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D E C I S I O N
of 10 December 1997

Case Number: T 0370/95 - 3.4.1

Application Number: 91104637.3

Publication Number: 0450440

IPC: G21C 13/087

Language of the proceedings: EN

Title of invention:

Method of providing extended life expectancy for components of boiling water reactors

Applicant:

General Electric Company

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 56

Keyword:

"Inventive step (yes) - after amendment"

Decisions cited:

-

Catchword:

-



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Beschwerdekammern	Boards of Appeal	Chambres de recours

Case Number: T 0370/95 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 10 December 1997

Appellant: General Electric Company
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Representative: Szary, Anne Catherine, Dr.
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 15 December 1994
refusing European patent application
No. 91 104 637.3 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: H. J. Reich
Members: U. G. O. Himmler
J. van Moer

Summary of Facts and Submissions

- I. The European patent application 91 104 637.3 was refused by a decision of the Examining Division dated 15 December 1994 following two communications of the Examining Division dated 9 November 1993 and 29 April 1994.
- II. The reason given for the refusal was that the subject-matter of the independent claims 1 and 8 filed with letter of 10 August 1994 lacked an inventive step having regard to the state of the art disclosed in documents
- D1: "Thin Films to Impede the Incorporation of Radionuclides in Austenitic Stainless Steels" by H. Ocken et al., published in >>Thin Solid Films<<, 171, (1989), pages 323-334;
- D2: "Protective Coatings for Radiation Control in Boiling Water Nuclear Power Reactors" by T.V. Rao et al., published in >>J.Vac.Sci.Technol.<<, Sect. A, vol. 5, No. 4, (1987), pages 2701-2705;
- D3: US-A-4 842 811
- III. On 10 February 1995 the Appellant filed an appeal against the decision having paid the appeal fee on the same day. It was requested to set aside the disputed decision and to grant a patent with the claims on file or auxiliarily on the basis of amended claims which would be filed with the Grounds of Appeal. In the event of any decision adverse to the Appellant oral proceedings were requested

The Statement of Grounds of Appeal was submitted on 20 April 1995. Together with the Grounds of Appeal the Appellant filed a new set of claims 1 to 10 replacing the claims on file.

- IV. In a communication annexed to the summons to attend oral proceedings dated 30 June 1997, the Board expressed a provisional opinion stating that the subject-matter of device claim 1 as on file was not new in view of the prior art disclosed in document D1 and the subject-matter of method claim 8 did not involve an inventive step with regard to the technical teaching derivable from documents D1 and D2.

Further the Board was of the provisional opinion that the subject-matter of a claim 10 which was directed to the use of the subject-matter of claim 1 did not appear either to involve an inventive step with regard to the state of the art of the documents D1 and D3.

- V. In the reply to the communication of the Board, the Appellant filed, by letter of 25 November 1997, new claims 1 to 3 as main request and withdrew all other sets of claims on file.

- VI. Oral proceedings were held on 10 December 1997 during which the subject-matter of the application was extensively discussed. The Appellant's arguments in favour of inventive step concerning the subject-matter of claim 1 were as follows:

- Document D1 and D2 are not relevant having regard to the subject-matter of claim 1 because both documents refer to the suppression of embedding ⁶⁰Co in oxide layers on the inner surfaces of stainless steel containment, and the resulting surface corrosion. However, this surface corrosion of a stainless steel containment is not comparable

with stress corrosion cracking of a high-temperature, high-pressure containment system: surface corrosion according to documents D1 and D2 concerns a **surface effect** whereas stress corrosion cracking according to the invention concerns a **volume effect**.

- Consequently, the only relevant document is D3 because it is the only document concerned with stress corrosion cracking. However, the stress corrosion cracking in document D3 refers to a recirculating pipe loop and not to a radiation exposed reactor containment. Consequently, the increase of oxidising products such as H_2O_2 , O_2 and OH^- which takes place in the strong radiation field of a reactor core, does not occur in the recirculating pipe loop of document D3. Furthermore, according to the invention Palladium influences the reaction on the surface of the reactor containment whereas in document D3 Palladium has an effect on the cooling fluid in order to reach a chemical water conditioning.

Therefore, the Appellant concluded that the concept of reducing the stress corrosion cracking in a high-temperature, high-pressure containment of a boiling water reactor

- by providing a corrosion potential at the internal surface of the containment (such a measure is nowhere described in the state of the art) below a critical value of $-230mV$ versus the standard hydrogen electrode, and

- by coating the internal surface of the containment with a deposit of at least 0,03 micrometers of at least one metal of the platinum group of metals

is new and not obvious from the cited state of the art.

VII. Independent claims 1 and 3 as amended and filed during oral proceedings on 10 December 1997, forming the basis of the present decision read as follows:

Claim 1

"1. A method of reducing the stress corrosion cracking of a high-temperature, high pressure containment system of a boiling water reactor by providing a corrosion potential at the internal surface of said containment below a critical value of -230mV versus the standard hydrogen electrode, which method comprises coating the internal surface of said containment with a thin deposit of at least 0.03 micrometers of at least one metal of the platinum group of metals, and dissolving sufficient hydrogen gas in the water of said boiling water reactor to bring the corrosion potential below said critical value."

Claim 3

"3. The use of a coating of a metal of the platinum group of metals on the surfaces of a stainless steel containment of a boiling water nuclear reactor exposed to high temperature, high pressure water, for reducing stress corrosion cracking of the containment in combination with the use of sufficient hydrogen gas in the water of said boiling water reactor to achieve a corrosion potential below a critical value of -230mV versus the standard hydrogen electrode."

Reasons for the Decision

1. The appeal complies with the requirements of Article 106 to 108 and Rule 64 EPC and is, therefore, admissible.

2. *Amendments and original disclosure*

The amendments introduced in claim 1 in comparison to the originally filed claim 15 and the corresponding amendments in claim 3 concern the features that

- (a) it is a "high pressure" containment system
- (b) "of a boiling water reactor providing a corrosion potential at the internal surface of said containment below a critical value of -230mV versus the standard hydrogen electrode" and that
- (c) the deposit of said at least one metal of the platinum group of metals having "at least 0.03 micrometers"; and
- (d) dissolving "sufficient" hydrogen gas in the water of said boiling water reactor "to bring the corrosion potential below said critical value".

The corresponding disclosure of these features can be found in the originally filed documents in

- (a) claim 5;
- (b) page 4, line 20 to page 5, line 3 and page 6, line 17 to 32;

(c) page 17, line 16.

(d) page 7, line 19 to page 8, line 17.

3. *Novelty*

Novelty of the subject-matter of claims 1 and 3 was not in dispute as neither D1 nor D2 nor D3 comprises all the features of one of these claims.

4. *Inventive step*

4.1 When the person skilled in the art is confronted with the problem of avoiding stress corrosion cracking of a high temperature, high pressure containment of a boiling water reactor the skilled person will realize that neither document D1 nor document D2 is concerned with this problem:

- **Document D1** concerns, inter alia, the suppression of developing ⁶⁰Co-embedded oxide layers on the inner surfaces of austenitic stainless steel containment exposed to a simulated boiling water reactor environment. This aim is achieved by coating the inner surfaces which are in contact with the oxygen-rich water of boiling water reactors, with an electroless layer of palladium. It was found that this palladium layer prevents the building-up of an oxide layer incorporating radioactive nuclides such as ⁶⁰Co.

Furthermore, it is reported in document D1 that the thin surface film of palladium increases the corrosion resistance of stainless steels. However, this increased corrosion resistance refers to surface corrosion by which one surface layer is removed after the previous one had been removed.

In contrast to the surface corrosion the stress corrosion cracking does not take place on the surface but **within** the wall and always only together with stress, so that surface corrosion is a surface effect whereas stress corrosion cracking is a volume effect. As there is no mentioning of stress corrosion cracking in document D1 the person skilled in the art could not derive any incentive to take the measures indicated in claim 1 because the surface corrosion process works in a completely different manner as the stress corrosion cracking process. The normal surface corrosion which takes place exclusively on the surface of the material exposed to the corrosive environment effects an impact only on the surface layer of the material and any kind of stress is not involved.

Contrary to the normal surface corrosion the stress corrosion cracking process takes place in the volume and not on the surface of the material and does not occur in the absence of stress in combination with a corrosive environment.

- **Document D2** - similarly as document D1 - refers to the protection against the incorporation of radioactive ^{60}Co by coating the stainless-steel surface with a protective thin film of Palladium. This protective layer was found also to be a good protection against surface corrosion if the protective layer was fairly thick, i.e. in the order of about 1 μm . This document does not mention the stress corrosion cracking process either.

4.2 The Board considers **document D3** to be the closest state of the art because it is the only document which is concerned with the problem of avoiding stress corrosion cracking in a recirculation line of a boiling water reactor system.

The problem is solved according to this document by introducing hydrogen gas into the recirculation loop coolant water and bringing the hydrogen enhanced coolant water into contact with a catalyst, such as platinum or palladium dispersed on a solid carrier, in order to enhance the reaction of the hydrogen gas with the oxygen dissolved in the coolant water. This dissolved oxygen is disclosed to be one of the main causes of the stress corrosion cracking. By removing the oxygen from the coolant water the radiolysis in the reactor core is suppressed. Radiolysis is known to take place in the **volume** of the coolant water by increasing the concentration of oxidizing products such as H_2O_2 , O_2 and OH^- .

4.3 Hence, the main differences between the present invention according to claim 1 and the state of the art according to document D3 is that

- according to the present invention the palladium layer is coating the surface of the reactor containment and works as a surface protective layer. Only the **coated surface** of the containment reacts with hydrogen gas and therefore, the invention incorporates a surface effect of the containment system itself having regard to the hydrogen gas. On the contrary, according to document D3 the palladium is dispersed on a solid carrier (cf. column 4, lines 50 to 52 of D3) such as polystyrene-based ion exchange resin in an ion exchange catalytic reactor (reference sign 43 in Figure 2 of D3) and works as a catalyst outside of

the radiation exposed reactor core in order to influence the chemical processing of the coolant water and refers to the radiolysis within the coolant water **volume**.

- Document D3 is silent about any influence of a corrosion potential on stress corrosion cracking, in particular it does not mention the advantage to work below a critical value of a corrosion potential at the internal surface of the reactor containment. Therefore, the person skilled in the art could neither derive any incentive from this document to bring the corrosion potential below such critical value nor could the skilled person derive from this document the necessary measures to be taken in order to achieve this effect, i.e. to deposit a coating on the internal surface of the reactor containment of at least 0.03 micrometers of one metal of the platinum group of metals and to dissolve sufficient hydrogen gas in the water of said boiling water reactor, as required by claim 1.

- 4.4 As neither the closest art document D3 nor any other document cited in the search report or during examination procedure gives any hint in the direction of increasing the stress corrosion cracking resistance by bringing the corrosion potential below a critical value and that a coating deposition on the internal surface of the reactor containment "of at least 0.03 micrometers" of one metal of the platinum group of metals is sufficient if a certain amount of hydrogen gas is dissolved in the water of said boiling water reactor, therefore, in the Board's view the subject-matter of claim 1 involves an inventive step.

5. The same considerations apply to the subject-matter of the independent claim 3 which refers to the use of a coating of a metal of the platinum group of metals in combination with the use of hydrogen gas according to the method claim 1 for reducing stress corrosion cracking of the containment.
6. The dependent claim 2 concerns a particular embodiment of the subject-matter of claim 1, therefore , it is allowable in accordance with Rule 29(3) EPC.

Order

For these reasons it is decided that:

1. The decision of the Examining Division is set aside.
2. The case is remitted to the first instance with the order to grant a patent on the basis of claims 1 to 3 filed on 10 December 1997.
3. The description has to be adapted by the first instance.

The Registrar:

The Chairman:

M. Beer

H. J. Reich