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Datasheet for the decision of 6 December 2023

Case Number: T 0312/22 - 3.2.04

Application Number: 16168479.0

Publication Number: 3093485

IPC: F03D1/06

Language of the proceedings: EN

Title of invention:
A WIND TURBINE BLADE

Patent Proprietor:
Blade Dynamics Limited

Opponent:
Vestas Wind Systems A/S

Headword:

Relevant legal provisions:
EPC Art. 56
RPBA 2020 Art. 12(3), 12(4)

Keyword:
Inventive step - (no)
Reply to statement of grounds of appeal - party's complete appeal case

Decisions cited:
T 1456/20

Catchword:

Europäisches Patentamt
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Beschwerdekammern

Boards of Appeal

Chambres de recours

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Case Number: T 0312/22 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 6 December 2023

Appellant: (Opponent)	Vestas Wind Systems A/S Hedeager 42 8200 Aarhus N (DK)
Representative:	Kent, Peter Joseph Keltie LLP No.1 London Bridge London SE1 9BA (GB)
Respondent: (Patent Proprietor)	Blade Dynamics Limited Gamma House Southampton Science Park Southampton, Hampshire SO16 7NS (GB)
Representative:	ZBM Patents - Zea, Barlocci & Markvardsen Rambla Catalunya, 123 08008 Barcelona (ES)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 21 January 2022 rejecting the opposition filed against European patent No. 3093485 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman	A. de Vries
Members:	S. Oechsner de Coninck
	C. Heath

Summary of Facts and Submissions

I. The appellant (opponent) lodged an appeal against the decision of the Opposition Division rejecting the opposition filed against the European patent pursuant to Article 101(2) EPC.

II. The Opposition Division held that the grounds for opposition mentioned in Article 100 (a),(b) and (c) EPC did not prejudice the maintenance of the patent as granted having regard inter alia to the following documents:

D1: WO 03078832 A1

D2: M.Ragheb: "Components of Wind Machines", archived by the WebArchive on 28 February 2013 from http://mragheb.com/NPRE 475 Wind Power Systems/ Components of Wind Machines.pdf

D5: L. Mishnaevsky Jr: "Composite Materials in Wind Energy Technology", Thermal to Mechanical Energy Conversion: Engines and Requirements, Encyclopedia of Life Support Systems, Unesco-Eolss Publishers, archived by the WebArchive on 26 June 2012 from https://www.eolss.net/Sample-Chapters/C08/E13-11-42.pdf

D7: Wind Energy Handbook, Gurit, archived by the WebArchive on 16 January 2012 from https:// www.gurit.com/gurit-wind-energyhandbook.aspx

III. In a communication in preparation for oral proceedings the Board gave its preliminary opinion on the relevant issues.

IV. Oral proceedings were held on 6 December 2023 by videoconference.

V. The appellant opponent requests that the decision be set aside and the patent be revoked.

VI. The respondent proprietor-requests dismissal of the appeal, alternatively the maintenance of the patent on the basis of one of the first to eighth auxiliary requests filed with the respondent's reply to the appeal dated 3 October 2022.

VII. The independent claim 1 according to the relevant requests reads as follows:

Main request (with feature numbering used in the decision under appeal added by the Board):

1.1 "A wind turbine blade
1.2 which is at least 45m long,
1.3 the blade having a main axis in the lengthwise direction from root to tip,
1.4 the blade comprising an aerodynamic shell (1) surrounding a spar (2) which extends in a lengthwise direction along a substantial proportion of the blade 1.5 at least a portion of the half of the shell closest to the tip being reinforced by high stiffness fibres (10,11)
1.6 having a Young's modulus to density ratio of greater than 50 GPa/(g.cm^{-3}),
1.7 and an electrical resistivity of greater than 10^{10} Ω.cm,
1.8 the fibres (11) being biaxial with a first axis angled with respect to the main axis at an acute angle and a second axis angled with respect to the main axis at an acute angle in the opposite sense to the first angle, characterised in that

1.9 at least the radially innermost third of the shell (1) and
1.10 a Zone (X) adjacent a tip of the blade are substantially free from high stiffness fibres."

First auxiliary request
Claim 1 of this request adds to granted claim 1 the following expression as a last feature:

"wherein the high stiffness fibres (10,11) are not present all the way to the tip of the shell."

Second auxiliary request
Claim 1 of this request adds to granted claim 1 the following expression as a last feature:

"wherein the high stiffness fibres (10, 11) extend along at least 20% of the blade length."

Third auxiliary request
Claim 1 of this request adds to claim 1 of the second auxiliary request the following expression as a last feature:

"and wherein the fibres (11) are aramid and have a Young's modulus to density ratio of greater than 60 GPa/(g.cm^{-3}) and preferably greater than 70 GPa/(g.cm^{-3})."

Fourth auxiliary request
Claim 1 of this request adds to claim 1 of the first auxiliary request the following expression as a last feature:

"and wherein the high stiffness fibres (10, 11) extend along at least 20% of the blade length."

Fifth auxiliary request
Claim 1 of this request adds to claim 1 of the fourth auxiliary request the following expression as a last feature:

"and wherein the fibres (11) are aramid and have a Young's modulus to density ratio of greater than 60 GPa/(g.cm^{-3}) and preferably greater than 70 GPa/ (g.cm^{-3})."

Sixth auxiliary request
Claim 1 of this request adds to claim 1 of the fifth auxiliary request the following expression as a last feature:

"wherein the shell (1) is also reinforced by low stiffness fibres which have a lower Young’s modulus than the high stiffness fibres (11), wherein the low stiffness are e-glass and are present as unidirectional fibres alongside the biaxial high stiffness fibres (11) and as biaxial fibres and unidirectional fibres in the regions of the shell (1) which have substantially no high stiffness fibres."

Seventh auxiliary request
Claim 1 of this request adds to claim 1 of the sixth auxiliary request the following expression as a last feature:

"wherein the biaxial fibres are oriented at an angle of substantially 45° with respect to the main axis."

Eighth auxiliary request(with addition and deletion with respect to granted claim 1 emphasized by the Board)

"A wind turbine blade ~~which is at least~~ of ~~45m~~ 80 metres long, the blade having a main axis in the lengthwise direction from root to tip, the blade comprising an aerodynamic shell (1) surrounding a spar (2) which extends in a lengthwise direction along a substantial proportion of the blade at least a portion of the half of the shell closest to the tip being reinforced by high stiffness fibres (10,11) having a Young's modulus to density ratio of greater than 50 GPa/(g.cm^{-3}), and an electrical resistivity of greater than 10^{10} Ω.cm, the fibres (11) being biaxial with a first axis angled with respect to the main axis at an acute angle and a second axis angled with respect to the main axis at an acute angle in the opposite sense to the first angle, characterized in that ~~at least~~ the radially innermost first 50 meters ~~third~~ of the shell (1) and a zone (X) of 5 metres adjacent a tip of the blade are substantially free from high stiffness fibres (10,11), wherein the high stiffness fibres (10,11) are aramid, and
wherein the shell is also reinforced by e-glass fibres being present as unidirectional fibres extending along the length of the blade and as biaxial fibres in the regions of the shell (1) which have substantially no high stiffness fibres."

VIII. The appellant argues as follows:

- Claim 1 as granted lacks an inventive step starting from D1 and considering common general knowledge shown in D2,D5 or D7.
- Claim 1 of the first to fifth auxiliary requests add features already disclosed in D1 that do not contribute to an inventive step.
- The sixth to eighth auxiliary requests should not be admitted into the procedure.

IX. The respondent argues as follows:
- Starting from D1 the skilled person would not have considered to use aramid fibres instead of carbon and would not have provided the biaxial orientation as required by granted claim 1.
- Claim 1 of the first to sixth auxiliary requests add features that are not disclosed by the cited prior art and thus contribute to an inventive step.
- The sixth to eighth auxiliary requests have been admissibly raised and justified.

Reasons for the Decision

1. The appeal is admissible.

2. Background

The patent concerns a wind turbine blade with increased length, and addresses the problem of providing a suitable torsional stiffness, paragraph 005 and protection against lightning strikes, paragraph 015. The solution is provided by a biaxial arrangement of high stiffness fibres that have a high electrical resistivity, particularly located in an outer intermediate portion of a wind turbine blade, where torsion loads are higher.

3. Main request - inventive step

3.1 Disclosure of D1

3.1.1 D1 as starting point generally concerns replacing the outermost portion of a wind turbine blade by a transition zone including one or more transitional shell blanks and a carbon fibre tip, page 8, lines

12-14. The wind turbine blade being an elongated aerodynamic profile has a main axis in its lengthwise direction from root to tip, feature 1.3. It also comprises an aerodynamic shell surrounding a spar, page 13, lines 9 "blade shell" and "strengthening Beams", feature 1.4. A first zone 17 of the shell is reinforced by carbon fibres, see also page 9, lines 15-16. This first zone is shown in figure 2 to extend in the outermost half of the blade shell close to the tip, feature 1.5. As acknowledged in the patent itself and shown in the graph of Figure 5, it is undisputed that carbon fibres have a Young's modulus to density ratio of 128 GPa/(g.cm^{-3}) above the limit of 50 GPa/(g.cm^{-3}) claimed, feature 1.6. A radially innermost portion of the shell, "second zone 15", page 9, lines 16-17, Figure 2 is reinforced substantially by glass fibres, and thus substantially free of carbon fibers in the innermost portion of the blade.

3.1.2 Concerning the extension of the second zone 15 visible in figure 2, the Board observes that though exact dimensions may not generally be derived from schematic drawings, under certain circumstances relative sizes can. In this case, the fact that the figure shows the zone 15 to extend across a larger part, well over half the blade's length is intentional and thus clearly derivable from D1. Therefore, at least 30% according top feature 1.9 is seen to be disclosed in D1.

3.1.3 Concerning the disclosure of a tip of the blade also substantially free from high stiffness fibres according to feature 1.10, the Board disagrees with the respondent that the statement in lines 22,23 of page 13 would represent another separate embodiment that is not disclosed in combination with or indeed combinable with the embodiment disclosed in figure 2, where the

tip is made of carbon, and thus contains high stiffness fibers.

For the skilled person using normal reading skills, it is clear from the context, in particular the last paragraph on page 12, that the passages that follow immediately on page 13 of D1 refer to other non illustrated modifications that are additional to the central concept of transitional regions as expressed in claim 1 and illustrated in the embodiments previously disclosed. Thus, the fourth paragraph of page 13 considers making the outermost portion of the blade tip entirely from glass fibers to avoid lightning problems. The Board is unable to see any conflict or contradiction between this aspect and the rest of the disclosure of D1, as it is only the outermost portion of the blade tip, not the entire blade tip, that is made of glass fibre, just as in the patent the tip area is made of conventional glass fibre (figure 4, rightmost zone X). The rest of the blade tip can continue to be made of stiffening fibre, such as carbon fibre. By realizing the outermost blade tip portion in this way, the separate further problem of lightening is addressed, in addition to the transition in laminate that forms the core of the disclosure of D1. Thus the opposition division correctly found feature 1.10 to be disclosed in D1, point 12.4 of the decision.

3.1.4 D1 thus discloses a wind turbine blade comprising features 1.1,1.3 to 1.6, 1.9 and 1.10 of claim 1.

3.2 Differing features and technical effects

3.2.1 The subject-matter of claim 1 therefore differs from the wind turbine blade of D1 by its length of at least 45m, feature 1.2, the electrical resistivity of the

high stiffness fibers greater than 10^{10} Ω.cm, feature 1.7, and that these fibers further are biaxial according to feature 1.8.

3.2.2 Given that carbon fibres are known to have low electrical resistivity, feature 1.7 is read as specifying a high stiffness fibre other than carbon fibre. In the main embodiment of the patent, the fibres are aramid fibres, though the claim of course is not limited thereto.

3.2.3 The technical effects associated in the patent with a longer blade, made of fibres of high stiffness and high electrical resistivity - and thus other than carbon fibres - in a biaxial configuration are that they allow longer blades to be designed with sufficient torsional stiffness, paragraph 005 and 021, while reducing problems due to lightning strikes, paragraph 0015.

Thus the differing features can be seen to address the problem of how to design ever longer blades with sufficient torsional stiffness while also providing protection against lightning strikes. D1 already addresses this problem to some degree, cf page 3, 2nd paragraph and page 13, lines 22-25, in its provision of the outermost blade tip portion made of glass fibres in combination with an outer blade portion made of carbon fibres.

3.3 Objective technical problem

3.3.1 The objective technical problem may therefore be reformulated as providing an alternative solution to the problem of how to design long blades with sufficient torsional stiffness that are torsionally

stiff while also providing protection against lightning strikes.

3.3.2 The skilled person seeking improvement for a composite blade of a wind turbine is a practitioner qualified in the field of wind turbines such as an engineer specializing in wind turbine construction knowledgeable of composite material used in that field.

3.4 Increasing blade length beyond 45 meters

3.4.1 That the trend is towards ever longer blades to increase electrical production goes without saying. Longer blades are also what D1 seeks to implement though without specifying any length or dimension, page 8, line 12. Thus, specifying a blade length of over 45m according to feature 1.2, which merely gives expression to this trend to ever longer blades, is per se devoid of inventive insight.

3.5 Aramid as alternative high stiffness fibers

3.5.1 The Board disagrees with respondent that D1 would be limited to the use of carbon fibre as stiffening fibre in the outermost portion and tip area. Carbon fibre is repeatedly mentioned as an example material, see paragraph bridging pages 4 and 5; page 9, lines 23-25, page 10, line 21. In the sentence bridging pages 1 and 2 it indeed suggests alternatives including aramid fibres (Kevlar®). Though not elaborating on a particular use at a certain blade location, it gives a clear indication that alternatives to carbon fibers are possible. Thus, the skilled person would have no reason to limit themselves to carbon fibers as the sole material for use in the outermost portion. Instead of carbon fibres they would also consider other suitable

materials for the blade outer section when realizing the teaching of D1.

3.5.2 D1 itself, on page 13, first paragraph, already considers the use of aramid fibres for an outermost section of the blade, though in a different embodiment with three different fibre sections (glass fibre - carbon fibre - aramid fibre from root to tip). If not already pointed in that direction by D1 itself, the skilled person in the search of a viable alternative would in any case look to D2. D2 is a publication explaining the different components of a wind turbine. In the section "Rotor Materials" on pages 3 to 6, D2 lists a number of materials together with their properties that are considered for rotor design. On page 6, subsection 3 ("Synthetic Composites), 3rd paragraph, D2 mentions carbon and aramid fibres (such as Kevlar) side by side as examples of composites offering the best mechanical properties though at a high cost. Aramid fibres are then singled out as the cheaper alternative with the added advantage that they are non conducting and thus obviate protection against inter alia lightning strikes. Even if this passage does refer to the blade root and hub junction (though possibly in relation only to galvanic corrosion), it is clear to the skilled person that D2 considers aramid fibres a viable alternative to carbon fibres in general, which moreover has the added benefit of improved electrical properties that can be used to advantage to protect a blade against lightning strikes. Tasked with strengthening a longer blade while providing lightning protection it would therefore be obvious for them to consider to use aramid as a straightforward alternative to carbon fibre in the tip zone of a blade as in D1, thereby providing a material

that also fulfills the electrical resistivity requirement of feature 1.7.

3.5.3 Contrary to the respondent's view, the Board is unable to recognise any technical prejudice in the field against the use of aramid fibers. Such a general prejudice is certainly not proven by D5, a paper on composite materials used in wind turbines, where on page 5, 3rd paragraph, it mentions disadvantages associated with aramid fibres such as moisture absorption. The relevant section 3.1 ("Fibres") of D5, similar to subsection 3 of D2 discussed above, simply reviews all candidate fibres together with their pros and cons. As is clear from the final paragraph of section 3.1, but see the first bullet point on page 8 of the following section as well as section 8, conclusion, 2nd paragraph, rather than suggesting that aramid fibres should not be used, D5 notes the growing interest in aramid fibres in hybrid reinforcements and clearly presents them as an alternative high strength fibre. Furthermore, as convincingly explained by the appellant, fibers are embedded in resin in the blade shell and are thereafter protected by a gel coat, which would in any case avoid or mitigate any problems of moisture absorption.

3.6 Arranging the fibers biaxially is routine manufacturing practice

3.6.1 Further considering how they would realise a laminate of composite fibers for the outer part of the blade to make it stiffer and less liable to deflect or bend as taught by D2, page 3, 2nd paragraph, the skilled person with knowledge of the manufacture of composites and fibre laminates will inevitably consider a biaxial arrangement of fibres at an acute angle with respect to

the main axis according to feature 1.8. This orientation is particularly adapted to provide torsional stiffness as is commonly known in the field of wind turbine blade manufacture. Firstly, the patent itself, paragraph 0025, acknowledges that a conventional fibre structure comprises a number of biaxial fibres 11 arranged at ± 45° to the blade axis. This statement is made without reference to a particular material used for this orientation of fibres.

3.6.2 Further confirmation of biaxial orientation as a routine fibre lamination technique is also found D5. In chapter 2 relating to construction, loads and requirements, the last paragraph of page 3 mentions as an example the production of multiaxial fabrics the use of +/- 45° laminates in the blade skin (as well as the web). It will also be apparent to the skilled person from straightforward considerations that such an arrangement provides stiffness in a multiplicity of directions, with the ultimate aim of maintaining blade shape against wind and gravitational forces (see Table 1, page 4, 2nd column, first entry). Here also there is no indication that this would be limited to any particular fibre or fabric. As noted various fiber materials are listed in the following chapter 3, item 3.1

3.6.3 That the use of multi- and biaxial composite fabrics is well known in wind turbine blade design is also confirmed by D7, which for example on page 74 (overall page numbering), in the first paragraph of the section "Material for Prepreg Blades" states that the shell is manufactured using multiaxial prepregs. These are discussed on the following pages 75 and 76 in the section "An Introduction to the WE91 Prepreg family".

Thus, in the paragraph bridging pages 75 and 76, a biaxial prepreg, a ± 45° stitched E-glass fabric, is used to impart tensile and torsional strength, an important function highlighted on page 16, in section "Blade Shells". As stated there, just like the spar shear webs, the shells have a high proportion of fibres running diagonally. The mention of spar shear webs and diagonal orientation refers to the preceding section "Laminate orientation", page 13, which in the 2nd paragraph states that "fibres in the shear webs should be laid diagonally, to meet the spar caps at 45 degrees in either direction". The fact that in the section "Laminate Orientation" on page 14 the diagonal, biaxial arrangement of fibers in a laminate is discussed without reference to any fiber material is a clear indication that it is the diagonal orientation of the fibers and not their nature that produces the required directional stiffness in the shear webs as well as in the shell (page 16, "Blade shell") r.

3.6.4 From the above the Board concludes that a a biaxial, diagonal arrangement of fibers is common general knowledge independent of the fibre material. The skilled person would therefore have contemplated such a commonly known biaxial arrangement along ± 45° angle to the blade's main axis according to feature 1.8 so as to increase torsional resistance of the portion 17 made of aramid as alternative fiber material to carbon of D1.

3.7 No synergy between the choice of fiber material and their orientation

3.7.1 Finally the Board is unable to identify a synergy between the choice of high stiffness fibers with greater electrical resistivity, such as aramid and their biaxial arrangement. The patent does not suggest

that providing aramid fibers in biaxial orientation provides a synergistic effect, that is, an effect which is over and above the sum of the effects associated of using aramid and providing a biaxial arrangement. As noted above, the particular stiffness of a biaxial, diagonal arrangement arises from its geometry and is independent of the nature of the fibres, which must naturally be inherently stiff themselves to be able to provide stiffness in any direction. Because aramid fibres have similar mechanical properties as carbon fibres a biaxial arrangement of aramid fibres will thus offer a similar stiffness and resistance to torsion as a carbon fibre biaxial arrangement. Nor was the respondent proprietor able to identify any special effect over and above what could be expected from an aramid biaxial arrangement in comparison to one made from carbon fibre.

3.8 It follows from the above that the skilled person seeking to modify the wind turbine blade according to D1 in order to design long blades with sufficient torsional stiffness while also providing protection against lightning strikes would have arrived at the subject-matter of claim 1 including features 1.2,1.7 and 1.8 in an obvious manner. Thus, contrary to the decision's findings, the Board concludes that the subject-matter of claim 1 according to the main request lacks an inventive step.

4. First to fifth auxiliary requests - inventive step

4.1 In relation to these requests the Board has expressed the following provisional opinion in its communication (see point 4, bridging pages 8 to 9):

"Regardless of their admissibility, the Board makes the

following comments regarding inventive step:
- The first auxiliary request is new in appeal and adds the features of granted claim 6 to overcome the question of added subject-matter. The question of lack of inventive step as for the main request would still apply.
- The second auxiliary request was filed in opposition and adds to granted claim 1 the features of dependent claim 4 concerning the extension of the high stiffness fibres. This minimum extension of 20% being also clearly visible for the frist zone 17 of D1, no contribution to an inventive step would be provided.
- The third auxiliary request adds to claim 1 of the previous request the features of claims 2 and 3, concerning the high stiffness fibres being aramid fibers. As already identified in relation to the main request, both D1 and D2 suggest to the skilled person to provide aramid fibers.
- The fourth auxiliary request adds the features of claim 1 according to the first and second requests, the fifth auxiliary request adds the features of the third and fourth auxiliary requests, thus leaving the conclusion of lack of inventive step valid for these various aggregation of the same features."

4.2 At the oral proceedings before the Board the respondent only commented in respect of the second auxiliary request. According to them, the further requirement that the high stiffness fibres extend along at least 20% of the blade length, implies the additional choice of a length that meets the requirement of providing enough torsional stiffness.

For the Board, the choice of a minimum length adapted to provide a certain threshold resistance in torsion belongs to the skilled person's workshop practice.

Thus, in putting D1's teaching into practice , the skilled person would, for example by trial and error, establish the dimensional limits of the regions with different fibre composition within which a desired stiffness is achieved. Indeed, as pointed out by the appellant, D1 already discloses several lengths of the zone including the blade tip in lines 26 to 28 of page 6, the majority of which is above 20%. Finally, the respondent was unable to explain any special effect associated with the choice of this limit value other than that it would be undisclosed.

The Board therefore sees no reason to change its preliminary opinion in respect of the 2nd auxiliary request, or, absent further comment, in regard of the 1st, and 3rd to 5th auxiliary requests.

4.3 The Board thus concludes that the subject-matter of claim 1 according to the first to fifth auxiliary requests lacks an inventive step.

5. Sixth to eighth auxiliary requests - admissibility.

The 6th to 8th auxiliary requests are said to correspond to requests filed in response to the summons to oral proceedings in opposition.

5.1 For these requests, the respondent in their reply of 3 October 2022 to the grounds, sections 6.6 to 6.8 on pages 20 to 21, identified the amendments made, while stating that certain added features would not be disclosed or taught by the prior art. However, there is no explanation why this is so, nor any cogent argument, for example in terms of the problem solution approach, why their addition then involves an inventive step. The Board does not see that providing such an explanation

would place an undue burden on the respondent, as they argued, certainly not in this case, where the number of attacks and citations is limited. Given that these features were in part added from granted, dependent claims 8 to 15 which had been objected to in the notice of opposition, pages 14 to 17, for lack of inventive step, the Board would have expected the respondent to at least present arguments addressing these objections. The Board concludes that the 6th to 8th auxiliary requests were not fully substantiated and thus no complete case was made in the respondent's reply to the appellant's statement of grounds as required by Art 12(3) RPBA. Using its discretion under Art 12(5) RPBA, the Board decided not to admit these requests.

5.2 In respect of the 8th auxiliary request, the Board adds that its amended claim 1 is not a limitation of higher auxiliary requests but pursues a new line of defence, so that it is not convergent with the higher requests. It is thus debatable whether this request was admissibly raised in opposition, as it is by no means certain that it would have been admitted by the opposition division had the higher requests failed. In this case the Board could also have applied the provisions of Art 12(4) RPBA.

6. As the Board finds that the opposition division was wrong to find that the subject-matter of granted claim 1 involves an inventive step it must set the decision aside. As the first to fifth were found not allowable on the grounds of inventive step, and the sixth to eighth auxiliary requests were not admitted into the proceedings, no allowable auxiliary request remains and the Board must revoke the patent pursuant to Article 101(2) and (3)(b) EPC.

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