BIDDING DOCUMENTS

FOR

China Renewable Energy Development Project
Shanghai (Chongming & Nanhui) Wind Farm Project

Funded by the Worldbank’s Loan

Section VI

TECHNICAL SPECIFICATIONS
(For approval)

Executing Company: Shanghai Wind Power Company

July, 2003
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DIVISION 1  GENERAL REQUIREMENTS

1.1 PURPOSE

The purpose of this specification is for the Employer of Shanghai Wind Power Company (SWPC) to provide the requirements for the procurement of goods, including wind turbines and remote supervision and control systems, and relevant services for about 20 MW of wind power in Shanghai (Chongming and Nanhui coastal areas), which will be built by the Shanghai Wind Power Company (SWPC), the Employer. The total installation capacity for this project is about 20 MW, including 6MW in Chongming and 14MW in Nanhui. The deviation of ± half a wind turbine’s normal capacity at each site will be permitted. Different combinations of turbine positions are detailed in BDS Attachment Tab2. The wind turbines will be designated by SWPC as described in Division 2 of this specification.

This specification contains the performance, design, manufacture, warranty, acceptance, technical services, and documentation requirements for the wind turbine units and the remote supervision and control system. The term “wind turbine” includes the following systems: rotor systems, drive train/brake system, yaw systems, nacelles and mainframes, tower, electrical systems, control and protection systems, connection to the low voltage terminal of the package transformers. The remote monitoring and control system includes control and monitoring in the central control room of the Nanhui and Chongming wind farms, as well as in the SWPC office; monitoring systems shall be installed in the Shanghai Dispatch Centre and in Beijing.

1.2 GENERAL DESCRIPTION

The Contractor will be responsible for the delivery, supervision and support of erection, commissioning, and the three years maintenance and Defect Liability services for the facilities comprising the Wind Turbines, up to the low voltage terminals of the package stations; as well as the remote monitoring and control systems.
The responsibilities of the contractor include the provision of all requirements for the design of the overall system also outside his scope of delivery (e.g. grid connection, lightning protection up to substation, etc.).

Shanghai Wind Power Company (SWPC) and its authorized representatives will complete the civil works and electrical works on the site, including supply of equipment and labour required for installation and the electric connection points being the low voltage terminals of the package transformers. The Contractor shall provide the Employer with the wind turbines, the remote monitoring and control system, support and supervise services for the installation and test-run, operation, maintenance of the wind turbines, as well as with design services for foundations (construction drawings, technical requirements, requirements for pile testing), training and the three years Defect Liability services. The Contractor shall render all advisory and supervisory services being required for taking the full responsibility for the Facilities.

1.2.1 Scope of Works

Contractor is required to carry out the following works:

- Preparation and submission of a project execution schedule for design, manufacture, factory testing and delivery; of monthly progress reports, of a factory testing program;
- Design, manufacture, factory test, packing, transporting to destination port and delivery, unpacking-inspection;
- Submission of documents, information and test record on design, installation, application, maintenance, repair and test records;
- Preparation and submission of training plans for training at the contractors site and at the site to train Employer’s personnel in installation, commissioning, operation and maintenance;
- Preparation and submission of instruction plan for installation of equipment supplied, and the operational maintenance manual;
- Preparation and submission of a work program covering supervision for installation, site test, test-run, and commissioning with the assignment of
responsible personnel; completion of all test-runs and commissioning under the contract; provision of complete test and commissioning reports;

- Preparation and submission of service plan for the supplied facilities within the Defect Liability Period and provision of scheduled and non-scheduled maintenance incl. repair;

- Requirements for access roads and shunting areas;

- Static calculation and design of foundation for wind turbines according to geotechnical investigation results of each site; verification of foundation calculations by an independent sworn foundation expert selected by the Contractor and confirmed by SWPC; inspection of foundation construction and acceptance inspection; provision of foundation drawings and requirements.

- Being responsible for the overall design of the lightning protection and earthing protection systems.

- Supervising the installation of the low-voltage and RMCS cables, the installation of these cables will be carried out by the Employer.

- Implementation of various co-ordinations for design, delivery, inspection and acceptance to ensure the project construction progress.

- All further services necessary to take the responsibility by the Contractor for a trouble free installation and functioning of the Facilities and of the scope of auxiliary services of the Employer such as geotechnical investigations, as well as foundation, access road and shunting area construction and also including the overall lightning protection concept of the overall wind park (low voltage and medium voltage side)

1.2.2 Scope of Supply

The scope of supply of the Contractor comprises:

- Wind turbines with a total capacity of 20 MW (Unit capacity between 800 kW and 1500 kW), including rotor system, drive train/brake system, yaw systems, nacelles and mainframes, towers including connecting parts for the foundation (to be provided in advance of towers), electrical systems, control and
protection systems, main circuit breakers of the wind turbines; low voltage cables up to the low voltage terminals of package transformers; all necessary lightning protection on the low voltage side in and outside the wind turbine;

- 2 sets of power curve verification equipment, including anemometers, wind vanes, temperature sensor, humidity and air-pressure sensors and the cable with the length sufficient to reach the site control room ready for being integrated into the remote monitoring system; requirements for the anemometer tower and sensor connection

- Remote monitoring and control systems including sufficient monitoring and control cable up to the control rooms at the sites. One set each of RCMS systems is supplied to Nanhui Wind Farm, Chongming Wind Farm and SWPC in Shanghai respectively. Two sets of monitoring systems will be supplied to the central office in Beijing and to the dispatch centre in Shanghai.

- Special tools, test equipment and materials for installation, test-run, operation and repairs of equipment supplied;

- Spare parts and consumables for three years.

1.3 LANGUAGE

The English language shall be used in all documents and all correspondence between the Contractor and the Procurement Agent/Employer or other Chinese agencies involved in the project. The English language shall also be used, whenever anything is required under the terms of the Contract to be written, marked, printed, or engraved. Safety signs should be in Chinese and English. For information purposes the documents shall also be provided in Chinese language.

1.4 UNITS

SI (Standard International Unit) measuring units should be used for all technical documents and tables, drawings and instruments.
1.5 STANDARD AND SPECIFICATION

Unless another standard is specifically mentioned in this specification, all equipment, element, materials used and provided under the Contract, and all design calculations and tests shall be in accordance with the following latest published standards prior to the date of closing of bids or in accordance with other approved standards, or in accordance with such other equivalent standards appropriate to the country of manufacture.

If the Bidder offers materials or equipment which conforms to standards other than the latest relevant wind power standards of the organizations given below, full details of the differences between the proposed standards and the following standards, in so far as they effect the design or performance of the equipment are to be explained by the Bidder to the Employer for approval. In this case, a copy of the standards or specification in the English language shall be provided to the Employer for approval.

The standards apply in the following ranking order:

IEC      International Electro-technical Commission
ISO     International standardization Organization
GL      German Lloyd
IEA     International Energy Agency
DIN-VDE Electrical Commission of Deutsche Industrie Normen
CEE     Commission on Rules for the Approval of Electrical Equipment
EC      Eurocode
ANSI    American National Standards Institute
GB      Chinese National Standard
DL      Chinese Power industry Standard
DIVISION 2 SITE DATA

2.1 ENVIRONMENTAL CONDITIONS

The Shanghai (Chongming, Nanhui) Wind Farm Project is carried out at two project sites in the Yangtze River Estuary Area, which are located in the East of Chongming Island (6 MW) and at the coast in the South-East from Shanghai, about 10 km in the south of the new Pudong Airport (Nanhui site –14 MW).

The Chongming site is located along the coastal area of “Dongwangsha”, in the North of the eastern coast of Chongming island. The wind turbines are lined along the outer side of the dyke built in 1992 (“Jiu-er Dyke) for the protection of newly reclaimed land. The area around the planned wind park is used for agricultural and aquatic production. The land is open and flat without any barrier. The distance to the seashores is about 2.3 km. In this distance in 1998 a new dyke parallel to the “Jiu-er Dyke” was built. The wind park area is bordering to a bird reserve. However, due to the continuous land reclamation and the rapid growing of the marshland towards the east the bird resting places are increasingly orientated away from the wind park area.

The Nanhui site is located in the coastal area near the Dazhi Estuary at the east coast of Nanhui. The wind turbines shall be placed along the outside of the old dike “Jiusitang” and on the new forest park area in the west of this dyke. This area is open and flat without any larger barriers. At present the reclamation of land has progressed up to a distance of about 3.7 km seaward from the dyke “Jiusitang”.

The locations of the wind farms are shown in the attached Drawing 1 to 4. The climatic conditions at both sites are very similar. Data can be obtained from the Chenjiazhen meteorological station, about 15 km to the west of the Chongming wind park site, and from the Laogang meteorological station, which is located about 6 km to the East from the Nanhui site. As representative data the data of Laogang were taken. The climatic conditions are shown in Tab. 1 and Tab. 2.
Tab. 1  Meteorological Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme max. temperature</td>
<td>37.5°C</td>
</tr>
<tr>
<td>Extreme min. Temperature</td>
<td>-9.8 °C</td>
</tr>
<tr>
<td>Annual average temperature</td>
<td>15.4 °C</td>
</tr>
<tr>
<td>Annual average rainfall</td>
<td>1180.5 mm</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>84 %</td>
</tr>
<tr>
<td>Frequency of typhoon</td>
<td>3 times/year</td>
</tr>
<tr>
<td>Days of thunderstorm / lightning</td>
<td>25.4 times/year</td>
</tr>
<tr>
<td>Days of fog</td>
<td>41.8 days/year</td>
</tr>
<tr>
<td>Annual average vapour pressure</td>
<td>16.6 hPa</td>
</tr>
<tr>
<td>Salt fog</td>
<td>Frequent</td>
</tr>
</tbody>
</table>

Tab. 2  Monthly Weather Data (Laogang weather station)

<table>
<thead>
<tr>
<th>Month</th>
<th>Average temperature (°C)</th>
<th>Air pressure (hPa)</th>
<th>Long term average monthly rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan.</td>
<td>3.4</td>
<td>1027</td>
<td>33.0</td>
</tr>
<tr>
<td>Feb.</td>
<td>4.3</td>
<td>1023</td>
<td>49.4</td>
</tr>
<tr>
<td>March</td>
<td>7.9</td>
<td>1021</td>
<td>105.8</td>
</tr>
<tr>
<td>April</td>
<td>13.3</td>
<td>1015</td>
<td>102.3</td>
</tr>
<tr>
<td>May</td>
<td>19.2</td>
<td>1010</td>
<td>135.8</td>
</tr>
<tr>
<td>June</td>
<td>22.8</td>
<td>1006</td>
<td>144.1</td>
</tr>
<tr>
<td>July</td>
<td>27.3</td>
<td>1004</td>
<td>131.5</td>
</tr>
<tr>
<td>Aug.</td>
<td>27.2</td>
<td>1005</td>
<td>99.7</td>
</tr>
<tr>
<td>Sept.</td>
<td>23.5</td>
<td>1012</td>
<td>162.8</td>
</tr>
<tr>
<td>Oct.</td>
<td>18.5</td>
<td>1018</td>
<td>111.0</td>
</tr>
<tr>
<td>Nov.</td>
<td>12.6</td>
<td>1023</td>
<td>75.4</td>
</tr>
<tr>
<td>Dec.</td>
<td>5.2</td>
<td>1026</td>
<td>29.7</td>
</tr>
</tbody>
</table>

In order to observe the wind speed and direction, at the Chongming and Nanhui wind farm sites two anemometer towers with a height of 50m were erected in 1997 at each site. In the following the Nanhui data are used as being representative for both sites, because the wind regimes at both sites are very similar. The measured average monthly wind speeds for the period Mar. 1997 to Feb. 2002 at Nanhui are given in Tab 3.
Tab. 3  Monthly Wind Speed at the Nanhui Wind Park Site  Unit: m/s

<table>
<thead>
<tr>
<th></th>
<th>Measured in 50 m height</th>
<th>Computed for a height of 70m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan.</td>
<td>7.1</td>
<td>7.6</td>
</tr>
<tr>
<td>Feb.</td>
<td>6.8</td>
<td>7.3</td>
</tr>
<tr>
<td>March</td>
<td>7.0</td>
<td>7.5</td>
</tr>
<tr>
<td>April</td>
<td>6.9</td>
<td>7.4</td>
</tr>
<tr>
<td>May</td>
<td>6.6</td>
<td>7.1</td>
</tr>
<tr>
<td>June</td>
<td>6.2</td>
<td>6.7</td>
</tr>
<tr>
<td>July</td>
<td>6.4</td>
<td>6.9</td>
</tr>
<tr>
<td>Aug.</td>
<td>6.9</td>
<td>7.4</td>
</tr>
<tr>
<td>Sept.</td>
<td>7.3</td>
<td>7.8</td>
</tr>
<tr>
<td>Oct.</td>
<td>6.3</td>
<td>6.8</td>
</tr>
<tr>
<td>Nov.</td>
<td>6.6</td>
<td>7.1</td>
</tr>
<tr>
<td>Dec.</td>
<td>6.6</td>
<td>7.1</td>
</tr>
<tr>
<td>Average</td>
<td>6.7</td>
<td>7.2</td>
</tr>
</tbody>
</table>

At the height of 50 m the observed maximum instantaneous wind speed was 37.1 m/s (Aug. 30, 2000, 22:04) and the maximum 10 minutes average was 30.6 m/s (22:20 on Aug. 30, 2000).

Based on the long-term data of the meteorological stations near the wind park areas, the Shanghai Weather Observation Centre has calculated for both sites the extreme wind speeds for an occurrence interval of 50 years for the height of 70 m. The results are shown in the following Table 4.

Table 4  50 Years Extreme Wind Speeds at 70 m height

<table>
<thead>
<tr>
<th>Unit</th>
<th>10-minute max. wind speed</th>
<th>Instantaneous max. wind speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>m/s</td>
<td>40.7</td>
<td>44.8</td>
</tr>
</tbody>
</table>

The plant and equipment supplied by the Contractor must be appropriate for the site conditions as described in this chapter, so as to guarantee the safe and continuous operation during the expected lifetime of 20 years of the plant and equipment.
2.2 WIND POWER RESOURCES

The wind power data for the Nanhui site are considered to be representative for both wind park sites, as they are similar to those established for Chongming. Major parameters of the wind regime and frequency distribution values are shown in Tab. 5 and Tab. 6, where values for a height of 50 m are measured and those for 70 m height are calculated.

Tab. 5    Features of Wind Power Resources at Nanhui Site

<table>
<thead>
<tr>
<th>Item</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual wind speed at the height of 70m (m/s)</td>
<td>7.2</td>
</tr>
<tr>
<td>Average air density on the site (kg/m³)</td>
<td>1.215</td>
</tr>
<tr>
<td>Wind shear index 10m-50m</td>
<td>0.15</td>
</tr>
<tr>
<td>Turbulence</td>
<td>0.066</td>
</tr>
<tr>
<td>Dominant wind direction</td>
<td>SSE, S (in summer), NNE (in winter)</td>
</tr>
</tbody>
</table>

Tab. 6 Wind Conditions

Weibull Parameters as a function of direction sector at the Height of 50m at Nanhui Site for the period 03/1997 to 02/1998

<table>
<thead>
<tr>
<th>Direction</th>
<th>Sector</th>
<th>A-parameter</th>
<th>Mean Wind Speed [m/s]</th>
<th>k-parameter</th>
<th>frequency</th>
<th>Wind shear</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>/mean</td>
<td>7.568</td>
<td>6.706</td>
<td>2,330</td>
<td>100,000</td>
</tr>
<tr>
<td>N</td>
<td>0</td>
<td>8,667</td>
<td>7.744</td>
<td>3,040</td>
<td>10,179</td>
<td>0.1250</td>
</tr>
<tr>
<td>NNE</td>
<td>1</td>
<td>8,493</td>
<td>7.525</td>
<td>2,319</td>
<td>11,079</td>
<td>0.1118</td>
</tr>
<tr>
<td>ENE</td>
<td>2</td>
<td>7,325</td>
<td>6.527</td>
<td>1,735</td>
<td>9,810</td>
<td>0.0911</td>
</tr>
<tr>
<td>E</td>
<td>3</td>
<td>7,173</td>
<td>6.353</td>
<td>2,103</td>
<td>6,748</td>
<td>0.1088</td>
</tr>
<tr>
<td>ESE</td>
<td>4</td>
<td>6,937</td>
<td>6.159</td>
<td>2,561</td>
<td>8,190</td>
<td>0.1399</td>
</tr>
<tr>
<td>SSE</td>
<td>5</td>
<td>7,955</td>
<td>7.050</td>
<td>2,369</td>
<td>12,860</td>
<td>0.2145</td>
</tr>
<tr>
<td>S</td>
<td>6</td>
<td>7,926</td>
<td>7.023</td>
<td>2,331</td>
<td>11,302</td>
<td>0.2240</td>
</tr>
<tr>
<td>SSW</td>
<td>7</td>
<td>6,581</td>
<td>5.862</td>
<td>2,826</td>
<td>6,919</td>
<td>0.2235</td>
</tr>
<tr>
<td>WSW</td>
<td>8</td>
<td>5,604</td>
<td>5.033</td>
<td>3,372</td>
<td>2,952</td>
<td>0.2501</td>
</tr>
<tr>
<td>W</td>
<td>9</td>
<td>5,869</td>
<td>5.239</td>
<td>2,973</td>
<td>3,085</td>
<td>0.2692</td>
</tr>
<tr>
<td>WNW</td>
<td>10</td>
<td>7,073</td>
<td>6.307</td>
<td>2,902</td>
<td>6,455</td>
<td>0.3227</td>
</tr>
<tr>
<td>NNW</td>
<td>11</td>
<td>7,416</td>
<td>6.595</td>
<td>2,691</td>
<td>10,421</td>
<td>0.1821</td>
</tr>
</tbody>
</table>

For the period 03/97 to 02/2002 the overall wind energy resource is described by the following Weibull frequency distribution for a height of 70 m (extrapolated from 50m data):

\[ k = 2.29 \text{ and } A = 8.0. \]
2.3 INTERFACE FOR THE ELECTRICITY GRID

The wind energy from each wind turbine will be supplied to the substations in the two wind farms through the package transformer connected to each turbine. The power will be supplied to the Shanghai Municipal Power Grid and Chongming Island Power Grid through two lines of 35kV/10kV cable or overhead lines.

The frequency of Shanghai Municipal Power Grid and Chongming Island Power Grid is 50Hz. Chongming is connected via a 220kV power line to the Jiangsu grid. Nanhui connects directly to the Shanghai network. The short circuit current of a 10kV busbar at both sites is 16kA.

The IEC61400-21 standard for grid connection and grid interaction of wind turbines shall apply. The employer will upgrade the substations to allow trouble free operation of the wind farm. The distance from the wind farms to the substations is about 6 km for either site.

The electrical network at Nanhui and Chongming is very stable.

The equipment shall meet the following requirements of the grid:

- Voltage: -10% / + 5%
- Frequency: 50Hz +/- 1Hz

The nominal power factor (cos phi): $\geq 0.95$

The contracted plant and equipment shall meet these requirements.

Any special requirements from the side of the offered turbines shall be explicitly described in the bid.

2.4 ENGINEERING GEOLOGY

Both, the Chongming and the Nanhui wind farm, are located on recently reclaimed beach land. Both sites are flat. For bidding purposes one characteristic geotechnical profile is given for each of the two wind park sites in the table below. These profiles shall serve as the base for a preliminary foundation calculation and design (piling and foundation slab) to be submitted together with the Bid.
After contract award and micrositing, detailed geotechnical exploration data will be provided for each wind turbine location according to Chinese local standards and the requirements provided by the contractor. The geotechnical investigations will be carried out by the Employer according to instructions agreed with the Contractor. One month after receipt of the geotechnical data the Contractor shall submit a detailed design drawing and requirements of the foundations including piling.

### 2.4.1 Geotechnical conditions of Chongming wind farm site and seismic intensity

At the Chongming wind farm site seven (7) soil sampling holes and four (4) static prospecting holes have been placed on east and west rows and the space between the holes is varied from 410 to 656m.

(1) **Strata characteristics and distribution of strata**

According to drilling information and results of soil sample test, there are six (6) strata within 60m under the ground surface, among them stratum No. 2, stratum No. 3, and stratum No. 5 is divided into two sub-strata. The strata are presented as follows (from surface to downwards):

- **Stratum No. 2** cultivated soil, grey-brown and yellow cinnamon clay, thickness: 0.6 to 1.0 m, EL of stratum bottom 3.35 to 2.28 vm, plant roots included in the soil, and the soil is rather soft.

- **Stratum No. 2 1** yellow cinnamon silty clay, thickness 0.5 to 1.2 m, EL of stratum bottom 2.75 to 1.62 m, wet, plastic to soft plastic, rust spots included in the soil, with silt interlayer, the soil is not so uniform, belongs to medium compressive soil.

- **Stratum No. 2 2** grey silt, fine silt, thickness: 7.4 to 10.3 m, EL of stratum bottom –5.81 to –7.55 m, saturated, dense to medium dense, mica and shell pieces included in the soil, with dark grey humus interlayer in the upper part of silt, the soil is not so uniform, belongs to medium compressive soil, blowing number of standard penetration test is 8~25, averaging 13.

- **Stratum No. 3 1** grey silty clay, thickness 2.2 to 7.0 m, EL of stratum bottom –9.48 to -14.30 m, saturated, soft plastic to medium dense, mica and shell pieces
included in the soil, with rather more clayey soil interlayer, the soil is not so uniform, belongs to medium compressive soil.

- Stratum No. 3_2 grey silt, silt, thickness 2.0 – 4.3, EL of stratum bottom – 13.38 to – 14.79 m, saturation, deser, medium dense, mica and shell pieces included in the soil, rather big quantity of clay embedding, the soil quality is not uniform, belongs to medium compressive soils. This stratum shows lenticular distribution.

- Stratum No. 4 grey miry clay, thickness 12.5 to 15.2m, EL of stratum bottom –27.29 to -29.11m, saturated, flow plastic, organic matter included in the soil, with few silt thin interlayer, in some part thin shell layer included in the soil, the soil is uniform, belongs to high compressive soil, this stratum is the main compressive layer of this area.

- Stratum No 5_1 grey silty clay, thickness 11.4 to 13.8m, EL of stratum bottom –39.58 to -42.71m, saturated, flow plastic to soft plastic, a few silt included in the soil, with thin silt interlayer, shell included in the soil, argillo-calcic block and semisaprophyte root is casually seen at the lower part, the soil is rather uniform, belongs to highly compressive soil.

- Stratum No. 5_2 grey clay, thickness 11.5 to 12.9m, EL of stratum bottom –52.90 to – 54.30 m, saturated, wet, soft plastic to plastic, silt included in the soil, with thin silt interlayer, argillo-calcic small block is casually seen, the soil is rather uniform, belongs to medium compressive soil.

- Stratum No. 7 grey silt, silt, the bore has not penetrated through this stratum, the thickness is estimated more than 3.4 m, saturated, medium dense, mica and shell included in the soil, with a few clay interlayer, the soil is rather uniform, belongs to medium compressive soil.

The physical and mechanical characteristics of the strata can be seen in Tab. 7. The value of $\phi$ and $C$ in the table is about 70% of the consolidation shear peak value.

The groundwater level is about 0.4 to 1.0 m below the surface. The corresponding elevation is 2.49 to 3.12 m above sea level. The base of the upper foundation slab shall be placed at 3.62 m, what is 0.5 m above the upper groundwater level. Groundwater samples showed no corrosiveness against concrete. However, this shall be verified during the coming geotechnical investigations at the individual wind turbine sites.
The seismic intensity of this area is considered according to the peak value for the horizontal acceleration of 0.15g (150cm/s²). The Contractor shall inform himself on the detailed requirements and shall assure that his plant and equipment as well as any static calculation and/or design will adequately consider the seismic risks and standards.
<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Strata</th>
<th>Thickness (m)</th>
<th>Water Content W (%)</th>
<th>Gravity y(kN/m³)</th>
<th>Specific Density G</th>
<th>Void Ratio e</th>
<th>Plastic Index IP</th>
<th>Liquid Index IL</th>
<th>Permeability</th>
<th>Compression Coefficient $c_{v}$ (MPa⁻¹)</th>
<th>Compression Modulus $E_v$ (MPa)</th>
<th>Inner Frictional Angle $\phi$ (°)</th>
<th>Cohesion C (kPa)</th>
<th>Blowing Number of Standard Penetration N63.5 Blow N</th>
<th>Specific Penetration F5 (MPa)</th>
<th>Bearing Capacity of Ground Soil f (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cultivated soil</td>
<td>0.6</td>
<td>3.35</td>
<td>1.0</td>
<td>2.28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Silt, fine sand</td>
<td>0.5</td>
<td>2.75</td>
<td>1.62</td>
<td>34.8</td>
<td>19.9</td>
<td>2.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Silt clay</td>
<td>2.2</td>
<td>-9.48</td>
<td>7.0</td>
<td>28.4</td>
<td>17.5</td>
<td>2.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Silt, silty soil</td>
<td>2.0</td>
<td>-13.38</td>
<td>4.3</td>
<td>24.2</td>
<td>18.6</td>
<td>2.69</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Clay</td>
<td>11.4</td>
<td>-39.58</td>
<td>13.8</td>
<td>48.6</td>
<td>17.4</td>
<td>2.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Silt clay</td>
<td>11.5</td>
<td>-52.90</td>
<td>12.9</td>
<td>30.5</td>
<td>17.6</td>
<td>2.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Silty soil, silt</td>
<td>&gt;3.4</td>
<td>Not penetrat ed</td>
<td>through</td>
<td>23.7</td>
<td>17.7</td>
<td>2.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- **KH:** Modulus of Elasticity
- **KV:** Poisson's Ratio
- **Min:** Minimum Value
- **Max:** Maximum Value
- **Average:** Average Value

**Variables:**
- **W:** Water Content (%)
- **y:** Specific Gravity
- **G:** Specific Density
- **e:** Void Ratio
- **IP:** Plastic Index
- **IL:** Liquid Index
- **v:** Permeability
- **E_v:** Compression Modulus
- **c_v:** Compression Coefficient
- **C:** Cohesion
- **Max:** Maximum Value
- **Min:** Minimum Value
- **Average:** Average Value

**Units:**
- **m:** Meter
- **MPa:** Megapascal
- **kPa:** Kilopascal
- **%:** Percentage
- **cm²/s:** Centimeter squared per second
- **g/cm³:** Gram per cubic centimeter

**Context:**
This table is from the *Physical Mechanic Characteristics Sheet of Strata (Chonmg in)* within the *China Renewable Energy Development Project* document. It provides detailed properties of various strata layers, including their physical characteristics and mechanical properties.
(2) Foundation characteristics

The height of the wind turbo-generator tower frame may reach 70m, and the foundation area is comparatively small. Dynamic loads may occur during operation caused by wind. In order to avoid a tilt of the tower, long pile foundation in the strata shall be applied to ensure the stability and reliability of the tower. Approximate parameters for the calculation of single pile bearing capacity are shown in Tab. 8.

### Tab. 8 Approximate parameters for the Calculation of Single Pile Bearing Capacities (Chongming)

<table>
<thead>
<tr>
<th>No</th>
<th>Name of stratum</th>
<th>Pre-cast pile</th>
<th>Drilled and cemented pile</th>
<th>Recommended value</th>
<th>(kpa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(22)</td>
<td>Yellow-brown silty clay</td>
<td>15</td>
<td>15</td>
<td>fi</td>
<td>fp</td>
</tr>
<tr>
<td>(23)</td>
<td>Grey silt, fine silt</td>
<td>6m 15/45</td>
<td>6m 15/45</td>
<td>fi</td>
<td>fp</td>
</tr>
<tr>
<td>(31)</td>
<td>Grey silty clay</td>
<td>25</td>
<td>400</td>
<td>20</td>
<td>250</td>
</tr>
<tr>
<td>(32)</td>
<td>Grey silt, sily</td>
<td>35</td>
<td>1200</td>
<td>30</td>
<td>650</td>
</tr>
<tr>
<td>(4)</td>
<td>Grey miry clay</td>
<td>40</td>
<td>500</td>
<td>20</td>
<td>200</td>
</tr>
<tr>
<td>(51)</td>
<td>Grey clay</td>
<td>45</td>
<td>1100</td>
<td>40</td>
<td>500</td>
</tr>
<tr>
<td>(52)</td>
<td>Grey silty clay</td>
<td>65</td>
<td>2500</td>
<td>45</td>
<td>1200</td>
</tr>
<tr>
<td>(7)</td>
<td>Silty soil, silt</td>
<td>70</td>
<td>4000</td>
<td>60</td>
<td>1500</td>
</tr>
</tbody>
</table>

Note: fi—limiting frictional resistance of soil around the pile
fp—limiting bearing capacity of soil at the bottom of pile

2.4.2 Geotechnical conditions of the Nanhui wind farm site and seismic intensity

Totally four (4) holes were bored nearby the new Nanhui wind farm site for geotechnical exploration purposes. The distance between holes was about 900m.

(1) Strata characteristics and distribution of strata
According to drilling information and results of geo-technical test, there are six (6) strata within 50m under the ground surface, among them stratum 3 and stratum 7 are divided into two (2) sub-strata. The strata are presented as follows (from surface to downwards).

- **Stratum No. 1** dark grey miry soil, thickness 2.8 to 3.0 m, EL of stratum bottom 1.20 to 0.89 m, bulrush roots and black humus included in the soil, with high water content, the soil is very soft, belongs to high compressive soil.

- **Stratum No. 3** grey sandy silt, thickness 6.5 to 9.0m, EL of stratum bottom –5.36 to –7.80 m, saturated, denser, generally sticky silt and clay content is high in upper part, fine silt interlayer and block mass can be casually seen in lower part, mica shell included in the soil, the soil is not uniform, belongs to medium compressive soil, blowing number of standard penetration test is 4 to 8.

- **Stratum No. 3** grey muddy silty clay, a thicker interlayer of stratum No 3, lenticular distribution, thickness 2.0 to 3.5m, EL of stratum bottom –5.50 to –6.90 m, saturated, flow plastic, silt, silt interlayer and block mass included in the soil, the soil is not uniform, belongs to high compressive soil.

- **Stratum No. 4** grey miry clay, thickness 9.6 to 12.0m, EL of stratum bottom –15.61 to –18.50 m, saturated, flow plastic, organic matter and shell included in the soil, with a few thin silt interlayer, the soil is fine and uniform, belongs to high compressive soil, it is the main compressive stratum of this area.

- **Stratum No. 5** grey clay, thickness 4.5 to 7.5m, EL of stratum bottom –22.40 to –24.36 m, saturated, flow plastic to soft plastic, with minor silt block and thin layer, mica and shell included in the soil, soil is uniform, belongs to high compressive soil.

- **Stratum No. 6** grass yellow silty clay, thickness 1.9m, EL of stratum bottom –24.30 m, wet, plastic, with rust spot and thin interlayer of silt, shows horizontal bedding.

- **Stratum No. 7** grass yellow sandy silt, thickness 1.6 to 2.8 m, EL of stratum bottom –25.90 to –26.36 m, saturated, medium dense, partial is sticky silt, mica
included in the soil, with a few clay interlayer, the soil is not very uniform, belongs to medium compressive soil.

- Stratum No. 7; grass yellow fine silt, the bore has not penetrated through this stratum, thickness is estimated more than 20m, saturated, medium dense to dense, mica included in the soil, with a few silt interlayer and sticky soil interlayer, gravel is casually seen, the soil is rather uniform, belongs to medium compressive soil.

The physical and mechanical characteristics of the strata can be seen in Tab. 9. The value of $\varphi$ and C in the table is about 70% of the consolidation shear peak value.

The groundwater level is about 0.14 to 0.60 m below the surface. The corresponding elevation is 3.54 m to 3.86m above sea level. The base of the upper foundation slab shall be placed at 4.36 m, what is 0.5 m above the upper groundwater level. Groundwater samples showed no corrosiveness against concrete. However, this shall be verified during the coming geotechnical investigations at the individual wind turbine sites.

The seismic intensity of this area is considered according to the peak value for the horizontal acceleration of 0.15g (150cm/s^2). The Contractor shall inform himself on the detailed requirements and shall assure that his plant and equipment as well as any static calculation and/or design will adequately consider the seismic risks and standards.
# Tab 9
## Physical Mechanic Characteristics Sheet of Strata (Nanhu)

<table>
<thead>
<tr>
<th>Strata No.</th>
<th>Name of Strata</th>
<th>Thickness (m)</th>
<th>Water Content W(%)&lt;br&gt;Min Max</th>
<th>Gravity γ(kN/m³)&lt;br&gt;Min Max</th>
<th>Specific Density G&lt;br&gt;Min Max</th>
<th>Void Ratio e&lt;br&gt;Min Max</th>
<th>Plastic Index IP&lt;br&gt;Min Max</th>
<th>Liquid Index IL&lt;br&gt;Min Max</th>
<th>Permeability&lt;br&gt;Min Max</th>
<th>Compression Coefficient&lt;br&gt;Min Max</th>
<th>Compression Modulus&lt;br&gt;Min Max</th>
<th>Inner Friction Angle&lt;br&gt;Min Max</th>
<th>Cohesion C&lt;br&gt;Min Max</th>
<th>Number of Standard Penetration N63.5′ Blow&lt;br&gt;Min Max</th>
<th>Blowing Capacity of Ground Soil&lt;br&gt;Min Max</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dark grey mud</td>
<td>2.0 ~ 3.0</td>
<td>1.20 ~ 0.89</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Gray sandy silt</td>
<td>6.5 ~ 9.0</td>
<td>28.5 ~ 33.9</td>
<td>16.5 ~ 19.4</td>
<td>18.4 ~ 19.4</td>
<td>2.70 ~ 2.71</td>
<td>0.788 ~ 0.966</td>
<td>9.7 ~ 9.7</td>
<td>1.12 ~ 1.12</td>
<td>3.35×10⁻⁴ ~ 4.94×10⁻⁴</td>
<td>1.35×10⁻⁷ ~ 3.16×10⁻⁶</td>
<td>0.17 ~ 0.33</td>
<td>5.41 ~ 10.51</td>
<td>24.0 ~ 24.0</td>
<td>0 ~ 8</td>
<td>6.4 ~ 75</td>
</tr>
<tr>
<td>3.2</td>
<td>Grey and silty clay</td>
<td>2.0 ~ 3.5</td>
<td>35.2 ~ 38.6</td>
<td>17.0 ~ 18.6</td>
<td>18.2 ~ 19.4</td>
<td>2.72 ~ 2.73</td>
<td>1.002 ~ 1.054</td>
<td>11.1 ~ 12.8</td>
<td>1.38 ~ 1.09</td>
<td>4.94×10⁻⁴ ~ 3.99×10⁻⁴</td>
<td>1.93×10⁻⁵ ~ 2.71×10⁻⁵</td>
<td>0.49 ~ 0.62</td>
<td>3.13 ~ 3.60</td>
<td>24.0 ~ 24.0</td>
<td>0 ~ 8</td>
<td>65</td>
</tr>
<tr>
<td>4</td>
<td>Grey silt</td>
<td>9.6 ~ 12.0</td>
<td>51.7 ~ 58.8</td>
<td>17.0 ~ 17.5</td>
<td>17.0 ~ 17.5</td>
<td>2.76 ~ 2.76</td>
<td>1.315 ~ 1.655</td>
<td>19.5 ~ 22.9</td>
<td>1.09 ~ 1.23</td>
<td>3.10×10⁻⁷ ~ 8.15×10⁻⁶</td>
<td>1.35×10⁻⁷ ~ 3.16×10⁻⁶</td>
<td>0.84 ~ 1.60</td>
<td>1.43 ~ 2.63</td>
<td>6.0 ~ 11.0</td>
<td>9.0 ~ 60</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Grey clay</td>
<td>4.5 ~ 7.5</td>
<td>36.2 ~ 44.6</td>
<td>17.2 ~ 18.4</td>
<td>17.8 ~ 18.4</td>
<td>2.73 ~ 2.74</td>
<td>1.040 ~ 1.290</td>
<td>16.2 ~ 19.3</td>
<td>0.69 ~ 1.02</td>
<td>1.43×10⁻⁷ ~ 1.65×10⁻⁵</td>
<td>2.07 ~ 4.87</td>
<td>0.72 ~ 1.03</td>
<td>3.01 ~ 11.0</td>
<td>8.1 ~ 12.1</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Grass yellow silt</td>
<td>1.9 ~ 2.4</td>
<td>33.4 ~ 38.6</td>
<td>18.8 ~ 19.4</td>
<td>18.8 ~ 19.4</td>
<td>2.71 ~ 2.74</td>
<td>0.931 ~ 0.985</td>
<td>0.38 ~ 0.48</td>
<td>4.81 ~ 20.0</td>
<td>1.99×10⁻⁴ ~ 1.27×10⁻⁴</td>
<td>1.65×10⁻⁶ ~ 3.00×10⁻⁵</td>
<td>0.19 ~ 0.23</td>
<td>7.88 ~ 9.73</td>
<td>22.5 ~ 22.5</td>
<td>8.0 ~ 8.0</td>
<td>140</td>
</tr>
<tr>
<td>7.1</td>
<td>Grass yellow sandy silt</td>
<td>1.6 ~ 2.8</td>
<td>29.8 ~ 32.1</td>
<td>18.6 ~ 19.0</td>
<td>18.9 ~ 19.0</td>
<td>2.70 ~ 2.71</td>
<td>0.841 ~ 0.901</td>
<td>0.19 ~ 0.23</td>
<td>7.88 ~ 9.73</td>
<td>1.99×10⁻⁴ ~ 1.27×10⁻⁴</td>
<td>1.65×10⁻⁶ ~ 3.00×10⁻⁵</td>
<td>0.19 ~ 0.23</td>
<td>7.88 ~ 9.73</td>
<td>22.5 ~ 22.5</td>
<td>8.0 ~ 8.0</td>
<td>140</td>
</tr>
<tr>
<td>7.2</td>
<td>Grass yellow fine silt</td>
<td>&gt;20.0</td>
<td>Not penetrated through</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(2) Foundation characteristics

The barycenter of the wind turbine is high and the load of that is high, the requirement for anti-tilt of the wind turbine is correspondingly high. Stratum No. 1 of the wind farm is mud, stratum No 31 is grey sandy silt; they are liquid strata and both strata cannot be used as natural foundation support. Therefore, pile foundations will have to be adopted. Approximate parameters for the calculation of the single pile bearing capacity is shown in Tab. 10.

**Tab. 10 Approximate parameters for the Calculation of Single Pile Bearing Capacity(Nanhui)**

<table>
<thead>
<tr>
<th>No</th>
<th>Name of stratum</th>
<th>Pre-cast pile</th>
<th>Drilled and cemented pile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>fi</td>
<td>fp</td>
</tr>
<tr>
<td>(3)</td>
<td>Grey sandy silt</td>
<td>6m 15 35</td>
<td></td>
</tr>
<tr>
<td>(3)</td>
<td>Grey miry and silty clay</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td>Grey miry clay</td>
<td>25 400</td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td>Grey clay</td>
<td>45 1200</td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td>Grass yellow silty clay</td>
<td>60 1500</td>
<td></td>
</tr>
<tr>
<td>(7)</td>
<td>Grass yellow sandy silt</td>
<td>65 3500</td>
<td></td>
</tr>
<tr>
<td>(7)</td>
<td>Grass yellow fine silt</td>
<td>90 5000</td>
<td></td>
</tr>
</tbody>
</table>

Note: fi---limiting frictional resistance of soil around the pile  
fp---limiting bearing capacity of soil at the bottom of pile

2.5 TRANSPORTATION TO THE SITE

Chongming Wind Farm is located on the eastern seacoast of Dongwangsha in the Chongming County. After the equipment is shipped to the Port of Shanghai, it will be shipped to Chongming Island and the distance of land transportation is about 44 km. Along the transportation line there are dozens of bridges and the allowable load of most bridges is truck-20 (Chinese standard for bridge capacity) with the exception of three to five bridges, which are designed for truck-10. During the transportation temporary measures will be carried out, and the allowable maximum weight of the
heaviest piece is 55 ton. The transport of the imported equipment will be carried out by the Employer. The transport of the tower segments will be carried out by the Contractor. The employer will organize all required permits to transport pieces up to 55 tons over all bridges to the site. For transport purposes some road curves near the site require an enlargement. This shall be done by the Employer according to instructions received from the Contractor.

The Nanhui Wind Farm is located inside the Binhai Township in the Nanhui County, which is about 60 km away to the South from the Shanghai downtown area more than 10 km in the South of the Pudong International Airport. The equipment will be shipped to the Waigaoqiao Dock, and then transported to the wind farm via highways. The total transportation distance is about 67km. The highway and bridges along the line can meet the transportation requirements. Near the project site an enlargement of access road curves will be required, what will be carried out by the employer according to instructions of the Contractor.

2.6 LOCAL RESIDENCES

The Chongming wind farm will be located on the eastern coast of Dongwangsha on the Chongming Island along the Dongwangsha Dyke. The area is formed by long-term deposition of mud and sand from the Yangtze River. Since the reclamation in 1992 it has been used for a comprehensive development and utilization including cropping and fish culture etc. In parallel to the Dongwangsha dyke in about 2.3 km distance towards the sea a new dyke was built in 1998 in order to protect newly reclaimed land. There are not any buildings between the dykes and near to the wind park area.

Nanhui wind farm is located inside and outside of the dyke “Jiusitang” in the south of the Dazhi river mouth within the Binhai Township in the Nanhui County. In the North of the wind farm a golf course is located and on the east lies a large piece of reclaimed marshy beachland. The wind park itself shall be constructed in parallel at the eastern side of the dyke as well within a presently developed forest park west of the dyke. Wide marshy land used for cropping and aquaculture as well as parts of tourism facilities mainly occupy the wind farm area and its surroundings. There are no residential areas nearby the wind park.
DIVISION 3  TECHNICAL REQUIREMENTS

3.1 WIND TURBINES

3.1.1 General Requirements

- Only one type of turbine for the wind farm, rated capacity between 800 and 1500 kW;
- The turbines must be of three-blade, upward wind direction and horizontal shaft, grid-connected;
- The offered turbines should be of a type that would be acceptable according to noise regulations applicable in Europe or the USA. IEC 61400-11 applies as a standard for noise of turbines.
- Ambient temperature range: -10°C and 40 °C.
- Electrical parameters according to IEC61400-21.
- Tubular steel tower giving a minimal hub height of 65 m, and a maximum of 72 m
- Radar screening for wind measurement equipment on the nacelle shall be considered in order to avoid malfunctioning.

Taking into account the wind conditions at the Nanhui site the Contractor shall guarantee the plant performance (see Division No. 8) with regard to

- power curve
- availability.

The wind turbines shall be able to safely operate in the environment without operator on duty. The Bidder has produced and put into commercial operation for at least one year at least 20 wind turbines of the offered type. During this one-year period the availability for those turbines has reached at least 95%. All components of the wind turbine shall be designed for operation under the site conditions. Turbines must comply with the IEC Wind Class II or equivalent GL Class. The design lifetime of WEC shall be a minimum of 20 years. Main components (blade, generator, gearbox, main shaft, nacelle, mainframe, tower) shall not be replaced in design life time. The wind turbines shall be certified according to IEC Class II (or equivalent GL class). Any deviations or improvements have to be specified and be accompanied by certificates of the type approval institute. Design changes affecting the power performance as given in the guaranteed power curve, have to be explicitly explained and verified by the certifying institute.
Doors and other covers or lids giving access to parts or installations of the Wind Turbine shall be accessible only by the use of keys or tools.

**Corrosion Protection**

Equipment not designed for outdoor operation and installed at the tower bases must be protected against sun, rain and sea spray by a shelter or a shed. For components and items, which cannot be protected by covering components and/or coating, appropriate materials shall be used.

The following measures should be clarified and verified with the specific type certificate:

- The corrosion protection shall be carried out to meet the requirements of ISO 12944-2, C5M or comparable standards applicable to wind turbines operating in coastal environments (deviations to be explained)
- The protection of materials, components and equipment has to be assured, which is not directly exposed to solar radiation, rain and dust
- All electrical components including their housings have to be protected against the aggressive climatic impacts
- Determination of painting and coatings systems
- Verification and approval of the materials and coating materials,
- Determination of the layer structure for surfaces with direct or indirect atmospheric exposure.

3.1.2 Mechanical, Aerodynamic, and Hydraulic Components

**Nacelle**

The nacelle shall be safely accessible and shall provide sufficient space and light for functional tests, maintenance, and repair.

The Nacelle shall be equipped with a lifting device, which is at least suitable for the lifting of tools, spare parts, materials.

Nacelles shall be equipped with air navigation lamps on the top. It must provide a safe working area with regard to the proximity to rotating components for safety of maintenance personnel. Appropriate attachment points for personal safety lanyards shall be provided including attachment points for access to the top of the nacelle.
Rotor and Blades

Material, dimension, and soundness of castings for hub shall comply with design specifications.

The locations of the wind parks and the climatic conditions require special measures against corrosion and salty dust impact.

- The blades shall be painted colour aviation marks, which are widely used in the world.
- The blades shall be covered with adequate coating.
- The Contractor may provide with his Bid and supply specific measures to avoid dust and dirt deposits at the blades. The leading edge of the blades shall be protected against erosion.
- For steel components used or integrated in the blades adequate corrosion protection shall be used.

Exchange of individual rotor blade shall be possible. The Contractor shall provide a detailed documentation about each rotor.

Emphasis is laid on a proper blade lightning protection and connection to the protection system of the nacelle.

Drive Train – Gear Box (if applicable)

Standard components of proven performance shall be used to give high reliability. All gear wheels, bearings and shafts shall be dimensioned with a considerable safety factor for the transfer of the mechanical load through the gearbox under all conditions. Measures shall be taken to minimise the transfer of vibrations from the gearbox to the main frame of the nacelle. The gearbox shall be equipped with highly efficient (!) oil filters and oil cooler, sufficiently dimensioned for the site conditions. The exchange interval for the gearbox oil shall be specified by the manufacturer of the gearbox for the respective oil type. The Contractor shall carry out this service accordingly during the Defect Liability Period, but at least during the last inspection visit at the end of the Defect Liability Period.
All drive train lubrication intervals shall be at least six months. The contractor shall be responsible to take gearbox oil samples during each turbine service (and more often if any unusual behaviour is experienced) and send them to be analysed by an independent institute. Results are to be provided to the employer.

The contractor shall supply with his bid detailed evidence that the offered gear box design has taken into account the lessons learned from the wide spread wind turbine gear box failures of the past years.

Evidence documents on conformance with design specifications as to material, dimensions, and surface finish shall be available for each shaft. Standard parts shall be reliable.

**Yaw System**

The system must be provided with an automatic control system to avoid damage to cables by twisting. Manual yawing must be operable from nacelle as well as from the local control panel.

### 3.1.3 Security Systems

A complete system of interlocking and safety devices shall be provided as required for the safety of the operators and for a trouble-free continuous operation of the wind park protecting:

- Operation and maintenance personnel,
- Mechanical and electrical equipment from damage,
- The perfect state when starting up and shutting down the wind park and all parts of the Plant and also to correct sequence control, when starting and stopping the latter.

All interlocking and safety devices shall operate preventively and shall not interfere with correct circuits in operation. The Wind Turbines must have security systems against vibration, over-speed, and electrical overloading.

**Brake system**

The Wind Turbines must be equipped with at least two independent braking systems, which guarantee that the Wind Turbine can be stopped under all load conditions (including loss of load respectively grid failure) and with the rotating speed of the
rotor as high as the maximum rotating speed. At least one of the brakes should work on the basis of aerodynamic principle acting directly on the rotor. If this is not the case, one mechanical braking system shall brake the low-speed shaft. The brake system shall provide device for locking the rotor position to facilitate brake maintenance.

3.1.4 Wind Turbine (WEC) Monitoring and Control Systems

The WEC control system together with the power system must fully protect the mechanical and electrical installations of the Wind Turbine against failure or breakdown, and at the same time ensure maximum overall electricity generation under given wind conditions.

The WEC control system has to be designed for automatic, unattended operation. The main control board must be individually for each WEC and shall be installed at the base of the WEC and be equipped with a standard interface that is compatible with the RCMS system. The control system shall detect all unsafe conditions and cause the WEC to cease operation and/or return to safe or non-hazardous condition. Manual or automatic intervention shall not comprise the protective function of the control system and the settings of the control system shall be protected against unauthorised interference. No single failure in the sensing or activation parts of the control system shall prevent safe shutdown of the WEC.

The controller shall be designed for operation in harsh environments including sudden change of temperature and humidity or sea climate.

The control system at the WEC shall provide manual control such as
- Disabling automatic operation and block remote control override
- Manual start
- Manual yawing
- Manual braking and release
- Manual pitch actuation (pitch controlled WECs)
- Manual shutdown.
The system shall, as a minimum, be able to shut down, display and give alarm under the following conditions:

- Activation of emergency stop
- Grid failures, e.g. frequency failure, voltage failure, excess current, phase sequence failure, phase asymmetry
- Rotor over speed
- Generator over speed
- Temporary accepted overload is exceeded
- Maximum momentary accepted overload is exceeded
- Excessive wind speed
- Excessive temperature (e.g. generator, gear box oil, bearings, control panel, ambient)
- Brake system failure
- Vibrations of the nacelle
- Yaw failure
- Twisted cables
- Anemometer and wind vane failure
- Control system failure
- Power system failure
- Hydraulic system failure

The system shall be able to display and give alarm in case of Anemometer and wind vane failures.

The control system shall restart the WEC automatically after a shut-down caused by grid failure, after un-twisting, after disappearance of excessive wind speeds, after disappearance of excessive system temperatures as a result of ambient temperatures, and after disappearance of temporary and momentary overload. The WEC shall have to be restarted manually in case of all other shutdowns.

An additional control board (top-box control board) shall be available at least in the nacelle. It must be designed for carrying out the essential operations during functional, maintenance, and repair checks.
An emergency-switch-off for manual operation must be available at least in the nacelle (top-box control board) and at the main switchboard or control board at the base of the WEC.

The turbine controller shall either be protected against loss of program or the operator shall be in a position to reinstall the program in case of program failure.

The turbine controller should indicate, whether it is sending/receiving data from the RCMS in order to identify potential communication errors.

**Monitoring Functions**

The monitoring system as part of the WEC control system shall, as a minimum, display the following:

- Status of WEC
- Operation times of WEC in h as monthly, yearly and cumulative values:
- Grid OK hours
- Turbine OK hours
- Generating hours
- Service hours
- Failure hours
- Electricity generation of WEC in kWh (monthly, yearly, cumulative)
- All phase voltages and currents
- Wind speed in m/s and wind direction in degree (present, classified monthly distribution, monthly average)
- Power Curve (kW over m/s; stored as monthly statistics)
- All failures (status message, number and total failure time and date, monthly and/or cumulative; memory to provide storage of more than 14 months)
- Active power output (kW)
- Reactive power (kvar) or Power factor cos \( \varphi \)
- Rotor speed
- Temperature at nacelle, generator’s stator, gearbox, bearings, ambient

If certain values cannot be measured directly, the contractor may propose an alternative way of deriving the data at the central monitoring computer.
It is required that all monitoring data formats are fully documented, so as to allow the interface with independent data logging systems. A suitable interface is highly recommended.

3.2 Remote Control and Monitoring System (RCMS)

The Contractor has to supply three Remote Control and Monitoring System (RCMS) for the centralised supervision of the operation and the centralised acquisition of operational data from the individual WECs and the meteorological monitoring masts used for power curve measurements. The system shall be installed in the control room at the SWPC control building at the wind park sites Nanhuí (14 MW) and Chongming (6 MW) for the respective wind parks and in the SWPC headquarters in Shanghai for both wind parks (being hierarchical below the on-site control systems) and consist of:

- Computer terminal(s) (including a CD-R written device)
- Remote control and monitoring software
- All necessary cabling, including the cabling from the met. Measuring tower
- Transmission equipment (modems, transmitter/receiver system etc.)
- Hardware and software to interconnect with the office network in the wind park control building
- Hardware and software to allow access to system via private Internet (VPN)
- Printer for evaluation of operational results
- Wind park internal data cable connection to the Control Building
- Software interface to allow data exchange with other monitoring systems installed in the wind parks, i.e. the data monitoring system from the package transformers of wind turbines to the substations near the wind farms till the Dispatch Centre of the grid.

The telecommunication connection of the SWPC Control Building at the wind park site to the national telecommunication network as well as the connection network in the control and the monitoring rooms will be provided by the Employer.

The Contractor has to supply two remote monitoring systems to be installed at the Shanghai dispatch Centre and in a central office in Beijing respectively (one for each
place), which is of the same principle and consists of the same modules as the RCMS except for the control functions.

The hardware shall be appropriate to deal with all requirements of the RCMS software. The computers shall be of the latest commercial version.

The complete RCMS (including the cables) shall be protected against overvoltage, lightning and static discharges. Preference should be given to optic fibre cables. Underground cables shall be used and the cables and their connecting items shall be protected against water. The control cables shall - where possible - be laid in parallel to the wind park internal 10 kV cables.

A back-up system (UPS = uninterrupted power supply) shall ensure the normal operation of the system for a period of at least 10 min to avoid the loss of data. The failure of a turbine or the wind park shall not influence the operation of the RCMS.

In case the RCMS fails, the operation of the individual turbines shall not be disturbed.

**Remote control functions**

The remote control function shall be protected against unauthorised access. Special emphasis has to be laid on a clear definition of the hierarchical order of access rights according to the responsibilities of parties involved. Unsafe operation while site personnel are working on the WECs should be prevented by appropriate precaution measures.

The following functions should be enabled by the remote control system as a minimum:

- Stop of WEC and complete wind park (normal and emergency)
- Reset of WEC and complete wind park
- Change of control parameters (to be enabled after end of Defect Liability Period).

The activation of these functions shall be recorded in log files with date and time and it shall be possible to print these log files.

**Remote monitoring and data acquisition functions**
All monitored data and functions shall be recorded and permanently stored. Functions to prepare printed reports have to be provided. The monitored data consist of operational on-line and historical data. The following data shall be monitored as a minimum:

- Status of each WEC and the complete wind park
- All failures of the complete wind park and individual WECs including grid failures (status message, number, type, failure date and time and total failure duration)
- All data according to paragraph 3.1.4

In addition, the following data has to be measured, displayed and stored:
- Active power output of each WEC and the complete wind park in kW (present and 10 min average)
- Electricity generation of each WEC and the complete wind park in kWh (daily, monthly, yearly, cumulative)
- Self consumption of each WEC
- Wind speed and wind direction (as distribution and time series) at each nacelle anemometer and wind vane (m/s, 10-min mean values, daily, monthly, yearly)
- Ambient temperature measured at each WEC by a temperature sensor (present, 10-min average, daily, monthly, yearly)
- Voltage and current of each WEC related to failure messages
- Temperatures of generator (stator and rotor), gearbox and sensitive electric devices of each WEC (present, 10-min interval, daily, monthly) and the related maximum permissible temperature values
- Availability of each WEC and the complete wind park as defined in the Tender documents (monitored on a monthly and yearly basis)
- Manual stop and start of each WEC, record of the stop periods (time, duration and number)
- Stop and re-start of each WEC due to ambient temperature range limits, record of the stop periods (time, duration and number) and ambient temperature
- Stops due to wind speed beyond the cut-off wind speed, record of the stop periods (time, duration and number)
− Stops due to wind speed below cut-in wind speed, record of the stop periods (time, duration and number)

The contractor shall be responsible to program the data acquisition system in such a way that each month an automatic report is generated for each turbine that gives adequate information on the turbines performance and error history. This report will be the starting-basis for discussions between the contractor and employer during the commissioning and 3 years defects liability period in case any problems arise.

The successful operation of the RCMS will be verified in detail during the commissioning period.

Data of Independent Weather Stations (for performance measuring):

− Wind speed and direction (as distribution and time series) at independent wind park anemometer at 10 m and hub height (m/s, 5 second gust, 10-min mean values, daily, monthly, yearly, standard deviation, calm duration, etc)

− Ambient temperature, humidity and air pressure measured by the independent sensors (10-min mean values, daily, monthly, yearly)

The RMCS shall permanently display the following instantaneous values for each of the wind parks as top text in all menus

− Last active error
− Number of WECs connected to the grid
− Wind speed (m/s) (Met. Mast)
− Total active power (MW)
− Total reactive power (MVAr)
− Power factor

The data acquisition system must provide for easy processing of statistical data such as:

− Power curve(s) comparison over a selected time period
− Availability of each WEC and the complete wind park as specified in the Technical Specifications
− Daily, monthly, any yearly averages or distributions
An automatic acoustic and visual alarm should be raised at the monitoring computer at the Site Control Buildings and SWPC Control Buildings in case of any abnormal operating condition e.g.:
- Failures and emergency stops
- Manual stop and start
- Stops due to wind speed beyond the cut-off wind speed
- Stops due to increase of the ambient temperature beyond its permissible limit

3.3 POWER SYSTEM

Electric components, such as switchgears, drives, generators, control units and equipment shall be designed according to the Rules and Regulation for Certifying of WECs. Every item of electrical equipment used in the electrical system shall comply with the relevant IEC, or equivalent standards. Each item shall be able to withstand all anticipated on-site conditions according to its installation and use including its duty-cycle as well as environmental, mechanical, chemical, and thermal stresses to which the system may be subject during operation. The rating of the electrical equipment shall be suited to steady and transient voltages and currents that may be experienced during normal operations and fault conditions. The effects of different external influences may be independent or have mutual interactions. If they have mutual interactions, an adequate level of protection for each item of electrical equipment shall be chosen.

Every electrical component shall have an appropriate level of immunity from electrical disturbances (refer to IEC 1000). All electrical components shall be selected so that they shall not cause harmful effects on or interfere with the function of other electrical system components.

3.3.1 Protection Against Electric Contact

The wind turbine electrical system shall be arranged to afford easy accessibility for operation, testing, inspection, maintenance, and repair. The design of the electrical system shall ensure the safety of people, and other fauna against dangers that may arise from direct or indirect contact with live parts of the system. All live parts shall be fully covered by insulating material, or shielded by suitable barriers.

Protection against power leakage of conductive parts in the indirect contact electrical system that have become live owing to a fault in the insulation of these parts that are
normally live shall be ensured. This protection shall be achieved by either of the following or others equivalence:

- Automatic disconnection of the fault circuit using ground fault protection equipment
- Double the insulation requirements of relevant IEC (or equivalent).

**Interface with Power Grid**

For protection purposes, a circuit breaker shall be installed between the grid and the wind turbine electrical system. It shall simultaneously interrupt all supply circuits, and shall be located conveniently for access of operational and maintenance personnel.

It shall be opened either manually or by the wind turbine control system. The rating of this circuit breaker shall be suitable for the maximum short circuit capacity of the wind turbine connection point and the grid.

Auxiliary circuits such as those for heating and lighting shall be provided with their own switching devices which shall be obviously disconnected and can operate in an unload state.

Soft starts or an equivalent system are required to minimise transients when connecting the turbines to the power grid, and to prevent the over voltage of wind turbine during start.

**Enclosures for electrical equipment**

Enclosures for electrical equipment that are protected from the weather shall also provide protection from dust, water, salt fog and light splashing. Doors and cover plates shall be provided with suitable tools for securely fastening them in the closed position. A minimum of NEMA 12 or IEC equivalent shall meet these requirements. All enclosures shall be sheltered reasonably and shall be located to minimize exposure to rain, attention shall be paid to prevent rain entering through access or maintenance openings when enclosure doors are open. For control cubicle particular consideration shall be given to the effects of salty fog and humidity.

**Arrangement of Electrical Wiring**

The characteristics of wiring between the components of the wind turbine electrical system shall comply with IEC standards 227, 245, 287, or equivalent, taking into
account the specific location and stresses to which conductors may be subjected
during installation and operation.

For arrangement of conductors, protection against over-voltage due to contact
between conductors at different rated voltages shall be ensured.
Conductors of different temperature classification shall not be run in the same conduit
unless the current density in each conductor is not greater than that permitted for the
conductor with the lowest temperature classification.
Conductors shall be routed and secured in a manner that shall prevent rubbing or wear
of the insulation due to turbine yawing, equipment vibration, or wind induced
vibration.
All cable ends shall be terminated properly with lugs or installed into terminal blocks.
All cable ends are to have identification tags or be color-coded. Color-coding must be
uniform for all turbines. All electrical connections shall be made in compliance with
IEC standards.

**Current Transformers**
Current transformers used for power measurements by the data acquisition system
shall be calibrated. They shall meet the IEC specifications for Sub/Metering
applications or equivalent.

**Control and protection requirements of wind turbines**
Equipment shall also be provided to shut down the wind turbine safely if conditions
on the external electrical system (such as voltage or frequency or Power is out) will
not allow continued safe operation. The wind turbine may only be restarted
automatically after steady conditions are restored in the external electrical system.
Protection devices shall be set at values of current, voltage, and time that are suitably
related to the characteristics of the circuits and of the electrical network, and to the
possibilities of danger.
Protective devices and equipment protecting the wind turbine and the electrical
network shall be co-ordinated to ensure proper clearing of faults on time.
The protection and control system shall have an appropriate level of immunity from
electromagnetic disturbances. All protection and control system components shall be
selected and arranged so that they shall not experience disruptive or damaging electro-
magnetic effects from components within the electrical system.
At a minimum, one emergency stop button shall individually be provided at ground and another one in the enclosed turbine nacelle. Emergency stop buttons shall be provided which will override the automatic control system and initiate a machine shutdown.

The Turbine Controller shall be equipped with an interface for a portable computer to commission, program and control. The Contractor shall provide two sets portable computer with corresponding software, and the Bidder shall specify the type and specifications in the bids.

The communication mode between Turbine Controllers and main control computer shall be explained in the bids. Each Turbine Controller, supervising each turbine, shall be built in a cubicle arranged in tower.

The Contractor shall provide Turbine Controller and connecting cable and/or optical fibre cable and its accessories between Turbine Controller and turbine equipment. The Contractor shall provide an UPS for the Turbine Controller.

33.2 Generator and related Equipment (Excitation System)

The relevant parameters and technical specifications were submitted with the Bid (Annex 2 to the Technical Specifications). In case of a WEC with a gearbox, the generator should be a totally enclosed type and shall have at least class F insulation.

The generator shall operate under the following conditions of the grid:
- Nominal frequency 50 Hz, operational frequency deviations within the limits of (±1 Hz) of the nominal frequency
- Voltage deviations of +5%/-10% on the 10 kV side of the package stations
- Voltage asymmetry limit of 5%.
- Electrical and mechanical parts of generator can endure impact during starting

3.3.3 Switchboards

Switchboards for the local control systems and power systems should be preferably built into a common panel. Circuits with low voltage (<50 V) must be separated from power circuits (>50 V)
Floor mounted switchboards shall include a bottom frame with a minimum height of 100 mm. The switchboards shall be provided with a suitable number of cable glands for all incoming and outgoing cables.

Current carrying components shall be able to carry their rated current continuously at the rated voltage without exceeding the permissible temperature rise under the specified conditions.

The switchboards shall be provided with a multi-way copper earthing bar (PE) to which the armouring of cable and/or earth conductors shall be connected. The earthing bar (PE) shall also be connected to the earthing system.

All components mounted inside the switchboard must be installed on mounting plates. Where equipment is to be installed in the front covers/doors the strength of the covers/doors must be maintained.

All the switchboards together with their modules shall have at least minimum clearances in air and creepage paths to the insulation group as specified in the relevant IEC standard.

The busbars shall consist of pure electrolytic copper.

The terminal blocks shall be mounted on a standard mounting rail. All internal wiring shall be made by flexible single core cables of min. 1 sq/mm cross-section. The cables shall be arranged in easily opened PVC trunking inside the switchboard.

Each switchboard shall be provided with 15% spare terminal blocks for control cables.

Each individual component mounted in a switchboard shall be separately labelled according to the corresponding drawings. Terminals for power cables shall be marked with phase-designation. Terminals for control cables shall be labelled according to the corresponding circuit diagrams prepared by the Contractor and approved by the employer.
Internal wiring must be ferruled and numbered in accordance with the circuit diagrams. All front mounted equipment shall be marked with plan identification and functional designation.

Text on labels and diagrams shall be in English. (Except for safety labels, which should be Chinese and English).

3.3.4 Capacitor Banks
To reduce the generator’s demand for reactive power from the grid, the WECs may be equipped with capacitor banks. The cut-in and -out of the banks shall be automatically controlled to reach at least the target cos $\varphi$ being at least 0.95.

The capacitor banks shall be enclosed in the switchboard, be of the metallized film type, corresponding to the rated voltage and frequency. The capacitor banks shall be automatically disconnected, whenever there is a loss of network power, to avoid self-excitation of the wind turbine.

3.3.5 Low Voltage Cabling
Power cables have to be in accordance with the respective IEC or DIN-VDE standards or other equivalent norms:

The power cables must be copper conductor with a rated voltage of min. 1000/600 V. Cables shall be laid in one length if possible. T-Joints will not be permitted.

Monitoring cables will be installed parallel to the power cables and special screening will be necessary.

3.3.6 Earthing/Grounding/Bonding
Each wind turbine shall be provided with an earthing arrangement in accordance with the wind turbine manufacturer’s recommendations and IEC standards. All electrical frames shall be effectively connected to earth. Earth circuits and the final conductor to the earth electrode shall be of copper. The branch circuits shall be provided with protective conductors.
At each WEC an earth electrode system must be established. The earth system resistance to earth must be not more than 4 Ohm. If the turbine manufacturer requires a lower resistance, this should be explicitly mentioned in the bid.

The earth electrodes must be designed for the max. possible short-circuit current. All mechanical components made of metallic materials shall be properly bonded to the consumer’s earthing terminal. Reliable earthing equipment specifically designed for this purpose shall be supplied. The underground earthing network and the earth electrode system at each turbine shall be supplied and constructed by the employer and confirmed by the Contractor. Bonding leads shall be at least half the size of earthing. Bonding shall also be carried out between earthed metal and extraneous metalwork with which it might accidentally come in contact. The extraneous metalwork includes:
- Ladders
- Accessible structural steelworks

3.3.7 Lightning Protection

The WECs and their installations shall be suitably protected against damage caused by lightning and over voltages due to lightning.

The WEC installations (including RCMS) must be protected against harmful voltage transients. The latest protection concepts from leading manufacturers of over voltage protection devices should be employed.

Protection shall allow the wind turbine to withstand lightning strikes and remain in safe condition during operation or stand still. The lightning rod and the switchboard shall be reliably connected to the earthing grid. Lightning surge arrestors shall meet or exceed the requirements of IEC 61400-24. However, if required according to the site conditions, measures have to be taken beyond the applicable standards and should take into account the current state of technology.

Lightning and electrical fault protection for the wind turbine generator and control system shall include surge arrestors and lightning arrestors at the interconnection of the wind turbine and the controller from over-voltages that may originate from the external electrical network or from local devices. Communication wires for the wind
park monitoring and remote control system shall include lightning protection and surge suppression.

3.4 OTHER REQUIREMENTS

3.4.1 Interchangeability

All wind turbines provided shall be identical in design and construction. All parts shall be interchangeable from one wind turbine to another. The colour coding and/or labelling of all wiring shall be identical for all turbines. However, the foundations shall be designed according to soil parameters respectively.

Any component of the wind power system, which is intended to be interchanged in normal service shall possess such functional and physical characteristics as to be equivalent in performance and durability, and shall be capable of being exchanged, one for another, without alterations of interfacing items.

3.4.2 Fail-safe Design

All components shall satisfy one of three Fail-safe requirements:

1. All possible failure modes shall be monitored by the control system and the system shall be safely shut down, if a fault is detected;
2. The component has been analysed to demonstrate that the required inspection interval is sufficient to discover and correct a problem before failure occurs; or
3. The system is designed such that components are redundant and the remaining components are capable of sustaining safe operation after one failure and have the capacity to continue operation until the problem would be detected by monitoring equipment or discovered during normal inspections. In case that these components or assemblies are failing, the degree of redundancy or operation of the control and inspection system must result in the wind power system remaining in a non-hazardous condition.

3.4.3 Lubricants

All lubricants required for the operation and maintenance of the wind turbines shall be specified and the equivalent products available in China listed. If no equivalent product is available in China, then arrangements shall be specified by which a cost-
effective supply of the lubricant may be obtained. All lubricants shall be appropriate for the temperatures and other conditions specified in Division 2.

3.4.4 Materials

All materials used in manufacturing and construction of the wind turbines shall be new material and free from known defects and flaws. The term defects and flaws are used here to denote imperfections that exceed the standards for the type and grade of material specified in the design. All materials shall be appropriate for the temperatures and other conditions specified in Division 2. Parts exchanged during the defects liability period have to be new and not repaired or refurbished.

3.4.5 Finishes

All material not naturally resistant shall be treated or finished to protect surface/functional integrity in the conditions specified in Division 2. It shall be a goal that refinishing shall not be required for a minimum of 10 years. Parts made of composite materials, such as the blades, shall have a gel coat finish or polyurethane paint finish. The leading edge of the blades shall be protected against erosion. All turbine external surfaces shall be neutral grey in colour. Any markings on the nacelle, including the manufacturer’s name, require approval from the Procurement Agent/Employer, or its designated representative, as to their colour, size, and shape.

3.4.6 Maintenance and Safety Characteristics

The turbine design shall provide for ease of maintenance. All parts must be readily accessible. All parts with mass in excess of 30 kg shall have either attachment points or an established sling for handling.

There must be adequate personal safety lanyard attachment points in all locations where personnel are required to perform maintenance or repair functions. The tower ladder shall have a safety cable or track. The safety cable or track shall be compatible with a readily available personal fall restraint device.

In order to ensure safety of the maintenance personnel, the design shall incorporate:

- Safe access parts and working space for personnel to perform inspection and routine maintenance
The wind power system shall have the following minimum maintenance and safety characteristics:

- Automatic emergency shutdown in case of serious faults
- Accommodation of local and remote monitoring of performance and operational status
- Work platforms or other means to allow access to all components
- Attachment device on all components requiring materials handling
- Safety climb line for personnel to attach to if ladder is used
- Attachment points for personnel on elevated work platforms and on top of the nacelle
- Lock device of rotor without the use of the normal braking systems during maintenance

3.4.7 Nameplates and Markings

Any component or assembly of the wind power system that may be inventoried as a spare part shall be marked for identification with a part number and the manufacturer’s name. Time- and cycle-sensitive components and components manufactured in lots or batches shall be marked with time and serial number.

Each wind turbine shall include permanent markings that provide the following information:

- Type
- Generator Type
3.5 TOWER

A tubular steel tower providing for a hub height of 65 m to 72 m shall be supplied. The tower design shall meet relevant manufacturing standards and IEC 61400-1. It shall meet the local transportation and erection possibilities. The tower will consist of three sections, and the maximum length of each section should be not more than 25 m. The tower shall be manufactured in China.

The tower shall have an interior safety ladder to the nacelle. An adequate number of intermediate platforms have to be foreseen. The ladder shall have a fall-arrest safety mechanism. There shall be lights in the tower (and nacelle) for safe climbing and working. The lights shall be protected against damage and be situated on the opposite side of the climbing ladder, so that they are not damaged easily. Approved safety belts shall be supplied with the WECs.

The Contractor shall provide also the embedded connection parts between the tower and the foundation. These have to be supplied in advance of the tower in order to facilitate foundation construction.
4.1 SPARE PARTS

4.1.1 Spare Parts for Three Years

The wind turbines shall be provided with necessary spare parts. The category and quantity of these spare parts shall be sufficient to be used for three years and determined based on the Contractor’s experience. The delivery of these spare parts shall take place together with the delivery of wind turbines and shall be carried out according to the lists enclosed to the Schedules of Prices “Schedule No. 1-B, Imported Spare Parts” and “Schedule No. 2-B, Domestic Spare Parts” (incl. Consumables), which shall be submitted with the Bid.

4.1.2 Spare Parts for the three year Defect Liability Period

The Contractor shall be responsible for replacing the bad parts free of charge during the three years Defect Liability Period. All spare parts and consumables used during the three year Defect Liability Period shall be replaced by the Contractor timely, so that at the end of the Defect Liability the spare part and consumable stock is completely refilled, i.e. the spare part and consumable stock corresponds to the contractual list of spare parts and consumables. Any additionally used spare parts or consumables (excluding main parts of wind turbines), which have not been included in the list of spare parts for three years with unit FOB price of more than US$10, shall be refilled according to the practical used number of these spare parts by the Contractor free of charge, i.e. the Contractor shall bear all expenses, including freight, insurance, loading and unloading fees, and inland transportation expenses in China.

4.1.3 Additional Supply of Spare Parts

At the end of the Defect Liability Period the Contractor shall provide the main spare parts, tools and service to the Employer according to the unit prices listed in the Contract Agreement- Appendix11. The unit prices for these equipment shall be fixed during the Defect Liability Period and may increase after the Defect Liability Period, with the maximum growth rate to be calculated according to the price adjustment formula (if any). The so calculated prices shall be considered as the maximum unit prices for future orders. If the Contractor plans to stop the production of these spare parts, the Employer shall be timely notified by the Contractor to carry out the last procurement. After the stoppage of the production of these spare parts, the Contractor shall help the Employer to get the blueprint, drawings and technical specifications of these spare parts within the possible range free of charge, if requested by the Employer.
4.1.4 **Spare Part Properties**

All spare parts and consumables furnished shall be interchangeable with the original part, and shall be of the same material and workmanship and according to the same standards. Spare parts should be new and not repaired or refurbished.

The contractor is obliged to provide at the end of the 3 years liability period a list of spare parts, which may be bought locally in China by then instead of importing them.

All spare parts shall be perfectly packed and properly protected to avoid any damage during long-time storage at the site. Each package shall be clearly labelled and numbered. An equipment list shall be added in each package. When different types of spare parts are packed in the same package, a list shall be attached outside and a detailed list shall be enclosed inside.

4.2 **SPECIAL TOOLS**

The Contractor shall provide two complete sets of tools required for continued operation and maintenance activities. The tools shall be new and unused. The corresponding cost is contained in price schedules 1 or 2. Moreover, the Contractor shall recommend further equipment and tools for erection and installation of the Plant and Equipment, which he will bring temporarily to Shanghai and may be optionally bought by the Procurement Agent/Employer. This equipment and tools is specified in Price Schedule 6.

Each turbine tower will be equipped with a fall protection device. The Contractor shall provide 20 sets of harnesses, which shall be compatible to the tower safety installations. The harnesses shall be a body type harness, incorporating shoulder, leg, and waist straps. Each harness shall be equipped with two safety lanyards.
Division 5  Test and Inspection, Completion of Facilities and Operational Acceptance

5.1 CONTRACTOR’S TEST AND INSPECTION

The Contractor or the manufacturer shall manufacture the contracted Plant and Equipment according to acknowledged quality assurance procedures and carry out the required inspection and testing according to internal test procedures, which shall follow general accepted standards. The test and quality assurance procedures shall be supplied beforehand to the Procurement Agent/Employer. He shall at his own cost provide the corresponding quality assurance and control documentation with the inspection records, type test and/or test certificates. The quality assurance and control documentation shall be submitted by the Contractor to the Procurement Agent/Employer before shipment of the Plant and Equipment. The documentation shall contain beside quality assurance checklists and test certificates the detailed specification of the major components of the Plant and Equipment.

5.2 TRANSPORTATION AND OPEN PACKAGE INSPECTION

Within ten (10) days after arrival of the Plant and Equipment at the port of destination, the Procurement Agent/Employer shall apply to the Inspection Administration (i.e. State Administration for Entry and Exit Inspection & Quarantine in China) for inspections: (a) the inspection in respect of the outward appearance, specifications and quantity/weight of Contract Equipment, (the packing shall not be opened here until arriving to the Job Site); (b) the Quarantine Inspection for wooden packing. If the Contractor wants to attend the Inspection, he should inform the Procurement Agent/Employer in advance and arrive at the destination in time.

The Procurement Agent/Employer shall, twenty (20) days prior to the open package inspection, inform the Contractor of the expected time for the inspection. If the Contractor’s representative cannot be present in the open package inspection, the Inspection Administration shall conduct the inspection in the absence of the Contractor’s representatives and the report by the Inspection Administration shall be an effective and proving document for claims under the freight insurance policy. In case of the container
transportation, the open up and return of the containers cannot be regarded as the open package inspection.

Should any shortage, defect, damage or other non-conformity with the Contract of the delivered Contract Facilities be found during the transportation and/or the open package inspection, the inspection certificate issued by the Inspection Administration shall be taken as effective evidence for the Employer to claim against the Contractor in case the Contractor is responsible.

5.3 PRE-COMMISSIONING AND COMPLETION.

The site testing of the individual wind turbines and the complete wind farms shall be carried out according to a commissioning plan submitted by the Contractor to and agreed with the Employer at least 3 weeks before start of pre-commissioning tests, if not already submitted with the Bid. The procedures shall be in line with GCC Clause 24. One Completion Certificate shall be issued for the two wind parks at Chongming and Nanhui.

The pre-commissioning tests shall comprise at least:

(1) Visual inspection

— Normal operation of wind speed and wind direction transducer;
— Oil leakage of hydraulic pressure system;
— Direction of rotor rotation;
— Vibration of nacelle;
— Noise.

(2) Operation inspection

— Functional tests of all major components being essential for a safe functioning including manual start (local & remote), emergency stop, manual stop, manual yawing, pitch control (in case of pitch controlled WTs), proper adjustment of blade angle (stall controlled WTs), etc.

— Functioning tests of the remote monitoring and control systems at the five different sites (remote monitoring & control at each wind park site and at SWPC headquarters, monitoring systems at Shanghai dispatch centre and in Beijing) such as display of wind turbine operation status (including local and remote), such as: wind speed, wind direction, current status, coding of
breakdowns, current power, current rotating speed, current wind speed, current pitch angle, oil temperature of gear-box, oil pressure of hydraulic pressure system and temperature of generator etc.;

— Connecting into the grid and disconnection test of wind turbines (remote and site);

The results of all pre-commissioning site tests shall be submitted to the Employer prior to the issuance of the Completion Certificate. Each turbine shall be connected to the power grid on completion.

The Reliability Runs defined in division 5.5 should start immediately for each turbine after it has passed pre-commissioning. However, the Completion Certificate will only be issued after the last turbine has passed pre-commissioning.

5.4 COMMISSIONING

The commissioning shall be carried out according to the submitted and agreed commissioning plan (see paragraph 5.4) and shall be in line with GCC, Clause 25. The commissioning phase shall last three months. The testing during commissioning shall consist of three major terms:

- Reliability runs: The reliability of the each WT shall be demonstrated by its continuous operation for a total of 120 hours without defects of any kind that could affect its long term operation. Stoppage due to grid failures or other events, which are not under the control of the Contractor, are not accounted for during reliability runs. Such stoppage times shall be added to the 120 hours period, so that the net WT operation time will be 120 hours. If the reliability run of a WT will be interrupted by any defect, such defect shall be immediately remedied by the Contractor and the reliability run for this WT shall start again for 120 hours.

- Guaranteed power curve: During the commissioning period the Employer is entitled to select one wind turbine in each of the wind parks to measure the power performance of the WT according to IEC 61400-12. The performance measurement shall last at least 3 months until the complete spectrum of the power curve is sufficiently measured based on the standard. The bidder agrees with his bid that the 2 sites correspond to the site requirements set out in this standard.

If during the measurement period not enough data values can be collected to fulfil the requirements of the standard, the performance monitoring shall be extended to a
maximum of three further months. If during a maximum period of 6 months the required number of data values can still not be reached due to lack of wind, the performance monitoring is nevertheless deemed to be accepted, if the so far measured data will show a sufficient concurrence with the guaranteed power curve as specified in the Performance Guarantee. In case that the guaranteed power curve is not met, the Contractor has the right to take within one month measures for power curve improvement. Then the measuring process will be restarted. The then measured power curve will be considered as the final one and any deviation from the guaranteed power curve will be treated according to the specifications detailed in the Performance Guarantees.

Details about the assessment of the power curve of those turbines are detailed in Appendix 9 - Cluase 3.2 of the Contract Agreement, which are not measured directly (nacelle anemometer correlation and verification).

- **Functional checking:** During the commissioning phase the proper functioning of the WT and its system components as well as of the remote monitoring and control system will be carefully checked. This will concentrate on keeping of the scheduled control values such as temperatures (Gear Box, Generator), voltage, ampere and reactive power levels (generator, output), pressure (hydraulic system, brake system), correct yaw control, relation of measured wind and power output, vibration and noise levels etc. Moreover, the proper automatically and manually or remote controlled functioning of the WT will be observed. Emphasis will be laid also on a failure free functioning of the remote monitoring and control system and the corresponding software according to specifications defined in the Contract.

### 5.5 INSPECTION DURING COMMISSIONING AND DEFECT LIABILITY PERIOD

If the Plant and Equipment is found defective during Commissioning and/or within the Defect Liability Period, for the reason including but not limited to latent defect or the use of unsuitable materials, the Procurement Agent/Employer shall apply for an inspection to be carried out by the Inspection Administration and have the right to claim against the Contractor on the strength of the inspection certificate under the Letter of Warranty. The Contractor will be allowed to participate in this inspection.
During all the inspections, if the standards stipulated in the Technical Documentation supplied by the Contractor are found incomplete, the Inspection Administration has the right to carry out the inspection according to the current standards of the Employer’s country and/or other standards considered suitable by the Inspection Administration.

5.6 OPERATIONAL ACCEPTANCE

Operational acceptance shall occur in accordance with GCC Clause 25.3 in respect to the facilities, when the Guarantee Test has been successfully completed and the functional Guarantees are met. The operational acceptance shall be considered separately for the wind parks Chongming and Nanhui.
Division 6 Additional Services

6.1 GENERAL

In order to guarantee the equipment to meet the guaranteed performance during the Defect Liability Period, the Contractor has the responsibility to know and care for the operation of the complete scope of facilities, and shall provide necessary advisory and supervisory services on the problems occurred or will occur, although the Contractor will only supply the main part of equipment. For this reason he has to carry out all relevant and necessary advisory, training, supervisory and maintenance/repair services until the end of the Defect Liability Period.

6.2 FOUNDATION OF WIND TURBINES

The Contractor has to submit with his Bid a design of the wind turbine foundations according to the geotechnical data shown in Division 2.4 consisting of:

1. Information on characteristic loads for the dimensioning of the WT foundation;
2. Preliminary design drawings of WT foundation of Chongming, and Nanhui Wind Farm; including piling and pile test concept
3. Bill of Quantities

After contract award the Employer or its authorized representative will provide the geotechnical data for each WT location in the Chongming and Nanhui wind park areas. The Contractor shall carry out the design of the wind turbine foundation including piling according to the detailed data. The design shall meet the standards and specifications set in the Contract. The so submitted final design and static calculation shall be verified and approved by an acknowledged independent accredited soil static calculation office of international good reputation at the cost of the Contractor. For this purpose two accredited soil static calculation offices shall be proposed by the Contractor. The calculation office for verification will be finally selected by the Employer out of these two proposed ones. However, the Employer reserves the right to not accept any one of the two proposed offices and to select another office by his own, if the independence and the reputation of the proposed offices cannot be sufficiently demonstrated by the Contractor.

The Contractor shall provide all necessary data for foundation construction incl. piling, such as foundation load, construction drawings with all necessary details such as empty
pipes or lightning protection, technical specifications and construction requirements etc.
The submission of foundation construction drawings shall be attached by the calculation of the pile foundation and of the testing requirements.

The Contractor shall carry out all necessary supervision and inspection of the foundation construction, as to the extend required to accept the foundations and to keep full responsibility for the overall Facilities. Such services may comprise:

- Inspect the construction and testing of pile foundation and analyse testing results,
- Inspect the foundation excavation pits,
- Inspect the reinforcement, embedded parts and embedded cable (piping) of foundation

The Contractor shall coordinate with the Employer or its authorized supervising organization the construction of the Wind Turbine foundations to ensure the quality and service life of the facilities. The Contractor shall consider only locally available materials and technologies for the foundation design.

6.3 ACCESS ROADS AND SHUNTING AREAS

The contractor shall define the requirements for the access roads and the shunting areas for the wind turbine installation for the individual wind turbine sites in accordance with the site conditions and the locally available erection equipment (heavy and auxiliary crane). Corresponding layout drawings shall be submitted with the Documentation and Drawings 21 days after effectiveness of the contract.

6.4 RESPONSIBILITIES DURING INSTALLATION AND COMMISSIONING

To take the full responsibility for the overall wind turbine construction the Contractor shall provide support, supervision and instruction for the erection and installation of the Plant and Equipment and shall be responsible for the commissioning.

The Employer or its authorized representative will act as the project manager and supply corresponding labour and equipment to carry out installation as well as the civil works and electrical works. The project manager will be responsible for the co-ordination of the local services and works. As far as these are directly concerned to components under the responsibility of the Contractor (e.g. foundations, shunting areas, access roads), the Project Manager will follow the advice of the Contractor.
The Contractor shall advise, co-ordinate and co-operate with the project manager, and shall carry out all required tasks such as:

(1) Preparation before erection/installation

- Provide the installation manual of supplied equipment; in the installation manual the unloading, assembly, installation and test-run of the equipment shall be described in detail;
- Provide the requirements with regard to labour and equipment for erection/installation;
- Carry out training as to the extend necessary for a safe erection/installation;
- Provide special tools necessary for erection/installation;
- Provide a commissioning plan;
- Check the readiness of the erection sites;
- Inspect and count the equipment going to be installed.

(2) In the course of erection/installation the Contractor shall

- Be responsible for the erection/installation of the supplied Plant and Equipment and support and supervise the activities;
- Co-ordinate with other contractors at the site, if any.

After the completion of the installation the Contractor shall be responsible for the pre-commissioning and commissioning according to Division 5. Moreover, he will be responsible for the proper functioning and for keeping of the guaranteed performance values during the Defect Liability Period. For this purpose he will carry out the scheduled maintenance (see 6.7) and all those repair and/or component replacements, which cannot or should not be carried out by the Employer himself.

6.5 DESIGN LIAISON MEETING

Design liaison meetings shall be held between the Employer and the Contractor to discuss the detailed requirements, clarify the technical specifications and to co-ordinate activities.

- The first meeting
Topics: Examine and discuss foundation design; examine detailed design, layout of wind turbine, hoisting and transportation schemes, equipment manufacturing plan, selection and configuration of control and protection system hardware, communication protocol for remote supervision and control system and relative designing technical documents.

Location: Employer

Time: 30 days after effectiveness of contract

Period: 10 days

• The second session

Topics: The Employer’s opinions on the factory drawings and other requirements; examine the Contractor’s test program including factory and site testing, project schedule such as delivery, training, erection, commissioning, co-ordination of activities etc.

Location: Employer’s premises

Time: 60 days after effectiveness of contract

Period: 5 days

Employer’s personnel: 8 persons

For each meeting a protocol shall be signed. The Contractor shall be responsible for minutes of meeting; the items discussed and conclusion shall be both in English and in Chinese and distributed to the participants after the minutes has been checked and signed by both parties. Consultants will participate in this meeting.

During the design liaison meeting in China, the Employer shall render the necessary assistance to the Contractor’s personnel for visiting the job-site and to perform their work. Expenses incurred in this meeting will be included in Contract price and will be borne by the Contractor.

6.6 TRAINING

6.6.1 Training at the site
The training shall be carried out for a period of four weeks during the installation and pre-commissioning of the facilities so that in accordance with the GCC 25.1.2 the operating personnel will be available and trained prior to commissioning and guarantee tests. The training shall comprise installation, error detection, repair, maintenance and trouble shooting of the Wind Turbines (WTs) in both, classroom and in plant training. Moreover, training in the Utilization of the remote monitoring and control system is required. The training during this period should be delivered by at least two training specialists: One for training on the WT and one for the remote control and monitoring system. The Employer is entitled to ask for the replacement of not sufficiently qualified trainers of the Contractor. The training program, must be sufficient to allow the Chinese personnel to operate the project after the commissioning is completed.

The Contractor shall in addition to the materials submitted with the Bid provide three weeks in advance of training a training plan and training material documenting how this will be accomplished. The training plan should include time, location, and type of training. The material shall include a detailed description of the Plant, part lists and a manual for installation, repair and maintenance.

The training shall include, but not be limited to the following:

- Review and application of manuals and documentation provided
- Erection methods and replacement of components of the WT
- Operation of control, data acquisition and monitoring systems
- Spare part management (stock-keeping, bookkeeping, spare-part order, etc.)
- Bookkeeping with regard to performance monitoring; machine maintenance and repair records;
- Practical demonstration in
  - Correct use of maintenance manuals,
  - Performing scheduled maintenance service for the plant, also for the blades,
  - Trouble shooting, spare part identification,
  - Repair/replacement of common components,
  - Bookkeeping for performance monitoring and for maintenance/repair for wind turbines
  - Local and remote operation of the wind turbines.
-Operational and maintenance safety procedures.

6.6.2 Factory training

The Employer will send 8 people for 4 weeks to the Contractor’s premises for training at the cost of the Contractor, which is included in the Contract. The training program shall be based on the program proposed with the Bid. A detailed training programme shall be submitted to and agreed with the Employer latest three weeks before start, which is 60 days after the effective date of the Contract. The training shall comprise practical oriented and theoretical training. It shall include organisational and responsibility aspects of wind park operation, presentation and description of a WT, wind park design and optimisation, safety aspects, reporting, remote monitoring and control, theoretical training on the functioning and trouble shouting of the plant, plant maintenance including blade maintenance, trouble shooting, spare part procurement, practical experience of wind power generation in the Contractors country and visit to major wind farms.

The Contractor shall assist the Employer to get the necessary entry visa in time. Moreover, the Contractor shall be responsible for the organisation and execution of the programme including all necessary arrangements with regard to travel, accommodation, allowance, training material & equipment, safety wear and clothes.

6.7 Defect Liability Period

The Contractor shall be responsible for all non-scheduled and scheduled maintenance of the Facilities within the three year Defect Liability Period (GCC Clause 27). The maintenance shall be comprehensive, covering maintenance and replacement of defective parts as well as all the cost such as for labour, equipment lifting and transportation. The Employer will assist the Contractor in maintenance and repair to the extent accepted by the Contractor.

The Contractor shall provide scheduled inspection and maintenance according to his maintenance instructions within the Defect Liability Period to be carried after 3, 6, 12, 18, 24, 30 and 36 months from start of warranty.
Division 7 Delivery, Documentation and Drawings

7.1 DELIVERY SCHEDULE

Delivery batch: 2 batches

Delivery place: Shanghai Waigaoqiao harbour/the two wind farm sites

Shipment time from Manufacturer:

- The “foundation package” including bolts, nuts, flange, template should be sent to the sites 10 weeks after effectiveness of the Contract.

- First batch: 6 MW of wind turbines 15 weeks after effectiveness of the Contract including all the equipment, remote supervision and control system, supervision system, spare parts, special tools used for installation, test-run and operation of these wind turbines;

- Second batch: 14 MW of wind turbines 19 weeks after effectiveness of the Contract complete as for the first batch.

The Contractor shall be held for responsible for late delivery according to the stipulations in this Contract.

Package, Transportation and Insurance

The Bidder shall provide adequate packing to prevent damage or deterioration of the Plant and Equipment during transport and transit up to their final destination. The packing shall be sufficient to withstand, without limitation, rough handling during transit and exposure to extreme temperature, salt fog, and precipitation during transit and open storage.

Components and assemblies of the wind power system must be able to be transported by land and sea, or by air.

The Contractor shall insure the purchased equipment for the Employer until arrival at the site according to the Appendix 3 of the Contract Agreement-- “Insurance Requirements”.
7.2 DOCUMENTATION AND DRAWINGS

The document submitted by the Contractor shall include design documents for the WT including tower and foundation as well as for the access road and the shunting areas, manufacturing quality assurance and control documentation, handling and storage instructions, installation document, operation and maintenance manual, spare parts list for the WT, training plan and training material, commissioning plan, testing and commissioning report, as built documentation, reports on scheduled maintenance and extraordinary repair work during the Defect Liability Period, final inspection report on termination of the Defect Liability Period. All drawings shall be of standard size, i.e. A0, A1, A2, A3 or A4, and shall also be made available on CD-ROM in PDF format.

7.2.1 Design documents

With its Bid the Contractor has submitted the following documents:

- Description of the Wind Turbine (General, mechanical and electrical)
- Description of control system
- Description of remote control and monitoring system
- List of major spare parts, tools and consumables
- Description of tower
- Description of foundation,
- Description of installation requirements such as shunting area and access road requirements, crane requirements, intermediate storage and construction yard, etc.

During the execution of the Contract the Contractor shall deliver additional documents such as

- Design explanations and manuals for the Wind Turbine and the internal control system (incl. overall drawing of wind turbine, factory drawing of assembly of principal elements such as including Rotor System, Drive Train, Hydraulic / Braking System, Yawing System, Nacelle and Mainframe, Electrical System, Control and Protection System), configuration drawing as well as list of major parts with manufacturer, characteristics, type and quantity of equipment and material of subsystems.
• Design explanations and manuals for the remote monitoring and control system hard and software.
• Manufacturing drawings and specifications for the towers.
• Static calculation and design of the foundations (slab and piling) based on geotechnical investigations of the individual wind turbine sites.
• Static verification report on the foundation calculation and design carried out by a certified independent sworn soil static expert approved by the Employer.

7.2.2 Quality assurance and control documentation
This documentation comprises the quality assurance and control documentation with the inspection records, type test and/or test certificates as specified in Chapter 5.1 in this Techno. Specifications.

7.2.3 Handling and storage instructions
Detailed instructions, with illustrations, diagrams and weights, for handling, storage and care of the Plant and Equipment at the site shall be submitted. The instructions shall include:
• Identification of parts requiring outdoor, indoor, temperature- or humidity-controlled for both long- or short-term storage.
• Space requirements for outdoor, indoor, temperature-or humidity-controlled for both long-or short-term storage;
• The procedures to be observed in unloading, placing, stacking and piling of equipment;
• Rigging and lifting procedures, location of handing point with mark;
• Maintenance procedures for both long-and short-term storage including recommended maximum storage period for items stored outdoors; and periodic rotation of components, if required.

7.2.4 Installation document
The installation document shall provide all necessary information for the erection/installation of the Plant and Equipment such as
• Installation drawings and technical requirements (including lifting position), description of installation procedures, installation material list;
• Description of special and general installation tools;
• Cable layout diagram including termination points and outer connections;
• Switch and control board layout, earthing diagram and environment requirements;
• Equipment safety instructions.

7.2.5 Operation and Maintenance document
The Contractor shall provide complete Operation and Maintenance (O&M) manuals for the wind turbines and the remote monitoring and control systems including but not limited to:

• Safety procedures
• Start and shutdown procedures
• Alarm list, emergency procedure plan
• A description of the subsystems of the wind turbine and their operation, including a detailed description of the control and protection logic
• A lubrication schedule prescribing the frequency of lubrication and types of lubricants or any other special fluids
• A retest-run procedure
• The maintenance inspection intervals and procedures
• The procedures for functional checks of protection subsystems
• A complete wiring and interconnection diagram
• Diagnostic procedures and troubleshooting guide
• A tooling list

7.2.6 Spare part list
A detailed spare part lists shall be provided by the Contractor, which include necessary ordering data including specifications and prices. Moreover, a list of spare-parts and or consumables available directly from independent sources with sufficient information to allow direct purchase shall be provided.

7.2.7 Training plan and training material
The Contractor shall provide detailed training plans with schedule and contents as a draft for approval by the Client and as a final version for or the training specified in chapter 6. Moreover, appropriate training material as are manuals, drawings, handouts etc. on the training shall be delivered.
7.2.8 Pre-commissioning and commissioning plan
The Contractor shall submit a pre-commissioning and commissioning plan for approval containing a schedule and detailed testing and test-run procedures together with relevant drawings and instructions.

The test and operation procedures shall be itemised, indicating, wherever applicable, the target results with admissible tolerances and keeping space for filling in the actually observed results during the debugging and testing procedures.

7.2.9 Testing and commissioning report
All testing and commissioning records and reports shall be compiled in a testing and commissioning report and be submitted to the Employer.

7.2.10 As-built documentation
Contractor shall submit 10 copies of as-built documents and 5 copies stored on CD-ROM disk after Operational Acceptance.

The As-Built Documentation shall include the Employer’s comments and modifications made in course of the installation, which shall be in such detail that the Employer shall be able to maintain, disassembly, reinstall, adjust and operate the Plant and Equipment.

The As-Built Document shall include the operation and maintenance manual as well the monitoring and control software handbook, being sufficiently detailed to allow the programming of data evaluation and presentation sheets and to contain all necessary information for a safe and comprehensive remote control of the Plant and Equipment.

7.2.11 Reports on scheduled maintenance and extraordinary repair work
The contractor shall issue reports on all scheduled and non-scheduled maintenance (repair) during the Defect Liability Period indicating in detail the executed measures and listing the used spare-parts and consumables with its clear designation, part/catalogue number, quantity and FOB price.

7.3 DELIVERY TIME FOR DOCUMENTATION AND DRAWINGS
All documents listed in Chapter 7.2 shall be submitted 21 days after effectiveness of the contract by courier, if not otherwise stated below:

- Static calculation and detailed construction design drawings and descriptions of foundations 4 weeks after having received the results of the geo-technical investigations at the individual WT sites.
- Static verification report 3 weeks after agreement on the independent sworn soil static expert
- Quality assurance and control documentation one week before shipment of the respective lot.
- Training plan and training material: 4 weeks before the respective training
- Testing and commissioning report: Before Operational Acceptance
- As built documentation: 14 days after Operational Acceptance
- Reports on maintenance and repair works: 2 weeks after the respective measure.