

Engineering Document

Transportation, installation, commissioning, acceptance, running & operating of the wind turbines (farm)

Chapter I Transportation & Installation

Section I: The transportation method

According to the destination and the specific conditions along the way, the following transportation methods are currently used:

1) Sea: by bulk carriers for large size components, such as the tower, blades, arms, and generator. The electrical equipment, hydraulic systems, and standard components would be transported in containers.

2) Motor Vehicle: For transport from seaport to the installation site by flatbed truck of 15m-18m in length. The conditions of the destination should be taken into consideration when deciding upon any other motor vehicles that may be needed. The longest part is the tower component, which is 25m length and light weight. The blade size is 20m length and 2.6m width.

3) On the low-grade roads, experienced technicians to carry necessary tools and materials, such as sleepers, triangle wood, wire rope, springboard, skid, wire, jack, shovel, crossbow, sledgehammer, brown rope, etc. Flat-panel counterparts to deal with emergency issues such as small bridge reinforcement, saddle-type pavement height, high-speed removal of the cabin cover and packaging in front of the tunnel.

4) In the instance where the road may be difficult to pass through, a crane with the appropriate tonnage should be considered, and the crane assisted shifting method is adopted to help the flatbed pass the curve.

In this method, the shifting operation method should be agreed with the driver and the crane driver of the carrier in advance, and safety operation should be paid attention to, especially when operating on the winding roads of Panshan.

Note:

If the transportation of 25m tower component is restricted, notify the manufacturer in advance to arrange to use a two section tower.

Section II: The process of hoisting & installation

1. Preparation before hoisting

a) Check and confirm that the foundation has been accepted and meets the installation requirements.

b) Confirm that the power transmission & transformation project of the wind

farm has been accepted.

c) Confirm that the weather conditions on the day of installation are appropriate and the maximum wind speed on the ground does not exceed 8m/s.

d) The manufacturer engineers and the representative of the investor, to organize the installers to read and become familiar with the installation manual.

e) Focus on the manufacturer engineers, organize the installation team, and clearly identify the only commander on the installation site.

f) Develop a detailed installation plan. Clear job positions, responsibility to people, clear installation sequence, operation procedures, technical requirements, safety requirements, clear installation equipment, tools, measuring tools, auxiliary materials, oil materials, etc. used in each position of each process, and prepare separately according to needs.

g) Clean up the installation site, remove debris, and clear out large vehicle passages. The installation site must at least 30*30m around the turbine site.

h) Clean the foundation of the wind turbine, the upper and lower end faces of the flange and the bolt holes, clean the thread surface of the bolt, remove the rust-proof packaging, and apply anti-rust oil.

i) Installation crane 2*(30-50) ton/50m crane arm, and the climber vehicle have been implemented as required and reached the scene.

j) The person responsible for each installation process is responsible for checking the goods one by one according to the installation operation plan and the schedule.

2. Installation schedule

Based on experience, the installation period of one turbine is two days.

3. Installation process

a) The control cabinet in place:

Before installing the turbine, the control cabinet and other electrical equipment must be hoisted to the reinforced concrete foundation in the middle of the bottom of the tower. The control cabinet and other electrical equipment are fixed on the foundation and installed as needed. Set up walls and roofs. If the control room consists of lightweight building materials, the walls and roof of the control room can be in place after installation.

b) Tower assembly:

The tower is assembled on the ground according to the installation drawings provided by the manufacturer. The torque wrench must be used for assembly. The torque value of the torque wrench must be set to the specified torque value according to the design requirements of the tower.

The first step is to put the two legs 1 and 2 of the tower on the flat ground.

And then assemble two independent trapezoidal faces. The four legs of the tower are numbered 1, 2, 3, 4 respectively. Pay attention to the upper end and the lower end position (up & low), the distance between the upper two legs is about 3 meters, and the distance between the lower two legs is about 8 meters. Then, according to the number, the tower is assembled from the upper end. The number of the truss starts from 1 to 12. The truss was divided into 1a, 2a, 3a.....12a; 1b, 2b, 3b....12b; 1c, 2c, 3c...12c; 1d, 2d, 3d.....12d. Two-sided assembly of the tower after completion, use one of the two cranes to lift one of the flat and one face of the ground face to face, and then assemble the truss to form a whole tower.

c) Tower hoist

Upon completion of the tower assembly, the engineer of manufacturer and safety personnel must inspect the fixed nodes, then use a 30-ton crane to hoist the tower into the foundation and bolt the tower.

d) Generator component hoist

When the tower is hoisted, the generator assembly is hoisted after the bolts are fixed. Four slings were used to fix the four lifting positions in the middle of the generator. The 30 tons crane was used to slowly hoist the generator to the top of the tower, and the generator was fixed with bolts. When the generator assembly is fixed, the operators will be sent to the top of operating platform of the tower by the climber.

e) Arms hoist:

When the generator assembly is hoisted and installed, the lower arms are hoisted separately. Each hoisting arm is fixed by bolts. The bolts must be torque wrenches to set the torque to the specified torque value. After all low arms are installed, install the up arms. The install method of up arms is the same with low arms.

f) Blade hoist:

Install the blades after all the arms are installed. When hoisting the blade, it is necessary to use the special blade lifting rope by the manufacturer. Fix the blade at the upper 1/3 position of the blade according to the installation instructions and using another smaller crane to pull the lower end of the blade with a long rope by the manufacturer to prevent the blade from greatly increasing swing during the lifting process. Bolted at the fixed position of the arm and the protruding part of the blade, and the upper end and the lower end of blade need to be fixed at the same time. The climber transports the operators to the upper and lower arms respectively and fixes the operator with a safety belt.

g) All types of cables in place

h) Electrical wiring:

Complete the connection of all control cables and power cables according to the instructions of the installation manual.

i) connecting hydraulic pipe & wire

Connect hydraulic pipes and lines according to the instructions of the installation manual.

Section III. Equipment acceptance & preservation management

1. Equipment acceptance

500kw wind turbine was divided into the following parts:

6*Blades in a steel framer without package

1*Generator assembly in a steel framer without package

12 Arms in a steel framer without package

1*Center controller with artificial board box with sign

10*Power controller with 10*artificial board box with sign

10*Inverter with 10*artificial board box with sign

Sensors & monitoring system in a small artificial board box with sign.

Power cables in a big steel box with sign.

Control wires & pipeline in a smaller steel box with sign.

Bolts, nuts in a big steel box with sign.

Installation tools in a steel box with sign (one wind farm/one set of tools)

Hydraulic oil with oil drums accordingly.

Technical documents.

2. Acceptance process

The warehouse storekeeper of investor in cooperation with the technical staff, performs equipment acceptance according to the following procedures:

a) Count all types of boxes, box numbers and records

b) Fill in the warehouse receipt, in addition to the number of boxes and the box number, please indicate whether there is any damage

c) When found that there is loss or some components was damaged, the warehouse storekeeper should fill out the report and report to his boss, and notify the carrier and supplier of the vacancy. Claims can be made to the responsible party when it affects the progress of the installation.

3. Warehouse management

a) Warehousing

All accepted equipment, parts, accessories, tools, oils, etc. shall be stored in the warehouse according to the regulations. For the packaging is intact, it will be installed in the near future. Under the premise of ensuring the safety of storage, the entire wind turbine can be completely unpacked in the original container.

b) Storage

Investors should establish and improve the rules and regulations of warehouse management to ensure that the materials in the warehouse are not damaged, and meet the requirements of safety, fire prevention, anti-theft, anti-deterioration, anti-corrosion and dust prevention.

c) Out of warehouse

The collection procedure should be completed. If it is stored on site, it shall be handled and taken by the responsible person.

Section IV: Commissioning the turbines

1. Commissioning item

- a) Checking main circuit, switch and ground states
- b) Checking center controller function of pitch angle, checking each sensor including oil liquid level sensors, oil press sensor, bearing temperature sensor, encoder, wind meter, cables, lubricating and start status.
- c) Adjust each oil on the specified value;
- d) Start the generator
- e) Checking lubricating
- f) Adjust brake pad clearance
- g) Set control parameters
- h) Review safe chain and monitoring.

2. Commissioning report

The commissioning report use \checkmark and \times mark recording the commissioning states. Pass use \checkmark and failed use \times . Status data such as temperature need to record the tested data. If one item commissioning failed, must stop the turbine, and start again after analyzing and judging the cause, until commissioning was passed.

Below is the format of on-site commissioning report.

On-site tested report

Turbine number: 1----N

Pass sign: \checkmark failed sign:X

1. Tested condition

10 minutes average wind speed ()m/s, Temperature () $^{\circ}$ C

2. Equipment states

- a) Pitch angle system

- b) Gearbox
- c) Generator
 - Temperature of bearing, temperature of generator rotor
- d) Hydraulic system
 - Press
- e) Brake system
 - Brake pad clearance(1~ 1.5mm). Brake function
- f) Switch rated data (according to the manufacturer's data) . Current & voltage of each pitch motor. Each hydraulic oil press of pitch system. Pitch software test
- g) Data set up

Max rotation speed	Nmax=15r/min
Max RPM of generator	Ngmax(5%)=157.5r/min
	Ngmax(10%)=165r/min

 - The highest temperature of generator rotor. T=()°C
 - The highest temperature of gearbox oil T=()°C
 - Average maxi power at 10min Pmax=()kW
 - Instantaneous max power Pmax=()kW
 - Max voltage of grid Umax=()V
 - High voltage of grid (50ms) Umax=()V
 - Low voltage of grid (50s) Umin=()V
 - High frequency(200ms) fmax=()Hz
 - Low frequency (200ms) fmax=()Hz
 - Cut out wind speed(10min average wind speed) Vout=()m/s
 - Max wind speed V=()m/s
- h) Emergency brake

The time of blade feathering,	1~2s
Brake time.	8-10s

Tested Results √ or X?

Chapter II Turbines running & operating

Section I Completion acceptance

1. The purpose of acceptance.
 - a) Inspection construction quality. Clarify contractual responsibility
 - b) Transfer the project from the construction phase to the production phase
2. Acceptance conditions
 - a) The wind turbine has passed the trial operation, analyzed and evaluated, and meets the design requirements. Both the manufacturer and the investor have signed the test operation record or memorandum.

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- b) Reconfirm the quality of the basic construction of the wind turbine
 - c) Reconfirm the qualified manufacturing quality of the wind turbine
 - d) Reconfirm that the wind turbine installation quality is qualified
 - e) Reconfirm that wind turbine commissioning basically meets the requirements.

3. Specific items and contents of acceptance

- a) The main components (pitch angle system, generator system, brake system) operate normally, without abnormal vibration, noise, and no leakage (oil).
 - b) The grounding resistance meets the requirements, and the single grounding resistance is not more than 4Ω .
 - c) Safety and function meet the design requirements.
 - d) Wind turbine and personnel safety in the engineering process
 - e) The control system is functioning normally, including pitch angle regulation, starting, braking, power generation stability, RPM, power generation, emergency braking etc.
 - f) Monitoring and sensor functions are normal, including: wind speed, wind direction, speed, electrical parameters, temperature, vibration, grid power loss, etc.
4. The power quality of the turbine meets the grid requirements, including voltage and current changes, voltage flicker, inrush current, harmonics, etc.
5. Vibration and noise are within the normal range
6. Electromagnetic interference is within the normal range
7. The tightening torque of all bolts meets the design requirements.
8. No abnormalities in coating
9. Acceptance conclusion
- a) Based on on-site observations and analysis of the above records, research, and comparison with contract terms, make conclusions on eligibility or not, and make suggestions and suggestions for improvement and occurrence.
 - b) Acceptance opinions and reports should be archived and used as official information for the wind turbine technical file.

Section II Commissioning of wind turbines

After the completion of the acceptance of the wind turbine, it will enter the trial operation phase. As the owner of the wind farm, the investor must not only prepare the project for normal operation, but also investigate whether the technical indicators of the various functions of the unit have met the design requirements under the test operation conditions.

1. The conditions of commissioning
 - a) The installation quality of wind turbines meets the requirements of the manufacturer's standards.
 - b) The on-site commissioning of the wind turbine has been completed, the parameters meet the requirements, and the trial operation is normal.
 - c) The wind farm power transmission and transformation facilities meet the normal operation requirements.
 - d) Environmental and meteorological conditions meet the requirements for safe operation.
 - e) Other requirements specified by the wind turbine manufacturer have been met.
 - f) The adaptability requirements of wind farms for wind turbines have been met, for example, for resisting strong typhoons, moisture and salt spray, sandstorms etc.

2. Everything is ready of the commissioning
 - a) Designated leadership for the commissioning
 - b) Developed a commissioning plan
 - c) Trained operators and with working conditions
 - d) Established wind farm management rules and regulations
 - e) Developed emergency measures for accident handling

3. The term of commissioning
The commissioning time of turbine is 250h

4. Management of wind turbine commissioning
The operators of wind farm should standardize the monitoring of the operation, and collect, sort and analyze the operating status and data, especially the monitoring and analysis of the adaptability of the wind turbine. Abnormal situations should be dealt with in a timely manner. When serious abnormal conditions (such as overheating, abnormal vibration and noise, etc.) occur, the equipment should be shut down decisively. All abnormal situations should be notified to the production plant in time, and information communication and communication with the production plant should be strengthened. After the trial run is completed, the test run records should be completed as required by the manufacturer's manual. Signed by the representative of investor and manufacturer and classified in the crew technical file.

Thank you!