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Datasheet for the decision of 27 June 2022

Case Number: T 0004/20 - 3.2.04

Application Number: 10732719.9

Publication Number: 2593670

IPC: F03D1/06

Language of the proceedings: EN

Title of invention:
WIND TURBINE BLADE WITH NARROW SHOULDER AND RELATIVELY THICK AIRFOIL PROFILES

Patent Proprietor:
LM WP Patent Holding A/S

Opponents:
Hutchinson, Thomas Owen
Nordex Energy GmbH

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - (no)

Decisions cited:

Catchword:

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Beschwerdekammern

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Case Number: T 0004/20 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 27 June 2022

Appellant (Opponent 1)	Hutchinson, Thomas Owen 2 Breeze Road Birkdale Southport PR8 2HG (GB)
Appellant: (Opponent 2)	Nordex Energy GmbH Langenhorner Chaussee 600 22419 Hamburg (DE)
Representative:	Hauck Patentanwaltspartnerschaft mbB Postfach 11 31 53 20431 Hamburg (DE)
Respondent: (Patent Proprietor)	LM WP Patent Holding A/S Jupitervej 6 6000 Kolding (DK)
Representative:	COPA Copenhagen Patents Rosenørns Allé 1, 2nd floor 1970 Frederiksberg C (DK)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 4 November 2019 concerning maintenance of the European Patent No. 2593670 in amended form.**

Composition of the Board:

Chairman	A. de Vries
Members:	S. Oechsner de Coninck
	K. Kerber-Zubrzycka

Summary of Facts and Submissions

I. The proprietor and both opponents filed appeals against the interlocutory decision of the Opposition Division of the European Patent Office concerning maintenance of the European Patent No. 2593670 in amended form.

II. In its written decision the opposition division held that the patent as amended according to the auxiliary request 2 met the requirements of the EPC, having regard in particular to the following documents:

E1: K. K. Jin et al.,"Life Prediction of Wind Turbine Blades", International Conference on Composite Materials (ICCM) 17, Edinburgh 27-31 July, 2009;
E17: D.M. Somers,"The S816, S817, and S818 Airfoils", NREL National Renewable Energy Laboratory, October 1991 -July 1992;
E20: P.S. Veers et al.,"Trends in the Design, Manufacture and Evaluation of Wind Turbine Blades", Wind Energy, July 2003.

III. In a communication of 20 January 2022 in preparation for oral proceedings the Board gave a provisional opinion on the relevant issues.

IV. Oral proceedings were held on 27 June 2022 in the form of a videoconference. At the oral proceedings the proprietor withdrew their appeal; all requests except auxiliary request 3 corresponding to auxiliary request 2 as upheld were also withdrawn.

V. The appellants-opponents 1 and 2 request that the decision under appeal be set aside and the patent be revoked.

VI. The respondent (proprietor) requests that the opponents' appeals be dismissed.

VII. The wording of claim 1 as upheld is as follows:

"A blade (10) for a rotor of a wind turbine (2) having a substantially horizontal rotor shaft, said rotor comprising a hub (8), from which the blade (10) extends substantially in a radial direction when mounted to the hub (8), the blade having a longitudinal direction (r) with a tip end (16) and a root end (14) and a transverse direction, the blade further comprising:
- a profiled contour including a pressure side and a suction side, as well as a leading edge (18) and a trailing edge (20) with a chord having a chord length (c) extending there between, the profiled contour, when being impacted by an incident airflow, generating a lift, wherein the profiled contour is divided into:
- a root region (30) having a substantially circular or elliptical profile closest to the hub,
- an airfoil region (34) having a lift-generating profile furthest away from the hub, and
- a transition region (32) between the root region (30) and the airfoil region (34), the transition region (32) having a profile gradually changing in the radial direction from the circular or elliptical profile of the root region to the lift-generating profile of the airfoil region, and with
- a shoulder (40) having a shoulder width (W) and located at the boundary between the transition region (32) and the airfoil region (34), wherein
- the blade (10) has a blade length (L), and
- the profiled contour comprises a local relative thickness defined as the local ratio between a maximum

profile thickness (t) and the chord length (c), characterised in that
- the ratio between the shoulder width (W) and the blade length (L) being less than or equal to 0.075,
- the relative thickness (t/c) in a blade length interval of 0-0.8L is at least 22%, and
- the wind turbine blade is prebent towards the pressure side of the blade, and a prebend (Δy) at the tip end of the blade is at least 0.05L."

VIII. The appellants (opponents 1 and 2) argued as follows:
Starting from either E1, the skilled person would use the teaching of E20 to provide a thicker profile up to 80% of the length and provide the necessary prebend in a tip region to avoid blade strike.

IX. The respondent (proprietor) argued as follows:
Starting from E1 the skilled person would have no obvious incentive to enlarge the thick portion beyond 75% of blade length or to provide any prebend tip for the wind turbine blade.

Reasons for the Decision

1. The appeals are admissible.

2. Inventive step

2.1 Public availability and disclosure of E1

In its communication in preparation for the oral proceedings, see section 3.1, the Board gave the following provisional opinion on the question of public availability of E1:
"*E1 is a scientific paper published in the year 2009 as evident from E1A, and presented at the ICCM conference*

in Edinburgh on 27 July 2009 as evident from E1B. Absent any evidence to the contrary, the Board has no reason to doubt the veracity of E1A and E1B. It therefore finds that E1 was made available before the relevant filing date on 16 July 2010 of the present patent."

As the now respondent proprietor did not provide any further arguments on this particular question, the Board does not see any reason to depart from its provisional assessment.

2.1.1 E1 on page 3, section "aerodynamic design" discloses a wind turbine blade topology depicted in figure 2 on the same page and having a distribution of NREL S-series airfoil aerodynamic profiles S816/S817/S818 along the blade length. The characteristics of each profile is given in reference [6] corresponding to E17, see table I, page 12.

The blade has a shoulder width derivable from table 1, figure 1(a) and the last paragraph on page 2 that at 5.12 m is less than 0,07 of rotor radius of 73.1 m. Even if the rotor radius - because it includes the hub - is somewhat larger than the blade length, then, assuming a realistic hub radius of 2 m, the width disclosed in E1 is nevertheless less than 0,075 of blade length as specified in claim 1. The blade's aerodynamic design is described at the top of page 3 in reference to E17. It has a high relative thickness t/C of 24% in the inner S818 portion between 25% and 75% r/R , see E17, page 12, but in the next portion, from 75% to 90% with profile S816 it has a relative thickness of 21%. Therefore it does not meet the final requirement of claim 1 that in the blade length

interval up to 0.8L, i.e. up to 80% r/R, relative thickness is at least 22%.

It is true that in the blade of E1 there has to be a gradual transition in relative thickness from 24% for the aerodynamic profile S818 extending up to 75% of the blade and the profile S816 between 75% and 90% that has the somewhat lower thickness of 21%. However the Board does not consider the transition to extend over a very large section of the span of the blade. Thus, the respective aerodynamic profiles S816, S817 and S818 will be present across most of their associated blade portions, with relatively small transition zones between adjacent portions. In the transition zone between the S818 (middle section) and S816 (tip) profiles, located around 75% radius (74% blade span assuming a hub radius of 2 m) relative thickness drops from 24% to 21%. Most likely it will still be above 21% in that part of the transition zone beyond 75% radius (74% span). However, it can certainly be said that in most of the short section from 74% to 80 % span relative thickness is 21%, just short of the 22% claimed.

As also visible on the airfoil stacking sequence in figure 2 (a) of E1 the blade is not prebent towards its pressure side.

2.1.2 The subject-matter of claim 1 thus differs from E1 by the features of at least 22% relative thickness until 80% of blade length, and a prebend of at least 0,05 of blade length at the tip.

2.2 Technical effects; partial problems

2.2.1 As concerns the first feature of increased thickness in the outer portion of the blade up to 80% of its length, any associated objective technical effect must be determined over and above that of the slender design with shorter shoulder width which is already present in the blade of E1. The marginal increase from 21% to at least 22% is said to make the blade stiffer due to the load carrying structure being spaced further apart which means that the blade shell can be made thinner (specification paragraph 0006, 3rd sentence onwards). This can be used to produce a blade of equal or increased stiffness at reduced mass.

2.2.2 Prebending of the blade towards its pressure side on the other hand allows the blade to curve away from the tower when installed on the wind turbine , cf. specification paragraph 0008. This compensates for bending of the blade due to the force of the wind towards the tower, which might cause tower strike. Thus at design speed the blade is straightened and its swept area maximized. As explained in specification paragraph 0008, because the blade is allowed to bend it need not be so stiff and material amount and blade load can be reduced.

2.2.3 The respondent considers the slender design, increased thickness and tip prebend to interact synergistically to produce surprisingly significant increase of 4% in AEP (annual energy production) mentioned in specification paragraph 0071 and indicated by the hatched area 82 in figure 9 of the patent.

The Board is unconvinced. It rather agrees with the appellants that it is not plausible that the stated increase of 4% arises from this difference alone. Nor does figure 9 represent plausible evidence for a gain

in AEP that is due to these design modifications alone. Firstly, figure 9, which is dimensionless, is clearly of a purely schematic nature as also indicated in paragraph 0071. As such it does not show empirical data derived from comparative measurements or simulations. Moreover, as stated in paragraph 0071, the figure is meant to show the power output (as function of wind speed) of a wind turbine provided with prior art blades with that of a turbine with blades according to the invention. Absent any indication to the contrary, it can be safely assumed that this comparison will be based on the same two blades as in figures 5 to 8, comparing various parameters of a prior art blade and of an inventive blade, namely shoulder distribution (figure 5), thickness distribution (figure 6), twist stacking (figure 7), and prebend distribution (figure 8). The prior art blade is the *LM 40.3 P*, which according to paragraph 0065 has a length of 40.0 m , while the example blade according to the invention is denoted *LM 42.1 P*, with a length of 42,13 meters (paragraph 061). The example blade is thus a good 5% longer than the prior art blade which most likely accounts for the 4% AEP mentioned in the last sentence of paragraph 0071.

2.2.4 Therefore absent any further convincing evidence that the increased thickness and prebend combine to provide a significant unexpected effect on the annual energy production, the alleged effect has not been made plausible to the Board. Such an advantage cannot be taken into consideration in respect of the determination of the problem underlying the invention (Case Law of the Boards of Appeal, 9th edition 2019, Chapter I.D.10.9).

The Board rather considers the differences of at least 22% thickness up to 80% of the length on the one hand and a tip prebend of at least 5% of blade length on the other to represent two adaptations of blade design that are separate in nature and which have separate and independent effects. This is evident already from the fact that an increase in relative thickness in the outer blade area is primarily associated with increased stiffness, while the main concern of prebend is tower strike and presupposes reduced stiffness. Consequently, the two differences can be assessed independently of one another for inventive step, by the formulation of respective partial problems, cf Case Law of the Boards of Appeal, 9th edition, 2019, Chapter I.D.9.2.

2.3 Increased relative thickness

2.3.1 The Board formulates the associated objective technical problem addressed by this first difference as further increasing the stiffness of a wind turbine blade as in E1.

2.3.2 E20 is a review article on "Trends in the Design, Manufacture and Evaluation of Wind Turbine Blades" published in 2003 and is seen to reflect common general knowledge in the design of wind turbine blades. In its communication in preparation for the oral proceedings, see section 3.3, the Board indicated its provisional opinion on the admission of E20 as follows:

"The appellant proprietor contests the admission of E20 by the opposition division. The Board observes that the OD correctly exercised its discretion to admit E20, using the right criteria of prima facie relevance (item 12.6 of the decision) and did so after duly hearing the parties. It thus sees no reason to overturn this

discretionary decision. This is all the more so as there is no legal basis or precedent for unadmitting a document on which a decision under appeal is based."

As the now respondent proprietor did not provide any further arguments on this particular question, the Board does not see any reason to reconsider the admission of E20.

2.3.3 On page 252, last paragraph, in the chapter "Some anticipated Trends in Design concepts" the section "blade geometry" E20 in particular suggests increasing thickness in the region near 75% span as very effective in providing stiffness at least weight and cost, with the overall aim of retaining high lift to drag ratio L/D with increased relative thickness. As held by the opposition division in its decision for granted claim 1, section 12.7, the skilled person would consider the teaching of E20 as representing a general trend in the design of large blades which they would continue to pursue.

The Board is unconvinced that E1, merely because it was published some years after E20, would represent the culmination of those design trends and thus the end of the road for the skilled person. The skilled person is always intent on further improvement, though any such improvement will be within the boundaries of their limited skills and abilities.

Nor does E20's teaching apply only to short blades; as is evident from its introduction E20 is concerned with growth trends and how to design ever longer blades, up to 120m diameter, and the Board does not see why the skilled person would not want to apply its insights to even longer blades.

2.3.4 In this case, as noted, relative thickness of the E1 blade is only marginally less than claimed in a short section of blade span between 74% and 80%. In the Board's view in particular absent any associated surprising or special effect, this marginal difference can but be the result of continuing effort by the skilled person to apply and optimize the teaching of E20. In performing such routine optimisation the skilled person, in the Board's view, would as matter of obviousness also consider trying relative thickness values beyond 21% in that short section between 74% and 80% of the blade length. As explained above, that a slight increase from 21% to 22% in the region beyond 75% at 80% r/R would lead to a surprisingly significant increase in AEP (beyond what might be expected) as stated in specification paragraph 0006 has not been plausibly demonstrated.

The Board concludes that, as held in the decision, the feature of at least 22% in the blade section up to 80% does not involve an inventive step.

2.4 Prebend

2.4.1 It is undisputed that prebending is a well-known measure to prevent tower strike, as also recognized as such in the patent itself, see specification paragraph 0069 and figure 8. Figure 8 indeed gives a value of 0.05L for the prebend of the prior art blade LM 40.3 P, i.e. within the claimed range. The respondent did not dispute that this blade is a well-known prior art blade.

As the claimed blade adopts this known measure to the same effect in the same measure, already in the light of the acknowledged prior art but also in view of E20,

the Board can but conclude that this feature lacks inventive step. As above, no special effect associated with this feature has been plausibly demonstrated. Insofar as it can be associated with an increase in AEP that will be the inevitable result, a bonus effect, of the obvious application of this measure.

2.4.2 Alternatively, the measure is also discussed in E20, page 253, 1st paragraph as known to provide increased tower clearance, but does not mention any values. As above the skilled person starting from E1 and in the light of E20 would adopt this measure as a matter of obviousness. As discussed in relation to the first difference, without any plausibly demonstrated, associated effect the amount of prebend is then the result of routine optimization. This is all the more so as the skilled person is well aware of the law relating increase of the deflection with the cube of the length, also expressed in E20, paragraph 1 of page 249. A longer blade will thus need even more prebend.

2.4.3 The decision, pages 16 and 17, argued that because E20 described prebending as an "alternative" to increased relative thickness in the outer blade span for preventing tower strike, it would teach away from combining the two measures. In the Board's understanding the term "alternative" merely indicates that it is *another* measure; it does not of itself imply that they are mutually exclusive. Nor is this apparent from their nature. Stiffness and flexibility may be complementary concepts, this does not imply that the two measures which pursue different aims are contradictory.
For example a prebent blade must still be sufficiently stiff: that requisite stiffness can be achieved at lower weight and cost by increasing thickness in the

75% span. Conversely, increasing thickness in the 75% span can be used to make a longer blade without raising cost, weight or stiffness. A longer blade will however require increased tower strike counter measures, such as a bigger prebend.

2.4.4 The Board thus finds, contrary to the decision under appeal, that prebending towards the pressure side at 5% of the blade length at the tip, also does not involve an inventive step.

2.5 As the differences of increased relative thickness and prebend do not involve inventive step, alone or in combination, the Board concludes that the subject-matter of claim 1 likewise does not involve an inventive step in the light of the prior art cited as required by Articles 52(1) and 56 EPC.

3. The appellant opponents succeed in their appeals by demonstrating that she patent in the amended version upheld fails to meet the requirements of the EPC. Pursuant to Article 101 (3)(b) EPC the patent must then be revoked.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

G. Magouliotis A. de Vries

Decision electronically authenticated