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**Datasheet for the decision
of 13 November 2025**

Case Number: T 0048/24 - 3.5.06

Application Number: 18840599.7

Publication Number: 3660397

IPC: F23G5/50, F23G5/44, B65F5/00

Language of the proceedings: EN

Title of invention:
WASTE COMPOSITION ESTIMATION DEVICE, SYSTEM, PROGRAM, METHOD,
AND DATA STRUCTURE

Patent Proprietor:
Ebara Environmental Plant Co., Ltd.

Opponent:
Hitachi Zosen Inova AG

Headword:
Estimating waste composition/EBARA

Relevant legal provisions:
EPC Art. 100(b), 83
EPC R. 42(1)(e)

Keyword:

Machine learning

Sufficiency of disclosure - main request (no) - auxiliary requests 1 to 7 (no)

Decisions cited:

T 0161/18, T 0149/21, T 1669/21



Beschwerdekammern

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Case Number: T 0048/24 - 3.5.06

D E C I S I O N
of Technical Board of Appeal 3.5.06
of 13 November 2025

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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted on 9 November 2023 rejecting the opposition filed against European patent No. 3660397 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman M. Müller
Members: M. Olapinski
K. Kerber-Zubrzycka
T. Alecu
F. Bostedt

Summary of Facts and Submissions

I. The appeal was filed by the opponent (appellant) against the opposition division's decision to reject the opposition against the patent in suit (the patent).

II. At the end of the oral proceedings before the Board, the parties' requests were as follows.

The appellant requested that the decision under appeal be set aside and that the patent be revoked. Further, it requested that auxiliary requests 4 to 7 and Annex 1, all filed with letter of 6 October 2025, not be admitted into the appeal proceedings. Upon question of the Chairman, it stated not to have any objection against the admittance of auxiliary request 8.

The respondent (patent proprietor) requested that the appeal be dismissed (main request). In the alternative, it requested that the decision under appeal be set aside and the patent be maintained on the basis of one of auxiliary requests 1 to 3 of 13 June 2022 (refiled with the reply to the grounds of appeal) or one of auxiliary requests 4 to 8, filed with letter of 6 October 2025, whereby auxiliary request 8 was submitted in case the Board decided not to maintain the patent based on a lack of novelty or inventive step starting from D6.

III. The following document is considered in the present decision:

Annex 1: filed with the respondent's letter of 6 October 2025.

IV. Independent claim 1 as granted (main request) reads
(with features labelled as in the impugned decision):

"[M1.1] A device (200) comprising:

[M1.2] a training data generation unit (220) adapted to generate training data associated with a captured image of waste stored in a waste pit;

[M1.3] a model construction unit (230) which is adapted to construct a model by performing learning using the training data; and

[M1.4] an estimation unit (250) which is adapted to input, in the model, data of a new captured image of waste stored in a waste pit, and to obtain a value representing composition of the waste corresponding to the new image."

V. Claim 1 of auxiliary request 1 differs from claim 1 as granted in that "piled and" is inserted between "waste" and "stored in a waste pit" in Features M1.2 and M1.4.

VI. Claim 1 of auxiliary request 2 differs from claim 1 of auxiliary request 1 by the following additional features taken from claim 5 as granted (labels in square brackets added):

"[M1.5] wherein the training data is collected from at least one of

[M1.5a] a value representing a characteristic of waste identified based on operation history of a waste treatment plant, and

[M1.5b] a label representing result of classification of composition of waste, wherein classification is performed by an operator based on image data of the waste in the waste pit."

- VII. Claim 1 of auxiliary request 3 differs from claim 1 of auxiliary request 2 in the further specification "and the operation history of a waste treatment plant" at the end of Feature M1.5b.
- VIII. Claim 1 of auxiliary requests 4 to 7 differs from claim 1 of the main request and auxiliary requests 1 to 3, respectively, by the addition "of a waste treatment plant" inserted after "stored in a waste pit" in Features M1.2 and M1.4.

Reasons for the Decision

Main request

1. Claim interpretation
 - 1.1 Claim 1 as granted defines a device comprising a "training data generation unit", a "model construction unit" and an "estimation unit". The device is for training and using machine learning for obtaining a "value representing the composition of waste" in a waste pit upon inputting "data of" a captured image of the waste.
 - 1.2 The "units" in Features M1.2 to M1.4 refer to algorithms or functions of a computer program that are implemented on a processor of the device (see paragraph [0029] of the patent).

Feature M1.2 specifies that the training data generation unit is adapted to generate training data associated with "a" captured image of waste stored in a waste pit. The skilled person understands that the training data generated is not based on the *same* single captured image but that each instance (or "set", see paragraph [0037]) of the training data is associated with a *respective* image or image section (considering the possible subdivision of a captured image into different blocks according to claim 2, paragraph [0038] and Figure 4). According to paragraph [0037], each set of "learning data" contains both the input and output data of the model ("supervised learning"), namely "data of an image of waste" and training data including "a value representing composition of the waste", which correspond to the input and output data defined in Feature M1.4.

Although the description appears to use the term "training data" only for the data containing the output value (see paragraphs [0037] and [0039]), it is understood that the model construction and learning according to Feature M1.3 must of course also involve the input data.

Feature M1.4 defines "data of" a new captured image of waste stored in a waste pit as the input to the trained model and "a value representing composition of the waste corresponding to the new image" as the output obtained by the estimation unit.

- 1.3 Claim 1 generally refers to "waste stored in a waste pit". It is not limited to waste in a waste treatment plant nor to the context of refuse incineration.

However, for the sake of argument, claim 1 is nevertheless considered to be limited to waste in a waste treatment plant with characteristics relevant for refuse incineration in the following. This is reasonable in view of corresponding limitations in claims 3 to 9 as granted and in anticipation of some of the auxiliary requests limited accordingly, and it is in line with the context of the patent (see e.g. Figure 1).

1.4 "Data of" a captured image

Neither the claim nor the patent specifies what "data of" the captured image refers to. This expression encompasses raw images, extracted features or even averaged properties, such as a colour tone. Even if the term "image data" used in the description were understood to refer to a raw image, the claim deliberately broadens the input to include any "data of" a captured image. Accordingly, the possible input data in claim 1 covers a wide range of possibilities.

1.5 Value representing composition

Claim 1 defines a "value representing composition" of the waste as the output of the trained machine learning model. It is not limited to a specific "value representing composition", nor does it specify what this value is or how it is (meant to be) used.

According to dependent claims 3 and 4, the value may be used to control the crane or combustion of an incinerator in a waste treatment plant. According to dependent claim 5, the value may be a characteristic of the waste identified based on operation history of a waste treatment plant or a label representing the

result of a classification of the composition performed by a human operator. Dependent claim 6 specifies that the value may be an index of flammability of the waste.

From paragraph [0030] onwards, the description of the embodiments provides further examples of the value, such as the weight of the waste thrown into the pit, the density, the water content included in waste thrown into the pit, and a quantity of heat generated when the waste is incinerated (paragraph [0033]). This data can be routinely obtained during the operation of the plant, e.g. by measuring heat generation or spectroscopically determining the constituents during combustion, by weighing the trucks and the portions grabbed by the crane, etc. Such data, stored as the "operation history" of the waste treatment plant, can be used to generate the training data (see paragraphs [0030] and [0031]). It is clear from this context that the "value representing composition" relates to information relevant to the operation and control of the waste treatment plant or the combustion of the waste.

The respondent submitted that paragraph [0031] disclosed a limiting *definition* that "the value representing composition of waste is an index showing the degree of flammability or non-flammability of waste", i.e. limited to a coarse classification of flammability as either yes/no or one of the three labels according to paragraph [0035]. The other parameters disclosed in the patent referred to optional, supplementary information.

However, this is not convincing. While it is true that such a coarse classification falls within the terms of claim 1, the passages of paragraphs [0031] and [0035]

refer only to exemplary embodiments that do not limit the subject-matter of claim 1. Furthermore, the mentioned "index" representing a "degree of flammability" does not correspond to a binary yes/no classification but to numerical values, as shown in Figure 4 (see paragraph [0043]). Furthermore, paragraph [0043] discloses that the other parameters mentioned in the description relate to different "output data", i.e. different "values representing composition", and not just supplementary information.

Accordingly, the expression "value representing composition" in claim 1 is not limited to the coarse classification according to calorific value or degree of flammability, nor to any of the specific examples mentioned in the dependent claims or the detailed description of embodiments. For instance, as suggested by the appellant, the value could also indicate whether the composition of the waste contains objects or substances that *should not* enter the incinerator.

Accordingly, the broad expression "value representing composition" in claim 1 also encompasses a wide variety of possibilities.

1.6 Accuracy

Claim 1 requires that the estimation unit is adapted to obtain a value "representing composition of the waste corresponding to the new image" from the trained model.

The Board takes the view that, for the value to "represent" the composition of the waste, the value must actually contain a meaningful estimation of the waste composition. Even though the level of the required accuracy is not implied in claim 1, nor is it

clearly derivable from the patent specification, the fact that claim 1 requires more than an arbitrary output of the trained model must be taken into account in the assessment of sufficiency of disclosure.

The respondent submitted that claim 1 did not require a specific level of accuracy. Any value that estimated the composition as being "better than arbitrary" could be considered to "represent" the composition as defined in claim 1. This was consistent with the coarse classification into three labels according to paragraph [0035]. Moreover, sufficiency of disclosure did not require the claimed objective to be achieved in each and every case - a certain number of outliers and exceptions did not contradict the general feasibility.

The Board agrees with the respondent that sufficiency of disclosure is not dependent on individual outliers or exceptions. The Board also agrees that claim 1 covers a coarse classification of the waste into three labels representing the average "high-", "medium-" and "low-calorific value", with a reliability comparable to that of a human classifier (which is used as training data), as set out in paragraph [0035]. However, claim 1 is not so limited. For example, the claimed invention also extends to numerical values for the index of flammability that "shows that the waste is more flammable as the value of the index is larger" (paragraph [0043]), with a resolution of 1% (integer steps in the number range up to 100) in Figure 4.

Therefore, in the Board's view, claim 1 must be taken to cover a wide range of precision requirements, including that of Figure 4 at least.

1.7 Machine learning model

Claim 1 defines a "model construction unit" adapted to "construct a model by performing learning using the training data", but it does not explicitly limit the type and architecture of the model, nor the learning method (apart from the fact that it is based on supervised learning, as mentioned above).

The description does not provide further details in this regard either. As submitted by the appellant, the relation $y=f(x,\theta)$ disclosed in paragraph [0039] between the input x and the output y and the internal parameter adjusted by machine learning applies to virtually any machine learning approach, and the list at the end of this paragraph is an almost arbitrary enumeration of well-established, but very different machine learning techniques. The patent does not provide any further details on the learning method. Accordingly, the type, implementation and training of a machine learning model suitable for the claimed purpose remain open.

2. Criteria for sufficiency of disclosure

2.1 The appellant submitted that the invention of claim 1, which concerned machine learning, did not meet the corresponding requirements set out in T 161/18 and T 1669/21 for sufficiency of disclosure of machine learning inventions.

2.2 According to the established case law of the Boards of appeal, sufficiency of disclosure in the patent under Article 100(b) EPC requires that the skilled person, based on the patent as a whole and taking into account the common general knowledge at the time of filing, was able to carry out the invention as claimed over the

whole claimed breadth without undue burden. This is to be assessed for each case individually.

However, there is no apparent reason to treat inventions in the field of machine learning differently from other inventions in this regard.

2.3 It goes without saying that the implementation of a suitable machine learning model, its training, and whether the trained model can successfully estimate the specified output based on the input parameters as claimed may be important aspects of sufficiency of disclosure of machine learning inventions. However, there are no special requirements and no general rules for assessing whether these aspects are sufficiently disclosed.

2.4 With regard to the decisions referred to by the appellant, in the case underlying T 161/18 the competent board concluded that the disclosure regarding the training of the artificial neural network in question was insufficient. This was because the application did not disclose which input data was suitable for the training of the artificial neural network of the invention, nor did it disclose at least one set of training data suitable for solving the technical problem at hand (Reasons 2.2). This had been the board's preliminary opinion, to which the appellant did not reply (Reasons 2.3). However, the decision does not explain in more detail which information the board found to be missing and the reasons for this. It is thus not possible to derive from this specific case any general criteria which might then be applicable to the present case.

2.5 Similarly, in T 1669/21, the competent board indeed considered what the appellant referred to as "four criteria", namely that the patent did not disclose any specific example for carrying out the invention, which specific machine learning model and combination of specific input values could be used for predicting the claimed output parameter, and how the invention could be carried out over the whole claimed breadth. However, in the present Board's view, these aspects, in that particular case, illustrate the glaring gap between the breadth of the claimed invention and the level of detail in the patent, and do not constitute generally applicable criteria required for sufficiently disclosing a machine learning invention.

3. Sufficiency of disclosure (Article 100(b) EPC)

3.1 Specific examples in the patent

The Board notes that the patent does not contain a specific example of the claimed invention. That is, it does not disclose any specific combination of certain "data of" captured images and a particular "value representing composition" of the waste in the images, nor does it provide any details on the implementation and training of an exemplary machine learning model, or any information on the achieved accuracy of estimation. In other words, the patent does not contain any concrete, reproducible example of implementation of the invention.

Such a specific example is not in itself an absolute requirement for sufficient disclosure, provided that the skilled person is aware of "at least one way" of carrying out the invention in other ways, for example, through the generic disclosure in the patent or the

common general knowledge (cf. Rule 42(1)(e) EPC, "using examples *where appropriate*").

In the present case, however, providing such an example could have demonstrated that the invention is workable at all, at least in this specific case of the example. It could have served as a reference to better understand the claimed invention, its terms and purpose and the achievable or expected level of accuracy.

3.2 Annex 1

In a letter dated 6 October 2025, the respondent stated that the patent in fact disclosed a specific example of carrying out the invention. It was well known that the composition of waste in a waste treatment plant was conventionally classified by human operators as also disclosed in paragraphs [0031] and [0036]. The classification could be made according to three labels representing waste of high-, medium- or low-calorific value, based solely on the visual identification of different types of waste (bulky crushed waste, pruned branches, normal household garbage and sludge, see paragraph [0002]) from the surface of the waste pit. The skilled person was thus aware from their common general knowledge that emulating this by machine learning represented "one way" of carrying out the claimed invention (see paragraphs [0035] and [0036]). It was thus clear that "raw images" were used as the input data as in the classification by a human operator. It was also widely known before the priority date of the patent that objects in raw images could be recognised particularly well using convolutional neural networks (CNNs), in which information such as color, shape and texture of objects could be detected without defining any predetermined feature values. Accordingly,

taking into account the common general knowledge of the skilled person, the patent sufficiently disclosed one way of carrying out the invention.

"Annex 1" setting out the details was submitted as evidence that the invention could be carried out in the manner described above. Annex 1 shows typical examples of images of waste falling within the categories of the three labels (section 3), some statistics on the training data (section 4), details on the machine learning algorithm and learning process (section 5), an evaluation of the accuracy of the trained model (section 6) and examples of the estimation of labels in different blocks of new captured images of waste in the waste pit (section 7).

This information indeed corresponds to a specific example - even a very detailed one - as referred to in point 3.1 above. In the Board's view, it shows that there *is* indeed "one way" in which the invention could be successfully reduced to practice. However, this information is *not disclosed* in the patent, nor is it part of the common general knowledge *in all its details*. Especially the particular automation aspects are not.

At any rate, this example is not sufficient for establishing how the invention can be carried out over the whole breadth of claim 1 for the reasons set out in the following.

Therefore, the question of admittance of Annex 1 under Article 13(2) RPBA, which the appellant contested, is not decisive and can be left open.

3.3 Breadth of the claimed invention / undue burden

As already mentioned (see point 2.2), sufficiency of disclosure requires that the invention can be carried out over the whole claimed breadth without undue burden. As discussed in T 149/21 (Reasons 3.2), this requirement has been formulated in decisions of the boards of appeal across all technical fields. It reflects the general principle that the protection obtained with the patent has to be commensurate with the disclosed teaching. Even if "one way" of performing the invention was disclosed as submitted by the appellant (see point 3.2), this would only be sufficient if this disclosure enabled the skilled person to perform the invention over the whole claimed breadth.

The patent in suit teaches the general idea of using machine learning to infer properties of the waste composition that could be relevant for operating and controlling a waste incineration plant from images of the surface of the waste pit. However, the disclosure is mostly limited to stating a "result to be achieved" (see, for example, paragraph [0039]: "The model is constructed in such a manner that it outputs a correct output corresponding to a new input when the new input is given"). However, the mere idea does not enable the skilled person to carry it out.

The task that the skilled person faces is to design solutions using machine learning models for all conceivable input data and output "values representing composition".

There is a wide variety of possible input "data of" a captured image (see point 1.4) and of conceivable

output "values representing composition" involving different precision requirements (see points 1.5 and 1.6). There is also a wide variety of types of machine learning models that the person skilled in the art could use (see point 1.7), each further characterised by a wide variety of possible parametrisations. The skilled person receives no specific guidance in the patent as to which types of data or machine learning algorithms are more or less promising for achieving the claimed objective, namely the output of different values that "represent" the composition of the waste. The patent leaves it to the skilled person to select and evaluate combinations of input data and machine learning models for different desired outputs. Each evaluation involves implementing, training and evaluating the selected models. Overall, this results in an enormous number of parameter combinations to choose from.

Each evaluation represents a considerable effort in itself. Exploring all the possible combinations of the parameters mentioned above would require a comprehensive research programme and would place an undue burden on the skilled person. To be clear, the undue burden does not originate solely from the breadth of the claim. It is due to the fact that the skilled person has insufficient information on the relevant criteria for finding workable solutions across the whole breadth of the claim, meaning they would have to try and evaluate each and every possible alternative individually. The undue burden also does not stem from the fact that each evaluation alone requires some effort. Instead, it is due to the fact that the skilled person has no guidance from the patent on how to choose a suitable combination from across the claimed breadth to start from. All of this reflects the fact that the

disclosure in the patent is not proportionate to the breadth of the claim, in the sense that the general principle that the protection obtained with the patent has to be commensurate with the disclosed teaching is not respected.

Even if the board were to accept that the example of paragraphs [0035] and [0036] referred to above as "one way" of carrying out the invention was sufficiently disclosed, in the sense that the missing information could be filled in by the person skilled in the art as e.g. in Annex 1, the conclusion would not change. It is, for instance, not apparent to the board if and how a solution developed for outputting coarse information could be improved to output values with the accuracy of 1% required by Figure 4. Furthermore, this example provides no information on the implementation of a system that outputs other types of "values representing compositions", neither in terms of which combinations are reasonable, nor in terms of how they perform.

Accordingly, the disclosure of the patent is so general and incomplete that it does not enable a person skilled in the art to carry out the invention over the claimed breadth without undue burden.

- 3.4 In summary, the patent does not disclose the invention according to claim 1 of the main request in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art. Therefore, maintenance of the patent as granted according to the main request is prejudiced by the ground for opposition under Article 100(b) EPC.

4. The Board would like to point out that, similar to the decisions discussed above (see points 2.4 and 2.5), the

considerations in the present case do not imply any universally applicable "criteria" for assessing sufficiency of disclosure of machine learning inventions.

In particular, not all details that the patent in suit fails to disclose are necessarily required to demonstrate sufficiency of disclosure in other cases. For instance, providing a more detailed specification of certain features might have an indirect impact on others. Clearly defined input and output data might allow the skilled person to deduce the necessary properties of a suitably trained machine learning system and to set it up accordingly. A clearly defined machine learning system might allow the skilled person to infer its suitability for certain applications. A clearly defined application of the obtained result might imply requirements for the input data that the skilled person would take into account.

Therefore, the level of detail with which each relevant aspect of a machine learning invention must be disclosed in a patent cannot be specified in general terms, independently of the individual case.

Auxiliary requests

5. Sufficiency of disclosure, Article 83 EPC

5.1 Auxiliary request 1

Claim 1 of auxiliary request 1 specifies that the invention concerns waste "piled and" stored in a waste pit. The specification that the waste is not only stored but also "piled" in the waste pit, as submitted by the respondent, merely highlighted the difference

between waste stored in a waste pit and individual waste items on a street or a conveyor band, but does not further limit claim 1. Therefore, this amendment has no impact on sufficiency of disclosure as set out for the main request. Accordingly, auxiliary request 1 is not allowable under Article 83 EPC for the same reasons as set out for the main request.

5.2 Auxiliary request 2

Claim 1 of auxiliary request 2 further includes the two alternatives for collecting the training data, as defined in claim 5 as granted.

In the first alternative, the training data is collected from "a value representing a characteristic of waste identified based on operation history of a waste treatment plant".

The term "characteristic" is broader than the term "composition". As the breadth of the definition of the output "value representing composition" was one of the aspects of the Board's objection to the sufficiency of disclosure, this amendment cannot overcome this objection.

The possibility of obtaining such a value based on the operation history of a waste treatment plant was already considered in the interpretation of claim 1 and the reasoning for the main request (see points 1.3 and 1.5). The respondent did not argue that this represented a further limitation either. Accordingly, the additional features of the first alternative in claim 1 of auxiliary request 2 do not overcome the insufficiency of disclosure found for the main request.

The presence of other alternatives in claim 1 of auxiliary request 2 cannot overcome the objection of insufficient disclosure against the amended claim as a whole. As already the first alternative of claim 1 is insufficiently disclosed, it is not meaningful to consider whether this second alternative could be carried out by a skilled person without undue burden.

For these reasons, auxiliary request 2 is not allowable under Article 83 EPC.

5.3 Auxiliary request 3

The same applies to claim 1 of auxiliary request 3. The additional amendment in auxiliary request 3 compared to auxiliary request 2 only concerns the second alternative of claim 1. Claim 1 of auxiliary request 3 thus contains the same, unamended first alternative (Feature M1.5a) as claim 1 of auxiliary request 2.

Accordingly, auxiliary request 3 is not allowable under Article 83 EPC either.

5.4 Auxiliary requests 4 to 7

Auxiliary requests 4 to 7 were filed with the letter of 6 October 2025 in response to the Board's observation in the communication under Article 15(1) RPBA that claim 1 as granted was not limited to waste stored in a waste pit in the context of a waste treatment plant.

Auxiliary requests 4 to 7 correspond, respectively, to the main request and auxiliary requests 1 to 3, with the additional specification of waste stored in a waste

pit "of a waste treatment plant" in the independent claims.

As this limitation was already taken into account in the reasoning set out for the main request (see point 1.3), which also applies to auxiliary requests 1 to 3 (see points 5.1 to 5.3 above), auxiliary requests 4 to 7 do not overcome the objection of insufficiency of disclosure either. Accordingly, they are not allowable on substantive grounds, and the question of their admittance under Article 13(2) RPBA, which the appellant contested, can be left undecided.

5.5 Auxiliary request 8

Auxiliary request 8 was submitted in case the Board decided not to maintain the patent due to a lack of novelty or inventive step starting from D6. The respondent agreed that this was not the case, meaning that the condition for requesting maintenance of the patent in the form of auxiliary request 8 was not met.

6. In view of the foregoing, none of the respondent's claim requests is allowable. The Board thus came to the conclusion that, taking into consideration the amendments made during the opposition (appeal) proceedings, the patent and the invention to which it relates do not meet the requirements of the 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:



L. Stridde

Martin Müller

Decision electronically authenticated