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# NB

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### **Guidelines for vibration condition monitoring and diagnose of wind turbine generator**

风力发电机组振动状态监测导则

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## Foreword

This Standard was proposed by National Energy Administration.

This Standard shall be under the jurisdiction of Wind Power Standardization Technical Committee.

Drafting organizations of this Standard: Zhong Neng Power-tech Development Co., Ltd.

Main drafters of this Standard: Shen Zhu, Zhou Jicheng, Zhang Baoquan, Sheng Yingxin, Xia Hui, Yue Junhong and Meng Kaifeng.

During implementation of this Standard, any comments or suggestions shall be feed-backed to China Electricity Council Standardized Management Center (No.1, 2nd lane, Baiguang Road, Beijing, 100761).

## Introduction

Vibration condition monitoring of wind turbine generator (hereinafter referred to as “wind turbine”) refers to monitoring the variation of wind turbine’s vibration condition, assessing the condition of wind turbine, detecting and tracking equipment failure in early stage by selecting different monitoring position according to the type of wind turbine that shall be monitored.

This Standard is used to provide corresponding provisions and guidance for manufacturer, installer, user, certification organization as well as relative technical staff of wind turbine’s vibration condition monitoring.

# Guidelines for vibration condition monitoring and diagnose of wind turbine generator

## 1 Scope

This Standard specifies the system type of wind turbine's vibration condition monitoring, sensor installation principle, measurement type and measured value, technical conditions of vibration condition monitoring system, evaluation of vibration value as well as signal treatment and analysis method.

This Standard is applicable to the horizontal axis wind turbine of which the unit capacity is greater than or equals to 1.5 MW. Other wind turbines may reference to this Standard according to their own features.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 19873.1-2005 Condition monitoring and diagnostics of machines - Vibration condition monitoring - Part 1: General procedures

GB/T 19873.2-2009 Condition monitoring and diagnostics of machines - Vibration condition monitoring - Part 2: Processing analysis and presentation of vibration data

IEC 61850-2002 Communication networks and systems in substations

## 3 Terms and definitions

The following terms and definitions apply to this Standard.

### 3.1 Breakdown maintenance

Maintenance after wind turbine failure.

### 3.2 Condition-based maintenance

Maintenance determined according to wind turbine condition.

### 3.3 Condition monitoring

Detected and gathered information and data that reflect wind turbine condition.

### **3.4 Diagnostics**

Symptom and syndrome inspections for determination of nature (type, condition, degree) of the fault or failure.

### **3.5 Failure**

The ability of failing to perform certain specified function.

### **3.6 Fault**

The condition of parts when a part or a module of wind turbine degrades, or anomalous condition occurs, which may cause wind turbine failure.

### **3.7 Alarm**

The operating signal or message designed for informing staff when selected parameter or its logical combination is abnormal.

### **3.8 Alert**

The operating signal or message designed for informing staff when selected parameter or its logical combination is abnormal and requires more attention.

### **3.9 Sign**

Characteristic parameters of signal that indicate the condition of relative information.

### **3.10 Vibration signal**

Measurement of all frequency components that are contained in a system vibration.

### **3.11 Frequency domain**

Physical quantity that takes frequency as measurement.

### **3.12 Time domain**

Physical quantity that takes time as measurement.

### **3.13 Cross-channel analysis**

Using two or more analyzers of input channel to realize functions such as phase, relevance and transfer function calculation.

### **3.14 Baseline**

Single or a group of descriptors that provides baseline for wind turbine's normal

condition in various processes.

### **3.15 Waterfall**

Three-dimensional multi-spectral display of relative time or speed.

## **4 Vibration condition monitoring system**

### **4.1 Types of vibration condition monitoring system**

Vibration condition monitoring system is divided into fixed installation system, semi-fixed installation system and portable system.

#### **4.1.1 Fixed installation system**

System sensor and data collection device adopt fixed installation. Data collection shall be continuous or periodic. Fixed installation system usually is used for wind turbine with complex monitoring tasks.

#### **4.1.2 Semi-fixed installation system**

System sensor adopts fixed installation. Data collection device adopts non-fixed installation; connect only during data collection. Data collection is periodic.

#### **4.1.3 Portable system**

System sensor and data collection device all adopt non-fixed installation. Data shall be collected by portable data collector. Data collection is periodic.

#### **4.1.4 System selection principle**

- a) Offshore wind turbine shall adopt fixed installation system;
- b) Onshore wind turbine of over 2 MW (including 2 MW) shall adopt fixed installation system;
- c) Onshore wind turbine of under 2 MW can choose semi-fixed installation or portable system;
- d) When the warranty expires, during the acceptance of wind turbine, it shall present the vibration condition report that is provided by wind turbine vibration condition monitoring system.

### **4.2 Procedure of condition monitoring**

The procedure of wind turbine vibration condition monitoring includes pre-test of vibration, vibration monitoring technology, vibration baseline test, vibration routine test, etc.

3) Harmonic content: not less than 5%.

f) Voltage caused by ground potential rise that monitoring system shall be able to withstand: not less than 2000 V.

## 6.2 Extreme ambient temperature for storage and transport

Permissible extreme ambient temperature for device's storage and transport is  $-45^{\circ}\text{C}$  ~  $+85^{\circ}\text{C}$ .

## 6.3 Detection unit

### 6.3.1 Overview

Detection unit is in wind turbine's cabin to realize the measured parameter's collection, signal conditioning, modulus conversion and data pre-processing.

### 6.3.2 Uncertainty

The uncertainty of sensor measurement shall be within  $\pm 1\%$ . The uncertainty of detection unit shall be within  $\pm 2\%$ .

### 6.3.3 Frequency range

Sensor's linear frequency range shall cover from 0.2 times the minimum rotation frequency to 3.5 times concerned highest signal frequency (usually it shall not exceed 40 kHz).

- a) Frequency range of accelerometer sensor: 0.1Hz ~ 30kHz;
- b) Frequency range of speed sensor: 1Hz ~ 2kHz;
- c) Frequency range of displacement sensor: 0Hz ~ 10kHz.

### 6.3.4 Insulating properties

Under normal test atmospheric conditions (ambient temperature:  $+15^{\circ}\text{C}$  ~  $+35^{\circ}\text{C}$ ; relative humidity: 30%~60%; atmospheric pressure: 86kPa~106kPa), detect unit's energized parts such as BETWEEN power, signal and data input loop-circuit AND non-conductive metal and shell, BETWEEN unconnected electrical circuits; the insulation shall meet requirements in 6.3.4.1 ~ 6.3.4.3.

#### 6.3.4.1 Insulation resistance

Under normal test atmospheric conditions, each circuit insulation resistance of different rated voltages shall be less than the stipulated values in Table 2.

**Table 2 Requirements for insulation resistance of each loop-circuit test**

| Rated working voltage | Insulation resistance requirements (measuring |
|-----------------------|-----------------------------------------------|
|-----------------------|-----------------------------------------------|



- c) Electrical fast transient burst immunity: test grade/voltage is grade 4,  $\pm 4$  kV;
- d) Surge (impact) immunity: test grade/voltage is grade 4,  $\pm 4$  kV;
- e) Conducted disturbance immunity induced by RF field: test grade/voltage is grade 3, 10 V;
- f) Power-frequency magnetic field immunity: test grade/magnetic field intensity is grade 5, 100 A/m;
- g) Pulse magnetic field immunity: test grade/magnetic field intensity is grade 5, 100 A/m;
- h) Damped oscillatory magnetic field immunity: test grade/magnetic field intensity is grade 5, 100 A/m;
- i) Voltage dip and short interruption immunity: voltage dip and short interruption is 60% of rated voltage, duration lasts 10 cycles.

#### **6.3.7 Mechanical performance**

Detection unit shall be able to withstand vibration (sinusoidal) response capability test of which the severity grade is grade I, vibration endurance test, impulse response capacity test, impact endurance test and crash test. During the tests, the device shall work as normal. After the tests, there shall be no loose fasteners nor structural damage. All functions shall be as normal within technical requirement limits.

#### **6.3.8 Shell protection performance**

Protection performance of main station unit shall comply with the provision in grade IP 51. Shell protection performance of detection unit and communication unit shall comply with the provisions in grade IP55.

#### **6.4 Communication unit**

Communication unit is in the cabin or tower bottom, so as to realize the communication of monitoring data.

#### **6.5 Main-station unit**

Main-station unit shall be equipped with functions such as data communication, monitoring apparatus time comparison, data browsing, alarm, report table and telecommunication. The communication of main-station unit and other systems shall comply with the provision in IEC 61850.

## 7 Measurement and evaluation

### 7.1 Baseline measurement

It shall take the vibration data, measured when wind turbine operates in grid connection, as the baseline.

New wind turbine and wind turbine after major repair shall collect the baseline data after run-in period ends.

### 7.2 Evaluation methods of vibration values

Evaluation methods of vibration values are shown in Appendix B.

Evaluation principles are:

- a) Wind turbine vibration amplitude shall be within normal range.
  - 1) Take no measures when there is no obvious change in amplitude.
  - 2) When vibration increases, rate of increase is near to linear; and it is expected that - before the next monitoring and when amplitude shall not exceed the upper limit of normal range, then it shall take no measures.
  - 3) When vibration increases, rate of increase is near to linear; and it is expected that - before the next monitoring and when amplitude shall exceed the upper limit of normal range, then it shall arrange more frequent monitoring.
  - 4) When rate of increase is non-linear or within the pre-set time period, and the increase of historical data rate change reaches to 25%, then it shall adopt continuous monitoring or arrange more frequent monitoring.
- b) Wind turbine vibration amplitude shall be within alarm area.
  - 1) When there is no change in amplitude, then maintain the same monitoring interval.
  - 2) When amplitude appears near-to-linear increase, before the planned maintenance or next monitoring, when it is expected that the amplitude exceeds the amplitude that requires measures or when rate of increase is non-linear, then it shall verify this rate of increase by continuous or more frequent monitoring and re-arrange maintenance plan. The increase of monitoring time shall ensure collecting data for three times before re-arranging maintenance. When vibration amplitude decreases, it shall continue to execute the existing monitoring interval.

**B.2** Vibration velocity boundary values in Area A, B, C and D shall be determined according to long-term operation experience. The general principles are:

- a) Vibration of new delivery wind turbine is usually in Area A;
- b) Usually, wind turbine of which the vibration point is in Area B shall be operated for a long-time without limitation;
- c) In general, wind turbine of which the vibration point is in Area C is not suitable for long-time continuous operation. Usually, the wind turbine can run under such a condition for a limited time and shall be repaired till there is appropriate opportunity;
- d) If the vibration point is in Area D, its vibration is so strong to cause wind turbine damage.

**B.3** Wind turbine's vibration report sample shall be determined based on the baseline value.

- a) The alarm value shall be greater than the baseline value; the value above that shall equal to 25% of upper limit value of Area B.
- b) If there is no baseline value, the initial alarm value shall be determined according to experience. After the baseline value is determined, it shall adjust alarm value setting.
- c) The alarm value shall not exceed 1.25 times of upper limit value of Area B;
- d) When baseline value varies, the alarm value setting shall be modified accordingly.
- e) The stop value shall be within Area C or Area D, and it shall not exceed 1.25 times of upper limit value of Area C.

|          |                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          | rotation frequency and related side frequency                                                       | causes gear mesh frequency, side frequency and harmonics.                                                                                                                                                                                                                                                                                                                                                                                     |
| Friction | Most are 1x component. There are also harmonics, sub-synchronous and inherent frequency components. | At low speed, slight friction can clean wind turbine. However, high-speed friction can cause vibration change, and vibration value rapidly increases to stop value. If the rotating speed is too fast or sudden change of temperature inside wind turbine, it may cause and generate friction. Besides, when the distance between rotating part and fixed part is too small, or parts are displaced during operation, friction may be caused. |

\_\_\_\_\_ **END** \_\_\_\_\_

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