Application of 8D Method in the Study on Quality Problems of Wind Turbines

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Abstract: As a common quality management tool, 8D method is often used in the research of quality related problems of wind turbines. In the post-market service of wind power, it is often faced with low operating efficiency of old units, insufficient power generation and various quality problems. The causes of quality problems in wind turbines are usually multifaceted, involving components such as blades, impellers, and motors. In addition to the large components of the wind turbine itself, extreme weather and natural disasters such as snow, frost, wind and sand will also cause damage to the wind turbine, resulting in various quality problems. When the wind turbine quality problems, the unit's operating efficiency and power generation will be greatly reduced, the loss of power generation will be greatly increased. At this time, it is necessary to apply the 8D method to diagnose and sort out the problem solving process of wind turbines. In this paper, 8D method is applied to solve the problems of low operating efficiency and insufficient power generation of wind turbines, and finally the role and position of 8D method in solving the problem of wind turbine quality are clarified.

Keywords: 8D Method; Wind Turbine; Fault Diagnosis; Quality and Efficiency Improvement

1. Introduction

In recent years, with the promulgation of relevant new energy policies, new energy power generation has flourished, and various types of wind power generation, photovoltaic power generation and other enterprises have also emerged. Such as wind power, photovoltaic and other emerging power generation methods in the power industry is getting higher and higher status, wind power as a new way of power generation in recent years, its clean and environmentally friendly power generation characteristics are also more and more respected. According to relevant data, the compound annual growth rate of global cumulative wind power installed capacity is 21.56%. As of the end of 2019, the cumulative installed capacity of onshore and offshore globally was 637.4GW, and the cumulative installed capacity of onshore and offshore nationwide was 236.5GW. In this case, the wind turbine operating efficiency is low, the power generation is insufficient, the power generation quality is poor and other wind turbine quality problems are also endless, the wind turbine related quality problems are urgent to solve. The unit equipment operates in the open air environment, the external environment will affect the operation performance of the equipment, coupled with the variable working conditions of the unit load, resulting in the actual life cycle of the equipment components of the unit to shorten, and often do not reach the service life period [1].

At present, domestic experts and scholars have conducted relevant research on the quality of wind turbines. Zhang Siming emphatically analyzed the construction key points and quality management measures of mass concrete for the foundation of wind power project fan [2]. Zheng Xiaotong, Man Xiang et al. used BMI+ measurement robot technology to discuss the installation quality control of fan Pan Hall water system [3]. Yang Chuanjian and Zhang Hongxia discussed the standardization of manufacturing quality of offshore wind turbines [4]. Chen Shu and Yu Xiaomei analyzed the quality control of fan foundation in Hainan wind farm [5]. Ding Haining studied the characteristics and essence of 8D method from the perspective of

scientific development theory [6]. Dai Dandan discussed the quality of a wind farm by taking the construction quality of a certain wind farm as an example [7]. Under the policy background of vigorously developing the integration of scenery, the requirements for the quality of wind power generation are getting higher and higher, and the research on the quality and performance of wind turbine power generation is gradually deepening.

Based on the research of common quality problems of wind turbines, this paper takes the diagnosis process of quality problems of wind turbines in a certain wind farm as the basis. The new quality management methods such as 8D and fishbone chart are used to analyze the causes of low operating efficiency and insufficient power generation of wind turbines, customize solutions according to different types of fan problems, and establish a fault early warning management system. This has a profound impact on the systematic diagnosis and solution of wind turbine quality problems and preventing the recurrence of problems. An important tool method, is widely used in all walks of life to solve quality problems in the work.

2. Introduction to Wind Power

Wind power generation is the use of wind to drive the rotation of windmill blades, and then through the acceleration machine to increase the speed of rotation, to promote the generator to generate electricity. Wind power is the process of converting wind energy into mechanical energy and then converting mechanical energy into electricity. Generally, the design life of wind turbines in onshore wind farms is 20 years. For wind farms with earlier production time, it is affected by factors such as climate, wind sand, and fan service life. Fan components such as gear boxes, converters, and blades will be damaged, resulting in a series of quality problems such as low fan operation efficiency and reduced power generation. With the leapfrog development of the wind power industry in recent years, the maturity of technology and products has significantly improved, and the occurrence of various quality problems affecting the power generation of wind turbines has significantly increased. Although the power generation and technical performance of the turbine can be significantly improved by upgrading and replacing the small turbine with the large impeller unit, standardized quality management methods and structured processes are still needed to analyze the quality problems of the wind turbine.

3. 8D Working Process

3.1. Create a Group on D1

In view of the low power generation of wind turbines, low operating efficiency of wind turbines, quality problems of large components and many other problems in wind power post-service, a special research group for wind turbine quality and efficiency improvement has been set up to explore and solve the problems faced.

Table 1. Analysis chart of 5W2H

5W2H	Problem description
When	During the operation of the wind turbine
Who	A wind farm owner
Where	A wind turbine runs a wind farm
What	Low power generation, low operating efficiency, component quality problems.
Why	The blades are small, the wear is serious, the quality of the large components of the unit is serious, and the management of the wind farm is chaotic.
How	Aiming at the problems of the unit, the blades are reformed, the unit technology is reformed, and the quality and efficiency are improved.
How much	The operating condition of the unit is very poor, and some units even stop operation.

3.2. D2 Describes the Problem

D2 is the second step in the 8D method, and accurately and truly describing the problem is the main task of D2 stage, and it is also a necessary means to solve the problem. For the quality problems of wind farm units, such as low operation efficiency and insufficient power generation, field investigation and investigation are conducted by actively going into first-line wind farms to comprehensively collect wind farm operation data, SCADA data and the actual situation feed-back from wind farm owners.As shown in Table 1,The quality problem of fan is described by 5W2H analysis method.

3.3. D3 Implement and Validate Interim Measures

Through the blade damage in the wind place, the operation efficiency is low and the power generation is low. Different temporary measures will be selected according to the severity of the unit's failure. When the unit has a major component failure, serious blade damage and other serious failures, the wind turbine will be shut down and inspected, repaired and maintained by professional operation and maintenance personnel. When the unit has relatively minor problems such as low power generation efficiency and insufficient power generation, it usually maintains the normal operation of the unit, analyzes the problem according to the on-site wind field SCADA data, and proposes solutions to improve the operation efficiency and quality of the unit and increase the power generation.

3.4. D4 Identify and Verify Root Causes

D4 is the fourth step of the 8D quality management method, the task of this step is to identify the various factors of the occurrence of quality problems or failures, and through adequate evaluation certification to determine the root cause. For many quality problems and failures of wind turbines, it is usually possible to analyze each module of wind turbines by drawing fishbone diagram, and determine the causes of quality problems and failures of wind turbines on the basis of analysis. Determine whether the root cause is correct and avoid frequent unit quality problems caused by misjudgment of the root cause in the future.

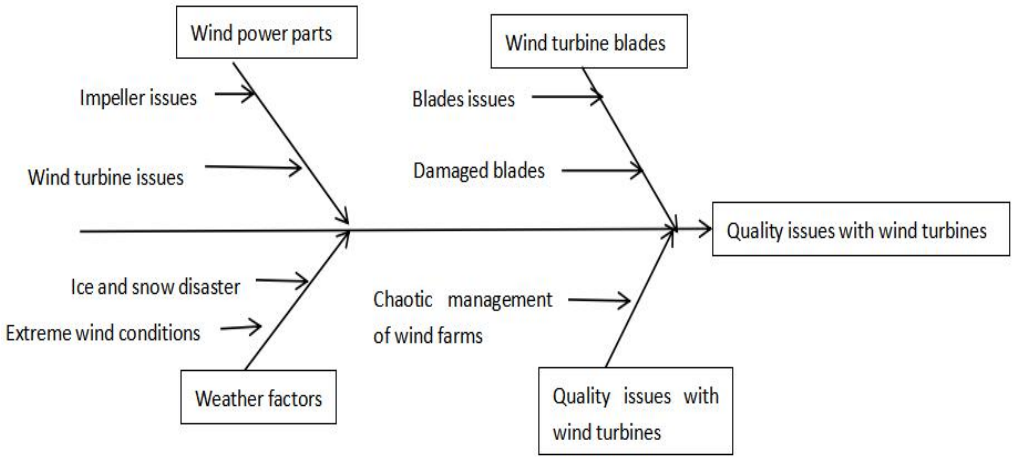

Figure 1. Wind Turbine Quality Problem Fishbone Diagram.

As shown in Figure 1, according to the fishbone diagram reflected in the large components of the unit, blade, climate and weather, and wind farm site management and other fan quality issues can be further explored by using the 5WHY method. As shown in Table 2.

3.5. D5 Select and Verify Corrective Actions

In the 8D quality management method, when the quality problem of the wind turbine is identified in the D4 step, it is necessary to carry out the D5 step to take corrective measures and methods for the quality problem of the wind turbine. In this link, relevant corrective measures should be put forward for problems such as large components, blades and power plant management of wind turbines. Corrective measures need to consider the size

of the problem to avoid making a fuss and causing cost waste. After the formulation of the measures, it is necessary to list the action plan and verify the feasibility and effectiveness of the measures [8]. The countermeasures are selected according to the main causes of low power generation and poor operation efficiency of wind turbines. In view of the main causes, consider as many countermeasures as possible, sort out the countermeasures, and concretize the contents of the countermeasures [9]. As shown in Table 3.

Table 2. 5WHY Analysis Method

Serial number	Question	Reason
WHY1	Why do the impellers and motors have problems	Impeller, motor and other components have a long operating life, and the operating quality has declined to different degrees
WHY2	Why do quality problems such as blade damage occur	The blade material quality is not up to standard, the blade rotation life is long, and the blade is old.
WHY3	Why is the unit affected by snow, ice, climate and other weather	There are many extreme weather conditions such as snow, ice, wind and sand in the area where the fan is installed.
WHY4	Why is the on-site management of wind power non-standard	Field personnel lacking professional training, and training, lack of effective management system.

Table 3. Countermeasures for Fan Quality Problems

Serial number	Reason	Measure
1	Impeller, motor and other components have a long operating life, and the operating quality has declined to different degrees.	Chooseimpeller maintenance and transformation, fan maintenance and transformation,main shaft maintenance and transformation or blade maintenance and transformation according to the shape and situation of the fault.
2	The blade material quality is not up to standard, the blade rotation life is long, and the blade is old.	By increasing the sweep area of the wind turbine, the efficiency of the blade is improved.
3	There are many extreme weather conditions such as snow, ice, wind and sand in the area where the fan is installed.	If necessary, anti-ice coating measures can be applied to the blades.
4	On-site personnel lack professional training and training, lack of effective management system.	Regular centralized training and assessment of on-site personnel to improve professional and standardized on-site personnel management methods.

3.6. D6 Implement and Confirm Corrective Actions

Using the corrective measures selected for various quality problems of the wind turbine, the power generation of the wind turbine is greatly increased, and the operation efficiency of the wind turbine is significantly improved.

3.6.1 Impeller, Fan Maintenance and Transformation Results

In actual operation, the impeller and fan of the wind turbine in operation for a certain number of years are inspected one by one, and the badly damaged impeller and fan are replaced completely. Repair and retrofit the less damaged ones to restore their operational

efficiency. After the relevant operation and maintenance procedures, the quality problems of wind turbines have been better solved, and the power generation has been greatly increased.

3.6.2 Blade Power Improvement

The blade improvement is as shown in Table 4:

Table 4. Blade Improvement

Serial number	Wind turbine type	Extend blade tip	Extend blade root	extended winglets	Step reconstruction	flap	Vortex generator
1	MY1.5-77	√	√	√	√	√	√
2	MY1.5-82	√	√	√	√	√	√
3	MY1.5-89	×	×	×	×	√	√
4	MY2.0-104	*	*	*	*	√	√
5	MY2.0-110	√	*	√	*	√	√
6	MY2.0-121	×	×	*	×	√	√
7	Benefit ratio	4%-10%	4%-10%	1.5%-6%	6%-15%	0.5%-2%	0.5%-2%

3.6.3. Technological Improvement of Blade deicing

How to solve the problem of wind turbine blade icing has always been a difficult technical problem. After the wind turbine blade icing, the aerodynamic shape of the blade will change, which will reduce the power generation efficiency of the fan. When the ice is serious, the fan must be shut down. In addition to affecting power generation, the wind turbine mass imbalance caused by icing will also increase the fatigue damage of fan components. For wind turbines that are already in service, air-thermal anti-icing technology is one of the most implementable technologies. An air heat deicing system is installed at the leading edge of the fan blade, and a heating device is installed at the root of the blade. The air heat circulation channel formed by the inner cavity of the blade and the inner cavity of the web plate is used to heat the inner cavity of the blade to achieve indirect deicing. In the air-thermal anti-icing system, the wind turbine can effectively melt ice at the ambient temperature of -10℃, start to lose ice about 40 minutes and gradually achieve normal power generation, and the wind turbine power generation and operation efficiency have been significantly improved.

3.6.4. Site Management Transformation Results

In view of the chaotic site management and low professional degree of on-site personnel, 5S management method is adopted to solve the wind farm.

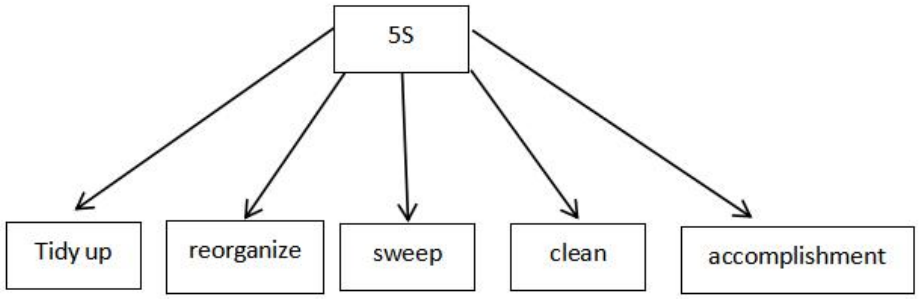

Figure 2. 5S Management Method Diagram

5S management is the key to the on-site management of wind power. As shown in Figure 2, it is necessary to fully implement the 5S management idea into the on-site

management of wind power, change the single management organization, establish a hierarchical management structure, clarify the rectification list, and fully implement the key points of 5S management to comprehensively improve the on-site management level of wind power [10].

3.7. D7 Determine Preventive Measures

Preventive measures are measures taken to eliminate the causes of potentially unreasonable or other potential problems [8]. In view of the quality problems faced by wind farms, wind farms can be combined with operation and maintenance services, regular maintenance, regular inspection, to prevent similar problems from appearing again. At the same time, according to the relevant quality standards for wind turbine management, the relevant quality and technical requirements for wind turbine manufacturers are put forward to prevent wind turbine quality problems from the source and ensure stable power generation.

3.8. D8 Summary and Evaluation

Due to the quality problems and failures of wind turbines, the wind turbine operation efficiency is low, the power generation is less than expected and other situations have taken various corresponding methods to solve. Under the theoretical guidance of 8D quality management method, it gradually analyzes the faults and quality problems of wind turbines, identifies the reasons and puts forward relevant solutions, properly solves the quality problems of fans, improves quality and efficiency, and improves the power generation quality and efficiency of generator sets. It also has a positive effect on the improvement of service quality in the wind power aftermarket.

4. Conclusion

This paper mainly uses 8D quality management research method to establish the structural process of fan quality problem diagnosis and solution. The quality problems of wind turbines such as blades, wind turbines, large components, low operating efficiency and less than expected power generation of wind turbines have been well solved. This also verifies that 8D quality management method is feasible and practical to solve the quality problems of wind turbines.

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