Wind Turbine Hazards and Rescue Operations

**PART 1**
The Wind Turbine Industry

**PART 2**
Terrestrial Rescue

**PART 3**
Helicopter Rescue
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Wind Turbine Height

- Often rising over 150 meters (500 feet)
- Tallest is 220 meters (722 feet)
- Future turbines will be even taller.
The Wind Power Industry

- Wind power is present in 90+ countries.
- Germany, UK, France, Belgium, Ireland, India all set new records.
- China is the global leader.
Industry Growth

Global Mean Wind Speed at 80m
Growth rate has exceeded 10% per year
Industry Growth

Europe +43%, North America +55%, Asia +62%,
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Common nacelle types

Windenergie

Bei Windkraftanlagen haben sich zwei verschiedene Konstruktionsprinzipien durchgesetzt: Anlagen mit Getriebe (1), bei denen die niedrige Drehzahl des Generators auf die für den Generator günstige Drehzahl gebracht werden. Bei getriebelosen Anlagen (2) sitzt der Rotor des Generators direkt auf der Rotordrehscheibe.

1. Beispiel einer Anlage mit Getriebe
Leistung: 2,0 Megawatt
Rotordurchmesser: 80 Meter
Turbine: ca. 80 Meter
Drehzahl: 9 - 10 Umdrehungen pro Minute

Generator-Getriebe-System

2. Beispiel einer getriebelosen Anlage
Leistung: 1,0 Megawatt
Rotordurchmesser: 114 Meter
Turbine: ca. 104 Meter
Drehzahl: 8 - 10 Umdrehungen pro Minute

Bremse

Der Nutzwerkluft der Windkraftanlage erfolgt über einen zusätzlichen ventilator. Der vom Generator eingespeiste Wechselstrom wird in Gleichstrom und anschließend wieder in Wechselstrom mit der richtigen Frequenz und Spannung umgewandelt. Dadurch ist ein dreizehnphasiges Betreiben der Windkraftanlage möglich und die mechanischen Belastungen werden minimiert.

Azimutmotor
dient der gesamten Generatorin den Wind

Elektrische Blattsteuerung
Bei pitch-gesteuerten Anlagen lässt sich der Azimutmotor verstellen, um bei unterschiedlichen Wind-gehaltungsfällen eine gleichbleibende Umdrehungsgeschwindigkeit zu erzielen.

Rotorblatt

Rotordrehscheibe

Steuer-Elektronik
Tower, platforms, hatches and openings
Common heights

Common shaft heights:
- Old: 90m-100m
- Actual: 130m-140m
- Ongoing: 160m-200m

Surprise:
- Ropes shrink in use
- “windsag“

Conclusion: rope length
- Min. shaft height + 15%
Access problems
Examples of real rescues
Arbeiter stürzt von Windrad

Lichtenau - Er stürzte acht Meter in die Tiefe. Ärzte kämpfen um sein Leben. Horror-Unfall in einer Windkraftanlage bei Lichtenau.


kw

Rottungshubschrauber Christof 13 flog den schwer verletzten Arbeiter in eine Klinik.

Lichtenau-Asseln (NRW)

2007
Emergency doctor climbed up with top belay
25m platform
Passing hatch, casualty becomes unconscious.
Passing hatch
Passing hatch, casualty becomes unconscious.
Accident investigation
Ffallarrest rail onsite
Missing screw on fall arrest rail connector
Operation after pinched hand
Operation after pinched hand
Debrief

- Slightly injured, hand was pinched
- Coworker contacted the rescue team and informed about the need for only a wrench
- No fall arrest rail sliders onsite → 80m lead climb with shock absorbers (about 20 min)
- Casualty unable to act himself, just lowering (rescue triangle) with attendant
Elevator

Spotted:
- Mostly upstairs
- >10min to get down
- 136m climb with fall arrest sliders around 15min
- Make a decision
  - Elevator vs. climb
Cardiac Arrest, winch rescue in PPE Harness

Photo source: Internet
Prospective analysis regarding rescue devices
Special medical demands

Rescue under CPR
Difficulties with casualty pathway
Passing hatch single time
Passing hatches multiple times
Passing hatches multiple times
Definition: Rescue central point
- Passive lowering with attendant
- Attendant hands free
- Compact setup required
Butterfly, two ropes
Compact setup
Changeover stretcher orientation

MPA Ring

Munter Hitch

Designed by: J. Diniis 1991

Drawing by: J. Diniis 1994
* Drawing not to scale
Nearby accident
Grimpday 2011
Nearby accident
Grimpday 2011
Solution with basket stretcher and Aztek
Solution with basket stretcher and Aztek
Problems with aluminium frame plastic litters
Solution with Skedco and Aztek
Problems
Rollup, Balance, automatic CPR
Rollup, Balance, automatic CPR
Hatch nacelle, Rollup balance
Hatch nacelle, Rollup balance
Passing hatches in the tower
Rotating Incident
Rescue out of the hub/blade
Hub/blade rescue

• Rescue out of the hub can require Confined Space Rescue (CSR) Operations
  • Maybe toxic atmosphere
  • Detailed look on accident mechanism
    • Worker unconscious → high alert
    • Due to time
      • Rescue vs. Recovery
  • Actually no experience with CSR operation on wind turbines
  • CSR Operation not very common in Europe
    • This needs to be improved
Spec-Pak

- Ridgity for dragging over edges
- Vertical use
- Semi vertical use
- Compatible with stretchers
Hub/blade rescue
Hub/blade rescue
Terrestrial Support for Air Rescue (Onshore)
Air Rescue (Offshore) North/baltic sea
- Nacelle → water
  - (Evac in case of fire)
- Nacelle → Heli hoist
- Hub → Heli hoist
- Tower → Transition piece
- Transition piece → ship
- Tower/transition piece → helicopter
• Long lifts required
• Comparison winch rope reel style vs. capstan style
• Conclusion only capstan style winch
• Winch operation indoor, risk assessment prohibits usage of gas powered winch
• Winches can shut down
  • Technical problems
  • Problems with rechargeable battery
    • Empty
    • Cold
Offshore long lifts
Offshore long lifts
Offshore winch issue
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Industry Promotion of helicopters

The offshore wind turbine industry is promoting helicopters as an asset – recognizing the utility of aircraft during high seas.
Offshore Wind Energy

The offshore wind energy industry is forecasted to experience significant growth over the coming years. To meet these new requirements, more and more wind farm operators are turning to helicopters, which offer a reliable, cost-effective solution, from construction to maintenance.

H135
Cost-effective access to wind farms close to shore

H145
High-performance, multi-task helicopter for crew transfer and hoisting

H160
The innovative medium helicopter for hoisting and crew transfer, up to 19/12 passengers

H175
The modern and cost-effective medium helicopter solution for long range crew transfer, up to 16 passengers

Cost-effectiveness and flexibility

Fewer power outages ➔ No loss of revenue

H175
150 Knots

H160
130 Knots

H135
25 Knots

The helicopter advantage

With a predicted rise in the number and size of offshore turbines, and their distance from land, wind farm operators are increasingly faced with important challenges concerning transportation, rescue and maintenance operations.

- Safe and easy access to wind turbines
- Reduced CO₂ emissions
- A longer window of time to work
- No sea sickness
- Rapid response time
- Enhanced situation awareness
- Centralisation of all helicopter systems
- Automatic flight control system
- Advanced human-machine interface (HMI)
Helicopter fleets projected to triple in size in 5 years

- In support of worker transport
- In support of search and rescue
HAZARD IN FLIGHT OPERATIONS #1: Wake vortices and turbulent flow behind a Wind Turbine

Helicopters may be affected by turbulence behind turbines.

© David Bock (National Center for Supercomputing Applications) Journal of Renewable and Sustainable Energy,
HAZARD IN **FLIGHT OPERATIONS #1:**
Wake vortices and turbulent flow *behind* a Wind Turbine

...as much as *5 times* the rotor diameter.

© Hui Hu Ph.D. huhui@iastate.edu
HAZARD IN **FLIGHT OPERATIONS #2**: Meteorological Evaluation Towers (aka “Measurement Tower”)

- Very difficult to see
  - 50-125 meters tall
  - Installed hours

- In the USA, many METs fall below the 60 meter federal law for markings.

© Wikipedia
HAZARD IN *FLIGHT OPERATIONS #3: Radar Signals*

A wind turbine farm can cause problems with radar signals:

- **Weather radar**
  - Turbine shows as a “false echo” and can hide thunderstorms behind it

- **Air Traffic Control Radar**
  - Can create false targets and hide real targets.
HAZARD IN **FLIGHT OPERATIONS #3:**

Radar Signals

- In Europe, Eurocontrol designates requirements on planned wind turbines.
- The U.S. has determined 4 zones of impact (significant impact to unlikely impact).
HAZARD IN **RESCUE** OPERATIONS #1: Weather Limitations

• Fog and clouds, heavy winds, stormy conditions are common
• Requires three rescue options:
  • Helicopter
  • Sea vessel
  • Combination (bring casualty to a vessel, ride the vessel outside the park and pickup from the vessel)
HAZARD IN **RESCUE OPERATIONS** #1: Poor Visual Reference

- Pilots have poor visual reference when near vessels
  - Big vessels mean easy reference
  - Small vessels mean poor reference
HAZARD IN RESCUE OPERATIONS #1: Rescue from Transition Piece

- Always have a “Plan B”
- ONLY if rescuers are not able to:
  - Raise the patient to the top of the turbine or
  - Lower the casualty to a vessel
HAZARD IN **RESCUE OPERATIONS #1:**
Rescue from Transition Piece

- The one key hazard on the transition piece is that you are not able to abort the lift as soon as you lift the patient / rescuer over the railing.
- For the flight crew, keep focus on the parameters specified in the SOP, this is important to keep the fleet angle of the hoist cable within the limitations of the manufacturer.
- Medics must keep an eye on pre-lift preparation, including positioning of the rescue bag and rope management on the ground.
HAZARD IN RESCUE OPERATIONS #1: Rotor Brake must be LOCKED

- The rotor of the wind turbine has to be on brake/"locked"
  - Offshore - indicated via signal lamp on the turbines top.
  - Onshore - NO signal light, you must seek status
    - From the team onsite
    - Or the operation control center of the windfarm
Helicopter Rescue Operations

Offshore, the easiest exit point is the top of the nacelle.

Anti-rotation is critical - Rotation can lead to rotation trauma, or unconsciousness.
Helicopter Rescue Operations

Dangers of tag lines

• Risk of the tag line being snagged in the railing, and not releasing via break away link.
Example of Anti-Rotation Rudder

Video courtesy Wiking Helicopters
Video of Rescuer Extrication from the Nacelle

Offshore extrication of a rescuer from the top of the nacelle

Video courtesy Uni-Fly Helicopters
Rescuer Extrication from the Transition Piece

- The main rotor must have enough clearance from the tower.
- The angle of the cable must be within the manufacturer’s limits.

Drawing courtesy Axel Manz
Video of Rescuer Extrication from the Transition Piece

Training for an extrication of a rescuer from the Transition Piece using an onshore training facility

Video courtesy Wiking Helicopters
Video Example #2 of Litter Rescue

Training for litter extrication from the transition piece.

- Using anti rotation rudder
- Using an unattended litter

© Wiking Helicopters

Video courtesy Wiking Helicopters
Airlift of litter from the top winching platform.

- Using an attendant and anti rotation rudder.
Offshore Wind Farms

Offshore represents <10% of the global market, but that will increase substantially in the coming five years.
HeliOffshore has a new *Wind Farm Group* with 3 sub-groups

- Safety strategy
- Helidecks
- Search and rescue (SAR)
  - Accident reports on HeliOffshore website
HeliOffshore

The companies involved in the group so far are:

- Leonardo Helicopters
- Bell
- Airbus Helicopters
- Wiking Helikopter Service
- CHC Helicopter Bristow Group
- Heli Service International
- HTM Helicopters
- KN Helicopters
- NHV
- Era
- Equinor
- and wind turbine manufacturers

The new group’s first meeting is THIS WEEK at the 9th annual Offshore Wind Event.

It will publish new guidelines in 2019.
Wind Turbine Hazards and Rescue Operations

Let’s prepare!

Industry growth will impact the rescue community worldwide.
Wind Turbine Hazards and Rescue Operations

Merci, thank you, danke, grazie.

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