25 October 2014

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

Subject: **Application for Modification in Generation License No. WPGL/24/2014**

I, Bruno Bucari, Chief Executive Officer, being the duly authorized representative of HAWA Energy (Private) Limited by virtue of Board Resolution dated 25 October 2014 (the "**Petitioner**"), hereby apply to the National Electric Power Regulatory Authority (the "**Authority**") for the modification of our Generation License, pursuant to Section 10 (2) of the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999.

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

Yours truly,
Hawa Energy Private Limited

Bruno Bucari
Chief Executive Officer
HAWA Energy (Private) Limited

HAWA **ENERGY**
Conservation Solutions
14 ISLAMABAD TERRACES, DIPLOMATIC ENCLAVE, G-5, ISLAMABAD.
+92-51-831 7413 +92-51-260 0650 info@hawa-energy.com

Extracts from
Resolution Passed by the Board of Directors of
OF HAWA ENERGY (PRIVATE) LIMITED
On 25 October 2014

"**RESOLVED** that an application for Modification of the Generation License (the "**LPM Application**") be filed by and on behalf of HAWA Energy (Private) Limited (the "**Company**") with the National Electric Power Regulatory Authority ("**NEPRA**"), in connection with the generation license for the Company bearing # WPGL/24/2014 dated 1 January 2014 in respect of the Company's 50 MW wind energy power project at Jhampir, Sindh (the "**Project**").

RESOLVED FURTHER that Mr. Bruno Bucari, the Chief Executive (CEO) of the Company, be and is hereby authorized to sign the LPM Application, and any documentation ancillary thereto, pay all filing fees, and provide any information required by NEPRA in respect of the Project, and do all acts and things necessary for the processing, completion and finalization of the LPM Application .

Certified true copy

Bruno Bucari
Chief Executive Officer
HAWA Energy (Private) Limited

CERTIFICATION

CERTIFIED, that, the above resolution by circulation was duly passed by the Board of Directors of Hawa Energy (Private) Limited, on 25 October 2014, for which the quorum of directors was present.

FURTHER CERTIFIED, that the said resolution has not been rescinded and is in operation and that this is a true copy thereof.

Bruno Bucari
Chief Executive Officer

VAKALATNAMA

I/We, MR. BRUNO BUCARI of HAWA Energy (Private) Limited (the "**Company**"), hereby appoint and constitute M/s **MR. NADIR ALTAF, MR. MUSTAFA MUNIR AHMED, MR. SHAHRUKH IFTIKHAR** of **RIAALAW,** Advocates and Corporate Counsellors, to appear and act for us as our advocates in connection with the processing, presentation of the Company's Application for Modification of the Generation License (the "**Application**"), in connection with the generation license for the Company bearing # WPGL/24/2014 dated 1 January 2014 in respect of the Company's 50 MW wind energy power project at Jhampir, Sindh (the "**Project**").

I/We also authorize the said Advocates or any one of them to do all acts and things necessary for the processing, completion and finalization of the Application with NEPRA.

ACCEPTED

SIGNATURE ____________________
Received by us: ____________________
From: ____________________

RIAALAW
ADVOCATES & CORPORATE COUNSELLORS
68 NAZIMUDDIN ROAD, F-8/4,
ISLAMABAD
UAN: 111-LAWYER

BEFORE

THE NATIONAL ELECTRIC POWER

REGULATORY AUTHORITY

PETITION FOR LICENSEE PROPOSED MODIFICATION OF LICENSE No WPGL/24/2014

ON BEHALF OF
HAWA ENERGY (PRIVATE) LIMITED

Dated: 29 October 2014

Submitted by:

Legal Consultants
RIAALAW
Advocates & Corporate Counselors
68, Nazimuddin Road, F-8/4, Islamabad
Tel: 051-111-LAWYER, Fax: 051-2850444
www.riaalaw.com

PETITION FOR LICENSEE PROPOSED MODIFICATION OF LICENSE No WPGL/24/2014

ON BEHALF OF
HAWA ENERGY (PRIVATE) LIMITED

1. **Legal Basis:**

HAWA Energy (Private) Limited in pursuance of *inter alia*, Regulation 10(2) of the (Application and Modification Procedure) Regulations, 1999 (the "**AMPR**") and other applicable provisions of the Regulation of Generation Transmission and Distribution of Electric Power Act, 1997 (the "**Act**"), Rules, Regulations and applicable documents submits this Licensee Proposed Modification Application (the "**LPM**") in respect of its Generation License # No. WPGL/24/2014.

Under Section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997, NEPRA awarded a Generation License HAWA Energy (Private) Limited for its Generation Facility/Wind Farm located at Jhampir, near Nooribad, District Thatta, in the Province of Sindh.

2. **HAWA Energy (Private) Limited ("HEPL" or the "Company") request for modification in a license:**

2.1 The Company was incorporated on 13 December 2011, and that the sponsors for HAWA's 50MW Wind Power Project at Jhimpir, Sindh (the "**Project**") have been actively developing the Project in collaboration with professional firms that are highly qualified and committed to developing and commissioning the Project on a fast track basis.

2.2 The Project is being developed with active facilitation by AEDB under the government of Pakistan's Policy for Renewable Energy Projects for Pakistan, 2006, on a fast track basis and the Company has successfully (i) obtained the land from the government of Sindh, (ii) obtained generation license from NEPRA, (iii) obtain the approval of upfront tariff approval from NEPRA, (iv) become eligible to obtain LOS from AEDB (having already submitted the required performance guarantee), (v) finalized the EPC and O&M arrangements, (vi) approval from OPIC for the financing of the Project.

2.3 The generation license issued to the Company was on the basis of EPC arrangement with, *inter alia,* Nordex. However, now the Company has decided to opt for GE technology in place of Nordex. The selection of GE technology is based on prudency and proven acceptance. The Company draws confidence from the fact that NEPRA has in other comparable projects allowed GE technology and therefore the transition from the existing equipment supplier (Nordex) to GE will be accepted by the lettered authority. The Company has already finalized the terms with GE and in due course would be executing a equipment supply agreement with the turbine manufacturer.

2.4 Consequently to effect this change a modification in the existing generation license of HEPL is required. The Company earlier filed its petition under Section 15 of Regulation of Generation, Transmission and Distribution of Electric Power Act 1997 which was accepted by NEPRA.

"(1) No person shall, except under the authority of a license issued by the Authority under this Act and subject to the conditions specified in this Act and as may be imposed by the Authority, construct, own or operate a generation facility.

(2) An application for the grant of a license for a generation facility shall specify-

(i) the type of facility for which the license is applied;
(ii) the location of the generation facility; and
(iii) the expected life of the generation facility.

(3) The Authority may, after such enquiry as it may deem appropriate and subject condition specified in this Act and as it may impose, grant a license authorizing the licensee to construct, own or operate connected generation facility.

(4) In the case of a generation facility connecting directly or indirectly to the transmission facilities of the national grid company, the licensee shall make the generation facility available to the national grid company for the safe, reliable, non-discriminatory, economic dispatch and operation of the national transmission grid and

connected facilities; subject to the compensation fixed by the Authority for voltage support and uneconomic dispatch directed by the national grid company."

3. Pursuant to the proposed change from Nordex to GE, the following parameters of the license are required to be modified and incorporated.

3.1 **<u>Wind Farm Capacity and Utilization</u>**

(i)	Wind Turbine type, make and model	General Electric (GE) 1.6 XLE
(ii)	Installed Capacity of Wind farm	49.6 MW
(iii)	Number of Wind turbine units/size of each unit	31 Units , each of 1.6 MW

3.2 **<u>Wind Turbine Details</u>**

(a) Rotor		
(i)	Number of Blades	3
(ii)	Rotor Speed	9 – 18 rpm
(iii)	Rotor Diameter	82.5 m
(iv)	Swept Area	5347 m^2
(v)	Power Regulation	Pitch control
(vi)	Rated Power from	11.5 m/s
(vii)	Cut-in wind speed	3.0 m/s
(viii)	Cut-out wind speed	13.5 m/s
(ix)	Survival wind speed	56 m/s
(x)	Pitch regulation	Independent blade pitch control, refer to 2.3 in Annex 2
(b) Blades		
(i)	Blade length	40.2m
(ii)	Material	Fiber Glass enforces epoxy resin
(c) Gear box		
(i)	Type	Multi-planetary
(ii)	Gear Ratio	1:107.368
(v)	Main shaft bearing	Viton V-ring
(d) Generator		
(i)	Power	1645 kW
(ii)	Voltage	690 V
(iii)	Type	Double fed induction generator
(iv)	Speed	1500 rpm
(v)	Enclosure class	IP 54

(vi)	Coupling	Flexible coupling, refer to 2.9 in Annex 1
(x)	Power Factor	0.9 leading to 0.9 lagging
(e) Yaw System		
(i)	Yaw Bearing	Active with yaw drives
(ii)	Brake	Electrically actuated
(iv)	Speed	0.5 degree/sec
(f) Control System		
(i)	Type	GE Mark Vie
(iv)	Recording	SCADA system with recording and storage capability
(g) Brake		
(ii)	Operational Brake	Electrically actuated braking through pitch
(iii)	Secondary Brake	Mechanical brake
(h) Tower		
(i)	Type	Steel tower
(ii)	Hub heights	80m
(i) Compact Pre Fabricated Substation		
(i)	Quantity	31
(ii)	Voltage level	0.69/22 kV
(j) 132 kv Substation		
(i)	Main transformer	22/132 kV
(ii)	Type	Step up
(k) WTG's Foundation		
(i)	Quantity	31
(ii)	Type	Concrete
(iii)	Natural Foundation Features	Standard Raft foundation
(l) Contract Pre Fabricated Substacntion Foundation		
(i)	Quantity	Concrete
(ii)	Type	31
(iii)	Natural Foundation Features	Standard Raft foundation
(m) Wind Resource		
(i)	Annual Average Wind Speed	7.3 m/s
(iii)	Annual Benchmark Energy	134,690 GWh per Year

3.3 **<u>Modification to other Details:</u>**

(1)	Total Installed/Gross ISO Capacity (MW)	49.6 MW
(2)	Total Annual Full Load Hours	2716
(3)	Average Wind Turbine Generator(WTG) Availability	95%

(4)	Total Gross Generation of the Generation Facility/Wind Farm (in GWh)	165.5 GWh
(5)	Array & Miscellaneous Losses (GWh)	8%
(6)	Availability Losses(GWh)	5%
(7)	Balance of Plant Losses (GWh)	2%
(8)	Annual Energy Generation (20 year equivalent Net AEP) GWh	134.69 GWh
(9)	Net Capacity Factor	31%

4. **Rationale for Proposed Modifications:**

The prosed modification is required to incorporate the change of technology from Nordex to GE.

5. **Impact of the Proposed Modification:**

5.1 Impact on Tariff

There will be no impact on Tariff.

5.2 Impact on Quality of Service

There will no impact on Quality of Services.

5.3 Impact on the obligations of the Company under the License

There will be no impact on the obligations of the Company under the License.

PRAYER:

It is respectfully prayed that NEPRA permits the modification in the HAWA Generation License as set out here and above.

Yours Sincerely,

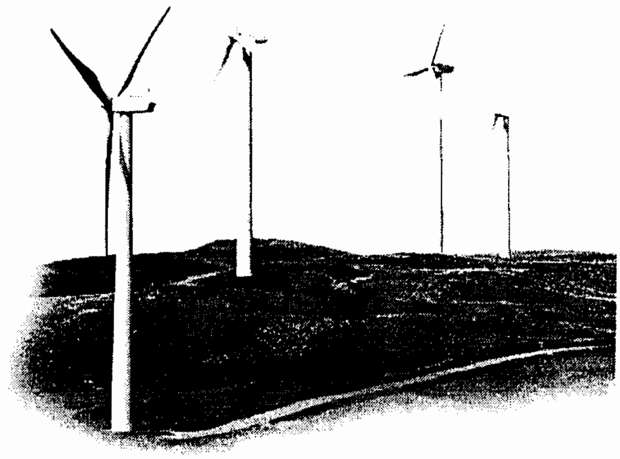
Bruno Bucari
Chief Executive Officer
HAWA Energy (Private) Limited

ANNEX-1

WTG Description

GE Energy

Technical Documentation Wind Turbine Generator Systems 1.6-82.5 - 50 Hz / 60 Hz



Technical Description and Data

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GE Energy

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All technical data is subject to change in line with ongoing technical development!

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1 Introduction

This document summarizes the technical description and specifications of the 1.6-82.5 wind turbine generator system.

2 Technical Description of the Wind Turbine and Major Components

The wind turbine is a three bladed, upwind, horizontal-axis wind turbine with a rotor diameter of 82.5 m. The turbine rotor and nacelle are mounted on top of a tubular tower. The machine employs active yaw control (designed to steer the machine with respect to the wind direction), active blade pitch control (designed to regulate turbine rotor speed), and a generator/power electronic converter system.

The wind turbine features a distributed drive train design wherein the major drive train components including main shaft bearings, gearbox, generator, yaw drives, and control panel are attached to a bedplate (see Figure 1).

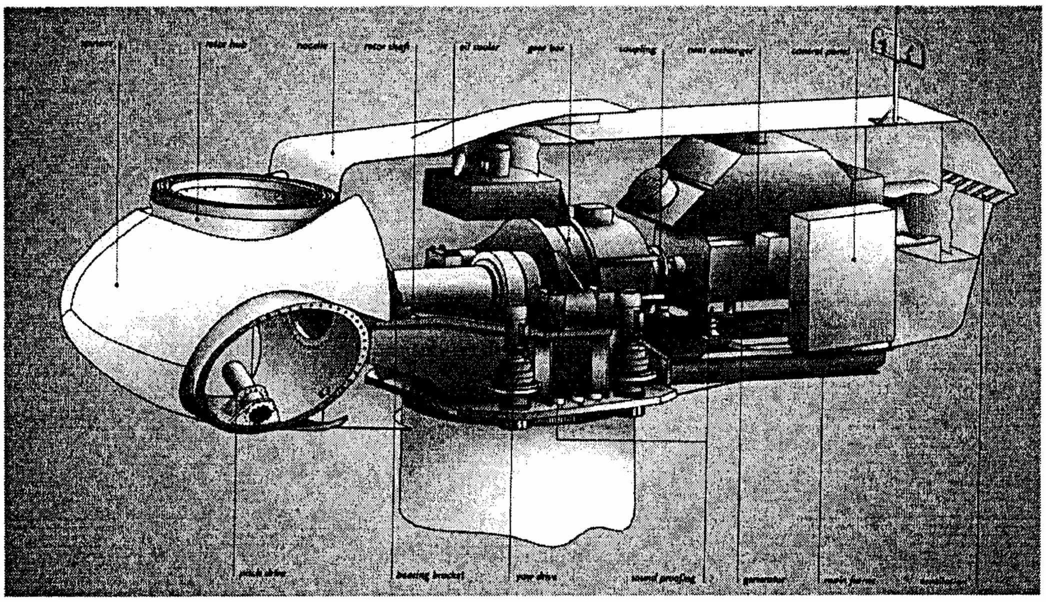


Figure 1: 1.6-82.5 wind turbine nacelle Layout

2.1 Rotor

The rotor diameter is 82.5 m, resulting in a swept area of 5,346 m^2, and is designed to operate between 9.8 and 18.7 revolutions per minute (rpm). Rotor speed is regulated by a combination of blade pitch angle adjustment and generator/converter torque control. The rotor spins in a clock-wise direction under normal operating conditions when viewed from an upwind location.

Full blade pitch angle range is approximately 90°, with the 0°-position being with the airfoil chord line flat to the prevailing wind. The blades being pitched to a full feather pitch angle of approximately 90° accomplishes aerodynamic braking of the rotor; whereby the blades "spill" the wind thus limiting rotor speed.

2.2 Blades

There are three rotor blades used on each wind turbine. The airfoils transition along the blade span with the thicker airfoils being located in-board towards the blade root (hub) and gradually tapering to thinner cross sections out towards the blade tip.

2.3 Blade Pitch Control System

The rotor utilizes three (one for each blade) independent electric pitch motors and controllers to provide adjustment of the blade pitch angle during operation. Blade pitch angle is adjusted by an electric drive that is mounted inside the rotor hub and is coupled to a ring gear mounted to the inner race of the blade pitch bearing (see Figure 1).

GE's active-pitch controller enables the wind turbine rotor to regulate speed when above rated wind speed by allowing the blade to "spill" excess aerodynamic lift. Energy from wind gusts below rated wind speed is captured by allowing the rotor to speed up, transforming this gust energy into kinetic energy which may then be extracted from the rotor.

Three independent back-up units are provided to power each individual blade pitch system to feather the blades and shut down the machine in the event of a grid line outage or other fault. By having all three blades outfitted with independent pitch systems, redundancy of individual blade aerodynamic braking capability is provided.

2.4 Hub

The hub is used to connect the three rotor blades to the turbine main shaft. The hub also houses the three electric blade pitch systerns and is mounted directly to the main shaft. Access to the inside of the hub is provided through a hatch.

2.5 Gearbox

The gearbox in the wind turbine is designed to transmit power between the low-rpm turbine rotor and high-rpm electric generator. The gearbox is a multi-stage planetary/helical gear design. The gearbox is mounted to the machine bedplate. The gearing is designed to transfer torsional power from the wind turbine rotor to the electric generator. A parking brake is mounted on the high-speed shaft of the gearbox.

2.6 Bearings

The blade pitch bearing is designed to allow the blade to pitch about a span-wise pitch axis. The inner race of the blade pitch bearing is outfitted with a blade drive gear that enables the blade to be driven in pitch by an electric gear-driven motor/controller.

The main shaft bearing is a roller bearing mounted in a pillow-block housing arrangement.

The bearings used inside the gearbox are of the cylindrical, spherical and tapered roller type. These bearings are designed to provide bearing and alignment of the internal gearing shafts and accommodate radial and axial loads.

2.7 Brake System

The electrically actuated individual blade pitch systems act as the main braking system for the wind turbine. Braking under normal operating conditions is accomplished by feathering the blades out of the wind. Any single feathered rotor blade is designed to slow the rotor, and each rotor blade has its own back-up to provide power to the electric drive in the event of a grid line loss.

The turbine is also equipped with a mechanical brake located at the output (high-speed) shaft of the gearbox. This brake is only applied as an auxiliary brake to the main aerodynamic brake and to prevent rotation of the machinery as required by certain service activities.

2.8 Generator

The generator is a doubly-fed induction type. The generator meets protection class requirements of the International Standard IP 54 (totally enclosed). The generator is mounted to the bedplate and the mounting is designed so as to reduce vibration and noise transfer to the bedplate.

2.9 Flexible Coupling

Designed to protect the drive train from excessive torque loads, a flexible coupling is provided between the generator and gearbox output shaft. This coupling is equipped with a torque-limiting device sized to keep the maximum allowable torque below the design limit of the drive train.

2.10 Yaw System

A roller bearing attached between the nacelle and tower facilitates yaw motion. Planetary yaw drives (with brakes that engage when the drive is disabled) mesh with the outside gear of the yaw bearing and steer the machine to track the wind in yaw. The automatic yaw brakes engage in order to prevent the yaw drives from seeing peak loads from any turbulent wind.

The controller activates the yaw drives to align the nacelle to the average wind direction based on the wind vane sensor mounted on top of the nacelle.

A cable twist sensor provides a record of nacelle yaw position and cable twisting. After the sensor detects excessive rotation in one direction, the controller automatically brings the rotor to a complete stop, untwists the cable by counter yawing of the nacelle, and restarts the wind turbine.

2.11 Tower

The wind turbine is mounted on top of a tubular tower. The tubular tower is manufactured in sections from steel plate. Access to the turbine is through a lockable steel door at the base of the tower. Service platforms are provided. Access to the nacelle is provided by a ladder and a fall arresting safety system is included. Interior lights are installed at critical points from the base of the tower to the tower top.

2.12 Nacelle

The nacelle houses the main components of the wind turbine generator. Access from the tower into the nacelle is through the bottom of the nacelle. The nacelle is ventilated. It is illuminated with electric light. A hatch at the front end of the nacelle provides access to the blades and hub. The rotor can be secured in place with a rotor lock.

2.13 Anemometer, Wind Vane and Lightning Rod

An anemometer, wind vane and lightning rod are mounted on top of the nacelle housing. Access to these sensors is accomplished through a hatch in the nacelle roof.

2.14 Lightning Protection

The rotor blades are equipped with a lightning receptors mounted in the blade. The turbine is grounded and shielded to protect against lightning, however, lightning is an unpredictable force of nature, and it is possible that a lightning strike could damage various components notwithstanding the lightning protection deployed in the machine.

2.15 Wind Turbine Control System

The wind turbine machine can be controlled automatically or manually from either an interface located inside the nacelle or from a control box at the bottom of the tower. Control signals can also be sent from a remote computer via a Supervisory Control and Data Acquisition System (SCADA), with local lockout capability provided at the turbine controller.

Service switches at the tower top prevent service personnel at the bottom of the tower from operating certain systems of the turbine while service personnel are in the nacelle. To override any machine operation, Emergency-stop buttons located in the tower base and in the nacelle can be activated to stop the turbine in the event of an emergency.

2.16 Power Converter

The wind turbine uses a power converter system that consists of a converter on the rotor side, a DC intermediate circuit, and a power inverter on the grid side.

The converter system consists of a power module and the associated electrical equipment. Variable output frequency of the converter allows operation of the generator.

3 Technical Data for the 1.6-82.5

3.1 Rotor

Diameter	82.5 m
Number of blades	3
Swept area	5346 m2
Rotor speed range	9 to 18 rpm
Rotational direction	Clockwise looking downwind
Maximum tip speed	77.2 m/s
Orientation	Upwind
Speed regulation	Pitch control
Aerodynamic brakes	Full feathering

3.2 Pitch System

Principle	Independent blade pitch control
Actuation	Individual electric drive

3.3 Yaw System

Yaw rate	0.5 degree/s

4 Reference Operational Conditions

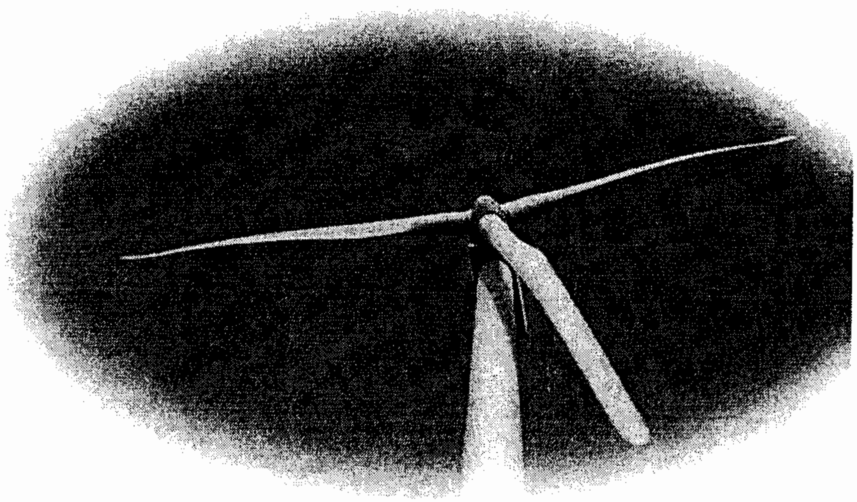
Height above sea level	Maximum 2500 m. See notes in section maximum standard ambient temperature below.
Minimum temperature (operation / survival)	Standard weather: -15°C / -20°C Cold weather package: -30 °C/ -40 °C Switching on takes place at a hysteresis of 5K (-10°C resp. -25°C)
Maximum standard ambient temperature (operation / survival)	+40°C / +50°C The turbine has a feature reducing the maximum output, resulting in minimized turbine revolutions once the component temperatures approach predefined thresholds. This feature operates best at higher altitudes, as the heat transfer properties of air diminish with decreasing density. Please note that the units are not derated in respect to site conditions. The units' reactions related to this feature are based solely on sensor temperatures.
Wind conditions according to IEC 61400	**60 Hz: (IEC 2B with reduced gust)** Standard weather package: $V_{average}$ = 8.5 m/s , T_i = 16% @ 15 m/s Cold weather package: $V_{average}$ = 8.5 m/s , T_i = 16 % @ 15 m/s **50 Hz: (IEC 2B with reduced gust)** Standard weather package: $V_{average}$ = 8.5 m/s, T_i = 16 % @ 15 m/s Cold weather package: $V_{average}$ = 8.5 m/s, T_i = 16 % @ 15 m/s
Maximum extreme 50 year gust (10 min) according to IEC 61400	**60 Hz:** Standard weather package: 40 m/s Cold weather package: 37.1 m/s **50Hz:** Standard weather package: 40 m/s Cold weather package: 37.5 m/s
Maximum extreme 50 year gust (3 s) according to IEC 61400	**60 Hz:** Standard weather package: 56 m/s Cold weather package: 52 m/s **50 Hz:** Standard weather package: 56 m/s Cold weather package: 52.5 m/s

<u>Annex-2</u>

Calculated Power Curve

GE Energy

Technical Documentation
Wind Turbine Generator Systems
1.6-82.5 - 50 Hz and 60 Hz



Calculated Power Curve

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1 Calculated Power Curve 1.6-82.5 – 50 Hz and 60 Hz

Standard Atmospheric Conditions (Air Density of 1.225 kg/m³)

Rotor Diameter: 82.5 m

(Cut-out wind speed based on 10 minute average)

Wind Speed at Hub Height [m/s]	Normal Turbulence Intensities 10% < TI < 15%	Low Turbulence Intensities TI < 10%	High Turbulence Intensities 15% < TI < 20%	Cp,e Normal Turbulence Intensities
3.0	0	0	0	-
3.5	20	18	24	0.14
4.0	63	61	69	0.30
4.5	116	114	123	0.39
5.0	178	175	186	0.43
5.5	248	244	259	0.46
6.0	331	326	344	0.47
6.5	428	422	446	0.48
7.0	540	532	562	0.48
7.5	667	657	692	0.48
8.0	812	801	840	0.48
8.5	971	960	990	0.48
9.0	1136	1132	1140	0.48
9.5	1289	1296	1274	0.46
10.0	1431	1447	1400	0.44
10.5	1530	1553	1488	0.40
11.0	1590	1607	1552	0.36
11.5	1615	1620	1593	0.32
12.0	1620	1620	1615	0.29
12.5 - cutout	1620	1620	1620	-

Table 1: Calculated power curve for the 1.6-82.5

2 Air Density Tables for Normal, Low and High Turbulence Intensities

Wind Speed at Hub Height [m/s]	Air Density [kg/m³]										
	ρ = 1.02	ρ = 1.04	ρ = 1.06	ρ = 1.08	ρ = 1.1	ρ = 1.12	ρ = 1.14	ρ = 1.16	ρ = 1.18	ρ = 1.2	ρ = 1.225
	Electrical Power [kW]										
3.0	0	0	0	0	0	0	0	0	0	0	0
3.5	11	12	13	14	14	15	16	17	18	19	20
4.0	47	49	50	52	53	55	57	58	60	61	63
4.5	91	94	96	99	101	104	106	108	111	113	116
5.0	143	146	149	153	156	160	163	166	170	173	178
5.5	202	206	211	215	220	224	229	234	238	243	248
6.0	271	277	282	288	294	300	306	312	318	324	331
6.5	352	360	367	374	382	389	397	404	412	419	428
7.0	446	455	464	473	483	492	501	510	519	529	540
7.5	552	564	575	586	597	609	620	631	642	653	667
8.0	674	688	701	715	728	742	755	768	782	795	812
8.5	810	826	842	858	874	889	905	921	936	952	971
9.0	958	976	994	1012	1030	1047	1064	1081	1098	1115	1136
9.5	1107	1126	1145	1163	1181	1199	1216	1234	1251	1268	1289
10.0	1253	1272	1291	1310	1328	1346	1363	1380	1396	1412	1431
10.5	1388	1406	1423	1439	1454	1468	1482	1494	1506	1517	1530
11.0	1491	1505	1517	1529	1540	1550	1560	1569	1576	1583	1590
11.5	1557	1564	1572	1578	1585	1592	1598	1604	1609	1613	1615
12.0	1594	1598	1602	1606	1609	1612	1615	1617	1619	1620	1620
12.5	1606	1608	1610	1612	1614	1616	1617	1619	1620	1620	1620
13.0	1616	1617	1618	1619	1620	1620	1620	1620	1620	1620	1620
13.5 - cutout	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620

Table 2: Calculated power curve for the 1.6-82.5 for normal turbulence intensities

Wind Speed at Hub Height [m/s]	Air Density [kg/m³]										
	ρ = 1.02	ρ = 1.04	ρ = 1.06	ρ = 1.08	ρ = 1.1	ρ = 1.12	ρ = 1.14	ρ = 1.16	ρ = 1.18	ρ = 1.2	ρ = 1.225
	Electrical Power [kW]										
3.0	0	0	0	0	0	0	0	0	0	0	0
3.5	10	10	11	12	13	14	15	15	16	17	18
4.0	46	47	49	50	52	53	55	56	58	59	61
4.5	89	92	94	97	99	101	104	106	108	111	114
5.0	140	144	147	150	154	157	160	164	167	170	175
5.5	198	203	207	212	216	221	225	230	234	239	244
6.0	266	272	278	284	290	295	301	307	313	318	326
6.5	346	354	361	368	376	383	390	398	405	412	422
7.0	439	448	457	466	475	484	493	502	511	520	532
7.5	544	555	566	577	589	600	611	622	633	644	657
8.0	664	678	691	704	718	731	744	757	771	784	801
8.5	799	815	831	847	862	878	894	909	925	940	960
9.0	948	966	985	1003	1021	1039	1057	1075	1092	1110	1132
9.5	1104	1124	1144	1164	1183	1202	1221	1240	1258	1275	1296
10.0	1259	1279	1299	1319	1338	1357	1375	1393	1410	1427	1447
10.5	1403	1422	1440	1457	1473	1488	1503	1516	1529	1540	1553
11.0	1512	1526	1539	1551	1562	1572	1581	1588	1595	1601	1607
11.5	1579	1586	1593	1598	1603	1607	1611	1613	1616	1618	1620
12.0	1610	1614	1617	1619	1620	1620	1620	1620	1620	1620	1620
12.5	1617	1619	1619	1620	1620	1620	1620	1620	1620	1620	1620
13 - cutout	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620

Table 3: Calculated power curve for the 1.6-82.5 for low turbulence intensities

Wind Speed at Hub Height [m/s]	Air Density [kg/m³]										
	ρ = 1.02	ρ = 1.04	ρ = 1.06	ρ = 1.08	ρ = 1.1	ρ = 1.12	ρ = 1.14	ρ = 1.16	ρ = 1.18	ρ = 1.2	ρ = 1.225
	Electrical Power [kW]										
3.0	0	0	0	0	0	0	0	0	0	0	0
3.5	15	16	16	17	18	19	20	21	22	23	24
4.0	52	53	55	57	58	60	62	63	65	67	69
4.5	97	99	102	104	107	110	112	115	117	120	123
5.0	149	153	156	160	164	167	171	174	178	181	186
5.5	210	215	220	224	229	234	239	243	248	253	259
6.0	282	288	294	300	306	312	318	324	330	337	344
6.5	367	375	382	390	398	406	413	421	429	436	446
7.0	464	474	483	493	503	512	522	531	541	550	562
7.5	574	586	597	609	620	632	644	655	667	678	692
8.0	700	714	727	741	755	769	782	796	809	823	840
8.5	834	850	866	882	897	912	927	942	957	972	990
9.0	976	993	1010	1027	1043	1059	1075	1090	1106	1121	1140
9.5	1108	1125	1142	1159	1176	1193	1209	1225	1241	1256	1274
10.0	1240	1257	1274	1291	1307	1323	1339	1354	1369	1383	1400
10.5	1359	1375	1390	1404	1417	1430	1442	1453	1464	1475	1488
11.0	1451	1464	1476	1487	1498	1508	1518	1527	1535	1543	1552
11.5	1517	1527	1536	1545	1553	1561	1569	1576	1582	1587	1593
12.0	1561	1568	1575	1581	1587	1593	1599	1603	1608	1611	1615
12.5	1588	1593	1598	1602	1606	1610	1614	1617	1619	1620	1620
13.0	1604	1607	1610	1613	1615	1616	1618	1619	1620	1620	1620
13.5	1612	1614	1616	1617	1618	1619	1619	1620	1620	1620	1620
14.0	1618	1619	1619	1620	1620	1620	1620	1620	1620	1620	1620
14.5 - cutout	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620

Table 4: Calculated power curve for the 1.6-82.5 for high turbulence intensities

3 Applicability

The power curve information provided above applies to the following conditions:

- The stated range of mean horizontal wind turbulence intensity, defined as the mean value at 15 m/s average hub height wind speed.
- The specified value for mean air density.

Furthermore, also referencing the comprehensive requirements given in the Technical Specifications for Machine Power Performance Tests:

- The stated performance applies to:
  - clean, non-degraded, and uncontaminated blade surfaces without icing;
  - A wind turbine generator system decoupled from WindCONTROL. WindCONTROL controls and regulates the voltage and/or power of the entire wind farm. The stated performance of the power curve in this document assumes that the wind turbine generator system power output is not being regulated or controlled by WindCONTROL. The term "decoupled" implies that there are no voltage or power commands being assigned from the WindCONTROL system and the output of the wind turbine generator system is free to operate up to the maximum capability of the machine itself.
  - power values apply to the low-voltage side of the transformer.

- Wind-speed labels are mid-bin values; for example, the 5.0 m/s bin extends from 4.75 to 5.25 m/s.
- The wind inclination at the site should be within the turbine design conditions (typically +/- 8° for onshore machines per the IEC 61400-1).
- Information on the influences of the cold weather options is located in the document "Technical Description – Cold Weather Adaptations".

The turbine shall operate within its normal operating range.

4 Cut-Out and Re-Cut-In Wind Speeds 1.6-82.5 - 50 Hz and 60 Hz

If the average wind speed exceeds

- 25 m/s in a 600 s time interval
- 28 m/s in a 30 s time interval or
- 30 m/s in a 3 s time interval

the wind turbine generator system will shut down.

If the average wind speed remains below

- 22 m/s in a 300 s time interval

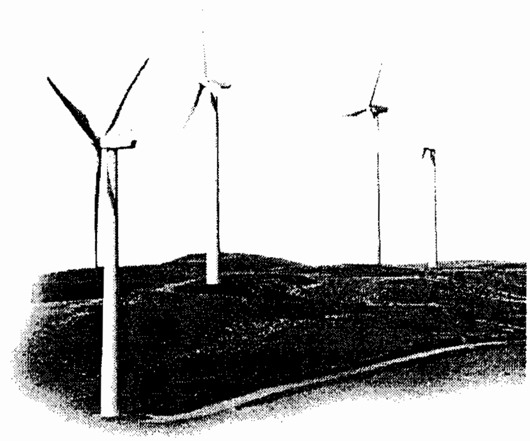
the wind turbine generator system will cut in again.

ANNEX-3

Thrust Coeffecient

GE Energy

Technical Documentation
Wind Turbine Generator Systems
1.6-82.5 - 50 Hz and 60 Hz



Thrust Coefficient

GE imagination at work

GE Energy

Gepower.com

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www.gewindenergy.com

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Thrust Coefficients 1.6-82.5 - 50 Hz and 60 Hz

Rotor diameter: 82.5 m

Hub Height Wind Speed [m/s]	Thrust Coefficient [ct]
3.0	1.29
3.5	1.15
4.0	1.03
4.5	0.93
5.0	0.86
5.5	0.80
6.0	0.78
6.5	0.78
7.0	0.78
7.5	0.78
8.0	0.78
8.5	0.77
9.0	0.75
9.5	0.72
10.0	0.67
10.5	0.60
11.0	0.53
11.5	0.45
12.0	0.39
12.5	0.34
13.0	0.30
13.5	0.26
14.0	0.23

Hub Height Wind Speed [m/s]	Thrust Coefficient [ct]
14.5	0.21
15.0	0.19
15.5	0.17
16.0	0.15
16.5	0.14
17.0	0.13
17.5	0.12
18.0	0.11
18.5	0.10
19.0	0.09
19.5	0.08
20.0	0.08
20.5	0.07
21.0	0.07
21.5	0.06
22.0	0.06
22.5	0.06
23.0	0.05
23.5	0.05
24.0	0.05
24.5	0.05
25.0	0.04

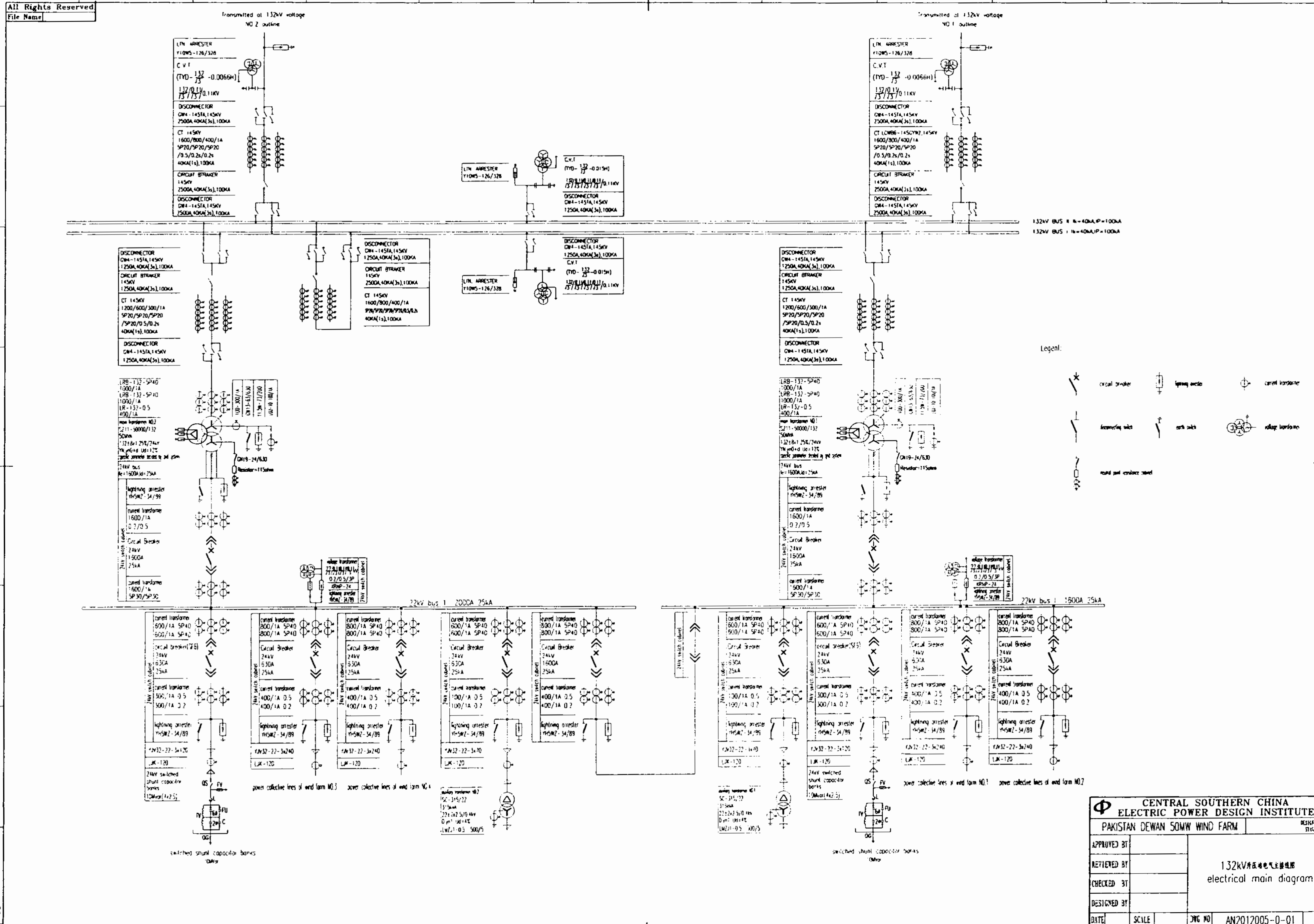
Table 1: 1.6-82.5 calculated thrust coefficient table

Standard Atmospheric Conditions according to ISO 2533.

ANNEX-4

Electrical SLD

File Name



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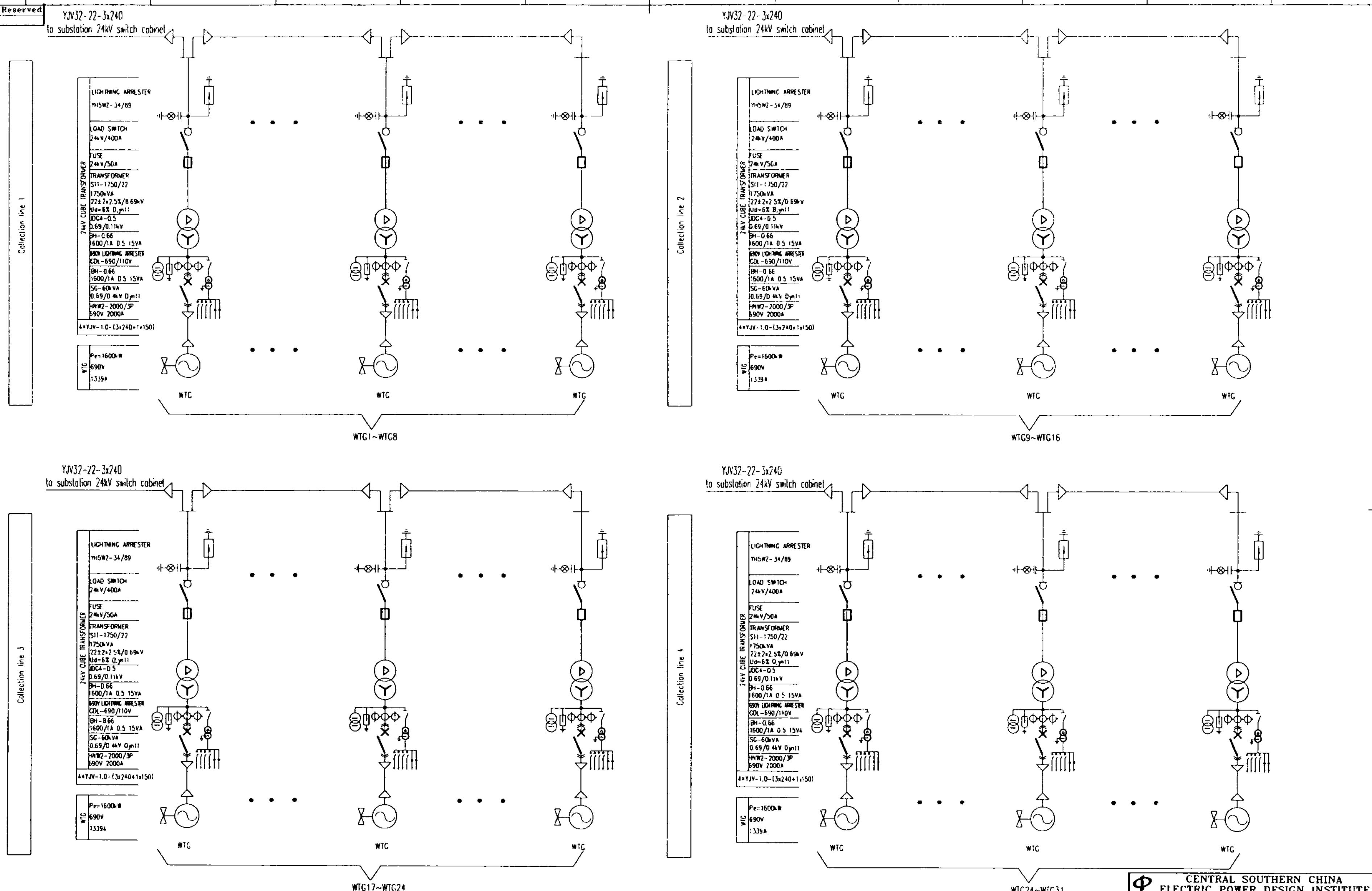
ANNEX-5

Collection Lines Diagram

File Name



CENTRAL SOUTHERN CHINA ELECTRIC POWER DESIGN INSTITUTE			
PAKISTAN DEWAN 50MW WIND FARM			
APPROVED BY		diagram of collection lines between 24kV switch panels and cube transformers	
REVIEWED BY			
CHECKED BY			
DESIGNED BY			
DATE	SCALE	DWG NO	AN2012005-0-05

Notice:

1. All the connection will be directly achieved on bus bar by cable in the cube transformer.
2. There are total 4 collective lines in the wind farm.

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