Agriculture and livestock are the major source of employment for the rural population of the district while people in urban areas are also engaged in various economic activities related to employment in private sector organizations, agricultural farming, private businesses and livestock rearing. The trading center for livestock and agriculture is Mithi town and a major source of attraction for Tharparkar locals in terms of business and trade. Females also play important role in economic activities as they prepare handicrafts at home which are sold for economic purposes, moreover the women are also engaged in agriculture.

¹ http://www.pbscensus.gov.pk/sites/default/files/bwpsr/sindh/Tharparkar_Blockwise.pdf

² Labour Force Survey 2010-11: Pakistan Bureau of Statistics

³ Pakistan Emergency Situation Analysis- A Profile of District Tharparkar (USAID)

6.4 INFRASTRUCTURE AND SERVICES

Though Tharparkar is one of the most deprived districts of Pakistan and has been particularly disadvantaged in terms of infrastructure, recent developments have greatly improved facilities such as roads, power supply and drinking water. However, the district still has a weak infrastructure when compared to other districts provincially and nationally. High quality (blacktop) roads form only about 28% of the total road length, and most parts of the district are covered by telephone and mobile phone services.

The towns of Mithi and Islamkot have provision shops, medical stores, internet facilities and hotels. A weekly livestock market (mal piri) is also held at Mithi. The 1998 census reported that there were only 3 post offices in the entire district. None of the villages included in the socioeconomic baseline survey reported having postal or police facilities, while only one reported a local market to purchase and sell produce. However, an almost negligible number, 35 out of 11,900 registered criminal cases in Sindh, as reported in the Development Statistics of Sindh (2006), suggest that the law and order situation in the district is generally peaceful.

6.5 POWER SUPPLY AND FUEL WOOD CONSUMPTION

The 1998 census reported that only 6.75% of the housing units were using electricity in Tharparkar. Electricity usage in the urban areas was much higher at 68.38% of housing units, compared to only 4% in rural areas. An improvement in this number was seen with 44% of rural houses in Tharparkar using electricity in 2011.⁴

Electricity was available in only four of the ten villages included in the Socioeconomic Baseline Survey. Findings of the Socioeconomic Baseline Survey show that fuel wood is generally used for heating and cooking in village houses. This wood is usually collected from surrounding areas. There is no natural gas supply in the Study Area. None of the surveyed villages reported the use of liquefied petroleum gas (LPG), kerosene or diesel to meet domestic fuel requirements

6.6 WATER SUPPLY AND SANITATION

Water supply is one of the major problem faced by villages in rural Tharparkar and it is always a scarce commodity in the Thar Desert. The only source of water is groundwater through dug wells and it is mostly brackish and is suspected of having high concentration of various salts and minerals. Moreover, Mithi and Islamkot are the only places where piped water supply is available indoors, although limited to its central area. The practice of installing tube wells, hand pumps, reverse osmosis (R.O) and wind mills have also been introduced recently in many parts of the district Tharparkar. There are no rivers and perennial springs. In addition, rainwater is also collected in traditional channels called tarais, underground and overhead tanks, and earthen jars.

⁴ Pakistan Social and Living Standards Measurement Survey 2010-11

Safe drinking water is a precious commodity and sanitation facility is a luxury that is hard to find in the rural towns and villages. There is no well-developed sewage or drainage system in the villages of the study area.

6.7 EDUCATION AND LITERACY

Education plays an important role in bringing social development, economic prosperity and to enhance the individual's potentials, however the education status is quite poor in district Tharparkar. The literacy rate of the urban areas of Tharparkar have the higher literacy rate as compare to rural areas (refer to Exhibit 6.2⁵). The literacy rate in the study area is very low due to the lack of educational facilities. Only primary education is available in the villages near the study area and for higher education students have to travel to central city i.e Mithi to get the higher education in different colleges.

Exhibit 6. 2: Population Literacy Rate of District Tharparkar

S. No	Age Group	Urban Literacy Rate (%)	Rural Literacy Rate (%)	Total Literacy Rate (%)
1	Population of Ten Years and Older	65	36	38
2	Population of Fifteen Years and Older	63	33	35

6.8 HEALTH CARE FACILITIES

At present number of health care facilities including BHUs, Clinics and a few government hospitals are operating in Tharparkar. The available Health care facilities in District Tharparkar includes: DHQH Mithi, THQH Chachro, THQH Diplo THQH, Nagar Parkar, RHC Kheensar, RHC Islamkot, BHU Wahoori, BHU Arokhi, BHU Mithi Gecho, BHU Malnoor veena, BHU Paboher, BHU Virvah

From the survey it was reported that population experience difficulties in getting medical treatment due to lack of reasonable healthcare facilities, the residents seek medical treatment from main hospital available in Islamkot town. However, recently Sindh Engro Coal Mining Company (SECMC) has established a family health care clinic which is situated at Rescue Center near Thariyo Halepoto, while the Marvi Clinic has been established at SECMC Camp Office which is about 3 to 8 kilometres and offers basic healthcare facility. Additionally PPHI is one of the renowned organization working in district Tharparkar by providing basic trainings to the locals of the area related to prevailing health care issues in the project surrounding. Not only is this but PPHI also working over prevailing and dominant health care issues in the project surrounding. Refer Figure 7 to view meeting at PPHI office.

⁵ http://www.pbs.gov.pk/sites/default/files//pslm/publications/PSLM_2014-15_National-Provincial-District_report.pdf

6.9 CULTURE, ETHNICITY AND RELIGION

In Tharparkar District there is a mix of Hindu-Muslim population which constitute of about 59 % of Muslims and 41 % Non-Muslims enjoying peaceful environment with equal religious rights and without any inter-religion or sectarian hostility. Majority of this district's residents are Thari speaking but Sindhi and Dhatki are also common languages of the district. Besides, Urdu is spoken and understood in the city areas of Mithi and Islamkot. Refer **Exhibit 6.3** to review major Muslim and Non-Muslim Castes observed in District Tharparkar.

Exhibit 6. 3: Caste distribution of the Study Area

Major Muslim Castes		Major Non-Muslim Castes.
Nohri.	Panhwar	Thakurs
Rahuma	Chandio	Mahraj
Junejo	Nareja	Birhman
Sameja	Faqeer	Mahshwari
Halepota	Sand	Lohana
Khaosa	Channa	Menghwar
Syed		Kolhi
Bajeer.		Bheel
Samma		Bajeer
Khaskhali		Thakurs
Dal		
Mehar		

6.10 ARCHEOLOGICAL HERITAGE

The Thar Desert has a number of sites of archaeological, religious and cultural significance which include hills of Karunjhar, ruins of paari nagar, gori temple. The ancient religious architecture of the Tharparkar region is represented by a mosque and some Jain temples situated at different places, scattered mostly over southern Thar, around the small town of Nagarparkar. However no site of Archeological/Heritage was observed in the study area.

6.11 ROLE OF WOMEN

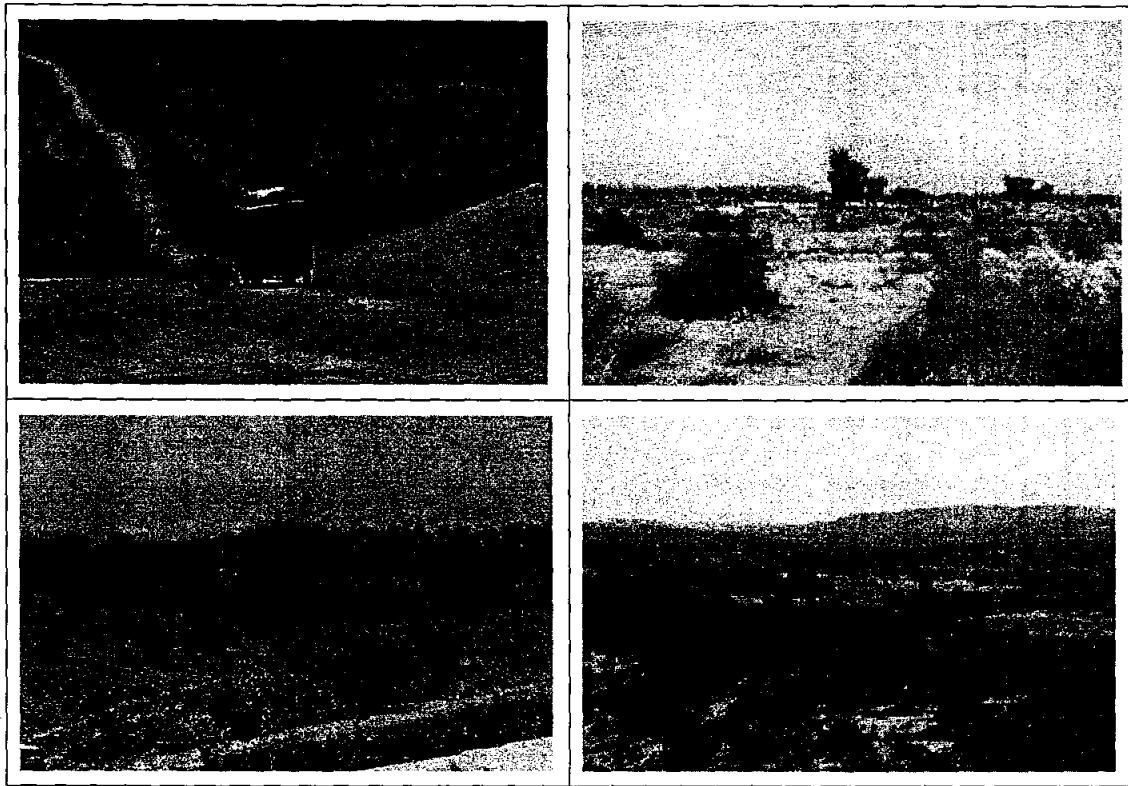
Majority of the women are housewives, they wake up early in the morning and remain engaged in preparation of food for their family, looking after their children, looking after livestock at household level, fetching water for drinking and domestic purposes, collect wood for cooking as well as assist

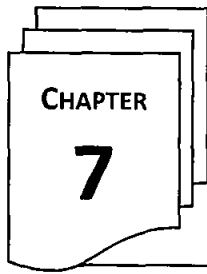
their menfolk in the fields for cultivation of rain fed cropping. At the leisure time they do the work of embroidery, make traditional items of daily use like 'Rili', 'shals', 'handkerchiefs' etc. These women are less educated and hardly crossed primary education due to unavailability of good schools in the villages and also the trend of low education in the society. However, the Sindh Engro Coal Mining Company have launched the dump truck training programme for thari female population of the district tharparkar in which the selected women were trained on professional grounds. Women are actively participating in the other skill development programmes launched by the SECMC such as the sewing of school dresses, most of the women of the study area are getting these trainings.

Exhibit 6. 4: Project Area Surrounding Environment

Well Being Indicator	Tharparkar
GPS Coordinates	24°47'50.03"N 70°23'22.95"E
Major Communities	Hindu and Muslim Communities
Population	1,649,661
Livelihood	Agriculture, Livestock, shops, transporters
Electricity	Available
Fueling Source	Fire wood, Biomass, LPG
Major Institutions	Cadet College , Mitthi
Literacy Rate	Low
Drinking Water	Well water, electric submersible pump
Major Health Problems	Malaria, Diarrhea Asthama, Hypertension Skin Infection, pneumonia, fever/flu/coughing, meningitis, and cholera,
Health Facilities	Unsatisfactory
Major Hospitals	District Health Development Center Mithi
Major Needs	Govt. hospitals. Security, Drinking Water, Continuous Electricity and Gas Supply
Major Markets	Small Markets and Shops
Transport	Public Transport, Motorcycle, Cars, Buses

Exhibit 6. 5: Pictorial view of study area





ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

7.1 SCREENING OF POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

This section discusses the potential environmental impacts of the proposed activities, assesses its significance and recommends mitigation measures to minimize adverse environmental impacts. The proposed Coal Fired Power Plant will be located within Sindh Engro Coal Mining Company (SECMC) Thar, Block II in close proximity to the coal mines and the mining facilities. Most of the power plant project impacts are largely seen as incremental impacts over the existing impacts of the mining activities.

The discussion starts with a description of the methodology used for the impact assessment. Discussion of the environmental and socioeconomic impact is then organized in the following manner:

- Impacts associated with construction phase
- Impacts associated with operational phase of proposed Power Plant.

7.2 IMPACT ASSESSMENT METHODOLOGY

Potential impacts from the proposed project activities were identified by review of the project activities, study of surrounding environment, review of literature, review of previous similar studies. Once potential impacts have been identified, the assessment of each potential impact follows these steps:

7.3 ENVIRONMENTAL IMPACTS ASSOCIATED WITH CONSTRUCTION AND OPERATION

Some of the environmental impacts of construction activities relate to activities at the construction site whereas others relate to the setting up and operation of the construction crew camp. These issues include:

- Site clearance leading to dust emission
- Removal of vegetation leading to loss of vegetation cover
- Erosion and sedimentation due to large scale earthwork
- Air quality impact from operation of construction machinery and earthwork
- Noise and vibration from machinery and construction work

- Generation of waste and its disposal
- Off-site impacts such as those related to borrow pits
- Disposal of effluent from construction camp
- Cultural impact related to presence of non-local workers

The construction impacts are temporary and end with the completion of the construction activity. However, poor management can result in long-term residual impacts.

Mitigation measures

- The camp of the construction contractor(s) will be located within the premises of Power Plant Site.
- The construction contractor will develop a specific construction management plan (CMP) based on the CMP included in the EMP (**Chapter 8**).
- The CMP will clearly identify all areas that will be utilized during construction for various purposes using a site plan. For example, the following will be shown:
 - Areas used for camp
 - Storage areas for raw material and equipment
 - Waste yard
 - Location of any potentially hazardous material such as oil
 - Parking area
 - Loading and unloading of material
 - Septic tanks
- The construction activities should be well planned to minimize disturbances to soil.
- Only limited area should be excavated which is required for laying foundation.
- All possible chemicals, lubricants, adhesives, paints etc. must be stored at an impermeable area where leakage or leaching in soil is completely ruled out.
- Movement of heavy vehicles, which are expected to carry heavy machinery for proposed construction sites will be restricted to marked pathways only and unnecessary movements will be avoided to reduce soil disturbance.
- Appropriate arrangements, including shovels, plastic bags and absorbent materials, will be available near fuel and oil storage areas;
- Contaminated soil will be removed and properly disposed after treatment such as incineration or soil remediation technique etc.

Disposal of Waste from Construction Works

The plant construction and installation of equipment will generate considerable amount of waste. It will include metals (mainly iron and copper), concrete residues, wood, cotton, plastic, packing

materials, E waste, and insulation material. Different types of hazards are associated with some of the waste material, which are given below;

- Sharp edges in metals
- Tripping hazards if material is left in the pathways
- Soil contamination from leaking oil from equipment
- Slipping hazard from oil on floors
- Dust
- Respiratory disorders

A comprehensive waste management plan will be developed and re-use opportunities for waste generated during construction will be investigated. Identified hazardous waste will be segregated and stored in the designated waste storage yard to be constructed at the site.

Impact on Air Quality

Impact assessment of the ambient air quality is one of the key issues for the coal/petroleum coke based power plant Project. This study provides detail emission estimates and air quality result to assess the air quality in the project areas. Construction activities will cause temporary increase in pollutant emission while operation of power plant will be causing emission of pollutants during the Project life leading to increase the ground level concentration of air pollutants. The air pollutants considered in the air quality analysis include Sulfur dioxide (SO₂), Oxides of nitrogen (NO_x), carbon monoxide (CO), and particulate matters less than 10 microns and 2.5 microns in diameter (PM₁₀ and PM_{2.5}).

Pollutants of Concern

Fugitive Emissions

The fugitive dust emissions will be generated from coal storage yards, coal conveyor belt area, ash dumping areas, transportation of fuel, and solid waste. The dust emissions, from the above areas will be fugitive in nature and maximum when the wind velocities are high. The dust emissions are likely to be confined to the place of generation only. Generally large dust particles (greater than about 30 µm), that make up the greatest proportion of dust emitted from construction activities and stockpiles will largely deposit within 100 m of sources. Dust particles in the size range 10-30 µm are typically likely to travel 200 m to 500 m. Smaller particles than these are not produced in significant amounts from construction activities. The potential for significant dust nuisance is therefore greatest within 500 m of the source and will be limited to within the plant. The quantification of these fugitive emissions from the area sources is difficult as it depends on a number of factors such as dust particle size, specific gravity of dust particles, wind velocity, moisture content of the material and ambient temperatures etc. Also, there is a high level of variability in these factors. Hence, these are not amenable for mathematical dispersion modelling.

Emissions from the power plant are a serious concern especially for the coal based power plant project. Potential pollutants of concern released from the proposed coal fired power plant are Sulfur Dioxide (SO₂), Nitrogen oxides (NO_x), Particulate Matter (PM_{2.5} and PM₁₀) and Carbon Monoxide (CO). The amount of SO₂ released is dependent on the properties of the fuel, the higher the sulfur content

of the fuel, higher the amount of SO₂ will be released. High levels of SO₂ can lead to acid rain, which damages crops, forests, and soils, and acidifies lakes and streams. Combustion of coal can also be a significant source of particulate matter. Ash is the main source of particulate matters. Coal fired power plants also tend to release a significant amount of particulate matter in the form of soot and fly ash. The formation of thermal NO_x is dependent on 3 factors during combustion; (i) oxygen concentration, (ii) peak temperature, and (iii) time of exposure at peak temperature. Fuel combustion releases NO_x which is composed of NO and NO₂. NO₂ is of particular concern and is considered a criteria pollutant.

Mitigation measures

By proper utilization of the following measures, dust generation and dispersions will be reduced.

- Dust extraction/suppression system will be provided at transfer points of conveyor system;
- Conveyor belt will be enclosed to prevent dust generation;
- Provision of water sprinkling system at material handling and storage yard;
- Asphalting of the roads within the plant area; and
- Developing of greenbelt around the plant to arrest the fugitive emissions.

Ash Disposal

The ash produced from the Project will be about 10 ton per hour fly ash and 300kg per hour bottom ash, disposal of fly ash will be done near to the existing disposal site, sale to the cement industry. Similarly, fly ash can be used for manufacture of brick and cement blocks locally.

Noise

Depending on the construction equipment used and its distance from the receptors, the commuters travelling on the road and the nearby industries may exposed to intermittent and variable noise levels however the chances of locals getting exposed to noise is quite low since the project activities would only be limited within premises.

In general, human sound perception is such that a change in sound level of 3dB is just noticeable, a change of 5dB is clearly noticeable, and a change of 10dB is perceived as a doubling or halving of sound level. Exposure to very high noise levels (exceeding 85 dBA), particularly for prolonged period can cause hearing loss. Construction and operation of a coal fired power plant will encounter certain unavoidable noise. The noise during the construction phase greatly depends on the stage of construction work and equipment used at the site.

The source of noise during operation and maintenance phase includes:

- Coal delivery, unloading and handling,
- Operation of equipment within the turbine generator building and outside,
- Steam blowing and purging, and
- Shutting down of components and switching to other equipment

Mitigation

The following mitigation measures are recommended in order not to further exceeding the noise due to construction activities:

- Use noise-abating devices wherever needed and practicable.
- Immobile machinery which may generate noise should be placed in enclosed rooms.
- It should be ensured that noise generating from one unit will be prevented by means of suitable noise absorbers such as UPVC doors (Unplastisized polyvinyl chloride) which reduces noise up to 75 dB (A)
- Vehicles must be tuned and maintained to reduce their noise levels.
- Civil works must be planned such that all works are in a sequence and no cumulative effect is formed which may escalate noise levels altogether.

7.4 WASTE GENERATION AND MANAGEMENT

Wastewater Discharge

The wastewater from the project includes the blowdown from cooling tower, blowdown from boilers and other sources most of which will be reused. However, the waste generated from the desalination has to be disposed separately. For some of the low volume waste, an evaporation pond will be constructed at the site.

The construction phase of the proposed project is expected to generate wastes including; packing waste; scrap, excess construction materials and debris, empty containers and drums, used lubricating oils, Sludge, and chemicals etc. Besides being an eyesore, the waste can also pose a health hazard; pollute soil, surface and ground water if disposed of improperly.

It is assumed that during construction phase laborers will be living at site for construction related activities, sewerage would be generated from temporary labour sheds and residence. A small portion of this sewerage may escape sewerage collection and disposal system. The fecal sludge would go to the existing septic tank. This added sewerage would not have any significant impact on the existing sewerage system.

Solid Waste

During construction, large amount of construction waste that includes unused construction materials, construction debris, excavated spoils, abandoned or broken machine parts, debris, kitchen wastes from labor sheds, packaging materials, used home appliances, etc. will be produced. Moreover, food waste, plastic, papers, cock sheet, cartons, metal or plastic binders, etc. may be produced as solid waste during this stage. If these wastes are not disposed and maintained properly, these would have impact on surrounding environment. Space for storage and disposal of stuffs and materials generated along with old and used equipment and materials is limited.

Unarranged piling up and disposal of construction waste will cause unhealthy situation in the area and become visual tiring. If not properly managed, this impact would remain during the life span of the Project but would be extended within the plant premises only. It is very likely to take place if proper management is not adopted which is the requirement of national and international environmental regulations. Considering all of these, it can be assumed that the magnitude of the impact would be moderate. Sensitivity of this impact would be medium as the Project has will be taken the waste management plan. From the analysis of sensitivity and magnitude, it is apprehended that the significance of the impact would be moderate adverse.

Mitigation Measures

- Waste generation will be minimized by adopting waste management strategy of reduce, reuses and recycle.
- Records of all waste generated will be maintained. Quantities of waste disposed, recycled, or reused will be logged on a Waste Tracking Register.
- Training will be provided to personnel for identification, segregation, and management of waste.
- All inert and non-hazardous wastes will be disposed to the existing tipping sites within or outside of the city limits.
- Waste storage areas should be located within the facility and sized to the quantities of waste generated.
- Sludge from the septic tank must be removed on regular basis.
- Prior to site works, a solid waste management plan will be developed for recyclable and non-recyclable waste, which may provide details of garbage collection and its disposal as well as recycling procedures.
- No waste will be dumped at any location outside the proposed site boundary.
- Any hazardous waste at project site will be disposed by engaging EPA certified contractor.
- A waste management plan will be developed before the start of the construction activities. Key elements of the waste management system will be the following:
 - Separate bins will be placed for different type of wastes - plastic, paper, metal, glass, wood, and cotton;
 - Recyclable material will be separated at source. The recyclable waste will be sold to waste contractors for recycling;
 - All hazardous waste will be separated from other wastes. Hazardous wastes will be stored in designated areas with restricted access and proper marking. Hazardous wastes will be disposed of through approved waste contractors;
 - Surplus construction materials including partially filled chemical and paint containers will be returned to suppliers. Inert construction wastes will be sold as scrap to contractors;

Disturbance to Wildlife

As the proposed project site is located within the existing operation facility of SEMC, already developed area with minimal presence of wild life, therefore no significant impacts are envisaged on the wildlife during the construction and operational phase.

7.5 SOCIOECONOMIC IMPACTS

The project activities will mainly result in positive socioeconomic impact on the existing socioeconomic environment locally as well as the broader region. The positive impacts include:

- Increased power generation reducing energy shortfall and reviving associated economy.
- Additional employment opportunities, resulting in increased prosperity and wellbeing due to higher and stable incomes of employed people.

Employment and Business

Implementation of the project will create new employment opportunities and ensure employment opportunities for the communities as well as in the country as electricity is the main need for industrial development. This Project will encourage in establishing industries which will obviously provide employment opportunities to a large number of population. Newly developed industries may appear as a strong source of livelihood.

The project will create additional job opportunities. Most of these positions will be skilled, having expertise in handling the new equipment and processes. During construction period 250 average manpower for the period of 12 months. To maximize employment of people from within the study area in both the construction and operational phases of the project, the project will invest in training programs that focus on the study area. This investment will be needed to overcome the lack of education and skills in the labor force of the study area. The training programs will be implemented in time for local people to at least benefit from unskilled employment opportunities that are available during the construction phase of the project. The proportion of locals in the workforce of the project will increase over time as training programs are completed. The proposed development will create employment during its construction and operational phase. The proposed development will create employment opportunities and other supporting staff. Most of the workforce will consist of local people. The generation of employment is likely to be another major beneficial impact arising from the proposed project during both construction.

Mitigation measure

- Employment preference will be given to the locals;
- Preferentially recruit local candidates provided they have the required skills and qualifications for the announced positions;
- Coordinate efforts to recruit unskilled labor, if any are required under the Project, from the adjacent rural areas.

- Require contractors to prefer local candidates in the recruitment process provided they have the required skills and qualifications.
- Include an assessment of the contractor's demonstrated commitment to local procurement and local hiring in the tender evaluation process.
- Locals, surrounding businesses, city government are kept on the same page during all stages of the development of the project;
- A complaint register will be maintained on site during construction and operation to record complaints of the nearby residents.
- It must be ensured that there is proper arrangement of reaching up to the top level in case of fire and extinguishing it.
- Maximize the benefits of indirect and induced impacts to local communities and businesses by implementing the community development initiatives pertaining to education, training and skill development of the local people.
- Assist employees, local communities and vulnerable groups in improving basic personal financial life skills through training and awareness campaigns.

7.6 HEALTH AND SAFETY

The construction Phase and operational phase expected the major or minor incident in the depot premises. In addition for the operational phase fire hazard, dispersion of volatile substance in ambient environment as well. A significant impact will be interpreted if the procedure and training is not given to employee properly; which may affect the Safety of employees. Prior to any site works, the proponent and contractor will develop a construction and operation management and waste management plan. Such plans will be reviewed and approved by the proponent, and their implementation will be monitored by third party consultants and relevant authorities.

During construction activities the worker safety affected when the heavy machineries work on the project site. Employee's health issues related to suffocation, headache, irritation & respiratory disorders due the contamination of ambient environment. The contractor will ensure that activities at the site will not cause damage to lives and properties by implementing the following measures to ensure the health and safety of workers and the public.

Particulate matter

Dust emissions will cause Particulate matter to disperse in the environment. This may occur due to excavation activities, vehicular movement on unpaved areas and improper piling or stacking of raw materials.

Criteria for Determining Significance

There will be no long term significant impact on air quality. Since the proposed project does not included heavy construction activity and civil works will be completed within a limited time scale, as

readymade steel building will be mounted on project site. In both construction and operational phase, a significant effect on the environment will be interpreted if there is an increase in visible dust or emissions beyond the boundaries of the proposed project site due to activities undertaken at site.

Mitigation Measures

- Installation of proper exhaust systems and fans will be ensured prior to paint activities in order to reduce the exposure probability of VOCs in the ambient environment; this would also reduce the severity of health effects.
- Machineries involved in power generation should be tuned so VOCs maintained
- It should be ensured that all the vehicles, machineries and or generators that may be used in future will be properly tuned in order to reduce the probability of other emissions.
- Emission reduction techniques should be employed on a regular basis.
- Sprinkling of water on unpaved areas will be done so that less dust emissions are emanated from vehicular movement.
- Speed limits must be kept at minimum.

Abatement of Particulate Matter

Handling and storage facilities of coal shall be equipped with dust suppression system. The conveyor belt shall be covered and the transfer point shall be equipped with dust suppression system. Hence, dust generation from coal/petroleum coke handling and storage activities shall be minimum and within the standard limit. Nevertheless, sometime, within the close proximity of the handling and storage facilities, SPM of the local air might rise but automatic dust sensor and suppression system shall control the generated dust. The options of removing particulate matter from exhaust gases using cyclones, bag houses (fabric filters), and ESPs have been reported. Bag houses can achieve removal efficiencies of 99.95% or better for particulate matter of all sizes. ESPs are available in a broad range of sizes for power plants and can achieve removal efficiencies of 99.7% or better for particulate matter of all sizes. The choice between a bag house and an ESP will depend on fuel and ash characteristics, as well as on operating and environmental factors. As per feasibility study, the coal/petroleum coke combustion process will produce maximum 12.77% ash (design specification) from the total coal/petroleum coke inflow. In order to maintain the standard limit of particulate matter (e.g. PM₁₀ & PM_{2.5}) controlling devices must be added before the flue gas emission. Based on technical and economic analysis, Electrostatic Dust Precipitator (ESP) has been selected for each of the unit.

Flue Gas Desulphurization System (FGD)

Flue gas desulphurization (FGD) is the current state-of-the art technology used for removing sulphur dioxide from the exhaust flue gases in power plants. SO₂ is an acid gas and thus the typical sorbent slurries or other materials used to remove the SO₂ from the flue gases are alkaline.¹

¹ 130 *International Journal of Chemical Engineering and Applications*, Vol. 3, No. 2, April 2012

FGD processes can be categorized as (a) wet and (b) dry or semidry systems. In most wet FGD systems, SO₂ is removed from the flue gas by reaction with a calcium-based sorbent in an aqueous solution or slurry. A relatively high degree of SO₂ removal is usually achieved, with a high level of sorbent utilization. In addition, wet FGD systems generally achieve excellent particulate removal because of intimate contact between the gas and liquid phases. Dry and semidry FGD systems involve injecting a solid sorbent (dry), usually limestone, or a sorbent slurry (semidry), usually lime, into the furnace or flue gas duct; the by-product solids are collected in a dry form along with the fly ash from the boiler in the existing particulate removal equipment. Compared with wet FGD systems, SO₂ removal efficiency and sorbent utilization are usually lower.²

The AFGD unit successfully achieved the target of removing more than 90% of the SO₂ from the flue gas. Five Midwestern bituminous coals, having sulfur contents between 2.25% and 4.5%, were burned during this demonstration. SO₂ removal efficiency averaged 94%, with a maximum of over 98%. The facility was operated for 26,300 hours during the demonstration, with system availability of 99.5%. High availability eliminates the need for a spare absorber.

Ecological Impacts

No significant impact of the proposed project on the flora and fauna of the area are anticipated. No threatened mammals or reptiles are found in the study area. Although part of the Thar Desert in the project area is cultivated, the agricultural activity is not very intense. Thus the natural habitat is relatively intact. Site clearance for proposed development and related infrastructure will result in immediate and direct habitat loss, however, the risk of direct impact of animals is minimal as the animals are likely to move away from the area once the clearance has started.

The habitat in the Thar Desert area is important for survival of vultures as endangered species of vultures are breeding in the Thar Desert. Availability of nesting sites and food are principle factors that determine the population of vultures in an area. The vulture population in the Indian subcontinent is declining due to existing threat to the vulture population. The cause of this is presumably poisoning by the veterinary drug Diclofenac, probably combined with other causes. (Bird Life International 2010)³. The birds feed on carcasses of animals treated with the veterinary drug.

Availability of nesting sites and food are principle factors that determine the population of vultures in an area. Clearing of land for power plant will reduce the potential habitat area of these vultures. While the trees for nesting and the feeding areas are widespread in the Thar Desert, a program for management of vulture population in the immediate vicinity and within Block II supported by the mining project will be required to contribute to the ongoing efforts of the Sindh Wildlife Department and other conservation groups in preventing the extirpation of this species from the Thar area. Vultures prefer to make nests on *Prosopis cineraria* trees in the Thar Desert. *Prosopis cineraria* trees can be planted outside the area that will be directly impacted by mining operations so the vultures can have access to alternate nesting sites. Such plantation may be started early during the project to minimize the potential impact of habitat loss during the construction period.

² Advanced Technologies for the Control of Sulfur Dioxide Emissions from Coal-Fired Boilers

³ BirdLife International 2010. Species factsheet: *Neophron percnopterus*. Downloaded from <http://www.birdlife.org> on 27/6/2010.

**FEASIBILITY STUDY REPORT
10 MW COAL POWER PLANT
AT
BLOCK-II, THARPARKER, SINDH**

AGJV (Private) Limited

LS 30, Block 13 Federal B Area,
Karachi, Pakistan

Table of Contents

1	Introduction	4
1.1	Sindh Engro Coal Mining Company	4
1.2	AGJV (Pvt.) Ltd.....	4
2	Location.....	4
3	Major Facilities of Plant	6
4	Project Features	10
5	Boiler	12
5.1	Boiler Main Parameters	12
5.2	Boiler Technology.....	12
6	Boiler Auxiliaries	15
6.1	ESP.....	15
6.1.1	Technical Description.....	15
6.1.2	Character.....	15
6.1.3	Supply List	18
6.2	Drafting System.....	19
6.3	Boiler Feed Water Pumps	20
6.4	Blow Down System	20
6.5	De-aerator (ASME Stamped).....	20
6.6	Dosing System	21
6.7	Soot blowing system	21
6.8	Silencers	22
6.9	PRDS.....	22
6.10	Piping and ducting system	22
6.10.1	Piping system	22
6.10.2	Air & Flue gas ducting.....	22
6.11	Refractory and Insulations	22
7	Turbine Generator and Auxiliaries.....	24
7.1	Turbine and Generator Main Parameters.....	24
7.2	Turbine Description.....	24
7.3	Generator Description	25
8	Fuel Analysis.....	26
9	Water Analysis	27
10	Balance of Plant	28
10.1	Fuel Handling System	28
10.1.1	Fuel Store Field and Its Equipment	28

10.1.2	Accessories.....	28
10.2	Ash Handling System.....	28
10.2.1	Fly ash handling system	28
10.2.2	Bed ash handling system.....	29
10.3	Plant Water System.....	29
10.3.1	DM water plant	29
10.3.2	Cooling Water System.....	30
10.3.3	Service water.....	30
10.4	Instrument & Control System	31
10.4.1	Control System Description.....	31
10.4.2	Field Instruments	32
10.4.3	DCS system description.....	33
10.5	Electric System (Dust proof type).....	34
10.6	Air conditioning and ventilation system (JL will provide the design only).....	35
10.7	Fire Fighting System.....	35
11	Auxiliary Consumption.....	36

1 Introduction

1.1 Sindh Engro Coal Mining Company

Sindh Engro Coal Mining Company Limited ("SECMC") is a joint venture of Engro Energy Limited & Affiliates and Government of Sindh. SECMC is working on the development of an Open Cast Lignite Mine and in Thar Block-II to support future energy needs of Pakistan.

SECMC has been granted a 30 years Mining Lease for Thar Block-II by Mines & Minerals Development Department, Government of Sindh. SECMC needs electricity to meet its own requirement for operations. For the purposes, SECMC issued Request for Proposal document, on November 2019, with the objective to invite proposals for Power Developer to install, commission and manage O&M of 10 MW Coal Power Plant based on Thar Coal (the Project) on BOO (Build, Own, Operate) basis. Following the examination of the bids submitted in response to the RFP, SECMC was pleased to accept the bid, submitted in Joint Venture of M/S AMCORP-GASCO. The Joint Venture has been issued Letter of Intent on January 28, 2021 to undertake Installation, Commissioning, Operation & Maintenance of a 10MW Coal Power Plant. Later the Special Purpose Company with the name of AGJV (Private) Limited ("Company") has been incorporated in between the shareholder of AMCORP and GASCO. M/S AGJV, being the Sponsors, will develop and maintain the Project and will supply electricity to SECMC under a Power Purchase Agreement between the parties.

1.2 AGJV (Pvt.) Ltd.

AMCORP Engineering & Construction (Pvt) Ltd., established in 1965 as Al-Mumtaz Corporation, is providing construction and engineering services in the areas of institutional and office buildings, road works & bridges, Plant Construction and Erection of Plant Equipment's, Factories, Industrial Buildings and Warehouses.

M/S GASCO Engineering (Pvt.) Ltd. was established as independent-equipment supplier in Karachi, Pakistan in 1990. Services rendered by GASCO are very broad base and multi-faceted. The services includes Pipeline Construction, Outsource Warehouse, Detail & Design Engineering, Supplies, Construction, Fabrication, Procurement, Venture Capitals/Development and Rental Equipment.

AMCOPRP and GASCO (JV Partner) established a company, as joint venture, specifically for the purposes of implementation of this Project.

2 Location

Thar Block-II covers an area of 95.5 km² and is located in District Tharparkar approximately 380 kms from Karachi, 65 kms from Mithi and 20 kms from Islamkot.

The area can be approached by road, using either the southern road via Badin/ Naukot or the northern via Hyderabad/ Mirpur Khas/ Naukot. Figure below indicates both alternative routes.

1

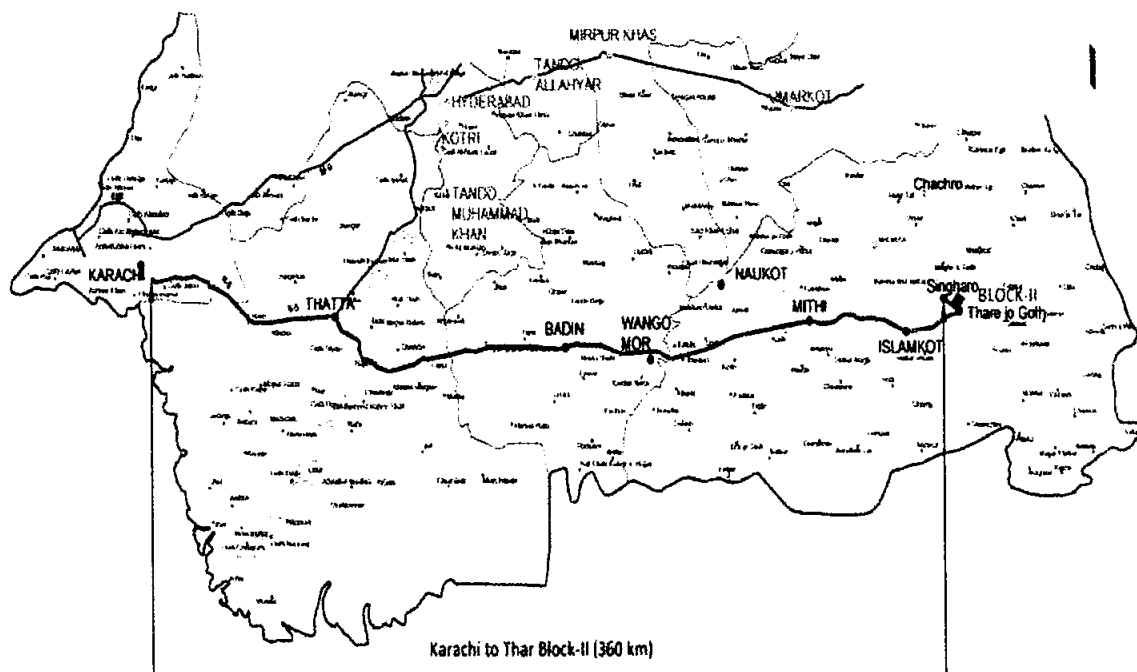


Figure: Project Area

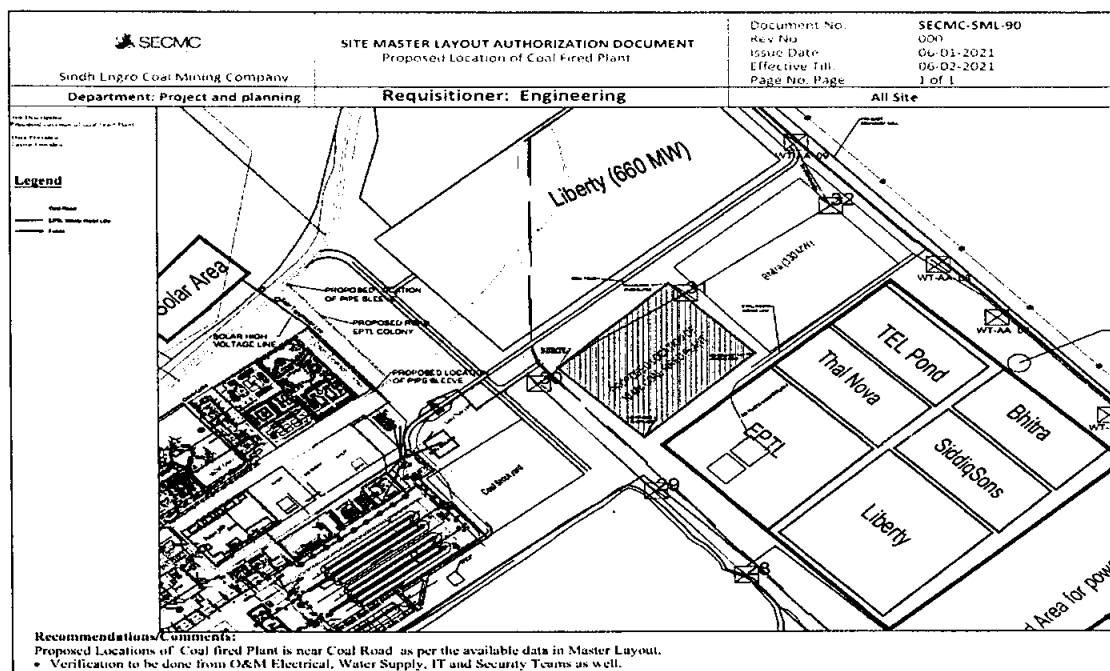


Figure: Proposed Location of Power Plant

3 Major Facilities of Plant

Following facilities / equipment's are to be provided as per the Bidding documents of the Project.

Power Developer is required for installation, commissioning and O&M of Coal power plant based on Thar Coal on BOO (Build, Own, Operate) basis for a period of 15 years. The configuration will be 1 x 10 MW steam turbine and a Boiler. A minimum system availability of 85% has to be ensured.

Operation and Maintenance of the Power plant with a guaranteed minimum availability of 85%.

- Boiler Design Parameters: Lignite Coal metallurgy compatibility as per specifications, With minimum standards of:
 - As per American Society of Mechanical Engineers or American Society for Testing and Materials
 - Bidder to provide an undertaking from the Boiler Manufacturer that the Boiler metallurgical design is compatible on the Boiler design parameters shared by SECMC. Additionally, a third-party verification certificate that operation of boiler on lignite is not an operational impediment.
 - All auxiliary equipment and systems pertaining to the boilers shall be the bidder's responsibility
 - Basic Specifications
 - Evaporating Capacity- 50 t/h
 - Steam pressure: 6.5 M Pa
 - Steam temperature: 450 degree Celsius

- Feeding water temperature: 150 degree Celsius
- Effective Soot Blowing System
- Calorific value of fuel: see Annexure
- System to include:
- Steam Bypass and Governors
- Reverse Osmosis Plant
- Sample Cooler System
- Microporous Muffle
- Blower and induced draft fan systems
- Fire Proof material for boiler
- Heat insulation
- Fume and Air piping
- All other auxiliary equipment and systems
 - Bidder to provide complete specifications of boiler
 - Boiler will be operated on varying load profile (Minimum 5MW, inclusive Parasitic load)
 - Vendor to provide measures that do not have detrimental impact on the boiler component metallurgies
 - Contractor shall select the optimal coal particle feed size upon analysing the coal samples and its moisture content according to the SECMCs provided supply coal particle size distribution (Attached as Annexure). However, SECMCs recommended top feed size is 20-25 mm
 - Boiler design parameters such as height, refractories thickness etc. to be finalized once the top coal particle size is selected by the bidder

Thermodynamic System

- Steam Turbine System including but not limited to:
 - Basic Specifications:
 - Inlet steam flow: 48.8 t/h
 - Inlet pressure: 6.3 MPa
 - Inlet temperature: 435 degree Celsius
 - Rated power: 10MW
 - Exhausting pressure: 0.00714 MPa
 - Rated Speed: 3000 r/min
- System to include:
- Turbine Governor system and Steam Bypass loop

- Condenser and condensate expansion tank
- High- and low-pressure heaters
- Oil and air coolers, oil tank, including AC motor driven and DC motor driven emergency oil pumps
- Throttle system
- Steam injectors
- Pumps for feed water and condenser
- Deaerator
- Precipitator
- Expanders
- Drainage system
- Bridge Crane
- Piping, ducting work
 - All auxiliary equipment and systems pertaining to the turbine shall be the bidders responsibility
 - Turbine shall be able to operate smoothly as per SECMCs load profile without any tripping. (Load profile attached as Annexure)

6.1.3 Fuel System

- Reciprocating coal feeder
- Vibratory Screen
- Crushing system
- Rotating feeder
- Conveying system
- Fuel treatment
- Other equipment and works as may be required
- Steel construction

Supply and Drainage Water system

- Cooling Towers
- Water tank
- Pumping system
- Piping works

Make-up Water System

- Filters
- Cation and Anion Exchangers

- De-gasifier
- Pumps and piping systems for process water, demineralized, diluting, ammonifying, booster, acid, alkali, sewage
- Tanks for acid, alkali conveying, measuring and storage and ammonia
- Acid and Alkali ejectors
- Ion exchange resins
- Other auxiliary systems, as required
- Piping works

Electrical Equipment

- Power Equipment
 - Dry type transformer(s)
 - Medium voltage switchgear
 - Low Voltage switchgear for auxiliaries
 - Grounding and equipotential bonding system
 - Transmission line from Coal Power plant to centralized 11kV distribution room (1 km)
- Control Equipment
 - PLC based power control system
 - DC battery-based power system
- Conductors
 - Medium voltage cables and raceways
 - Low voltage busway system, cables and raceways
- Lighting and control system
- Lightning Protection System

Thermal Control and Instrumentation System

- Boiler thermal control system
- Turbine thermal control system
- Deaerator thermal control system
- Water treatment control system
- Control cabling, raceways, etc.
- System protections

Life Safety, Security and Firefighting system.

- Firefighting, fire water tank, pumps sprinklers/ hydrants/ suppression, as required in complete compliance with NFPA requirements.
- Fire Detection and Alarm system and evacuation system

- Emergency lighting
- Security surveillance throughout the Power plant
- Access Control system for both physical and software access.
- Central Security control room.
- CEMS for Stack

Communications

- ICT infrastructure
- Integration of ICT infrastructure of the Power Plant with site infrastructure through overhead fibre optic cabling infrastructure
- Emergency lighting
- Integration of Power plant control system with Owner's plant management and other ERP systems through standard APIs

Structure and Civil Construction

- Structure design to comply with local codes, soil type (See Annexure XX) especially taking into consideration seismic categorization of the area
- Civil design of the building shall adopt similar design basis as existing power plant in close proximity of the site. Design shall comply with all related international building and fire protection codes for Power Plant building
- Civil design shall have space provision for waste heat recovery through absorption chiller, including its auxiliaries, piping, condensate and electrical systems
- Design shall allow physical expansion of the Power plant in future to add another 10 MW steam turbine, complete with its fuel, combustion, mechanical and electrical systems.

Integration with Power and Control Systems

- Integration of 11kV output of the coal plant with the centralized 11kV distribution switchgear will be bidder's responsibility
- Integration of turbine power control system with existing diesel engine-controllers and solar power plant controllers (existing controllers are Deif AGC-200 and ASC-200 for generators and solar plant respectively)

4 Project Features

The configuration will be 1 x 10 MW steam turbine and 1 Boilers (100 % operational). A minimum system availability of 85% has to be ensured. The power installation capacity of 10000kW in according with this thermal and electrical load to build a co-generate power plant in order to save energy, improve the environment, enhance the quality of power supply. Boiler will be of fluidized bed technique, Main steam maximum continuous rating 50 t/h, Superheater outlet steam temperature 450°C , Superheater outlet steam pressure 6.7 MPa(g), Feedwater temperature 150°C, Flue gas temperature at A/H outlet 140°C, Boiler design efficiency 91.±1%, Minimum stable combustion load 60% MCR(without oil supporting). The steam turbine will be a standard multistage, single-cylinder,

non-reheat, condensing unit. The turbine will exhaust against condenser pressure of 6kPa (0.06ata) at the design condenser cooling water temperature.

Coal Type	Lignite
Capacity	10 MW
Lignite Burning Capacity Per Month	10,000 Ton
Bottom Ash Production Capacity	300 kg per hour
Fly Ash Production Capacity	10 Ton Per Hour
Make up water requirement	120 ton per hour
Gaseous Emission	CO ₂ , CO, NO _x , SO ₂ , Particulate matter
Chimney	40 meter
Steam Turbine Temperature	450° C
Feed Water Temperature	150° C
Generator	12500 kVA
Power Generation(Gross)	10MW
Steam Flow	42(Max 45) TPH
Steam Pressure	67 Bar
Steam Temperature	485°C
Steam purity	
TDS	0.1 Ppm
Silica as SiO ₂	0.02 Ppm
Fuel Consumption based on designed fuel (basis onLHV=10mj/Kg	13280 kg/hr
Turbine Heat Rate	11753 kcal/kw.h
Turbine Steam Rate	4.18± 0.02 kg/kw.h
Boiler Efficiency	88 %
Auxiliary Power Consumption	1321±30 kW

NEQS: Sox=400mg/Nm³ and JLIANCO =300mg/Nm³, NEQS NO_x=1200mg/Nm³

Contractor =400mg/nm³ Particulate matter: NEQS=500mg/nm³ JLIANCO= 80mg/nm³. Atthe outlet of boiler chimney

5 Boiler

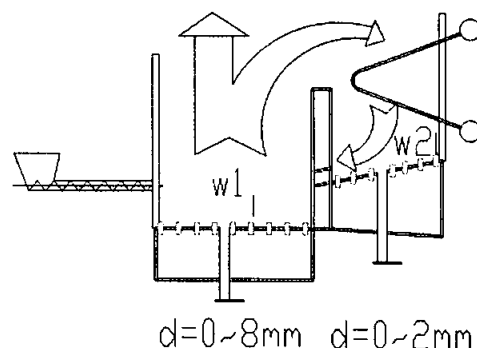
5.1 Boiler Main Parameters

Boiler Model	JG-42/6.7
Boiler Type	CFBC
No	1
BMCR (Rated Output)	42TPH
Steam pressure	67 bar
Steam Temperature	485 °C ±5 °C
Boiler Efficiency (LCV)	88%
Coal Consumption at BMCR	13.280 TPH based on LHV: 10 MJ/kg
F.W. Temperature	130 °C
Outlet Flue Gas Temperature	145 °C
Boiler's Pressure parts, De-aerator & blow down tanks construction Code	Design & fabrication according to ASME Boiler & Pressure Vessel Code. (ASME Stamped)

5.2 Boiler Technology

The boiler is adopting high-low bed CFBC technology introduced from Germany, the core part of this technology is that the bed coils are arranged for taking the major heat absorption of the boiler (45-50%). Instead of recycled hot ash flushing membrane wall, which is having the risk of refractory damage, corrosion and unstable output, this arrangement is proven to be suitable for ensuring the stable steam output while firing high moisture /ash content and low caloric value fuel, with much less risk in cyclone refractory damage and tube corrosion. The detailed technology philosophy will be as below, which is an introduced technology from Germany:

Combustion area is arranged with 3 compartments with one main bed (lower bed) and two auxiliary beds (higher beds) (as shown in left sketch), auxiliary beds are arranged at front and rear side of the boiler. Air nozzles are mounted on all 3 beds. Above the two auxiliary beds, bed coils are arranged. Air velocity at main bed is higher (around 3 - 3.5m/s, air source from PA fan), whereas air velocity at auxiliary beds are lower (1.6- 2m/s, air source from SA fan). The fuel is fed into the furnace from two sides into main bed, where air velocity is higher, the fuel is fluidized by the Primary Air which velocity is around 3-3.5m/s, because the auxiliary bed air velocity is much less (1.6-2m/s), due to air pressure difference, a circulation is formed inside the furnace like "fountain effect", the smaller size of fuel is spread and drop onto the auxiliary bed, and the bigger size taken by the flue gas is dropped into the main bed for complete combustion. While the size of the fuel/bed material in the auxiliary bed accumulated to a bigger level, it will automatically fluidize into the main bed to maintain the combustion and circulation (refer to second sketch). As per the design and practical experience of us, the particle sizes fluidized to the auxiliary beds are always limited to 0-2mm. For the bed coils above auxiliary bed, alloy steel fins and covering shield are arranged for protection.



With above combustion arrangement, accordingly to the formula of abrasion calculation:

$$E=C*d^{1.5}*W^{2.3}$$

(E-Abrasion Loss; C- Material Constant; d= Particle Size; W=Air velocity)

As per the design, d=0-2 mm, W=1.6m/s, both of the value is controlled at a very small level (1/4 of the ordinary design), and with good protection with alloys steel for bed coils (shown as the photo), the abrasion of this design is less than 1% of the normal design, which is greatly reducing the abrasion on the bed coils. As per our experience, the bed coils are guaranteed for 3 years continuous operation (above photo shows bed coils after 2 years operation).

Under bed ignition is adopted for this boiler. Beneath the bed a hot flue gas reactor is arranged vertically at the rear side of main bed chamber as ignition heat source. LDO is used as start-up fuel; the LDO is atomized and get combusted at the hot flue gas reactor and generating high temperature flue gas. The flue gas mixed with cooling air forming flue gas at temperature around 850 degree and enters air chamber. Ignition oil gun pressure around 1.96MPa, oil gun capacity Q=200kg/h.

On the main bed 2xDia 159mm pipe is arranged for discharging the bed ash generated while combustion. On the pipe discharge valve is fitted.

Air Distribution

The primary air supplied from PA fan passing through PA air preheater and led into the water cooled air chamber beneath the main bed, the primary air is blowing up through the air nozzles mounted on the main bed at a velocity around 3m/s. At the same time, the combustion air supplied from SA fan passing through SA air preheater and led into air chamber beneath the auxiliary bed, and the air is supplying the air for auxiliary bed with a velocity around 1.6-2 m/s. The quantity of the air supplied for main bed is about 40-50% of the total required air quantity, and the air supplied for auxiliary bed is around 40%/. The balance 10% is for secondary air which is blowing through air chambers at left / right side into the furnace and also the air required for spreading the fuel. At all the air distribution ducts, air dampers and air flow elements are fitted, for controlling main & auxiliary bed air quantity so as to control boiler load.

Advantages in Low Heat value coal Application

- a. Stable Output. As the heat absorption of the boiler is mainly focused in the bed coil tubes area (dense phase), the heat absorption is not majorly depending on flue gas temperature, which means heat absorption is more stable and firm, ensures the output of the boiler;
- b. Corrosion Control. With the special arrangement at the combustion area, the flue gas temperature can be easily controlled at a proper level so that the corrosion can be reduced to the minimum level. This is achieved only because the flue gas heat transfer requirement is not as strict as other type of boilers that even with a relevant low flue gas temperature, still boiler can be operated very stably with rated steam parameter;
- c. Easy and economic maintenance. The boiler is having a longer duration of continuous operation, and it will be much easier and economic to fulfil maintenance work as there will be no grate parts.

Flue Gas Side Description

This boiler is adopting two flue gas path arrangements with "Π" structure. Hot flue gas generated is passing through the dense area, uprising in sequence passing through HT super heater, MT Super heater, LT super heater, Cyclone separators, 2 stage Economizers and air preheater then exhausted out of boiler.

Front flue gas path is of full membrane wall structure. The super heaters are arranged at the horizontal flue gas path. Cyclone separators are arranged at the top of rear flue gas path above economizers and air preheater.

Along boiler width direction, in all reasonable positions of heating surfaces temperature & pressure measuring points are arranged. Besides, in the first path both side is reserved with SNCR opening for flue gas denitrogenation use if required.

Steam & Water Side

Boiler feed water is entering economizer inlet header, passing through economizer coils and then enters economizer outlet header. During start-up, economizer recycle system could lead furnace water to economizer inlet header from boiler drum and protects economizer.

Natural circulation is adopted for this boiler: Furnace water in boiler drum is flowing downward through down comers and distributed to water wall lower header and bed coils lower header, after passing through and get heated through bed coil tubes and water wall, the mixture of steam and water is led into boiler drum by led-out pipe for steam-water separation, the water separated is entering into drum water portion and proceed for re-circulation; the saturated steam separated is led into LT SH inlet header through steam connecting pipe, and passing through LT SH, de-super heater and HT super heater. Finally qualified superheated steam is led into turbine.

One set of de-super heater are arranged, superheaters are arranged at furnace top horizontal flue gas path, the de-super heater is arranged at the between LTSH and HTSH.

Boiler drum Dimension will be ID 1400X50 THK. Inside boiler drum sufficient steam & water separators are arranged.

6 Boiler Auxiliaries

6.1 ESP

6.1.1 Technical Description

- a. The ESP will be installed outdoor, and every boiler will be equipped with 1 ESP with 3 chamber and 3 electrical fields. When the amount of flue-gas produced by boiler at BMCR conditions flows by, the performance of the ESP will meet the technical characteristics.
- b. ESP inlet dust concentration is considered as 4 g/Nm^3 , which is a worst condition for the fuel.
- c. The ESP will be designed as per the worst condition and satisfying achieving the emission level of 100mg/Nm^3 .
- d. The designing maximum temperature of ESP steel structures is 200°C .
- e. ESP will be operated normally when boilers are in the minimum stable coal fired load (without the use of oil), and without any clog.
- f. The designing lifetime of ESP is 30 years.

6.1.2 Character

ESP Paper

- a. The inlet of every ESP will be equipped with porous plate and even flow devices, so that the flue gas can flow through the electrical fields evenly.
- b. The case will be sealed, rainproof, and the designing of which shall avoid dead angle or dust concentration area as far as possible.
- c. Before and behind every field of ESP will be equipped with manholes and access way. The maintenance holes will be installed at the top of ESP for the convenience of maintenance of electrode pendent system. The diameter of round manholes will at least be $\varnothing 600\text{mm}$, and the minimum of rectangular manholes will be $450 \times 600\text{mm}$.
- d. The entrance to every high-voltage parts will be interlocked with rectifier transformers for power supply of such high-voltage parts in order to prevent getting electric shock accident.
- e. The insulators will be equipped with heating fittings.
- f. All the platforms will be equipped with railings and fences. The platform load will not be less than 4kN/m^2 . The top platform will consider the load of rectifier transformer.
- g. The ladders will be high enough to reach every operation level needed to do maintenance and operation, and the ladder load will be 2kN/m^2 .
- h. The ladders of the first platform from zero meter to ESP proper will be supplied by the Purchaser
- i. The earthquake acceleration will be taken into account when designing the pedestal of equipment supports.
- j. The shell will fully consider the expansion requirement.
- k. The maximum noise level at 1m from ESP shell will not exceed 85dB (A).
- l. The pressure of ESP shell will be designed at -4000Pa and $+4000\text{Pa}$. The shell will be gas-tight, weather proof and reinforced as far as possible in order to undertake air flow pulse.

Ash Hoper

- a. The ash hopper and ash discharging outlet will be designed as such that the ash can be guaranteed to flow freely and to be discharged out of it. The capacity of ash hopper will be able to store the amount of ash produced in not less than 8 hours of the first electric field when the boiler is operated at BMCR conditions.
- b. The distance between ash hoppers will be matched with that of electrical fields. Maintenance platform will be installed under ash hopper.
- c. In order to avoid flue gas short circuit, the inside of ash hoppers will be equipped with flow-resistance plates, the lower part of which will be kept away from ash discharging outlet as far as possible. The angle between the ash hopper slope wall and horizontal level will be more than 60°. The inner side of intersections of two contiguous walls will be made with an arc type, with 200mm angle radius to ensure that the ash can flow smoothly.
- d. The ash hopper will have good thermal-insulation methods. Every hopper will be equipped with electrical heating.
- e. Every hopper will have a well-sealed ash poking holes with convenient operation.
- f. The ash hopper will be equipped with devices preventing ash flow inside hoppers against cohesion or dewing. Each hopper will be equipped with a team of fluidizing plates.
- g. The ash hopper will be equipped with high/low level indicators which can indicate the level of ash and alarm when the ash level is over the warning level.
- h. The manholes will be installed at the bottom of ash-hopper in order to discharge ash during accident.
- i. The outlet dimensions of ash hoppers will be designed in consideration of the case that if the preceding electric field is shutdown, the hoppers will have sufficient ash discharging capacity.
- j. The hopper proper will take into account of the loads of hanging air-lock valve.

Collection Plates and emitting wires

- a. The thickness of collecting plates will not be less than 1.2mm. Before and after erection, there permits no such deformation of positive plates as bending and torsion. For positive plates we will use 480C.
- b. The supporting frames of all positive plates and cathode wires will be installed plumb, and precautions against oscillation shall be taken. For cathode wire we will use new-RS wire.
- c. The vibrating programs of supporting frames of positive plates and cathode wires will be adjustable according to each type of coal, and the vibrating devices will enable the whole electrode to produce strong enough axial acceleration.

Hoisting Fittings of Rectifier Transformer

- a. The hoisting fittings of rectifier transformers will be able to lift the equipment from top to zero meter, and have corresponding hole and steel wire length.
- b. The motor-driven hoisting fittings will be equipped with moisture-proof motors, and provided with enough hoisting capacity to lift up rectifier transformers under the protection of its safety measures.

Insulations

- a. Seller will be responsible for all designing with regards to ESP insulation and supply all the thermal insulation structural material with the mineral wool. Seller will supply the purchasing list (incl. Function requirement, specifications, usage positions, etc.) of mineral wool and construction instructions.
- b. Seller will design the insulation in line with the standards stipulated in the inquiry.
- c. The outer thermal insulation plate will adopt colored corrugated steel plate with thickness of 0.6 mm. The thickness of walls for casing and hoppers are not less than 5mm.

Power Supply

- a. The power supplied is $400\text{VAC} \pm 10\%$, 3 phases 4 wires, 50 Hertz $\pm 5\%$. All the electrical equipment and control system can be operated normally when the power voltage and frequency are within the scope as follows:

AC power source ($+5\% \sim -10\%$) U_e , frequency $\pm 2\%$, 50 Hertz long term;

No equipment accident will happen when the voltage is $-22.5\% U_e$ and the lasting time is within the limit of 1 minute.

- b. The permissible max. Uneven load of power source is 5 KVA. Seller will keep balance of the 3 phase loads of power sources as far as possible in the designing of equipment circuit.

Rectifier Transformer

- a. The rectifier transformer will meet the outside application requirement, and will be a whole type.
- b. The primary and secondary side current and voltage of each rectifier equipment will all be input to control panel and displayed out, the feedback wires of which will use metal H-wires.
- c. During the operation of rectifier transformers, no disturbance will be caused to wireless set, television, telephone and other communication facilities in PowerPlant.
- d. The high voltage output terminals will be equipped with high voltage resistance components before entering the electrical fields.
- e. The rectifier transformers will not permit any oil leakage and seepage.
- f. The oil tank will be installed under oil dip (silicon) rectifier transformers, and each oil tank will have oil pipe up to the ground.

Control panel

- a. The control panels of rectifier transformers, vibrating devices, heating devices, ash hoppers, etc shall be dust-proof, vibration-proof and prevent small animals from getting inside. If the panels are installed locally, the protective level will not be lower than IP54.
- b. The surfaces of panels will be flat and smooth, all the steel structures of which will do surface antirust treatment before painting.
- c. The steel plate used for manufacturing panel cases will meet the requirements of hardness and lifetime.
- d. 25% spare space will be preserved when designing the cable inlet of control panels to be prepared for adding cables and changing cable lay.

- e. 20% reservation will be kept for terminal blocks used for connection cable of panels.
- f. There will be equipped with lighting inside panels supplied by Seller, at least one light for each panel. A switch will be installed inside panel door, the open/close of which automatically controls the on/off of the lights.
- g. When the radiated heat of panels exceeds the allowable temperature of the components, Seller will adopt mechanical ventilation, the control switches of which have start/stop functions.
- h. Before being delivered to site, the operation of control panel will be tested under simulated conditions

Control Circuit

- a. Copper wire with efficient current load capacity will be used as control wire, which will not bear any damage or marks made by tools during construction.
- b. As for the wires used for trip circuits of current mutual inductors and breakers, the cross-section will not be less than 4 mm². For the wires used for other strong current control circuits, the cross section will not be less than 1.5 mm².
- c. Seller will supply terminal blocks for all the equipment needed to be output and each terminal can only be connected with one exterior conductive wire. The connection between Seller's interior circuits and terminal blocks will also be one wire for one terminal, at most two wires for one terminal. The terminal blocks are best to be installed vertically.
- d. Because there are electromagnetic disturbance in the surroundings of ESP, the electric control wires will be equipped with electromagnetic shield to prevent the normal operation of circuit from being disturbed.
- e. If the control switches are rotating type, the clockwise rotation will be regarded as increase looking in front. It is different in shapes of control switch and selection switch. The continuous current flow through switch connection point will be less than 80% of rated value.
- f. The arrangement of push buttons will be in compliance with certain rules if there are too many push buttons in control panels, that is, the push buttons of startup, increase, breaker on, valve open shall be arranged in the right or upside of panels; conversely, the push buttons of shutdown, decrease, breaker off, valve close will be arranged in the left or downside of panels

6.1.3 Supply List

- a. ESP proper (the part from the flanges of inlet flue gas box to the flanges of outlet flue gas box, and down to ash hopper outlet flanges).
- b. Auxiliary facilities
- c. Platforms, access ways, ladders, railings and the supporting structures necessary for these parts
- d. Monorail crane used for rectifier transformers maintenance.
- e. Thermal insulation items include: ESP proper (incl. Inlet, outlet flue gas box); ash hopper and incubators; metal parts for thermal insulation, metal protective case.
- f. Ash hopper auxiliary facilities and fittings
- g. Ash hopper high/low level indicator

- h. Electrical heaters for hoppers will be supply by purchaser.
- i. Electrical equipment
- j. Control equipment for rectifier transformers, vibrating devices, heaters, etc.
- k. For each rectifier transformer, the currency and voltage meters for checking the primary and secondary side of currency and voltage.
- l. Cables and cable trays
- m. Rectifier transformers and corresponding control panel.
- n. Vibrating fittings and corresponding control panel
- o. Heaters (of the insulator, casing pipe) and corresponding control panels.
- p. High voltage lines between rectifier transformers and discharge pole when rectifier transformers higher located.

6.2 Drafting System

Drafting system are taking suction from ambient air to provide air required for boiler combustion and also providing suction force for flue gas so as to maintain draft balance and furnace boiler negative pressure. The individual equipment for fans will be as bellow for each boiler:

- a. 1X100% motor driven Primary Air fan with VFD motor will be provided, with 15% margin in flow and 20% margin in head. One (1) no of pneumatic controllable damper will be provided at the inlet of the fan.
- b. 1X100% motor driven Secondary Air fan with VFD motor will be provided, with 15% margin in flow and 20% margin in head. One (1) no of pneumatic controllable damper will be provided at the inlet of the fan.
- c. 1x100% motor driven ID fan with VFD motor will be provided, with 15% margin in flow and 20% margin in head. One (1) no of ON / OFF type Isolating Dampers will be provided at the inlet of the fan.

All fans will be provided with shut off isolation to enable repair & maintenance during operation.

Fan Data Sheet

Fan Data		PA fan	SA fan	ID fan
Type		Single suction, Centrifugal		
Config		1x100% for boiler		
a. ON / OFF type Isolating Dampers at ID Fan Inlet & Outlet, PA / FD Fans and SA Fanoutlets shall be pneumatically operated Guillotine type with VFD control b. PA fan and SA fan will be provided with silencer, noise level will be controlled at 85dB at 5 metre distance. c. Fan outlet are furnished with isolation dampers d. Vibration and speed sensors are provided				

6.3 Boiler Feed Water Pumps

The condensate water from two deaerators will be delivered through 2 nos of boiler feed water pumps each having 45m³/h capacity at 1 working plus 1 standby basis . The HP feed water from boiler feed water pump will be delivered into boiler via feedcontrol station. BFP will be furnished with hydraulic coupling.

BFP shall be complete with the following but not limited to ;

- a. ARC
- b. Differential Pressure Switch for High Alarm and Indication across BFP SuctionStrainer
- c. TG at each Pump Discharge
- d. TG at Common Suction Header and Pump Discharge end
- e. Pressure Gauge at Common Discharge header
- f. Pressure Gauge at Suction and Discharge Side
- g. Pressure Switch for Low Pressure Alarm at Pump Discharge End
- h. Suction Strainer
- i. Mechanical Seal
- j. NRV and Isolating Valve at Pump Discharge Side before Common Discharge Header
- k. Motorised Discharge Valve
- l. Provision of separate line with Isolating Valve for PRDS Spray Water Header.

BFP Data Sheet

SN	DESCRIPTION	Unit	VALUE
1	Design flow	M ³ /hr	45
2	Quantity		2
4	Head	M	940
5	Working temperature	oC	130
6	Rated speed	RPM	2980
7	Motor	kW/V	220 / 380

6.4 Blow Down System

The boiler will be fitted with one CBD tank designed according to IBR and an IBD tank. Outlet of the CBD tank will be connected to the IBD tank and the CBD vent will be connected to De-aerator.

6.5 De-aerator (ASME Stamped)

One (1) fixed pressure De-aerator of de aerating capacity equal to Twenty percent (20 %) higher than the gross MCR steam generation capacity of the boiler with a de aerated water storage tank of net useful capacity (normal water level to Low water level) equivalent to twenty minutes (20 minutes) of MCR generation capacity of the boiler shall be provided. The design of the de-aerator and de aerated water storagetank shall be such that wherever applicable the minimum statutory requirements ofIBR shall be met with. The De-aerator and the De aerated water storage tanks shall be designed with a minimum corrosion allowance as per industrial norms. The de-aerator shall be of

either spray-cum-tray type or spray type with counter current flow of steam and water. The de-aerator and the storage tank shall be complete with all the fittings and mountings like vents, controlled vent, drains, gauge glasses, pressure indicators, relief valve, steam and water inlet and outlet nozzles, overflow nozzle etc. The size of the overflow nozzle shall be minimum one size higher than the inlet pipe size. If one or more inlet nozzles are provided, the size shall be one size higher than the maximum inlet size. The De-aerator shall be designed to achieve the following: Dissolved O₂ in the outlet water without chemical dosing ppm (Max.) < 0.007

Data Sheet for De-aerator and Blow down tanks

De-aerator		
Number Provided		1
Type		Spray tray type
Design code		ASME
Capacity of Deaerator (Max.)	M ³ /hr	45
Operating Pressure	Kg/cm ²	3
Temperature of Incoming Water	oC	46
Temperature of deaerated Water	oC	130
Capacity of Storage Tank	M ³	15
Dissolved Oxygen in deaerated Water	Ppm	0.007
Design Pressure	Kg/cm ²	5
Material of De-aerator		SA-106
MOC of Tray		
Material of Storage Tank		Normal
Plate thickness of de-aerator shell and ends		10
Blow down system		
CBD tank (ASME STAMPED)		
Design code		ASME
Number provided		1
Type of vessel		Class III
Material specification		ASME
Design pressure,	Ksca	15
IBD tank (ASME STAMPED)		
Design code		ASME
Number provided		1
Type of vessel		Low pressure vessel
Material specification		ASME
Design pressure,	Ksca	3

6.6 Dosing System

H.P. dosing system will be provided for phosphate dosing to boiler drum to reduce the water hardness inside boiler drum, dosing tank one (1) no and dosing pumps two (2) no will be provided.

L.P. dosing for feed water will be provided for ammonia dosing to feed water to maintain the PH value, dosing tank one (1) no and dosing pumps two (2) nos will be provided.

6.7 Soot blowing system

Electrically operated soot blowers will be provided using steam as the blowing medium for the superheater and economizer with associated control, instrumentation and electrical items.

Retractable type soot blower will be used for high temperature zone. This offer covers Eight (8) nos of retractable soot blowers for superheater (SH zone), and economizer.

6.8 Silencers

Totally Four (3) nos of silencers will be furnished, 2 for drum safety valve vent, and 1 for main steam header vent.

The silencer shall ensure during boiler safety valve venting the noise level will be not more than 85dB.

6.9 PRDS

During start-up, auxiliary steam is required to be used as pegging steam to deaerator, on which purpose, an auxiliary PRDS will be provided to reduce boiler new steam to pegging steam capacity to ensure warm start-up. The PRDS will be supplied to reduce the steam from boiler rated steam parameter to deaerator steam required parameter.

6.10 Piping and ducting system

6.10.1 Piping system

Following external pipelines are considered with necessary valves & instruments:

a) Main Steam Line Between Boiler and Turbine	DN250
b) HP feed water line from BFP to boilereconomizer	DN150
c) Steam line to PRDS	DN100
d) Steam line from PRDS to turbine	DN100
e) Spray de-super heater water line to boiler	DN 75
f) LP feed water line from de-aerator to BFP	DN150
g) De-super heater water line to PRDS	DN20
h) Connecting pipeline between CBD tank and de- aerator	DN100
i) Others within battery limits	

6.10.2 Air & Flue gas ducting

Following ducting system are considered with necessary fittings and accessories:

a) Air ducting between fans to APH, from APH to combustion chamber	4mm THK	Q235-A
b) Flue gas ducting between boiler to scrubber, between scrubber to ID fan, between ID fan to Chimney	5mm THK	Q235-A

6.11 Refractory and Insulations

a) Insulation	
Material of insulation	Mineral wool/ LRB
Material of cladding	Q235
Surface temperature	60

Boiler furnace area shall be neatly covered with mineral wool mattress of adequate thickness and clad with corrugated metal poly sheet sheeting.

Hot air ducts, flue gas ducts and other exposed portions shall be provided with necessary insulation and clad with plain aluminum sheeting.

b) Furnace Refractory

Refractory lining in the furnace at the burner interface.

7 Turbine Generator and Auxiliaries

7.1 Turbine and Generator Main Parameters

No.	Description	Turbo-generator
1	Make	HCTC/ QINGDAO
2	Type	Condensing Turbine with bleed to DA
3	Type of condenser	Water cooled condenser
4	Number	1
5	Max. Contin. Rating	10MW
6	RPM	3000
7	Press & Temp at I/L	6.7MPa, 475 deg. C
8	Exhaust Steam Pressure	0.0082 Mpa
9	Steam Consumption	4.186kg/kw.h
10	Heat Rate	11753 kJ/kw.h
11	Governor control	Woodward (505) for parallel operation of theTG's & grid, TSI Bentley
12	Generator rating	10 MW @ 0.8PF, 11 kV
13	CEP	2 (1W +1S) for turbine
14	HP heaters	Not applied
15	LP Heater	2 stage
16	Gen. volt, PF, Freq	3 Ph. 3 w, 11.0 KV+10%, 0.85PF, 50Hz

7.2 Turbine Description

The turbine is an axial-flow, single casing construction with reaction blading, which has proven itself over the course of many years. This combines a highly robust and compact design with low steam consumption and cost-effective production. The work load of the turbine is from 50%-100%.

1. Governing system

A digital electrical-hydraulic governing system (DEH) is adopted which is composed of Woodward 505, electro-hydraulic converter (Voith Valve), hydraulic servo mechanism, steam governing valve etc.

2. Safety System

The safety system is adopted with redundancy protection. Besides the mechanical- hydraulic safety equipment, an electronic protection system composed of electricalgoverning equipment, measuring instrument monitoring system is also adopted.

The complete safety system is composed of emergency governor, emergency oil valve, test governing valve, solenoid valve, main steam stop valve, TSI measuring instrument inspection system and electrical governor overspeed protection etc.

When any emergency happened, such as vibration, displacement, overspeed, bearing pad temperature, or lube oil temperature, and so on, over the stipulated limitation, the safety system will alarm or trip out the machine.

Detail requirement please check in the control part.

3. Oil System

Oil system consists of main oil pump (shaft mounted), start-up pump (Centrifugal type and AC motorized), lube oil pump (AC motorized), emergency oil pump (DC motorized),oil injector, oil cooler, oil filters and main oil tank.

4. Auxiliary System

The auxiliary system of this steam turbine is composed of condensate system,Regenerative system, drain system and gland system.

a. Condensate system

This system consists mainly of a water-cooled condenser with heat exchange area of 1000 sqm, steam jet air ejector, start-up ejector, and condensate extraction pump. he tubes of the condenser will select titanium. The no of tube will be known at the detail design stage

b. Gland cooler

The steam leakage from the front gland sealing will be guided to gland cooler.

c. Regenerative system

The regenerative system of this steam turbine is composed of deaerator, the water delivered form de-aerator will be discharged to feed water pumps and feed watercontrol station will be in customer's supply scope.

d. Surge tank

This function of surge tank is to supply sealing steam to the shaft glands at two ends of the steam turbine to keep the air out. Self-acting regulating valves are equipped for the surge tank to keep the pressure being of 0.103~0.13 MPa(a.) inside the surge tank.

e. Drainage system

Water drained from the steam turbine proper and extraction piping, in different pressure rating, is discharged to flash tank where it flashes to steam, and, the steam thus formed goes to the top and the water to the bottom of the condenser.

7.3 Generator Description

Generator is a 3 phase non-salient pole generator driven by a steam turbine. It is drivencoupling with the turbine directly.

The rated rotating speed of the generator is 3000 rpm, frequency is 50 Hz, power factor is 0.8 pf and the cooling mode is close-cycle air cooled type with a water-cooled air cooler.

The rotation direction of generator is CW viewing from driven end.

At rated power factor with voltage deviation within +/-5% and frequency deviation +/- 2% output of the generator remains at normal rating.

With an unbalanced 3-phase load, when current of each phase is not larger than the rated value and when the ratio of negative sequence current to the rated phase current is not over 10% the generator is allowed to be in continuous operation.

Generally the generator should not be allowed overload.

Coolers shall be designed in such a way that even with one cooler out of service generator shall be capable of meeting maximum duty requirements with temperature raise still limited to class B

The rotor winding is rounded by bare flat copper wire. The insulation class is F.

The air circulation system of the generator is of double closed circuit type. The air cooler and filter are fixed under the generator.

The generator is fitted with temperature detectors as follows:

Resistance thermometers (Pt 100) are embedded between upper and lower layers of stator winding, in the teeth and yoke of the core. The temperature detectors are fitted in the inlet air ducts and the outlet air ducts of the generator as well as in the bearings to detect oil temperature.

The generator excitation is applied by brushless excitation device. The device consists of coaxial AC brushless exciter, permanent exciter and AVR automatic voltage regulator. AVR shall be digital with two auto and two manual channel.

8 Fuel Analysis

The fuel used in this plant will be 100% Coal with following fuel analysis: According to the dry ash basis by the above blank, Moreover, lower heating value of coal is considered as 10 MJ/kg = 2389 Kcal/kg for the coal consumption calculation basis.

Parameters (as Received basis)	Range
Moisture (%)	37.40-57.73
Ash (%)	4.34- 13.23
Volatiles (%)	20.06 -29.33
Fixed Carbon (%)	14.03 -22.66
Total Sulphur (%)	0.61- 1.93
Lower Heating value (MJ/kg)	8.70- 14.69

9 Water Analysis

Raw water source will be taken from Deep Water well, water analysis will be as below:



Sindh Engro Coal Mining Company Limited
Proposal for 10 MW Power Plant on BOC Basis



3.1.3 Raw Water Analysis

Sr. #	Parameter	Analysis
1	pH	7.85
2	Conductivity (us/cm)	10145
3	TDS (ppm)	5478
4	Total Hardness (ppm CaCO ₃)	939
5	Ca (ppm CaCO ₃)	154
6	Mg (ppm CaCO ₃)	134
7	Na (ppm)	1610
8	SO ₄ (ppm)	266
9	Cl (ppm)	2795
10	SiO ₂ (ppm)	10.95
11	Ar (ppm)	< 0.006
12	Fe (ppm)	0.212
13	Al (ppm)	0.053

10 Balance of Plant

10.1 Fuel Handling System

10.1.1 Fuel Store Field and Its Equipment

The store capacity of dry coal shed is designed with 7 days boiler consumption. As the owner requirement, JLIANCO will supply the steel structure part of this coal shed. There will be a set of loaders in the dry coal shed which used for the fuel store and feeding fuel to the coal conveyance system (loader will be the owner scope). A set of underground receiving hopper will be assembled in the shed for coal/biomass feeding.

For fitting for the requirement of coal size ($\leq 10\text{mm}$), and according to the coal condition, for this kind of coal we have used the Four tooth roll crusher instead of the normal harmer crusher to forbid the blocking problem. It has two stage crushers inside and a sieving room will be set. The coal which size is less than 10mm will be sieved and then the size larger than 10mm will be send into hammer crusher for crush, that can fit the requirement of boiler coal size.

This system will be operated as following: 2 teams per day and 8 hours per team, the annual working days is equal to main building working days. The capacity of fuel conveyance system is $2 \times 25\text{t/h}$. The fuel will be send into underground receiving hopper by loader, and then it will be send to No.1 belt conveyor by K-0 reciprocating type fuel feeder then it will be send for crush in crush room, after that it will be send to the front furnace coal store by No.2 and No.3 belt conveyor. Under the front furnace coal store there will be compression resistance weighting coal feeder, the coal should be weighted and then send into boiler.

10.1.2 Accessories.

Iron removing device

2 grades iron removing device will be used for system, on the No.1 and No.2 belt conveyor there will be belt type permanent magnet iron removal which is used for removing the iron in the coal/biomass.

For metering the fuel consumption, there will be a electronic belt conveyor scale (CS- 17A B=650mm) assembled on the No.2 belt conveyor and an electronic belt conveyor scale for the biomass conveyor

The feeding of boiler will be finished by weighing fuel feeder which can metering the fuel consumption of each boiler.

The capacity of coal bunker for the boiler is 120T which can insure 10 hours (As per request) consumption. First, the coal in the coal bunker pass through the weighting feeder, then it will be entered into boiler feeder inlet by dropping pipe.

For avoiding blinding, the bunker has a liner. The liner will use ultra-high weight molecular polymer/plastic material. We will consider to place the air cannon to remove the blocks at the bottom of the coal bunker to solve this blocking problem.

10.2 Ash Handling System

10.2.1 Fly ash handling system

Pneumatic dense phase ash handling system is adopted, which is of high reliability and automaticity. The fly ash is discharged into the individual pumping device under the ash hopper, with the pressure of the compressed air, the air-ash mixture is delivered into the ash silo through ash pipelines. Wet

type ash load methods are proposed – the ash be wetted by a wetting agitator and loaded on the truck. A common pneumatic ash conveying system will be provided for both boilers.

Two sets of 10m³/min screw type air compressors (1 working+1 standby) will be furnished fitted with complete filtering and de-moisture device, and one 10 m³ air tank is provided. For the convenience of maintenance, a set of 3 ton capacity electric hoist will be provided. Fly ash handling system is designed for 400 kg/hr.

10.2.2 Bed ash handling system

The bed ash is discharged through 2 x dia219 slag discharge pipe into the ash cooler, the cold bed ash (less than 100 °C) will be discharged onto chain plate conveyers from where the bed ash will be conveyed into the bed ash silo.

10.3 Plant Water System

10.3.1 DM water plant

Raw water treatment plant is provided for treating raw water into qualified boiler water. The system is adopting Reverse Osmosis (RO) +EDI plus anion & cation exchange mixed bed type to remove the minerals in the raw water so as to achieve boiler water requirement.

Since the water quality analysis report is not comprehensive, and according to the water quality features, such as numerous suspended solids, high turbidity and high silicon content, and in accordance with the unit requirements for make-up water, the principle technical process of this boiler make-up water treatment is: plant make-up water supply → raw water tank → raw water pump → ultrafiltration → ultrafiltration tank → ultrafiltration water pump → security filter → high pressure pump → primary reverse osmosis unit → primary reverse osmosis buffer tank → primary intermediate water pump → security filter → high pressure pump → secondary reverse osmosis unit → secondary reverse osmosis buffer tank → secondary intermediate water pump → EDI security filter → EDI demineralizing unit → demineralizing tank → demineralizing water pump → de-aerator of main power building.

Compared to conventional sand filtration, as the membrane filtration, ultrafiltration has a higher adaptability to water quality. And water quality of this project has features such as many suspended solids, high turbidity. Against these features, if we utilize conventional sand filtration, backwash time would be very short. And we would have to replace filter materials more frequently. Moreover, after long operation time, output water quality and quantity are difficult to ensure. In addition, labor intensity of the operators would be greater. On contrary, as the membrane filtration, ultrafiltration is relatively adaptable to water with high suspended solids. Moreover, both backwash and wash use PLC automatic control. Thus, the equipment can run in a long-term with high efficiency and stability. As a result, against features of this project, we use ultrafiltration in the pre-process part. This process will make the water go to the normal level around 150PPM to cooling tower system.

The reverse osmosis pre-demineralization unit has advantages such as high demineralization rate, easy to operate and maintain. Thus, it has been widely used in water treatment technique at present. Compared with simple ion exchange, it can save 95% acid and alkali for regeneration use. Thus, economic benefits are evident. While as the pre-process before reverse osmosis, ultrafiltration has a good output water quality. Thus, it can make sure the reverse osmosis membrane runs in a long term with high efficiency. Moreover, replacement cycle of the membrane is long, and maintenance costs in later stages are less. As a result, this project used reverse osmosis unit for pre- demineralization.

This project uses EDI as the demineralization unit. EDI is short for its English name Electro-deionization. It combines electro-osmosis and ion exchange technologies together organically. It is a new technique for deep demineralization. It uses ion exchange to overcome the disadvantage that electro-osmosis demineralization is not complete. And electro-osmosis membrane and ion exchange resin surface are polarized under electric field to produce H^+ and OH^- . EDI uses this feature. And it uses selective permeability of electro-osmosis membrane. Thus, it realizes self-generalization of ion exchange resin. And it overcomes the disadvantage that after resin loses effectiveness, it requires acid and alkali regeneration.

DM water quality after process

DESC	Unit	Value
SiO ₂	μg/L	≤20
Conductivity(25°C)	μS/cm	≤0.2
Hardness	μmol/L	≈0

10.3.2 Cooling Water System

The open type cooling water system will be composed of cooling towers, auxiliary cooling towers, circulation water pumps, Auxiliary Cooling Water pumps and circulation water pipelines and accessories (Jlianco scope).

Induced Draft Cross flow type Main Cooling Tower will be having 3 (three) cells, auxiliary cooling water will be composed of 2 (Two) Cells. The Tower will be complete in all respect with Cold water Basin sized adequately with proper outlet, overflow, drain and Pump suction connections, complete with Fans with GRP make Blades and Hollow SS 304 Drive Shaft, Spiral Bevel Gear Reducers, Drive Motors, proper access to Fan Deck and adequate arrangement for equipment handling etc.

The System will be provided with 3 x 100% Capacity Circulating Water Pumps (2Working + 1 Standby), and Shock Chlorination System for reducing the Organic Levels in CW Water.

Main Cooling Tower:

Type	:	Induced Draft Cross flow type
No of cells	:	3
Capacity of each cell	:	1000 m ³ /h
Type of Fill used	:	High grade special PVC
Inlet/outlet temperature considered	:	40 °C/Less than 32°C
Maximum Power Consumption	:	115kW

10.3.3 Service water

Service water will also be considered for workshop de-dusting, equipment maintenance, lab service, wetter, back wash, coal yard spread water, firefighting water, and domestic consumptions, etc.

10.4 Instrument & Control System

10.4.1 Control System Description

In this plant, it is proposed that all main plant equipment is centrally controlled. Boiler, steam turbine, generator, deaerator feed water and electrical control system are all located in a central control room located at TG hall. BOP systems shall be site controlled separately within its own separated workshop in the terms of relevant PLC system.

In order to ensure safety and reliable operation of the plant, a complete system of detection, automatic adjustment, control, interlock and protection devices are provided. In the central control room, the operating personnel can also achieve the control, supervision and adjustment to the plant thermal system and its auxiliary systems, give alarm of any abnormal conditions, make records and handle the correlated data.

As per above basic requirements and combined with the specialty of this project, one set of distributed control system (DCS) is provided for main plant monitoring and control. The function of DCS includes: Data Acquisition System (DAS), Main analog Control System (MCS), Sequence Control System (SCS), Emergency Trip System (ETS), Electrical Control system (ECS). The DCS system will take the LCD and keyboard operation as the central of monitoring and control and fitted with a few necessary buttons for boiler or turbine-generator shut-down to carry out the central control of boiler and turbine-generator operation.

The ash handling system adopts PLC control system, and conducts data exchange through the communication cables with the DCS.

The compressed air system adopts common instrument monitor, the control box is set in the air compressor house communicate with main DCS

The following data required by the owner will be included in our control:

Turbine:

- a. Turbine over speed tripping
- b. Auto main lube oil pump start
- c. Low lube oil pressure
- d. Axial displacement
- e. Low vacuum
- f. Differential expansion

Generator:

- a. Over current
- b. Over voltage
- c. Low voltage
- d. High differential protection
- e. Rotor ground fault
- f. Stator ground fault
- g. Loss of excitation

- h. Back setting effect (Generator reverse Power)
- i. Under frequency

STG Alarms & Indications:

- a. Steam high temperature and high pressure.
- b. Oil pressure low and auxiliary pump start.
- c. Oil pressure Low Low.
- d. Turbine bearing temperature high.
- e. Turbine thrust bearing temperature high
- f. Generator bearing temperature high and oil flow low.
- g. Shaft displacement high
- h. Shaft displacement High High.
- i. Condensate water level high
- j. Condensate high conductivity
- k. Sealing steam temperature high.
- l. Exhaust end temperature high.
- m. Oil temperature high
- n. Turning gear failure
- o. Low vacuum
- p. Low Low vacuum
- q. Over current relay
- r. Differential relay.
- s. Back setting effect relay.
- t. Stator grounded
- u. Rotor grounded
- v. Over voltage relay
- w. Loss of excitation
- x. Low steam temperature /pressure.
- y. Generator winding temperature high.

10.4.2 Field Instruments

- a. The pressure and differential pressure transmitter shall be of smart type, two-wire system and 4-20mA signal system;
- b. Temperature measuring instrument: adopts thermocouples suitable for power plant operation, the graduation number is K、S (excluding supporting supply of main equipment plant), also the thermal resistance adopts Pt100 graduation (excluding supporting supply of main equipment plant);

- c. Flow measuring instrument: adopts welded standard nozzle or orifice, three-curve wing anemometer device or well bar;
- d. Display instruments: adopts smart type digital display instruments;
- e. Waste gas, flue gas and chemical analysis instrument: adopting international advanced technical product.
- f. Actuators: the actuators will be pneumatic actuators of import or introduced technical product;
- g. Electric equipment: the button, switch, signal lamp, relay and etc. shall select high performance domestic (or import) device.
- h. Protection switch instrument shall select introduced product controller.

10.4.3 DCS system description

The boiler, turbine, generator and electric power system will be monitored and controlled in a centralized mode in this project. Distributed Control System (DCS) will be adopted for monitoring, control, alarm, interlock and protection of the boiler, turbine, generator and auxiliary systems in the central control room. Common system, including ash handling control system, fuel handling control system, is based on programmable logic controller (PLC). The communication interface between PLC and DCS will be furnished for monitoring in the central control room.

The boiler, turbine, generator and electric power system will be monitored and controlled in a centralized mode from the central control room. The main control room will be located on the suitable area of operation floor. There are three (6) operator workstations and one (1) engineer station in the central control room. Control system logic processor cabinets, I/O cabinets, turbine protection cabinet, electric protection cabinets, and other electronic equipment will be located in the control equipment room.

Microprocessor-based Distributed Control System (DCS) will be provided for monitoring, control, alarm, interlock and protection of Unit.

The monitoring and control of the unit normal start-stop and associated interlock and trip logic for plant equipment will be performed in main control room by means of color LCDs, keyboards, or mouse with the help of local shift assistant.

The principle for hardwired control equipment setting-up is that the units can stop safely when DCS fails. This hardwired equipment will be set on the operator desks in the central control room.

The circulating water system and the steam cycle sampling and analysis system will be in the DCS via remote I/O cabinet.

Common systems, including ash handling control system, coal handling control system, are based on programmable logic controller (PLC). The communication interface between PLC and DCS will be furnished for monitoring in the central control room.

DCS main functions are as followings:

- Data Acquisition System (DAS) - DAS is the main monitoring system of the units. The operator can view all kinds of the real time parameters and information of the units via the CRTs. DAS includes acquirement of processing parameters, display of graphics, alarm monitoring, various printouts, storage and retrieval of historical data.
- Modulating Control System (MCS)- MCS function shall include but not limited to:

- Plant load control- Main steam header pressure control for new power plant only ;
- Steam drum level control;
- Super heater outlet temperature control;
- Furnace draught control;
- Bed temperature control;
- Bed pressure control;
- Main steam temperature control;
- Main steam pressure control;
- Fuel feed control;
- De-aerator pressure control;
- De-aerator level control;
- Condenser hot well level control;
- Gland-steam pressure control;
- Sequence Control System (SCS);, the SCS for this project is mainly composed of:
 - Control of auxiliary equipment of the boiler combustion system, such as: PA fan, SA fan, ID fan, coal feeder, ash cooler, etc;
 - Water drainage system control;
 - Control of AC, DC lubrication oil pump for turbine;
 - Feed water pump control;

10.5 Electric System (Dust proof type)

The generator outlet voltage of 11kV to connect the 11kv bus bar; Plant auxiliary consumption is having two grades, HT power adopting 11kV, which is fetched directly from 11kV bus duct from Generator outlet, plant LT power adopting 400V, the 11kV power is transformed into 400V through two units of 116/0.4kV, 1.5 MVA auxiliary transformer.

HT panels and MCC are furnished for plant electric system control and power distribution.

11 kV outgoing breaker, Auxiliary transformer incoming breaker and one outgoing breaker to connecting with busbar with electronic / latest protection relay. 11 KV synchronizing panel system and protection system required for power synchronizing with SOLAR and HSD Gen. set and back power for 10 MW PP start-up

According to related regulations in Technical Code for Designing DC System of Power Projects, DC system adopts the power supply method of the combination of power and control This project includes one set of storage battery set for supplying power to drive and control loading. The voltage of storage battery set adopts 220V grade. Capacity 300AH. A set of 100 (20×5) A/230V high-frequency switch-type charger is set in the battery group, and the charger the DC panel are arranged in the electrical and electronic equipment room of the centralized control room.

The electric main control room arranged one set of online Uninterrupted Power System (UPS) to supply power to microcomputer monitoring system, metering system output voltage is 220V, single phase

50Hz. The UPS arranged in electric device room of concentrating control room. Static inversion device is adopted for UPS, which is mainly composed of rectifier, inverter, static switch, and bypass system and power distribution panel. When normally operated, low voltage section supplies power to the rectifier and then supplies power to the power distribution panel after being converted to single phase 220V by an inverter. When the AC power source gets cut off disappeared or the rectifier is damaged, the storage battery supplies power to power distribution panel through an inverter. When the inverter is damaged, the static switches will automatically switch over to the bypass system, and another low voltage service power source supplies power to the power distribution panel. Manual bypass switch is provided, which can guarantee uninterruptible power supply when the inverter and static switch is out of use.

A load resistor system will be selected according to the actual requirement. The capacity will be around 1-2MW for balancing the load variation in the coal mine.

A Step down Transformer (11 KV to 400 volts) = 01 No. with synchronizing panel package for PP auxiliary equipment operation start.

The solution for the sudden trip from the solar power plant with the capacity around 2.5MW. here we suggest to use the SCADA system, we can use the power from the existing plant directly or cut one electrical circle in 5-10mins. The boiler & turbine can increase the capacity 2.5MW in 5-10mins. This solution is what we proposed in this project.

10.6 Air conditioning and ventilation system (JL will provide the design only)

Main plant boiler house and TG hall are adopting natural draught and ventilation. For other workshops and steels, wherever natural draught is effective and applicable, the same will be adopted. For special requirements in healthy or special equipment requirements, mechanical ventilation will be adopted by furnishing axial flow fan.

The mechanical ventilation is applicable in:

Main plant HT/LT power distribution room, Main control room, Electronic device room, valve control room, chemical water station ammonia room, test rooms, CWP pump house, dosing room, coal handling system underground portion.

Control room, electronic device room, engineer's room, conference rooms are considered with air conditioning.

10.7 Fire Fighting System

Fire fighting system is considered with relevant fire fighting water pipeline net and sufficient no of hydrants at adequate locations.

Fire fighting water consumption is as below:

Description	Water Consumption (L/s)	Duration(h)	Total water volume (m ³ /time)
Indoor fire fighting	25	2	180
Outdoor fire fighting	40	2	288
Total	65		468

Fire fighting water pump is furnished at CWP house, at the highest level of main plant, a 20m³ fire fighting water tank is provided with 2 units of pressure-stable pumps and 1 set of air pressure tank. We hope the owner can undertake this part of work

11 Auxiliary Consumption

Primary air fan	kW	150	120
Secondary air fan	kW	220	190
Induce draft fan	kW	355	290
Recirculation air fan	kW	90	75
Feed water pump	kW	220	196
Boiler and TG auxiliaries	kW	500	400
Other balance of plant	kW	50	50
Total plant power consumption	kW		1321

12 Cost Estimation and Financial Analysis

12.1 Assumptions

Technical Assumptions

Generation Capacity		
Gross Capacity (MW)		10.00
Auxiliary Load (MW)		1.20
Net Capacity (MW)		8.80
Available Hours per annum		8,760
Availability (95%)		85%
Less: Outages (hours)		1314
No. of Operational Hours		7,446
Gross Annual Energy	GWh	74.46
	KWh	74,460,000
Net Annual Energy	GWh	65.52
	KWh	65,524,800

Cost Estimation:

Below table presents the estimated cost of the Project in USD.

EPC Cost	
Civil Works	6,266,788
Electrical	7,000,000
Total EPC Cost	13,266,788
Non-EPC Cost	
Development Cost	100,000
Fuel & Startup cost	100,000
Insurance During Construction	172,468
Total Non-EPC Cost	372,468
Base Project Cost	13,639,256
Base Project Cost (Million)	13.639
Interest During Construction (Million)	1.234
Total Project Cost (Million)	14.873
Exchange Rate (PKR – USD)	165
Discount Factor	10%
Construction Period	24 Months
Tariff Period	15 Years

12.2 Financing Plan

The Project is to be financed through Debt and Equity. AGJV (Pvt.) Ltd. being the sponsors will inject the equity.

Total Project Cost (USD Million)		14.873
Debt	75%	11.75
Equity	25%	3.72

The debt is to be arranged from the local bank at following rates

Debt	75%
KIBOR	7.25%
Spread	3.00%
Repayment Years	10
Repayment Frequency	Quarterly

12.3 Operation & Maintenance

		USD Million	PKR Million
Variable O&M Cost		1.091	180.000
Local	100%	1.091	180.000
Foreign	0%	0.000	0.000
Fixed O&M Cost		0.909	150.000
Local	100%	0.909	150.000
Foreign	0%	0.000	0.000
Total O&M Cost		2.000	330.000
Insurance During Operations (Per Annum)		0.13	21.8902002
Coal Handling		Rs/Month	1,200,000
Coal Handling		Rs/KWh	0.22
Cost of lime stone including transportation		Rs./M.Ton	1,250
Consumption		Kg./Kwh	0.049
Cost of Lime stone		Rs./Kwh	0.061
Ash Produced		Kg./Kwh	-
Ash Handling & Transportation cost		Rs/Month	825,000
Ass Disposal Cost		Rs./Kwh/annum	0.151

12.4 Annual Debt Repayment Schedule

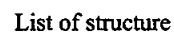
Annual Debt Repayment Schedule

Debt Amount	USD Million	11.155
Maximum Repayment Period	Years	10
Maximum Installments		40
Total Payments	USD Million	17.962
Total Principal	USD Million	11.155
Total Interest	USD Million	6.808

No. of Quarter	Outstanding Principal	Total Payment	Principal Repayment	Interest Repayment	Balance Principal
1	11.155	0.449	0.163	0.286	10.992
2	10.992	0.449	0.167	0.282	10.824
3	10.824	0.449	0.172	0.277	10.653
4	10.653	0.449	0.176	0.273	10.477
Year 1		1.796	0.678	1.118	
5	10.477	0.449	0.181	0.268	10.296
6	10.296	0.449	0.185	0.264	10.111
7	10.111	0.449	0.190	0.259	9.921
8	9.921	0.449	0.195	0.254	9.726
Year 2		1.796	0.751	1.046	
9	9.726	0.449	0.200	0.249	9.526
10	9.526	0.449	0.205	0.244	9.321
11	9.321	0.449	0.210	0.239	9.111
12	9.111	0.449	0.216	0.233	8.895
Year 3		1.796	0.831	0.966	
13	8.895	0.449	0.221	0.228	8.674
14	8.674	0.449	0.227	0.222	8.447
15	8.447	0.449	0.233	0.216	8.215
16	8.215	0.449	0.239	0.211	7.976
Year 4		1.796	0.919	0.877	
17	7.976	0.449	0.245	0.204	7.732
18	7.732	0.449	0.251	0.198	7.481
19	7.481	0.449	0.257	0.192	7.223
20	7.223	0.449	0.264	0.185	6.959
Year 5		1.796	1.017	0.779	
21	6.959	0.449	0.271	0.178	6.689
22	6.689	0.449	0.278	0.171	6.411
23	6.411	0.449	0.285	0.164	6.126
24	6.126	0.449	0.292	0.157	5.834
Year 6		1.796	1.125	0.671	
25	5.834	0.449	0.300	0.149	5.535
26	5.535	0.449	0.307	0.142	5.227
27	5.227	0.449	0.315	0.134	4.912
28	4.912	0.449	0.323	0.126	4.589
Year 7		1.796	1.245	0.551	
29	4.589	0.449	0.331	0.118	4.258
30	4.258	0.449	0.340	0.109	3.918
31	3.918	0.449	0.349	0.100	3.569
32	3.569	0.449	0.358	0.091	3.211
Year 8		1.796	1.378	0.419	
33	3.211	0.449	0.367	0.082	2.844
34	2.844	0.449	0.376	0.073	2.468
35	2.468	0.449	0.386	0.063	2.083
36	2.083	0.449	0.396	0.053	1.687
Year 9		1.796	1.524	0.272	
37	1.687	0.449	0.406	0.043	1.281
38	1.281	0.449	0.416	0.033	0.865
39	0.865	0.449	0.427	0.022	0.438
40	0.438	0.449	0.438	0.011	0.000
Year 10		1.796	1.687	0.109	

12.5 Tariff Table

Years	Variable Energy Charge (Rs./KWh)					Fixed Energy Charge (Rs./KWh)						Total Profit	
	Coal	Ash Disposal	Limestone	Variable O&M	Total EPP	Fixed O&M	Insurance	ROE	Debt	Interest	Total CPP	Rs/KWH	Cents/KWh
1	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	1.708	2.815	9.119	12.419	7.527
2	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	1.890	2.633	9.119	12.419	7.527
3	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	2.092	2.432	9.119	12.419	7.527
4	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	2.314	2.209	9.119	12.419	7.527
5	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	2.561	1.962	9.119	12.419	7.527
6	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	2.834	1.690	9.119	12.419	7.527
7	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	3.135	1.388	9.119	12.419	7.527
8	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	3.469	1.054	9.119	12.419	7.527
9	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	3.839	0.684	9.119	12.419	7.527
10	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	4.248	0.276	9.119	12.419	7.527
11	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	-	-	4.596	7.896	4.786
12	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	-	-	4.596	7.896	4.786
13	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	-	-	4.596	7.896	4.786
14	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	-	-	4.596	7.896	4.786
15	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	-	-	4.596	7.896	4.786
Levelised Tariff	0.220	0.151	0.182	2.747	3.300	2.289	0.334	1.973	2.097	1.557	8.250	11.550	7.000



说明 Note

SHANDONG YUANTIAN POWER				OWNER	
SHANDONG NEW FUTURE CO., LTD.				PROJECT	
				1x50T/H+1x110	
Duty		Signature		Date	
Chief Engineer		 总平面布置图 General layout		Design Item	
Project Engineer				LAYOUT	
Specialty Engineer				PROJECT DESIGN	
Chief Designer				201	
Checking					
Designer		01/05/2011		Scale	
				Specialty	
				ELECTRICAL	
				QINGDAO, CHINA	

[illegible]

1x10MW POWER PLANT PORJECT



江联国际工程有限公司

Jianglian International Engineering Co., Ltd.

PROJECT: 1X 10 MW (Gross)

OWN DWG. NO.



ETIMAAD ENGINEERING (PRIVATE) LIMITED

APP'D BY
批准

REV'D BY
審核

CHK'D BY
校对

DSN'D BY
设计

SCALE 1:100
比例

DATE 2020.7.30
日期

DWG. NO.	
图号	

巴基斯坦拉合尔1X10MW工程项目

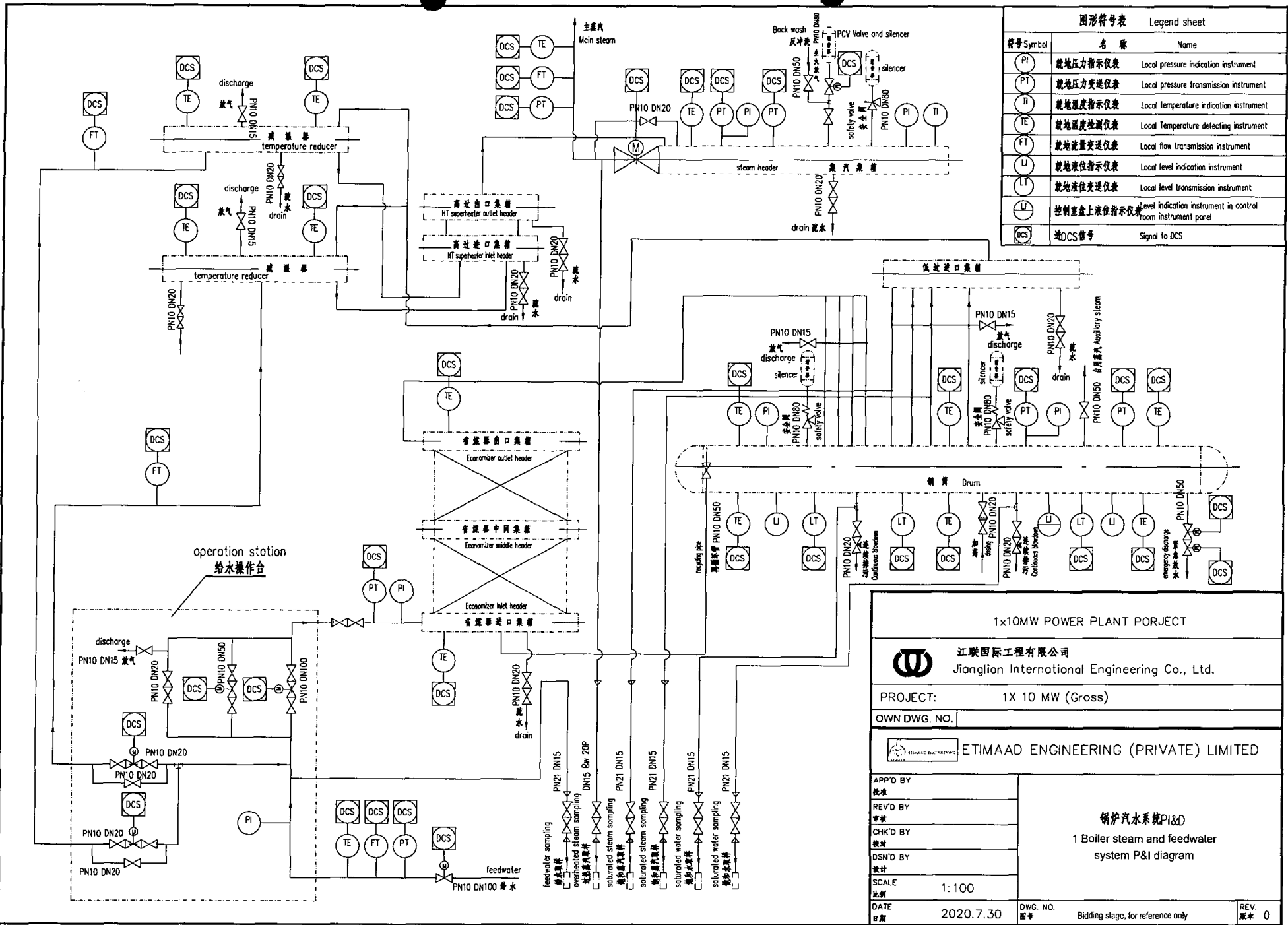
电站各系统图纸参考

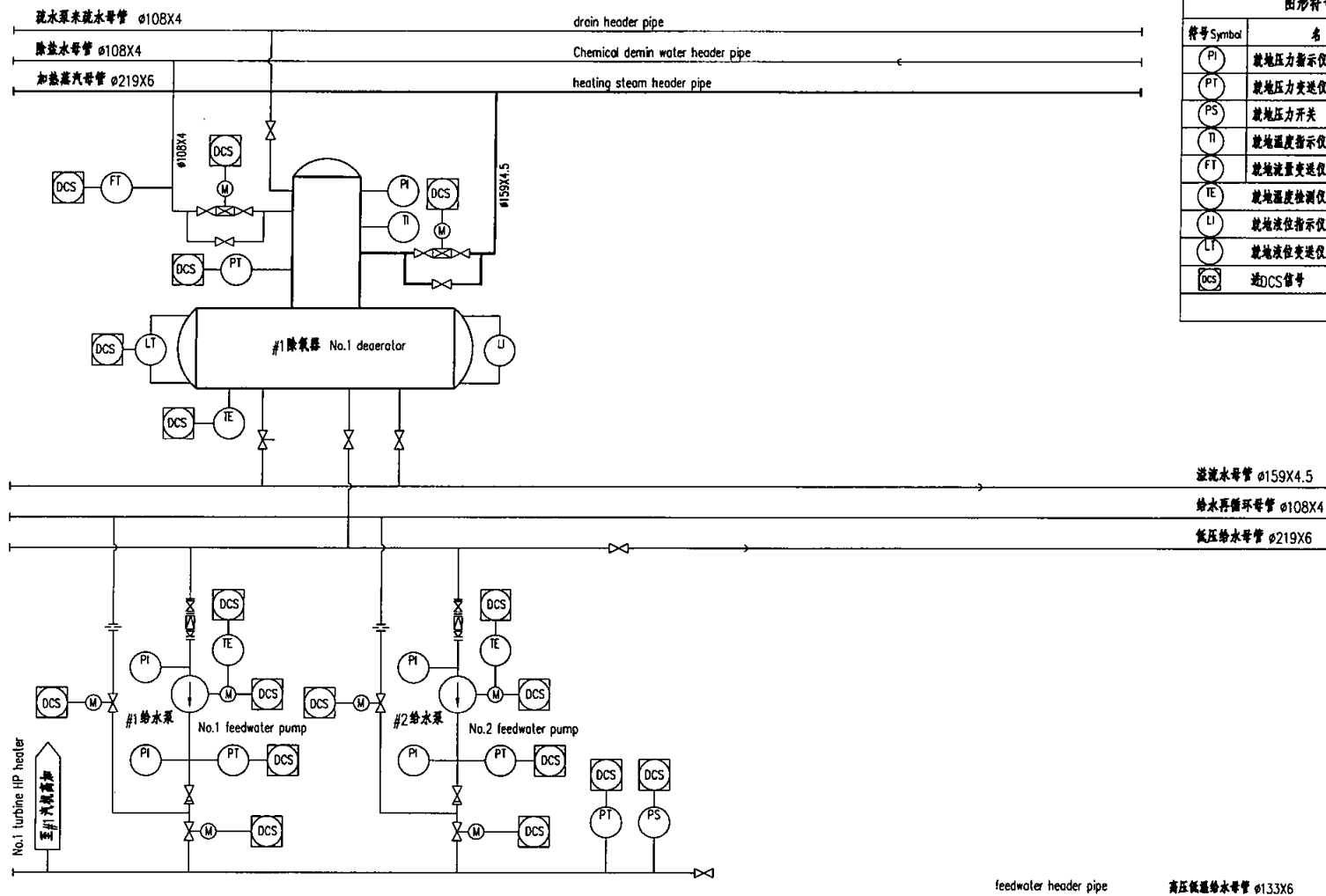
Power plant 1x10MW,

Drawing list of Power Plant System 2

Bidding stage, for reference only

REV.
版本





图形符号表 Legend sheet

符号 Symbol	名称 Name
PI	就地压力指示仪表 Local pressure indication instrument
PT	就地压力变送器 Local pressure transmission instrument
PS	就地压力开关 Local pressure switch
TI	就地温度指示仪表 Local temperature indication instrument
FT	就地流量变送器 Local flow transmission instrument
TE	就地温度检测仪表 Local Temperature detecting instrument
LI	就地液位指示仪表 Local level indication instrument
LT	就地液位变送器 Local level transmission instrument
DCS	送DCS信号 Signal to DCS

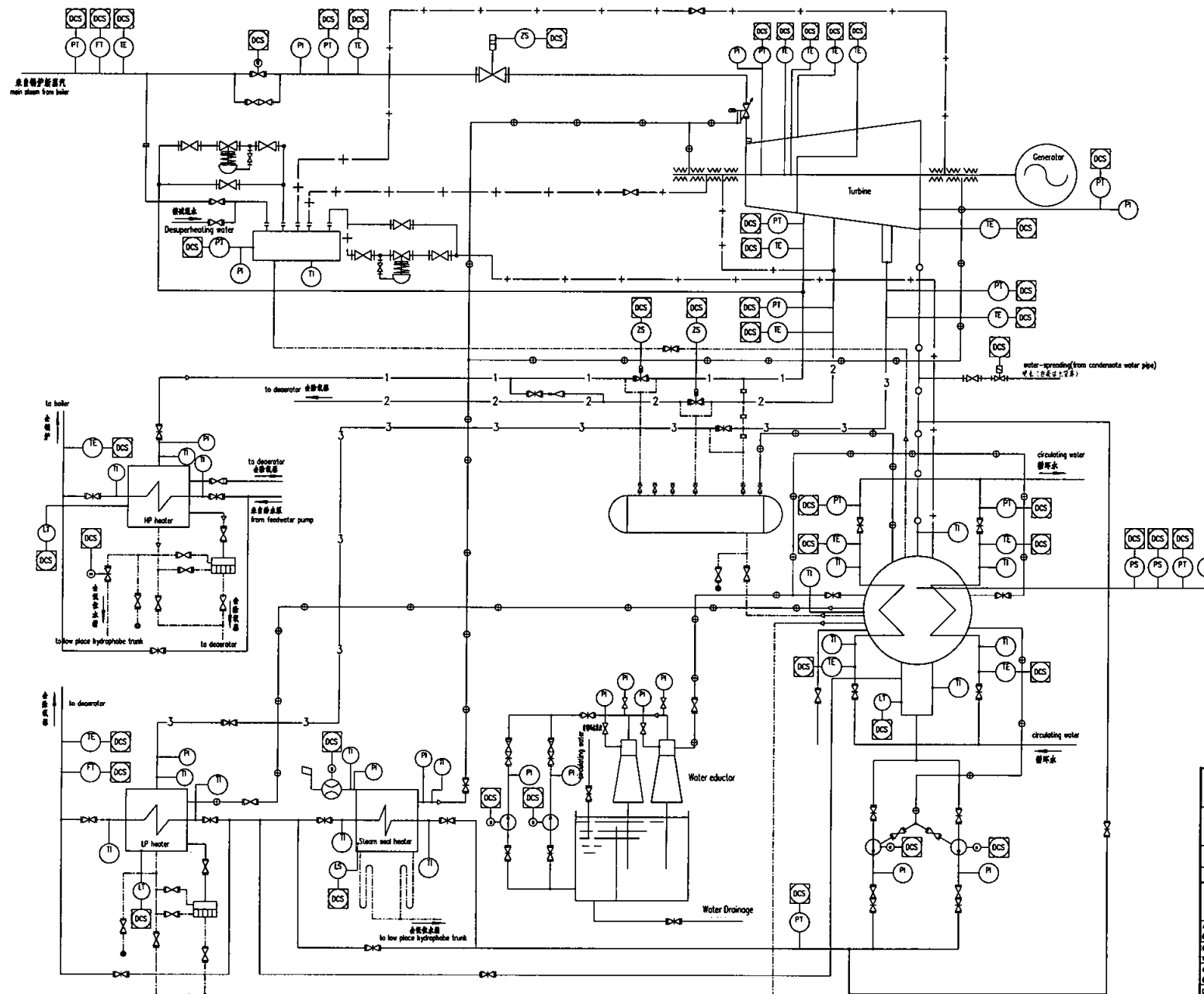
feedwater header pipe

高压低温给水母管 #133X6

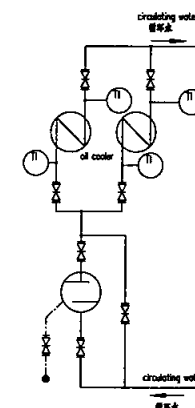
ETIMAAD ENGINEERING (PRIVATE) LIMITED	
APP'D BY	江联国际工程有限公司 Jianglian International Engineering Co., Ltd.
REV'D BY	
CHK'D BY	
DSN'D BY	
SCALE	
比例	1:100
DATE	2020.7.30
日期	2020.7.30
DWG. NO.	招标图章
Bidding stage for reference only	
REV.	版本

江联国际工程有限公司 Jianglian International Engineering Co., Ltd.	
PROJECT:	1X 10 MW (Gross)
OWN DWG. NO.	

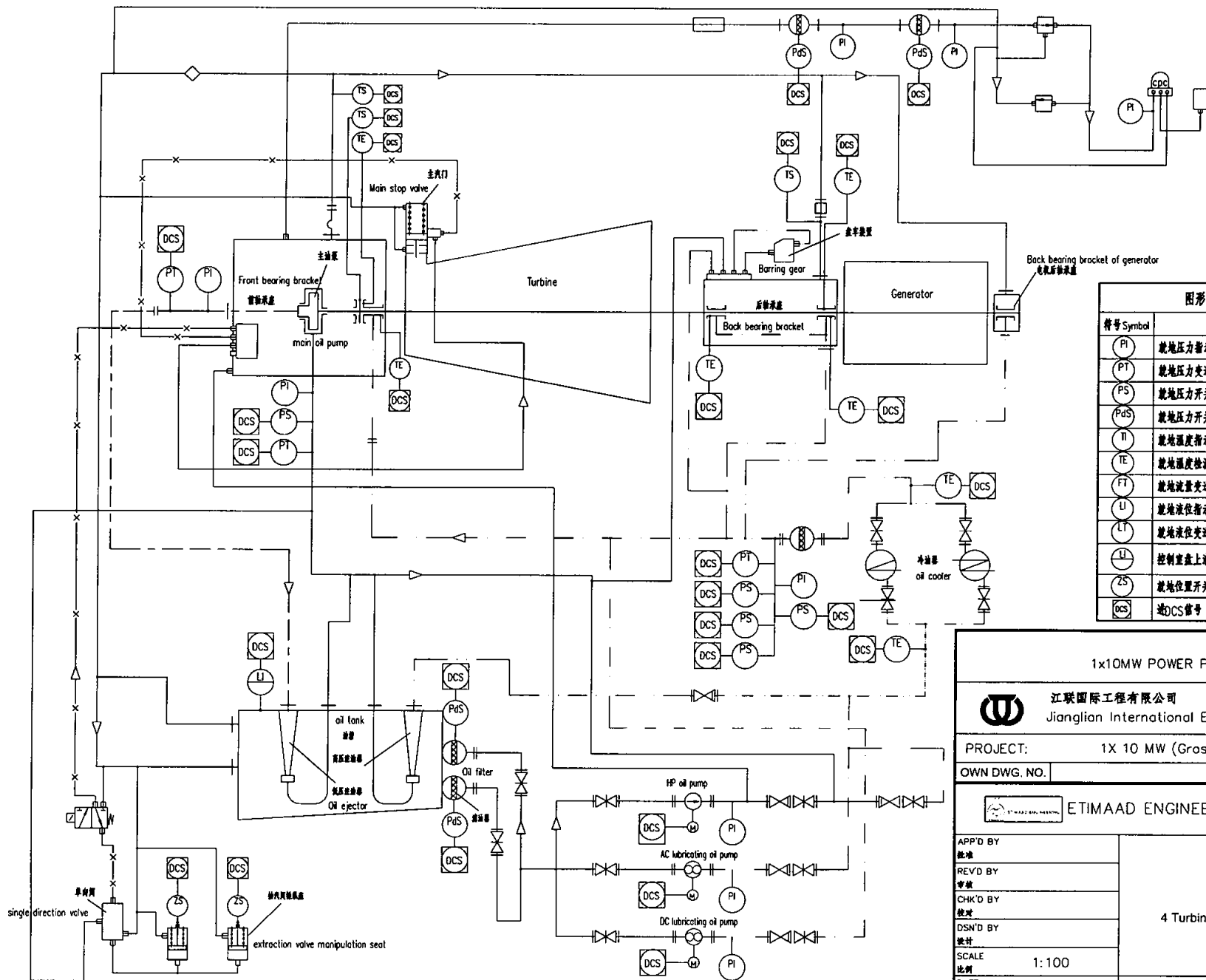
除氧给水系统P&ID
2 Deaerator feed water
system P&I diagram



图例符号表 Legend sheet		
符号 Symbol	名称 Name	名称 Name
PI	就地压力指示仪表	Local pressure indication instrument
PT	就地压力变送仪表	Local pressure transmission instrument
PS	就地压力开关	Local pressure switch
TI	就地温度指示仪表	Local temperature indication instrument
TE	就地温度变送仪表	Local temperature detecting instrument
LI	就地液位指示仪表	Local level indication instrument
LS	就地液位开关	Local level transmission instrument
ZS	就地位置开关	Local position switch
DCS	DCS信号	Signal to DCS



1x10MW POWER PLANT PROJECT	
江联国际工程有限公司 Jianglian International Engineering Co., Ltd.	
PROJECT: 1X 10 MW (Gross)	
OWN DWG. NO.	
ETIMAAD ENGINEERING (PRIVATE) LIMITED	
APP'D BY 审核	汽机汽水系统P&ID 3 Turbine steam and feedwater system P&I diagram
REV'D BY 审核	
CHK'D BY 审核	
DSND BY 审核	
SCALE 比例	
DATE 日期	2020.7.30
DWG. NO. 图号	Bidding stage: For reference only
REV. 版本	0



图形符号表 Legend sheet	
符号 Symbol	名称 Name
PI	就地压力指示仪表 Local pressure indication instrument
PT	就地压力变送仪表 Local pressure transmission instrument
PS	就地压力开关 Local pressure switch
PdS	就地压力开关 Local differential pressure switch
TI	就地温度指示仪表 Local temperature indication instrument
TE	就地温度检测仪表 Local temperature detecting instrument
FI	就地流量变送仪表 Local flow transmission instrument
LI	就地液位指示仪表 Local level indication instrument
LT	就地液位变送仪表 Local level transmission instrument
LL	控制室盘上液位指示仪表 Level indication instrument in control room instrument panel
LS	就地位置开关 Local position switch
DCS	通DCS信号 Signal to DCS

1x10MW POWER PLANT PROJECT



江联国际工程有限公司
Jianglian International Engineering Co., Ltd.

PROJECT: 1X 10 MW (Gross)

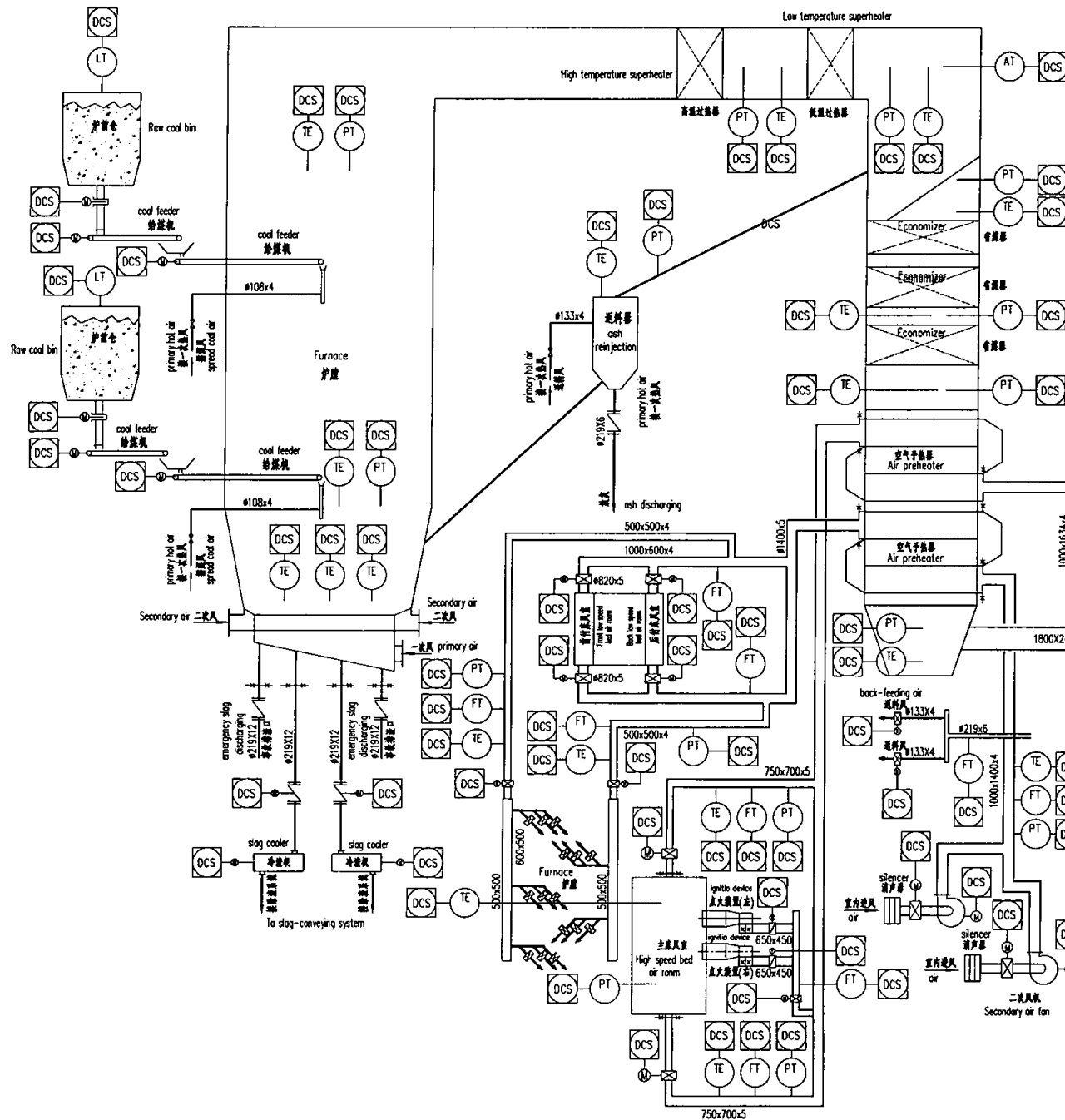
OWN DWG. NO.



ETIMAAD ENGINEERING (PRIVATE) LIMITED

APP'D BY	批准
REV'D BY	审核
CHK'D BY	校核
DSN'D BY	设计
SCALE	1:100
DATE	2020.7.30

汽机油系统P&ID 4 Turbine oil system P&I diagram	
DWG. NO.	REV.
图号	版本
Bidding stage, for reference only	



图形符号表 Legend sheet		
符号 Symbol	名称 Name	Name
PI	就地压力指示仪表	Local pressure indication instrument
PT	就地压力变送器	Local pressure transmission instrument
TI	就地温度指示仪表	Local temperature indication instrument
TE	就地温度检测仪表	Local Temperature detecting instrument
FT	就地流量变送器	Local flow transmission instrument
LI	就地料位指示仪表	Local level indication instrument
LT	就地料位变送器	Local level transmission instrument
AT	就地分析变送器	Local analysis transmission instrument
DCS	进DCS信号	Signal to DCS

1x10MW POWER PLANT PROJECT

江联国际工程有限公司
Jianglian International Engineering Co., Ltd.

PROJECT: 1X 10 MW (Gross)

OWN DWG. NO. _____

ETIMAAD ENGINEERING (PRIVATE) LIMITED

APP'D BY: 批准

REV'D BY: 审核

CHK'D BY: 校核

DSN'D BY: 设计

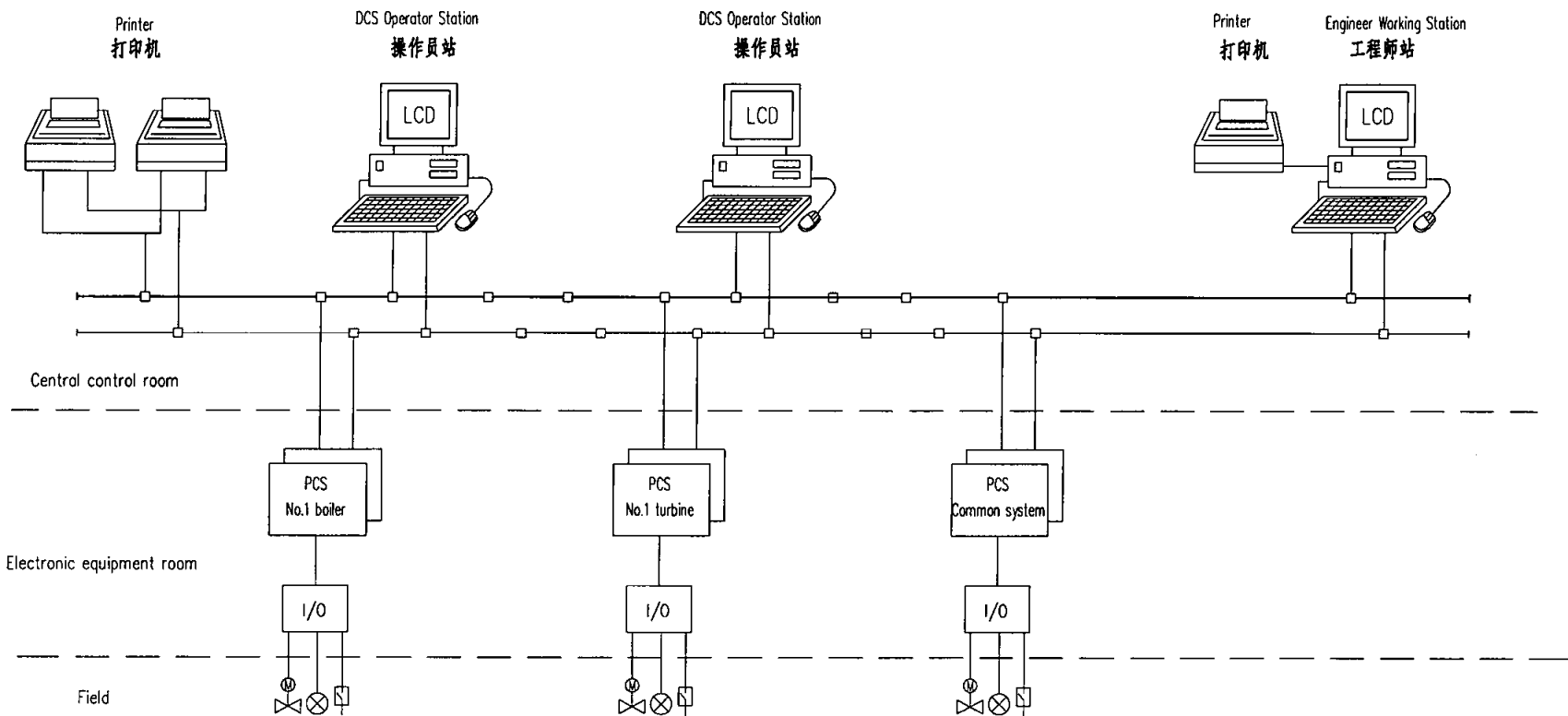
SCALE: 1:100

DATE: 2020.7.30

DWG. NO. 锅炉燃烧系统P&ID

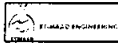
Boiler combustion system P&I diagram

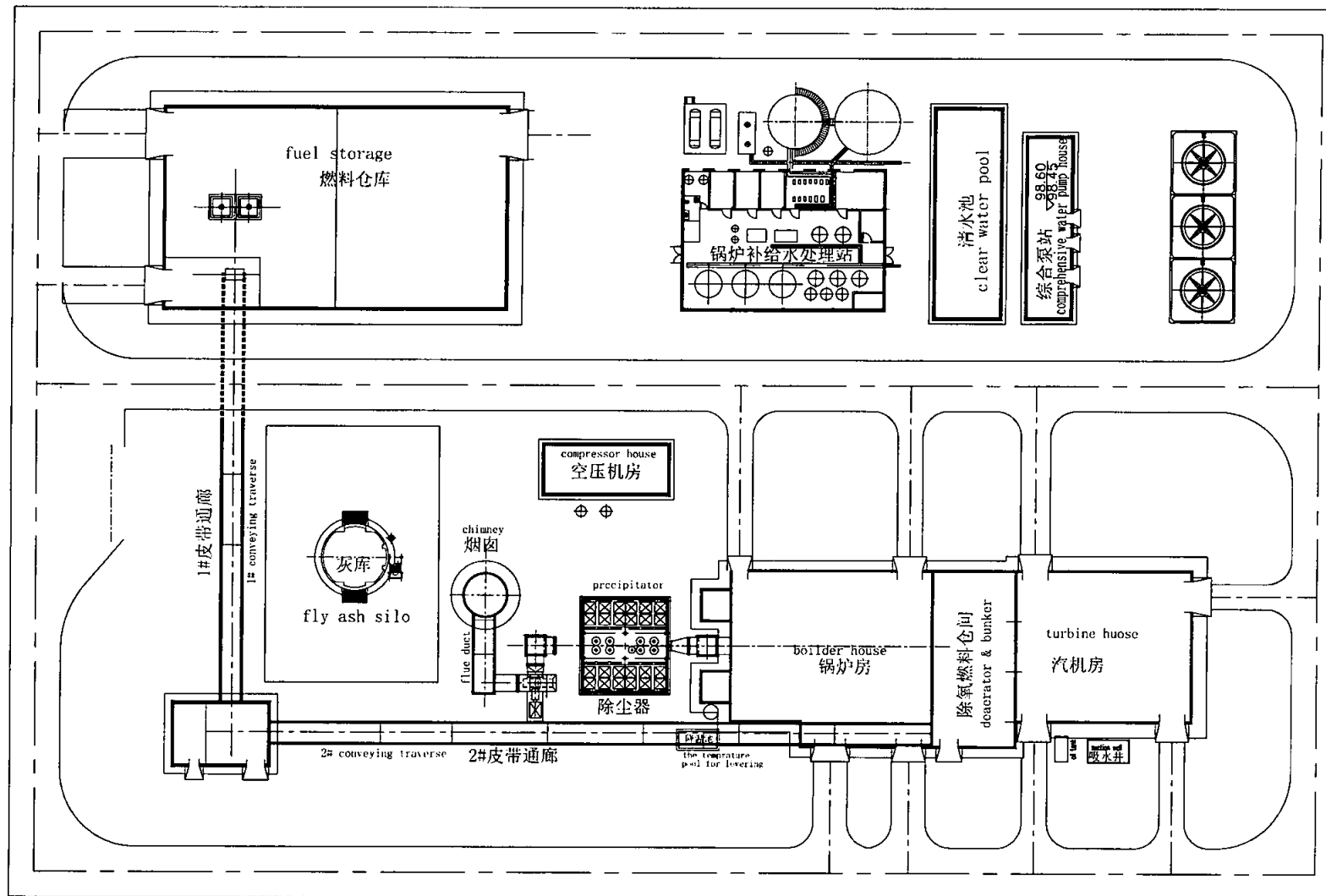
REV. 0



PCS: Process control station

 江联国际工程有限公司 Jianglian International Engineering Co., Ltd.		PROJECT: 1X 10 MW (Gross)	
OWN DWG. NO.			

 ETIMAAD ENGINEERING (PRIVATE) LIMITED			
APP'D BY 批准	DCS配置图 6 DCS configuration diagram		
REV'D BY 审核			
CHK'D BY 校对			
DSN'D BY 设计			
SCALE 比例	1:100		
DATE 日期	2020.7.30	DWG. NO. 图号	Bidding stage, for reference only
		REV. 版本	



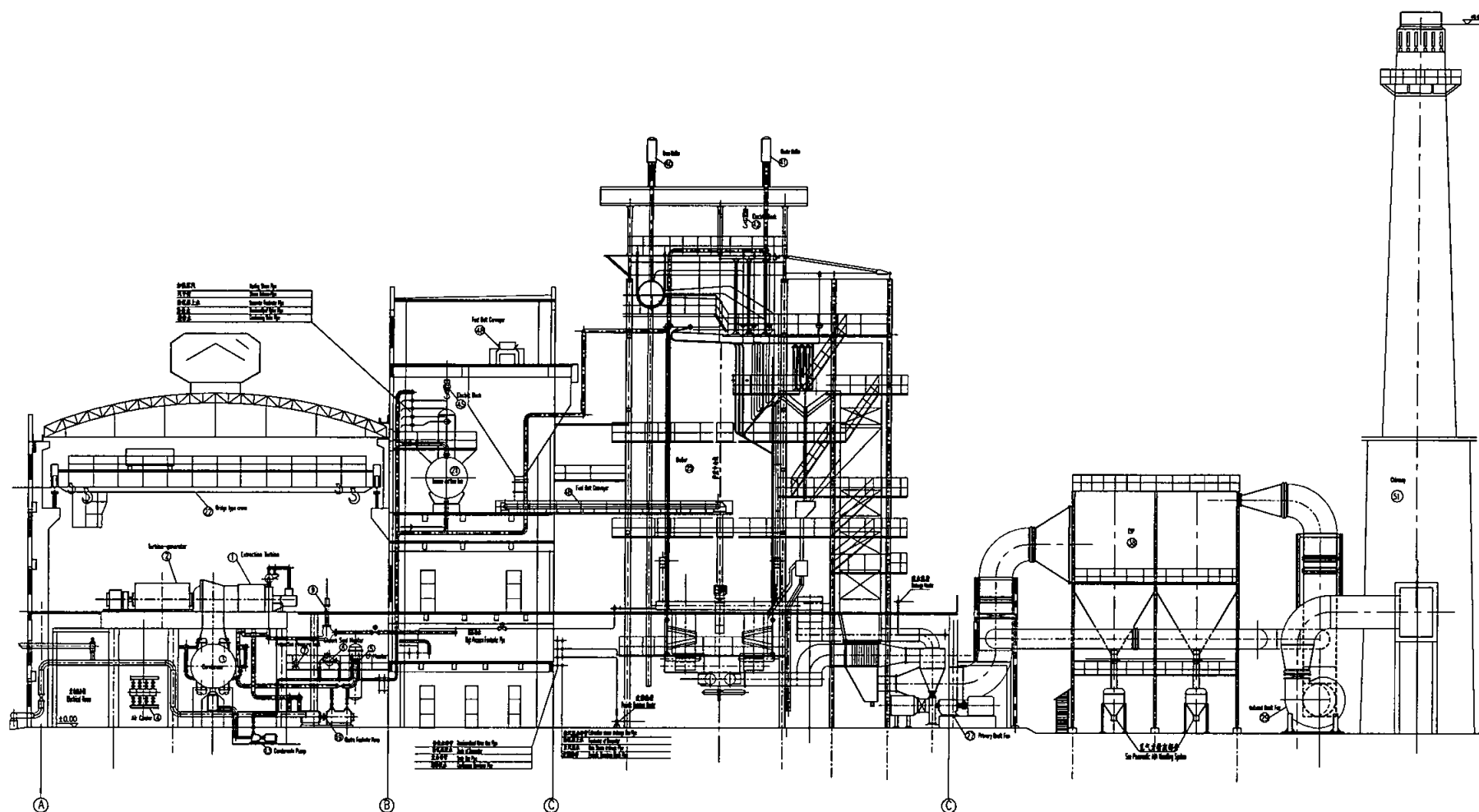
	江联国际工程有限公司 Jianglian International Engineering Co., Ltd.
	PROJECT: X 10 MW (Gross)
OWN DWG. NO.	

OWNER: ETIMAAD ENGINEERING (PRIVATE) LIMITED

APP'D BY	批准
REV'D BY	审核
CHK'D BY	校核
DSN'D BY	设计
SCALE	1:100
DATE	2020.7.30

电站平面布置
1. Power plant layout drawing

DWG. NO.	Bidding stage for reference only	REV.
图样编号		版本



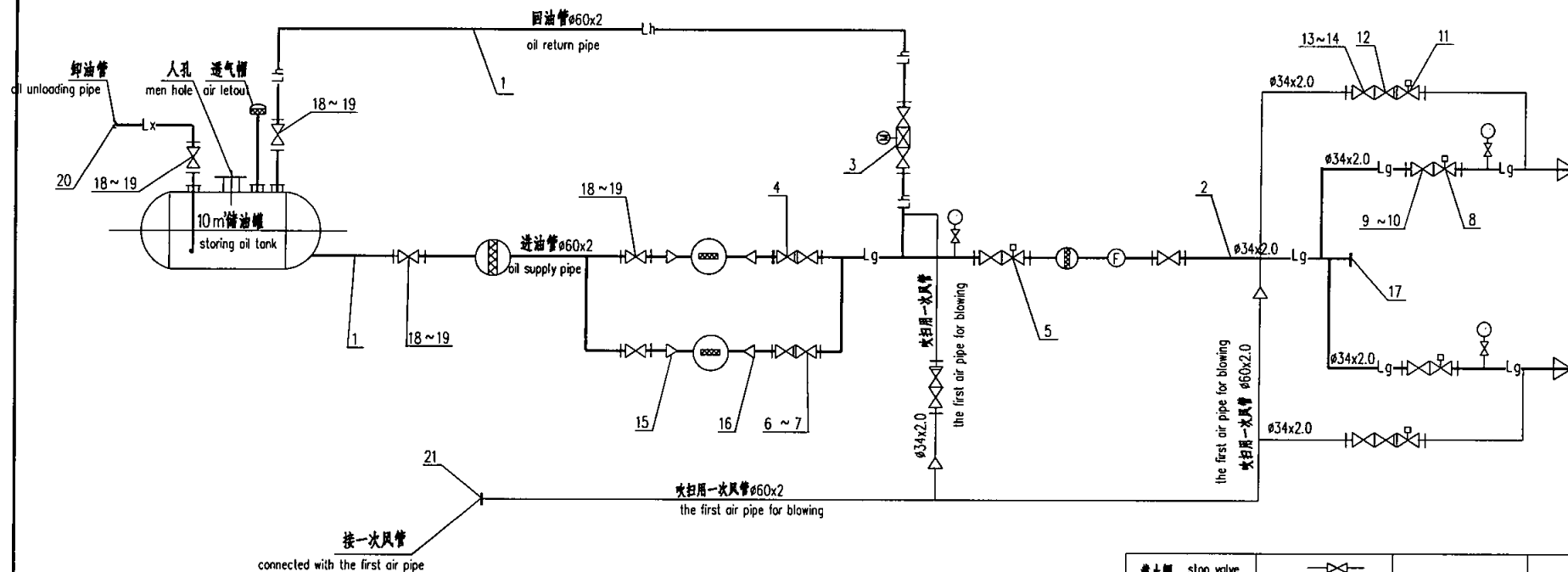
PROJECT: 1X 10 MW (Gross)

APP'D BY

DWG. NO.	设计图号
----------	------

Bidding stage for reference only

REV. 原本	
------------	--

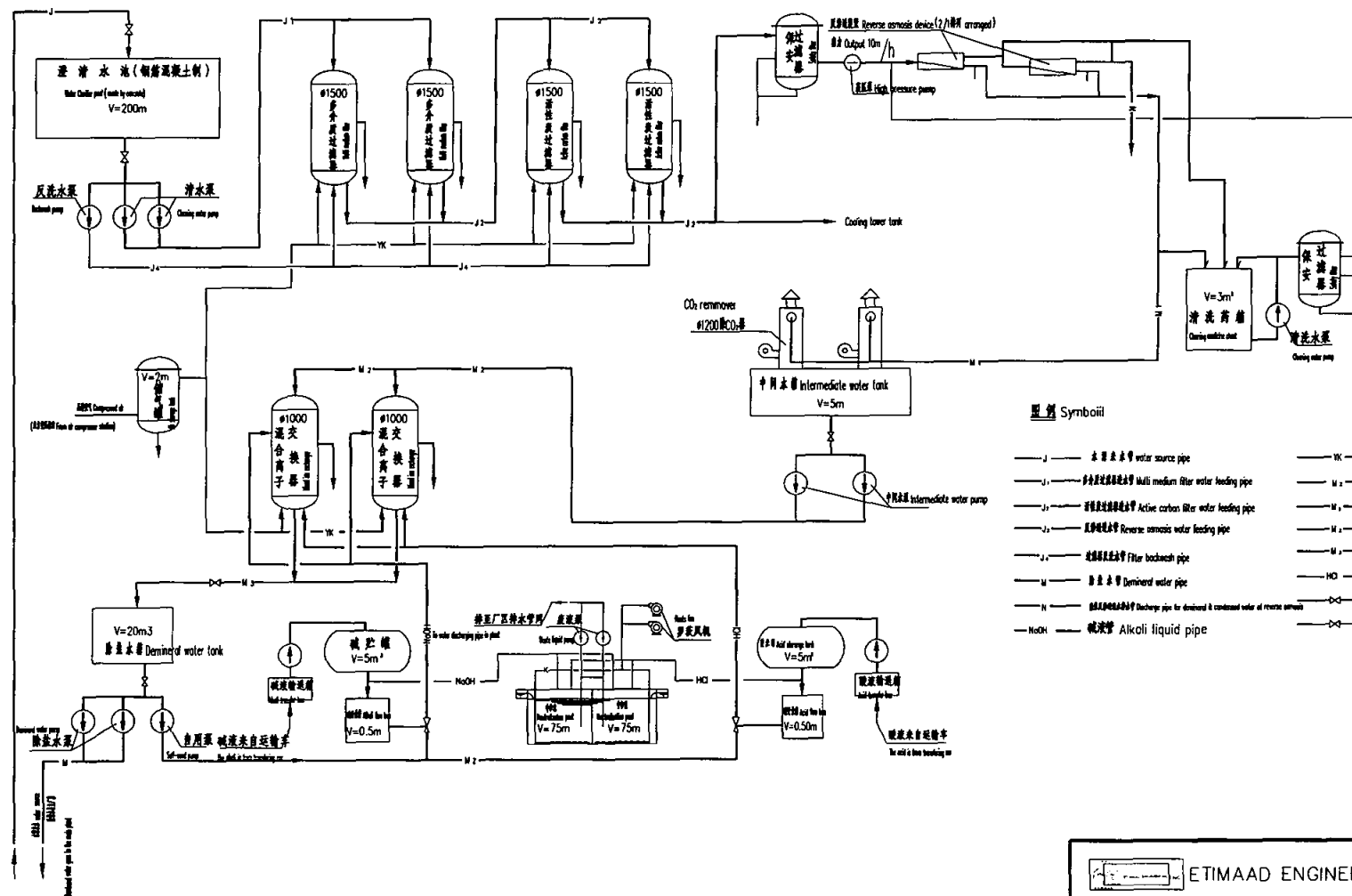


截止阀 stop valve			
止回阀 check valve		流量表 flow gauge	
电动球阀 electric ball valve		压力表 pressure gauge	
电动调节阀 electric adjusting valve		压缩空气管道 compressing air pipe	
大小头 reducer		卸油管 oil unloading pipe	
滤网 separating mesh		回油管 oil return pipe	
螺杆泵 screw pump		供油管 oil supply pipe	
名称 Name	符号 symbol	名称 Name	符号 symbol

图 例 LEGEND

ETIMAAD ENGINEERING (PRIVATE) LIMITED			
APP'D BY	油点火系统 3.Oil ignition System		
批准			
REV'D BY			
审核			
CHK'D BY			
校核			
DSN'D BY			
设计			
SCALE	1:100		
比例			
DATE	2020.7.30		
日期			
DWG. NO.	Bidding stage for reference only		
图号			
REV.	版本		

江联国际工程有限公司 Jianglian International Engineering Co., Ltd.			
PROJECT:	1X 10 MW (Gross)		
OWN DWG. NO.			



图例 Symbol

- | | |
|--|--|
| — J — 本厂来水供水源水管 | — WK — 压缩空气 Compressed air tube |
| — J ₁ — 多介质过滤器供水管 Multi media filter water leading pipe | — M — 自吸水管 Self-suck pipe |
| — J ₂ — 活性炭过滤器供水管 Active carbon filter water leading pipe | — M ₁ — 反渗透供水管 Reverse osmosis water leading pipe |
| — J ₃ — 反渗透供水管 Reverse osmosis water leading pipe | — M ₂ — 反渗透供水管 Reverse osmosis water leading pipe |
| — J ₄ — 过滤器供水管 Filter backwash pipe | — M ₃ — 反渗透供水管 Reverse osmosis water leading pipe |
| — M — 自吸水管 Demineral water pipe | — M ₄ — 反渗透供水管 Reverse osmosis water leading pipe |
| — H — 反渗透供水管 Reverse osmosis water leading pipe | — HO — 酸液管 Acid pipe |
| — HO — 酸液管 Acid pipe | — HO — 碱液管 Alkali liquid pipe |
| — HO — 碱液管 Alkali liquid pipe | — HO — 碱液管 Alkali liquid pipe |

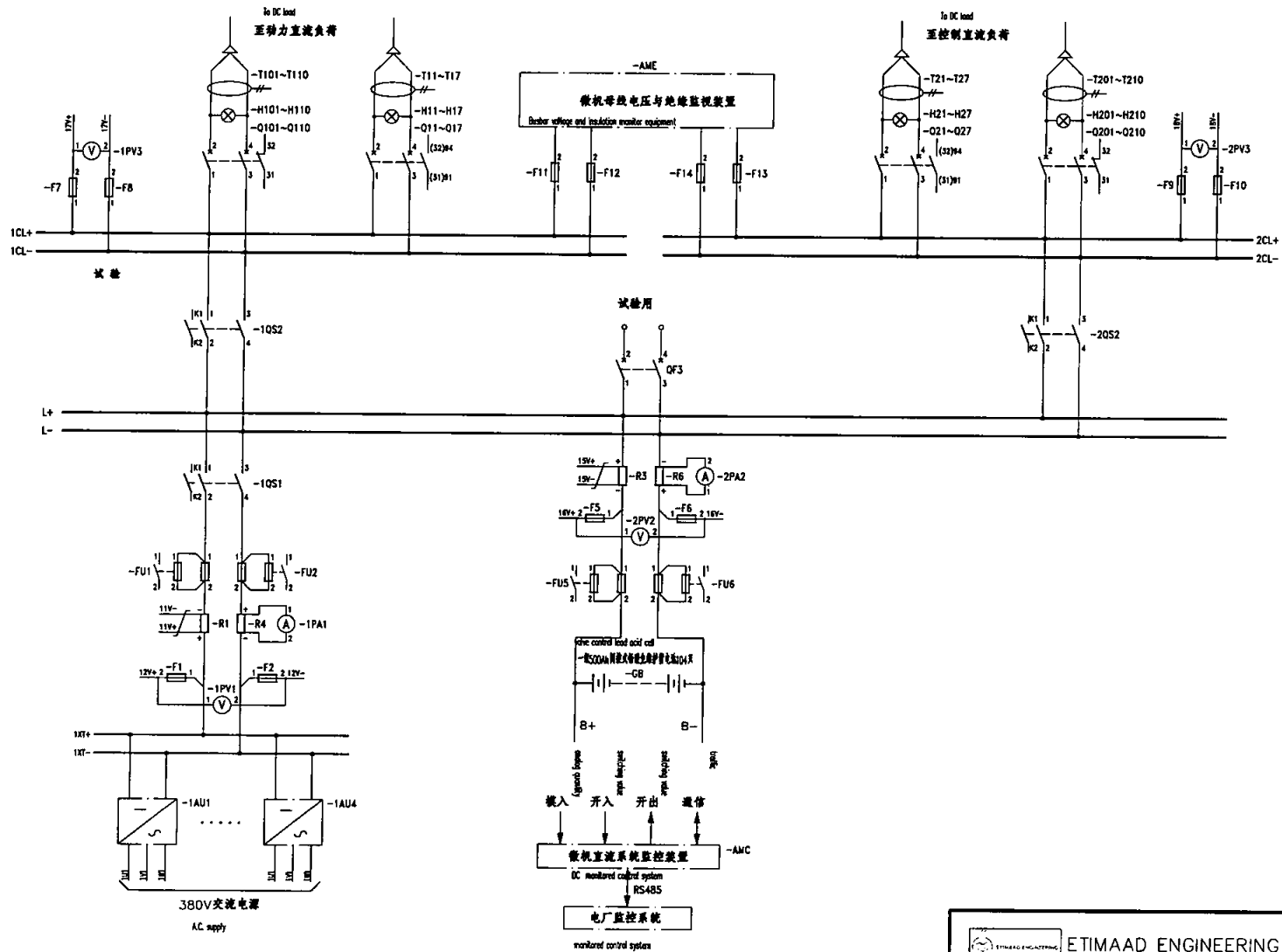
ETIMAAD ENGINEERING (PRIVATE) LIMITED			
APP'D BY	批准	化水处理系统 4. Water treatment plant	
REV'D BY	审核		
CHK'D BY	校核		
DSN'D BY	设计		
SCALE	比例		
DATE	日期	DWG. NO.	图号
2020.7.30		Bidding stage for reference only	REV. 版本



江联国际工程有限公司
Jianglian International Engineering Co., Ltd.

PROJECT: 1X 10 MW (Gross)

OWN DWG. NO.

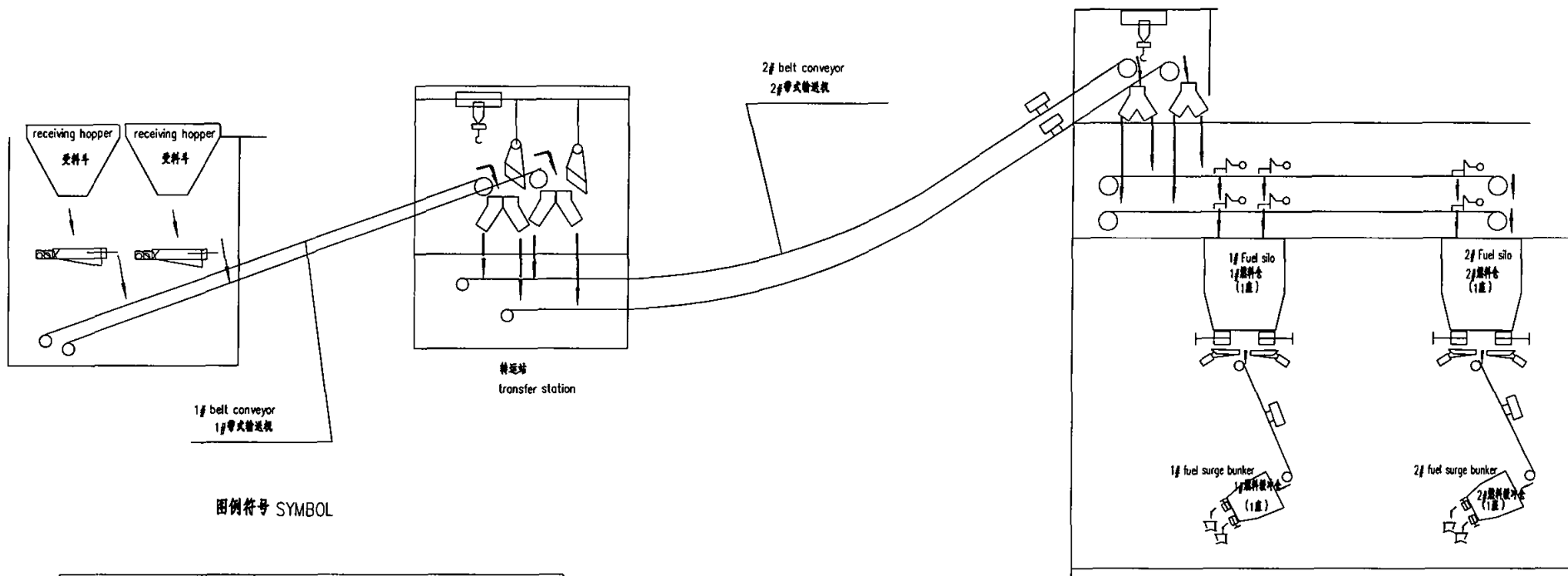


江联国际工程有限公司
Jianglian International Engineering Co., Ltd.

PROJECT: 1X 10 MW (Gross)

OWN DWG. NO.

ETIMAAD ENGINEERING (PRIVATE) LIMITED			
APPD BY	批准	直流电源系统 5.DC System	
REV'D BY	审核		
CHK'D BY	校核		
DSN'D BY	设计		
SCALE	比例		
DATE	日期	2020.7.30	DWG. NO. 增补图号
			Bidding stage for reference only
			版本



图例符号 SYMBOL

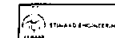
	K型给料机 K type fuel feeder
	电动犁式卸料器 plough type discharger
	电子皮带秤 electronic belt conveyor scale
	永磁除铁器 magnetic separator
	电动葫芦 electric block



江联国际工程有限公司
Jianglian International Engineering Co., Ltd.

PROJECT: 1X 10 MW (Gross)

OWN DWG. NO.



ETIMAAD ENGINEERING (PRIVATE) LIMITED

APP'D BY

批准

REV'D BY

审核

CHK'D BY

校对

DSN'D BY

设计

SCALE

1:100

DATE

2020.7.30

日期

DWG. NO.

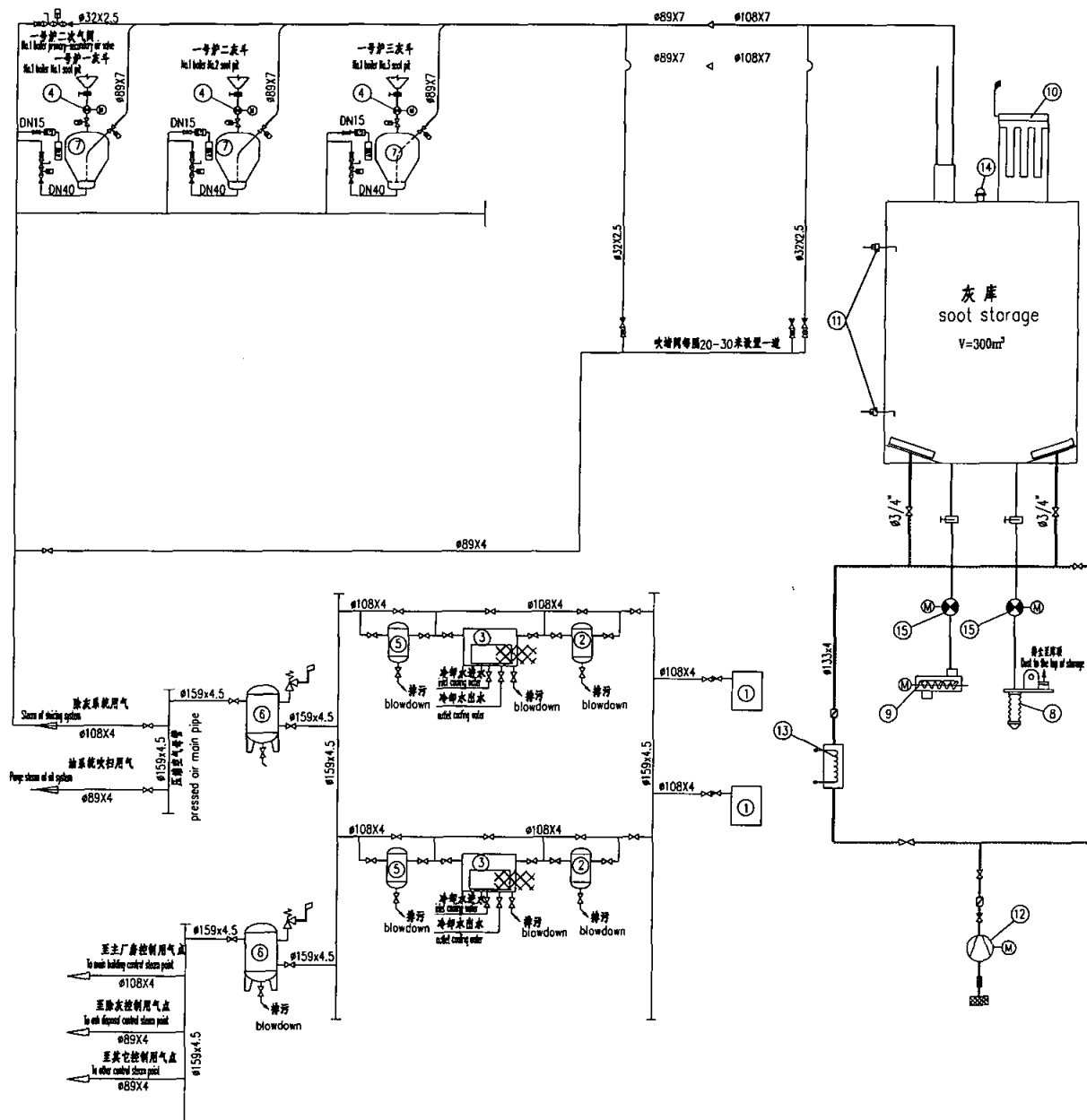
图样编号

输送系统图
6.Coal handling system

Bidding stage for reference only

REV.

版本



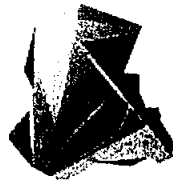
流量调节阀 flow control valve		大小头 Reducer	
球阀 globe valve		空气过滤器 Aerial dust filter	
截止阀 check valve		消声器 Air silencer	
截止阀 cut-off valve		气包 Gas bag	
电磁阀 solenoid-operated valve		清灰气 Dump free-air	
手动控制阀 Direct manual control block valve		气包管道 Gasifiable pipeline	
气动控制阀 Electropneumatic gate valve		控制气源管道 Control gas supply pipeline	
分路阀 shunt valve		输送气源管道 Entraining gas supply pipeline	
蝶阀 butterfly damper		灰管道 Ash pipeline	
名称 Name	符号 symbol	名称 Name	符号 symbol

图 形 符 号 表 Legend

15	动态控制(灰库) Dynamical feeder(soot storage)	2	
14	真空压力释放阀 Pressure-vacuum relief valve		
13	电加热器 Electric heaterN=20KW		
12	灰库气包风阀 Gasifiable fan of soot storage		
11	料位计 Level gauge		
10	除尘器 Collector		
9	湿法加湿搅拌机 Biox humidiified mixer		
8	干灰加湿机 Dry ash feed-erected machine		
7	仓泵 Pump of storage V=1.0m		
6	储气罐 Air cylinder V=8m		
5	二级过滤器regumping filter		
4	动态控制(灰斗) Dynamical feeder(soot pit)		
3	冷冻式干燥器 Cryogenic drier		
2	一级过滤器 First stage filter		
1	螺杆式空压机(水冲)		

设备明细表 EQUIPMENT LIST

1x10MW POWER PLANT PROJECT			
江联国际工程有限公司 Jianglian International Engineering Co., Ltd.			
PROJECT: 1X 10 MW (Gross)			
OWN DWG. NO.			
ETIMAAD ENGINEERING (PRIVATE) LIMITED			
APP'D BY 批准	除灰系统图 7. Ash removal flow diagram		
REV'D BY 审核			
CHK'D BY 校对			
DSN'D BY 设计			
SCALE 比例			
DATE 日期	2020.7.30	DWG. NO. 图号	for reference only
		REV. 版本	



SECMC

Sindh Engro Coal Mining Company

Sindh Engro Coal Mining Company Limited (SECMC)

Short Circuit Calculations and Load Flow Analysis

Technical Report

Siemens Pakistan
Smart Infrastructure - Digital Grid
Power Technologies International

Project Reference	3006722831
Date	18.05.2020
Worked By	Hemant Parkash
Office Address	B-72, Estate Avenue S.I.T.E. P.O. Box No. 7158, Karachi-75700.
Phone	+92 21 32592971
Fax	+92 21 32567461
E-Mail	hemant.parkash@siemens.com farhan.ali@siemens.com

Siemens PTI – Power Systems Consulting

<http://www.siemens.com/power-technologies>

SIEMENS

Table of Contents

Table of Contents.....	2
List of Tables	4
EXECUTIVE SUMMARY.....	7
1. INTRODUCTION.....	9
1.1 Job Description	9
1.2 Network Background	9
1.3 Simulation Cases	10
2. METHODOLOGY.....	11
2.1 Electrical Network Data.....	11
2.1.1 Nominal Voltages.....	11
2.1.2 Generator / Solar Unit Model.....	11
2.1.3 Transformer Model.....	12
2.1.4 Load Model.....	13
2.1.5 Modeling of Cables / Overhead Conductors.....	13
2.1.6 Annotations:.....	13
3. SHORT CIRCUIT STUDY.....	15
3.1 Introduction to Short Circuit Calculations.....	15
3.2 Adopted Procedure.....	15
3.3 3-Phase Maximum Short Circuit Results	19
3.4 3-Phase Minimum Short Circuit Results.....	34
3.5 2-Phase Maximum Short Circuit Results	48
3.6 2-Phase Minimum Short Circuit Results.....	61
3.7 1-Phase Maximum Short Circuit Results	76
3.8 1-Phase Minimum Short Circuit Results.....	90
3.9 Short Circuit Calculations Conclusion.....	104
4. LOAD FLOW ANALYSIS.....	105
4.1 Introduction to Load Flow Analysis.....	105
4.2 Load Flow Scenarios and Results	105
4.3 Voltage Profile	107
4.4 Transformer Loading	119

4.5	Generators' Loading	125
4.6	Load Flow Analysis Conclusion	126
5.	OBSERVATIONS & RECOMMENDATIONS	127
5.1	Observations	127
5.2	Recommendations	128
ANNEX-A.....		130
	Input Data Model	131
	3-Phase Maximum Short Circuit Results (Case-1A)	132
	3-Phase Maximum Short Circuit Results (Case-1B)	133
	3-Phase Maximum Short Circuit Results (Case-2A)	134
	3-Phase Maximum Short Circuit Results (Case-2B)	135
	3-Phase Maximum Short Circuit Results (Case-3A)	136
	3-Phase Maximum Short Circuit Results (Case-3B)	137
	3-Phase Minimum Short Circuit Results (Case-1A)	138
	3-Phase Minimum Short Circuit Results (Case-1B)	139
	3-Phase Minimum Short Circuit Results (Case-2A)	140
	3-Phase Minimum Short Circuit Results (Case-2B)	141
	3-Phase Minimum Short Circuit Results (Case-3A)	142
	3-Phase Minimum Short Circuit Results (Case-3B)	143
	2-Phase Maximum Short Circuit Results (Case-1A)	144
	2-Phase Maximum Short Circuit Results (Case-1B)	145
	2-Phase Maximum Short Circuit Results (Case-2A)	146
	2-Phase Maximum Short Circuit Results (Case-2B)	147
	2-Phase Maximum Short Circuit Results (Case-3A)	148
	2-Phase Maximum Short Circuit Results (Case-3B)	149
	2-Phase Minimum Short Circuit Results (Case-1A)	150
	2-Phase Minimum Short Circuit Results (Case-1B)	151
	2-Phase Minimum Short Circuit Results (Case-2A)	152
	2-Phase Minimum Short Circuit Results (Case-2B)	153
	2-Phase Minimum Short Circuit Results (Case-3A)	154
	2-Phase Minimum Short Circuit Results (Case-3B)	155
	1-Phase Maximum Short Circuit Results (Case-1A)	156
	1-Phase Maximum Short Circuit Results (Case-1B)	157
	1-Phase Maximum Short Circuit Results (Case-2A)	158
	1-Phase Maximum Short Circuit Results (Case-2B)	159
	1-Phase Maximum Short Circuit Results (Case-3A)	160

1-Phase Maximum Short Circuit Results (Case-3B)	161
1-Phase Minimum Short Circuit Results (Case-1A)	162
1-Phase Minimum Short Circuit Results (Case-1B)	163
1-Phase Minimum Short Circuit Results (Case-2A)	164
1-Phase Minimum Short Circuit Results (Case-2B)	165
1-Phase Minimum Short Circuit Results (Case-3A)	166
1-Phase Minimum Short Circuit Results (Case-3B)	167
Load Flow Results (Case-1A)	168
Load Flow Results (Case-1B)	169
Load Flow Results (Case-2A)	170
Load Flow Results (Case-2B)	171
Load Flow Results (Case-3A)	172
Load Flow Results (Case-3B)	173

List of Tables

Table 1.3-1 SECMC Electrical Network Operational Cases	10
Table 2.1-1 Specifications of Sources	11
Table 2.1-2 Specifications of Transformer.....	12
Table 2.1-3 Annotations.....	13
Table 3.2-1 Voltage Factors according to IEC-60909-2	17
Table 3.2-2 Short Circuit Calculations Operational Cases	18
Table 3.3-1 3-Phase Maximum Results (1A).....	19
Table 3.3-2 3-Phase Maximum Results (1B)	21
Table 3.3-3 3-Phase Maximum Results (2A).....	24
Table 3.3-4 3-Phase Maximum Results (2B)	26
Table 3.3-5 3-Phase Maximum Results (3A).....	28
Table 3.3-6 3-Phase Maximum Results (3B)	31
Table 3.4-1 3-Phase Minimum Results (1A)	34
Table 3.4-2 3-Phase Minimum Results (1B).....	36
Table 3.4-3 3-Phase Minimum Results (2A)	38
Table 3.4-4 3-Phase Minimum Results (2B).....	41
Table 3.4-5 3-Phase Minimum Results (3A)	43

Table 3.4-6 3-Phase Minimum Results (3B).....	45
Table 3.5-1 2-Phase Maximum Results (1A).....	48
Table 3.5-2 2-Phase Maximum Results (1B).....	50
Table 3.5-3 2-Phase Maximum Results (2A).....	52
Table 3.5-4 2-Phase Maximum Results (2B).....	54
Table 3.5-5 2-Phase Maximum Results (3A).....	56
Table 3.5-6 2-Phase Maximum Results (3B).....	59
Table 3.6-1 2-Phase Minimum Results (1A).....	61
Table 3.6-2 2-Phase Minimum Results (1B).....	63
Table 3.6-3 2-Phase Minimum Results (2A).....	66
Table 3.6-4 2-Phase Minimum Results (2B).....	68
Table 3.6-5 2-Phase Minimum Results (3A).....	70
Table 3.6-6 2-Phase Minimum Results (3B).....	73
Table 3.7-1 1-Phase Maximum Results (1A).....	76
Table 3.7-2 1-Phase Maximum Results (1B).....	78
Table 3.7-3 1-Phase Maximum Results (2A).....	81
Table 3.7-4 1-Phase Maximum Results (2B).....	83
Table 3.7-5 1-Phase Maximum Results (3A).....	85
Table 3.7-6 1-Phase Maximum Results (3B).....	88
Table 3.8-1 1-Phase Minimum Results (1A).....	90
Table 3.8-2 1-Phase Minimum Results (1B).....	92
Table 3.8-3 1-Phase Minimum Results (2A).....	95
Table 3.8-4 1-Phase Minimum Results (2B).....	97
Table 3.8-5 1-Phase Minimum Results (3A).....	99
Table 3.8-6 1-Phase Minimum Results (3B).....	102
Table 4.2-1 Load Flow Analysis Operational Cases.....	106
Table 4-4.3-1 Voltage Profile at all Main Buses Case 1A.....	107
Table 4-4.3-2 Voltage Profile at all Main Buses Case 1B.....	109
Table 4-4.3-3 Voltage Profile at all Main Buses Case 2A.....	111
Table 4-4.3-4 Voltage Profile at all Main Buses Case 2B.....	113
Table 4-4.3-5 Voltage Profile at all Main Buses Case 3A.....	115
Table 4-4.3-6 Voltage Profile at all Main Buses Case 3B.....	117
Table 4-4.4-1 Transformer loading Case 1A.....	119
Table 4-4.4-2 Transformer loading Case 1B.....	120
Table 4-4.4-3 Transformer loading Case 2A.....	121
Table 4-4.4-4 Transformer loading Case 2B.....	122
Table 4-4.4-5 Transformer loading Case 3A.....	123

Table 4-4.4-6 Transformer loading Case 3B	124
Table 4-4.5-1 Generator Loadings	125

EXECUTIVE SUMMARY

1. Sindh Engro Coal Mining Company (SECMC) was created with the vision in order to develop a technically and commercially viable Coal Mining Project in Thar Block – II to bring energy security to Pakistan. The total reserves of block II are sufficient to support 5000MW of energy.
2. Comprehensive short circuit calculations and load flow analysis of M/s Sindh Engro Coal Mining Company (SECMC) electrical network have been carried out to determine short circuit levels on different substations and determination of electrical equipment loadings, voltage drops on system buses under steady state operation.
3. Following cases have been simulated for the steady state condition evaluation,

Case	2 MVA Diesel Engine [Qty]	11 kV Generation Bus Coupler	Interconnection of Solar Plant
1A	4	ON	YES
1B	4	OFF	YES
2A	5	ON	NO
2B	5	OFF	NO
3A	6	ON	NO
3B	6	OFF	NO

4. SECMC's maximum demand running load is around 7.4 MW (as per the data received) and it is entirely fed via 11 kV Diesel Generators and Solar farm. The electrical network of SECMC consists of 9 x 2MVA Diesel Generators, rated at 11 kV. Moreover, a Solar farm of 3.960 MW_{pAC} has also been installed and it is coupled with SECMC 11 kV generation bus bar, which supports the network to fulfill the load demand of the plant.
5. Short circuit analysis of the network has been performed on above mentioned cases (Point No. 3) with various fault conditions (3-Phase, 2-Phase & 1-Phase faults). Short-circuits calculations have been performed as per RMS (Root Mean Square – I_{k''}) & Peak current (i_p) values of the breakers connected to the bus bar.

Short circuit results show that for 3-Phase, 2-Phase and 1-Phase faults, the initial symmetrical short circuit current as well as the peak fault current are well within the rated capacity for all the Medium Voltage (MV) switchgears in all cases. Rated I_{k''} and i_p values of all MV switchgears have been considered 31.5 kA and 78.8 kA respectively, except for the switchgears installed at Solar farm, which are rated at 20 kA RMS and 50 kA peak.

For Low Voltage (LV) switchgears connected to 0.69 kV system, the short-circuit rating of busbars as well as for the breakers have been considered 42 kA and the switchgears, which are connected to 0.4 kV network are rated at 50 kA. After performing short-circuit calculations, it has been observed that switchgears are well within prescribed limits.

To limit the earth fault current in SECMC network, Resonant Earthed System has been installed, i.e. a neutral point reactance source is connected between the ZN connected transformer neutral and the station earthing system. A system in which at least one of the neutrals is connected to earth via an inductive reactance, a Petersen coil or Arc Suppression Coil, and the current generated by the reactance source during an earth fault approximately compensates the capacitive component of the single-phase earth fault current. The capacitive earth fault current has been observed to be around 26 A, which is compensated by the Arc Suppression Coil having 50A current limit.

6. Load flow conditions show that the voltage profile on all the bus bars is within the permissible range (95% to 105%). Transformer loadings are also within rated MVA with a safety margin. MV & LV cables are found to be loaded well below than 100% rating. Moreover, by operating the network at peak load of around 7.4 MW, it has been observed that the network operates satisfactory.

1. INTRODUCTION

1.1 Job Description

Comprehensive short circuit calculations and load flow analysis of M/s Sindh Engro Coal Mining Company (SECMC) have been carried out to determine short circuit levels on different substations and determination of electrical equipment loadings, voltage drops on system buses under steady state operation.

The focus of this report is mainly on:

- Short circuit calculations.
- Load flow conditions.

1.2 Network Background

Sindh Engro Coal Mining Company (SECMC) was created with the vision in order to develop a technically and commercially viable Coal Mining Project in Thar Block – II to bring energy security to Pakistan. The total reserves of block II are sufficient to support 5000MW of energy.

SECMC's maximum demand running load is around 7.4 MW (as per the data received) and it is entirely fed via 11 kV Diesel Engines and Solar farm. The electrical network of SECMC consists of 9 x 2MVA Diesel Engines, rated at 11 kV. Moreover, a Solar farm of 3.960 MW_{pAC} has also been installed and it is coupled with SECMC 11 kV generation bus bar, which supports the network to fulfill the load demand of the plant.

The entire load of the plant is connected at Low Voltage (LV) level; therefore, distribution transformers of different ratings are being installed to feed the load at 0.69 kV and 0.4 kV levels.

The major and most critical load is connected at Line-01, Line-02 & Line-03 feeders. These substations altogether make 75% of the total demand load of SECMC plant. The distribution of these load is carried out via overhead conductors & underground cables.

As far as the system grounding is concerned, the 11 kV system is grounded via Arc Suppression Coil (ARC) reactance that has the maximum current limitation of 50A at primary winding ZN connected neutral point. The network consists of two ARCs and both are connected at main 11 kV load bus, which is also coupled with 11 kV generation bus., however in normal scenario only one ARC remains in service. The LV level is completely solidly grounded i.e. at both 0.69 kV and 0.4 kV.

An Emergency Diesel Engine (EDG) of 800 KW, rated at 0.4 kV is connected at Comprehensive LV bus bar. This generator remains out of service in normal condition; however, it is brought into service in case of emergency.

Fixed shunt capacitors of different kVAR ratings are connected at some of the LV bus bars for reactive power compensation in the system.

Please refer Annex A for the network structure / input data model.

1.3 Simulation Cases

As per the discussion with M/s SECMC engineers regarding the network operation and loading conditions, following operational cases have been simulated with respect to short circuit and load flow calculations:

Following cases have been simulated for the steady state condition evaluation,

Table 1.3-1 SECMC Electrical Network Operational Cases

Case	2 MVA Diesel Engine [Qty]	11 kV Generation Bus Coupler	Interconnection of Solar Plant
1A	4	ON	YES
1B	4	OFF	YES
2A	5	ON	NO
2B	5	OFF	NO
3A	6	ON	NO
3B	6	OFF	NO

2. METHODOLOGY

The input data for network was provided by engineers of M/s SECMC in the form of single line diagrams, data sheets and load lists. The data was then used to develop the model on network analysis tool, PSS® SINCAL (Siemens Network Calculation) software.

2.1 Electrical Network Data

The network input model is prepared and modified with the help of data sent via emails. Please see the input data model in Annex A.

2.1.1 Nominal Voltages

Considering the nominal voltages of SECMC network at different points, following voltage levels have been considered as reference voltages:

- 11 kV
- 0.69 kV
- 0.4 kV

2.1.2 Generator / Solar Unit Model

11 kV generator and Solar farm data of the considered network is tabulated below.

Table 2.1-1 Specifications of Sources

Source Identification	Rated Voltage (kV)	Xd'' (%)	Rated Active Power (MW)
Diesel Generator (01 – 09)	11	11.5	1.6
Solar KIOSK I	11	N/A	0.96
Solar KIOSK II	11	N/A	0.96
Solar KIOSK III	11	N/A	0.96
Solar KIOSK IV	11	N/A	1.080

2.1.3 Transformer Model

- Transformers are modeled as per their name plate data.
- All the no-load tap-changers have been set at 0 positions (Central Point).

The details are as follows:

Table 2.1-2 Specifications of Transformer

S.No.	Transformer	Vn1 [kV]	Vn2 [kV]	Sn [kVA]	vsc [%]	VecGrp
1	522 S/S	11	0.4	630	5.5	Dyn11
2	518 S/S	11	0.69	2500	5.5	Dyn11
3	2T897	11	0.69	2500	5.5	Dyn11
4	510 S/S	11	0.69	630	4.5	Dyn11
5	511 S/S	11	0.69	630	4.5	Dyn11
6	512 S/S	11	0.69	630	4.5	Dyn11
7	513 S/S	11	0.69	630	4.5	Dyn11
8	BUFFER PUMP-II	11	0.4	500	4.5	Dyn11
9	BUFFER PUMP-I	11	0.4	500	4.5	Dyn11
10	505 S/S	11	0.69	630	4.5	Dyn11
11	506 S/S	11	0.69	630	4.5	Dyn11
12	508 S/S	11	0.69	630	4.5	Dyn11
13	509 S/S	11	0.69	630	4.5	Dyn11
14	514 S/S	11	0.69	630	4.5	Dyn11
15	521 S/S	11	0.4	800	4.5	Dyn11
16	507 S/S	11	0.69	630	4.5	Dyn11
17	DIESEL STORAGE AREA	11	0.4	400	4.5	Dyn11
18	CRUSHING STATION	11	0.4	1250	4.5	Dyn11
19	CONVEYOR BELT MV	11	0.4	1250	4.5	Dyn11
20	DRIVER'S COLONY MV	11	0.4	1250	4.5	Dyn11
21	CHINESE COLONY S/S	11	0.4	800	4.5	Dyn11
22	MSF	11	0.4	800	4.5	Dyn11
23	PAKISTAN COLONY	11	0.4	1500	4.5	Dyn11
24	504 S/S	11	0.69	630	4.5	Dyn11
25	519 S/S	11	0.4	800	4.5	Dyn11
26	COMP. PUMP STATION-I	11	0.4	1000	4.5	Dyn11
27	COMP. PUMP STATION-II	11	0.4	1000	4.5	Dyn11
28	515 S/S	11	0.69	630	4.5	Dyn11
29	OWNER'S COLONY	11	0.4	800	4.5	Dyn11
30	504 S/S 100 KVA TF	0.69	0.4	100	4.5	Dyn11
31	505 S/S 100 KVA TF	0.69	0.4	100	4.5	Dyn11
32	506 S/S 100 KVA TF	0.69	0.4	100	4.5	Dyn11
33	508 S/S 100 KVA TF	0.69	0.4	100	4.5	Dyn11
34	509 S/S 100 KVA TF	0.69	0.4	630	4.5	Dyn11
35	510 S/S 100 KVA TF	0.69	0.4	100	4.5	Dyn11

2.1.4 Load Model

- Starting current (I_a/I_n) of all LV motors is considered as 6.7 in accordance with the IEC 60909-2 and for lumped motors the ratio of 5.0 has been considered.
- Low voltage motors without cable connections, R/X ratio= 0.15 is considered as per IEC 60909-2.
- Lighting loads have been modeled as static load in the network.

Please see the input data model in Annex A.

2.1.5 Modeling of Cables / Overhead Conductors

Cable and Overhead conductors' impedances are chosen from PSS®SINCAL database. The data for cable sizes, lengths and number of parallel systems have been provided by M/s SECMC. The permissible maximum continuous load current (I_{th}) is evaluated by considering the reduction factor i.e. $I_{th} = I_{rated} \times \text{Reduction Factor}$.

Reduction factor of the cables is calculated by considering the following factors:

- Ambient temperature: 45°C.
- Number of parallel systems.
- Nature of cable laying.
- Soil thermal resistivity etc.

We have considered an overall reduction factor of 0.7 for all cables laid in the entire SECMC network. Zero sequence data of the cables was not available. We have therefore considered these values from PSS®SINCAL database.

2.1.6 Annotations:

The short names and their description for different electrical elements used in PSS®SINCAL are listed below:

Table 2.1-3 Annotations

Short Names	Unit	Description
GRID		
Sk"	MVA	Short Circuit Power
Transformer		
Vr1	kV	Rated Voltage (Side 1)
Vr2	kV	Rated Voltage (Side 2)
Sn	MVA	Rated Apparent Power

vk	%	Reference Short Circuit Voltage (% impedance)
S/Sb	%	Ratio Apparent Power
BusBars		
V/Vn	%	Actual voltage/Rated Voltage
Ik''	KA	Initial SC Current the maximum of the effective values of the current expected at the moment the short circuit occurs
ip	KA	Peak SC Current the peak value of the maximum possible short circuit current in the conductor
IL1a, IL2a, IL3a	KA	Absolute current
3I0a	KA	Absolute return current
Motors		
Pn	MW	rated active power
cosphin		Rated Power Factor
Ia/In	pu	Current Ratio At Start-Up
etan	pu	Rated Efficiency
cosphi		Running Power Factor
Cables		
q	mm ²	Cross Section
l	m	Length
p		No. of Parallel Systems
f		Reduction factor
I/Ib	%	Current Loading
Short Names	Unit	Description
Capacitor Bank		
Qr	Mvar	Rated Reactive Power
General		
+ (P,Q)		Power flow towards the node
- (P,Q)		Power flow away from the node
IK'' , ip (For cables)		Depicts the flow towards the respective node.

3. SHORT CIRCUIT STUDY

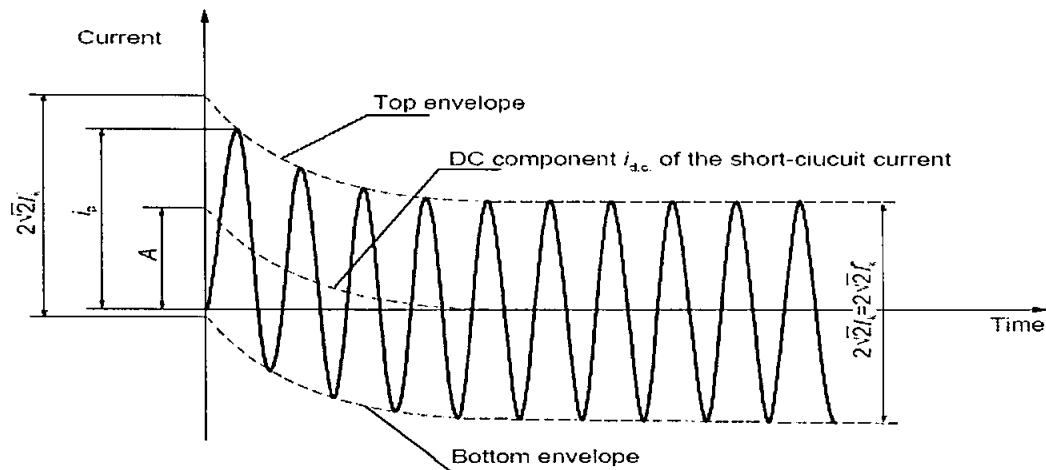
3.1 Introduction to Short Circuit Calculations

The short circuit calculations are carried out using IEC 60909-2/2016 standard. The initial symmetrical short circuit (I_k'') is referred to as the thermal stress of breaker and peak current (i_p) will determine the mechanical stresses on the breaker.

3-Phase, 2-Phase and 1-Phase to ground short-circuit calculations have been simulated in order to determine the fault level at all Medium Voltage (MV) and Low Voltage (LV) buses.

3.2 Adopted Procedure

The method used for calculation is based on the introduction of an equivalent voltage source at the short-circuit location. The equivalent voltage source is the only active voltage of the system. All network feeders, synchronous and asynchronous machines are replaced by their internal impedances. In all cases it is possible to determine the short-circuit current at the short-circuit location with the help of an equivalent voltage source. Operational data and the load of consumers, tap changer position of transformers, excitation of generators are dispensable. Short circuit current distribution diagram is given below:



- I_k'' = initial symmetrical short-circuit current
- i_p = peak short-circuit current
- I_k = steady-state short-circuit current
- i_{dc} = d.c. component of short-circuit current
- A = initial value of the d.c. component i_{dc} .

Figure 1 Short-circuit current distribution in a far from generator short circuit

Initial symmetrical short circuit current (I_k''): RMS value of the ac component of short circuit current applicable at the onset of short circuit.

Peak short circuit current (i_p): The highest possible instantaneous value of the current, following the occurrence of the short circuit. The highest value of i_p depends on the time constant of the decaying aperiodic component i.e on the X/R or R/X of the short circuit impedance and is reached if the short circuit starts at zero voltage. i_p also depends on the decay of the symmetrical ac component of the short circuit current.

Steady state short circuit current (I_k): RMS value of the short circuit current which remains after the decay of the transient phenomenon.

DC component of short circuit current (i_{dc}): Mean value between the top and bottom envelope of a short circuit current, decaying from an initial value A to zero.

Table 3.2-1 Voltage Factors according to IEC-60909-2

Nominal Voltage Un	Voltage factor c for the calculation of	
	Maximum Currents Cmax ¹⁾	Short-Circuit Minimum Currents Cmin
Low Voltage 100V to 1000V (IEC 60038)	1.05 ³⁾ 1.04 ⁴⁾	0.95
Medium Voltage >1kV to 35 kV (IEC 60038)	1.10	1.00
High Voltage ²⁾ >35 kV (IEC 60038)		
1) c_{max}U_n should not exceed the highest voltage U_m for equipment of power systems. 2) If no nominal voltage is defined c_{max}U_n = U_m or c_{max}U_n = 0.90 x U_m should be applied. 3) For low-voltage systems with a tolerance of +6 %, for example systems renamed from 380V to 400V. 4) For low-voltage systems with a tolerance of +10 %.		

When calculating maximum short circuits, it is necessary to introduce the following conditions as per IEC 60909-2:

- Voltage factor c_{max} according to above table shall be used for the calculation of short circuit currents.
- Choose the system configuration and the maximum contribution from the power plants and the network feeders which lead to the maximum short circuit current at the short circuit location.
- When equivalent impedances are used to represent the external networks, the minimum equivalent impedance shall be used which corresponds to the maximum short circuit contribution from the network feeders.
- Motors shall be included in accordance with their appropriate reactance by resistance ratios.
- Resistance of line (overhead lines and cables) is to be introduced at a temperature of 20 degree centigrade.

When calculating minimum short circuits, it is necessary to introduce the following conditions as per IEC 60909-2:

- Voltage factor c_{min} according to above table shall be used for the calculation of short circuit currents.

- Choose the system configuration and the minimum contribution from the power plants and the network feeders which lead to the minimum short circuit current at the short circuit location.
- Motors shall be neglected.
- Resistance of line (overhead lines, cables and neutral conductors) is to be introduced at a higher temperature of 90 degree centigrade.

For 3-Phase, 2-Phase and 1-Phase short circuit calculations, the following color coding have been used to check the switchgear thermal withstand capability (ik”).

Green: OK

Red: Switchgear exposed to 100% of its rated limit under 3-phase, 2-Phase & 1-phase fault conditions.

All MV and LV buses RMS and Peak short-circuit capacity has been considered as per the associated breaker.

Following operating scenarios have been simulated for short circuit calculations:

Table 3.2-2 Short Circuit Calculations Operational Cases

Case	2 MVA Diesel Engine [Qty]	11 kV Generation Bus Coupler	Interconnection of Solar Plant
1A	4	ON	YES
1B	4	OFF	YES
2A	5	ON	NO
2B	5	OFF	NO
3A	6	ON	NO
3B	6	OFF	NO

For Phase-Phase faults, the contribution of fault current is mainly from generating source. In SECMC network, diesel generators and solar plant are the main sources to fault current. Moreover, from load side, dynamic nature of loads, also contribute in case of phase faults.

In earth faults, the contribution of fault current is the grounding source. In SECMC network, 11 kV system is grounded via Arc Suppression Coil having 50A neutral point current maximum limit of reactance. Therefore, the magnitude of earth fault current in this case cannot exceed 50A. Moreover, line capacitive earth currents are also considerable in the network due to huge lengths installed in the system. Further, LV level is completely solidly grounded and would have earth fault current of higher magnitude as compare to 11 kV earth fault current.

3.3 3-Phase Maximum Short Circuit Results

3-Phase short circuit results at different bus bars are given below:

For detailed results please refer Annex-A.

Case – 1A

Results of Buses:

Table 3.3-1 3-Phase Maximum Results (1A)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	I _k " [kA]	i _p [kA]	I _k "/I _k "max [%]
1	504 S/S MV	11	31.5	78.8	3.3	6.8	10.5
2	505 S/S MV	11	31.5	78.8	4.6	8.8	14.6
3	506 S/S MV	11	31.5	78.8	5.0	9.7	15.8
4	507 S/S MV	11	31.5	78.8	4.3	9.0	13.6
5	508 S/S MV	11	31.5	78.8	5.6	11.7	17.7
6	509 S/S MV	11	31.5	78.8	6.0	13.2	18.9
7	510 S/S MV	11	31.5	78.8	6.1	13.8	19.3
8	511 S/S MV	11	31.5	78.8	5.4	11.7	17.0
9	512 S/S MV	11	31.5	78.8	4.6	9.8	14.7
10	513 S/S MV	11	31.5	78.8	4.1	8.6	13.1
11	514 S/S MV	11	31.5	78.8	4.9	9.5	15.5
12	515 S/S MV	11	31.5	78.8	3.7	7.3	11.6
13	518 S/S MV	11	31.5	78.8	3.6	7.4	11.3
14	519 S/S MV	11	31.5	78.8	4.5	8.2	14.1
15	521 S/S MV	11	31.5	78.8	3.8	7.6	12.1
16	522 S/S MV	11	31.5	78.8	4.4	8.5	13.8
17	BUFFER PUMP-I	11	31.5	78.8	5.0	10.4	15.7
18	CHINESE COLONY MV	11	31.5	78.8	6.7	14.8	21.1
19	COMP. PUMP STATION MV-I	11	31.5	78.8	6.3	12.5	20.1
20	CONVEYOR BELT MV	11	31.5	78.8	6.7	15.0	21.2
21	CRUSHING STATION MV	11	31.5	78.8	6.8	14.8	21.5
22	DIESEL STORAGE AREA MV	11	31.5	78.8	6.7	14.1	21.3
23	DRIVER'S COLONY MV	11	31.5	78.8	6.7	14.8	21.1
24	Generation Bus-I	11	31.5	78.8	7.3	17.9	23.1
25	Generation Bus-II	11	31.5	78.8	7.3	17.9	23.1
26	KIOSK 1 & 2 MV	11	20.0	50.0	4.7	9.1	23.4
27	KIOSK 3 & 4 MV	11	20.0	50.0	4.7	9.1	23.4
28	LINE-01 BUS	11	31.5	78.8	7.2	17.7	23.0
29	LINE-02 BUS	11	31.5	78.8	7.2	17.7	23.0
30	Load Bus-I	11	31.5	78.8	7.3	17.9	23.1

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	Ip [kA]	Ik" [kA]	ip [kA]	
31	Load Bus-II	11	31.5	78.8	7.3	17.9	23.1
32	MSF MV	11	31.5	78.8	7.0	16.1	22.4
33	OWNER'S COLONY MV	11	31.5	78.8	5.8	10.6	18.4
34	PAKISTAN COLONY MV	11	31.5	78.8	5.8	10.4	18.3
35	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.3	29.2	26.8
36	504 S/S LV	0.69	42.0	94.5	11.3	29.2	26.8
37	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	14.2	36.1	33.7
38	505 S/S LV	0.69	42.0	94.5	14.2	36.1	33.7
39	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.0	33.8	30.9
40	506 S/S LV	0.69	42.0	94.5	13.0	33.8	30.9
41	507 S/S LV	0.69	42.0	94.5	12.2	32.2	29.1
42	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	14.4	37.6	34.3
43	508 S/S LV	0.69	42.0	94.5	14.4	37.6	34.3
44	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.6	36.3	32.5
45	509 S/S LV	0.69	42.0	94.5	13.6	36.3	32.5
46	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	10.2	18.3	24.3
47	510 S/S LV	0.69	42.0	94.5	13.5	36.1	32.1
48	511 S/S LV	0.69	42.0	94.5	14.1	37.0	33.5
49	512 S/S LV	0.69	42.0	94.5	13.8	36.1	32.9
50	513 S/S LV	0.69	42.0	94.5	13.6	35.3	32.5
51	514 S/S LV	0.69	42.0	94.5	13.4	34.6	31.9
52	515 S/S LV	0.69	42.0	94.5	11.2	29.2	26.8
53	518 S/S MV	0.69	42.0	94.5	36.7	85.7	87.4
54	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.9	8.2	5.9
55	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.6	9.7	7.1
56	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	8.4	6.0
57	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.6	9.7	7.1
58	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	8.5	6.0
59	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.5	8.7	6.9
60	519 S/S LV	0.4	50.0	112.5	27.8	69.7	55.6
61	521 S/S LV	0.4	50.0	112.5	28.6	71.9	57.1

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	Ip [kA]	Ik" [kA]	ip [kA]	
62	522 S/S LV	0.4	50.0	112.5	15.8	42.1	31.6
63	BUFFER PUMP-I LV	0.4	50.0	112.5	28.3	71.8	56.7
64	BUFFER PUMP-II LV	0.4	50.0	112.5	28.3	71.8	56.7
65	CHINESE COLONY LV	0.4	50.0	112.5	24.7	67.2	49.4
66	COMP. PUMP STATION LV-I	0.4	50.0	112.5	32.5	84.3	65.0
67	COMP. PUMP STATION LV-II	0.4	50.0	112.5	32.5	84.3	65.0
68	CONVEYOR BELT LV	0.4	50.0	112.5	40.0	105.6	79.9
69	CRUSHING STATION LV	0.4	50.0	112.5	40.1	105.4	80.2
70	DIESEL STORAGE AREA LV	0.4	50.0	112.5	19.4	50.6	38.7
71	DRIVER'S COLONY LV	0.4	50.0	112.5	35.2	94.4	70.3
72	MSF LV	0.4	50.0	112.5	25.2	68.8	50.4
73	OWNER'S COLONY LV	0.4	50.0	112.5	24.4	63.3	48.8
74	PAKISTAN COLONY LV	0.4	50.0	112.5	39.8	98.0	79.7

Case – 1B

Results of Buses:

Table 3.3-2 3-Phase Maximum Results (1B)

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	Ik" [kA]	ip [kA]	
1	504 S/S MV	11	31.5	78.8	2.4	5.4	7.7
2	505 S/S MV	11	31.5	78.8	3.2	6.6	10.1
3	506 S/S MV	11	31.5	78.8	3.3	7.1	10.6
4	507 S/S MV	11	31.5	78.8	2.8	6.4	8.9
5	508 S/S MV	11	31.5	78.8	3.5	7.9	11.2
6	509 S/S MV	11	31.5	78.8	3.6	8.5	11.5
7	510 S/S MV	11	31.5	78.8	3.7	8.7	11.7
8	511 S/S MV	11	31.5	78.8	3.4	7.9	10.9
9	512 S/S MV	11	31.5	78.8	3.1	7.1	10.0
10	513 S/S MV	11	31.5	78.8	2.9	6.4	9.2
11	514 S/S MV	11	31.5	78.8	3.3	7.0	10.4
12	515 S/S MV	11	31.5	78.8	2.6	5.6	8.2
13	518 S/S MV	11	31.5	78.8	2.6	5.8	8.2
14	519 S/S MV	11	31.5	78.8	3.1	6.3	9.9
15	521 S/S MV	11	31.5	78.8	2.7	5.8	8.4
16	522 S/S MV	11	31.5	78.8	2.8	6.0	8.8
17	BUFFER PUMP-I	11	31.5	78.8	3.3	7.3	10.4

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	Ik" [kA]	ip [kA]	Ik"/Ik"max [%]
18	CHINESE COLONY MV	11	31.5	78.8	3.2	7.4	10.1
19	COMP. PUMP STATION MV-I	11	31.5	78.8	3.7	8.0	11.8
20	CONVEYOR BELT MV	11	31.5	78.8	3.2	7.5	10.1
21	CRUSHING STATION MV	11	31.5	78.8	3.2	7.4	10.2
22	DIESEL STORAGE AREA MV	11	31.5	78.8	3.8	8.6	12.1
23	DRIVER'S COLONY MV	11	31.5	78.8	3.2	7.4	10.1
24	Generation Bus-I	11	31.5	78.8	4.0	9.8	12.6
25	Generation Bus-II	11	31.5	78.8	3.3	8.1	10.5
26	KIOSK 1 & 2 MV	11	20.0	50.0	3.1	6.5	15.4
27	KIOSK 3 & 4 MV	11	20.0	50.0	2.7	5.7	13.4
28	LINE-01 BUS	11	31.5	78.8	4.0	9.7	12.6
29	LINE-02 BUS	11	31.5	78.8	3.3	8.1	10.5
30	Load Bus-I	11	31.5	78.8	4.0	9.8	12.6
31	Load Bus-II	11	31.5	78.8	3.3	8.1	10.5
32	MSF MV	11	31.5	78.8	3.3	7.7	10.4
33	OWNER'S COLONY MV	11	31.5	78.8	3.5	7.1	11.2
34	PAKISTAN COLONY MV	11	31.5	78.8	3.5	7.1	11.2
35	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	10.5	27.5	25.1
36	504 S/S LV	0.69	42.0	94.5	10.5	27.5	25.1
37	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.4	34.1	31.9
38	505 S/S LV	0.69	42.0	94.5	13.4	34.1	31.9
39	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.2	31.8	29.1
40	506 S/S LV	0.69	42.0	94.5	12.2	31.8	29.1
41	507 S/S LV	0.69	42.0	94.5	11.4	29.9	27.1
42	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.6	35.4	32.3
43	508 S/S LV	0.69	42.0	94.5	13.6	35.4	32.3
44	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.8	33.9	30.5
45	509 S/S LV	0.69	42.0	94.5	12.8	33.9	30.5
46	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.8	17.7	23.2
47	510 S/S LV	0.69	42.0	94.5	12.7	33.6	30.1
48	511 S/S LV	0.69	42.0	94.5	13.3	34.7	31.6
49	512 S/S LV	0.69	42.0	94.5	13.1	33.9	31.1
50	513 S/S LV	0.69	42.0	94.5	12.9	33.3	30.7
51	514 S/S LV	0.69	42.0	94.5	12.7	32.7	30.1

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	i _p [kA]	I _k " [kA]	i _p [kA]	I _k "/I _k "max [%]
52	515 S/S LV	0.69	42.0	94.5	10.5	27.3	24.9
53	518 S/S MV	0.69	42.0	94.5	32.2	76.2	76.8
54	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.9	8.1	5.8
	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.5	9.6	7.1
55	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	8.3	6.0
	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.5	9.7	7.1
56	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	8.4	6.0
	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.4	8.6	6.9
57	519 S/S LV	0.4	50.0	112.5	25.9	65.0	51.8
58	521 S/S LV	0.4	50.0	112.5	26.5	66.8	53.0
59	522 S/S LV	0.4	50.0	112.5	14.7	39.1	29.4
60	BUFFER PUMP-I LV	0.4	50.0	112.5	27.4	69.0	54.7
61	BUFFER PUMP-II LV	0.4	50.0	112.5	27.4	69.0	54.7
62	CHINESE COLONY LV	0.4	50.0	112.5	21.7	58.0	43.3
63	COMP. PUMP STATION LV-I	0.4	50.0	112.5	29.3	75.3	58.5
	COMP. PUMP STATION LV-II	0.4	50.0	112.5	29.3	75.3	58.5
64	CONVEYOR BELT LV	0.4	50.0	112.5	33.6	86.9	67.1
65	CRUSHING STATION LV	0.4	50.0	112.5	33.6	86.8	67.3
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	18.7	48.5	37.3
	DRIVER'S COLONY LV	0.4	50.0	112.5	29.1	76.7	58.1
67	MSF LV	0.4	50.0	112.5	22.1	59.3	44.2
68	OWNER'S COLONY LV	0.4	50.0	112.5	22.2	57.3	44.5
69	PAKISTAN COLONY LV	0.4	50.0	112.5	34.2	84.2	68.4

Case – 2A

Results of Buses:

Table 3.3-3 3-Phase Maximum Results (2A)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	I _k " [kA]	i _p [kA]	I _k "/I _k "max [%]
1	504 S/S MV	11	31.5	78.8	3.4	6.9	10.9
2	505 S/S MV	11	31.5	78.8	4.9	9.1	15.4
3	506 S/S MV	11	31.5	78.8	5.3	10.2	16.8
4	507 S/S MV	11	31.5	78.8	4.5	9.3	14.2
5	508 S/S MV	11	31.5	78.8	6.0	12.4	18.9
6	509 S/S MV	11	31.5	78.8	6.4	14.1	20.4
7	510 S/S MV	11	31.5	78.8	6.6	14.8	20.9
8	511 S/S MV	11	31.5	78.8	5.7	12.4	18.2
9	512 S/S MV	11	31.5	78.8	4.9	10.3	15.5
10	513 S/S MV	11	31.5	78.8	4.3	9.0	13.7
11	514 S/S MV	11	31.5	78.8	5.2	9.9	16.4
12	515 S/S MV	11	31.5	78.8	3.8	7.4	12.0
13	518 S/S MV	11	31.5	78.8	3.7	7.5	11.7
14	519 S/S MV	11	31.5	78.8	4.7	8.5	14.8
15	521 S/S MV	11	31.5	78.8	3.9	7.8	12.5
16	522 S/S MV	11	31.5	78.8	4.6	8.8	14.5
17	BUFFER PUMP-I	11	31.5	78.8	5.3	11.0	16.7
18	CHINESE COLONY MV	11	31.5	78.8	7.3	16.2	23.1
19	COMP. PUMP STATION MV-I	11	31.5	78.8	6.9	13.4	21.9
20	CONVEYOR BELT MV	11	31.5	78.8	7.3	16.3	23.2
21	CRUSHING STATION MV	11	31.5	78.8	7.4	16.1	23.5
22	DIESEL STORAGE AREA MV	11	31.5	78.8	7.3	15.3	23.2
23	DRIVER'S COLONY MV	11	31.5	78.8	7.3	16.2	23.1
24	Generation Bus-I	11	31.5	78.8	8.0	19.8	25.5
25	Generation Bus-II	11	31.5	78.8	8.0	19.8	25.5
26	Load Bus-I	11	31.5	78.8	8.0	19.8	25.5
27	Load Bus-II	11	31.5	78.8	8.0	19.8	25.5
28	MSF MV	11	31.5	78.8	7.8	17.7	24.6
29	OWNER'S COLONY MV	11	31.5	78.8	6.3	11.2	19.9
30	PAKISTAN COLONY MV	11	31.5	78.8	6.2	11.0	19.7
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.3	29.4	27.0
32	504 S/S LV	0.69	42.0	94.5	11.3	29.4	27.0
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	14.2	36.4	33.9

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	I _k " [kA]	i _p [kA]	I _k "/I _k "max [%]
34	505 S/S LV	0.69	42.0	94.5	14.2	36.4	33.9
	506 S/S 100 KVA TF						
35	(690V)	0.69	42.0	94.5	13.1	34.0	31.2
36	506 S/S LV	0.69	42.0	94.5	13.1	34.0	31.2
37	507 S/S LV	0.69	42.0	94.5	12.3	32.4	29.3
	508 S/S 100 KVA TF						
38	(690V)	0.69	42.0	94.5	14.5	37.9	34.5
39	508 S/S LV	0.69	42.0	94.5	14.5	37.9	34.5
	509 S/S 100 KVA TF						
40	(690V)	0.69	42.0	94.5	13.7	36.6	32.7
41	509 S/S LV	0.69	42.0	94.5	13.7	36.6	32.7
	510 S/S 100 KVA TF						
42	(690V)	0.69	42.0	94.5	10.3	18.4	24.5
43	510 S/S LV	0.69	42.0	94.5	13.6	36.4	32.3
44	511 S/S LV	0.69	42.0	94.5	14.1	37.3	33.7
45	512 S/S LV	0.69	42.0	94.5	13.9	36.4	33.2
46	513 S/S LV	0.69	42.0	94.5	13.7	35.6	32.7
47	514 S/S LV	0.69	42.0	94.5	13.5	34.9	32.2
48	515 S/S LV	0.69	42.0	94.5	11.3	29.4	26.9
49	518 S/S MV	0.69	42.0	94.5	37.1	86.5	88.4
	504 S/S 100 KVA TF						
50	(400V)	0.4	50.0	112.5	2.9	8.2	5.9
	505 S/S 100 KVA TF						
51	(400V)	0.4	50.0	112.5	3.6	9.7	7.1
	506 S/S 100 KVA TF						
52	(400V)	0.4	50.0	112.5	3.0	8.4	6.0
	508 S/S 100 KVA TF						
53	(400V)	0.4	50.0	112.5	3.6	9.7	7.1
	509 S/S 100 KVA TF						
54	(400V)	0.4	50.0	112.5	3.0	8.5	6.1
	510 S/S 100 KVA TF						
55	(400V)	0.4	50.0	112.5	3.5	8.7	6.9
56	519 S/S LV	0.4	50.0	112.5	28.1	70.3	56.1
57	521 S/S LV	0.4	50.0	112.5	28.7	72.3	57.5
58	522 S/S LV	0.4	50.0	112.5	15.9	42.4	31.8
59	BUFFER PUMP-I LV	0.4	50.0	112.5	28.5	72.1	56.9
60	BUFFER PUMP-II LV	0.4	50.0	112.5	28.5	72.1	56.9
61	CHINESE COLONY LV	0.4	50.0	112.5	25.0	68.1	50.0
	COMP. PUMP STATION						
62	LV-I	0.4	50.0	112.5	32.9	85.5	65.9
	COMP. PUMP STATION						
63	LV-II	0.4	50.0	112.5	32.9	85.5	65.9
64	CONVEYOR BELT LV	0.4	50.0	112.5	40.6	107.5	81.2

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	I _k " [kA]	i _p [kA]	I _k "/I _k "max [%]
65	CRUSHING STATION LV	0.4	50.0	112.5	40.7	107.3	81.4
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	19.4	50.9	38.9
67	DRIVER'S COLONY LV	0.4	50.0	112.5	35.7	96.3	71.5
68	MSF LV	0.4	50.0	112.5	25.5	69.7	51.0
69	OWNER'S COLONY LV	0.4	50.0	112.5	24.7	64.1	49.3
70	PAKISTAN COLONY LV	0.4	50.0	112.5	40.6	99.9	81.2

Case – 2B

Results of Buses:

Table 3.3-4 3-Phase Maximum Results (2B)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	i _p [kA]	I _k " [kA]	i _p [kA]	I _k "/I _k "max [%]
1	504 S/S MV	11	31.5	78.8	2.4	5.3	7.6
2	505 S/S MV	11	31.5	78.8	3.6	7.4	11.5
3	506 S/S MV	11	31.5	78.8	3.8	8.0	12.2
4	507 S/S MV	11	31.5	78.8	2.7	6.3	8.7
5	508 S/S MV	11	31.5	78.8	4.1	9.1	13.1
6	509 S/S MV	11	31.5	78.8	4.3	9.9	13.6
7	510 S/S MV	11	31.5	78.8	4.4	10.2	13.8
8	511 S/S MV	11	31.5	78.8	4.0	9.1	12.7
9	512 S/S MV	11	31.5	78.8	3.6	8.0	11.4
10	513 S/S MV	11	31.5	78.8	3.3	7.2	10.4
11	514 S/S MV	11	31.5	78.8	3.8	7.8	12.0
12	515 S/S MV	11	31.5	78.8	2.5	5.5	8.1
13	518 S/S MV	11	31.5	78.8	2.5	5.7	8.0
14	519 S/S MV	11	31.5	78.8	3.5	7.0	11.2
15	521 S/S MV	11	31.5	78.8	2.6	5.7	8.3
16	522 S/S MV	11	31.5	78.8	2.7	5.9	8.6
17	BUFFER PUMP-I	11	31.5	78.8	3.8	8.3	12.0
18	CHINESE COLONY MV	11	31.5	78.8	3.1	7.2	9.8
19	COMP. PUMP STATION MV-I	11	31.5	78.8	4.4	9.4	14.1
20	CONVEYOR BELT MV	11	31.5	78.8	3.1	7.2	9.8
21	CRUSHING STATION MV	11	31.5	78.8	3.1	7.2	9.9
22	DIESEL STORAGE AREA MV	11	31.5	78.8	4.6	10.2	14.6
23	DRIVER'S COLONY MV	11	31.5	78.8	3.1	7.2	9.8
24	Generation Bus-I	11	31.5	78.8	4.8	12.0	15.3

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	Ik" [kA]	ip [kA]	
25	Generation Bus-II	11	31.5	78.8	3.2	7.8	10.2
26	Load Bus-I	11	31.5	78.8	4.8	12.0	15.3
27	Load Bus-II	11	31.5	78.8	3.2	7.8	10.2
28	MSF MV	11	31.5	78.8	3.2	7.5	10.0
29	OWNER'S COLONY MV	11	31.5	78.8	4.2	8.2	13.3
30	PAKISTAN COLONY MV	11	31.5	78.8	4.2	8.2	13.2
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	10.5	27.3	25.0
32	504 S/S LV	0.69	42.0	94.5	10.5	27.3	25.0
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.7	34.9	32.6
34	505 S/S LV	0.69	42.0	94.5	13.7	34.9	32.6
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.5	32.6	29.8
36	506 S/S LV	0.69	42.0	94.5	12.5	32.6	29.8
37	507 S/S LV	0.69	42.0	94.5	11.3	29.7	26.9
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.9	36.3	33.1
39	508 S/S LV	0.69	42.0	94.5	13.9	36.3	33.1
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.1	34.8	31.3
41	509 S/S LV	0.69	42.0	94.5	13.1	34.8	31.3
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.9	17.9	23.7
43	510 S/S LV	0.69	42.0	94.5	13.0	34.6	30.9
44	511 S/S LV	0.69	42.0	94.5	13.6	35.6	32.3
45	512 S/S LV	0.69	42.0	94.5	13.4	34.8	31.8
46	513 S/S LV	0.69	42.0	94.5	13.2	34.1	31.4
47	514 S/S LV	0.69	42.0	94.5	12.9	33.4	30.8
48	515 S/S LV	0.69	42.0	94.5	10.4	27.2	24.8
49	518 S/S MV	0.69	42.0	94.5	32.0	75.7	76.2
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.9	8.1	5.8
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.5	9.6	7.1
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	8.3	6.0
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.6	9.7	7.1
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	8.4	6.0
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.4	8.7	6.9
56	519 S/S LV	0.4	50.0	112.5	26.6	66.9	53.2

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	Ik" [kA]	ip [kA]	
57	521 S/S LV	0.4	50.0	112.5	26.4	66.5	52.7
58	522 S/S LV	0.4	50.0	112.5	14.6	38.9	29.2
59	BUFFER PUMP-I LV	0.4	50.0	112.5	27.7	70.1	55.5
60	BUFFER PUMP-II LV	0.4	50.0	112.5	27.7	70.1	55.5
61	CHINESE COLONY LV	0.4	50.0	112.5	21.5	57.5	43.0
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	30.5	78.7	60.9
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	30.5	78.7	60.9
64	CONVEYOR BELT LV	0.4	50.0	112.5	33.2	86.0	66.4
65	CRUSHING STATION LV	0.4	50.0	112.5	33.3	85.9	66.6
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	18.9	49.3	37.9
67	DRIVER'S COLONY LV	0.4	50.0	112.5	28.7	75.8	57.5
68	MSF LV	0.4	50.0	112.5	21.9	58.8	43.9
69	OWNER'S COLONY LV	0.4	50.0	112.5	23.0	59.6	46.1
70	PAKISTAN COLONY LV	0.4	50.0	112.5	36.2	89.4	72.4

Case – 3A

Results of Buses:

Table 3.3-5 3-Phase Maximum Results (3A)

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	Ik" [kA]	ip [kA]	
1	504 S/S MV	11	31.5	78.8	3.5	7.0	11.2
2	505 S/S MV	11	31.5	78.8	5.1	9.5	16.3
3	506 S/S MV	11	31.5	78.8	5.6	10.7	17.8
4	507 S/S MV	11	31.5	78.8	4.7	9.6	14.9
5	508 S/S MV	11	31.5	78.8	6.4	13.1	20.4
6	509 S/S MV	11	31.5	78.8	7.0	15.2	22.1
7	510 S/S MV	11	31.5	78.8	7.2	16.0	22.7
8	511 S/S MV	11	31.5	78.8	6.1	13.2	19.5
9	512 S/S MV	11	31.5	78.8	5.2	10.8	16.5
10	513 S/S MV	11	31.5	78.8	4.5	9.4	14.4
11	514 S/S MV	11	31.5	78.8	5.5	10.3	17.4
12	515 S/S MV	11	31.5	78.8	3.9	7.6	12.4
13	518 S/S MV	11	31.5	78.8	3.6	6.9	11.4
14	519 S/S MV	11	31.5	78.8	4.9	8.9	15.6
15	521 S/S MV	11	31.5	78.8	4.1	8.0	12.9

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	Ik" [kA]	ip [kA]	
16	522 S/S MV	11	31.5	78.8	4.8	9.1	15.2
17	BUFFER PUMP-I	11	31.5	78.8	5.6	11.6	17.8
18	CHINESE COLONY MV	11	31.5	78.8	8.1	17.8	25.6
19	COMP. PUMP STATION MV-I	11	31.5	78.8	7.6	14.5	24.0
20	CONVEYOR BELT MV	11	31.5	78.8	8.1	17.9	25.7
21	CRUSHING STATION MV	11	31.5	78.8	8.2	17.7	26.1
22	DIESEL STORAGE AREA MV	11	31.5	78.8	8.1	16.7	25.7
23	DRIVER'S COLONY MV	11	31.5	78.8	8.1	17.7	25.6
24	Generation Bus-I	11	31.5	78.8	9.0	22.3	28.6
25	Generation Bus-II	11	31.5	78.8	9.0	22.3	28.6
26	Load Bus-I	11	31.5	78.8	9.0	22.3	28.6
27	Load Bus-II	11	31.5	78.8	9.0	22.3	28.6
28	MSF MV	11	31.5	78.8	8.6	19.6	27.4
29	OWNER'S COLONY MV	11	31.5	78.8	6.8	12.0	21.6
30	PAKISTAN COLONY MV	11	31.5	78.8	6.7	11.7	21.3
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.4	29.5	27.1
32	504 S/S LV	0.69	42.0	94.5	11.4	29.5	27.1
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	14.3	36.6	34.1
34	505 S/S LV	0.69	42.0	94.5	14.3	36.6	34.1
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.2	34.3	31.4
36	506 S/S LV	0.69	42.0	94.5	13.2	34.3	31.4
37	507 S/S LV	0.69	42.0	94.5	12.4	32.6	29.5
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	14.6	38.2	34.7
39	508 S/S LV	0.69	42.0	94.5	14.6	38.2	34.7
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.8	36.9	33.0
41	509 S/S LV	0.69	42.0	94.5	13.8	36.9	33.0
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	10.3	18.5	24.6
43	510 S/S LV	0.69	42.0	94.5	13.7	36.7	32.6
44	511 S/S LV	0.69	42.0	94.5	14.2	37.6	33.9
45	512 S/S LV	0.69	42.0	94.5	14.0	36.6	33.4
46	513 S/S LV	0.69	42.0	94.5	13.8	35.8	32.9
47	514 S/S LV	0.69	42.0	94.5	13.6	35.2	32.4
48	515 S/S LV	0.69	42.0	94.5	11.4	29.5	27.1
49	518 S/S MV	0.69	42.0	94.5	37.2	83.4	88.5

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	Ik" [kA]	ip [kA]	
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.9	8.2	5.9
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.6	9.7	7.1
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	8.4	6.0
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.6	9.7	7.1
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	8.5	6.1
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.5	8.7	6.9
56	519 S/S LV	0.4	50.0	112.5	28.3	70.9	56.6
57	521 S/S LV	0.4	50.0	112.5	28.9	72.8	57.9
58	522 S/S LV	0.4	50.0	112.5	16.0	42.6	32.0
59	BUFFER PUMP-I LV	0.4	50.0	112.5	28.6	72.5	57.1
60	BUFFER PUMP-II LV	0.4	50.0	112.5	28.6	72.5	57.1
61	CHINESE COLONY LV	0.4	50.0	112.5	25.3	69.0	50.6
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	33.4	86.8	66.7
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	33.4	86.8	66.7
64	CONVEYOR BELT LV	0.4	50.0	112.5	41.2	109.4	82.5
65	CRUSHING STATION LV	0.4	50.0	112.5	41.4	109.2	82.7
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	19.5	51.1	39.0
67	DRIVER'S COLONY LV	0.4	50.0	112.5	36.4	98.2	72.7
68	MSF LV	0.4	50.0	112.5	25.8	70.7	51.6
69	OWNER'S COLONY LV	0.4	50.0	112.5	25.0	64.9	49.9
70	PAKISTAN COLONY LV	0.4	50.0	112.5	41.4	102.0	82.8

Case – 3B

Results of Buses:

Table 3.3-6 3-Phase Maximum Results (3B)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	I _k " [kA]	I _p [kA]	I _k "/I _k "max [%]
1	504 S/S MV	11	31.5	78.8	2.7	5.8	8.6
2	505 S/S MV	11	31.5	78.8	3.6	7.4	11.5
3	506 S/S MV	11	31.5	78.8	3.8	8.0	12.2
4	507 S/S MV	11	31.5	78.8	3.2	7.2	10.2
5	508 S/S MV	11	31.5	78.8	4.1	9.1	13.1
6	509 S/S MV	11	31.5	78.8	4.3	9.9	13.6
7	510 S/S MV	11	31.5	78.8	4.4	10.2	13.8
8	511 S/S MV	11	31.5	78.8	4.0	9.1	12.7
9	512 S/S MV	11	31.5	78.8	3.6	8.0	11.4
10	513 S/S MV	11	31.5	78.8	3.3	7.2	10.4
11	514 S/S MV	11	31.5	78.8	3.8	7.8	12.0
12	515 S/S MV	11	31.5	78.8	2.9	6.1	9.2
13	518 S/S MV	11	31.5	78.8	2.8	5.8	8.9
14	519 S/S MV	11	31.5	78.8	3.5	7.0	11.2
15	521 S/S MV	11	31.5	78.8	3.0	6.4	9.5
16	522 S/S MV	11	31.5	78.8	3.2	6.7	10.2
17	BUFFER PUMP-I	11	31.5	78.8	3.8	8.3	12.0
18	CHINESE COLONY MV	11	31.5	78.8	4.0	9.2	12.6
19	COMP. PUMP STATION MV-I	11	31.5	78.8	4.4	9.4	14.1
20	CONVEYOR BELT MV	11	31.5	78.8	4.0	9.3	12.6
21	CRUSHING STATION MV	11	31.5	78.8	4.0	9.2	12.7
22	DIESEL STORAGE AREA MV	11	31.5	78.8	4.6	10.2	14.6
23	DRIVER'S COLONY MV	11	31.5	78.8	4.0	9.2	12.6
24	Generation Bus-I	11	31.5	78.8	4.8	12.0	15.3
25	Generation Bus-II	11	31.5	78.8	4.2	10.3	13.2
26	Load Bus-I	11	31.5	78.8	4.8	12.0	15.3
27	Load Bus-II	11	31.5	78.8	4.2	10.3	13.2
28	MSF MV	11	31.5	78.8	4.1	9.7	13.0
29	OWNER'S COLONY MV	11	31.5	78.8	4.2	8.2	13.3
30	PAKISTAN COLONY MV	11	31.5	78.8	4.2	8.2	13.2
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	10.8	28.1	25.7
32	504 S/S LV	0.69	42.0	94.5	10.8	28.1	25.7
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.7	34.9	32.6

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	I _k " [kA]	I _p [kA]	I _k "/I _k "max [%]
34	505 S/S LV	0.69	42.0	94.5	13.7	34.9	32.6
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.5	32.6	29.8
36	506 S/S LV	0.69	42.0	94.5	12.5	32.6	29.8
37	507 S/S LV	0.69	42.0	94.5	11.7	30.7	27.8
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.9	36.3	33.1
39	508 S/S LV	0.69	42.0	94.5	13.9	36.3	33.1
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.1	34.8	31.3
41	509 S/S LV	0.69	42.0	94.5	13.1	34.8	31.3
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.9	17.9	23.7
43	510 S/S LV	0.69	42.0	94.5	13.0	34.6	30.9
44	511 S/S LV	0.69	42.0	94.5	13.6	35.6	32.3
45	512 S/S LV	0.69	42.0	94.5	13.4	34.8	31.8
46	513 S/S LV	0.69	42.0	94.5	13.2	34.1	31.4
47	514 S/S LV	0.69	42.0	94.5	12.9	33.4	30.8
48	515 S/S LV	0.69	42.0	94.5	10.8	28.0	25.6
49	518 S/S MV	0.69	42.0	94.5	33.6	76.7	79.9
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.9	8.2	5.8
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.5	9.6	7.1
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	8.3	6.0
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.6	9.7	7.1
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	8.4	6.0
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.4	8.7	6.9
56	519 S/S LV	0.4	50.0	112.5	26.6	66.9	53.2
57	521 S/S LV	0.4	50.0	112.5	27.2	68.6	54.5
58	522 S/S LV	0.4	50.0	112.5	15.1	40.2	30.2
59	BUFFER PUMP-I LV	0.4	50.0	112.5	27.7	70.1	55.5
60	BUFFER PUMP-II LV	0.4	50.0	112.5	27.7	70.1	55.5
61	CHINESE COLONY LV	0.4	50.0	112.5	22.7	61.2	45.4
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	30.5	78.7	60.9
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	30.5	78.7	60.9
64	CONVEYOR BELT LV	0.4	50.0	112.5	35.7	93.3	71.4

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I_k'' [kA]	I_p [kA]	I_k'' [kA]	I_p [kA]	$I_k''/I_k''_{max}$ [%]
65	CRUSHING STATION LV	0.4	50.0	112.5	35.8	93.1	71.6
	DIESEL STORAGE AREA						
66	LV	0.4	50.0	112.5	18.9	49.3	37.9
67	DRIVER'S COLONY LV	0.4	50.0	112.5	31.1	82.7	62.2
68	MSF LV	0.4	50.0	112.5	23.2	62.7	46.4
69	OWNER'S COLONY LV	0.4	50.0	112.5	23.0	59.6	46.1
70	PAKISTAN COLONY LV	0.4	50.0	112.5	36.2	89.4	72.4

3.4 3-Phase Minimum Short Circuit Results

3-Phase Minimum short circuit results at different bus bars are given below:

For detailed results please refer Annex-A.

Case – 1A

Results of Buses:

Table 3.4-1 3-Phase Minimum Results (1A)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	Ik" [kA]	ip [kA]	Ik"/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	1.9	3.9	6.0
2	505 S/S MV	11	31.5	78.8	2.7	5.4	8.5
3	506 S/S MV	11	31.5	78.8	2.8	5.8	8.9
4	507 S/S MV	11	31.5	78.8	2.3	5.0	7.4
5	508 S/S MV	11	31.5	78.8	3.0	6.7	9.7
6	509 S/S MV	11	31.5	78.8	3.2	7.4	10.2
7	510 S/S MV	11	31.5	78.8	3.3	7.7	10.4
8	511 S/S MV	11	31.5	78.8	3.0	6.8	9.4
9	512 S/S MV	11	31.5	78.8	2.7	6.0	8.5
10	513 S/S MV	11	31.5	78.8	2.5	5.4	7.9
11	514 S/S MV	11	31.5	78.8	2.8	5.6	8.8
12	515 S/S MV	11	31.5	78.8	2.0	4.1	6.4
13	518 S/S MV	11	31.5	78.8	1.9	3.9	6.1
14	519 S/S MV	11	31.5	78.8	2.6	5.0	8.2
15	521 S/S MV	11	31.5	78.8	2.1	4.2	6.6
16	522 S/S MV	11	31.5	78.8	2.4	5.0	7.7
17	BUFFER PUMP-I	11	31.5	78.8	2.8	6.2	9.0
18	CHINESE COLONY MV	11	31.5	78.8	3.5	8.4	11.3
19	COMP. PUMP STATION MV-I	11	31.5	78.8	3.4	7.3	10.9
20	CONVEYOR BELT MV	11	31.5	78.8	3.5	8.4	11.3
21	CRUSHING STATION MV	11	31.5	78.8	3.6	8.3	11.3
22	DIESEL STORAGE AREA MV	11	31.5	78.8	3.6	8.0	11.3
23	DRIVER'S COLONY MV	11	31.5	78.8	3.5	8.4	11.3
24	Generation Bus-I	11	31.5	78.8	3.7	9.5	11.9
25	Generation Bus-II	11	31.5	78.8	3.7	9.5	11.9
26	KIOSK 1 & 2 MV	11	20.0	50.0	2.9	5.9	14.3
27	KIOSK 3 & 4 MV	11	20.0	50.0	2.9	5.9	14.3
28	LINE-01 BUS	11	31.5	78.8	3.7	9.5	11.8
29	LINE-02 BUS	11	31.5	78.8	3.7	9.5	11.8
30	Load Bus-I	11	31.5	78.8	3.7	9.5	11.9
31	Load Bus-II	11	31.5	78.8	3.7	9.5	11.9

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	Ik" [kA]	ip [kA]	
32	MSF MV	11	31.5	78.8	3.7	8.9	11.6
33	OWNER'S COLONY MV	11	31.5	78.8	3.3	6.4	10.4
34	PAKISTAN COLONY MV	11	31.5	78.8	3.2	6.3	10.3
35	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.6	19.5	18.2
36	504 S/S LV	0.69	42.0	94.5	7.6	19.5	18.2
37	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.3	21.6	19.8
38	505 S/S LV	0.69	42.0	94.5	8.3	21.6	19.8
39	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.4	22.0	20.0
40	506 S/S LV	0.69	42.0	94.5	8.4	22.0	20.0
41	507 S/S LV	0.69	42.0	94.5	8.1	21.1	19.2
42	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.5	22.8	20.3
43	508 S/S LV	0.69	42.0	94.5	8.5	22.8	20.3
44	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.6	23.3	20.5
45	509 S/S LV	0.69	42.0	94.5	8.6	23.3	20.5
46	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.7	12.0	16.0
47	510 S/S LV	0.69	42.0	94.5	8.6	23.5	20.5
48	511 S/S LV	0.69	42.0	94.5	8.5	22.9	20.2
49	512 S/S LV	0.69	42.0	94.5	8.3	22.2	19.8
50	513 S/S LV	0.69	42.0	94.5	8.2	21.6	19.4
51	514 S/S LV	0.69	42.0	94.5	8.4	21.9	20.0
52	515 S/S LV	0.69	42.0	94.5	7.8	19.9	18.6
53	518 S/S MV	0.69	42.0	94.5	15.5	35.8	36.8
54	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.6	4.7
55	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.7	4.8
56	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.7	4.8
57	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.8	4.8
58	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.8	4.8
59	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.3	5.9	4.7
60	519 S/S LV	0.4	50.0	112.5	17.2	43.1	34.4
61	521 S/S LV	0.4	50.0	112.5	16.1	40.3	32.2
62	522 S/S LV	0.4	50.0	112.5	12.0	31.5	24.0
63	BUFFER PUMP-I LV	0.4	50.0	112.5	12.0	32.4	24.0
64	BUFFER PUMP-II LV	0.4	50.0	112.5	12.0	32.4	24.0
65	CHINESE COLONY LV	0.4	50.0	112.5	18.3	49.7	36.6
66	COMP. PUMP STATION LV-I	0.4	50.0	112.5	21.7	56.4	43.4
67	COMP. PUMP STATION LV-II	0.4	50.0	112.5	21.7	56.4	43.4
68	CONVEYOR BELT LV	0.4	50.0	112.5	25.6	68.5	51.3
69	CRUSHING STATION LV	0.4	50.0	112.5	25.7	68.3	51.4
70	DIESEL STORAGE AREA LV	0.4	50.0	112.5	10.2	28.1	20.5
71	DRIVER'S COLONY LV	0.4	50.0	112.5	25.6	68.5	51.3

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	Ik" [kA]	ip [kA]	Ik"/Ik"max [%]
27	KIOSK 3 & 4 MV	11	20.0	50.0	1.6	3.7	8.2
28	LINE-01 BUS	11	31.5	78.8	1.9	4.7	5.9
29	LINE-02 BUS	11	31.5	78.8	1.9	4.8	5.9
30	Load Bus-I	11	31.5	78.8	1.9	4.8	5.9
31	Load Bus-II	11	31.5	78.8	1.9	4.8	5.9
32	MSF MV	11	31.5	78.8	1.9	4.6	5.9
33	OWNER'S COLONY MV	11	31.5	78.8	1.8	3.8	5.6
34	PAKISTAN COLONY MV	11	31.5	78.8	1.7	3.8	5.5
35	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.7	17.0	15.9
36	504 S/S LV	0.69	42.0	94.5	6.7	17.0	15.9
37	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.2	18.6	17.2
38	505 S/S LV	0.69	42.0	94.5	7.2	18.6	17.2
39	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.3	19.0	17.3
40	506 S/S LV	0.69	42.0	94.5	7.3	19.0	17.3
41	507 S/S LV	0.69	42.0	94.5	7.0	18.3	16.7
42	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.4	19.5	17.5
43	508 S/S LV	0.69	42.0	94.5	7.4	19.5	17.5
44	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.4	19.9	17.6
45	509 S/S LV	0.69	42.0	94.5	7.4	19.9	17.6
46	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.0	11.0	14.3
47	510 S/S LV	0.69	42.0	94.5	7.4	20.1	17.7
48	511 S/S LV	0.69	42.0	94.5	7.3	19.6	17.4
49	512 S/S LV	0.69	42.0	94.5	7.2	19.1	17.1
50	513 S/S LV	0.69	42.0	94.5	7.1	18.7	16.9
51	514 S/S LV	0.69	42.0	94.5	7.3	18.9	17.3
52	515 S/S LV	0.69	42.0	94.5	6.8	17.3	16.2
53	518 S/S MV	0.69	42.0	94.5	12.0	28.4	28.6
54	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.3	6.4	4.6
55	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.3	6.5	4.7
56	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.3	6.5	4.7
57	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.6	4.7
58	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.6	4.7

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	I _k " [kA]	I _p [kA]	I _k "/I _k "max [%]
59	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.3	5.8	4.6
60	519 S/S LV	0.4	50.0	112.5	14.5	36.4	29.0
61	521 S/S LV	0.4	50.0	112.5	13.7	34.4	27.4
62	522 S/S LV	0.4	50.0	112.5	10.6	27.8	21.3
63	BUFFER PUMP-I LV	0.4	50.0	112.5	10.6	28.4	21.3
64	BUFFER PUMP-II LV	0.4	50.0	112.5	10.6	28.4	21.3
65	CHINESE COLONY LV	0.4	50.0	112.5	15.3	41.1	30.6
66	COMP. PUMP STATION LV-I	0.4	50.0	112.5	17.6	45.5	35.1
67	COMP. PUMP STATION LV-II	0.4	50.0	112.5	17.6	45.5	35.1
68	CONVEYOR BELT LV	0.4	50.0	112.5	20.1	53.1	40.2
69	CRUSHING STATION LV	0.4	50.0	112.5	20.1	53.0	40.3
70	DIESEL STORAGE AREA LV	0.4	50.0	112.5	9.2	25.1	18.4
71	DRIVER'S COLONY LV	0.4	50.0	112.5	20.1	53.1	40.2
72	MSF LV	0.4	50.0	112.5	15.4	41.5	30.8
73	OWNER'S COLONY LV	0.4	50.0	112.5	15.2	38.9	30.3
74	PAKISTAN COLONY LV	0.4	50.0	112.5	21.8	53.5	43.6

Case – 2A

Results of Buses:

Table 3.4-3 3-Phase Minimum Results (2A)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	I _k " [kA]	I _p [kA]	I _k "/I _k "max [%]
1	504 S/S MV	11	31.5	78.8	2.0	4.1	6.4
2	505 S/S MV	11	31.5	78.8	3.0	5.9	9.5
3	506 S/S MV	11	31.5	78.8	3.2	6.4	10.1
4	507 S/S MV	11	31.5	78.8	2.6	5.4	8.2
5	508 S/S MV	11	31.5	78.8	3.5	7.5	11.0
6	509 S/S MV	11	31.5	78.8	3.7	8.4	11.7
7	510 S/S MV	11	31.5	78.8	3.8	8.8	11.9
8	511 S/S MV	11	31.5	78.8	3.4	7.7	10.7
9	512 S/S MV	11	31.5	78.8	3.0	6.6	9.6
10	513 S/S MV	11	31.5	78.8	2.7	5.9	8.7
11	514 S/S MV	11	31.5	78.8	3.1	6.2	9.9
12	515 S/S MV	11	31.5	78.8	2.2	4.4	7.0
13	518 S/S MV	11	31.5	78.8	2.1	4.2	6.6
14	519 S/S MV	11	31.5	78.8	2.9	5.5	9.2

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	Ik" [kA]	Ip [kA]	Ik"/Ik"max [%]
15	521 S/S MV	11	31.5	78.8	2.3	4.5	7.2
16	522 S/S MV	11	31.5	78.8	2.7	5.4	8.6
17	BUFFER PUMP-I	11	31.5	78.8	3.2	6.9	10.1
18	CHINESE COLONY MV	11	31.5	78.8	4.1	9.7	13.1
19	COMP. PUMP STATION MV-I	11	31.5	78.8	4.0	8.3	12.7
20	CONVEYOR BELT MV	11	31.5	78.8	4.1	9.7	13.1
21	CRUSHING STATION MV	11	31.5	78.8	4.2	9.6	13.3
22	DIESEL STORAGE AREA MV	11	31.5	78.8	4.1	9.2	13.2
23	DRIVER'S COLONY MV	11	31.5	78.8	4.1	9.7	13.1
24	Generation Bus-I	11	31.5	78.8	4.4	11.3	14.0
25	Generation Bus-II	11	31.5	78.8	4.4	11.3	14.0
26	Load Bus-I	11	31.5	78.8	4.4	11.3	14.0
27	Load Bus-II	11	31.5	78.8	4.4	11.3	14.0
28	MSF MV	11	31.5	78.8	4.3	10.3	13.7
29	OWNER'S COLONY MV	11	31.5	78.8	3.7	7.2	11.9
30	PAKISTAN COLONY MV	11	31.5	78.8	3.7	7.0	11.8
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.8	19.9	18.6
32	504 S/S LV	0.69	42.0	94.5	7.8	19.9	18.6
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.5	22.1	20.3
34	505 S/S LV	0.69	42.0	94.5	8.5	22.1	20.3
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.6	22.6	20.5
36	506 S/S LV	0.69	42.0	94.5	8.6	22.6	20.5
37	507 S/S LV	0.69	42.0	94.5	8.2	21.6	19.6
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.7	23.4	20.8
39	508 S/S LV	0.69	42.0	94.5	8.7	23.4	20.8
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.8	24.0	21.0
41	509 S/S LV	0.69	42.0	94.5	8.8	24.0	21.0
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.8	12.1	16.3
43	510 S/S LV	0.69	42.0	94.5	8.8	24.2	21.0
44	511 S/S LV	0.69	42.0	94.5	8.7	23.5	20.7
45	512 S/S LV	0.69	42.0	94.5	8.5	22.7	20.3
46	513 S/S LV	0.69	42.0	94.5	8.4	22.1	19.9
47	514 S/S LV	0.69	42.0	94.5	8.6	22.4	20.5
48	515 S/S LV	0.69	42.0	94.5	8.0	20.3	19.0

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	I _k " [kA]	I _p [kA]	I _k "/I _k "max [%]
49	518 S/S MV	0.69	42.0	94.5	16.2	37.3	38.5
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.6	4.8
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.7	4.8
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.8	4.8
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.8	4.8
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.8	4.9
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	5.9	4.7
56	519 S/S LV	0.4	50.0	112.5	17.7	44.3	35.4
57	521 S/S LV	0.4	50.0	112.5	16.5	41.4	33.0
58	522 S/S LV	0.4	50.0	112.5	12.3	32.1	24.5
59	BUFFER PUMP-I LV	0.4	50.0	112.5	12.3	33.1	24.5
60	BUFFER PUMP-II LV	0.4	50.0	112.5	12.3	33.1	24.5
61	CHINESE COLONY LV	0.4	50.0	112.5	18.9	51.4	37.8
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	22.5	58.6	45.0
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	22.5	58.6	45.0
64	CONVEYOR BELT LV	0.4	50.0	112.5	26.8	71.7	53.5
65	CRUSHING STATION LV	0.4	50.0	112.5	26.8	71.5	53.7
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	10.4	28.6	20.8
67	DRIVER'S COLONY LV	0.4	50.0	112.5	26.8	71.7	53.5
68	MSF LV	0.4	50.0	112.5	19.0	52.1	38.0
69	OWNER'S COLONY LV	0.4	50.0	112.5	18.7	48.0	37.4
70	PAKISTAN COLONY LV	0.4	50.0	112.5	29.9	72.5	59.8

Case – 2B

Results of Buses:

Table 3.4-4 3-Phase Minimum Results (2B)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	Ik" [kA]	ip [kA]	Ik"/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	1.2	2.7	3.8
2	505 S/S MV	11	31.5	78.8	2.1	4.4	6.6
3	506 S/S MV	11	31.5	78.8	2.2	4.6	6.8
4	507 S/S MV	11	31.5	78.8	1.4	3.2	4.4
5	508 S/S MV	11	31.5	78.8	2.3	5.2	7.2
6	509 S/S MV	11	31.5	78.8	2.4	5.6	7.5
7	510 S/S MV	11	31.5	78.8	2.4	5.8	7.6
8	511 S/S MV	11	31.5	78.8	2.2	5.3	7.1
9	512 S/S MV	11	31.5	78.8	2.1	4.8	6.6
10	513 S/S MV	11	31.5	78.8	1.9	4.4	6.2
11	514 S/S MV	11	31.5	78.8	2.1	4.6	6.8
12	515 S/S MV	11	31.5	78.8	1.3	2.8	4.0
13	518 S/S MV	11	31.5	78.8	1.2	2.7	3.9
14	519 S/S MV	11	31.5	78.8	2.0	4.1	6.4
15	521 S/S MV	11	31.5	78.8	1.3	2.8	4.1
16	522 S/S MV	11	31.5	78.8	1.4	3.1	4.5
17	BUFFER PUMP-I	11	31.5	78.8	2.2	4.9	6.9
18	CHINESE COLONY MV	11	31.5	78.8	1.7	4.2	5.5
19	COMP. PUMP STATION MV-I	11	31.5	78.8	2.5	5.6	7.9
20	CONVEYOR BELT MV	11	31.5	78.8	1.7	4.2	5.5
21	CRUSHING STATION MV	11	31.5	78.8	1.7	4.2	5.5
22	DIESEL STORAGE AREA MV	11	31.5	78.8	2.6	5.9	8.1
23	DRIVER'S COLONY MV	11	31.5	78.8	1.7	4.2	5.5
24	Generation Bus-I	11	31.5	78.8	2.6	6.8	8.4
25	Generation Bus-II	11	31.5	78.8	1.8	4.5	5.6
26	Load Bus-I	11	31.5	78.8	2.6	6.8	8.4
27	Load Bus-II	11	31.5	78.8	1.8	4.5	5.6
28	MSF MV	11	31.5	78.8	1.7	4.3	5.5
29	OWNER'S COLONY MV	11	31.5	78.8	2.4	5.1	7.6
30	PAKISTAN COLONY MV	11	31.5	78.8	2.4	5.0	7.6
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.6	16.8	15.7
32	504 S/S LV	0.69	42.0	94.5	6.6	16.8	15.7
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.8	20.3	18.6

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	Ik" [kA]	ip [kA]	Ik"/Ik"max [%]
34	505 S/S LV	0.69	42.0	94.5	7.8	20.3	18.6
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.9	20.7	18.8
36	506 S/S LV	0.69	42.0	94.5	7.9	20.7	18.8
37	507 S/S LV	0.69	42.0	94.5	6.9	18.0	16.4
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.0	21.4	19.1
39	508 S/S LV	0.69	42.0	94.5	8.0	21.4	19.1
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.1	21.8	19.2
41	509 S/S LV	0.69	42.0	94.5	8.1	21.8	19.2
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.4	11.6	15.3
43	510 S/S LV	0.69	42.0	94.5	8.1	22.0	19.2
44	511 S/S LV	0.69	42.0	94.5	8.0	21.4	18.9
45	512 S/S LV	0.69	42.0	94.5	7.8	20.8	18.6
46	513 S/S LV	0.69	42.0	94.5	7.7	20.3	18.3
47	514 S/S LV	0.69	42.0	94.5	7.9	20.5	18.8
48	515 S/S LV	0.69	42.0	94.5	6.7	17.1	16.0
49	518 S/S MV	0.69	42.0	94.5	11.7	27.7	27.8
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.3	6.4	4.6
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.6	4.8
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.6	4.8
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.7	4.8
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.7	4.8
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.3	5.8	4.6
56	519 S/S LV	0.4	50.0	112.5	16.0	40.1	31.9
57	521 S/S LV	0.4	50.0	112.5	13.5	33.8	26.9
58	522 S/S LV	0.4	50.0	112.5	10.5	27.4	21.0
59	BUFFER PUMP-I LV	0.4	50.0	112.5	11.4	30.6	22.8
60	BUFFER PUMP-II LV	0.4	50.0	112.5	11.4	30.6	22.8
61	CHINESE COLONY LV	0.4	50.0	112.5	15.0	40.3	30.0
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	19.8	51.4	39.6
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	19.8	51.4	39.6
64	CONVEYOR BELT LV	0.4	50.0	112.5	19.6	51.7	39.1

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik"	ip	Ik"	ip	
			[kA]	[kA]	[kA]	[kA]	
65	CRUSHING STATION LV	0.4	50.0	112.5	19.6	51.6	39.2
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	9.8	26.8	19.6
67	DRIVER'S COLONY LV	0.4	50.0	112.5	19.6	51.7	39.1
68	MSF LV	0.4	50.0	112.5	15.1	40.7	30.2
69	OWNER'S COLONY LV	0.4	50.0	112.5	16.8	43.1	33.6
70	PAKISTAN COLONY LV	0.4	50.0	112.5	25.3	61.8	50.6

Case – 3A

Results of Buses:

Table 3.4-5 3-Phase Minimum Results (3A)

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik"	ip	Ik"	Ip	
			[kA]	[kA]	[kA]	[kA]	
1	504 S/S MV	11	31.5	78.8	2.2	4.4	7.0
2	505 S/S MV	11	31.5	78.8	3.3	6.4	10.6
3	506 S/S MV	11	31.5	78.8	3.6	7.0	11.4
4	507 S/S MV	11	31.5	78.8	2.8	5.9	9.0
5	508 S/S MV	11	31.5	78.8	4.0	8.5	12.7
6	509 S/S MV	11	31.5	78.8	4.3	9.6	13.6
7	510 S/S MV	11	31.5	78.8	4.4	10.2	13.9
8	511 S/S MV	11	31.5	78.8	3.9	8.6	12.3
9	512 S/S MV	11	31.5	78.8	3.4	7.3	10.8
10	513 S/S MV	11	31.5	78.8	3.1	6.5	9.7
11	514 S/S MV	11	31.5	78.8	3.5	6.8	11.2
12	515 S/S MV	11	31.5	78.8	2.4	4.7	7.6
13	518 S/S MV	11	31.5	78.8	2.1	3.9	6.8
14	519 S/S MV	11	31.5	78.8	3.2	5.9	10.2
15	521 S/S MV	11	31.5	78.8	2.5	4.8	7.8
16	522 S/S MV	11	31.5	78.8	3.0	5.9	9.5
17	BUFFER PUMP-I	11	31.5	78.8	3.6	7.7	11.5
18	CHINESE COLONY MV	11	31.5	78.8	4.9	11.3	15.6
19	COMP. PUMP STATION MV-I	11	31.5	78.8	4.7	9.4	14.9
20	CONVEYOR BELT MV	11	31.5	78.8	4.9	11.3	15.6
21	CRUSHING STATION MV	11	31.5	78.8	5.0	11.2	15.7
22	DIESEL STORAGE AREA MV	11	31.5	78.8	4.9	10.6	15.6
23	DRIVER'S COLONY MV	11	31.5	78.8	4.9	11.3	15.6
24	Generation Bus-I	11	31.5	78.8	5.3	13.5	16.8

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	i _p [kA]	I _k " [kA]	i _p [kA]	I _k "/I _k "max [%]
25	Generation Bus-II	11	31.5	78.8	5.3	13.5	16.8
26	Load Bus-I	11	31.5	78.8	5.3	13.5	16.8
27	Load Bus-II	11	31.5	78.8	5.3	13.5	16.8
28	MSF MV	11	31.5	78.8	5.1	12.2	16.3
29	OWNER'S COLONY MV	11	31.5	78.8	4.3	8.0	13.7
30	PAKISTAN COLONY MV	11	31.5	78.8	4.3	7.9	13.6
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.0	20.3	19.0
32	504 S/S LV	0.69	42.0	94.5	8.0	20.3	19.0
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.7	22.6	20.8
34	505 S/S LV	0.69	42.0	94.5	8.7	22.6	20.8
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.8	23.1	21.0
36	506 S/S LV	0.69	42.0	94.5	8.8	23.1	21.0
37	507 S/S LV	0.69	42.0	94.5	8.4	22.1	20.1
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.9	24.0	21.3
39	508 S/S LV	0.69	42.0	94.5	8.9	24.0	21.3
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.0	24.6	21.5
41	509 S/S LV	0.69	42.0	94.5	9.0	24.6	21.5
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.0	12.3	16.6
43	510 S/S LV	0.69	42.0	94.5	9.0	24.8	21.5
44	511 S/S LV	0.69	42.0	94.5	8.9	24.1	21.2
45	512 S/S LV	0.69	42.0	94.5	8.7	23.3	20.7
46	513 S/S LV	0.69	42.0	94.5	8.5	22.7	20.3
47	514 S/S LV	0.69	42.0	94.5	8.8	23.0	20.9
48	515 S/S LV	0.69	42.0	94.5	8.2	20.7	19.4
49	518 S/S MV	0.69	42.0	94.5	16.6	35.6	39.5
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.6	4.8
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.8	4.8
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.8	4.9
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.8	4.9
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.8	4.9
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	5.9	4.7
56	519 S/S LV	0.4	50.0	112.5	18.2	45.5	36.4
57	521 S/S LV	0.4	50.0	112.5	16.9	42.4	33.9
58	522 S/S LV	0.4	50.0	112.5	12.5	32.8	25.0
59	BUFFER PUMP-I LV	0.4	50.0	112.5	12.5	33.7	25.0
60	BUFFER PUMP-II LV	0.4	50.0	112.5	12.5	33.7	25.0
61	CHINESE COLONY LV	0.4	50.0	112.5	19.4	53.0	38.9
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	23.3	60.7	46.6
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	23.3	60.7	46.6

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	Ik" [kA]	Ip [kA]	Ik"/Ik"max [%]
64	CONVEYOR BELT LV	0.4	50.0	112.5	27.9	74.9	55.8
65	CRUSHING STATION LV	0.4	50.0	112.5	28.0	74.7	56.0
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	10.6	29.1	21.1
67	DRIVER'S COLONY LV	0.4	50.0	112.5	27.9	74.9	55.8
68	MSF LV	0.4	50.0	112.5	19.6	53.8	39.2
69	OWNER'S COLONY LV	0.4	50.0	112.5	19.2	49.5	38.5
70	PAKISTAN COLONY LV	0.4	50.0	112.5	31.3	75.8	62.7

Case – 3B

Results of Buses:

Table 3.4-6 3-Phase Minimum Results (3B)

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	Ip [kA]	Ik" [kA]	ip [kA]	
1	504 S/S MV	11	31.5	78.8	1.6	3.3	4.9
2	505 S/S MV	11	31.5	78.8	2.1	4.4	6.6
3	506 S/S MV	11	31.5	78.8	2.2	4.6	6.8
4	507 S/S MV	11	31.5	78.8	1.9	4.1	5.9
5	508 S/S MV	11	31.5	78.8	2.3	5.2	7.2
6	509 S/S MV	11	31.5	78.8	2.4	5.6	7.5
7	510 S/S MV	11	31.5	78.8	2.4	5.8	7.6
8	511 S/S MV	11	31.5	78.8	2.2	5.3	7.1
9	512 S/S MV	11	31.5	78.8	2.1	4.8	6.6
10	513 S/S MV	11	31.5	78.8	1.9	4.4	6.2
11	514 S/S MV	11	31.5	78.8	2.1	4.6	6.8
12	515 S/S MV	11	31.5	78.8	1.7	3.5	5.3
13	518 S/S MV	11	31.5	78.8	1.5	3.0	4.9
14	519 S/S MV	11	31.5	78.8	2.0	4.1	6.4
15	521 S/S MV	11	31.5	78.8	1.7	3.6	5.4
16	522 S/S MV	11	31.5	78.8	1.9	4.1	6.1
17	BUFFER PUMP-I	11	31.5	78.8	2.2	4.9	6.9
18	CHINESE COLONY MV	11	31.5	78.8	2.5	6.2	8.1
19	COMP. PUMP STATION MV-I	11	31.5	78.8	2.5	5.6	7.9
20	CONVEYOR BELT MV	11	31.5	78.8	2.5	6.2	8.1
21	CRUSHING STATION MV	11	31.5	78.8	2.6	6.1	8.1
22	DIESEL STORAGE AREA MV	11	31.5	78.8	2.6	5.9	8.1

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	I _k " [kA]	i _p [kA]	I _k "/I _k "max [%]
23	DRIVER'S COLONY MV	11	31.5	78.8	2.5	6.2	8.1
24	Generation Bus-I	11	31.5	78.8	2.6	6.8	8.4
25	Generation Bus-II	11	31.5	78.8	2.6	6.8	8.4
26	Load Bus-I	11	31.5	78.8	2.6	6.8	8.4
27	Load Bus-II	11	31.5	78.8	2.6	6.8	8.4
28	MSF MV	11	31.5	78.8	2.6	6.4	8.3
29	OWNER'S COLONY MV	11	31.5	78.8	2.4	5.1	7.6
30	PAKISTAN COLONY MV	11	31.5	78.8	2.4	5.0	7.6
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.2	18.4	17.2
32	504 S/S LV	0.69	42.0	94.5	7.2	18.4	17.2
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.8	20.3	18.6
34	505 S/S LV	0.69	42.0	94.5	7.8	20.3	18.6
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.9	20.7	18.8
36	506 S/S LV	0.69	42.0	94.5	7.9	20.7	18.8
37	507 S/S LV	0.69	42.0	94.5	7.6	19.9	18.1
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.0	21.4	19.1
39	508 S/S LV	0.69	42.0	94.5	8.0	21.4	19.1
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.1	21.8	19.2
41	509 S/S LV	0.69	42.0	94.5	8.1	21.8	19.2
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.4	11.6	15.3
43	510 S/S LV	0.69	42.0	94.5	8.1	22.0	19.2
44	511 S/S LV	0.69	42.0	94.5	8.0	21.4	18.9
45	512 S/S LV	0.69	42.0	94.5	7.8	20.8	18.6
46	513 S/S LV	0.69	42.0	94.5	7.7	20.3	18.3
47	514 S/S LV	0.69	42.0	94.5	7.9	20.5	18.8
48	515 S/S LV	0.69	42.0	94.5	7.4	18.7	17.5
49	518 S/S MV	0.69	42.0	94.5	13.6	30.1	32.5
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.3	6.5	4.7
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.6	4.8
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.6	4.8
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.7	4.8
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.4	6.7	4.8

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	I _k " [kA]	i _p [kA]	I _k "/I _k "max [%]
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.3	5.8	4.6
56	519 S/S LV	0.4	50.0	112.5	16.0	40.1	31.9
57	521 S/S LV	0.4	50.0	112.5	15.0	37.6	30.0
58	522 S/S LV	0.4	50.0	112.5	11.4	29.8	22.8
59	BUFFER PUMP-I LV	0.4	50.0	112.5	11.4	30.6	22.8
60	BUFFER PUMP-II LV	0.4	50.0	112.5	11.4	30.6	22.8
61	CHINESE COLONY LV	0.4	50.0	112.5	16.9	45.8	33.9
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	19.8	51.4	39.6
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	19.8	51.4	39.6
64	CONVEYOR BELT LV	0.4	50.0	112.5	23.0	61.2	46.0
65	CRUSHING STATION LV	0.4	50.0	112.5	23.1	61.0	46.1
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	9.8	26.8	19.6
67	DRIVER'S COLONY LV	0.4	50.0	112.5	23.0	61.2	46.0
68	MSF LV	0.4	50.0	112.5	17.0	46.3	34.1
69	OWNER'S COLONY LV	0.4	50.0	112.5	16.8	43.1	33.6
70	PAKISTAN COLONY LV	0.4	50.0	112.5	25.3	61.8	50.6

3.5 2-Phase Maximum Short Circuit Results

2-Phase Maximum short circuit results at different bus bars are given below:

For detailed results please refer Annex-A.

Case – 1A

Results of Buses:

Table 3.5-1 2-Phase Maximum Results (1A)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	2.9	2.9	9.1
2	505 S/S MV	11	31.5	78.8	4.0	4.0	12.7
3	506 S/S MV	11	31.5	78.8	4.3	4.3	13.7
4	507 S/S MV	11	31.5	78.8	3.7	3.7	11.8
5	508 S/S MV	11	31.5	78.8	4.8	4.8	15.3
6	509 S/S MV	11	31.5	78.8	5.2	5.2	16.4
7	510 S/S MV	11	31.5	78.8	5.3	5.3	16.7
8	511 S/S MV	11	31.5	78.8	4.6	4.6	14.7
9	512 S/S MV	11	31.5	78.8	4.0	4.0	12.7
10	513 S/S MV	11	31.5	78.8	3.6	3.6	11.3
11	514 S/S MV	11	31.5	78.8	4.2	4.2	13.4
12	515 S/S MV	11	31.5	78.8	3.2	3.2	10.1
13	518 S/S MV	11	31.5	78.8	3.1	3.1	9.8
14	519 S/S MV	11	31.5	78.8	3.9	3.9	12.2
15	521 S/S MV	11	31.5	78.8	3.3	3.3	10.4
16	522 S/S MV	11	31.5	78.8	3.8	3.8	12.0
17	BUFFER PUMP-I	11	31.5	78.8	4.3	4.3	13.6
18	CHINESE COLONY MV	11	31.5	78.8	5.8	5.8	18.3
19	COMP. PUMP STATION MV-I	11	31.5	78.8	5.5	5.5	17.4
20	CONVEYOR BELT MV	11	31.5	78.8	5.8	5.8	18.4
21	CRUSHING STATION MV	11	31.5	78.8	5.9	5.9	18.6
22	DIESEL STORAGE AREA MV	11	31.5	78.8	5.8	5.8	18.4
23	DRIVER'S COLONY MV	11	31.5	78.8	5.8	5.8	18.3
24	Generation Bus-I	11	31.5	78.8	6.3	6.3	20.0
25	Generation Bus-II	11	31.5	78.8	6.3	6.3	20.0
26	KIOSK 1 & 2 MV	11	20.0	50.0	4.1	4.1	20.3
27	KIOSK 3 & 4 MV	11	20.0	50.0	4.1	4.1	20.3
28	LINE-01 BUS	11	31.5	78.8	6.3	6.3	19.9
29	LINE-02 BUS	11	31.5	78.8	6.3	6.3	19.9
30	Load Bus-I	11	31.5	78.8	6.3	6.3	20.0

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	
31	Load Bus-II	11	31.5	78.8	6.3	6.3	20.0
32	MSF MV	11	31.5	78.8	6.1	6.1	19.4
33	OWNER'S COLONY MV	11	31.5	78.8	5.0	5.0	16.0
34	PAKISTAN COLONY MV	11	31.5	78.8	5.0	5.0	15.8
35	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.8	9.8	23.2
36	504 S/S LV	0.69	42.0	94.5	9.8	9.8	23.2
37	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.3	12.3	29.2
38	505 S/S LV	0.69	42.0	94.5	12.3	12.3	29.2
39	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.3	11.3	26.8
40	506 S/S LV	0.69	42.0	94.5	11.3	11.3	26.8
41	507 S/S LV	0.69	42.0	94.5	10.6	10.6	25.2
42	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.5	12.5	29.7
43	508 S/S LV	0.69	42.0	94.5	12.5	12.5	29.7
44	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.8	11.8	28.1
45	509 S/S LV	0.69	42.0	94.5	11.8	11.8	28.1
46	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.9	8.9	21.1
47	510 S/S LV	0.69	42.0	94.5	11.7	11.7	27.8
48	511 S/S LV	0.69	42.0	94.5	12.2	12.2	29.0
49	512 S/S LV	0.69	42.0	94.5	12.0	12.0	28.5
50	513 S/S LV	0.69	42.0	94.5	11.8	11.8	28.1
51	514 S/S LV	0.69	42.0	94.5	11.6	11.6	27.7
52	515 S/S LV	0.69	42.0	94.5	9.7	9.7	23.2
53	518 S/S MV	0.69	42.0	94.5	31.8	31.8	75.7
54	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.5	2.5	5.1
55	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.1	3.1	6.2
56	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.6	2.6	5.2
57	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.1	3.1	6.2
58	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.6	2.6	5.2
59	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	3.0	6.0
60	519 S/S LV	0.4	50.0	112.5	24.1	24.1	48.2
61	521 S/S LV	0.4	50.0	112.5	24.7	24.7	49.5
62	522 S/S LV	0.4	50.0	112.5	13.7	13.7	27.4
63	BUFFER PUMP-I LV	0.4	50.0	112.5	24.5	24.5	49.1
64	BUFFER PUMP-II LV	0.4	50.0	112.5	24.5	24.5	49.1
65	CHINESE COLONY LV	0.4	50.0	112.5	21.4	21.4	42.8
66	COMP. PUMP STATION LV-I	0.4	50.0	112.5	28.2	28.2	56.3
67	COMP. PUMP STATION LV-II	0.4	50.0	112.5	28.2	28.2	56.3
68	CONVEYOR BELT LV	0.4	50.0	112.5	34.6	34.6	69.2
69	CRUSHING STATION LV	0.4	50.0	112.5	34.7	34.7	69.4

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
70	DIESEL STORAGE AREA LV	0.4	50.0	112.5	16.8	16.8	33.5
71	DRIVER'S COLONY LV	0.4	50.0	112.5	30.4	30.4	60.9
72	MSF LV	0.4	50.0	112.5	21.8	21.8	43.7
73	OWNER'S COLONY LV	0.4	50.0	112.5	21.1	21.1	42.3
74	PAKISTAN COLONY LV	0.4	50.0	112.5	34.5	34.5	69.0

Case – 1B

Results of Buses:

Table 3.5-2 2-Phase Maximum Results (1B)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	2.1	2.1	6.7
2	505 S/S MV	11	31.5	78.8	2.7	2.7	8.7
3	506 S/S MV	11	31.5	78.8	2.9	2.9	9.2
4	507 S/S MV	11	31.5	78.8	2.4	2.4	7.7
5	508 S/S MV	11	31.5	78.8	3.1	3.1	9.7
6	509 S/S MV	11	31.5	78.8	3.2	3.2	10.0
7	510 S/S MV	11	31.5	78.8	3.2	3.2	10.1
8	511 S/S MV	11	31.5	78.8	3.0	3.0	9.4
9	512 S/S MV	11	31.5	78.8	2.7	2.7	8.6
10	513 S/S MV	11	31.5	78.8	2.5	2.5	8.0
11	514 S/S MV	11	31.5	78.8	2.8	2.8	9.0
12	515 S/S MV	11	31.5	78.8	2.2	2.2	7.1
13	518 S/S MV	11	31.5	78.8	2.2	2.2	7.1
14	519 S/S MV	11	31.5	78.8	2.7	2.7	8.5
15	521 S/S MV	11	31.5	78.8	2.3	2.3	7.3
16	522 S/S MV	11	31.5	78.8	2.4	2.4	7.6
17	BUFFER PUMP-I	11	31.5	78.8	2.8	2.8	9.0
18	CHINESE COLONY MV	11	31.5	78.8	2.8	2.8	8.7
19	COMP. PUMP STATION MV-I	11	31.5	78.8	3.2	3.2	10.2
20	CONVEYOR BELT MV	11	31.5	78.8	2.8	2.8	8.8
21	CRUSHING STATION MV	11	31.5	78.8	2.8	2.8	8.8
22	DIESEL STORAGE AREA MV	11	31.5	78.8	3.3	3.3	10.5
23	DRIVER'S COLONY MV	11	31.5	78.8	2.8	2.8	8.7
24	Generation Bus-I	11	31.5	78.8	3.4	3.4	10.9
25	Generation Bus-II	11	31.5	78.8	2.9	2.9	9.1
26	KIOSK 1 & 2 MV	11	20.0	50.0	2.7	2.7	13.3

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
27	KIOSK 3 & 4 MV	11	20.0	50.0	2.3	2.3	11.6
28	LINE-01 BUS	11	31.5	78.8	3.4	3.4	10.9
29	LINE-02 BUS	11	31.5	78.8	2.9	2.9	9.1
30	Load Bus-I	11	31.5	78.8	3.4	3.4	10.9
31	Load Bus-II	11	31.5	78.8	2.9	2.9	9.1
32	MSF MV	11	31.5	78.8	2.8	2.8	9.0
33	OWNER'S COLONY MV	11	31.5	78.8	3.1	3.1	9.7
34	PAKISTAN COLONY MV	11	31.5	78.8	3.0	3.0	9.7
35	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.1	9.1	21.7
36	504 S/S LV	0.69	42.0	94.5	9.1	9.1	21.7
37	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.6	11.6	27.6
38	505 S/S LV	0.69	42.0	94.5	11.6	11.6	27.6
39	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	10.6	10.6	25.2
40	506 S/S LV	0.69	42.0	94.5	10.6	10.6	25.2
41	507 S/S LV	0.69	42.0	94.5	9.8	9.8	23.4
42	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.8	11.8	28.0
43	508 S/S LV	0.69	42.0	94.5	11.8	11.8	28.0
44	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.1	11.1	26.4
45	509 S/S LV	0.69	42.0	94.5	11.1	11.1	26.4
46	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.5	8.5	20.1
47	510 S/S LV	0.69	42.0	94.5	11.0	11.0	26.1
48	511 S/S LV	0.69	42.0	94.5	11.5	11.5	27.3
49	512 S/S LV	0.69	42.0	94.5	11.3	11.3	27.0
50	513 S/S LV	0.69	42.0	94.5	11.2	11.2	26.6
51	514 S/S LV	0.69	42.0	94.5	11.0	11.0	26.1
52	515 S/S LV	0.69	42.0	94.5	9.1	9.1	21.6
53	518 S/S MV	0.69	42.0	94.5	27.9	27.9	66.5
54	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.5	2.5	5.0
55	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.1	3.1	6.1
56	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.6	2.6	5.2
57	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.1	3.1	6.1
58	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.6	2.6	5.2
59	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	3.0	5.9
60	519 S/S LV	0.4	50.0	112.5	22.4	22.4	44.9
61	521 S/S LV	0.4	50.0	112.5	22.9	22.9	45.9
62	522 S/S LV	0.4	50.0	112.5	12.7	12.7	25.4
63	BUFFER PUMP-I LV	0.4	50.0	112.5	23.7	23.7	47.4
64	BUFFER PUMP-II LV	0.4	50.0	112.5	23.7	23.7	47.4
65	CHINESE COLONY LV	0.4	50.0	112.5	18.8	18.8	37.5

Rated Capacity

S.No.	Bus	Network Level [kV]	Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
66	COMP. PUMP STATION LV-I	0.4	50.0	112.5	25.3	25.3	50.7
67	COMP. PUMP STATION LV-II	0.4	50.0	112.5	25.3	25.3	50.7
68	CONVEYOR BELT LV	0.4	50.0	112.5	29.1	29.1	58.1
69	CRUSHING STATION LV	0.4	50.0	112.5	29.1	29.1	58.3
70	DIESEL STORAGE AREA LV	0.4	50.0	112.5	16.2	16.2	32.3
71	DRIVER'S COLONY LV	0.4	50.0	112.5	25.2	25.2	50.3
72	MSF LV	0.4	50.0	112.5	19.1	19.1	38.3
73	OWNER'S COLONY LV	0.4	50.0	112.5	19.2	19.2	38.5
74	PAKISTAN COLONY LV	0.4	50.0	112.5	29.6	29.6	59.2

Case – 2A

Results of Buses

Table 3.5-3 2-Phase Maximum Results (2A)

		Rated Capacity					
S.No.	Bus	Network Level [kV]	Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	3.0	3.0	9.4
2	505 S/S MV	11	31.5	78.8	4.2	4.2	13.3
3	506 S/S MV	11	31.5	78.8	4.6	4.6	14.5
4	507 S/S MV	11	31.5	78.8	3.9	3.9	12.3
5	508 S/S MV	11	31.5	78.8	5.2	5.2	16.4
6	509 S/S MV	11	31.5	78.8	5.6	5.6	17.6
7	510 S/S MV	11	31.5	78.8	5.7	5.7	18.1
8	511 S/S MV	11	31.5	78.8	5.0	5.0	15.7
9	512 S/S MV	11	31.5	78.8	4.2	4.2	13.5
10	513 S/S MV	11	31.5	78.8	3.7	3.7	11.9
11	514 S/S MV	11	31.5	78.8	4.5	4.5	14.2
12	515 S/S MV	11	31.5	78.8	3.3	3.3	10.4
13	518 S/S MV	11	31.5	78.8	3.2	3.2	10.1
14	519 S/S MV	11	31.5	78.8	4.1	4.1	12.9
15	521 S/S MV	11	31.5	78.8	3.4	3.4	10.8
16	522 S/S MV	11	31.5	78.8	4.0	4.0	12.5
17	BUFFER PUMP-I	11	31.5	78.8	4.6	4.6	14.5
18	CHINESE COLONY MV	11	31.5	78.8	6.3	6.3	20.0
19	COMP. PUMP STATION MV-I	11	31.5	78.8	6.0	6.0	19.0
20	CONVEYOR BELT MV	11	31.5	78.8	6.3	6.3	20.1
		Rated Capacity					

S.No.	Bus	Network Level [kV]	Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
21	CRUSHING STATION MV	11	31.5	78.8	6.4	6.4	20.4
22	DIESEL STORAGE AREA MV	11	31.5	78.8	6.3	6.3	20.1
23	DRIVER'S COLONY MV	11	31.5	78.8	6.3	6.3	20.0
24	Generation Bus-I	11	31.5	78.8	7.0	7.0	22.1
25	Generation Bus-II	11	31.5	78.8	7.0	7.0	22.1
26	Load Bus-I	11	31.5	78.8	7.0	7.0	22.1
27	Load Bus-II	11	31.5	78.8	7.0	7.0	22.1
28	MSF MV	11	31.5	78.8	6.7	6.7	21.3
29	OWNER'S COLONY MV	11	31.5	78.8	5.4	5.4	17.2
30	PAKISTAN COLONY MV	11	31.5	78.8	5.4	5.4	17.0
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.8	9.8	23.3
32	504 S/S LV	0.69	42.0	94.5	9.8	9.8	23.3
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.3	12.3	29.4
34	505 S/S LV	0.69	42.0	94.5	12.3	12.3	29.4
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.3	11.3	27.0
36	506 S/S LV	0.69	42.0	94.5	11.3	11.3	27.0
37	507 S/S LV	0.69	42.0	94.5	10.7	10.7	25.4
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.5	12.5	29.9
39	508 S/S LV	0.69	42.0	94.5	12.5	12.5	29.9
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.9	11.9	28.3
41	509 S/S LV	0.69	42.0	94.5	11.9	11.9	28.3
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.9	8.9	21.2
43	510 S/S LV	0.69	42.0	94.5	11.8	11.8	28.0
44	511 S/S LV	0.69	42.0	94.5	12.3	12.3	29.2
45	512 S/S LV	0.69	42.0	94.5	12.1	12.1	28.7
46	513 S/S LV	0.69	42.0	94.5	11.9	11.9	28.3
47	514 S/S LV	0.69	42.0	94.5	11.7	11.7	27.8
48	515 S/S LV	0.69	42.0	94.5	9.8	9.8	23.3
49	518 S/S MV	0.69	42.0	94.5	32.2	32.2	76.6
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.6	2.6	5.1
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.1	3.1	6.2
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.6	2.6	5.2

Rated Capacity

S.No.	Bus	Network Level [kV]	Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.1	3.1	6.2
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.6	2.6	5.2
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	3.0	6.0
56	519 S/S LV	0.4	50.0	112.5	24.3	24.3	48.6
57	521 S/S LV	0.4	50.0	112.5	24.9	24.9	49.8
58	522 S/S LV	0.4	50.0	112.5	13.8	13.8	27.5
59	BUFFER PUMP-I LV	0.4	50.0	112.5	24.6	24.6	49.3
60	BUFFER PUMP-II LV	0.4	50.0	112.5	24.6	24.6	49.3
61	CHINESE COLONY LV	0.4	50.0	112.5	21.6	21.6	43.3
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	28.5	28.5	57.0
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	28.5	28.5	57.0
64	CONVEYOR BELT LV	0.4	50.0	112.5	35.1	35.1	70.3
65	CRUSHING STATION LV	0.4	50.0	112.5	35.2	35.2	70.5
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	16.8	16.8	33.7
67	DRIVER'S COLONY LV	0.4	50.0	112.5	31.0	31.0	61.9
68	MSF LV	0.4	50.0	112.5	22.1	22.1	44.2
69	OWNER'S COLONY LV	0.4	50.0	112.5	21.4	21.4	42.7
70	PAKISTAN COLONY LV	0.4	50.0	112.5	35.2	35.2	70.3

Case – 2B

Results of Buses

Table 3.5-4 2-Phase Maximum Results (2B)

Rated Capacity							
S.No.	Bus	Network Level [kV]	Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	2.1	2.1	6.6
2	505 S/S MV	11	31.5	78.8	3.1	3.1	10.0
3	506 S/S MV	11	31.5	78.8	3.3	3.3	10.5
4	507 S/S MV	11	31.5	78.8	2.4	2.4	7.5
5	508 S/S MV	11	31.5	78.8	3.6	3.6	11.3
6	509 S/S MV	11	31.5	78.8	3.7	3.7	11.8
7	510 S/S MV	11	31.5	78.8	3.8	3.8	12.0
8	511 S/S MV	11	31.5	78.8	3.5	3.5	11.0
9	512 S/S MV	11	31.5	78.8	3.1	3.1	9.9
Rated Capacity							

S.No.	Bus	Network Level [kV]	Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
10	513 S/S MV	11	31.5	78.8	2.8	2.8	9.0
11	514 S/S MV	11	31.5	78.8	3.3	3.3	10.4
12	515 S/S MV	11	31.5	78.8	2.2	2.2	7.0
13	518 S/S MV	11	31.5	78.8	2.2	2.2	7.0
14	519 S/S MV	11	31.5	78.8	3.1	3.1	9.7
15	521 S/S MV	11	31.5	78.8	2.3	2.3	7.2
16	522 S/S MV	11	31.5	78.8	2.4	2.4	7.5
17	BUFFER PUMP-I	11	31.5	78.8	3.3	3.3	10.4
18	CHINESE COLONY MV	11	31.5	78.8	2.7	2.7	8.5
19	COMP. PUMP STATION MV-I	11	31.5	78.8	3.8	3.8	12.2
20	CONVEYOR BELT MV	11	31.5	78.8	2.7	2.7	8.5
21	CRUSHING STATION MV	11	31.5	78.8	2.7	2.7	8.5
22	DIESEL STORAGE AREA MV	11	31.5	78.8	4.0	4.0	12.6
23	DRIVER'S COLONY MV	11	31.5	78.8	2.7	2.7	8.5
24	Generation Bus-I	11	31.5	78.8	4.2	4.2	13.3
25	Generation Bus-II	11	31.5	78.8	2.8	2.8	8.8
26	Load Bus-I	11	31.5	78.8	4.2	4.2	13.3
27	Load Bus-II	11	31.5	78.8	2.8	2.8	8.8
28	MSF MV	11	31.5	78.8	2.7	2.7	8.7
29	OWNER'S COLONY MV	11	31.5	78.8	3.6	3.6	11.5
30	PAKISTAN COLONY MV	11	31.5	78.8	3.6	3.6	11.5
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.1	9.1	21.7
32	504 S/S LV	0.69	42.0	94.5	9.1	9.1	21.7
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.8	11.8	28.2
34	505 S/S LV	0.69	42.0	94.5	11.8	11.8	28.2
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	10.8	10.8	25.8
36	506 S/S LV	0.69	42.0	94.5	10.8	10.8	25.8
37	507 S/S LV	0.69	42.0	94.5	9.8	9.8	23.3
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.0	12.0	28.6
39	508 S/S LV	0.69	42.0	94.5	12.0	12.0	28.6
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.4	11.4	27.1
41	509 S/S LV	0.69	42.0	94.5	11.4	11.4	27.1
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.6	8.6	20.5
43	510 S/S LV	0.69	42.0	94.5	11.2	11.2	26.7
44	511 S/S LV	0.69	42.0	94.5	11.7	11.7	28.0
45	512 S/S LV	0.69	42.0	94.5	11.6	11.6	27.6
46	513 S/S LV	0.69	42.0	94.5	11.4	11.4	27.2
47	514 S/S LV	0.69	42.0	94.5	11.2	11.2	26.7
48	515 S/S LV	0.69	42.0	94.5	9.0	9.0	21.5

Rated Capacity

S.No.	Bus	Network Level [kV]	Ik" [kA]	Ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
49	518 S/S MV	0.69	42.0	94.5	27.7	27.7	66.0
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.5	2.5	5.0
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.1	3.1	6.1
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.6	2.6	5.2
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.1	3.1	6.1
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.6	2.6	5.2
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	3.0	6.0
56	519 S/S LV	0.4	50.0	112.5	23.1	23.1	46.1
57	521 S/S LV	0.4	50.0	112.5	22.8	22.8	45.6
58	522 S/S LV	0.4	50.0	112.5	12.7	12.7	25.3
59	BUFFER PUMP-I LV	0.4	50.0	112.5	24.0	24.0	48.1
60	BUFFER PUMP-II LV	0.4	50.0	112.5	24.0	24.0	48.1
61	CHINESE COLONY LV	0.4	50.0	112.5	18.6	18.6	37.2
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	26.4	26.4	52.7
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	26.4	26.4	52.7
64	CONVEYOR BELT LV	0.4	50.0	112.5	28.8	28.8	57.5
65	CRUSHING STATION LV	0.4	50.0	112.5	28.8	28.8	57.7
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	16.4	16.4	32.8
67	DRIVER'S COLONY LV	0.4	50.0	112.5	24.9	24.9	49.8
68	MSF LV	0.4	50.0	112.5	19.0	19.0	38.0
69	OWNER'S COLONY LV	0.4	50.0	112.5	19.9	19.9	39.9
70	PAKISTAN COLONY LV	0.4	50.0	112.5	31.4	31.4	62.7

Case – 3A

Results of Buses

Table 3.5-5 2-Phase Maximum Results (3A)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	Ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	3.1	3.1	9.7
2	505 S/S MV	11	31.5	78.8	4.4	4.4	14.1
3	506 S/S MV	11	31.5	78.8	4.9	4.9	15.4
4	507 S/S MV	11	31.5	78.8	4.1	4.1	12.9
5	508 S/S MV	11	31.5	78.8	5.6	5.6	17.7
6	509 S/S MV	11	31.5	78.8	6.0	6.0	19.2
7	510 S/S MV	11	31.5	78.8	6.2	6.2	19.7
8	511 S/S MV	11	31.5	78.8	5.3	5.3	16.9
Rated Capacity							

Rated Capacity

S.No.	Bus	Network Level [kV]	Ik" [kA]	Ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
9	512 S/S MV	11	31.5	78.8	4.5	4.5	14.3
10	513 S/S MV	11	31.5	78.8	3.9	3.9	12.5
11	514 S/S MV	11	31.5	78.8	4.7	4.7	15.1
12	515 S/S MV	11	31.5	78.8	3.4	3.4	10.8
13	518 S/S MV	11	31.5	78.8	3.1	3.1	9.9
14	519 S/S MV	11	31.5	78.8	4.3	4.3	13.6
15	521 S/S MV	11	31.5	78.8	3.5	3.5	11.2
16	522 S/S MV	11	31.5	78.8	4.1	4.1	13.2
17	BUFFER PUMP-I	11	31.5	78.8	4.9	4.9	15.4
18	CHINESE COLONY MV	11	31.5	78.8	7.0	7.0	22.2
19	COMP. PUMP STATION MV-I	11	31.5	78.8	6.6	6.6	20.8
20	CONVEYOR BELT MV	11	31.5	78.8	7.0	7.0	22.2
21	CRUSHING STATION MV	11	31.5	78.8	7.1	7.1	22.6
22	DIESEL STORAGE AREA MV	11	31.5	78.8	7.0	7.0	22.3
23	DRIVER'S COLONY MV	11	31.5	78.8	7.0	7.0	22.1
24	Generation Bus-I	11	31.5	78.8	7.8	7.8	24.7
25	Generation Bus-II	11	31.5	78.8	7.8	7.8	24.7
26	Load Bus-I	11	31.5	78.8	7.8	7.8	24.7
27	Load Bus-II	11	31.5	78.8	7.8	7.8	24.7
28	MSF MV	11	31.5	78.8	7.5	7.5	23.8
29	OWNER'S COLONY MV	11	31.5	78.8	5.9	5.9	18.7
30	PAKISTAN COLONY MV	11	31.5	78.8	5.8	5.8	18.5
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.9	9.9	23.5
32	504 S/S LV	0.69	42.0	94.5	9.9	9.9	23.5
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.4	12.4	29.6
34	505 S/S LV	0.69	42.0	94.5	12.4	12.4	29.6
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.4	11.4	27.2
36	506 S/S LV	0.69	42.0	94.5	11.4	11.4	27.2
37	507 S/S LV	0.69	42.0	94.5	10.7	10.7	25.5
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.6	12.6	30.1
39	508 S/S LV	0.69	42.0	94.5	12.6	12.6	30.1
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.0	12.0	28.5
41	509 S/S LV	0.69	42.0	94.5	12.0	12.0	28.5
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.9	8.9	21.3

Rated Capacity

S.No.	Bus	Network Level [kV]	Ik" [kA]	Ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
43	510 S/S LV	0.69	42.0	94.5	11.9	11.9	28.2
44	511 S/S LV	0.69	42.0	94.5	12.3	12.3	29.4
45	512 S/S LV	0.69	42.0	94.5	12.1	12.1	28.9
46	513 S/S LV	0.69	42.0	94.5	12.0	12.0	28.5
47	514 S/S LV	0.69	42.0	94.5	11.8	11.8	28.0
48	515 S/S LV	0.69	42.0	94.5	9.9	9.9	23.5
49	518 S/S MV	0.69	42.0	94.5	32.2	32.2	76.7
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.6	2.6	5.1
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.1	3.1	6.2
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.6	2.6	5.2
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.1	3.1	6.2
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.6	2.6	5.2
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	3.0	6.0
56	519 S/S LV	0.4	50.0	112.5	24.5	24.5	49.0
57	521 S/S LV	0.4	50.0	112.5	25.1	25.1	50.1
58	522 S/S LV	0.4	50.0	112.5	13.9	13.9	27.7
59	BUFFER PUMP-I LV	0.4	50.0	112.5	24.7	24.7	49.5
60	BUFFER PUMP-II LV	0.4	50.0	112.5	24.7	24.7	49.5
61	CHINESE COLONY LV	0.4	50.0	112.5	21.9	21.9	43.8
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	28.9	28.9	57.8
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	28.9	28.9	57.8
64	CONVEYOR BELT LV	0.4	50.0	112.5	35.7	35.7	71.4
65	CRUSHING STATION LV	0.4	50.0	112.5	35.8	35.8	71.6
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	16.9	16.9	33.8
67	DRIVER'S COLONY LV	0.4	50.0	112.5	31.5	31.5	63.0
68	MSF LV	0.4	50.0	112.5	22.3	22.3	44.7
69	OWNER'S COLONY LV	0.4	50.0	112.5	21.6	21.6	43.2
70	PAKISTAN COLONY LV	0.4	50.0	112.5	35.9	35.9	71.7

Case – 3B

Results of Buses

Table 3.5-6 2-Phase Maximum Results (3B)

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	
1	504 S/S MV	11	31.5	78.8	2.3	2.3	7.4
2	505 S/S MV	11	31.5	78.8	3.1	3.1	10.0
3	506 S/S MV	11	31.5	78.8	3.3	3.3	10.5
4	507 S/S MV	11	31.5	78.8	2.8	2.8	8.9
5	508 S/S MV	11	31.5	78.8	3.6	3.6	11.3
6	509 S/S MV	11	31.5	78.8	3.7	3.7	11.8
7	510 S/S MV	11	31.5	78.8	3.8	3.8	12.0
8	511 S/S MV	11	31.5	78.8	3.5	3.5	11.0
9	512 S/S MV	11	31.5	78.8	3.1	3.1	9.9
10	513 S/S MV	11	31.5	78.8	2.8	2.8	9.0
11	514 S/S MV	11	31.5	78.8	3.3	3.3	10.4
12	515 S/S MV	11	31.5	78.8	2.5	2.5	8.0
13	518 S/S MV	11	31.5	78.8	2.4	2.4	7.7
14	519 S/S MV	11	31.5	78.8	3.1	3.1	9.7
15	521 S/S MV	11	31.5	78.8	2.6	2.6	8.2
16	522 S/S MV	11	31.5	78.8	2.8	2.8	8.9
17	BUFFER PUMP-I	11	31.5	78.8	3.3	3.3	10.4
18	CHINESE COLONY MV	11	31.5	78.8	3.4	3.4	10.9
19	COMP. PUMP STATION MV-I	11	31.5	78.8	3.8	3.8	12.2
20	CONVEYOR BELT MV	11	31.5	78.8	3.4	3.4	10.9
21	CRUSHING STATION MV	11	31.5	78.8	3.5	3.5	11.0
22	DIESEL STORAGE AREA MV	11	31.5	78.8	4.0	4.0	12.6
23	DRIVER'S COLONY MV	11	31.5	78.8	3.4	3.4	10.9
24	Generation Bus-I	11	31.5	78.8	4.2	4.2	13.3
25	Generation Bus-II	11	31.5	78.8	3.6	3.6	11.5
26	Load Bus-I	11	31.5	78.8	4.2	4.2	13.3
27	Load Bus-II	11	31.5	78.8	3.6	3.6	11.5
28	MSF MV	11	31.5	78.8	3.5	3.5	11.2
29	OWNER'S COLONY MV	11	31.5	78.8	3.6	3.6	11.5
30	PAKISTAN COLONY MV	11	31.5	78.8	3.6	3.6	11.5
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.4	9.4	22.3
32	504 S/S LV	0.69	42.0	94.5	9.4	9.4	22.3
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.8	11.8	28.2

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
34	505 S/S LV	0.69	42.0	94.5	11.8	11.8	28.2
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	10.8	10.8	25.8
36	506 S/S LV	0.69	42.0	94.5	10.8	10.8	25.8
37	507 S/S LV	0.69	42.0	94.5	10.1	10.1	24.1
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.0	12.0	28.6
39	508 S/S LV	0.69	42.0	94.5	12.0	12.0	28.6
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.4	11.4	27.1
41	509 S/S LV	0.69	42.0	94.5	11.4	11.4	27.1
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.6	8.6	20.5
43	510 S/S LV	0.69	42.0	94.5	11.2	11.2	26.7
44	511 S/S LV	0.69	42.0	94.5	11.7	11.7	28.0
45	512 S/S LV	0.69	42.0	94.5	11.6	11.6	27.6
46	513 S/S LV	0.69	42.0	94.5	11.4	11.4	27.2
47	514 S/S LV	0.69	42.0	94.5	11.2	11.2	26.7
48	515 S/S LV	0.69	42.0	94.5	9.3	9.3	22.2
49	518 S/S MV	0.69	42.0	94.5	29.1	29.1	69.2
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.5	2.5	5.1
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.1	3.1	6.1
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.6	2.6	5.2
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.1	3.1	6.1
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.6	2.6	5.2
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.0	3.0	6.0
56	519 S/S LV	0.4	50.0	112.5	23.1	23.1	46.1
57	521 S/S LV	0.4	50.0	112.5	23.6	23.6	47.2
58	522 S/S LV	0.4	50.0	112.5	13.1	13.1	26.1
59	BUFFER PUMP-I LV	0.4	50.0	112.5	24.0	24.0	48.1
60	BUFFER PUMP-II LV	0.4	50.0	112.5	24.0	24.0	48.1
61	CHINESE COLONY LV	0.4	50.0	112.5	19.7	19.7	39.4
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	26.4	26.4	52.7
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	26.4	26.4	52.7
64	CONVEYOR BELT LV	0.4	50.0	112.5	30.9	30.9	61.9

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
65	CRUSHING STATION LV	0.4	50.0	112.5	31.0	31.0	62.0
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	16.4	16.4	32.8
67	DRIVER'S COLONY LV	0.4	50.0	112.5	26.9	26.9	53.8
68	MSF LV	0.4	50.0	112.5	20.1	20.1	40.2
69	OWNER'S COLONY LV	0.4	50.0	112.5	19.9	19.9	39.9
70	PAKISTAN COLONY LV	0.4	50.0	112.5	31.4	31.4	62.7

3.6 2-Phase Minimum Short Circuit Results

2-Phase Minimum short circuit results at different bus bars are given below:

For detailed results please refer Annex-A.

Case – 1A

Results of Buses

Table 3.6-1 2-Phase Minimum Results (1A)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	1.6	1.6	5.2
2	505 S/S MV	11	31.5	78.8	2.3	2.3	7.3
3	506 S/S MV	11	31.5	78.8	2.4	2.4	7.7
4	507 S/S MV	11	31.5	78.8	2.0	2.0	6.4
5	508 S/S MV	11	31.5	78.8	2.6	2.6	8.4
6	509 S/S MV	11	31.5	78.8	2.8	2.8	8.8
7	510 S/S MV	11	31.5	78.8	2.8	2.8	9.0
8	511 S/S MV	11	31.5	78.8	2.6	2.6	8.2
9	512 S/S MV	11	31.5	78.8	2.3	2.3	7.4
10	513 S/S MV	11	31.5	78.8	2.1	2.1	6.8
11	514 S/S MV	11	31.5	78.8	2.4	2.4	7.6
12	515 S/S MV	11	31.5	78.8	1.8	1.8	5.6
13	518 S/S MV	11	31.5	78.8	1.7	1.7	5.3
14	519 S/S MV	11	31.5	78.8	2.2	2.2	7.1
15	521 S/S MV	11	31.5	78.8	1.8	1.8	5.7
16	522 S/S MV	11	31.5	78.8	2.1	2.1	6.7
17	BUFFER PUMP-I	11	31.5	78.8	2.5	2.5	7.8
18	CHINESE COLONY MV	11	31.5	78.8	3.1	3.1	9.7
19	COMP. PUMP STATION MV-I	11	31.5	78.8	3.0	3.0	9.5

S.No.	Bus	Network Level [kV]	Rated Capacity					Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]		
20	CONVEYOR BELT MV	11	31.5	78.8	3.1	3.1	9.7	
21	CRUSHING STATION MV	11	31.5	78.8	3.1	3.1	9.8	
22	DIESEL STORAGE AREA MV	11	31.5	78.8	3.1	3.1	9.8	
23	DRIVER'S COLONY MV	11	31.5	78.8	3.1	3.1	9.7	
24	Generation Bus-I	11	31.5	78.8	3.2	3.2	10.3	
25	Generation Bus-II	11	31.5	78.8	3.2	3.2	10.3	
26	KIOSK 1 & 2 MV	11	20.0	50.0	2.5	2.5	12.4	
27	KIOSK 3 & 4 MV	11	20.0	50.0	2.5	2.5	12.4	
28	LINE-01 BUS	11	31.5	78.8	3.2	3.2	10.2	
29	LINE-02 BUS	11	31.5	78.8	3.2	3.2	10.2	
30	Load Bus-I	11	31.5	78.8	3.2	3.2	10.3	
31	Load Bus-II	11	31.5	78.8	3.2	3.2	10.3	
32	MSF MV	11	31.5	78.8	3.2	3.2	10.1	
33	OWNER'S COLONY MV	11	31.5	78.8	2.8	2.8	9.0	
34	PAKISTAN COLONY MV	11	31.5	78.8	2.8	2.8	8.9	
35	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.6	6.6	15.7	
36	504 S/S LV	0.69	42.0	94.5	6.6	6.6	15.7	
37	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.2	7.2	17.2	
38	505 S/S LV	0.69	42.0	94.5	7.2	7.2	17.2	
39	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.3	7.3	17.4	
40	506 S/S LV	0.69	42.0	94.5	7.3	7.3	17.4	
41	507 S/S LV	0.69	42.0	94.5	7.0	7.0	16.6	
42	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.4	7.4	17.6	
43	508 S/S LV	0.69	42.0	94.5	7.4	7.4	17.6	
44	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.4	7.4	17.7	
45	509 S/S LV	0.69	42.0	94.5	7.4	7.4	17.7	
46	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	5.8	5.8	13.9	
47	510 S/S LV	0.69	42.0	94.5	7.5	7.5	17.8	
48	511 S/S LV	0.69	42.0	94.5	7.3	7.3	17.5	
49	512 S/S LV	0.69	42.0	94.5	7.2	7.2	17.1	
50	513 S/S LV	0.69	42.0	94.5	7.1	7.1	16.8	
51	514 S/S LV	0.69	42.0	94.5	7.3	7.3	17.3	
52	515 S/S LV	0.69	42.0	94.5	6.8	6.8	16.1	
53	518 S/S MV	0.69	42.0	94.5	13.4	13.4	31.9	
54	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.1	

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
55	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.2
56	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.2
57	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.2
58	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.2
59	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.0	2.0	4.1
60	519 S/S LV	0.4	50.0	112.5	14.9	14.9	29.8
61	521 S/S LV	0.4	50.0	112.5	13.9	13.9	27.8
62	522 S/S LV	0.4	50.0	112.5	10.4	10.4	20.8
63	BUFFER PUMP-I LV	0.4	50.0	112.5	10.4	10.4	20.8
64	BUFFER PUMP-II LV	0.4	50.0	112.5	10.4	10.4	20.8
65	CHINESE COLONY LV	0.4	50.0	112.5	15.9	15.9	31.7
66	COMP. PUMP STATION LV-I	0.4	50.0	112.5	18.8	18.8	37.6
67	COMP. PUMP STATION LV-II	0.4	50.0	112.5	18.8	18.8	37.6
68	CONVEYOR BELT LV	0.4	50.0	112.5	22.2	22.2	44.4
69	CRUSHING STATION LV	0.4	50.0	112.5	22.3	22.3	44.5
70	DIESEL STORAGE AREA LV	0.4	50.0	112.5	8.9	8.9	17.7
71	DRIVER'S COLONY LV	0.4	50.0	112.5	22.2	22.2	44.4
72	MSF LV	0.4	50.0	112.5	16.0	16.0	31.9
73	OWNER'S COLONY LV	0.4	50.0	112.5	15.7	15.7	31.4
74	PAKISTAN COLONY LV	0.4	50.0	112.5	24.7	24.7	49.4

Case – 1B

Results of Buses

Table 3.6-2 2-Phase Minimum Results (1B)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	1.1	1.1	3.4
2	505 S/S MV	11	31.5	78.8	1.4	1.4	4.3
3	506 S/S MV	11	31.5	78.8	1.4	1.4	4.4
4	507 S/S MV	11	31.5	78.8	1.2	1.2	4.0
5	508 S/S MV	11	31.5	78.8	1.5	1.5	4.6
6	509 S/S MV	11	31.5	78.8	1.5	1.5	4.7

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	
7	510 S/S MV	11	31.5	78.8	1.5	1.5	4.8
8	511 S/S MV	11	31.5	78.8	1.4	1.4	4.6
9	512 S/S MV	11	31.5	78.8	1.4	1.4	4.3
10	513 S/S MV	11	31.5	78.8	1.3	1.3	4.1
11	514 S/S MV	11	31.5	78.8	1.4	1.4	4.4
12	515 S/S MV	11	31.5	78.8	1.1	1.1	3.6
13	518 S/S MV	11	31.5	78.8	1.1	1.1	3.5
14	519 S/S MV	11	31.5	78.8	1.3	1.3	4.2
15	521 S/S MV	11	31.5	78.8	1.2	1.2	3.7
16	522 S/S MV	11	31.5	78.8	1.3	1.3	4.1
17	BUFFER PUMP-I	11	31.5	78.8	1.4	1.4	4.4
18	CHINESE COLONY MV	11	31.5	78.8	1.6	1.6	5.0
19	COMP. PUMP STATION MV-I	11	31.5	78.8	1.6	1.6	4.9
20	CONVEYOR BELT MV	11	31.5	78.8	1.6	1.6	5.0
21	CRUSHING STATION MV	11	31.5	78.8	1.6	1.6	5.0
22	DIESEL STORAGE AREA MV	11	31.5	78.8	1.6	1.6	5.0
23	DRIVER'S COLONY MV	11	31.5	78.8	1.6	1.6	5.0
24	Generation Bus-I	11	31.5	78.8	1.6	1.6	5.1
25	Generation Bus-II	11	31.5	78.8	1.6	1.6	5.1
26	KIOSK 1 & 2 MV	11	20.0	50.0	1.4	1.4	7.1
27	KIOSK 3 & 4 MV	11	20.0	50.0	1.4	1.4	7.1
28	LINE-01 BUS	11	31.5	78.8	1.6	1.6	5.1
29	LINE-02 BUS	11	31.5	78.8	1.6	1.6	5.1
30	Load Bus-I	11	31.5	78.8	1.6	1.6	5.1
31	Load Bus-II	11	31.5	78.8	1.6	1.6	5.1
32	MSF MV	11	31.5	78.8	1.6	1.6	5.1
33	OWNER'S COLONY MV	11	31.5	78.8	1.5	1.5	4.8
34	PAKISTAN COLONY MV	11	31.5	78.8	1.5	1.5	4.8
35	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	5.8	5.8	13.8
36	504 S/S LV	0.69	42.0	94.5	5.8	5.8	13.8
37	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.2	6.2	14.9
38	505 S/S LV	0.69	42.0	94.5	6.2	6.2	14.9
39	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.3	6.3	15.0
40	506 S/S LV	0.69	42.0	94.5	6.3	6.3	15.0
41	507 S/S LV	0.69	42.0	94.5	6.1	6.1	14.5

Rated Capacity

S.No.	Bus	Network Level [kV]	Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
42	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.4	6.4	15.2
43	508 S/S LV	0.69	42.0	94.5	6.4	6.4	15.2
44	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.4	6.4	15.3
45	509 S/S LV	0.69	42.0	94.5	6.4	6.4	15.3
46	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	5.2	5.2	12.4
47	510 S/S LV	0.69	42.0	94.5	6.4	6.4	15.3
48	511 S/S LV	0.69	42.0	94.5	6.3	6.3	15.1
49	512 S/S LV	0.69	42.0	94.5	6.2	6.2	14.8
50	513 S/S LV	0.69	42.0	94.5	6.1	6.1	14.6
51	514 S/S LV	0.69	42.0	94.5	6.3	6.3	15.0
52	515 S/S LV	0.69	42.0	94.5	5.9	5.9	14.1
53	518 S/S MV	0.69	42.0	94.5	10.4	10.4	24.8
54	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.0	2.0	4.0
55	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.0	2.0	4.1
56	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.0	2.0	4.1
57	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.0	2.0	4.1
58	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.0	2.0	4.1
59	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.0	2.0	4.0
60	519 S/S LV	0.4	50.0	112.5	12.6	12.6	25.1
61	521 S/S LV	0.4	50.0	112.5	11.9	11.9	23.7
62	522 S/S LV	0.4	50.0	112.5	9.2	9.2	18.4
63	BUFFER PUMP-I LV	0.4	50.0	112.5	9.2	9.2	18.4
64	BUFFER PUMP-II LV	0.4	50.0	112.5	9.2	9.2	18.4
65	CHINESE COLONY LV	0.4	50.0	112.5	13.3	13.3	26.5
66	COMP. PUMP STATION LV-I	0.4	50.0	112.5	15.2	15.2	30.4
67	COMP. PUMP STATION LV-II	0.4	50.0	112.5	15.2	15.2	30.4
68	CONVEYOR BELT LV	0.4	50.0	112.5	17.4	17.4	34.8
69	CRUSHING STATION LV	0.4	50.0	112.5	17.4	17.4	34.9
70	DIESEL STORAGE AREA LV	0.4	50.0	112.5	8.0	8.0	16.0
71	DRIVER'S COLONY LV	0.4	50.0	112.5	17.4	17.4	34.8
72	MSF LV	0.4	50.0	112.5	13.3	13.3	26.6

Rated Capacity

S.No.	Bus	Network Level [kV]	Ik" [kA]	Ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
73	OWNER'S COLONY LV	0.4	50.0	112.5	13.1	13.1	26.3
74	PAKISTAN COLONY LV	0.4	50.0	112.5	18.9	18.9	37.7

Case – 2A

Results of Buses

Table 3.6-3 2-Phase Minimum Results (2A)

		Rated Capacity					
S.No.	Bus	Network Level [kV]	Ik" [kA]	Ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	1.8	1.8	5.6
2	505 S/S MV	11	31.5	78.8	2.6	2.6	8.2
3	506 S/S MV	11	31.5	78.8	2.7	2.7	8.7
4	507 S/S MV	11	31.5	78.8	2.2	2.2	7.1
5	508 S/S MV	11	31.5	78.8	3.0	3.0	9.6
6	509 S/S MV	11	31.5	78.8	3.2	3.2	10.1
7	510 S/S MV	11	31.5	78.8	3.3	3.3	10.3
8	511 S/S MV	11	31.5	78.8	2.9	2.9	9.3
9	512 S/S MV	11	31.5	78.8	2.6	2.6	8.3
10	513 S/S MV	11	31.5	78.8	2.4	2.4	7.6
11	514 S/S MV	11	31.5	78.8	2.7	2.7	8.6
12	515 S/S MV	11	31.5	78.8	1.9	1.9	6.1
13	518 S/S MV	11	31.5	78.8	1.8	1.8	5.7
14	519 S/S MV	11	31.5	78.8	2.5	2.5	7.9
15	521 S/S MV	11	31.5	78.8	2.0	2.0	6.2
16	522 S/S MV	11	31.5	78.8	2.3	2.3	7.4
17	BUFFER PUMP-I	11	31.5	78.8	2.8	2.8	8.8
18	CHINESE COLONY MV	11	31.5	78.8	3.6	3.6	11.4
19	COMP. PUMP STATION MV-I	11	31.5	78.8	3.5	3.5	11.0
20	CONVEYOR BELT MV	11	31.5	78.8	3.6	3.6	11.4
21	CRUSHING STATION MV	11	31.5	78.8	3.6	3.6	11.5
22	DIESEL STORAGE AREA MV	11	31.5	78.8	3.6	3.6	11.4
23	DRIVER'S COLONY MV	11	31.5	78.8	3.6	3.6	11.4
24	Generation Bus-I	11	31.5	78.8	3.8	3.8	12.1
25	Generation Bus-II	11	31.5	78.8	3.8	3.8	12.1
26	Load Bus-I	11	31.5	78.8	3.8	3.8	12.1
27	Load Bus-II	11	31.5	78.8	3.8	3.8	12.1
28	MSF MV	11	31.5	78.8	3.7	3.7	11.8
		Rated Capacity					

S.No.	Bus	Network Level [kV]	Ik" [kA]	Ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
29	OWNER'S COLONY MV	11	31.5	78.8	3.2	3.2	10.3
30	PAKISTAN COLONY MV	11	31.5	78.8	3.2	3.2	10.2
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.8	6.8	16.1
32	504 S/S LV	0.69	42.0	94.5	6.8	6.8	16.1
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.4	7.4	17.6
34	505 S/S LV	0.69	42.0	94.5	7.4	7.4	17.6
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.5	7.5	17.8
36	506 S/S LV	0.69	42.0	94.5	7.5	7.5	17.8
37	507 S/S LV	0.69	42.0	94.5	7.1	7.1	17.0
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.6	7.6	18.0
39	508 S/S LV	0.69	42.0	94.5	7.6	7.6	18.0
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.6	7.6	18.2
41	509 S/S LV	0.69	42.0	94.5	7.6	7.6	18.2
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	5.9	5.9	14.1
43	510 S/S LV	0.69	42.0	94.5	7.7	7.7	18.2
44	511 S/S LV	0.69	42.0	94.5	7.5	7.5	17.9
45	512 S/S LV	0.69	42.0	94.5	7.4	7.4	17.5
46	513 S/S LV	0.69	42.0	94.5	7.2	7.2	17.2
47	514 S/S LV	0.69	42.0	94.5	7.4	7.4	17.7
48	515 S/S LV	0.69	42.0	94.5	6.9	6.9	16.5
49	518 S/S MV	0.69	42.0	94.5	14.0	14.0	33.4
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.1
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.2
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.2
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.2
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.2
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.0	2.0	4.1
56	519 S/S LV	0.4	50.0	112.5	15.3	15.3	30.7
57	521 S/S LV	0.4	50.0	112.5	14.3	14.3	28.6
58	522 S/S LV	0.4	50.0	112.5	10.6	10.6	21.2
59	BUFFER PUMP-I LV	0.4	50.0	112.5	10.6	10.6	21.2

Rated Capacity

S.No.	Bus	Network Level [kV]	Ik" [kA]	Ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
60	BUFFER PUMP-II LV	0.4	50.0	112.5	10.6	10.6	21.2
61	CHINESE COLONY LV	0.4	50.0	112.5	16.4	16.4	32.7
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	19.5	19.5	39.0
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	19.5	19.5	39.0
64	CONVEYOR BELT LV	0.4	50.0	112.5	23.2	23.2	46.4
65	CRUSHING STATION LV	0.4	50.0	112.5	23.2	23.2	46.5
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	9.0	9.0	18.0
67	DRIVER'S COLONY LV	0.4	50.0	112.5	23.2	23.2	46.4
68	MSF LV	0.4	50.0	112.5	16.5	16.5	32.9
69	OWNER'S COLONY LV	0.4	50.0	112.5	16.2	16.2	32.4
70	PAKISTAN COLONY LV	0.4	50.0	112.5	25.9	25.9	51.8

Case – 2B

Results of Buses

Table 3.6-4 2-Phase Minimum Results (2B)

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	
1	504 S/S MV	11	31.5	78.8	1.0	1.0	3.3
2	505 S/S MV	11	31.5	78.8	1.8	1.8	5.7
3	506 S/S MV	11	31.5	78.8	1.9	1.9	5.9
4	507 S/S MV	11	31.5	78.8	1.2	1.2	3.8
5	508 S/S MV	11	31.5	78.8	2.0	2.0	6.3
6	509 S/S MV	11	31.5	78.8	2.1	2.1	6.5
7	510 S/S MV	11	31.5	78.8	2.1	2.1	6.6
8	511 S/S MV	11	31.5	78.8	1.9	1.9	6.2
9	512 S/S MV	11	31.5	78.8	1.8	1.8	5.7
10	513 S/S MV	11	31.5	78.8	1.7	1.7	5.3
11	514 S/S MV	11	31.5	78.8	1.8	1.8	5.8
12	515 S/S MV	11	31.5	78.8	1.1	1.1	3.5
13	518 S/S MV	11	31.5	78.8	1.1	1.1	3.4
14	519 S/S MV	11	31.5	78.8	1.8	1.8	5.6
15	521 S/S MV	11	31.5	78.8	1.1	1.1	3.5
16	522 S/S MV	11	31.5	78.8	1.2	1.2	3.9
17	BUFFER PUMP-I	11	31.5	78.8	1.9	1.9	5.9
18	CHINESE COLONY MV	11	31.5	78.8	1.5	1.5	4.7

Rated Capacity

S.No.	Bus	Network Level [kV]	Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
19	COMP. PUMP STATION MV-I	11	31.5	78.8	2.2	2.2	6.9
20	CONVEYOR BELT MV	11	31.5	78.8	1.5	1.5	4.7
21	CRUSHING STATION MV	11	31.5	78.8	1.5	1.5	4.7
22	DIESEL STORAGE AREA MV	11	31.5	78.8	2.2	2.2	7.0
23	DRIVER'S COLONY MV	11	31.5	78.8	1.5	1.5	4.7
24	Generation Bus-I	11	31.5	78.8	2.3	2.3	7.3
25	Generation Bus-II	11	31.5	78.8	1.5	1.5	4.8
26	Load Bus-I	11	31.5	78.8	2.3	2.3	7.3
27	Load Bus-II	11	31.5	78.8	1.5	1.5	4.8
28	MSF MV	11	31.5	78.8	1.5	1.5	4.8
29	OWNER'S COLONY MV	11	31.5	78.8	2.1	2.1	6.6
30	PAKISTAN COLONY MV	11	31.5	78.8	2.1	2.1	6.6
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	5.7	5.7	13.6
32	504 S/S LV	0.69	42.0	94.5	5.7	5.7	13.6
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.8	6.8	16.1
34	505 S/S LV	0.69	42.0	94.5	6.8	6.8	16.1
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.8	6.8	16.3
36	506 S/S LV	0.69	42.0	94.5	6.8	6.8	16.3
37	507 S/S LV	0.69	42.0	94.5	6.0	6.0	14.2
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.9	6.9	16.5
39	508 S/S LV	0.69	42.0	94.5	6.9	6.9	16.5
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.0	7.0	16.6
41	509 S/S LV	0.69	42.0	94.5	7.0	7.0	16.6
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	5.5	5.5	13.2
43	510 S/S LV	0.69	42.0	94.5	7.0	7.0	16.7
44	511 S/S LV	0.69	42.0	94.5	6.9	6.9	16.4
45	512 S/S LV	0.69	42.0	94.5	6.8	6.8	16.1
46	513 S/S LV	0.69	42.0	94.5	6.7	6.7	15.8
47	514 S/S LV	0.69	42.0	94.5	6.8	6.8	16.3
48	515 S/S LV	0.69	42.0	94.5	5.8	5.8	13.8
49	518 S/S MV	0.69	42.0	94.5	10.1	10.1	24.1
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.0	2.0	4.0
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.1
Rated Capacity							

S.No.	Bus	Network Level [kV]	Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.1
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.1
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.1
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.0	2.0	4.0
56	519 S/S LV	0.4	50.0	112.5	13.8	13.8	27.7
57	521 S/S LV	0.4	50.0	112.5	11.7	11.7	23.3
58	522 S/S LV	0.4	50.0	112.5	9.1	9.1	18.2
59	BUFFER PUMP-I LV	0.4	50.0	112.5	9.9	9.9	19.7
60	BUFFER PUMP-II LV	0.4	50.0	112.5	9.9	9.9	19.7
61	CHINESE COLONY LV	0.4	50.0	112.5	13.0	13.0	26.0
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	17.1	17.1	34.3
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	17.1	17.1	34.3
64	CONVEYOR BELT LV	0.4	50.0	112.5	16.9	16.9	33.9
65	CRUSHING STATION LV	0.4	50.0	112.5	17.0	17.0	34.0
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	8.5	8.5	16.9
67	DRIVER'S COLONY LV	0.4	50.0	112.5	16.9	16.9	33.9
68	MSF LV	0.4	50.0	112.5	13.1	13.1	26.1
69	OWNER'S COLONY LV	0.4	50.0	112.5	14.5	14.5	29.1
70	PAKISTAN COLONY LV	0.4	50.0	112.5	21.9	21.9	43.8

Case – 3A

Results of Buses

Table 3.6-5 2-Phase Minimum Results (3A)

S.No.	Bus	Network Level [kV]	Rated Capacity					Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]		
1	504 S/S MV	11	31.5	78.8	1.9	1.9	6.0	
2	505 S/S MV	11	31.5	78.8	2.9	2.9	9.2	
3	506 S/S MV	11	31.5	78.8	3.1	3.1	9.9	
4	507 S/S MV	11	31.5	78.8	2.5	2.5	7.8	
5	508 S/S MV	11	31.5	78.8	3.5	3.5	11.0	
6	509 S/S MV	11	31.5	78.8	3.7	3.7	11.8	
7	510 S/S MV	11	31.5	78.8	3.8	3.8	12.0	
8	511 S/S MV	11	31.5	78.8	3.4	3.4	10.7	
Rated Capacity								

Rated Capacity

S.No.	Bus	Network Level [kV]	Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
9	512 S/S MV	11	31.5	78.8	2.9	2.9	9.3
10	513 S/S MV	11	31.5	78.8	2.7	2.7	8.4
11	514 S/S MV	11	31.5	78.8	3.0	3.0	9.7
12	515 S/S MV	11	31.5	78.8	2.1	2.1	6.6
13	518 S/S MV	11	31.5	78.8	1.9	1.9	5.9
14	519 S/S MV	11	31.5	78.8	2.8	2.8	8.9
15	521 S/S MV	11	31.5	78.8	2.1	2.1	6.8
16	522 S/S MV	11	31.5	78.8	2.6	2.6	8.2
17	BUFFER PUMP-I	11	31.5	78.8	3.1	3.1	10.0
18	CHINESE COLONY MV	11	31.5	78.8	4.2	4.2	13.5
19	COMP. PUMP STATION MV-I	11	31.5	78.8	4.1	4.1	12.9
20	CONVEYOR BELT MV	11	31.5	78.8	4.2	4.2	13.5
21	CRUSHING STATION MV	11	31.5	78.8	4.3	4.3	13.6
22	DIESEL STORAGE AREA MV	11	31.5	78.8	4.3	4.3	13.5
23	DRIVER'S COLONY MV	11	31.5	78.8	4.2	4.2	13.5
24	Generation Bus-I	11	31.5	78.8	4.6	4.6	14.5
25	Generation Bus-II	11	31.5	78.8	4.6	4.6	14.5
26	Load Bus-I	11	31.5	78.8	4.6	4.6	14.5
27	Load Bus-II	11	31.5	78.8	4.6	4.6	14.5
28	MSF MV	11	31.5	78.8	4.5	4.5	14.1
29	OWNER'S COLONY MV	11	31.5	78.8	3.7	3.7	11.9
30	PAKISTAN COLONY MV	11	31.5	78.8	3.7	3.7	11.8
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.9	6.9	16.4
32	504 S/S LV	0.69	42.0	94.5	6.9	6.9	16.4
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.6	7.6	18.0
34	505 S/S LV	0.69	42.0	94.5	7.6	7.6	18.0
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.6	7.6	18.2
36	506 S/S LV	0.69	42.0	94.5	7.6	7.6	18.2
37	507 S/S LV	0.69	42.0	94.5	7.3	7.3	17.4
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.7	7.7	18.4
39	508 S/S LV	0.69	42.0	94.5	7.7	7.7	18.4
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.8	7.8	18.6
41	509 S/S LV	0.69	42.0	94.5	7.8	7.8	18.6
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.0	6.0	14.4

Rated Capacity

S.No.	Bus	Network Level [kV]	Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
43	510 S/S LV	0.69	42.0	94.5	7.8	7.8	18.7
44	511 S/S LV	0.69	42.0	94.5	7.7	7.7	18.3
45	512 S/S LV	0.69	42.0	94.5	7.5	7.5	17.9
46	513 S/S LV	0.69	42.0	94.5	7.4	7.4	17.6
47	514 S/S LV	0.69	42.0	94.5	7.6	7.6	18.1
48	515 S/S LV	0.69	42.0	94.5	7.1	7.1	16.8
49	518 S/S MV	0.69	42.0	94.5	14.4	14.4	34.2
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.1
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.2
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.2
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.2
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.2
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.0	2.0	4.1
56	519 S/S LV	0.4	50.0	112.5	15.8	15.8	31.5
57	521 S/S LV	0.4	50.0	112.5	14.7	14.7	29.3
58	522 S/S LV	0.4	50.0	112.5	10.8	10.8	21.6
59	BUFFER PUMP-I LV	0.4	50.0	112.5	10.8	10.8	21.6
60	BUFFER PUMP-II LV	0.4	50.0	112.5	10.8	10.8	21.6
61	CHINESE COLONY LV	0.4	50.0	112.5	16.8	16.8	33.7
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	20.2	20.2	40.4
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	20.2	20.2	40.4
64	CONVEYOR BELT LV	0.4	50.0	112.5	24.2	24.2	48.3
65	CRUSHING STATION LV	0.4	50.0	112.5	24.2	24.2	48.5
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	9.2	9.2	18.3
67	DRIVER'S COLONY LV	0.4	50.0	112.5	24.2	24.2	48.3
68	MSF LV	0.4	50.0	112.5	17.0	17.0	33.9
69	OWNER'S COLONY LV	0.4	50.0	112.5	16.7	16.7	33.3
70	PAKISTAN COLONY LV	0.4	50.0	112.5	27.1	27.1	54.3

Case – 3B

Results of Buses

Table 3.6-6 2-Phase Minimum Results (3B)

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	
1	504 S/S MV	11	31.5	78.8	1.3	1.3	4.3
2	505 S/S MV	11	31.5	78.8	1.8	1.8	5.7
3	506 S/S MV	11	31.5	78.8	1.9	1.9	5.9
4	507 S/S MV	11	31.5	78.8	1.6	1.6	5.1
5	508 S/S MV	11	31.5	78.8	2.0	2.0	6.3
6	509 S/S MV	11	31.5	78.8	2.1	2.1	6.5
7	510 S/S MV	11	31.5	78.8	2.1	2.1	6.6
8	511 S/S MV	11	31.5	78.8	1.9	1.9	6.2
9	512 S/S MV	11	31.5	78.8	1.8	1.8	5.7
10	513 S/S MV	11	31.5	78.8	1.7	1.7	5.3
11	514 S/S MV	11	31.5	78.8	1.8	1.8	5.8
12	515 S/S MV	11	31.5	78.8	1.4	1.4	4.6
13	518 S/S MV	11	31.5	78.8	1.3	1.3	4.2
14	519 S/S MV	11	31.5	78.8	1.8	1.8	5.6
15	521 S/S MV	11	31.5	78.8	1.5	1.5	4.6
16	522 S/S MV	11	31.5	78.8	1.7	1.7	5.3
17	BUFFER PUMP-I	11	31.5	78.8	1.9	1.9	5.9
18	CHINESE COLONY MV	11	31.5	78.8	2.2	2.2	7.0
19	COMP. PUMP STATION MV-I	11	31.5	78.8	2.2	2.2	6.9
20	CONVEYOR BELT MV	11	31.5	78.8	2.2	2.2	7.0
21	CRUSHING STATION MV	11	31.5	78.8	2.2	2.2	7.0
22	DIESEL STORAGE AREA MV	11	31.5	78.8	2.2	2.2	7.0
23	DRIVER'S COLONY MV	11	31.5	78.8	2.2	2.2	7.0
24	Generation Bus-I	11	31.5	78.8	2.3	2.3	7.3
25	Generation Bus-II	11	31.5	78.8	2.3	2.3	7.3
26	Load Bus-I	11	31.5	78.8	2.3	2.3	7.3
27	Load Bus-II	11	31.5	78.8	2.3	2.3	7.3
28	MSF MV	11	31.5	78.8	2.3	2.3	7.2
29	OWNER'S COLONY MV	11	31.5	78.8	2.1	2.1	6.6
30	PAKISTAN COLONY MV	11	31.5	78.8	2.1	2.1	6.6
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.2	6.2	14.9
32	504 S/S LV	0.69	42.0	94.5	6.2	6.2	14.9
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.8	6.8	16.1

S.No.	Bus	Network Level [kV]	Rated Capacity				Ik"/Ik"max [%]
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	
34	505 S/S LV	0.69	42.0	94.5	6.8	6.8	16.1
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.8	6.8	16.3
	506 S/S LV	0.69	42.0	94.5	6.8	6.8	16.3
37	507 S/S LV	0.69	42.0	94.5	6.6	6.6	15.6
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	6.9	6.9	16.5
	508 S/S LV	0.69	42.0	94.5	6.9	6.9	16.5
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.0	7.0	16.6
	509 S/S LV	0.69	42.0	94.5	7.0	7.0	16.6
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	5.5	5.5	13.2
	510 S/S LV	0.69	42.0	94.5	7.0	7.0	16.7
44	511 S/S LV	0.69	42.0	94.5	6.9	6.9	16.4
45	512 S/S LV	0.69	42.0	94.5	6.8	6.8	16.1
46	513 S/S LV	0.69	42.0	94.5	6.7	6.7	15.8
47	514 S/S LV	0.69	42.0	94.5	6.8	6.8	16.3
48	515 S/S LV	0.69	42.0	94.5	6.4	6.4	15.2
49	518 S/S MV	0.69	42.0	94.5	11.8	11.8	28.1
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.0	2.0	4.1
	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.1
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.1
	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.1
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.1	2.1	4.1
	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.0	2.0	4.0
56	519 S/S LV	0.4	50.0	112.5	13.8	13.8	27.7
57	521 S/S LV	0.4	50.0	112.5	13.0	13.0	26.0
58	522 S/S LV	0.4	50.0	112.5	9.9	9.9	19.8
59	BUFFER PUMP-I LV	0.4	50.0	112.5	9.9	9.9	19.7
60	BUFFER PUMP-II LV	0.4	50.0	112.5	9.9	9.9	19.7
61	CHINESE COLONY LV	0.4	50.0	112.5	14.7	14.7	29.3
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	17.1	17.1	34.3
	COMP. PUMP STATION LV-II	0.4	50.0	112.5	17.1	17.1	34.3
64	CONVEYOR BELT LV	0.4	50.0	112.5	19.9	19.9	39.8

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL2 [kA]	IL3 [kA]	Ik"/Ik"max [%]
65	CRUSHING STATION LV	0.4	50.0	112.5	20.0	20.0	39.9
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	8.5	8.5	16.9
67	DRIVER'S COLONY LV	0.4	50.0	112.5	19.9	19.9	39.8
68	MSF LV	0.4	50.0	112.5	14.8	14.8	29.5
69	OWNER'S COLONY LV	0.4	50.0	112.5	14.5	14.5	29.1
70	PAKISTAN COLONY LV	0.4	50.0	112.5	21.9	21.9	43.8

3.7 1-Phase Maximum Short Circuit Results

1-Phase Maximum short circuit results at different bus bars are given below:

For detailed results please refer Annex-A.

Case – 1A

Results of Buses

Table 3.7-1 1-Phase Maximum Results (1A)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	IL1a [kA]	3I0a [kA]	3I0a/I _k "max [%]
1	504 S/S MV	11	31.5	78.8	0.024	0.024	0.076
2	505 S/S MV	11	31.5	78.8	0.024	0.024	0.076
3	506 S/S MV	11	31.5	78.8	0.024	0.024	0.076
4	507 S/S MV	11	31.5	78.8	0.024	0.024	0.076
5	508 S/S MV	11	31.5	78.8	0.024	0.024	0.077
6	509 S/S MV	11	31.5	78.8	0.024	0.024	0.077
7	510 S/S MV	11	31.5	78.8	0.024	0.024	0.077
8	511 S/S MV	11	31.5	78.8	0.024	0.024	0.077
9	512 S/S MV	11	31.5	78.8	0.024	0.024	0.076
10	513 S/S MV	11	31.5	78.8	0.024	0.024	0.076
11	514 S/S MV	11	31.5	78.8	0.024	0.024	0.076
12	515 S/S MV	11	31.5	78.8	0.024	0.024	0.076
13	518 S/S MV	11	31.5	78.8	0.024	0.024	0.076
14	519 S/S MV	11	31.5	78.8	0.024	0.024	0.076
15	521 S/S MV	11	31.5	78.8	0.024	0.024	0.076
16	522 S/S MV	11	31.5	78.8	0.024	0.024	0.076
17	BUFFER PUMP-I	11	31.5	78.8	0.024	0.024	0.077
18	CHINESE COLONY MV	11	31.5	78.8	0.024	0.024	0.077
19	COMP. PUMP STATION MV-I	11	31.5	78.8	0.024	0.024	0.077
20	CONVEYOR BELT MV	11	31.5	78.8	0.024	0.024	0.077
21	CRUSHING STATION MV	11	31.5	78.8	0.024	0.024	0.077
22	DIESEL STORAGE AREA MV	11	31.5	78.8	0.024	0.024	0.077
23	DRIVER'S COLONY MV	11	31.5	78.8	0.024	0.024	0.077
24	Generation Bus-I	11	31.5	78.8	0.024	0.024	0.077
25	Generation Bus-II	11	31.5	78.8	0.024	0.024	0.077
26	KIOSK 1 & 2 MV	11	20.0	50.0	0.024	0.024	0.120
27	KIOSK 3 & 4 MV	11	20.0	50.0	0.024	0.024	0.120
28	LINE-01 BUS	11	31.5	78.8	0.024	0.024	0.077
29	LINE-02 BUS	11	31.5	78.8	0.024	0.024	0.077

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	IL1a [kA]	3I0a [kA]	3I0a/I _k "max [%]
30	Load Bus-I	11	31.5	78.8	0.024	0.024	0.077
31	Load Bus-II	11	31.5	78.8	0.024	0.024	0.077
32	MSF MV	11	31.5	78.8	0.024	0.024	0.077
33	OWNER'S COLONY MV	11	31.5	78.8	0.024	0.024	0.077
34	PAKISTAN COLONY MV	11	31.5	78.8	0.024	0.024	0.077
35	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.882	11.882	28.291
36	504 S/S LV	0.69	42.0	94.5	11.882	11.882	28.291
37	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.875	13.875	33.037
38	505 S/S LV	0.69	42.0	94.5	13.875	13.875	33.037
39	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.110	13.110	31.213
40	506 S/S LV	0.69	42.0	94.5	13.110	13.110	31.213
41	507 S/S LV	0.69	42.0	94.5	12.581	12.581	29.954
42	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	14.024	14.024	33.391
43	508 S/S LV	0.69	42.0	94.5	14.024	14.024	33.391
44	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.537	13.537	32.230
45	509 S/S LV	0.69	42.0	94.5	13.537	13.537	32.230
46	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.007	8.007	19.064
47	510 S/S LV	0.69	42.0	94.5	13.434	13.434	31.985
48	511 S/S LV	0.69	42.0	94.5	13.808	13.808	32.875
49	512 S/S LV	0.69	42.0	94.5	13.670	13.670	32.547
50	513 S/S LV	0.69	42.0	94.5	13.542	13.542	32.243
51	514 S/S LV	0.69	42.0	94.5	13.393	13.393	31.889
52	515 S/S LV	0.69	42.0	94.5	11.866	11.866	28.253
53	518 S/S MV	0.69	42.0	94.5	38.834	38.834	92.461
54	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.146	3.146	6.293
55	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.588	3.588	7.176
56	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.192	3.192	6.384
57	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.592	3.592	7.184
58	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.206	3.206	6.412
59	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.521	3.521	7.042
60	519 S/S LV	0.4	50.0	112.5	28.289	28.289	56.577

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	Ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
61	521 S/S LV	0.4	50.0	112.5	28.795	28.795	57.589
62	522 S/S LV	0.4	50.0	112.5	16.727	16.727	33.454
63	BUFFER PUMP-I LV	0.4	50.0	112.5	23.950	23.950	47.900
64	BUFFER PUMP-II LV	0.4	50.0	112.5	23.950	23.950	47.900
65	CHINESE COLONY LV	0.4	50.0	112.5	26.056	26.056	52.113
66	COMP. PUMP STATION LV-I	0.4	50.0	112.5	33.759	33.759	67.518
67	COMP. PUMP STATION LV-II	0.4	50.0	112.5	33.759	33.759	67.518
68	CONVEYOR BELT LV	0.4	50.0	112.5	41.708	41.708	83.415
69	CRUSHING STATION LV	0.4	50.0	112.5	41.791	41.791	83.582
70	DIESEL STORAGE AREA LV	0.4	50.0	112.5	17.469	17.469	34.939
71	DRIVER'S COLONY LV	0.4	50.0	112.5	38.072	38.072	76.143
72	MSF LV	0.4	50.0	112.5	26.422	26.422	52.844
73	OWNER'S COLONY LV	0.4	50.0	112.5	25.827	25.827	51.653
74	PAKISTAN COLONY LV	0.4	50.0	112.5	43.872	43.872	87.745

Case – 1B

Results of Buses

Table 3.7-2 1-Phase Maximum Results (1B)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	0.035	0.035	0.112
2	505 S/S MV	11	31.5	78.8	0.038	0.038	0.121
3	506 S/S MV	11	31.5	78.8	0.038	0.038	0.121
4	507 S/S MV	11	31.5	78.8	0.036	0.036	0.113
5	508 S/S MV	11	31.5	78.8	0.038	0.038	0.122
6	509 S/S MV	11	31.5	78.8	0.038	0.038	0.122
7	510 S/S MV	11	31.5	78.8	0.038	0.038	0.122
8	511 S/S MV	11	31.5	78.8	0.038	0.038	0.122
9	512 S/S MV	11	31.5	78.8	0.038	0.038	0.121
10	513 S/S MV	11	31.5	78.8	0.038	0.038	0.121
11	514 S/S MV	11	31.5	78.8	0.038	0.038	0.121
12	515 S/S MV	11	31.5	78.8	0.035	0.035	0.112
13	518 S/S MV	11	31.5	78.8	0.035	0.035	0.112
14	519 S/S MV	11	31.5	78.8	0.038	0.038	0.121
15	521 S/S MV	11	31.5	78.8	0.035	0.035	0.112

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
16	522 S/S MV	11	31.5	78.8	0.036	0.036	0.113
17	BUFFER PUMP-I	11	31.5	78.8	0.038	0.038	0.122
18	CHINESE COLONY MV	11	31.5	78.8	0.036	0.036	0.114
19	COMP. PUMP STATION MV-I	11	31.5	78.8	0.038	0.038	0.122
20	CONVEYOR BELT MV	11	31.5	78.8	0.036	0.036	0.114
21	CRUSHING STATION MV	11	31.5	78.8	0.036	0.036	0.114
22	DIESEL STORAGE AREA MV	11	31.5	78.8	0.038	0.038	0.122
23	DRIVER'S COLONY MV	11	31.5	78.8	0.036	0.036	0.114
24	Generation Bus-I	11	31.5	78.8	0.038	0.038	0.122
25	Generation Bus-II	11	31.5	78.8	0.036	0.036	0.114
26	KIOSK 1 & 2 MV	11	20.0	50.0	0.038	0.038	0.191
27	KIOSK 3 & 4 MV	11	20.0	50.0	0.036	0.036	0.178
28	LINE-01 BUS	11	31.5	78.8	0.038	0.038	0.122
29	LINE-02 BUS	11	31.5	78.8	0.036	0.036	0.114
30	Load Bus-I	11	31.5	78.8	0.038	0.038	0.122
31	Load Bus-II	11	31.5	78.8	0.036	0.036	0.114
32	MSF MV	11	31.5	78.8	0.036	0.036	0.114
33	OWNER'S COLONY MV	11	31.5	78.8	0.038	0.038	0.122
34	PAKISTAN COLONY MV	11	31.5	78.8	0.038	0.038	0.122
35	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.337	11.337	26.993
36	504 S/S LV	0.69	42.0	94.5	11.337	11.337	26.993
37	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.377	13.377	31.851
38	505 S/S LV	0.69	42.0	94.5	13.377	13.377	31.851
39	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.582	12.582	29.958
40	506 S/S LV	0.69	42.0	94.5	12.582	12.582	29.958
41	507 S/S LV	0.69	42.0	94.5	11.954	11.954	28.461
42	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.501	13.501	32.144
43	508 S/S LV	0.69	42.0	94.5	13.501	13.501	32.144
44	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.986	12.986	30.918
45	509 S/S LV	0.69	42.0	94.5	12.986	12.986	30.918
46	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.827	7.827	18.636
47	510 S/S LV	0.69	42.0	94.5	12.875	12.875	30.654
48	511 S/S LV	0.69	42.0	94.5	13.284	13.284	31.628
49	512 S/S LV	0.69	42.0	94.5	13.165	13.165	31.346

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
50	513 S/S LV	0.69	42.0	94.5	13.051	13.051	31.073
51	514 S/S LV	0.69	42.0	94.5	12.876	12.876	30.658
52	515 S/S LV	0.69	42.0	94.5	11.286	11.286	26.87
53	518 S/S MV	0.69	42.0	94.5	35.363	35.363	84.197
54	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.123	3.123	6.246
55	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.573	3.573	7.146
56	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.173	3.173	6.347
57	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.577	3.577	7.153
58	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.188	3.188	6.375
59	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.504	3.504	7.008
60	519 S/S LV	0.4	50.0	112.5	26.939	26.939	53.877
61	521 S/S LV	0.4	50.0	112.5	27.348	27.348	54.695
62	522 S/S LV	0.4	50.0	112.5	15.875	15.875	31.749
63	BUFFER PUMP-I LV	0.4	50.0	112.5	23.485	23.485	46.971
64	BUFFER PUMP-II LV	0.4	50.0	112.5	23.485	23.485	46.971
65	CHINESE COLONY LV	0.4	50.0	112.5	23.707	23.707	47.414
66	COMP. PUMP STATION LV-I	0.4	50.0	112.5	31.344	31.344	62.689
67	COMP. PUMP STATION LV-II	0.4	50.0	112.5	31.344	31.344	62.689
68	CONVEYOR BELT LV	0.4	50.0	112.5	36.819	36.819	73.638
69	CRUSHING STATION LV	0.4	50.0	112.5	36.88	36.88	73.759
70	DIESEL STORAGE AREA LV	0.4	50.0	112.5	17.089	17.089	34.178
71	DRIVER'S COLONY LV	0.4	50.0	112.5	33.069	33.069	66.138
72	MSF LV	0.4	50.0	112.5	24.061	24.061	48.122
73	OWNER'S COLONY LV	0.4	50.0	112.5	24.16	24.16	48.32
74	PAKISTAN COLONY LV	0.4	50.0	112.5	39.126	39.126	78.252

Case – 2A

Results of Buses

Table 3.7-3 1-Phase Maximum Results (2A)

S.No.	Bus	Network Level [kV]	Rated Capacity					3I0a/Ik"max [%]
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]		
1	504 S/S MV	11	31.5	78.8	0.033	0.033	0.103	
2	505 S/S MV	11	31.5	78.8	0.033	0.033	0.104	
3	506 S/S MV	11	31.5	78.8	0.033	0.033	0.104	
4	507 S/S MV	11	31.5	78.8	0.033	0.033	0.104	
5	508 S/S MV	11	31.5	78.8	0.033	0.033	0.104	
6	509 S/S MV	11	31.5	78.8	0.033	0.033	0.105	
7	510 S/S MV	11	31.5	78.8	0.033	0.033	0.105	
8	511 S/S MV	11	31.5	78.8	0.033	0.033	0.104	
9	512 S/S MV	11	31.5	78.8	0.033	0.033	0.104	
10	513 S/S MV	11	31.5	78.8	0.033	0.033	0.104	
11	514 S/S MV	11	31.5	78.8	0.033	0.033	0.104	
12	515 S/S MV	11	31.5	78.8	0.033	0.033	0.103	
13	518 S/S MV	11	31.5	78.8	0.033	0.033	0.103	
14	519 S/S MV	11	31.5	78.8	0.033	0.033	0.104	
15	521 S/S MV	11	31.5	78.8	0.033	0.033	0.104	
16	522 S/S MV	11	31.5	78.8	0.033	0.033	0.104	
17	BUFFER PUMP-I	11	31.5	78.8	0.033	0.033	0.104	
18	CHINESE COLONY MV	11	31.5	78.8	0.033	0.033	0.105	
19	COMP. PUMP STATION MV-I	11	31.5	78.8	0.033	0.033	0.105	
20	CONVEYOR BELT MV	11	31.5	78.8	0.033	0.033	0.105	
21	CRUSHING STATION MV	11	31.5	78.8	0.033	0.033	0.105	
22	DIESEL STORAGE AREA MV	11	31.5	78.8	0.033	0.033	0.105	
23	DRIVER'S COLONY MV	11	31.5	78.8	0.033	0.033	0.105	
24	Generation Bus-I	11	31.5	78.8	0.033	0.033	0.105	
25	Generation Bus-II	11	31.5	78.8	0.033	0.033	0.105	
26	Load Bus-I	11	31.5	78.8	0.033	0.033	0.105	
27	Load Bus-II	11	31.5	78.8	0.033	0.033	0.105	
28	MSF MV	11	31.5	78.8	0.033	0.033	0.105	
29	OWNER'S COLONY MV	11	31.5	78.8	0.033	0.033	0.105	
30	PAKISTAN COLONY MV	11	31.5	78.8	0.033	0.033	0.105	
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.927	11.927	28.398	
32	504 S/S LV	0.69	42.0	94.5	11.927	11.927	28.398	
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.934	13.934	33.176	

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
34	505 S/S LV	0.69	42.0	94.5	13.934	13.934	33.176
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.172	13.172	31.361
36	506 S/S LV	0.69	42.0	94.5	13.172	13.172	31.361
37	507 S/S LV	0.69	42.0	94.5	12.633	12.633	30.077
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	14.085	14.085	33.537
39	508 S/S LV	0.69	42.0	94.5	14.085	14.085	33.537
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.601	13.601	32.384
41	509 S/S LV	0.69	42.0	94.5	13.601	13.601	32.384
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.028	8.028	19.114
43	510 S/S LV	0.69	42.0	94.5	13.499	13.499	32.141
44	511 S/S LV	0.69	42.0	94.5	13.869	13.869	33.022
45	512 S/S LV	0.69	42.0	94.5	13.729	13.729	32.687
46	513 S/S LV	0.69	42.0	94.5	13.599	13.599	32.38
47	514 S/S LV	0.69	42.0	94.5	13.454	13.454	32.033
48	515 S/S LV	0.69	42.0	94.5	11.914	11.914	28.368
49	518 S/S MV	0.69	42.0	94.5	39.135	39.135	93.178
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.148	3.148	6.296
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.59	3.59	7.18
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.194	3.194	6.388
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.594	3.594	7.188
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.208	3.208	6.417
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.523	3.523	7.046
56	519 S/S LV	0.4	50.0	112.5	28.449	28.449	56.898
57	521 S/S LV	0.4	50.0	112.5	28.914	28.914	57.829
58	522 S/S LV	0.4	50.0	112.5	16.798	16.798	33.595
59	BUFFER PUMP-I LV	0.4	50.0	112.5	24.003	24.003	48.006
60	BUFFER PUMP-II LV	0.4	50.0	112.5	24.003	24.003	48.006
61	CHINESE COLONY LV	0.4	50.0	112.5	26.26	26.26	52.52
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	34.054	34.054	68.108
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	34.054	34.054	68.108
64	CONVEYOR BELT LV	0.4	50.0	112.5	42.145	42.145	84.291

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
65	CRUSHING STATION LV	0.4	50.0	112.5	42.231	42.231	84.462
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	17.513	17.513	35.026
67	DRIVER'S COLONY LV	0.4	50.0	112.5	38.528	38.528	77.055
68	MSF LV	0.4	50.0	112.5	26.626	26.626	53.253
69	OWNER'S COLONY LV	0.4	50.0	112.5	26.028	26.028	52.057
70	PAKISTAN COLONY LV	0.4	50.0	112.5	44.48	44.48	88.959

Case – 2B

Results of Buses

Table 3.7-4 1-Phase Maximum Results (2B)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	0.04	0.04	0.126
2	505 S/S MV	11	31.5	78.8	0.042	0.042	0.134
3	506 S/S MV	11	31.5	78.8	0.042	0.042	0.135
4	507 S/S MV	11	31.5	78.8	0.04	0.04	0.127
5	508 S/S MV	11	31.5	78.8	0.043	0.043	0.135
6	509 S/S MV	11	31.5	78.8	0.043	0.043	0.136
7	510 S/S MV	11	31.5	78.8	0.043	0.043	0.136
8	511 S/S MV	11	31.5	78.8	0.043	0.043	0.135
9	512 S/S MV	11	31.5	78.8	0.043	0.043	0.135
10	513 S/S MV	11	31.5	78.8	0.042	0.042	0.135
11	514 S/S MV	11	31.5	78.8	0.042	0.042	0.135
12	515 S/S MV	11	31.5	78.8	0.04	0.04	0.126
13	518 S/S MV	11	31.5	78.8	0.04	0.04	0.126
14	519 S/S MV	11	31.5	78.8	0.042	0.042	0.134
15	521 S/S MV	11	31.5	78.8	0.04	0.04	0.126
16	522 S/S MV	11	31.5	78.8	0.04	0.04	0.127
17	BUFFER PUMP-I	11	31.5	78.8	0.043	0.043	0.135
18	CHINESE COLONY MV	11	31.5	78.8	0.04	0.04	0.128
19	COMP. PUMP STATION MV-I	11	31.5	78.8	0.043	0.043	0.136
20	CONVEYOR BELT MV	11	31.5	78.8	0.04	0.04	0.128
21	CRUSHING STATION MV	11	31.5	78.8	0.04	0.04	0.128
22	DIESEL STORAGE AREA MV	11	31.5	78.8	0.043	0.043	0.136

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/ik"max [%]
23	DRIVER'S COLONY MV	11	31.5	78.8	0.04	0.04	0.128
24	Generation Bus-I	11	31.5	78.8	0.043	0.043	0.136
25	Generation Bus-II	11	31.5	78.8	0.04	0.04	0.128
26	Load Bus-I	11	31.5	78.8	0.043	0.043	0.136
27	Load Bus-II	11	31.5	78.8	0.04	0.04	0.128
28	MSF MV	11	31.5	78.8	0.04	0.04	0.128
29	OWNER'S COLONY MV	11	31.5	78.8	0.043	0.043	0.136
30	PAKISTAN COLONY MV	11	31.5	78.8	0.043	0.043	0.136
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.305	11.305	26.916
32	504 S/S LV	0.69	42.0	94.5	11.305	11.305	26.916
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.569	13.569	32.306
34	505 S/S LV	0.69	42.0	94.5	13.569	13.569	32.306
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.784	12.784	30.439
36	506 S/S LV	0.69	42.0	94.5	12.784	12.784	30.439
37	507 S/S LV	0.69	42.0	94.5	11.916	11.916	28.372
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.701	13.701	32.622
39	508 S/S LV	0.69	42.0	94.5	13.701	13.701	32.622
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.196	13.196	31.42
41	509 S/S LV	0.69	42.0	94.5	13.196	13.196	31.42
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.898	7.898	18.804
43	510 S/S LV	0.69	42.0	94.5	13.088	13.088	31.163
44	511 S/S LV	0.69	42.0	94.5	13.485	13.485	32.106
45	512 S/S LV	0.69	42.0	94.5	13.359	13.359	31.806
46	513 S/S LV	0.69	42.0	94.5	13.239	13.239	31.522
47	514 S/S LV	0.69	42.0	94.5	13.075	13.075	31.13
48	515 S/S LV	0.69	42.0	94.5	11.251	11.251	26.788
49	518 S/S MV	0.69	42.0	94.5	35.166	35.166	83.729
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.122	3.122	6.244
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.579	3.579	7.158
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.181	3.181	6.361
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.583	3.583	7.165
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.195	3.195	6.39

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.511	3.511	7.021
56	519 S/S LV	0.4	50.0	112.5	27.454	27.454	54.907
57	521 S/S LV	0.4	50.0	112.5	27.262	27.262	54.524
58	522 S/S LV	0.4	50.0	112.5	15.824	15.824	31.648
59	BUFFER PUMP-I LV	0.4	50.0	112.5	23.665	23.665	47.331
60	BUFFER PUMP-II LV	0.4	50.0	112.5	23.665	23.665	47.331
61	CHINESE COLONY LV	0.4	50.0	112.5	23.574	23.574	47.148
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	32.25	32.25	64.5
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	32.25	32.25	64.5
64	CONVEYOR BELT LV	0.4	50.0	112.5	36.551	36.551	73.103
65	CRUSHING STATION LV	0.4	50.0	112.5	36.611	36.611	73.221
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	17.236	17.236	34.472
67	DRIVER'S COLONY LV	0.4	50.0	112.5	32.8	32.8	65.599
68	MSF LV	0.4	50.0	112.5	23.928	23.928	47.855
69	OWNER'S COLONY LV	0.4	50.0	112.5	24.788	24.788	49.577
70	PAKISTAN COLONY LV	0.4	50.0	112.5	40.863	40.863	81.727

Case – 3A

Results of Buses

Table 3.7-5 1-Phase Maximum Results (3A)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	0.033	0.033	0.105
2	505 S/S MV	11	31.5	78.8	0.033	0.033	0.105
3	506 S/S MV	11	31.5	78.8	0.033	0.033	0.106
4	507 S/S MV	11	31.5	78.8	0.033	0.033	0.105
5	508 S/S MV	11	31.5	78.8	0.033	0.033	0.106
6	509 S/S MV	11	31.5	78.8	0.033	0.033	0.106
7	510 S/S MV	11	31.5	78.8	0.033	0.033	0.106
8	511 S/S MV	11	31.5	78.8	0.033	0.033	0.106
9	512 S/S MV	11	31.5	78.8	0.033	0.033	0.106
10	513 S/S MV	11	31.5	78.8	0.033	0.033	0.106
11	514 S/S MV	11	31.5	78.8	0.033	0.033	0.106

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
12	515 S/S MV	11	31.5	78.8	0.033	0.033	0.105
13	518 S/S MV	11	31.5	78.8	0.033	0.033	0.105
14	519 S/S MV	11	31.5	78.8	0.033	0.033	0.105
15	521 S/S MV	11	31.5	78.8	0.033	0.033	0.105
16	522 S/S MV	11	31.5	78.8	0.033	0.033	0.106
17	BUFFER PUMP-I	11	31.5	78.8	0.033	0.033	0.106
18	CHINESE COLONY MV	11	31.5	78.8	0.034	0.034	0.106
19	COMP. PUMP STATION MV-I	11	31.5	78.8	0.034	0.034	0.106
20	CONVEYOR BELT MV	11	31.5	78.8	0.034	0.034	0.106
21	CRUSHING STATION MV	11	31.5	78.8	0.034	0.034	0.106
22	DIESEL STORAGE AREA MV	11	31.5	78.8	0.034	0.034	0.106
23	DRIVER'S COLONY MV	11	31.5	78.8	0.034	0.034	0.106
24	Generation Bus-I	11	31.5	78.8	0.034	0.034	0.107
25	Generation Bus-II	11	31.5	78.8	0.034	0.034	0.107
26	Load Bus-I	11	31.5	78.8	0.034	0.034	0.107
27	Load Bus-II	11	31.5	78.8	0.034	0.034	0.107
28	MSF MV	11	31.5	78.8	0.034	0.034	0.106
29	OWNER'S COLONY MV	11	31.5	78.8	0.034	0.034	0.106
30	PAKISTAN COLONY MV	11	31.5	78.8	0.034	0.034	0.106
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.975	11.975	28.512
32	504 S/S LV	0.69	42.0	94.5	11.975	11.975	28.512
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.995	13.995	33.320
34	505 S/S LV	0.69	42.0	94.5	13.995	13.995	33.320
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.236	13.236	31.515
36	506 S/S LV	0.69	42.0	94.5	13.236	13.236	31.515
37	507 S/S LV	0.69	42.0	94.5	12.687	12.687	30.208
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	14.150	14.150	33.689
39	508 S/S LV	0.69	42.0	94.5	14.150	14.150	33.689
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.669	13.669	32.546
41	509 S/S LV	0.69	42.0	94.5	13.669	13.669	32.546
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.050	8.050	19.166
43	510 S/S LV	0.69	42.0	94.5	13.568	13.568	32.305
44	511 S/S LV	0.69	42.0	94.5	13.933	13.933	33.174

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
45	512 S/S LV	0.69	42.0	94.5	13.790	13.790	32.834
46	513 S/S LV	0.69	42.0	94.5	13.660	13.660	32.523
47	514 S/S LV	0.69	42.0	94.5	13.517	13.517	32.184
48	515 S/S LV	0.69	42.0	94.5	11.965	11.965	28.489
49	518 S/S MV	0.69	42.0	94.5	39.220	39.220	93.380
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.150	3.150	6.300
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.592	3.592	7.183
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.196	3.196	6.393
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.596	3.596	7.191
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.210	3.210	6.421
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.525	3.525	7.050
56	519 S/S LV	0.4	50.0	112.5	28.617	28.617	57.234
57	521 S/S LV	0.4	50.0	112.5	29.042	29.042	58.084
58	522 S/S LV	0.4	50.0	112.5	16.872	16.872	33.744
59	BUFFER PUMP-I LV	0.4	50.0	112.5	24.059	24.059	48.117
60	BUFFER PUMP-II LV	0.4	50.0	112.5	24.059	24.059	48.117
61	CHINESE COLONY LV	0.4	50.0	112.5	26.474	26.474	52.948
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	34.364	34.364	68.728
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	34.364	34.364	68.728
64	CONVEYOR BELT LV	0.4	50.0	112.5	42.608	42.608	85.216
65	CRUSHING STATION LV	0.4	50.0	112.5	42.696	42.696	85.392
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	17.558	17.558	35.117
67	DRIVER'S COLONY LV	0.4	50.0	112.5	39.011	39.011	78.022
68	MSF LV	0.4	50.0	112.5	26.841	26.841	53.683
69	OWNER'S COLONY LV	0.4	50.0	112.5	26.240	26.240	52.481
70	PAKISTAN COLONY LV	0.4	50.0	112.5	45.125	45.125	90.250

Case – 3B

Results of Buses

Table 3.7-6 1-Phase Maximum Results (3B)

S.No.	Bus	Network Level [kV]	Rated Capacity					3I0a/Ik"max [%]
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]		
1	504 S/S MV	11	31.5	78.8	0.04	0.04	0.127	
2	505 S/S MV	11	31.5	78.8	0.042	0.042	0.134	
3	506 S/S MV	11	31.5	78.8	0.042	0.042	0.135	
4	507 S/S MV	11	31.5	78.8	0.04	0.04	0.128	
5	508 S/S MV	11	31.5	78.8	0.043	0.043	0.135	
6	509 S/S MV	11	31.5	78.8	0.043	0.043	0.136	
7	510 S/S MV	11	31.5	78.8	0.043	0.043	0.136	
8	511 S/S MV	11	31.5	78.8	0.043	0.043	0.135	
9	512 S/S MV	11	31.5	78.8	0.043	0.043	0.135	
10	513 S/S MV	11	31.5	78.8	0.042	0.042	0.135	
11	514 S/S MV	11	31.5	78.8	0.042	0.042	0.135	
12	515 S/S MV	11	31.5	78.8	0.04	0.04	0.128	
13	518 S/S MV	11	31.5	78.8	0.04	0.04	0.128	
14	519 S/S MV	11	31.5	78.8	0.042	0.042	0.134	
15	521 S/S MV	11	31.5	78.8	0.04	0.04	0.128	
16	522 S/S MV	11	31.5	78.8	0.04	0.04	0.129	
17	BUFFER PUMP-I	11	31.5	78.8	0.043	0.043	0.135	
18	CHINESE COLONY MV	11	31.5	78.8	0.041	0.041	0.13	
19	COMP. PUMP STATION MV-I	11	31.5	78.8	0.043	0.043	0.136	
20	CONVEYOR BELT MV	11	31.5	78.8	0.041	0.041	0.13	
21	CRUSHING STATION MV	11	31.5	78.8	0.041	0.041	0.13	
22	DIESEL STORAGE AREA MV	11	31.5	78.8	0.043	0.043	0.136	
23	DRIVER'S COLONY MV	11	31.5	78.8	0.041	0.041	0.13	
24	Generation Bus-I	11	31.5	78.8	0.043	0.043	0.136	
25	Generation Bus-II	11	31.5	78.8	0.041	0.041	0.13	
26	Load Bus-I	11	31.5	78.8	0.043	0.043	0.136	
27	Load Bus-II	11	31.5	78.8	0.041	0.041	0.13	
28	MSF MV	11	31.5	78.8	0.041	0.041	0.13	
29	OWNER'S COLONY MV	11	31.5	78.8	0.043	0.043	0.136	
30	PAKISTAN COLONY MV	11	31.5	78.8	0.043	0.043	0.136	
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	11.537	11.537	27.47	
32	504 S/S LV	0.69	42.0	94.5	11.537	11.537	27.47	
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.569	13.569	32.306	
34	505 S/S LV	0.69	42.0	94.5	13.569	13.569	32.306	
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	12.784	12.784	30.439	
36	506 S/S LV	0.69	42.0	94.5	12.784	12.784	30.439	

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
37	507 S/S LV	0.69	42.0	94.5	12.183	12.183	29.007
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.701	13.701	32.622
39	508 S/S LV	0.69	42.0	94.5	13.701	13.701	32.622
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	13.196	13.196	31.42
41	509 S/S LV	0.69	42.0	94.5	13.196	13.196	31.42
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.898	7.898	18.804
43	510 S/S LV	0.69	42.0	94.5	13.088	13.088	31.163
44	511 S/S LV	0.69	42.0	94.5	13.485	13.485	32.106
45	512 S/S LV	0.69	42.0	94.5	13.359	13.359	31.806
46	513 S/S LV	0.69	42.0	94.5	13.239	13.239	31.522
47	514 S/S LV	0.69	42.0	94.5	13.075	13.075	31.13
48	515 S/S LV	0.69	42.0	94.5	11.498	11.498	27.377
49	518 S/S MV	0.69	42.0	94.5	36.439	36.439	86.76
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.132	3.132	6.264
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.579	3.579	7.158
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.181	3.181	6.361
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.583	3.583	7.165
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.195	3.195	6.39
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	3.511	3.511	7.021
56	519 S/S LV	0.4	50.0	112.5	27.454	27.454	54.907
57	521 S/S LV	0.4	50.0	112.5	27.877	27.877	55.755
58	522 S/S LV	0.4	50.0	112.5	16.186	16.186	32.371
59	BUFFER PUMP-I LV	0.4	50.0	112.5	23.665	23.665	47.331
60	BUFFER PUMP-II LV	0.4	50.0	112.5	23.665	23.665	47.331
61	CHINESE COLONY LV	0.4	50.0	112.5	24.54	24.54	49.079
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	32.25	32.25	64.5
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	32.25	32.25	64.5
64	CONVEYOR BELT LV	0.4	50.0	112.5	38.518	38.518	77.037
65	CRUSHING STATION LV	0.4	50.0	112.5	38.586	38.586	77.173
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	17.236	17.236	34.472
67	DRIVER'S COLONY LV	0.4	50.0	112.5	34.79	34.79	69.579
68	MSF LV	0.4	50.0	112.5	24.898	24.898	49.797
69	OWNER'S COLONY LV	0.4	50.0	112.5	24.788	24.788	49.577
70	PAKISTAN COLONY LV	0.4	50.0	112.5	40.863	40.863	81.727

3.8 1-Phase Minimum Short Circuit Results

1-Phase Minimum short circuit results at different bus bars are given below:

For detailed results please refer Annex-A.

Case – 1A

Results of Buses

Table 3.8-1 1-Phase Minimum Results (1A)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	Ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	0.018	0.018	0.058
2	505 S/S MV	11	31.5	78.8	0.018	0.018	0.058
3	506 S/S MV	11	31.5	78.8	0.018	0.018	0.058
4	507 S/S MV	11	31.5	78.8	0.018	0.018	0.058
5	508 S/S MV	11	31.5	78.8	0.018	0.018	0.058
6	509 S/S MV	11	31.5	78.8	0.018	0.018	0.058
7	510 S/S MV	11	31.5	78.8	0.018	0.018	0.058
8	511 S/S MV	11	31.5	78.8	0.018	0.018	0.058
9	512 S/S MV	11	31.5	78.8	0.018	0.018	0.058
10	513 S/S MV	11	31.5	78.8	0.018	0.018	0.058
11	514 S/S MV	11	31.5	78.8	0.018	0.018	0.058
12	515 S/S MV	11	31.5	78.8	0.018	0.018	0.058
13	518 S/S MV	11	31.5	78.8	0.018	0.018	0.058
14	519 S/S MV	11	31.5	78.8	0.018	0.018	0.058
15	521 S/S MV	11	31.5	78.8	0.018	0.018	0.058
16	522 S/S MV	11	31.5	78.8	0.018	0.018	0.058
17	BUFFER PUMP-I	11	31.5	78.8	0.018	0.018	0.058
18	CHINESE COLONY MV	11	31.5	78.8	0.018	0.018	0.058
19	COMP. PUMP STATION MV-I	11	31.5	78.8	0.018	0.018	0.058
20	CONVEYOR BELT MV	11	31.5	78.8	0.018	0.018	0.058
21	CRUSHING STATION MV	11	31.5	78.8	0.018	0.018	0.058
22	DIESEL STORAGE AREA MV	11	31.5	78.8	0.018	0.018	0.058
23	DRIVER'S COLONY MV	11	31.5	78.8	0.018	0.018	0.058
24	Generation Bus-I	11	31.5	78.8	0.018	0.018	0.058
25	Generation Bus-II	11	31.5	78.8	0.018	0.018	0.058
26	KIOSK 1 & 2 MV	11	20.0	50.0	0.018	0.018	0.091
27	KIOSK 3 & 4 MV	11	20.0	50.0	0.018	0.018	0.091
28	LINE-01 BUS	11	31.5	78.8	0.018	0.018	0.058
29	LINE-02 BUS	11	31.5	78.8	0.018	0.018	0.058

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	Ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/1k"max [%]
30	Load Bus-I	11	31.5	78.8	0.018	0.018	0.058
31	Load Bus-II	11	31.5	78.8	0.018	0.018	0.058
32	MSF MV	11	31.5	78.8	0.018	0.018	0.058
33	OWNER'S COLONY MV	11	31.5	78.8	0.018	0.018	0.058
34	PAKISTAN COLONY MV	11	31.5	78.8	0.018	0.018	0.058
35	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.528	8.528	20.304
36	504 S/S LV	0.69	42.0	94.5	8.528	8.528	20.304
37	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.093	9.093	21.649
38	505 S/S LV	0.69	42.0	94.5	9.093	9.093	21.649
39	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.158	9.158	21.804
40	506 S/S LV	0.69	42.0	94.5	9.158	9.158	21.804
41	507 S/S LV	0.69	42.0	94.5	8.871	8.871	21.122
42	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.244	9.244	22.010
43	508 S/S LV	0.69	42.0	94.5	9.244	9.244	22.010
44	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.297	9.297	22.136
45	509 S/S LV	0.69	42.0	94.5	9.297	9.297	22.136
46	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	5.594	5.594	13.319
47	510 S/S LV	0.69	42.0	94.5	9.314	9.314	22.177
48	511 S/S LV	0.69	42.0	94.5	9.203	9.203	21.912
49	512 S/S LV	0.69	42.0	94.5	9.070	9.070	21.596
50	513 S/S LV	0.69	42.0	94.5	8.956	8.956	21.323
51	514 S/S LV	0.69	42.0	94.5	9.140	9.140	21.763
52	515 S/S LV	0.69	42.0	94.5	8.672	8.672	20.647
53	518 S/S MV	0.69	42.0	94.5	19.143	19.143	45.579
54	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.557	2.557	5.114
55	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.585	2.585	5.169
56	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.587	2.587	5.175
57	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.591	2.591	5.183
58	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.594	2.594	5.187
59	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.543	2.543	5.085
60	519 S/S LV	0.4	50.0	112.5	19.078	19.078	38.156

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik"	Ip	IL1a	3I0a	3I0a/Ik"max [%]
			[kA]	[kA]	[kA]	[kA]	
61	521 S/S LV	0.4	50.0	112.5	18.138	18.138	36.276
62	522 S/S LV	0.4	50.0	112.5	13.034	13.034	26.069
63	BUFFER PUMP-I LV	0.4	50.0	112.5	12.914	12.914	25.828
64	BUFFER PUMP-II LV	0.4	50.0	112.5	12.914	12.914	25.828
65	CHINESE COLONY LV	0.4	50.0	112.5	19.963	19.963	39.927
66	COMP. PUMP STATION LV-I	0.4	50.0	112.5	23.994	23.994	47.988
67	COMP. PUMP STATION LV-II	0.4	50.0	112.5	23.994	23.994	47.988
68	CONVEYOR BELT LV	0.4	50.0	112.5	28.761	28.761	57.521
69	CRUSHING STATION LV	0.4	50.0	112.5	28.821	28.821	57.643
70	DIESEL STORAGE AREA LV	0.4	50.0	112.5	10.800	10.800	21.600
71	DRIVER'S COLONY LV	0.4	50.0	112.5	28.761	28.761	57.521
72	MSF LV	0.4	50.0	112.5	20.055	20.055	40.110
73	OWNER'S COLONY LV	0.4	50.0	112.5	19.827	19.827	39.654
74	PAKISTAN COLONY LV	0.4	50.0	112.5	32.621	32.621	65.243

Case – 1B**Results of Buses**

Table 3.8-2 1-Phase Minimum Results (1B)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik"	ip	IL1a	3I0a	3I0a/Ik"max [%]
			[kA]	[kA]	[kA]	[kA]	
1	504 S/S MV	11	31.5	78.8	0.028	0.028	0.09
2	505 S/S MV	11	31.5	78.8	0.031	0.031	0.098
3	506 S/S MV	11	31.5	78.8	0.031	0.031	0.098
4	507 S/S MV	11	31.5	78.8	0.029	0.029	0.091
5	508 S/S MV	11	31.5	78.8	0.031	0.031	0.099
6	509 S/S MV	11	31.5	78.8	0.031	0.031	0.099
7	510 S/S MV	11	31.5	78.8	0.031	0.031	0.099
8	511 S/S MV	11	31.5	78.8	0.031	0.031	0.099
9	512 S/S MV	11	31.5	78.8	0.031	0.031	0.098
10	513 S/S MV	11	31.5	78.8	0.031	0.031	0.098
11	514 S/S MV	11	31.5	78.8	0.031	0.031	0.098
12	515 S/S MV	11	31.5	78.8	0.028	0.028	0.09
13	518 S/S MV	11	31.5	78.8	0.028	0.028	0.09
14	519 S/S MV	11	31.5	78.8	0.031	0.031	0.098
15	521 S/S MV	11	31.5	78.8	0.029	0.029	0.09

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
16	522 S/S MV	11	31.5	78.8	0.029	0.029	0.091
17	BUFFER PUMP-I	11	31.5	78.8	0.031	0.031	0.099
18	CHINESE COLONY MV	11	31.5	78.8	0.029	0.029	0.092
19	COMP. PUMP STATION MV-I	11	31.5	78.8	0.031	0.031	0.099
20	CONVEYOR BELT MV	11	31.5	78.8	0.029	0.029	0.092
21	CRUSHING STATION MV	11	31.5	78.8	0.029	0.029	0.092
22	DIESEL STORAGE AREA MV	11	31.5	78.8	0.031	0.031	0.099
23	DRIVER'S COLONY MV	11	31.5	78.8	0.029	0.029	0.092
24	Generation Bus-I	11	31.5	78.8	0.031	0.031	0.099
25	Generation Bus-II	11	31.5	78.8	0.029	0.029	0.092
26	KIOSK 1 & 2 MV	11	20.0	50.0	0.031	0.031	0.155
27	KIOSK 3 & 4 MV	11	20.0	50.0	0.029	0.029	0.144
28	LINE-01 BUS	11	31.5	78.8	0.031	0.031	0.099
29	LINE-02 BUS	11	31.5	78.8	0.029	0.029	0.092
30	Load Bus-I	11	31.5	78.8	0.031	0.031	0.099
31	Load Bus-II	11	31.5	78.8	0.029	0.029	0.092
32	MSF MV	11	31.5	78.8	0.029	0.029	0.092
33	OWNER'S COLONY MV	11	31.5	78.8	0.031	0.031	0.099
34	PAKISTAN COLONY MV	11	31.5	78.8	0.031	0.031	0.099
35	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	7.712	7.712	18.363
36	504 S/S LV	0.69	42.0	94.5	7.712	7.712	18.363
37	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.167	8.167	19.446
38	505 S/S LV	0.69	42.0	94.5	8.167	8.167	19.446
39	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.22	8.22	19.571
40	506 S/S LV	0.69	42.0	94.5	8.22	8.22	19.571
41	507 S/S LV	0.69	42.0	94.5	7.993	7.993	19.031
42	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.29	8.29	19.739
43	508 S/S LV	0.69	42.0	94.5	8.29	8.29	19.739
44	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.333	8.333	19.841
45	509 S/S LV	0.69	42.0	94.5	8.333	8.333	19.841
46	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	5.275	5.275	12.559
47	510 S/S LV	0.69	42.0	94.5	8.347	8.347	19.874
48	511 S/S LV	0.69	42.0	94.5	8.257	8.257	19.661
49	512 S/S LV	0.69	42.0	94.5	8.15	8.15	19.405

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
50	513 S/S LV	0.69	42.0	94.5	8.057	8.057	19.184
51	514 S/S LV	0.69	42.0	94.5	8.206	8.206	19.538
52	515 S/S LV	0.69	42.0	94.5	7.83	7.83	18.643
53	518 S/S MV	0.69	42.0	94.5	15.47	15.47	36.833
54	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.511	2.511	5.022
55	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.537	2.537	5.075
56	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.54	2.54	5.08
57	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.544	2.544	5.088
58	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.546	2.546	5.092
59	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.497	2.497	4.993
60	519 S/S LV	0.4	50.0	112.5	16.766	16.766	33.532
61	521 S/S LV	0.4	50.0	112.5	16.046	16.046	32.091
62	522 S/S LV	0.4	50.0	112.5	11.919	11.919	23.838
63	BUFFER PUMP-I LV	0.4	50.0	112.5	11.814	11.814	23.627
64	BUFFER PUMP-II LV	0.4	50.0	112.5	11.814	11.814	23.627
65	CHINESE COLONY LV	0.4	50.0	112.5	17.463	17.463	34.926
66	COMP. PUMP STATION LV-I	0.4	50.0	112.5	20.45	20.45	40.899
67	COMP. PUMP STATION LV-II	0.4	50.0	112.5	20.45	20.45	40.899
68	CONVEYOR BELT LV	0.4	50.0	112.5	23.839	23.839	47.677
69	CRUSHING STATION LV	0.4	50.0	112.5	23.88	23.88	47.759
70	DIESEL STORAGE AREA LV	0.4	50.0	112.5	10.02	10.02	20.04
71	DRIVER'S COLONY LV	0.4	50.0	112.5	23.839	23.839	47.677
72	MSF LV	0.4	50.0	112.5	17.533	17.533	35.067
73	OWNER'S COLONY LV	0.4	50.0	112.5	17.343	17.343	34.686
74	PAKISTAN COLONY LV	0.4	50.0	112.5	26.394	26.394	52.788

Case – 2A

Results of Buses

Table 3.8-3 1-Phase Minimum Results (2A)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	0.026	0.026	0.082
2	505 S/S MV	11	31.5	78.8	0.026	0.026	0.083
3	506 S/S MV	11	31.5	78.8	0.026	0.026	0.083
4	507 S/S MV	11	31.5	78.8	0.026	0.026	0.083
5	508 S/S MV	11	31.5	78.8	0.026	0.026	0.083
6	509 S/S MV	11	31.5	78.8	0.026	0.026	0.083
7	510 S/S MV	11	31.5	78.8	0.026	0.026	0.084
8	511 S/S MV	11	31.5	78.8	0.026	0.026	0.083
9	512 S/S MV	11	31.5	78.8	0.026	0.026	0.083
10	513 S/S MV	11	31.5	78.8	0.026	0.026	0.083
11	514 S/S MV	11	31.5	78.8	0.026	0.026	0.083
12	515 S/S MV	11	31.5	78.8	0.026	0.026	0.083
13	518 S/S MV	11	31.5	78.8	0.026	0.026	0.082
14	519 S/S MV	11	31.5	78.8	0.026	0.026	0.083
15	521 S/S MV	11	31.5	78.8	0.026	0.026	0.083
16	522 S/S MV	11	31.5	78.8	0.026	0.026	0.083
17	BUFFER PUMP-I	11	31.5	78.8	0.026	0.026	0.083
18	CHINESE COLONY MV	11	31.5	78.8	0.026	0.026	0.084
19	COMP. PUMP STATION MV-I	11	31.5	78.8	0.026	0.026	0.084
20	CONVEYOR BELT MV	11	31.5	78.8	0.026	0.026	0.084
21	CRUSHING STATION MV	11	31.5	78.8	0.026	0.026	0.084
22	DIESEL STORAGE AREA MV	11	31.5	78.8	0.026	0.026	0.084
23	DRIVER'S COLONY MV	11	31.5	78.8	0.026	0.026	0.084
24	Generation Bus-I	11	31.5	78.8	0.026	0.026	0.084
25	Generation Bus-II	11	31.5	78.8	0.026	0.026	0.084
26	Load Bus-I	11	31.5	78.8	0.026	0.026	0.084
27	Load Bus-II	11	31.5	78.8	0.026	0.026	0.084
28	MSF MV	11	31.5	78.8	0.026	0.026	0.084
29	OWNER'S COLONY MV	11	31.5	78.8	0.026	0.026	0.084
30	PAKISTAN COLONY MV	11	31.5	78.8	0.026	0.026	0.084
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.667	8.667	20.636
32	504 S/S LV	0.69	42.0	94.5	8.667	8.667	20.636
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.251	9.251	22.026

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
34	505 S/S LV	0.69	42.0	94.5	9.251	9.251	22.026
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.318	9.318	22.186
36	506 S/S LV	0.69	42.0	94.5	9.318	9.318	22.186
37	507 S/S LV	0.69	42.0	94.5	9.022	9.022	21.481
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.408	9.408	22.399
39	508 S/S LV	0.69	42.0	94.5	9.408	9.408	22.399
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.463	9.463	22.53
41	509 S/S LV	0.69	42.0	94.5	9.463	9.463	22.53
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	5.645	5.645	13.44
43	510 S/S LV	0.69	42.0	94.5	9.48	9.48	22.572
44	511 S/S LV	0.69	42.0	94.5	9.365	9.365	22.298
45	512 S/S LV	0.69	42.0	94.5	9.228	9.228	21.971
46	513 S/S LV	0.69	42.0	94.5	9.109	9.109	21.689
47	514 S/S LV	0.69	42.0	94.5	9.3	9.3	22.144
48	515 S/S LV	0.69	42.0	94.5	8.816	8.816	20.99
49	518 S/S MV	0.69	42.0	94.5	19.86	19.86	47.286
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.564	2.564	5.128
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.592	2.592	5.184
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.595	2.595	5.19
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.599	2.599	5.197
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.601	2.601	5.202
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.55	2.55	5.099
56	519 S/S LV	0.4	50.0	112.5	19.484	19.484	38.969
57	521 S/S LV	0.4	50.0	112.5	18.505	18.505	37.009
58	522 S/S LV	0.4	50.0	112.5	13.222	13.222	26.445
59	BUFFER PUMP-I LV	0.4	50.0	112.5	13.098	13.098	26.197
60	BUFFER PUMP-II LV	0.4	50.0	112.5	13.098	13.098	26.197
61	CHINESE COLONY LV	0.4	50.0	112.5	20.407	20.407	40.815
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	24.639	24.639	49.278
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	24.639	24.639	49.278
64	CONVEYOR BELT LV	0.4	50.0	112.5	29.692	29.692	59.384

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/ik"max [%]
65	CRUSHING STATION LV	0.4	50.0	112.5	29.757	29.757	59.514
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	10.928	10.928	21.857
67	DRIVER'S COLONY LV	0.4	50.0	112.5	29.692	29.692	59.384
68	MSF LV	0.4	50.0	112.5	20.503	20.503	41.006
69	OWNER'S COLONY LV	0.4	50.0	112.5	20.266	20.266	40.532
70	PAKISTAN COLONY LV	0.4	50.0	112.5	33.828	33.828	67.656

Case – 2B

Results of Buses

Table 3.8-4 1-Phase Minimum Results (2B)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/ik"max [%]
1	504 S/S MV	11	31.5	78.8	0.032	0.032	0.102
2	505 S/S MV	11	31.5	78.8	0.035	0.035	0.111
3	506 S/S MV	11	31.5	78.8	0.035	0.035	0.111
4	507 S/S MV	11	31.5	78.8	0.032	0.032	0.103
5	508 S/S MV	11	31.5	78.8	0.035	0.035	0.111
6	509 S/S MV	11	31.5	78.8	0.035	0.035	0.111
7	510 S/S MV	11	31.5	78.8	0.035	0.035	0.112
8	511 S/S MV	11	31.5	78.8	0.035	0.035	0.111
9	512 S/S MV	11	31.5	78.8	0.035	0.035	0.111
10	513 S/S MV	11	31.5	78.8	0.035	0.035	0.111
11	514 S/S MV	11	31.5	78.8	0.035	0.035	0.111
12	515 S/S MV	11	31.5	78.8	0.032	0.032	0.103
13	518 S/S MV	11	31.5	78.8	0.032	0.032	0.103
14	519 S/S MV	11	31.5	78.8	0.035	0.035	0.111
15	521 S/S MV	11	31.5	78.8	0.032	0.032	0.103
16	522 S/S MV	11	31.5	78.8	0.033	0.033	0.103
17	BUFFER PUMP-I	11	31.5	78.8	0.035	0.035	0.111
18	CHINESE COLONY MV	11	31.5	78.8	0.033	0.033	0.104
19	COMP. PUMP STATION MV-I	11	31.5	78.8	0.035	0.035	0.112
20	CONVEYOR BELT MV	11	31.5	78.8	0.033	0.033	0.104
21	CRUSHING STATION MV	11	31.5	78.8	0.033	0.033	0.104
22	DIESEL STORAGE AREA MV	11	31.5	78.8	0.035	0.035	0.112
23	DRIVER'S COLONY MV	11	31.5	78.8	0.033	0.033	0.104

S.No.	Bus	Network Level [kV]	Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
55	510 S/S 100 A TF (400V)	0.4	50.0	112.5	2.523	2.523	5.047
56	519 S/S LV	0.4	50.0	112.5	18.051	18.051	36.101
57	521 S/S LV	0.4	50.0	112.5	15.819	15.819	31.638
58	522 S/S LV	0.4	50.0	112.5	11.794	11.794	23.587
59	BUFFER PUMP-I LV	0.4	50.0	112.5	12.436	12.436	24.872
60	BUFFER PUMP-II LV	0.4	50.0	112.5	12.436	12.436	24.872
61	CHINESE COLONY LV	0.4	50.0	112.5	17.195	17.195	34.39
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	22.392	22.392	44.784
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	22.392	22.392	44.784
64	CONVEYOR BELT LV	0.4	50.0	112.5	23.342	23.342	46.685
65	CRUSHING STATION LV	0.4	50.0	112.5	23.382	23.382	46.763
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	10.464	10.464	20.927
67	DRIVER'S COLONY LV	0.4	50.0	112.5	23.342	23.342	46.685
68	MSF LV	0.4	50.0	112.5	17.264	17.264	34.528
69	OWNER'S COLONY LV	0.4	50.0	112.5	18.72	18.72	37.441
70	PAKISTAN COLONY LV	0.4	50.0	112.5	29.726	29.726	59.452

Case – 3A

Results of Buses

Table 3.8-5 1-Phase Minimum Results (3A)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	0.026	0.026	0.084
2	505 S/S MV	11	31.5	78.8	0.027	0.027	0.084
3	506 S/S MV	11	31.5	78.8	0.027	0.027	0.085
4	507 S/S MV	11	31.5	78.8	0.027	0.027	0.084
5	508 S/S MV	11	31.5	78.8	0.027	0.027	0.085
6	509 S/S MV	11	31.5	78.8	0.027	0.027	0.085
7	510 S/S MV	11	31.5	78.8	0.027	0.027	0.085
8	511 S/S MV	11	31.5	78.8	0.027	0.027	0.085
9	512 S/S MV	11	31.5	78.8	0.027	0.027	0.085
10	513 S/S MV	11	31.5	78.8	0.027	0.027	0.085
11	514 S/S MV	11	31.5	78.8	0.027	0.027	0.085
12	515 S/S MV	11	31.5	78.8	0.026	0.026	0.084
13	518 S/S MV	11	31.5	78.8	0.026	0.026	0.084

Rated Capacity

S.No.	Bus	Network Level [kV]	Ik" [kA]	ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
14	519 S/S MV	11	31.5	78.8	0.027	0.027	0.084
15	521 S/S MV	11	31.5	78.8	0.027	0.027	0.084
16	522 S/S MV	11	31.5	78.8	0.027	0.027	0.085
17	BUFFER PUMP-I	11	31.5	78.8	0.027	0.027	0.085
18	CHINESE COLONY MV	11	31.5	78.8	0.027	0.027	0.085
19	COMP. PUMP STATION MV-I	11	31.5	78.8	0.027	0.027	0.085
20	CONVEYOR BELT MV	11	31.5	78.8	0.027	0.027	0.085
21	CRUSHING STATION MV	11	31.5	78.8	0.027	0.027	0.085
22	DIESEL STORAGE AREA MV	11	31.5	78.8	0.027	0.027	0.085
23	DRIVER'S COLONY MV	11	31.5	78.8	0.027	0.027	0.085
24	Generation Bus-I	11	31.5	78.8	0.027	0.027	0.085
25	Generation Bus-II	11	31.5	78.8	0.027	0.027	0.085
26	Load Bus-I	11	31.5	78.8	0.027	0.027	0.085
27	Load Bus-II	11	31.5	78.8	0.027	0.027	0.085
28	MSF MV	11	31.5	78.8	0.027	0.027	0.085
29	OWNER'S COLONY MV	11	31.5	78.8	0.027	0.027	0.085
30	PAKISTAN COLONY MV	11	31.5	78.8	0.027	0.027	0.085
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.801	8.801	20.955
32	504 S/S LV	0.69	42.0	94.5	8.801	8.801	20.955
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.404	9.404	22.39
34	505 S/S LV	0.69	42.0	94.5	9.404	9.404	22.39
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.473	9.473	22.555
36	506 S/S LV	0.69	42.0	94.5	9.473	9.473	22.555
37	507 S/S LV	0.69	42.0	94.5	9.167	9.167	21.827
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.566	9.566	22.775
39	508 S/S LV	0.69	42.0	94.5	9.566	9.566	22.775
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	9.622	9.622	22.91
41	509 S/S LV	0.69	42.0	94.5	9.622	9.622	22.91
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	5.693	5.693	13.555
43	510 S/S LV	0.69	42.0	94.5	9.64	9.64	22.953
44	511 S/S LV	0.69	42.0	94.5	9.522	9.522	22.67
45	512 S/S LV	0.69	42.0	94.5	9.38	9.38	22.333
46	513 S/S LV	0.69	42.0	94.5	9.257	9.257	22.041
47	514 S/S LV	0.69	42.0	94.5	9.455	9.455	22.511

Rated Capacity

S.No.	Bus	Network Level [kV]	Ik" [kA]	Ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
48	515 S/S LV	0.69	42.0	94.5	8.954	8.954	21.32
49	518 S/S MV	0.69	42.0	94.5	20.319	20.319	48.378
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.571	2.571	5.141
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.599	2.599	5.197
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.602	2.602	5.203
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.605	2.605	5.211
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.608	2.608	5.216
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.556	2.556	5.112
56	519 S/S LV	0.4	50.0	112.5	19.879	19.879	39.759
57	521 S/S LV	0.4	50.0	112.5	18.86	18.86	37.721
58	522 S/S LV	0.4	50.0	112.5	13.403	13.403	26.806
59	BUFFER PUMP-I LV	0.4	50.0	112.5	13.275	13.275	26.55
60	BUFFER PUMP-II LV	0.4	50.0	112.5	13.275	13.275	26.55
61	CHINESE COLONY LV	0.4	50.0	112.5	20.84	20.84	41.679
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	25.273	25.273	50.547
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	25.273	25.273	50.547
64	CONVEYOR BELT LV	0.4	50.0	112.5	30.617	30.617	61.234
65	CRUSHING STATION LV	0.4	50.0	112.5	30.686	30.686	61.372
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	11.051	11.051	22.102
67	DRIVER'S COLONY LV	0.4	50.0	112.5	30.617	30.617	61.234
68	MSF LV	0.4	50.0	112.5	20.94	20.94	41.879
69	OWNER'S COLONY LV	0.4	50.0	112.5	20.693	20.693	41.387
70	PAKISTAN COLONY LV	0.4	50.0	112.5	35.037	35.037	70.074

Case – 3B

Results of Buses

Table 3.8-6 1-Phase Minimum Results (3B)

S.No.	Bus	Network Level [kV]	Rated Capacity				
			Ik" [kA]	Ip [kA]	IL1a [kA]	3I0a [kA]	3I0a/Ik"max [%]
1	504 S/S MV	11	31.5	78.8	0.033	0.033	0.105
2	505 S/S MV	11	31.5	78.8	0.035	0.035	0.111
3	506 S/S MV	11	31.5	78.8	0.035	0.035	0.111
4	507 S/S MV	11	31.5	78.8	0.033	0.033	0.105
5	508 S/S MV	11	31.5	78.8	0.035	0.035	0.111
6	509 S/S MV	11	31.5	78.8	0.035	0.035	0.111
7	510 S/S MV	11	31.5	78.8	0.035	0.035	0.111
8	511 S/S MV	11	31.5	78.8	0.035	0.035	0.111
9	512 S/S MV	11	31.5	78.8	0.035	0.035	0.111
10	513 S/S MV	11	31.5	78.8	0.035	0.035	0.111
11	514 S/S MV	11	31.5	78.8	0.035	0.035	0.111
12	515 S/S MV	11	31.5	78.8	0.033	0.033	0.105
13	518 S/S MV	11	31.5	78.8	0.033	0.033	0.105
14	519 S/S MV	11	31.5	78.8	0.035	0.035	0.111
15	521 S/S MV	11	31.5	78.8	0.033	0.033	0.105
16	522 S/S MV	11	31.5	78.8	0.033	0.033	0.105
17	BUFFER PUMP-I	11	31.5	78.8	0.035	0.035	0.111
18	CHINESE COLONY MV	11	31.5	78.8	0.033	0.033	0.105
19	COMP. PUMP STATION MV-I	11	31.5	78.8	0.035	0.035	0.111
20	CONVEYOR BELT MV	11	31.5	78.8	0.033	0.033	0.105
21	CRUSHING STATION MV	11	31.5	78.8	0.033	0.033	0.105
22	DIESEL STORAGE AREA MV	11	31.5	78.8	0.035	0.035	0.111
23	DRIVER'S COLONY MV	11	31.5	78.8	0.033	0.033	0.105
24	Generation Bus-I	11	31.5	78.8	0.035	0.035	0.111
25	Generation Bus-II	11	31.5	78.8	0.033	0.033	0.105
26	Load Bus-I	11	31.5	78.8	0.035	0.035	0.111
27	Load Bus-II	11	31.5	78.8	0.033	0.033	0.105
28	MSF MV	11	31.5	78.8	0.033	0.033	0.105
29	OWNER'S COLONY MV	11	31.5	78.8	0.035	0.035	0.111
30	PAKISTAN COLONY MV	11	31.5	78.8	0.035	0.035	0.111
31	504 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.169	8.169	19.450
32	504 S/S LV	0.69	42.0	94.5	8.169	8.169	19.450
33	505 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.686	8.686	20.681

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	IL1a [kA]	3I0a [kA]	3I0a/I _k "max [%]
34	505 S/S LV	0.69	42.0	94.5	8.686	8.686	20.681
35	506 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.746	8.746	20.824
36	506 S/S LV	0.69	42.0	94.5	8.746	8.746	20.824
37	507 S/S LV	0.69	42.0	94.5	8.484	8.484	20.200
38	508 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.825	8.825	21.012
39	508 S/S LV	0.69	42.0	94.5	8.825	8.825	21.012
40	509 S/S 100 KVA TF (690V)	0.69	42.0	94.5	8.874	8.874	21.129
41	509 S/S LV	0.69	42.0	94.5	8.874	8.874	21.129
42	510 S/S 100 KVA TF (690V)	0.69	42.0	94.5	5.458	5.458	12.995
43	510 S/S LV	0.69	42.0	94.5	8.889	8.889	21.164
44	511 S/S LV	0.69	42.0	94.5	8.788	8.788	20.924
45	512 S/S LV	0.69	42.0	94.5	8.667	8.667	20.636
46	513 S/S LV	0.69	42.0	94.5	8.562	8.562	20.386
47	514 S/S LV	0.69	42.0	94.5	8.730	8.730	20.786
48	515 S/S LV	0.69	42.0	94.5	8.301	8.301	19.764
49	518 S/S MV	0.69	42.0	94.5	17.246	17.246	41.062
50	504 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.538	2.538	5.076
51	505 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.565	2.565	5.130
52	506 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.568	2.568	5.136
53	508 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.571	2.571	5.142
54	509 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.574	2.574	5.148
55	510 S/S 100 KVA TF (400V)	0.4	50.0	112.5	2.523	2.523	5.046
56	519 S/S LV	0.4	50.0	112.5	18.051	18.051	36.102
57	521 S/S LV	0.4	50.0	112.5	17.207	17.207	34.414
58	522 S/S LV	0.4	50.0	112.5	12.547	12.547	25.094
59	BUFFER PUMP-I LV	0.4	50.0	112.5	12.436	12.436	24.872
60	BUFFER PUMP-II LV	0.4	50.0	112.5	12.436	12.436	24.872
61	CHINESE COLONY LV	0.4	50.0	112.5	18.844	18.844	37.688
62	COMP. PUMP STATION LV-I	0.4	50.0	112.5	22.392	22.392	44.784
63	COMP. PUMP STATION LV-II	0.4	50.0	112.5	22.392	22.392	44.784
64	CONVEYOR BELT LV	0.4	50.0	112.5	26.491	26.491	52.982

S.No.	Bus	Network Level [kV]	Rated Capacity				
			I _k " [kA]	I _p [kA]	I _{L1a} [kA]	I _{L0a} [kA]	I _{L0a} /I _k "max [%]
65	CRUSHING STATION LV	0.4	50.0	112.5	26.542	26.542	53.084
66	DIESEL STORAGE AREA LV	0.4	50.0	112.5	10.464	10.464	20.928
67	DRIVER'S COLONY LV	0.4	50.0	112.5	26.491	26.491	52.982
68	MSF LV	0.4	50.0	112.5	18.926	18.926	37.852
69	OWNER'S COLONY LV	0.4	50.0	112.5	18.720	18.720	37.440
70	PAKISTAN COLONY LV	0.4	50.0	112.5	29.726	29.726	59.452

3.9 Short Circuit Calculations Conclusion

- Short-circuits calculations have been performed as per RMS (Root Mean Square – I_k") & Peak current (I_p) values of the breakers connected to the bus bar.
- Short circuit results show that for 3-Phase, 2-Phase and 1-Phase faults, the initial symmetrical short circuit current as well as the peak fault current are well within the rated capacity for all the Medium Voltage (MV) switchgears in all cases. Rated I_k" and I_p values of all MV switchgears have been considered 31.5 kA and 78.8 kA respectively, except for the switchgears installed at Solar farm, which are rated at 20 kA RMS and 50 kA peak.
- For Low Voltage (LV) switchgears connected to 0.69 kV system, the short-circuit rating of busbars as well as for the breakers have been considered 42 kA and the switchgears, which are connected to 0.4 kV network are rated at 50 kA. After performing short-circuit calculations, it has been observed that switchgears are well within prescribed limits.

4. LOAD FLOW ANALYSIS

4.1 Introduction to Load Flow Analysis

Every load flow problem specifies a system of non-linear equations with no direct solution. Iterative methods, such as current iteration or the Newton-Raphson method, are the only methods that remain. With PSS® SINCAL, either of these procedures can be used.

Newtonian procedures solve problems through iteration by beginning with an initial solution to the desired solution. This solution is improved step by step in order to obtain a linearized statement. Corrections to the voltage rate and the voltage angle are calculated from the active and reactive power still at variance with the prescribed values.

In the normal operation scenario, the load shall be fed by Diesel Engines and Solar Plant. The total load requirement of network is of about 7.4 MW. All the continuous running motors are considered in load flow study.

Load flow study has been carried out to verify:

- The voltage drops at all main busbars.
- Loading of generator, transformers, cables etc.
- Active and reactive power flow in the network.

4.2 Load Flow Scenarios and Results

The voltage profiles results from load flow results are tabulated below. For detailed results at each node, active and reactive power flow and percentage current loadings of MV cables in the branches and motor power consumptions, please refers Annex-A.

For load flow analysis the following color coding have been used to check the components loadings and voltage profile on buses.

Red: Network element exposed to heavy loading based on its rated capacity / Voltages on the network buses drop to less than 95% of the rated values.

- **For Transformer loading**

$$S/S_b < 100[\%]$$

$$S/S_b > = 100[\%]$$

- **For Cables with applied derating factors**

$I/I_b < 100[\%]$

$I/I_b \geq 100[\%]$ (Please refer Annex-A for detailed results)

▪ **For Bus Bar Voltages**

$V/V_n < 95[\%]$

$V/V_n \geq 95[\%]$

Following cases have been simulated for load flow calculations

Table 4.2-1 Load Flow Analysis Operational Cases

Case	2 MVA Diesel Engine [Qty]	11 kV Generation Bus Coupler	Interconnection of Solar Plant
1A	4	ON	YES
1B	4	OFF	YES
2A	5	ON	NO
2B	5	OFF	NO
3A	6	ON	NO
3B	6	OFF	NO

4.3 Voltage Profile

Case – 1A

The voltage level and profile of the network at specified locations are shown in the table below.

Table 4-4.3-1 Voltage Profile at all Main Buses Case 1A

S.No.	Bus	Network Level [kV]	V/Vn [%]
1	504 S/S MV	11	99
2	505 S/S MV	11	99
3	506 S/S MV	11	99
4	507 S/S MV	11	99
5	508 S/S MV	11	99
6	509 S/S MV	11	100
7	510 S/S MV	11	100
8	511 S/S MV	11	100
9	512 S/S MV	11	99
10	513 S/S MV	11	99
11	514 S/S MV	11	99
12	515 S/S MV	11	99
13	518 S/S MV	11	99
14	519 S/S MV	11	99
15	521 S/S MV	11	99
16	522 S/S MV	11	99
17	BUFFER PUMP-I	11	100
18	CHINESE COLONY MV	11	100
19	COMP. PUMP STATION MV-I	11	100
20	CONVEYOR BELT MV	11	100
21	CRUSHING STATION MV	11	100
22	DIESEL STORAGE AREA MV	11	100
23	DRIVER'S COLONY MV	11	100
24	Generation Bus-I	11	100
25	Generation Bus-II	11	100
26	KIOSK 1 & 2 MV	11	100
27	KIOSK 3 & 4 MV	11	100
28	LINE-01 BUS	11	100
29	LINE-02 BUS	11	100
30	Load Bus-I	11	100
31	Load Bus-II	11	100
32	MSF MV	11	100
33	OWNER'S COLONY MV	11	100
34	PAKISTAN COLONY MV	11	100
35	504 S/S 100 KVA TF (690V)	0.69	99
36	504 S/S LV	0.69	99
37	505 S/S 100 KVA TF (690V)	0.69	98

S.No.	Bus	Network Level [kV]	V/Vn [%]
38	505 S/S LV	0.69	98
39	506 S/S 100 KVA TF (690V)	0.69	99
40	506 S/S LV	0.69	99
41	507 S/S LV	0.69	99
42	508 S/S 100 KVA TF (690V)	0.69	98
43	508 S/S LV	0.69	98
44	509 S/S 100 KVA TF (690V)	0.69	99
45	509 S/S LV	0.69	99
46	510 S/S 100 KVA TF (690V)	0.69	99
47	510 S/S LV	0.69	99
48	511 S/S LV	0.69	99
49	512 S/S LV	0.69	97
50	513 S/S LV	0.69	98
51	514 S/S LV	0.69	98
52	515 S/S LV	0.69	100
53	518 S/S MV	0.69	98
54	504 S/S 100 KVA TF (400V)	0.4	99
55	505 S/S 100 KVA TF (400V)	0.4	96
56	506 S/S 100 KVA TF (400V)	0.4	98
57	508 S/S 100 KVA TF (400V)	0.4	97
58	509 S/S 100 KVA TF (400V)	0.4	98
59	510 S/S 100 KVA TF (400V)	0.4	98
60	519 S/S LV	0.4	98
61	521 S/S LV	0.4	99
62	522 S/S LV	0.4	100
63	BUFFER PUMP-I LV	0.4	99
64	BUFFER PUMP-II LV	0.4	99
65	CHINESE COLONY LV	0.4	100
66	COMP. PUMP STATION LV-I	0.4	100
67	COMP. PUMP STATION LV-II	0.4	100
68	CONVEYOR BELT LV	0.4	99
69	CRUSHING STATION LV	0.4	99
70	DIESEL STORAGE AREA LV	0.4	100
71	DRIVER'S COLONY LV	0.4	100
72	MSF LV	0.4	101
73	OWNER'S COLONY LV	0.4	100
74	PAKISTAN COLONY LV	0.4	100

*V/Vn = Bus Voltage / Rated Bus Voltage

For detailed results, please refer Annex A.

Case – 1B

The voltage level and profile of the network at specified locations are shown in the table below.

Table 4-4.3-2 Voltage Profile at all Main Buses Case 1B

S.No.	Bus	Network Level [kV]	V/Vn [%]
1	504 S/S MV	11	99
2	505 S/S MV	11	99
3	506 S/S MV	11	99
4	507 S/S MV	11	99
5	508 S/S MV	11	99
6	509 S/S MV	11	100
7	510 S/S MV	11	100
8	511 S/S MV	11	100
9	512 S/S MV	11	99
10	513 S/S MV	11	99
11	514 S/S MV	11	99
12	515 S/S MV	11	99
13	518 S/S MV	11	99
14	519 S/S MV	11	99
15	521 S/S MV	11	99
16	522 S/S MV	11	99
17	BUFFER PUMP-I	11	100
18	CHINESE COLONY MV	11	100
19	COMP. PUMP STATION MV-I	11	100
20	CONVEYOR BELT MV	11	100
21	CRUSHING STATION MV	11	100
22	DIESEL STORAGE AREA MV	11	100
23	DRIVER'S COLONY MV	11	100
24	Generation Bus-I	11	100
25	Generation Bus-II	11	100
26	KIOSK 1 & 2 MV	11	100
27	KIOSK 3 & 4 MV	11	100
28	LINE-01 BUS	11	100
29	LINE-02 BUS	11	100
30	Load Bus-I	11	100
31	Load Bus-II	11	100
32	MSF MV	11	100
33	OWNER'S COLONY MV	11	100
34	PAKISTAN COLONY MV	11	100
35	504 S/S 100 KVA TF (690V)	0.69	99
36	504 S/S LV	0.69	99
37	505 S/S 100 KVA TF (690V)	0.69	98
38	505 S/S LV	0.69	98

S.No.	Bus	Network Level [kV]	V/Vn [%]
39	506 S/S 100 KVA TF (690V)	0.69	99
40	506 S/S LV	0.69	99
41	507 S/S LV	0.69	99
42	508 S/S 100 KVA TF (690V)	0.69	98
43	508 S/S LV	0.69	98
44	509 S/S 100 KVA TF (690V)	0.69	99
45	509 S/S LV	0.69	99
46	510 S/S 100 KVA TF (690V)	0.69	99
47	510 S/S LV	0.69	99
48	511 S/S LV	0.69	99
49	512 S/S LV	0.69	97
50	513 S/S LV	0.69	98
51	514 S/S LV	0.69	98
52	515 S/S LV	0.69	100
53	518 S/S MV	0.69	98
54	504 S/S 100 KVA TF (400V)	0.4	99
55	505 S/S 100 KVA TF (400V)	0.4	96
56	506 S/S 100 KVA TF (400V)	0.4	98
57	508 S/S 100 KVA TF (400V)	0.4	97
58	509 S/S 100 KVA TF (400V)	0.4	98
59	510 S/S 100 KVA TF (400V)	0.4	98
60	519 S/S LV	0.4	98
61	521 S/S LV	0.4	99
62	522 S/S LV	0.4	100
63	BUFFER PUMP-I LV	0.4	99
64	BUFFER PUMP-II LV	0.4	99
65	CHINESE COLONY LV	0.4	100
66	COMP. PUMP STATION LV-I	0.4	100
67	COMP. PUMP STATION LV-II	0.4	100
68	CONVEYOR BELT LV	0.4	99
69	CRUSHING STATION LV	0.4	99
70	DIESEL STORAGE AREA LV	0.4	100
71	DRIVER'S COLONY LV	0.4	100
72	MSF LV	0.4	101
73	OWNER'S COLONY LV	0.4	100
74	PAKISTAN COLONY LV	0.4	100

Case – 2A

The voltage level and profile of the network at specified locations are shown in the table below.

Table 4-4.3-3 Voltage Profile at all Main Buses Case 2A

S.No.	Bus	Network Level [kV]	V/Vn [%]
1	504 S/S MV	11	99
2	505 S/S MV	11	99
3	506 S/S MV	11	99
4	507 S/S MV	11	99
5	508 S/S MV	11	99
6	509 S/S MV	11	100
7	510 S/S MV	11	100
8	511 S/S MV	11	100
9	512 S/S MV	11	99
10	513 S/S MV	11	99
11	514 S/S MV	11	99
12	515 S/S MV	11	99
13	518 S/S MV	11	99
14	519 S/S MV	11	99
15	521 S/S MV	11	99
16	522 S/S MV	11	99
17	BUFFER PUMP-I	11	100
18	CHINESE COLONY MV	11	100
19	COMP. PUMP STATION MV-I	11	100
20	CONVEYOR BELT MV	11	100
21	CRUSHING STATION MV	11	100
22	DIESEL STORAGE AREA MV	11	100
23	DRIVER'S COLONY MV	11	100
24	Generation Bus-I	11	100
25	Generation Bus-II	11	100
26	Load Bus-I	11	100
27	Load Bus-II	11	100
28	MSF MV	11	100
29	OWNER'S COLONY MV	11	100
30	PAKISTAN COLONY MV	11	100
31	504 S/S 100 KVA TF (690V)	0.69	99
32	504 S/S LV	0.69	99
33	505 S/S 100 KVA TF (690V)	0.69	98
34	505 S/S LV	0.69	98
35	506 S/S 100 KVA TF (690V)	0.69	99
36	506 S/S LV	0.69	99
37	507 S/S LV	0.69	99
38	508 S/S 100 KVA TF (690V)	0.69	98

S.No.	Bus	Network Level [kV]	V/Vn [%]
39	508 S/S LV	0.69	98
40	509 S/S 100 KVA TF (690V)	0.69	99
41	509 S/S LV	0.69	99
42	510 S/S 100 KVA TF (690V)	0.69	99
43	510 S/S LV	0.69	99
44	511 S/S LV	0.69	99
45	512 S/S LV	0.69	97
46	513 S/S LV	0.69	98
47	514 S/S LV	0.69	98
48	515 S/S LV	0.69	100
49	518 S/S MV	0.69	98
50	504 S/S 100 KVA TF (400V)	0.4	99
51	505 S/S 100 KVA TF (400V)	0.4	96
52	506 S/S 100 KVA TF (400V)	0.4	98
53	508 S/S 100 KVA TF (400V)	0.4	97
54	509 S/S 100 KVA TF (400V)	0.4	98
55	510 S/S 100 KVA TF (400V)	0.4	98
56	519 S/S LV	0.4	98
57	521 S/S LV	0.4	99
58	522 S/S LV	0.4	100
59	BUFFER PUMP-I LV	0.4	99
60	BUFFER PUMP-II LV	0.4	99
61	CHINESE COLONY LV	0.4	100
62	COMP. PUMP STATION LV-I	0.4	100
63	COMP. PUMP STATION LV-II	0.4	100
64	CONVEYOR BELT LV	0.4	99
65	CRUSHING STATION LV	0.4	99
66	DIESEL STORAGE AREA LV	0.4	102
67	DRIVER'S COLONY LV	0.4	100
68	MSF LV	0.4	101
69	OWNER'S COLONY LV	0.4	101
70	PAKISTAN COLONY LV	0.4	100

Case – 2B

The voltage level and profile of the network at specified locations are shown in the table below.

Table 4-4.3-4 Voltage Profile at all Main Buses Case 2B

S.No.	Bus	Network Level [kV]	V/Vn [%]
1	504 S/S MV	11	99
2	505 S/S MV	11	99
3	506 S/S MV	11	99
4	507 S/S MV	11	99
5	508 S/S MV	11	99
6	509 S/S MV	11	100
7	510 S/S MV	11	100
8	511 S/S MV	11	100
9	512 S/S MV	11	99
10	513 S/S MV	11	99
11	514 S/S MV	11	99
12	515 S/S MV	11	99
13	518 S/S MV	11	99
14	519 S/S MV	11	99
15	521 S/S MV	11	99
16	522 S/S MV	11	99
17	BUFFER PUMP-I	11	100
18	CHINESE COLONY MV	11	100
19	COMP. PUMP STATION MV-I	11	100
20	CONVEYOR BELT MV	11	100
21	CRUSHING STATION MV	11	100
22	DIESEL STORAGE AREA MV	11	100
23	DRIVER'S COLONY MV	11	100
24	Generation Bus-I	11	100
25	Generation Bus-II	11	100
26	Load Bus-I	11	100
27	Load Bus-II	11	100
28	MSF MV	11	100
29	OWNER'S COLONY MV	11	100
30	PAKISTAN COLONY MV	11	100
31	504 S/S 100 KVA TF (690V)	0.69	99
32	504 S/S LV	0.69	99
33	505 S/S 100 KVA TF (690V)	0.69	98
34	505 S/S LV	0.69	98
35	506 S/S 100 KVA TF (690V)	0.69	99
36	506 S/S LV	0.69	99
37	507 S/S LV	0.69	99
38	508 S/S 100 KVA TF (690V)	0.69	98

S.No.	Bus	Network Level [kV]	V/Vn [%]
39	508 S/S LV	0.69	98
40	509 S/S 100 KVA TF (690V)	0.69	99
41	509 S/S LV	0.69	99
42	510 S/S 100 KVA TF (690V)	0.69	99
43	510 S/S LV	0.69	99
44	511 S/S LV	0.69	99
45	512 S/S LV	0.69	97
46	513 S/S LV	0.69	98
47	514 S/S LV	0.69	98
48	515 S/S LV	0.69	100
49	518 S/S MV	0.69	98
50	504 S/S 100 KVA TF (400V)	0.4	99
51	505 S/S 100 KVA TF (400V)	0.4	96
52	506 S/S 100 KVA TF (400V)	0.4	98
53	508 S/S 100 KVA TF (400V)	0.4	97
54	509 S/S 100 KVA TF (400V)	0.4	98
55	510 S/S 100 KVA TF (400V)	0.4	98
56	519 S/S LV	0.4	98
57	521 S/S LV	0.4	99
58	522 S/S LV	0.4	100
59	BUFFER PUMP-I LV	0.4	99
60	BUFFER PUMP-II LV	0.4	99
61	CHINESE COLONY LV	0.4	100
62	COMP. PUMP STATION LV-I	0.4	100
63	COMP. PUMP STATION LV-II	0.4	100
64	CONVEYOR BELT LV	0.4	99
65	CRUSHING STATION LV	0.4	99
66	DIESEL STORAGE AREA LV	0.4	102
67	DRIVER'S COLONY LV	0.4	100
68	MSF LV	0.4	101
69	OWNER'S COLONY LV	0.4	101
70	PAKISTAN COLONY LV	0.4	100

Case – 3A

The voltage level and profile of the network at specified locations are shown in the table below.

Table 4-4.3-5 Voltage Profile at all Main Buses Case 3A

S.No.	Bus	Network Level [kV]	V/Vn [%]
1	504 S/S MV	11	99
2	505 S/S MV	11	99
3	506 S/S MV	11	99
4	507 S/S MV	11	99
5	508 S/S MV	11	99
6	509 S/S MV	11	100
7	510 S/S MV	11	100
8	511 S/S MV	11	100
9	512 S/S MV	11	99
10	513 S/S MV	11	99
11	514 S/S MV	11	99
12	515 S/S MV	11	99
13	518 S/S MV	11	99
14	519 S/S MV	11	99
15	521 S/S MV	11	99
16	522 S/S MV	11	99
17	BUFFER PUMP-I	11	100
18	CHINESE COLONY MV	11	100
19	COMP. PUMP STATION MV-I	11	100
20	CONVEYOR BELT MV	11	100
21	CRUSHING STATION MV	11	100
22	DIESEL STORAGE AREA MV	11	100
23	DRIVER'S COLONY MV	11	100
24	Generation Bus-I	11	100
25	Generation Bus-II	11	100
26	Load Bus-I	11	100
27	Load Bus-II	11	100
28	MSF MV	11	100
29	OWNER'S COLONY MV	11	100
30	PAKISTAN COLONY MV	11	100
31	504 S/S 100 A TF (690V)	0.69	99
32	504 S/S LV	0.69	99
33	505 S/S 100 A TF (690V)	0.69	98
34	505 S/S LV	0.69	98
35	506 S/S 100 A TF (690V)	0.69	99
36	506 S/S LV	0.69	99
37	507 S/S LV	0.69	99

S.No.	Bus	Network Level [kV]	V/Vn [%]
38	508 S/S 100 A TF (690V)	0.69	98
39	508 S/S LV	0.69	98
40	509 S/S 100 A TF (690V)	0.69	99
41	509 S/S LV	0.69	99
42	510 S/S 100 A TF (690V)	0.69	99
43	510 S/S LV	0.69	99
44	511 S/S LV	0.69	99
45	512 S/S LV	0.69	97
46	513 S/S LV	0.69	98
47	514 S/S LV	0.69	98
48	515 S/S LV	0.69	100
49	518 S/S MV	0.69	98
50	504 S/S 100 A TF (400V)	0.4	99
51	505 S/S 100 A TF (400V)	0.4	96
52	506 S/S 100 A TF (400V)	0.4	98
53	508 S/S 100 A TF (400V)	0.4	97
54	509 S/S 100 A TF (400V)	0.4	98
55	510 S/S 100 A TF (400V)	0.4	98
56	519 S/S LV	0.4	98
57	521 S/S LV	0.4	99
58	522 S/S LV	0.4	100
59	BUFFER PUMP-I LV	0.4	99
60	BUFFER PUMP-II LV	0.4	99
61	CHINESE COLONY LV	0.4	100
62	COMP. PUMP STATION LV-I	0.4	100
63	COMP. PUMP STATION LV-II	0.4	100
64	CONVEYOR BELT LV	0.4	99
65	CRUSHING STATION LV	0.4	99
66	DIESEL STORAGE AREA LV	0.4	100
67	DRIVER'S COLONY LV	0.4	100
68	MSF LV	0.4	101
69	OWNER'S COLONY LV	0.4	100
70	PAKISTAN COLONY LV	0.4	100

Case – 3B

The voltage level and profile of the network at specified locations are shown in the table below.

Table 4-4.3-6 Voltage Profile at all Main Buses Case 3B

S.No.	Bus	Network Level [kV]	V/Vn [%]
1	504 S/S MV	11	99
2	505 S/S MV	11	99
3	506 S/S MV	11	99
4	507 S/S MV	11	99
5	508 S/S MV	11	99
6	509 S/S MV	11	100
7	510 S/S MV	11	100
8	511 S/S MV	11	100
9	512 S/S MV	11	99
10	513 S/S MV	11	99
11	514 S/S MV	11	99
12	515 S/S MV	11	99
13	518 S/S MV	11	99
14	519 S/S MV	11	99
15	521 S/S MV	11	99
16	522 S/S MV	11	99
17	BUFFER PUMP-I	11	100
18	CHINESE COLONY MV	11	100
19	COMP. PUMP STATION MV-I	11	100
20	CONVEYOR BELT MV	11	100
21	CRUSHING STATION MV	11	100
22	DIESEL STORAGE AREA MV	11	100
23	DRIVER'S COLONY MV	11	100
24	Generation Bus-I	11	100
25	Generation Bus-II	11	100
26	Load Bus-I	11	100
27	Load Bus-II	11	100
28	MSF MV	11	100
29	OWNER'S COLONY MV	11	100
30	PAKISTAN COLONY MV	11	100
31	504 S/S 100 KVA TF (690V)	0.69	99
32	504 S/S LV	0.69	99
33	505 S/S 100 KVA TF (690V)	0.69	98
34	505 S/S LV	0.69	98
35	506 S/S 100 KVA TF (690V)	0.69	99
36	506 S/S LV	0.69	99
37	507 S/S LV	0.69	99
38	508 S/S 100 KVA TF (690V)	0.69	98

S.No.	Bus	Network Level [kV]	V/Vn [%]
39	508 S/S LV	0.69	98
40	509 S/S 100 KVA TF (690V)	0.69	99
41	509 S/S LV	0.69	99
42	510 S/S 100 KVA TF (690V)	0.69	99
43	510 S/S LV	0.69	99
44	511 S/S LV	0.69	99
45	512 S/S LV	0.69	97
46	513 S/S LV	0.69	98
47	514 S/S LV	0.69	98
48	515 S/S LV	0.69	100
49	518 S/S MV	0.69	98
50	504 S/S 100 KVA TF (400V)	0.4	99
51	505 S/S 100 KVA TF (400V)	0.4	96
52	506 S/S 100 KVA TF (400V)	0.4	98
53	508 S/S 100 KVA TF (400V)	0.4	97
54	509 S/S 100 KVA TF (400V)	0.4	98
55	510 S/S 100 KVA TF (400V)	0.4	98
56	519 S/S LV	0.4	98
57	521 S/S LV	0.4	99
58	522 S/S LV	0.4	100
59	BUFFER PUMP-I LV	0.4	99
60	BUFFER PUMP-II LV	0.4	99
61	CHINESE COLONY LV	0.4	100
62	COMP. PUMP STATION LV-I	0.4	100
63	COMP. PUMP STATION LV-II	0.4	100
64	CONVEYOR BELT LV	0.4	99
65	CRUSHING STATION LV	0.4	99
66	DIESEL STORAGE AREA LV	0.4	100
67	DRIVER'S COLONY LV	0.4	100
68	MSF LV	0.4	101
69	OWNER'S COLONY LV	0.4	100
70	PAKISTAN COLONY LV	0.4	100

4.4 Transformer Loading

Case – 1A

The power loading for all the transformers is as follows:

Table 4-4.4-1 Transformer loading Case 1A

S.No.	Element Name	Loading [MVA]	Rated [MVA]	S/Sb [%]
1	504 S/S 100 KVA TF	63	100	63
2	504 S/S	187	630	30
3	505 S/S 100 KVA TF	50	100	50
4	505 S/S	467	630	74
5	506 S/S 100 KVA TF	63	100	63
6	506 S/S	321	630	51
7	507 S/S	195	630	31
8	508 S/S 100 KVA TF	50	100	50
9	508 S/S	397	630	63
10	509 S/S 100 KVA TF	63	100	63
11	509 S/S	355	630	56
12	510 S/S 100 KVA TF	56	100	56
13	510 S/S	289	630	46
14	511 S/S	385	630	61
15	512 S/S	464	630	74
16	513 S/S	379	630	60
17	514 S/S	316	630	50
18	515 S/S	121	630	19
19	518 S/S	1105	2500	44
20	519 S/S	380	800	48
21	521 S/S	300	800	38
22	522 S/S	148	630	23
23	BUFFER PUMP-I	292	500	58
24	CHINESE COLONY S/S	123	800	15
25	COMP. PUMP STATION-I	331	1000	33
26	CONVEYOR BELT MV	469	1250	38
27	CRUSHING STATION	469	1250	38
28	DIESEL STORAGE AREA	32	400	8
29	DRIVER'S COLONY MV	201	1250	16
30	MSF	273	800	34
31	OWNER'S COLONY	74	800	9
32	PAKISTAN COLONY	54	1500	4

*S/Sb = MVA Loading

For detailed results, please refer Annex A.

Case – 1B

The power loading for all the transformers is as follows:

Table 4-4.4-2 Transformer loading Case 1B

S.No.	Element Name	Loading [MVA]	Rated [MVA]	S/Sb [%]
1	504 S/S	187	630	30
2	504 S/S 100 KVA TF	63	100	63
3	505 S/S	467	630	74
4	505 S/S 100 KVA TF	50	100	50
5	506 S/S	321	630	51
6	506 S/S 100 KVA TF	63	100	63
7	507 S/S	195	630	31
8	508 S/S	397	630	63
9	508 S/S 100 KVA TF	50	100	50
10	509 S/S	355	630	56
11	509 S/S 100 KVA TF	63	100	63
12	510 S/S	289	630	46
13	510 S/S 100 KVA TF	56	100	56
14	511 S/S	385	630	61
15	512 S/S	464	630	74
16	513 S/S	379	630	60
17	514 S/S	316	630	50
18	515 S/S	121	630	19
19	518 S/S	1105	2500	44
20	519 S/S	380	800	48
21	521 S/S	300	800	38
22	522 S/S	148	630	23
23	BUFFER PUMP-I	292	500	58
24	CHINESE COLONY S/S	123	800	15
25	COMP. PUMP STATION-I	331	1000	33
26	CONVEYOR BELT MV	469	1250	38
27	CRUSHING STATION	469	1250	38
28	DIESEL STORAGE AREA	32	400	8
29	DRIVER'S COLONY MV	201	1250	16
30	MSF	273	800	34
31	OWNER'S COLONY	74	800	9
32	PAKISTAN COLONY	54	1500	4

*S/Sb = MVA Loading

For detailed results, please refer Annex A.

Case – 2A

The power loading for all the transformers is as follows:

Table 4-4.4-3 Transformer loading Case 2A

S.No.	Element Name	Loading [MVA]	Rated [MVA]	S/Sb [%]
1	504 S/S	187	630	30
2	504 S/S 100 KVA TF	63	100	63
3	505 S/S	467	630	74
4	505 S/S 100 KVA TF	50	100	50
5	506 S/S	321	630	51
6	506 S/S 100 KVA TF	63	100	63
7	507 S/S	195	630	31
8	508 S/S	397	630	63
9	508 S/S 100 KVA TF	50	100	50
10	509 S/S	355	630	56
11	509 S/S 100 KVA TF	63	100	63
12	510 S/S	289	630	46
13	510 S/S 100 KVA TF	56	100	56
14	511 S/S	385	630	61
15	512 S/S	464	630	74
16	513 S/S	379	630	60
17	514 S/S	316	630	50
18	515 S/S	121	630	19
19	518 S/S	1105	2500	44
20	519 S/S	380	800	48
21	521 S/S	300	800	38
22	522 S/S	148	630	23
23	BUFFER PUMP-I	292	500	58
24	CHINESE COLONY S/S	123	800	15
25	COMP. PUMP STATION-I	331	1000	33
26	CONVEYOR BELT MV	469	1250	38
27	CRUSHING STATION	469	1250	38
28	DIESEL STORAGE AREA	170	400	43
29	DRIVER'S COLONY MV	201	1250	16
30	MSF	273	800	34
31	OWNER'S COLONY	220	800	28
32	PAKISTAN COLONY	54	1500	4

*S/Sb = MVA Loading

For detailed results, please refer Annex A.

Case – 2B

The power loading for all the transformers is as follows:

Table 4-4.4-4 Transformer loading Case 2B

S.No.	Element Name	Loading [MVA]	Rated [MVA]	S/Sb [%]
1	504 S/S	187	630	30
2	504 S/S 100 KVA TF	63	100	63
3	505 S/S	467	630	74
4	505 S/S 100 KVA TF	50	100	50
5	506 S/S	321	630	51
6	506 S/S 100 KVA TF	63	100	63
7	507 S/S	195	630	31
8	508 S/S	397	630	63
9	508 S/S 100 KVA TF	50	100	50
10	509 S/S	355	630	56
11	509 S/S 100 KVA TF	63	100	63
12	510 S/S	289	630	46
13	510 S/S 100 KVA TF	56	100	56
14	511 S/S	385	630	61
15	512 S/S	464	630	74
16	513 S/S	379	630	60
17	514 S/S	316	630	50
18	515 S/S	121	630	19
19	518 S/S	1105	2500	44
20	519 S/S	380	800	48
21	521 S/S	300	800	38
22	522 S/S	148	630	23
23	BUFFER PUMP-I	292	500	58
24	CHINESE COLONY S/S	123	800	15
25	COMP. PUMP STATION-I	331	1000	33
26	CONVEYOR BELT MV	469	1250	38
27	CRUSHING STATION	469	1250	38
28	DIESEL STORAGE AREA	170	400	43
29	DRIVER'S COLONY MV	201	1250	16
30	MSF	273	800	34
31	OWNER'S COLONY	220	800	28
32	PAKISTAN COLONY	54	1500	4

*S/Sb = MVA Loading

For detailed results, please refer Annex A.

Case – 3A

The power loading for all the transformers is as follows:

Table 4-4.4-5 Transformer loading Case 3A

S.No.	Element Name	Loading [MVA]	Rated [MVA]	S/Sb [%]
1	504 S/S	187	630	30
2	504 S/S 100 KVA TF	64	100	64
3	505 S/S	467	630	74
4	505 S/S 100 KVA TF	50	100	50
5	506 S/S	323	630	51
6	506 S/S 100 KVA TF	64	100	64
7	507 S/S	195	630	31
8	508 S/S	401	630	64
9	508 S/S 100 KVA TF	51	100	51
10	509 S/S	355	630	56
11	509 S/S 100 KVA TF	63	100	63
12	510 S/S	290	630	46
13	510 S/S 100 KVA TF	57	100	57
14	511 S/S	385	630	61
15	512 S/S	464	630	74
16	513 S/S	383	630	61
17	514 S/S	316	630	50
18	515 S/S	121	630	19
19	518 S/S	1037	2500	41
20	519 S/S	380	800	48
21	521 S/S	301	800	38
22	522 S/S	148	630	24
23	BUFFER PUMP-I	292	500	58
24	CHINESE COLONY S/S	123	800	15
25	COMP. PUMP STATION-I	330	1000	33
26	CONVEYOR BELT MV	469	1250	38
27	CRUSHING STATION	469	1250	38
28	DIESEL STORAGE AREA	32	400	8
29	DRIVER'S COLONY MV	201	1250	16
30	MSF	269	800	34
31	OWNER'S COLONY	74	800	9
32	PAKISTAN COLONY	54	1500	4

*S/Sb = MVA Loading

For detailed results, please refer Annex A.

Case – 3B

The power loading for all the transformers is as follows:

Table 4-4.4-6 Transformer loading Case 3B

S.No.	Element Name	Loading [MVA]	Rated [MVA]	S/Sb [%]
T	504 S/S	187	630	30
2	504 S/S 100 KVA TF	63	100	63
3	505 S/S	467	630	74
4	505 S/S 100 KVA TF	50	100	50
5	506 S/S	321	630	51
6	506 S/S 100 KVA TF	63	100	63
7	507 S/S	195	630	31
8	508 S/S	397	630	63
9	508 S/S 100 KVA TF	50	100	50
10	509 S/S	355	630	56
11	509 S/S 100 KVA TF	63	100	63
12	510 S/S	289	630	46
13	510 S/S 100 KVA TF	56	100	56
14	511 S/S	385	630	61
15	512 S/S	464	630	74
16	513 S/S	379	630	60
17	514 S/S	316	630	50
18	515 S/S	122	630	19
19	518 S/S	1037	2500	41
20	519 S/S	380	800	48
21	521 S/S	300	800	38
22	522 S/S	148	630	24
23	BUFFER PUMP-I	292	500	58
24	CHINESE COLONY S/S	123	800	15
25	COMP. PUMP STATION-I	331	1000	33
26	CONVEYOR BELT MV	469	1250	38
27	CRUSHING STATION	469	1250	38
28	DIESEL STORAGE AREA	32	400	8
29	DRIVER'S COLONY MV	201	1250	16
30	MSF	273	800	34
31	OWNER'S COLONY	74	800	9
32	PAKISTAN COLONY	54	1500	4

*S/Sb = MVA Loading

For detailed results, please refer Annex A.

4.5 Generators' Loading

Below table has been formulated to present the contribution from power sources in different scenarios for feeding an approximate peak load of 7.4 MW of SECMC plant.

Table 4-4.5-1 Generator Loadings

Case	Unit	Generation Bus-I						Generation Bus-II				
		Diesel Engine-09	Diesel Engine-07	Diesel Engine-05	Diesel Engine-03	Diesel Engine-01	KIOSK I & II	Diesel Engine-02	Diesel Engine-04	Diesel Engine-06	Diesel Engine-08	KIOSK III & IV
1A	MW	1.11	1.11				1.44	1.11	0.963			1.53
	MVAr	0.538	0.538	Out of Service	Out of Service	Out of Service	0.024	0.538	0.464	Out of Service	Out of Service	0.024
	S/Sb [%]	61.67	61.67				75	61.67	53.47			75
1B	MW	1.4	1.42				1.44	1.11	0.368			1.53
	MVAr	0.678	0.753	Out of Service	Out of Service	Out of Service	0.024	0.538	0.107	Out of Service	Out of Service	0.024
	S/Sb [%]	77.78	80.19				75	61.67	19.14			75
2A	MW	1.48	1.48	1.48				1.48	1.33			
	MVAr	0.486	0.486	0.486	Out of Service	Out of Service	Out of Service	0.486	-0.261	Out of Service	Out of Service	Out of Service
	S/Sb [%]	77.89	77.89	77.89				77.89	67.71			
2B	MW	1.42	1.42	1.41				1.5	1.5			
	MVAr	0.467	0.467	0.088	Out of Service	Out of Service	Out of Service	0.493	0.171	Out of Service	Out of Service	Out of Service
	S/Sb [%]	74.74	74.74	70.58				78.95	75.48			
3A	MW	1.2	1.2	1.2				1.2	1.2	1.25		
	MVAr	0.394	0.394	0.394	Out of Service	Out of Service	Out of Service	0.394	0.394	0.165	Out of Service	Out of Service
	S/Sb [%]	63.16	63.16	63.16				63.16	63.16	63.05		
3B	MW	1.42	1.42	1.41				1	1	1		
	MVAr	0.467	0.467	0.514	Out of Service	Out of Service	Out of Service	0.329	-0.298	0.329	Out of Service	Out of Service
	S/Sb [%]	74.74	74.74	74.99				52.63	52.24	52.63		

4.6 Load Flow Analysis Conclusion

Load flow conditions show that the voltage profile on all the bus bars is within the permissible range (95% to 105%). Transformer loadings are also within rated MVA with a safety margin. MV & LV cables are found to be loaded well below than 100% rating. Moreover, by operating the network at peak load of around 7.4 MW, it has been observed that the network operates satisfactory, please refer Annex-A for detailed results.

5. OBSERVATIONS & RECOMMENDATIONS

5.1 Observations

The electrical network of Sindh Engro Coal Mining Company has been evaluated for different operational scenarios for breach in the short circuit ratings as well as the continuous ratings of the network elements.

Following are our observations and recommendations with respect to Short Circuit and load flow Calculations:

Short circuit Calculations

- Short-circuits calculations have been performed as per RMS (Root Mean Square – I_k'') & Peak current (i_p) values of the breakers connected to the bus bar.
- Short circuit results show that for 3-Phase, 2-Phase and 1-Phase faults, the initial symmetrical short circuit current as well as the peak fault current are well within the rated capacity for all the Medium Voltage (MV) switchgears in all cases. Rated I_k'' and i_p values of all MV switchgears have been considered 31.5 kA and 78.8 kA respectively, except for the switchgears installed at Solar farm, which are rated at 20 kA RMS and 50 kA peak.
- For Low Voltage (LV) switchgears connected to 0.69 kV system, the short-circuit rating of busbars as well as for the breakers have been considered 42 kA and the switchgears, which are connected to 0.4 kV network are rated at 50 kA. After performing short-circuit calculations, it has been observed that switchgears are well within prescribed limits.
- To limit the earth fault current in SECMC network, Resonant Earthed System has been installed, i.e. a neutral point reactance source is connected between the ZN connected transformer neutral and the station earthing system. A system in which at least one of the neutrals is connected to earth via an inductive reactance, a Petersen coil or Arc Suppression Coil, and the current generated by the reactance during an earth fault approximately compensates the capacitive component of the single-phase earth fault current.

The meshed network of SECMC, i.e. when the Generation bus coupler is in Normally Closed position; the network generates capacitive earth fault currents of around 26 A and on the other hand, in islanded operation, i.e. when the Generation bus coupler is in Normally Open position, Gen Bus I & II sides generate capacitive earth fault currents of 12 A and 14 A respectively. These capacitive currents have been observed without connecting Arc Suppression Coil. After connecting ARC to the network,

capacitive currents have been suppressed by the reactive current of 50 A, which give resultantly the actual earth fault current of 38A.

- The system is hardly ever exactly tuned, i.e. the reactive current does not exactly equal the capacitive earth fault current of the system. A system in which the inductive current is slightly larger than the capacitive earth fault current is over compensated. A system in which the induced earth fault current is slightly smaller than the capacitive earth fault current is under compensated. Below figure shows the earth fault current phasors of a slightly over compensated system, which is the case in SECMC network.

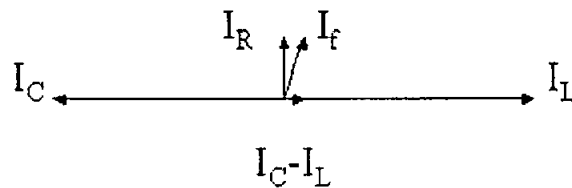


Figure 2 Over Compensated Resonant Earthed Systems

From the above explanation, it is evident to conclude that the earth fault currents are less in magnitude.

Load Flow Analysis:

- Load flow conditions show that the voltage profile on all the bus bars is within the permissible range (95% to 105%). Transformer loadings are also within rated MVA with a safety margin. MV & LV cables are found to be loaded well below than 100% rating. Moreover, by operating the network at peak load of around 7.4 MW, it has been observed that the network operates satisfactory, please refer Annex-A for detailed results.
- In case 2A and 3B, Diesel Generator-04, which has been considered a slack source to the network, operates slightly in under-excitation mode, i.e. the reactive power of approximately 260 kVAR is being consumed by the generator. This occurs when the other generators and system reactive compensation units are enough to fulfill the reactive demand of the network. Mostly generators are designed to operate between 0.8 lagging to 0.9 leading power factor, however, this shall be verified from the capability curve of the generator provided by its manufacturer.

5.2 Recommendations

- Both Arc Suppression Coils shall be connected to the 11 kV bus bar when the network is operating in two islands i.e. when bus couplers of both Generation and Load buses are in Normally open position.

- Voltage at following LV bus bars is around 0.97 pu, which is in the permissible range as per the current conditions of the network, however prior to making any changes on these substations (change in cable length/configuration and load addition) proper assessment shall be carried out to analyze the post voltage profile,
 - 505 S/S LV Bus
 - 512 S/S LV Bus
 - 518 S/S LV Bus
 - 519 S/S LV Bus
- 2 x 300 kVAR capacitor banks are connected to MSF Substation, it has been observed that single 300 kVAR effectively fulfill the reactive demand of the substation.