Offshore Wind Farms:
Risk and Initial Loss Experience

Brake failure causes total loss of wind turbine

On an island in the Atlantic a wind farm was being built with about 70 turbines, each producing an output of 300 kW. During testing one of the machines suffered a total loss.

The towers are 24m tall with a rotor diameter of 30m.

Electronic controls in the tower regulate the mechanism for adjusting the attitude of the rotors and the pitch of the rotor blades depending on the measured wind velocity and direction. The mechanism that controls the attitude of the rotors has a hydraulically controlled break which also acts as a locking device.

Modern machines can operate at wind speeds of between 19 and 90km/h. The structures can withstand a hypothetical maximum load of 216 km/h.

The wind farm is monitored by computer from a central control room. Eventually it will operate in connection with a conventional power plant that has been erected on the same site.

On the day of the loss the wind was very gusty and was constantly changing direction. As one of the machines was turning to point into the wind, the breaking device failed. It was found in a subsequent investigation that the break shoes had closed too slowly because of a foreign body in the hydraulic circuit.

The three rotor blades of glass-fibre-reinforced plastic were therefore exposed to a very unfavourable angle of attack and became severely bent by the wind forces. One of the blades scraped against the tower and was totally ruined. Shortly afterwards the other two blades came into contact with the tower and were likewise destroyed. The impact transferred through the rotor hub to the turret was such that hardly any use could be made of the machinery afterwards.

The wind turbine had to be dismantled and was replaced with a new one. This involved costs of over US$200,000.

The hydraulic oil had been fed through filters on its way to the storage tank. It is assumed that the metal foreign body had already been in the tank or in one of the pre-assembled pipes when the parts arrived at the assembly shop.

This loss encouraged the operator to step up quality controls on arriving machine parts.

Achim Fehrmann, Madrid

Temple Insurance
A Member of the Munich Re Group

Wind Farms

Tropical cyclone in India causes major damage at refineries

Meteorological profile of the catastrophe

Cyclone 03A developed on 6th June 1998 from a tropical low-pressure system in the southeast of the Arabian Sea and steadily gathered in strength on its way north. On 8th June the storm attained its maximum intensity 500km west of Mumbai with peak wind speeds of 240km/h and was already much weaker when it finally hit land on 9th June near the town of Porbandar. Pictures of the damage caused suggest that the storm surge reached a height of 2-4m. Judging by the wind speeds and the duration of the storm, the waves must have been 5-6m high. The astronomic tide reached its maximum that day about three hours after the eye of the cyclone had passed. If these two events had occurred simultaneously, the water levels would have been even higher.

Destroyed wind turbines

The power of Cyclone 03A is clearly demonstrated by the damage to wind turbines. There are 782 installed in the state of Gujarat alone, primarily on the coast, with a total power output of 174 MW. The cyclone damaged about 260 of them. About half of them were torn down and destroyed. The partial damage mainly affected the rotor blades, hub components, and other machine parts. The property damage to the wind turbines and the connected transformers and power lines may run into eight figures. It is likely to be many months before the power supply in the region is completely restored to normal.

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The future at sea

Most of the sites that are suitable for wind farms in Germany have already been equipped with wind turbines. The construction of new plants on land is now confronted with increasing resistance from neighbours. For this reason, the operators and the federal government agree that the future of wind power plants is more likely to be in the sea.

Being located in the sea has two major advantages for wind farms:

- First, if they are far enough away from the coastline, they are hardly visible from the land and
- second, constantly strong winds at sea and larger plants guarantee optimum energy exploitation.

The question for insurers is whether the promising visions of offshore wind farms can also lead to profitable business because hardly any experience has been gathered on this kind of facility to date.

Between 1990 and 2001, for example, 78 wind turbines were erected in the North Sea and the Baltic; most of them were near the coast, but they only had a total output of 58mW.

The largest wind farm to date is located in the North Sea and already produces 160mW. Further plants with even higher overall performance are being planned, mostly in the North Sea, up to 50km from the coast and at water depths of up to 40m.

The foundations for the rotors are rammed 30m into the sea floor, while the tips of the rotors rise to a height of 150m above the sea surface.

Wind farms in the sea are exposed to the constantly changing stresses of the waves and wind; their erection and operations require a large amount of technological and financial input. In order to make sure that the investment pays off, a wind turbine is installed on each base with as large a capacity as possible. This means, however, that offshore installations must always be at the forefront of development; as yet it is not possible to test them in adequately on land. In one offshore park, for instance, the prototype for the 3.6mW turbines that were installed had gone into operation only the previous September!

How wind farms will survive severe storms is something that nobody can say in advance. Our experience with facilities on land has been varied. In India 40% of the wind turbines were crippled by a cyclone, whereas in Denmark only 13 older plants out of the country's total 3,500 were destroyed during the gale Anatol. A windstorm scenario developed by Munich Re with a recurrence probability of 100 years shows that the track of such a storm runs straight through the area in which offshore wind farms are planned. This is not surprising since investors seek out those areas where the wind is at its strongest.

The capacity of large wind farms also requires the construction of a transforming plant in the vicinity, i.e. in the sea. This is usually a platform weighing up to 1,000t, standing on stilts in the water. The platform is erected on land and then put in position using a floating crane.

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The future at sea - continued

Finally the generated energy is transported to the mainland sea cables laid on the ocean floor. Although these cables are entrenched in the sea bed or covered for protection, heavy ships' anchors may still get caught in them and cause damage. Over and above the fact that repairing a sea cable is a very expensive operation, the wind farm remains cut off from the grid on land during the repair work. This can lead to a prolonged business interruption. If such a loss occurs in a period of bad weather, the business interruption can last even longer – quite apart from the fact that the special vessels needed for this work may not be readily available.

Another question that has still to be answered is how wind farms will fare in a maritime climate over an extended period of time. Moist, salty air generally causes corrosion problems in machines and leads to difficulties with the insulation in electrical installations.

The accessibility of wind turbines has also proven to be anything but simple. In the winter it can take weeks before the weather permits access. Although the latest wind farm, Horns Rev off the Danish coast, is equipped with platforms onto which technicians can be lowered by helicopter, this is not an option for transporting heavy spare parts.

Repairing a turbine at sea is many times more expensive than repairing comparable damage on land. The special vessels that are needed involve one-off costs of €0.5M – €1M; added to this comes a daily rate of €50,000 to €100,000.

It remains to be seen how the peril of collisions with other vessels develops. After all, the German Bight is one of the world's busiest sea areas and many shipping routes pass through the middle of regions in which wind farms are planned.

In spite of all the difficulties involved, Munich Re stated from the very beginning that it was willing to support such plants with reinsurance and has developed special conditions from them. The experience gained in erecting the offshore wind farms Horns Rev and Nysted-Rodstand in Denmark can now be used in the insurance of further projects.

With a view to possible operational covers we are discussing the matter with insurers, manufacturers, and operators in order to devise a coverage concept that is commensurate with the risk.

Alfred Fackler, Munich