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**Datasheet for the decision
of 25 September 2012**

Case Number: T 1965/09 - 3.2.04

Application Number: 99953725.1

Publication Number: 1230479

IPC: F03D 7/00, F03D 11/00

Language of the proceedings: EN

Title of invention:

Method of controlling the operation of a wind turbine and wind turbine for use in said method

Patentee:

Vestas Wind Systems A/S

Opponent:

ENERCON GmbH

Headword:

-

Relevant legal provisions:

EPC Art. 100(a)(b), 54(2), 56, 83

Keyword:

"Novelty - main request (yes)"
"Inventive step - main request (yes)"
"Sufficiency of disclosure (yes)"

Decisions cited:

-

Catchword:

-



Case Number: T 1965/09 - 3.2.04

D E C I S I O N
of the Technical Board of Appeal 3.2.04
of 25 September 2012

Appellant I: Vestas Wind Systems A/S
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Decision under appeal: Interlocutory decision of the Opposition
Division of the European Patent Office posted
24 July 2009 concerning maintenance of the
European patent No. 1230479 in amended form.

Composition of the Board:

Chairman: T. Bokor
Members: A. de Vries
P. Petti

Summary of Facts and Submissions

- I. Both the Opponent and the Proprietor lodged appeals against the interlocutory decision of the Opposition Division posted 24 July 2009 on the amended form in which European Patent No. 1 230 479 can be maintained.

The appeal of Opponent was received 30 September 2009 together with payment of the appeal fee. The statement setting out the grounds followed on 3 December 2009.

The Proprietor filed his appeal on 30 September 2009 together with payment of the appeal fee. The statement setting out the grounds was received 1 December 2009.

- II. Opposition had been filed against the patent as a whole and was based, amongst others, on Article 100(b) for insufficient disclosure and Article 100(a) together with Articles 52(1) and 54 EPC for lack of novelty, and together with Articles 52(1) and 56 EPC for lack of inventive step.

The Opposition Division held that the subject-matter of granted claims 1 and 7 though novel, did not involve an inventive step, but that the patent as amended according to a first auxiliary request met all the requirements of the EPC. In its decision the division considered the following documents:

E3: DE-A1-197 31 918

E7: DE-A1-30 09 922

E9: E. Hau: "Windkraftanlagen", Springer-Verlag, Berlin 1996, pages 80 to 91.

III. The Appellant-Opponent requests that the decision under appeal be set aside and the patent be revoked in its entirety.

The Appellant-Proprietor requests, as main request, that the decision under appeal be set aside and that the patent be maintained as granted, or in the alternative, that the patent be maintained in amended form according to one of auxiliary requests 1 to 5 filed with letter of 17 June 2010.

IV. Oral proceedings were duly held before the Board on 25 September 2012.

V. The wording of the independent claims as granted (main request) is as follows:

1. "Method of controlling (4) the operations of a wind turbine (1) comprising a rotor (2) with a number of blades mounted for rotation about a mainly horizontal axis (3), said method comprising
a) controlling (4) the pitch of the blades of the wind turbine (1) in dependence on measured parameters in order to optimize the operation of the wind turbine (1) with respect to produced energy under varying weather and wind conditions, and
b) measuring (7,8) mechanical loads on the blades, characterized by further comprising
using the measured (7,8) mechanical loads to calculate the positions of the blade tips and adjusting the control (4) of the wind turbine (1) in order to maintain a certain safety distance between the blades and the tower (5)."

7. "Wind turbine (1) for use in a method in accordance with any of the preceding claims, comprising

- a rotor (2) with a number of blades mounted for rotation about a mainly horizontal axis (3),
- means (4) for controlling the pitch of the blades in dependence on measured parameters,
- mechanical load sensors (7,8) mounted to measure the mechanical loads on the blades and connected to influence the means (4) for controlling the pitch of the blades,

characterized by the mechanical load sensors (7,8) being connected to a controller (4) comprising means for calculating the positions of the blade tips and influencing the control (4) of the individual blade pitch angles in order to maintain a certain safety distance between the blades and the tower (5)."

VI. The Appellant-Opponent argued as follows:

The claims are broadly worded, such that any pitch control that strives to limit the load during strong winds must fall within its terms. It does not require any specific calculation, or any particular parameters, nor is there any link between the calculation and control adjusting features. The final feature applies to any control that maintains a safety distance.

The pitch control in E7, which is to avoid maximum allowable blade bending, thus falls within the claim's terms. Underlying E7's approach is a correlation between load, bending and blade position. This correlation surmises some form of calculation, for example a correspondence table.

Claim 1 also applies to small wind speeds, below nominal power where the blade is still unpitched, and bending is towards the tower and thus directly correlated with the distance of blade to tower.

The final feature of claim 1 does not require that the calculated blade tip position is actually used to adjust the control, nor can it be interpreted that way. Any passages in the specification cited to support this view have been added during examination and cannot therefore be relied on.

As for inventive step, calculating blade tip position addresses the problem of maintaining a safety distance. This is a problem encountered in any wind turbine, and normally flows into its design. It underlies the concern in E3 and E7 to optimize the wind turbine and avoid excessive loads. That is why they focus on blade bending, and is most clear in E7's express mention of a maximum allowable blade bending. That can only be related to avoiding collisions between blade and tower. Material failure due to excessive bending is not a realistic concern for normal operating conditions and turbine designs.

In order to maintain a safety distance there is a choice between only two alternatives: measurement or calculation. Choosing one or the other does not involve an inventive step.

The patent does not explain in any detail how exactly to perform the calculation of blade tip position which involves various factors. Even if the skilled person, a control engineer, were familiar with beam bending

theory or finite element analysis, these factors and the fact that the system is dynamic not static means that their application goes far beyond his average skills.

Moreover, the effects shown in part B of the graph of figure 2 cannot be achieved. In the partial load region of operation, before wind speed reaches nominal power level, the blades are unpitched and power is optimal. It is not possible to produce better than optimal power. This is only possible by altering the design, and cannot be achieved by adjusting control. Any benefit lies in part D of the graph but this is already done.

VII. The Appellant-Proprietor argued as follows:

The invention departs from the usual idea of only looking at loads and bending. What is of real interest is the blade tip position with respect to the tower. By focusing on blade tip position, under certain circumstances the blade may pass the tower at a smaller distance than when based on load alone. As a result blades can be designed to be less rigid. The claimed invention is more than a simple alternative to the systems of E3 or E7, but adds a level of sophistication over these load oriented approaches.

The skilled person has not realized the need to know the blade tip position. Neither E3 nor E7 disclose or suggest in any way calculating blade tip position or using the calculated value to adjust control in order to maintain a safety distance. They focus only on mechanical load and bending. In E7 setting a maximum on

allowable blade bending avoids loads that in the long term lead to material failure.

That the calculation of the blade tip position flows into the adjustment of pitch control follows from specification paragraph [0011] linking variation of the safety distance to deduced tip position. Whether or not other supporting parts of the patent have been unallowably amended is not open to debate as Article 100(c) has not been raised, nor is consent given to discuss this new ground.

That the claimed invention would be insufficiently disclosed has not been substantiated by any evidence. In this respect the opponent carries the burden of proof and none has been provided that beam bending theory and finite element analysis would not belong to the skilled person's common general knowledge. Rather they are commonly employed by mechanical engineers in solving structural analysis problems.

Figures 2 and 3 of the patent are not based on empirical data, but are merely meant to illustrate and possibly exaggerate potential benefits.

Reasons for the Decision

1. Both appeals are admissible.
2. *Background & Claim Interpretation*
 - 2.1 The patent is concerned with the control of blade pitch angle in a wind turbine to take into account varying

wind conditions. This is normally done by measuring mechanical load on the blades. The underlying idea as expressed in method claim 1 is to use the measured mechanical loads to *calculate the positions of the blade tips* and *adjust the control* of the wind turbine *in order to maintain a safety distance between the blades and the tower*. Claim 7 directed to the wind turbine has the controller comprising corresponding means for *calculated blade tip position* and *influencing the control of blade pitch in order to maintain the safety distance between blade and tower*.

2.2 Claim 1 or 7 may not recite how exactly blade tip positions is to be calculated from the mechanical loads. Nevertheless, it is clear that this feature requires the execution of a distinct step in the method of claim 1, and the presence of corresponding means in the controller in the device of claim 7, which produces as output a calculated value for blade tip position from input measured loads.

2.3 As regards the final feature, defined variously in claims 1 and 7, this is interpreted by the Board as meaning that pitch control is effected using the calculated blade tip positions. This follows from a genuine attempt to make technical sense of the wording of the claims, when read contextually and against the backdrop of the rest of the patent of which they form an integral part. Thus, claim 1 may not expressly mention which control is adjusted, a technically meaningful reading of the claim means that this can only reasonably refer back to the only control specifically mentioned elsewhere in the claim, at feature a), namely pitch control. This is confirmed

when reading claim 1 together with claim 7, which does mention pitch control in the final feature.

- 2.4 Similarly, reading claim 1 or 7 in a technically coherent manner the Board finds that that the two final features should be understood as linked. As the distance of blade to tower is determined by the position of the blade tip and the final feature's purpose is to maintain that distance at a safe value it stands to reason that the calculated blade tip position output in the first step is used in the subsequent control step to maintain that safety margin. This understanding of the claim is in particular also borne out when reading the granted patent as a whole. It is stated expressly in specification paragraph [0006], lines 9 to 16, and again in paragraph [0010].

Admittedly, these specific passages do not appear in the application as filed and, by adding them to possibly clarify what was before unclear and ambiguous in the original disclosure, subject-matter may arguably have been added. However, this ground, which under Article 100(c) can be raised against any extension of subject-matter beyond the content of the application as filed, was not previously raised. As the Appellant-Proprietor expressly withholds its consent, the Board cannot consider the issue pursuant to G 1/95 (OJ EPO 1996, 615). In the Board's view this bar is absolute, meaning that the issue may not be considered directly, nor may it be allowed to affect indirectly the consideration of other issues. In interpreting the claims the Board therefore sees itself bound to doing so in the light of the description and figures of the

patent specification of which the claims now form an integral part.

As for specification paragraph [0011] cited by the Appellant-Proprietor and unchanged with respect to the application as filed, this passage teaches nothing more than that the safety margin to be maintained by the pitch control can be varied or adjusted depending on the known instant wind character. This does not necessarily mean that the pitch control itself is varied depending on calculated tip position.

2.5 Finally, the Board reads the formulation "maintain[ing] a certain safety distance between the blades and the tower" used in claims 1 and 7 in its usual sense of not allowing the blades and tower to come nearer than that safety distance. The safety distance thus sets a lower limit on the separation of blades and tower.

3. Novelty

3.1 Novelty has been called into question with respect to E3 and E7. In deciding this question the Board reads the claims as indicated above.

3.2 E3 and E7 are indisputably concerned with controlling pitch in response to measured load in particular to avoid excessive loads and/or bending.

To this end E3, see its abstract, proposes measuring the instantaneous load on the turbine and adjusting pitch accordingly. The measuring means may include strain gauges 38 located on the hub, or, column 6, lines 38 to 42, on the blades, that feed pitch control

34. By so adjusting pitch angle to an optimal value loads are reduced and power output optimized, column 2, lines 12 to 17 and 42 to 50.

E7, see claims 1 and 2, describes a similar electronic feedback pitch control scheme based on measurement of wind speed or pressure. The general scheme is shown in the sole figure with various sensors at 10, 43, 44 and 45 feeding into a control that outputs to the pitch adjusting mechanism at I. Additional strain gauges 45 placed on each blade 41, page 16, lines 21 to 24, measure mechanical load in the blade to correct the pitch control signal, so the blade does not exceed maximum allowable bending of the blade, page 17, lines 17-21.

3.3 There is no express mention in either document of calculating blade tip position from the measured loads, much less of using calculated blade tip position to control pitch angle in order to maintain a safety distance. Nor is there any clear and unambiguous indication that they might be concerned in some way with the relative position of blades and tower or even keeping them at a safe distance from one another to avoid collisions. Both are certainly intent on avoiding excessive loads and bending, but the particular damage or malfunction that might result is never explicitly mentioned, and the Board can only surmise as to what that might be.

E3, see column 2, lines 42 to 54 and column 3, lines 1 to 17, for instance discusses asymmetric loads acting on the blades due to inhomogeneous and varying wind fields. These are said to shorten the life-span of

various components of the turbine, not only of the blades but in particular also of the hub, the drive shaft and the bearings that make up the drive train, column 2, lines 42 to 49. That these loads should affect the life span of individual components other than just the blades, suggests to the Board, that, if anything, the damage targeted in E3 is that of high wear and tear, as well as material fatigue and failure resulting from repeated exposure to excessive loads.

E7 mentions excess loads in particular in the context of gusts and tropical storms. This poses a risk to the blades, their bearings and other parts of the rotor (hub and blades), cf. page 7, lines 16 to 20. The blades should never be overloaded during gusts and storms, page 8, lines 4 to 7. To that end E7 proposes a safety control scheme for swift pitch angle adjustment which may be multiply redundant, page 7, final sentence. This means, as described on page 17, lines 17 to 21, that outputs from strain gauges (placed at the highest load area, see page 16, lines 22 to 24, that is at the base end of the blade), can be used to correct signals to the pitch control unit from the differential pressure sensors 44 elsewhere on the blade so as not to exceed maximum allowable blade bending. There is no indication of the type of malfunction or failure that might result, though it is clear that it is something serious. However, it is by no means evident to the Board that this necessarily implies collisions between blades and tower. Material failure resulting from stress within the bent blade exceeding tolerances is an equally serious concern. Indeed the mention of damage to individual components such as blade bearings and other parts of the rotor may even suggest the latter.

3.4 Bending and load naturally correlate closely with blade tip position in particular when both controls result in small pitch angles. It may indeed be that in this partial load range below nominal power where the control has not yet started to pitch the blades out of the wind, cf. patent specification paragraph [0013], the results are similar or even the same for the two controls. However, this does not logically mean that the controls are identical and include the very same steps.

3.5 In summary, E3 and E7 do not expressly mention the characterizing features of claim 1 or 7, and any passages from which these features might have been inferred also allow for other, more likely interpretations. The Board can then but conclude that E3 and E7 both fail to disclose *clearly and unambiguously* these features. It therefore finds that the subject-matter of claims 1 and 7 is novel over this prior art, Articles 52(1) and 54 EPC.

4. Inventive Step

4.1 E3 and E7 both represent valid starting points for assessing inventive step as both are concerned with pitch angle control and measuring mechanical load. The claimed method and device then differ from this prior art by their characterizing features as indicated in the preceding section.

4.2 The idea of calculating blade tip position from the measured load and adjusting pitch angle in response thereto serves the stated purpose of maintaining a

safety distance between blades and tower and thus of avoiding collisions between the two. Based on this purpose a technical problem can be formulated as how to maintain a safety distance between the blade and the tower to avoid collisions.

It may be that this problem is generally known in the field and normally enters into the overall design of the turbine. It can however not be inferred from the teaching of E3 or E7. From a purely objective comparison of what these documents teach and what the differing features achieve it follows that the above problem represents the objective technical problem addressed by the claimed invention's differing features *vis-à-vis this prior art*. The fact that the claimed solution is alternative to other known solutions or that it might allow for less rigid blades does not so much enter into the definition of the actual technical problem addressed by the invention as that it indicates factors that may enter into the consideration of whether or not the claimed solution to this problem is inventive.

- 4.3 The present solution is not evident from any of the cited prior art. No other prior art has been cited as disclosing determining blade tip position and using it to control or adjust pitch. Nor is the Board convinced that the claimed solution would belong to the common general knowledge of the skilled person, a mechanical engineer with specific knowledge in the field of wind turbines and their control. In particular, it differs from the standard solution which is to design a turbine with the rotor placed far enough forward of the tower to provide a set safety distance between blades and

tower for all prevalent wind conditions. That known solution does not imply or require that the blade tip position be continuously monitored in some way, by measurement or calculation. Indeed, no evidence has been provided that it would be desirable at all in the present field to know blade tip position during operation, much less calculate it from the mechanical load measured in a blade, and even less to then use the calculated value to control the blade's pitch angle to maintain a safety distance.

Moreover, it differs from pitch control as in E3 or E7 applied to a turbine designed with a set safety margin, in that it offers more versatility and flexibility. For a given turbine the safety distance, which is now a control rather than a set design parameter, can in principle be varied depending on the prevalent wind at a site, cf. specification paragraph [0011]. A different safety distance will give a different pitch control. The same blade can be controlled to rotate closer or further away from the tower depending on whether expected wind variation at different sites is smaller or greater. In some situations, where wind speed variations are small, a less rigid blade will then suffice.

Finally, the present solution does not simply represent an obvious choice between two alternative ways of maintaining a safety distance, namely by measuring and calculating. This argument is again based on the erroneous assumption that maintaining a safety distance already forms part of the teaching of E3 or E7.

4.4 The Board finds that the Opponent-Appellant has failed to demonstrate that the subject-matter of claims 1 and 7 lacks an inventive step, Articles 52(1) and 56 EPC.

5. Sufficiency of disclosure

5.1 In established jurisprudence of the Boards of Appeal Article 100(b) and 83 EPC is understood as requiring that the disclosure - description, figures and claims - should provide enough information for the skilled person to be able to put the invention, which is claimed in its broadest form, into practice. This should be without undue burden, that is without having recourse to anything other than his normal skills and common general knowledge in the relevant field.

5.2 In the present case the patent provides little or no detail as to how to calculate blade tip position from measured load, or how exactly pitch angle adjustment can be carried out to maintain a safety distance.

5.2.1 The only information regarding calculation of blade tip position is given in patent specification paragraph [0011] stating that tip position follows from bending which is deduced from load. For the skilled person, who as noted is a mechanical engineer, this will be read as a clear pointer to beam bending theory. Together with finite element analysis this is standard fare of any mechanical engineering degree course. The skilled person is very familiar with these approaches and applies them routinely in any problem of structural analysis. Indeed, the Board believes these textbook approaches are so commonly used in mechanical

engineering, that, even without paragraph [0011], the skilled person would immediately think of them as a way of carrying out the required calculation. Nor does he need to be told that he will need to know blade shape or material or any other parameter that would typically enter into such a textbook analysis.

5.2.2 As for the idea of adjusting pitch in response to the calculated position so as to maintain a safety distance the Board believes this to be self-explanatory. The above skilled person requires no further information as to how to proceed in order to configure such a control and devise a suitable control algorithm appropriate to the particular circumstances. The basic steps are clear. He can rely on the knowledge of control engineering that he must possess as mechanical engineer involved in the design and operation of wind turbines.

5.3 The Board is also unconvinced that, because the effects illustrated by graph B in figures 2 and 3 would be impossible to achieve the skilled person would not be able to reproduce the claimed invention. It is clear from the hand drawn nature of these figures that they are not based directly on empirical fact. They are rather meant to illustrate expected benefits. In this respect they are most likely exaggerated, which is however not to say that they cannot be achieved at all. Figure 2 of the patent, for example, appears to correspond to the grey area ("Betriebsbereich") drawn in figure 5.12 on page 80 of E9, which also shows power output for various pitch angles (drawn lines). The front flank of the operation area in that figure, which corresponds to partial load before nominal power is achieved (and where the blade is as yet unpitched, or

at small pitch angle), does not coincide with the dashed line that represents the theoretical power limit. The front flank thus appears to represent a relative optimum (relative to undefined other conditions) and some gain, if not very much, still appears possible. In any case, the claimed method and turbine do not require that these effects must be achieved.

5.4 In the light of the above the Board concludes that the disclosure of the claimed invention is sufficiently clear and complete for it to be carried out by the skilled person.

6. The Board finds that none of the opposition grounds raised against the granted patent prejudices its maintenance.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The patent is maintained unamended.

The Registrar

The Chairman

L. Fernández Gómez

T. Bokor