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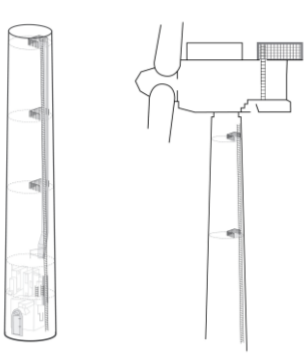
The evolution of technical rescue in wind turbines / a field analyses for rescue technicians.

Definitions; Wind Turbines



Accidents on wind turbines can happen on different spots within the structure. There are different steps of escalation relevant to the injuries of the casualty. The following examples are rated as possibly life threating, with the goal of rescuing the seriously injured casualties.

Basement:

- Falling from heights with sudden stop hitting obstacles or floor
- Dehydration
- Cardiac arrest
- Poison atmosphere
- Electric shock

Tower:

- Falling from heights with sudden stop hitting obstacles or floor creating fractures
- Slipping and crushing bones
- Slipping from ladder and catching in fall arrest system
- Dehydration

- Cardiac arrest

Nacelle:

- Falling from heights with sudden stop hitting obstacles or floor creating fractures
- Dehydration
- Cardiac arrest
- Electric shock
- Crushing an jamming in turning machine parts
- Slipping and crushing bones
- Poison atmosphere

Hub:

- Dehydration
- Cardiac arrest
- Electric shock
- Hydraulic injuries
- Crushing and jamming in turning machine parts
- Slipping and crushing bones

Blade:

- Dehydration
- Cardiac arrest
- Electric shock
- Slipping and crushing bones
- Bad/toxic atmosphere

Definition for rescue devices:

Special requirements for treating injuries:

- Cardiac Arrest: PPE harness/rescue triangle/Spec Pak front attachment point/ stretcher
- Electric burnings and shocks: small injuries rescue triangle/ heavy once or under resuscitation stretcher
- Fractures: Neck collar/ spine board vs. vacuum-mattress/ stretcher

Unique challenges relevant to the location:

- Hub, gear box and blade: Spec Pak
- Basement: stretcher vertical, Spec Pak
- Tower: passing hatches, stretcher with changeover from orientation, rescue triangle, PPE harness
- Nacelle: passing hatches stretcher with changeover from orientation, rescue triangle, PPE harness

Conclusion on rescue devices:

The assessments have shown that a rescue team should be familiar with the following rescue devices to perform each rescue from a wind turbine. For fast operation (PPE harness or rescue triangle), for rescue out of confined areas (Spec Pak), for heavy injuries which require immobilization (stretcher with possibility to change over the orientation, vacuum mattress and thermal protection)

Medical special demands:

Due to limited possibility of the rescuer to perform ventilation or resuscitation during lowering, a search for technical support was required. Based on the recommendation of a big air rescue organization the Zoll Autopulse and the Oxylator has be field-tested. Both worked well also with changeover of the stretcher orientation.

Videos and pictures of these test shown in the presentation.

Rigging:

Definition on devices:

Comparison on devices:
twisted rope path vs. S-shape rope path

During field tests, several devices exhibited excessive rope twist. So much so, lowering with constant flow is not possible. Lowering had to be stopped to undue twists. This created long exposure time of the casualty and rescuer outside the wind turbine with all its dangers. Of course, the time until the casualty received medical care increased as well. S-shape rope paths have shown a constant lowering flow.

Conclusion: Only devices with S-shape rope path should be used and the devices must be able to absorb the energy of descends from 90m-160m

Central rigging point for rescuer and stretcher in lowering (passive) mode

At the beginning of the analysis, there has been no system in Germany for a central rigging point to lower stretchers and rescuers passively, which met the requirements of a risk analyses. Reading US rope rescue books, the author was fascinated about the interlocking bowline system as part of the toolbox. Based on an accident, the bowline is prohibited at most of the departments in Germany. The bowline has been used around a tree as anchor during mountain rescue training. Two participants felt down due to ring loading and the resulting opening of the bowline.

The author learned in cross discipline training (IRATA rope access) the butterfly and tried to use the butterfly for the system to create something similar like the interlocking bowline which will be accepted in Germany.

The need for “change-over” stretcher orientation, horizontal to vertical and back.

A trainee of the author has been involved in a rescue 2007. The casualty fell off the ladder, while climbing down the tower after a system failure. He fell 12m to the platform, located 25m above ground level, which caused serious injury. In order to pass thru the hatch of the 25m platform, the stretcher was turned vertical, which is caused the victim fall unconscious. The team speed up the rescue and brought him back horizontal, after which he regained consciousness. (Pictures shown in the presentation)

After that operation, different ways of litter rigging techs have been developed. Depending on ideas seen in the Internet from rope rescue teams out of the states (rotary litter rig) and information Knut Foppe took over (change over of the Skedco with the Aztek) from the US, different techniques have been tested. Conclusion:

- technique with Aztek for Skedco style stretchers and baskets
- technique with counterbalance

Observing an incident on Grimpday 2011 (wrong interpretation of rotary litter rig) a head limiter where added to the balance bridle (Pictures shown in the presentation)

The need of a tag line.

Video shows one of our trainings where the casualty and the rescue where lowered out of the nacelle. The stretcher begun to rotate very fast due to the aerodynamics around the tower. This was a very dangerous situation and stopped just after smashing against the structure and speeding up the lowering (vertical downward speed decreased rotation)

Evaluation of different tag line techniques;

Conclusion: A tag line on the central point should be attached and the working angle should be between 30°-40°

Special Offshore demands:

Stretcher compatibility with water?

During rescue operation from wind turbines offshore, stretchers has to be lowered over water. The author has observed a incident during the Grimpday 2014 where a stretcher fell into water, sinking. Only the quick reaction from a real hero ensured that the training casualty did not drown.

Video of the incident is shown in the presentation.

Open point: Search for solution. Two possible ways are identified. Usage of flotation kit or usage of a watertight casualty bag, but is seems that there no proper solution available.

Rescue via raising within the tower to the helicopter winch zone. Usage of a winch.

Comparison of “single rope reel style winch” vs. capstan drum winch. Weight of casualty and rescuer up to 250 kg has to be assumed.
Field tests have shown that “single line rope reel winches” could not lift the load when the rope passes a high direction. The breakaway moment before the rope starts to move creates too much friction. The rope slips in the “single line rope reel” and gets damaged. Capstan style winches perform safe at 250kg loads.

Due to the closed environment, the risk assessment prohibits the use of gas-powered winches.
Additionally, relevant to a detailed risk assessment, the danger of shut down of the winch has to be considered. This could happen when the rechargeable battery is damaged for various reasons, not charged, or simply due lack of performance in cold temperature environments.

Due to the risk of the winches shut down, it has been tried to integrate the winch into a setup behind the rigging setup, which could perform lifting via a counterbalance. In that case, the field test showed the need of a device working as a pulley and taking over as pcd when the winch collapses. (Rigging scheme is shown in the presentation). If the winch collapses, the team just has to take the rope out of the winch and bring a two-person load to the outgoing rope. With an additional 1:2, the impulse to move the load up will be given.

Dangers of tag lines during air lifting from helicopter winch zones on top of a wind turbine

Offshore, the easiest exit point to the transport to the hospital via helicopter will be the winch zone on the top of the nacelle. Regarding the downwash of the helicopter, it is necessary to use something against possible rotation of the stretcher during the airlift. Especially days with less wind are very dangerous regarding rotation. Rotation can lead to dangerous injuries like rotation trauma, unconsciousness or losing the casualty (victim thrown of the stretcher).

Based upon the risk assessment, activities against this danger have to be performed.

In air rescue, a tag line is very common tool to combat the challenges mentioned above. Additional risk assessments have shown that other ways should be found. There is a big risk that the tag line could get snagged in the railing. If the helicopter has to perform an emergency procedure, he has to head away from the wind turbine and to speed up. If the tag line does not release via break away link its very dangerous for the rescuer which handles the tag line. It could also get snagged in the railing.

Based upon mountain rescue experience of the Bavarian mountain rescue. An anti rotation rudder has been added so that there is no need of a tag line and a free escape route for helicopter emergency procedures.