

# IMIA

## Insurance of Wind Turbines - Update

Update on Report July 1999 (IMIA – WGP5 (99) E) (C. Jakobsen, H. Reymann-Carlsen, J. Boogaard, A. Martin Martin and N. Kragelund, B. Balschmidt, Danish Insurance Association)



Offshore park Middelgrunden, Denmark, 20 2MW Turbines

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IMIA Conference – 2002

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## 1. Introduction

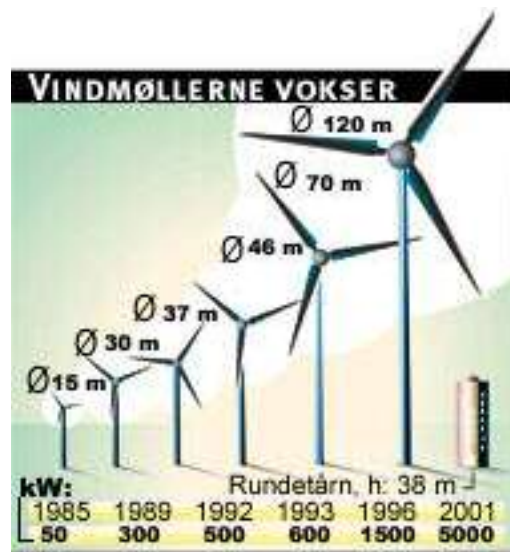
In 1999 the Danish Insurance Association published a report, Insurance of Wind Turbines (IMIA – WGP5(99) E. The report examined existing wind-turbine technology, the basis on which insurance is contracted, claims experience, claims-prevention measures and existing certification schemes. Since the appearance of that report, wind turbines have become more and more common, and offshore installations in particular have been built in large numbers. At the same time, new types of turbines have been developed. This situation poses a new challenge for the insurer, who is requested to afford the wind-turbine owner financial security in the event of sudden and unforeseen breakdowns.

Wind-turbine owners must weigh up a number of difficult options when they invest in new wind turbines. New technology enables them to optimise operations but a lack of operational experience can impose a risk of claims. The other side of the coin is the older but tried and tested technology whose claims profile is known but which may not make optimum use of the available production possibilities. The dilemma facing insurers is that they must insure both the well-known technology and the new, less familiar wind-turbine designs.

This update to the earlier wind-turbine report will focus on the new wind-energy technologies, on the special problems associated with offshore installations, and on the claims experience accumulated by Danish insurers.

## 2. New wind-turbine technology

Production and installation of wind turbines have increased substantially since the 1999 report was published. Turbines continue to increase in size. Wind turbines with an output of 2.5 MW are already in serial production, and turbines with 5 MW or so will also soon be in serial production.



**Wind Turbines gets bigger**

(image from Ingeniøren)

The most remarkable aspect of the situation is perhaps not the size or number of turbines installed but the fact that so many projects now involve offshore wind farms off the coasts of Europe.

Technological development is hardly innovative. The principal advance lies in technical improvement – particularly of bearings and gears.

Another trend is for established technology in the field of systems monitoring to be applied to wind turbines – especially to offshore turbines. These involve in particular vibration and temperature controls to permit the control centre to reduce wind-power production or to stop the turbine completely to prevent major damage occurring.

### 3. Offshore installations

The number of new offshore wind-turbine projects is growing rapidly. And projects are getting bigger and bigger. The largest projects produce 500 MW of power, and investment is of a similar magnitude to the cost of building a modern, conventional power station.

The difference, however, is that the power station is based on wind energy – and it is located 15-20 km from the shore.

Projects are currently in the pipeline for wind farms 100 km from land at depths of 20-30 meters. Today, it is only the cost of transmitting the power that limits where offshore wind farms can be sited. Design and structural considerations no longer represent this type of limitation.

Offshore wind farms impose great demands on design, construction methods, service and maintenance. Consequently, design engineers and contractors must be able to prove a special combination of skill, experience and inventiveness. Professional investors setting up major new offshore wind farms expect their consultants and construction companies to satisfy many, very specific requirements – and they often satisfy themselves that the project can be insured both during the period of construction and after expiry of the warranty period. For this reason, it is more and more usual for insurance companies to have the opportunity to follow the project right from the outset. In these circumstances, it is important that decisions are made on the basis of what you KNOW, not what you THINK.

What standards should the insurance industry set for offshore wind farms?

A number of factors are highlighted below which may be regarded as significant. The list is not exhaustive but focuses on points for which the manufacturer should have a proven, documented solution.

- The wind turbine must be designed for offshore operation. Every single component, large or small, must be suitable for offshore use – high humidity, high salt content in the air, powerful pulsating dynamic loads, and high energy content in the air.
- Documentation must be provided to prove that each wind turbine complies with the builder's specifications and that the lifetime of components is also documented.
- The wind turbine must be tested on shore.
- It must be guaranteed that there are no defects in components or assembly BEFORE the turbine is installed offshore.
- The wind turbine must be easy to service and maintain. In other words, that service inspections can be limited, for example, to once a year.
- Gears must be easy to maintain, and replacement of components must be possible without removing the whole gear assembly. Gear lubrication must be optimum; this should include forced lubrication of all bearings and gear cogs, with conditioned oil being fed to critical points and harmful particles removed by filtration. The installation should be fitted with both inline and offline filters. Filtration of gear oil should ensure a purity of 17:15:12.
- The oil-conditioning system must be tested on the gear, proving that the system complies with the manufacturer's temperature, purity and quality specifications.
- Noise, vibration and running in of cog flanges must be documented.

- Space, crane facilities must be optimum; replacement of major components must be easy.
- Service and inspection, for example, of internal components within the gear must be possible in a simple, uncomplicated manner.
- As in so many other situations, choosing the right contractor is extremely important. An experienced contractor with people experienced in offshore work is worth his weight in gold!
- Having the right installation equipment and materials is a MUST!
- There is a world of difference between building a wind farm on land and building one offshore.

Monitoring offshore wind turbines is a science all of its own.

Monitoring must be comprehensive, and monitoring systems should be duplicated or triplicated to avoid a situation in which a fault in the monitoring system causes unnecessary shut-down of the turbine. Monitoring should include, for example, temperature, vibration, oil flow, oil level, power generation, arc detection on switchboards, transformer, generator terminal box, wind and weather.

A solitary monitoring component must not be capable of shutting down an offshore wind turbine. It is too costly an affair to have a turbine out of commission for perhaps several weeks on account of a minor defect, bearing in mind that a medium-size offshore turbine generates power worth approx. EUR 1,500 per day. It must be realised that it is not unusual for bad weather to prevent a maintenance visit to the wind turbine for 2-3 weeks.

The cost of hiring a floating crane or similar equipment necessary for replacement of large components can easily be in the region of EUR 40,000 per day.

The worst possible scenario is if one of the underwater cables connecting the offshore wind farm to the mainland is breached by trawling or a marine accident. In such a situation a whole wind farm is prevented from delivering its power to the mainland. The cost of re-establishing the marine cable and the bill for consequential loss can be astronomical.

Fortunately many wind-farm investors are extremely professional and possess great technical insight. They seek a high degree of security by laying down strict product specifications, exercising their own quality control, and demanding ease of maintenance. There are examples of investors and their staff of consultants stipulating more than 50 modifications in design and execution. Demands which must be complied with, if a contractor is to be awarded the contract.

#### 4. Insurance claims/damage experience

The general claims picture has changed little since the 1999 report. There have, however, been a number of consequential-loss claims after warranty repairs. Consequential loss has arisen after an occurrence of physical damage which was covered by the turbine manufacturer's warranty. See also section on serial defects.

With the building of offshore wind farms, damage to these will naturally occur. The cost of repairing damage to offshore wind turbines can be substantial as it requires special-purpose equipment, and the repair process can be difficult and lengthy.

A specific example: a fire broke out in an offshore wind turbine.

The entire nacelle was destroyed by fire, and there was damage to the upper tower section and blades.

The cost of repairing the damage and consequential loss is estimated at EUR 2 mill., of which approx. 30% was for the hire of equipment necessary for carrying out the repair.

It has been established with great certainty that the cause of the damage was a fault occurring at the time of installation, made by the contractor who erected the turbine.

##### *4.1 Serial defects*

In 1996 and 1997 600-kW and 750-kW wind turbines were very popular, and manufacturers sold them in large numbers. These turbines still sell well, but the market is urgently demanding the development of new, larger wind turbines – and developments are moving at rather a frightening rate. Operating experience with the new turbines has not yet been registered and digested – yet the next generation of turbine is already in production.

Unfortunately, after a few years of operation, many of the 600-kW and 750-kW wind turbines turned out to suffer from defects and errors in design, manufacture or post-installation. A lot of faults occurred in gear and on blades. Claims were usually covered by the manufacturer's warranty. The cost of repairing damage caused by defects and errors was extensive.

At an earlier stage of its development, the wind-turbine industry was plagued by serial defects – but it was nothing compared with the current high level.

Repairing damage to gears and blades, in addition to being expensive, is often a very complex process. Large cranes are necessary, and replacing large components requires good – not windy – weather conditions.

The cost of repairing serial defects was (and still is) a very heavy burden on the wind-turbine industry and its suppliers. Only the largest wind-turbine manufacturers can overcome the economic problems and find acceptable technical solutions.

Some manufacturers are finding that the job of repairing serial defects is continuous.

There is no doubt that serial defects will occur in future production but it is to be hoped that manufacturers and their suppliers will have learned their lesson. Turbine manufacturers and their suppliers have invested enormous resources – both manpower and money – in eliminating the possibility of future serial defects.

Skimming through the past 20 years of wind-turbine history indicates that there have always been serial defects – perhaps more correctly referred to as “development defects”.

But much has been done to improve quality through national approval schemes, international standardisation work, and ISO 9000 certification of wind-turbine manufacturers. Despite these factors, however, it is surprising that so much damage occurred to gearboxes as was the case with 600-kW and 750-kW turbines.

What has the insurance industry learned?

These are some of the products of our experience:

- that conservative design is good.
- that good-quality craftsmanship in manufacture and assembly is essential.
- that careful quality control of both the incoming products of suppliers and the outgoing finished product is essential.
- that the management of wind-turbine manufacturing companies must react quickly and competently at the first signs of serial defects.
- that the wind-turbine manufacturer must have the will, skill and economic wherewithal to handle serial defects.
- that even though wind-turbine technology is becoming more common, it still requires a considerable effort on the part of insurers’ engineering departments to handle underwriting and claims processing.

## 5. Conclusions

The wind-turbine industry is in a state of rapid expansion – not in the form of major technical advance but involving the development of larger and larger turbines. Turbines with a capacity of 5 MW will soon be in serial production. Many old, smaller turbines will be replaced by fewer and larger turbines.

To harness as much of the wind’s energy potential as possible, there is a move towards more and more offshore wind farms. These are now being built 100 km from the mainland at depths of up to 30 m. The construction of offshore wind farms imposes increasing demands upon the technical characteristics of the individual turbine because maintaining and repairing offshore turbines is so much more complex. Monitoring equipment must cover every aspect of the problem, and steps must be taken to ensure that monitoring equipment itself does not halt the turbine. This can be achieved, for example, by duplicating detection systems.

Investors must be very wary in their choice of advisers and contractors. The investor must also be able to rely upon his own staff of qualified technical experts, who can assist with both the planning and operational stages. All equipment must be tested before assembly and installation.

Danish insurers have seen extensive serial defects, for example, in gearboxes. These serial defects were “fortunately” warranty repairs – regrettably inflicting heavy financial costs on the manufacturers concerned.

Serial defects/development defects can be avoided or minimised if there is comprehensive quality control, if the investor opts for well-tested and proven products, and if consultants are used who have a broad range of know-how and experience in the field.

## 6. Examples of interesting Internet information

[www.ewea.org](http://www.ewea.org)  
(The European Wind Energy Association)

[www.wind-energie.de](http://www.wind-energie.de)  
(The German Wind Energy Association)

[www.ens.dk](http://www.ens.dk)  
(The Danish Environmental and Energy Ministry)

[www.windpower.dk](http://www.windpower.dk)  
(The Danish Wind Turbine Manufacturers Association)

[www.bwea.com](http://www.bwea.com)  
(the British Wind Energy Association)

Search: [www.google.com](http://www.google.com)  
Type: Wind energy  
Wind Turbine

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