How Vestas works with quality

by Neil Jones, SVP, Group Quality
Agenda

1. Introduction
2. Quality journey & priorities
3. From quality control to assurance
Introduction
Who am I?

- SVP of Global Group Quality
- Strong background in quality from automotive industry
- Engineering leadership in R&D

- My approach to **Quality**
Quality journey & priorities
Quality journey

Building on experience of the experts…

Pioneers of quality

1950 Deming
1955 Taguchi

Tools

1984 8D methodology
1986 Six Sigma (Motorola)
1993: AIAG standards; e.g. PPAP
2009 LPF reporting
2011: Group Quality established
2012: Group Quality as one function

1984 8D
1986 Six Sigma
1993: AIAG standards; e.g. PPAP
The quality journey continues

... but now we are **intensifying work on existing tools and processes** to ensure quality across Vestas’ **Value Chain**
Quality **priorities**

- Single standardised approach to quality – building on existing best practice
- World class problem resolution – eliminate repeat and like problems
- More reliance on quality assurance and less on quality control
- Reduce cost of poor quality
- An aligned Vestas quality organisation with simplified interface
From quality control to assurance
Quality across **Vestas’ value chain**
**Safety** comes first at Vestas

33 per cent annual reduction of industrial injuries at Vestas since 2006.

This means 2.7 injuries per one million working hours (as of June 2012).

In 2015, the target is 0.5 injuries per one million working hours.

“Personal safety is always our top priority – not only because our employees are entitled to it, but also because our customers increasingly demand documentation that we actually have top-of-the-range safety”.

- Ditlev Engel, CEO

Incidence of industrial injuries  
(per one million working hours)

<table>
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<tr>
<th>Year</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012 Q1</th>
<th>2012 H1</th>
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<td>25.3</td>
<td>20.8</td>
<td>15.6</td>
<td>8.1</td>
<td>5.0</td>
<td>3.2</td>
<td>2.8</td>
<td>2.7</td>
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*Wind. It means the world to us.*
In two years, Vestas has reduced **LPF from 4.5% to below 2%**

A variety of quality improvement initiatives across the value chain lowers LPF, improves customer’s output and saves Vestas money

Lost Production Factor, **all platforms** (percentage)

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**Product Design**

- **Design Life of 20+ Years**

**Validation Testing**

- **Verification Testing of Complete Nacelle & Critical Components**

**Project Siting**

- **Siting to optimise Component Loads and Production**

**Sourcing & Production**

- **Supply & Production Control to Produce to Specification**

**Logistics & Construction**

- **30 Years Experience & Quality Focus**

**Operations & Maintenance**

**Diagnostics & Maintenance**

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**Performance diagnostics on 22,000+ turbines feed back to the rest of Vestas’ value chain**

Source: Vestas Performance & Diagnostics Centre; LPF trend as per 6 August 2012. Sample: All platforms (2 MW, V90-3.0 MW, V112-3.0 MW, V82-1.65 MW and V60/V52-750 kW.

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*Wind. It means the world to us.*
1% of LPF = EUR 1,840 MW/year*

* Based on CF 30 per cent and a PPA of 70 EUR/MWh.
Quality

Improves customer's output and saves Vestas money

Warranty consumption to revenue
Percentage

- 2006 FY: 4.5%
- 2007 FY: 5.6%
- 2008 FY: 4.4%
- 2009 FY: 5.1%
- 2010 FY: 3.7%
- 2011 FY: 3.1%
- 2012 Q1: 2.8%
- 2012 Q2: 2.6%

-49%
What is Quality Assurance

Closed quality loop

The Vestas closed quality loop, spanning everything from product development to O&M, ensures product quality and reliability.
Technical Reviews throughout the Vestas Way to Market

Wind turbines are developed according to the Vestas Way to Market process where technical requirements travel from customer to production.

The Vestas Way to Market

- Technical Reviews
- Key Activities – prototype to serial production
>900 hours testing capacity per day – in-house.

With a testing capacity of > 900 hours per day, Vestas has the world's largest group of wind turbine test facilities employing 150+ engineers and 50 test rigs spanning 12,000 sqm.

**Denmark**
Dedicated Field Prototype Test Sites for field testing verification

**Global Locations**
Test agreements with customers

**Aarhus, Denmark**
Drivetrain / Power Generation / Electrical / Materials / Software / GSS

**Isle of Wright, UK**
Rotor (blades and bearings), pitch, yaw

**Chennai, India**
Components, software, GSS

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Wind. It means the world to us."
**Verification testing** of complete nacelles

Vestas assesses reliability based on facts – not specifications

<table>
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<tr>
<th>COMPONENTS</th>
<th>SYSTEM</th>
<th>INTEGRATION</th>
<th>FIELD</th>
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**Testing of 20+ main components, incl.**
- Generator
- Gearboxes
- Blade & main bearings
- Yaw gear
- Converter

**Testing of 15+ systems, incl.**
- Drivetrain
- Wind park control
- Rotor & hub
- Pitch actuation
- Conditioning & cooling
- Power conversion system

**Testing of integration, i.e.**
- Nacelle assembly test
- Generator & converter integration
- Drivetrain system integration

**Field testing, i.e.**
- Run in tuning
- Power curve
- Grid compliance
- Loads
- Noise
- System validation

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Thorough **suppliers assessments** carried out globally

Central function ensures aligned assessment and approval of the global supply base

Central supplier approval functions **World Wide**

All locations use the same supplier assessment tool
Standardised **supplier assessment tools** rolled-out globally

The supplier assessment tool ensures that suppliers meet Vestas’ requirements to safety, quality, and delivery – and enables high product reliability for our customers

The **supplier assessment tool** consists of five main elements

1. **Assessment summary**
   Includes all basic supplier information from the assessment.

2. **Assessment questionnaire**
   List of questions which the supplier is rated on.

3. **Rating matrix**
   Score weighing (practical information and documentation).

4. **Assessment charts**
   Compilation of the assessment results.

5. **Task & project list**
   List of improvement activities recommended to the supplier.
Factory flows are made up of modular “process steps”

Standardisation of work processes across factories ensures product quality and reliability anywhere in the world.

- Process failure mode and effect analysis
- Process design
- Control plan
- Work instructions
- Quality documentation
Vestas manages **320 CTQs through the QDA System**

The implementation of the Quality Data Analysis system (QDA) in manufacturing allows for continuous and systematic collection of quality data for analysis.

More process reliability & predictability

**Example**

- The number of CTQs – Critical to Quality - characteristics in Machining factories has improved the quality of the final product by increasing data transparency and identifying clear priorities.
- The number of defined CTQs has increased from 38 to 320 CTQs ensuring variance reductions.

Managing CTQs in the QDA system enables:

- Data quality availability and reliability.
- The capability to analyse competences using Six Sigma Black Belt engineers.
- Structured Six Sigma projects for continuous quality improvements.
- Monitoring and controlling of the quality in manufacturing with clear closed quality loops.
Quality improvement plans minimise failure rates

Management tools used as systematic and structured approach to focus on key quality issues in production, to implement actions and monitor their effectiveness

Quality Improvement Plans (QIP)

Example

✓ QIP is a set of tools used to drive a manufacturing unit to continuously improve its performance in quality.

✓ With an intensive follow up and discipline on conducting problem-solving techniques, the number of non-conformities has decreased significantly.

Result

✓ Increased quality competence at factory level.
✓ Structured follow-up to assure correct use of the quality methods.
✓ Clear metrics to measure the quality performance across factories.
Conditions are monitored at the **global diagnostics centre**

VPDC has global coverage to analyse conditions and alerts to initiate preventative maintenance.

**Vestas’ Performance & Diagnostics Centre (VPDC)**

- Seven locations to support local preventative maintenance.
- Each VPDC location is equipped with state-of-the-art tools that analyse incoming conditions and issues.

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Prevention through prediction fully enabled

Prevention is ensured through prediction

**Information** flow & processes

**Supporting tools** & systems

Systems are in place to support customers and technicians in every step to ENABLE PREVENTIVE MAINTENANCE.
Quality continuous improvement

- Vestas and Quality = one approach
- Quality focus on improvements
- Quality delivery and services
- Cost of poor quality
- Accountability
- LFP < 2 per cent in 2012
The quality journey and improvements continue
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