# The Offshore Wind CVA Role: Charting the Path on the OCS

MMS

Offshore Risk & Technology Inc.

Malcolm Sharples

# Complex Issues

- **Geographically Concentrated Risk**

- **Structural Integrity depends on**
  - **Tower Strength**
  - **Battery Backup for Yaw Alignment**
  - **Control Systems**
  - **Communications**
  - **Software**
  - **Fatigue Resistance of Soil**
  - **Very little redundancy**

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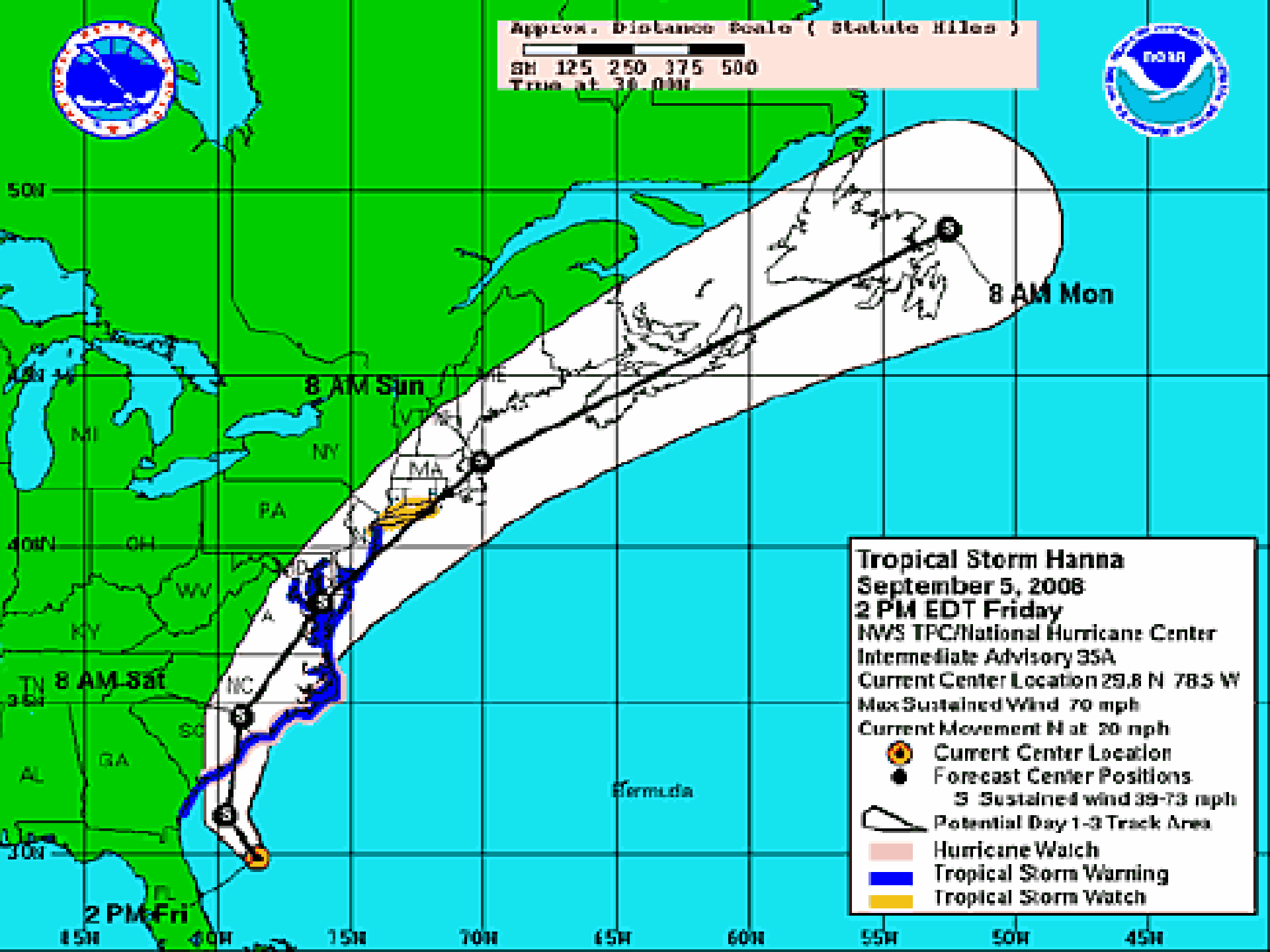
Approx. Distance Scale ( Statute Miles )
SM 125 250 375 500
True at 30.0N
8 AM Mon
8 AM Sun
8 AM Sat
2 PM Fri
Bermuda
Tropical Storm Hanna
September 5, 2008
2 PM EDT Friday
NWS TPC/National Hurricane Center
Intermediate Advisory 35A
Current Center Location 29.8 N 78.5 W
Max Sustained Wind 70 mph
Current Movement N at 20 mph
Current Center Location
Forecast Center Positions
S Sustained wind 39-73 mph
Potential Day 1-3 Track Area
Hurricane Watch
Tropical Storm Warning
Tropical Storm Watch

# What do we Need for Safety?

- **What do we know?**
  - **Look at Wind Farm Accidents**
- **Provide for a Safe Working Culture:**
  - **Safety Management System**
- **Provide for a Safe Structure:**
  - **Guidance on Information for the Facility Design Report**

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# What are the Structures?

- **Liftboats – for met towers, research**
- **Jack-up Installation Vessels**
- **Transformer Stations**
- **Turbine Structures-mono or jacket**


## Turbines

- **Turbine Towers are Different– structure dependent on power, control systems, automated shut-down**
  - **Attractive to lightning**
- **Available Codes – are not prescriptive or complete**
- **Certification - Methods different than O&G MMS regulatory process.**

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# SMS is a Separate Presentation



# SMS is Important

Offshore : Risk & Technology Consulting Inc.

Dr. Malcolm Sharples, Principal Author, Houston, Texas

**Template**
**for a**
**Safety Management System**
**for**
**Offshore Wind Farms**
**on the OCS**

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**October 2009**

*Project No. 633,* Contract M09PC00015

*Prepared for:*
**Minerals Management Service**
**Department of the Interior**

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# What I Don't Know

- **Why haven't there been more accidents?**
  - **Record is very good**
- **If Type and Project Certification works**
  - **Why are there so many failures?**
- **Why is there 20% difference between the event that NOAA$_{(75mr)}$ & Oil & Gas$_{(75kd)}$ wind data: same event?**
- **What Load factors to use?:**
  - **Recommending Reporting Design-year (100) Survival-year 1000? (TRS Areas: Dan Dolan – Tarp-Johansen)**

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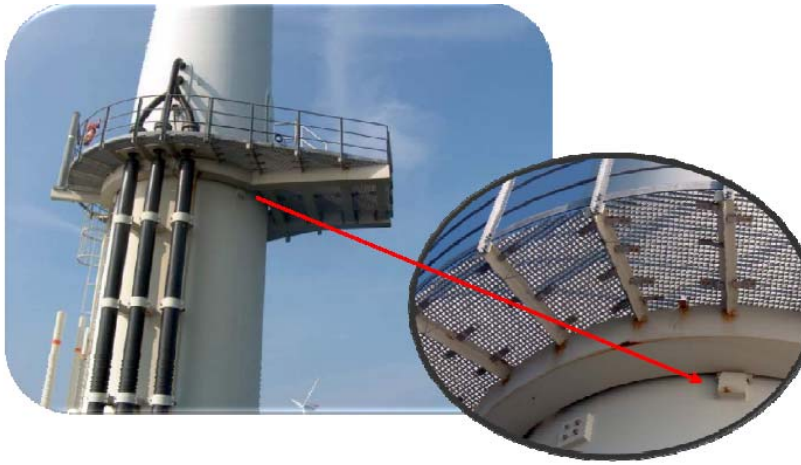
# What I Do Know

- **Better job Documenting Casualties**
  - **Learn from the Past – O&G as same issues**
  - **Must prioritize the accident issues**

- **PRIORITIZE RISKS for REGULATOR**
  1. **Towers: multiple towers/multiple fields**
  2. **Subsea Cables**
  3. **Blades – serial issues**
  4. **Secondary Structures**



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# 2 Design Approaches

## APPROACH: OMNIDIRECTIONAL

**Design not sensitive to the changes in the wind direction**

**API RP2A**

## APPROACH: STANDARD

**Design, which is supported by *back-up power supply securing power for the yawing systems***

**IEC Code Solution: 6-hour Battery**

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# Experience from India!

**Tropical Cyclone 03/A destroyed**

**129 or 40% of the 315**

**wind turbines**

***A critical factor in the failures in India is that the grid also failed…….. Wind turbine manufacturers would be well advised to check that this load case has been included in their design calculations.***

***(prior to IEC Code)***

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# Experience from Japan!

***When typhoon passed through, the wind direction changes from North to Southwest for 3 hours. From these evidences, these turbines would lose yaw control, then subjected to the side attack of strong gust and broke. This experience shows the importance of wind turbine protection against power failure."*** [Ref. 3.6.54].

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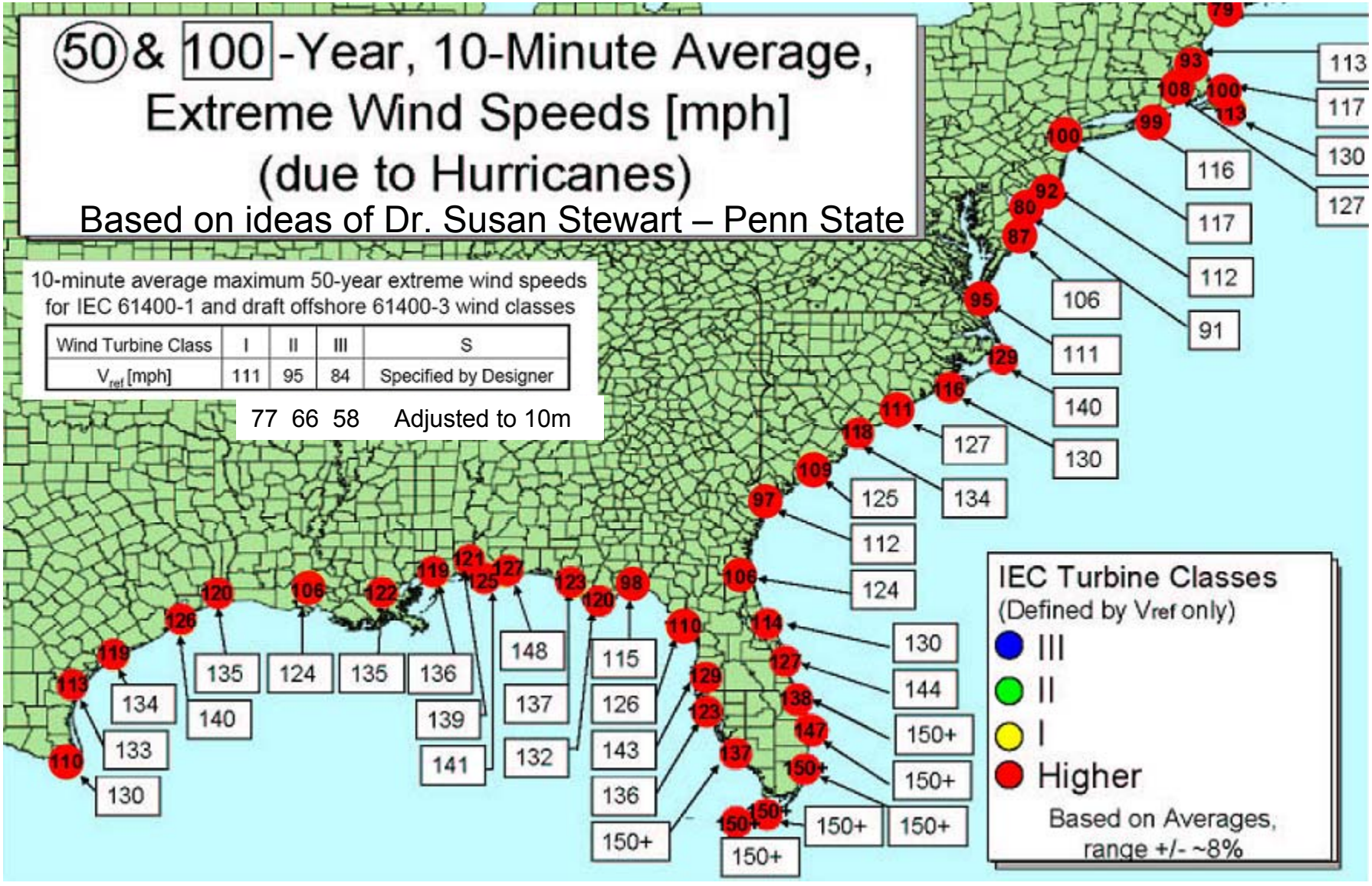
# S-Class Turbines – 50 or 100 yr?

Is the Tower design governed by extreme winds or by dynamics?



# What I think I know!

- API RP2A – Omni-directional design only
- Wind Industry is LRFD – use API RP2A- LRFD?
- IEC Load Cases -may govern or GL's: APIRP2A
- Type Certification & Project Cert. – industry too far down the road to change: we can adapt it
- Must incorporate Industry Methods in CVA practice
- Design of the system must allow flexibility in concepts to be presented e.g. Owner selected Standards – With Justification offered to Regulator

**Guideline Identifies the Issues to be Addressed**

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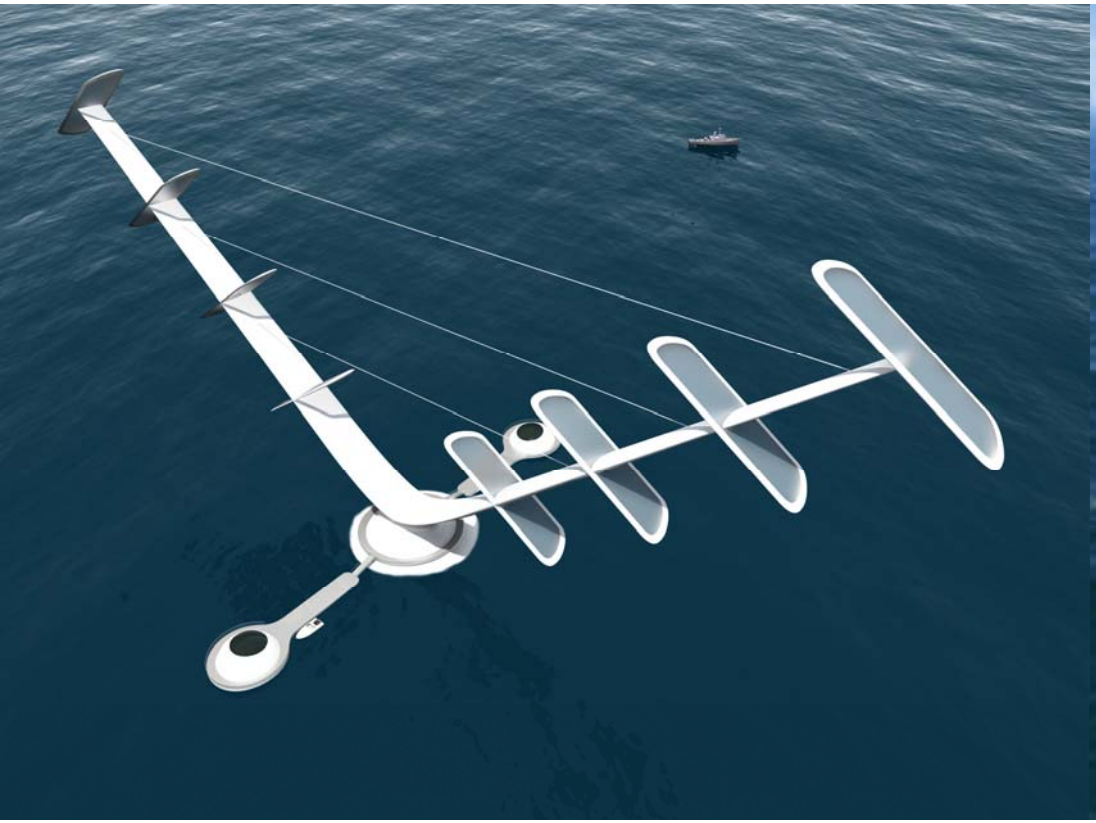
# Adaptable for New Concepts



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# European System of Approvals?

- IEC Code
- Eur. Accreditation: (ANSI Equivalent) gives Country Acceptance of Certifier
- Certification Bodies Advisory Committee
  - Acceptance of other Cert Body Certs
- Country Requirements additional
- MMS CVA (traditionally different
  - similar approach to Germany)
- MMS Submissions
  - English not Metric, Location of docs.
  - ? – Eur steels, Eur welding, Eur Safety Equip. EN50308
- Electrical Standards – EU Not API, UL, IEEE
- USCG has requirements for applicability for Lifesaving/ Firefighting etc.

**The Devil is in the Details**

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# Adapting IEC

- Fire not dealt with – ADD As Mandatory
- Lightning is state-of-art statements – ADD As Mandatory
- Accredited Certifiers – not a system set up in US for Wind (see ANSI)
- Certification Bodies Advisory Committee – doesn't exist in US (Turbines are GL, Riso and CIWI) – CVA is a P.E.
- Acceptance of other Cert. Body Certs – legal issues – 20 years?
- Scope of Evaluation identified by supplier/ owner Project basis – CVA
- Extent of Blade tests- vague; What Lab are they tested in? How many? Who witnesses?
- Certifier shall verify turbine can be transported according to design documentation
- Certifier has to evaluate personnel safety aspects are dealt with appropriately (too vague to certify to).
- Evaluation of Quality system –(to what standard?)
- Design Verification–repeating calculations is costly: is there a better way?
- Assumptions are Critical; Competence in Certification is Critical
- Control Monitoring /Software mandatory for Structure survival?
- Corrosion Evaluation – should be part of the process

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# Facility Design Report

## Proposed Submittal

- Open Architecture

## Requirements

- Described

## Proposed Codes

- Tabulated

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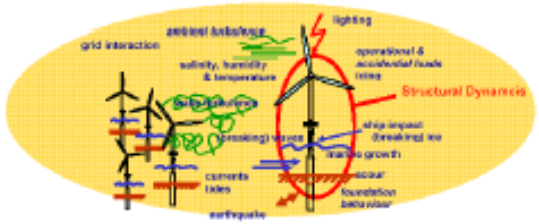
**Structure, Equipment and Systems for Offshore Wind Farms on the OCS**

Part 1 of 2 Parts - Guideline

*Project No. 633,* Contract M09PC00015




*Prepared for:*

**Minerals Management Service**

Department of the Interior



**March 2010**

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# Report Provides MMS the Design Basis of Facility

- Primary Structures e.g. Towers and Transformer Station, cables
- Control and Protection Systems (if power req'd for Struct.)
- Fire Detection and Protection
- Lightning Protection
- Accommodation Equipment/Temporary Permanent
- Equipment for Access onto and within the structures
- Emergency Equipment and Escape Equipment
- Condition Monitoring
- Etc.

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# HAZID for Load Cases Reported

1. During Power Production
2. Power Production with Fault –e.g. loss of grid
3. Start up
4. Normal Shut Down
5. Emergency Shut down: To ensure Blades etc don't get overloaded with sudden braking
6. Parked – Return period
7. Parked with Fault
   - 1- year return period storm?
   - Battery Life ? (Japanese Guidelines?)
8. Other Conditions for Load Cases
   - Maximum size service vessel hitting at 0.5 m/sec?
   - If manufacturer's condition lasts more than a week consider a 1-year return storm. (max wind, associated wave; max wave, associated wind).

(At this stage **there may be no power, no control system)**

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# State the % of Surveillance

## Fabrication, Installation, Commissioning

### GL System – 2 levels of Surveillance

A *"Surveillance is to be undertaken covering 100% of the offshore wind turbines of the offshore wind farm are to be monitored. Surveillance shall cover the support structure and essential parts of machinery, blades and electrical system".*

B *"Surveillance is to be undertaken covering 25% of the offshore wind turbines on a random sample basis, which means that a minimum of 25% of the offshore turbines are to be monitored . Surveillance shall cover the support structure and essential parts of machinery, blades and electrical system. In case the surveillance should reveal major failures, deviations from the certified design or deviations in the quality management the number of turbines to be monitored is to be doubled."*

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# Guidelines for Offshore Wind Farms

**Rules and Guidelines**
**IV Industrial Services**

2 Guideline for the Certification of Offshore Wind Turbines

GERMANISCHER LLOYD
1867

1 General Conditions for Approval
2 Safety System, Protective and Monitoring Devices
3 Requirements for Manufacturers, Quality Management, Materials, Production and Corrosion Protection
4 Load Assumptions
5 Strength Analyses
6 Structures
7 Machinery Components
8 Electrical Installations
9 Manuals
10 Testing of Offshore Wind Turbines
11 Periodic Monitoring
12 Marine Operations
13 Condition Monitoring

GL OPERATING 24/7

Edition 2005

DNV

OFFSHORE STANDARD
DNV-OS-J101

DESIGN OF OFFSHORE WIND TURBINE STRUCTURES

JUNE 2004

DNV

OFFSHORE STANDARD
DNV-OS-J102

DESIGN AND MANUFACTURE OF WIND TURBINE BLADES, OFFSHORE AND ONSHORE WIND TURBINES

OCTOBER 2006

*start in April 2007.*
*xt page.*

DNV

PRODUCTS
RvA C 257

**Type certified according to <*Insert name of scheme i.e.* ***Danish, Dutch or IEC WT 01***> type certification system**
**DET NORSKE VERITAS, DANMARK A/S**

# Germany Regulatory Approval

## These standards are at the core of the German Approval process


# Fire Protection: Mandatory?


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# Lightning Protection: Mandatory?

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# Pioneers – some of the issues

**Offshore Denmark W.D. 6-14m.**

- **Since 2002**
- **Issues with:**
  - **Cables**
  - **Lightning**
  - **Software & Control System (overspeed damaged blades)**
  - **Standstill marks (8) gearboxes**
  - **Transformers (insulation defect)**
  - **Defective Generators (production defects)**
  - **Quality (blades/ gears etc.)**
  - **Hydraulic System**
  - **Secondary Construction**
  - **Corrosion Protection**
  - **Terminal Strips (HR 2)**


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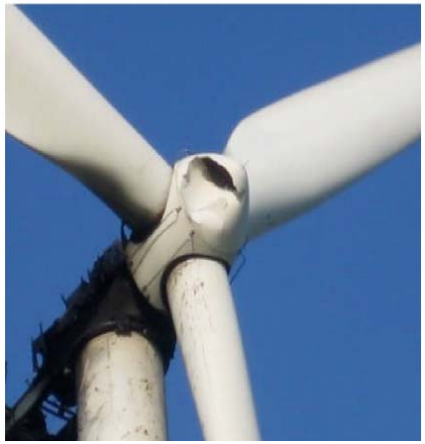
# Overspeed I. Fire in the nacelle.

## *Root causes.* Pitch system.



Due to mechanical/electrical problems with the pitch system the turbine went overspeed. Oil from a broken component was ignited when the oil hit the disk brake.

*Damaged parts.* Nacelle, one blade, upper section of the tower.

*Estimated costs.* 800.000 Euro. Plus business interruption.

The burned nacelle. Notice the nosecone. Due to the overspeed an implosion have occurred.

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# Overspeed II. Mechanical damages.

*Root causes.* Pitch system.

Due to problems with the control system of the pitch system the turbine went overspeed. *Damaged parts.*

Nacelle (repairable), 3 blades, upper section of the tower, foundation

*Estimated costs.* 600.000 Euro. Plus business interruption.

Notice the cracks in the foundation and damaged upper tower section.

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# Overspeed III. Mechanical damages.

*Root causes.* Bad workmanship. Pitch system.

Notice the marks on the tower from one of the blades. When the nacelle crashed to the ground it was totally destroyed.

Due to human interference with the control system of the pitch system the turbine went overspeed. One of the blades hit the tower and the whole nacelle broke loose and fell to the ground. Damaged parts. Nacelle, 3 blades, upper section of the tower.

*Estimated costs.* 1.300.000 Euro. Plus business interruption.

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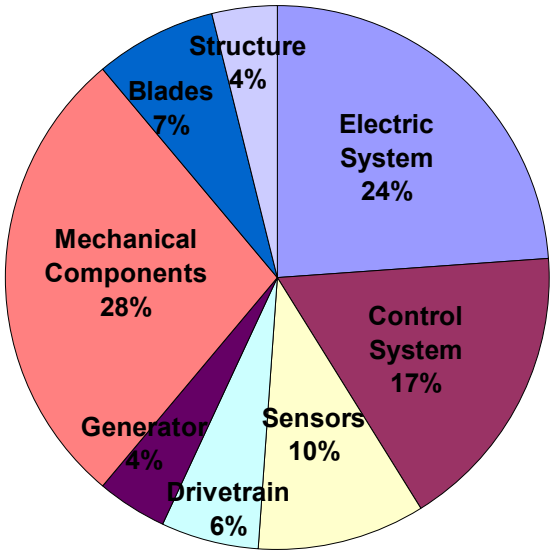
## Condition Monitoring

Analysis can lead to identifying
Bearing faults
Coupling Faults
Misalignment Faults
Gear Faults
Unbalance
Support Structure Faults




% Total Failure by Component Type

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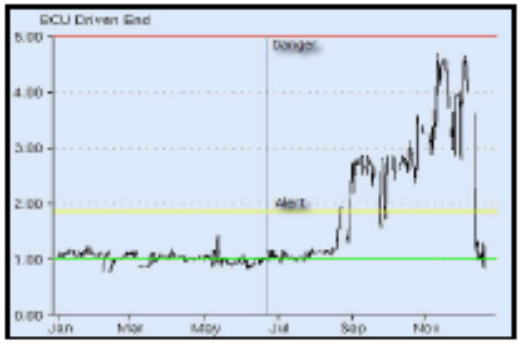
(a) Inner ring fault detected in gearbox intermediate shaft bearing




(b) Bearing fault detected in generator bearing


(c) Coupling fault

Figure 4: Examples of mechanical faults detected using trending of fault symptoms

# Acceptable Qualifications/Skillsets of Certifiers

- Structure Analysis – wind turbine structures incl. dynamics for structure and soil
- Familiarity with standard selected by owner
- Materials & Repair of materials
  - (concrete, composites, grout, steel)
- Joining e.g. welding, bolting, etc.
- Blade Construction – fiberglass, composites
- Manufacturing of Turbine components
- Blade testing
- Gear analysis
- Control system and software
- Subsea cable and Terminations
- Recordkeeping – changes in the type approval
- Availability at Location?
- Availability of multiple surveyors in multiple disciplines e.g. bolting, piling, soils, etc.

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**Acceptability of Cross training?**

# Crafting the MMS Review Process

**REVIEW THE DESIGN & TYPE CERTIFICATION**

- **Design Load Cases, Tests done, Reports of manufacturing surveillance: what %?**

**REVIEW THE PROJECT CERTIFICATION**

- **Assumptions? e.g. what storm values?**
- **% Attend soil sampling? Load factors?**
- **CONFIRM ALL DOCUMENTATION IS IN USA**
- **Attend for Transport, Installation, commissioning?**

**TECHNICAL AUDIT**

- **Control System? Condition Monitoring?**

**WHO IS Your Proposed CVA? PROJECT CERTIFIER?**

- **With what expertise/ independence?**
- **What MMS CVA training has your Certifier received?**
- **How much surveillance?**

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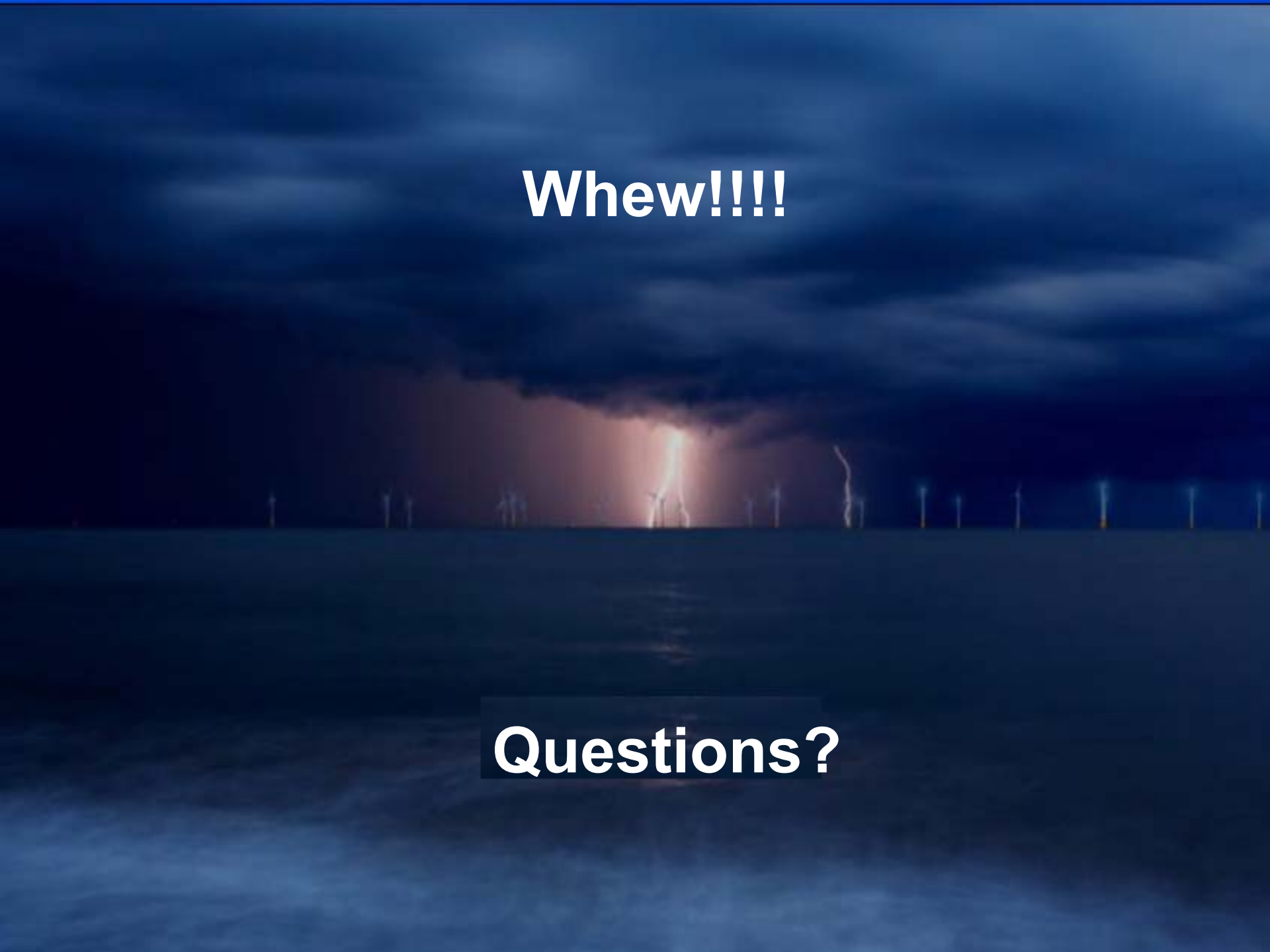
Whew!!!!
Questions?

# Thankyou!

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