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**Datasheet for the decision  
of 20 September 2021**

**Case Number:** T 1101/18 - 3.5.03

**Application Number:** 12740580.1

**Publication Number:** 2737376

**IPC:** G05B23/02

**Language of the proceedings:** EN

**Title of invention:**

Gas turbine life prediction and optimization device and method

**Applicant:**

Nuovo Pignone S.p.A.

**Headword:**

Gas turbine life prediction/PIGNONE

**Relevant legal provisions:**

EPC Art. 56

EPC R. 103(4) (c)

**Keyword:**

Inventive step - main and auxiliary request (no)  
Partial reimbursement of appeal fee at 25% - (yes): timely  
withdrawal of request for oral proceedings



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Case Number: T 1101/18 - 3.5.03

**D E C I S I O N**  
**of Technical Board of Appeal 3.5.03**  
**of 20 September 2021**

**Appellant:** Nuovo Pignone S.p.A.  
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**Representative:** Openshaw & Co.  
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**Decision under appeal:** **Decision of the Examining Division of the  
European Patent Office posted on 31 October 2017  
refusing European patent application  
No. 12740580.1 pursuant to Article 97(2) EPC.**

**Composition of the Board:**

**Chair** K. Bengi-Akyürek  
**Members:** R. Gerdes  
R. Winkelhofer

## Summary of Facts and Submissions

I. The examining division refused the patent application on the grounds that the subject-matter of the independent claims of the main and auxiliary requests did not involve an inventive step (Article 56 EPC) in view of either of the following prior-art documents and the skilled person's common general knowledge:

**D1:** US 2004/0148129 A1

**D2:** EP 1 217 189 A1.

The examining division also referred to the following prior-art document:

**D4:** US 2009/0030752 A1.

II. The applicant (appellant) appealed against this decision and requested that the decision under appeal be set aside and that a patent be granted based on the claims of the **main request** or the **auxiliary request**, filed with the statement of grounds of appeal. These claim requests are identical to the claim requests on which the decision under appeal was based. The appellant also requested oral proceedings if the board intended to dismiss the appeal.

III. In a preliminary opinion under Article 15(1) RPBA 2020 dated 15 February 2021, the board stated *inter alia* that the subject-matter of the independent claims of both of the appellant's claim requests did not involve an inventive step in view of D1 in combination with D4 (Article 56 EPC).

IV. By a reply dated 12 March 2021, the appellant withdrew their request for oral proceedings and requested a partial reimbursement of the appeal fee (cf. Rule 103(4) (c) EPC). They did not submit any comments on the substance of the board's communication.

V. The board then cancelled the oral proceedings.

VI. Claim 1 of the **main request** reads as follows (with a numbering of features as indicated in the decision under appeal):

"A computer-based method for determining a residual life expectancy of a rotor of a gas turbine, the method comprising:

- (a) receiving at a computer operating conditions of the gas turbine (500);
- (b) receiving a gas turbine rotor inspection result (502);
- (c) updating, based on the operating conditions of the gas turbine and the gas turbine rotor inspection result, a database of a fleet of a class of gas turbines that have a set of common characteristics corresponding to the gas turbine (504); and
- (d) calculating the residual life expectancy of the rotor of the gas turbine and an associated risk to life extension (506)
- (e) using the updated fleet database and by measuring independent variables of the gas turbine and using physical models of the gas turbine to calculate plural dependent variables of the gas turbine based on the independent variables."

VII. Claim 1 of the **first auxiliary request** differs from claim 1 of the main request in that the following additional features have been appended to the claim:

- "(f) wherein the plural dependent variables are flows, pressures, and temperatures of the gas turbine, heat transfer coefficients between flows and the rotor, rotor metal temperatures, rotor displacements, strains and stresses; and
- (g) providing the independent variables as input to transfer functions for calculating life variables, wherein a life variable is a cycles-to-LCF (low cycle fatigue) crack initiation parameter, and an independent variable is one of an ambient temperature and a rotor rotating speed."

## **Reasons for the Decision**

### *1. The present application*

The application relates to a computer-based method and device for predicting and optimising the operating life of a rotor of a gas turbine. Previously, statistical methods and structural models of turbines have been used to predict a residual life expectancy of a turbine. However, these methods rely on optical inspections and require plant shutdown to collect data. In addition, these methods are not applicable to components that do not show evident failure (see page 1, lines 5 to 7 and page 2, lines 1 to 20 of the application as published).

In order to improve these methods, the application proposes a computer-based method which receives the operating conditions of the gas turbine and a gas turbine rotor inspection result. The method updates, based on the operating conditions of the gas turbine and the gas turbine rotor inspection result, a database

for a fleet of gas turbines, with each of the gas turbines having common characteristics. Using the measurement results, the updated fleet database and physical models of the gas turbine, the residual life expectancy of the rotor of the gas turbine is calculated (see page 3, line 27 to page 4, line 3; page 6, line 13 to page 7, line 15; page 9, lines 8 to 23 and page 12, line 7 to page 13, line 8 of the application).

2. *Main request, inventive step*

2.1 It has not been disputed that **D1** may be considered a suitable starting point for the assessment of inventive step with regard to the claimed subject-matter.

2.2 D1 discloses a computer-based method for determining a residual life expectancy of a rotor of a gas turbine and a device for implementing said method (see paragraphs [0014] to [0016]), comprising the steps of:

- (a) receiving, at the computer, operating conditions of the gas turbine (paragraphs [0039] and [0052]);
- (b) receiving a gas turbine rotor inspection result (paragraphs [0109], [0110] and [0114]);
- (c) updating, based on the operating conditions and the gas turbine rotor inspection result, a database (paragraphs [0047] and [0048]);
- (d) calculating the residual life expectancy of the rotor gas turbine and an associated risk to life extension (paragraphs [0049], [0050], [0107] and [0108]);
- (e) wherein the calculating uses the updated database and measured independent variables of the gas turbine and uses physical models of the gas turbine to calculate physical variables of the gas turbine

based on the independent variables (see paragraph [0064], "equation 2" in combination with paragraph [0114]).

- 2.3 Hence, D1 discloses all features of claim 1 except for the use of "a database of a fleet of a class of gas turbines that have a set of common characteristics" according to steps (c) to (e). Instead, D1 discloses the use of a database relating to a *single* gas turbine (see paragraphs [0048] and [0049]).

The appellant did not dispute the above analysis as to the distinguishing feature between claim 1 and D1.

- 2.4 According to the appellant, the availability of data from a fleet of gas turbines allowed for a more reliable calculation of risk. Therefore, starting from D1, the objective technical problem could be formulated as "how to provide more reliable calculations of the residual life expectancy of a gas turbine". The person who would have been tasked with such a problem was a person skilled in the field of system design for gas turbines.

- 2.5 The board is however not convinced that the mere availability of "data of a fleet of a class of gas turbines" - without any specification of the necessary calculations and their implementation - credibly provides for "a reliable calculation of risk". However, even if - for the sake of argument - this technical effect was accepted and the purported technical problem adopted, the claimed subject-matter would not involve an inventive step having regard to prior-art documents D1 and D4, for the reasons set out below:

2.5.1 **D4** relates to preventive maintenance of gas turbines and thus belongs to the technical field of D1.

Moreover, D4 discloses the distinguishing feature of collecting and analysing data from a group of turbines having the same or similar characteristics (see D4, title and paragraphs [0034] to [0037]).

2.5.2 The appellant argued that the skilled person would not have combined D1 with D4, because D4 related to determining whether an operational metric representing a target-machine had an anomalous value and not to determining a "residual life expectancy" of a rotor of a gas turbine as in the present application. Even if D4 were combined with D1, such a combination would still not disclose or suggest the feature of calculating the residual life expectancy of the rotor of the gas turbine and an associated risk to life extension using the updated fleet database and by measuring independent variables of the gas turbine and using physical models of the gas turbine to calculate plural dependent variables of the gas turbine based on the independent variables, in accordance with features (d) and (e) of present claim 1.

However, the calculation of the "residual life expectancy" of the rotor of a gas turbine is closely linked to the detection of anomalies in a turbine. A skilled person would have considered all available and relevant information for the determination of residual life expectancy, as soon as they became aware of it. Hence, the skilled person would have been incited to collectively evaluate the different data of D1 and D4 to improve the calculations of the residual life expectancy of a gas turbine. It follows that the skilled person, starting from D1, would have used the additional information relating to gas turbines having



similar characteristics for improving the estimate of residual life expectancy and would thus arrive at the claimed subject-matter.

2.6 Hence, the subject-matter of present claim 1 lacks an inventive step in view of D1 in combination with D4 (Article 56 EPC).

3. *First auxiliary request, inventive step*

3.1 In addition to claim 1 of the main request, claim 1 of the auxiliary request specifies the type of dependent and independent variables and defines some of the rules for processing the independent variables (see point VII. above).

3.2 With regard to the assessment of inventive step on the basis of these features, the board agrees with the reasoning set out in the decision under appeal (cf. Article 15(8) RPBA 2020).

The additional step of calculating plural depending variables of the gas turbine based on independent variables is disclosed in **D1**, but with reference to a subset of the dependent variables claimed (see paragraphs [0056] to [0072]). The objective technical problem solved by the added dependent variables may therefore be regarded as "how to obtain additional information on the monitored turbine". Performing further calculations to determine further dependent variables of the gas turbine (namely, the heat transfer coefficients) would have been regarded by the skilled person as a normal routine procedure, to be carried out on the basis of the common general knowledge, whenever such additional information were needed. The additional step of providing the independent variables as input to

transfer functions for calculating life variables, where an independent variable is one of an ambient temperature and a rotor rotating speed, is already disclosed in D1 (see paragraphs [0111], [0114] and figure 8).

3.3 Hence, the subject-matter of claim 1 of the auxiliary request lacks an inventive step in view of D1 in combination with D4 and the skilled person's common general knowledge (Article 56 EPC).

4. *Conclusion*

Since none of the appellant's claim requests is allowable, the appeal has to be dismissed.

5. *Partial reimbursement of the appeal fee*

The conditions for a partial reimbursement of the appeal fee according to Rule 103(4)(c) EPC are fulfilled (see points III to V above).

**Order**

**For these reasons it is decided that:**

1. The appeal is dismissed.
2. Reimbursement of the appeal fee at 25% is ordered.

The Registrar:

The Chair:



B. Brückner

K. Bengi-Akyürek

Decision electronically authenticated