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D E C I S I O N
of 12 November 2004

Case Number: T 0061/02 - 3.4.1

Application Number: 95100314.4

Publication Number: 0667539

IPC: G01T 1/172

Language of the proceedings: EN

Title of invention:

Method for measuring gamma-rays of radionuclides, particularly
in primary water of nuclear reactor

Patentee:

NUCLEAR ENGINEERING, LTD.

Opponent:

Framatome ANP GmbH

Headword:

Measuring gamma-rays of radionuclides in the primary coolout
of a nuclear reactor/NUCLEAR ENGINEERING LTD.

Relevant legal provisions:

EPC Art. 123(2), (3), 56

Keyword:

"Inventive step (no)"

Decisions cited:

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Catchword:

-



Case Number: T 0061/02 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 12 November 2004

Appellant: Framatome ANP GmbH
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Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 21 November 2001
rejecting the opposition filed against European
patent No. 0667539 pursuant to Article 102(2)
EPC.

Composition of the Board:

Chairman: G. Davies
Members: H. K. Wolfrum
R. Q. Bekkering

Summary of Facts and Submissions

I. The appellant (opponent) lodged an appeal against the decision of the opposition division, dispatched on 21 November 2001, rejecting the opposition against European patent No. 0 667 539. The notice of appeal was received on 12 January 2002 and the prescribed fee was paid on the same day. On 21 March 2002 a statement of grounds of appeal was filed.

II. The opposition was based on the ground of Article 100(a) EPC and substantiated on the ground of lack of inventive step (Articles 52(1) and 56 EPC). As regards the prior art, the following documents were cited:

O1: US-A-3 849 655;

O2: F.R. Markwell et al: "Active Sample Anticoincidence Guarded Ge(Li) Spectrometer for Environmental Radionuclide Analysis" in TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY, vol. 15, no. 2, November 1972, page 639; and

O3: R.L. Auble et al : "Coincidence-Anticoincidence Gamma-Ray Spectroscopy with a NaI(Tl) Split Annulus and a Ge(Li) Detector, in NUCLEAR INSTRUMENTS AND METHODS; vol. 51, 1967, pages 61-71.

III. Oral proceedings were held at the parties' request on 12 November 2004.

IV. The appellant requests that the contested decision be set aside and the European patent revoked in its entirety.

V. The respondent (patent proprietor) requests that the appeal be dismissed and the patent maintained on the basis of the following documents :

claims: 1 to 8 filed on 12 October 2004,

description: pages 1, 2, 4 and 5 of the patent as granted,
page 3 as filed on 12 October 2004,

drawings: Figures 1 to 3 of the patent as granted.

VI. Independent claim 1 on file reads as follows:

"1. A gamma-ray spectrometric arrangement for measuring selectively gamma-rays of radionuclides in a primary coolant, said radionuclides further containing b^+ -decaying radionuclides each emitting a pair of annihilation gamma-rays in diametrically opposite directions, comprising a primary detector (1) for detecting photons of the gamma-rays and photons of the one annihilation gamma-rays in the one direction, a secondary detector (2) for detecting at least photons of the other annihilation gamma-rays in the opposite direction, a shield detector (3) for detecting Compton-scattered photons of the gamma-rays escaped from the primary detector to the shield detector, and an anticoincidence circuit (11) connecting the primary, secondary, and shield detectors (1,2,3), the primary detector (1) and the secondary detector (2) being

located in opposed manner relative to the axis of a pipe (P) through which the primary coolant flows, the shield detector (3) surrounding the primary detector (1) except for its portion facing the pipe (P) on which the gamma-rays and the annihilation gamma-rays are incident."

Independent claim 5 on file reads as follows:

"5. A method for measuring selectively gamma-rays of radionuclides in a primary coolant, which further contain β^+ -decaying radionuclides each emitting a pair of annihilation gamma-rays in diametrically opposite directions, by the use of a gamma-ray spectrometric system which includes a primary detector (1), a secondary detector (2), a shield detector (3) and an anticoincidence circuit (11) connecting the primary, secondary, and shield detectors (1,2,3), the primary detector (1) and the secondary detector (2) being located in opposed manner relative to the axis of a pipe (P) through which said primary coolant flows, the shield detector (3) surrounding the primary detector (1) except for its portion facing the pipe (P) on which the gamma-rays and the annihilation gamma-rays are incident, which method comprises:

detecting the photons of the gamma-rays and the photons of the one annihilation gamma-rays on the primary detector as pulses while detecting the photons of the other annihilation gamma-rays on the secondary detector as pulses;

counting the pulses of the secondary detector in anticoincidence with the pulses of the primary detector thereby to reject the recording of the pulses of the annihilation gamma-rays from the primary detector, thus

minimizing the count of annihilation gamma-rays on the primary detector;

simultaneously detecting the Compton-scattered photons of the gamma-rays on the shield detector as pulses; and

counting the pulses of the shield detector in anticoincidence with the pulses of the primary detector thereby to reject the recording of the Compton-scattered gamma-rays from the primary detector, whereby the count of Compton-scattered gamma-rays on the primary detector are also diminished; and

subsequently determining count numbers of the gamma-rays."

Claims 2 to 4 and 6 to 8 are dependent claims.

VII. The appellant essentially relied on the following submissions:

The subject-matter of the independent claims on file lacked inventive step in view of a combination of the teachings of documents 01 and either 02 or 03. In the technical field at issue the skilled person was an expert in safety related diagnosis and analysis of nuclear facilities. For such a skilled person it was a standard task to monitor the operation of the nuclear facility by routinely checking for the presence of radionuclides and, for this purpose, to record gamma-spectra of radionuclides by making use of coincidence as well as anticoincidence detection techniques.

Document 01 did not only teach to use a gamma-ray measuring spectrometric arrangement comprising primary and secondary detectors, being oppositely arranged and connected to a coincidence circuit for selectively

detecting the presence of certain β^+ -decaying nuclides which were particularly suitable indicators of leakages in the coolant system, such as ^{13}N , but also pointed to non- β^+ -decaying radionuclides as a further source of gamma-photons being fission products and released into the primary coolant upon failure of a fuel element cladding within the reactor core. Starting from O1 it was obvious to the skilled person, being faced with the task of monitoring non- β^+ -decaying radionuclides, to evaluate the counts of the pair of oppositely arranged detectors of the known arrangement in anticoincidence so as to suppress the counts from the β^+ -decaying nuclides. Moreover, the skilled person was aware from each of documents O2 and O3 about the possibility to additionally suppress the Compton background by means of a shield detector surrounding a primary detector and an anticoincidence circuit connecting the two detectors.

VIII. The respondent's arguments may be summarised as follows:

There was no suggestion in the prior art on file which would have rendered obvious the particular combination of features according to the present invention. The appellant's submission was based on unproven allegations and an analysis made with the benefit of hindsight. Document O1 taught in fact away from the invention in that it was concerned with a specific problem, namely the surveillance of the integrity of the cooling system of a nuclear reactor, and taught a particular solution consisting of detecting in the gas of the reactor containment trace amounts of specific β^+ -decaying nuclides, namely N^{13} or F^{18} , by means of a coincidence detection, which differed from the problem

and solution of the present patent. In addition to being suitable only for measuring a specific non-fission type of radionuclide at a different location, the known arrangement did also not contain a shield detector for suppressing Compton-scattered gamma-photons. Starting from the teaching of O1, the objective technical problem to be solved by the subject-matter of the invention was to monitor the reactor coolant for the presence of radioactive fission materials in the reactor coolant originating from nuclear fuel elements in the core of the reactor whose cladding had ruptured. The prior art on file did not provide any evidence that surveillance of the reactor core for rupture of fuel claddings was a standard problem. Corresponding remarks in the patent specification could not be construed as reflecting the skilled person's knowledge at the priority date. Moreover, the solution according to the present invention required information about several important items which was not available in the cited prior art. These items particularly concerned knowledge about the nature of the fission materials in the core of a reactor whose cladding had ruptured; as to whether the detection of such fission materials would present any problems in respect of other sources of radiation in the reactor coolant; about the energy and intensity of radiation used for detecting the fission materials in question; as to whether the radiation to be detected was masked by the radioactive decay of N^{13} or F^{18} forming the detection scheme of document O1; and as to whether other sources of interference due to other radiation effects were present.

Documents 02 and 03 concerned gamma-ray spectrometers for performing coincidence or anticoincidence experiments. They were not concerned with measuring selectively gamma-rays of radionuclides in the primary coolant of a reactor and, in particular, did not provide any indication that Compton scattering could have an influence on the detection of the fission radionuclides.

IX. In its decision, the opposition division considered the skilled person to have all usual tools at his disposal for gamma-photon spectrum analysis and that it would have been obvious for the skilled person to employ anticoincidence circuitry in a system in which the gamma-rays of β^+ -decaying nuclides were to be screened out of the counting system.

However, starting from 01, it would not have been obvious to pose a problem of analysing the measurement spectrum for non-positron-emitting radionuclides. Using a general desire for spectrum analysis as an alternative starting point for a problem-solution-analysis, the division held that no evidence had been submitted to indicate that spectra were produced for a primary coolant and, furthermore, that no indication was given in the prior art citations that non- β^+ -decaying radionuclides could be of interest. Therefore, the opposition division concluded that the skilled person received no suggestion from the prior art that leakage could be detectable by analysing for other radionuclides nor as to how a gamma-ray detection device had to be arranged so as to exclude the positron-emitting radionuclides from the spectral count.

Reasons for the Decision

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

2. *Amendments*

2.1 The amendments concern independent claim 5, which is a combination of claims 5 and 6 of the patent as granted, and concern a corresponding adaptation of the description to the subject-matter of the amended claim.

Dependent claims 6 to 8 correspond to claims 7 to 9, respectively, of the patent as granted.

2.2 The amendments do not introduce subject-matter which extends beyond the content of the application documents. Moreover, the amendment to claim 5 limits the scope of protection with respect to that of claim 5 as granted.

Therefore, the amendments comply with the requirements of Articles 123(2) and 123(3) EPC.

3. *Inventive step (Articles 52(1) and 56 EPC)*

3.1 It is not in dispute that document O1 can be regarded as representing the closest prior art.

The document discloses a gamma-ray spectrometric arrangement and method for surveillance of a nuclear power plant by measuring selectively gamma-rays

originating from β^+ -decaying radionuclides (see in particular Figures 1 to 3). The arrangement comprises at least one primary detector for detecting photons of the one annihilation gamma-rays in the one direction, at least one secondary detector for detecting photons of the other annihilation gamma-rays in the opposite direction, and a coincidence circuit in connection with the primary and secondary detectors.

The teaching of O1 is predominantly concerned with the early and sensitive detection of leakages of radioactive material from the primary coolant into either the containment atmosphere, the secondary heat exchange fluid, the auxiliary buildings or into the external atmosphere (column 1, lines 7 to 13 and 36 to 51; column 2, lines 57 to 60; column 5, lines 18 to 28) and based on the recognition that in particular the β^+ -decaying nuclides N^{13} and F^{18} are suitable indicators for the occurrence of such leakages (column 3, lines 1 to 7; column 4, lines 15 to 38; column 6, lines 40 to 51). A sample of the containment air may be taken from a general position within the reactor containment building or from any number of local positions around the primary and secondary coolant systems where leakage is suspected or where leakage is likely to occur and may be delivered to a detection site by a sample delivery tube or pipe (column 5, lines 29 to 37) so that specific leak location is possible with the coincidence detector system (column 6, lines 55 to 59). The passage of sampled air or fluid through the sample tube or duct is monitored with the primary detector and the secondary detector being located in opposed manner relative to the axis of the tube (column 6, lines 60 to 62; Figure 3).

The document mentions various sources of radionuclides in the primary coolant, including in particular radionuclides being fission products which are released into the coolant from fuel elements with ruptured fuel claddings (column 1, lines 23 to 26) and radionuclides (such as the β^+ -decaying nuclides N^{13} and F^{18}) formed by exposure of the coolant to neutron and proton flux in the reactor core (column 1, lines 18 to 20; column 2, lines 60 to 67; column 4, lines 5 to 14). In this context, it is expressly mentioned that the proposed coincidence detection of gamma-ray photons does not "see" and count any fission radionuclides originating from ruptured fuel element claddings (column 3, lines 4 to 7; column 4, lines 32 to 38).

- 3.2 In distinction to the arrangement known from 01, the arrangement according to claim 1 of the patent in suit is designed to detect selectively gamma-rays of radionuclides which are non- β^+ -decaying radionuclides, due to the provision of an anticoincidence circuit connecting the primary and secondary detectors.

In this context, claim 1 specifies that these radionuclides are detected within the primary coolant. However, as is apparent from dependent claim 4 and the description in column 7, lines 11 to 16, according to which the "*primary coolant may be one of steam of a secondary system and drain water of a primary coolant*", the patent does not use the term "*primary coolant*" in its strict conventional sense of meaning the primary cooling system of the core of a nuclear reactor. Rather the term has to be construed as referring to the cooling system in general of a nuclear reactor, within

which the radionuclides to be detected may exist. Thus, the wording of claim 1 merely requires that the claimed arrangement is suitable for detecting radionuclides within a pipe, tube or duct, such as that of a primary or secondary coolant circuit. This requirement, however, is met by the arrangement known from document O1 (see for instance column 6, lines 60 to 62) and hence cannot be regarded as a distinguishing feature for the claimed subject-matter.

In consequence, the subject-matter of claim 1 under consideration differs from the gamma-ray spectroscopic arrangement according to document O1 in that the primary and secondary detectors are connected by an anticoincidence circuit so as to suppress the counts of gamma-rays originating from β^+ -decaying radionuclides and hence to detect the presence of non- β^+ -decaying radionuclides, and in that it further comprises a shield detector also connected in anticoincidence with the primary detector so as to eliminate counts due to Compton-scattered gamma-photons.

- 3.3 Based on these differences, the objective problem underlying claim 1 of the patent in suit may be seen in the task of providing a gamma-spectroscopic arrangement capable of monitoring the coolant system of a nuclear reactor for the presence of non- β^+ -decaying radionuclides occurring in small concentrations, so as to detect, for instance, radioactive fission materials in the reactor coolant originating from nuclear fuel elements in the core of the reactor whose cladding has ruptured.

3.4 In this respect, it is known from document O1 that non- β^+ -decaying radioactive fission materials would be present in the primary (and, possibly, the secondary) cooling system of a reactor, where they would constitute a source of gamma-rays when claddings of fuel elements become ruptured. Thus, notwithstanding the fact that the teaching of O1 is as such concerned with the task of monitoring the integrity of the cooling system and suppressing for this purpose the gamma-ray counts of non- β^+ -decaying radionuclides, the document nevertheless provides viable information concerning the occurrence of ruptured fuel claddings and the ensuing release of non- β^+ -decaying radionuclides indicative of such ruptures into the primary coolant.

Moreover, given the fact that a close monitoring in particular of the physical and chemical conditions of the reactor core is an indispensable prerequisite for operating a nuclear reactor, the Board considers surveillance of the integrity of fuel elements a standard task for a skilled person entrusted with devising systems and methods for monitoring the proper operation of nuclear power plants, as is confirmed in column 1, lines 18 to 23 of the specification of the patent in suit. In the Board's view, monitoring of the integrity of fuel elements and monitoring of the integrity of the cooling system constitute complementary aspects of the necessity of supervising the safe operation of a nuclear power plant.

For these reasons, the Board is convinced that, contrary to the finding of the opposition division, the recognition of the aforementioned objective problem

does not require the benefit of hindsight or the exercise of any inventive skills.

- 3.5 The Board agrees however with the opposition division that the skilled person, when faced with the task of monitoring the coolant system for the presence of radioactive fission materials, would have all usual tools at his disposal.

In particular, it is considered common general knowledge of the skilled person that the spectrum obtained from the counts of a gamma-ray detector in the vicinity of the primary coolant of a nuclear reactor would be composed of signals at characteristic energies from β^+ -decaying radionuclides as well as non- β^+ -decaying radionuclides, on which a background of Compton-scattered gamma-photons would be superposed. Hence, when looking specifically for the presence of non- β^+ -decaying fission radionuclides, the skilled person would be aware that the counts arising from pairs of annihilation gamma-rays would constitute an undesirable source of noise in the measured gamma spectrum.

The detectors in the spectrometric arrangement of O1 inevitably count the gamma-rays of all types of sources (see column 1, lines 13 to 30). The reason why the teaching of O1 is interested in selecting specifically the counts from the annihilation gamma-rays and thus discards the counts from other radionuclides lies in the fact that the β^+ -decaying radionuclides are found to be indicative of the integrity of the coolant system. However, when faced with the task of searching the coolant system for radionuclides indicative of a rupture of fuel claddings, and knowing from O1 about

the fact that coincidence of the annihilation gamma-ray-pairs from β^+ -decaying radionuclides is used for efficiently discriminating the corresponding signal counts against the counts from the non- β^+ -decaying radionuclides, it would be immediately evident for the skilled person that an evaluation of the signal counts received by the oppositely arranged primary and secondary detectors by means of the complementary tool of an anticoincidence circuit would effectively suppress the signal from the former type of radionuclides and leave as signal counts only the counts from the latter type.

3.6 As regards the undesired signal background from Compton-scattered gamma-rays, the skilled person would have known from each of documents O2 and O3 that Compton background is effectively reduced when a primary detector and a surrounding shield detector are connected in anticoincidence.

3.7 The respondent has further stressed the point that the prior art did not provide any information as to the nature of the fission products and the circumstances of their detection via gamma-ray spectroscopy so that the skilled person had no indication as to which location and intensity in the energy spectrum the gamma-ray signals were to be expected and which sources of noise would possibly mask the signal.

In the Board's view, no distinction exists in this respect between the prior art and the subject-matter of claim 1 under consideration. First of all it is noted that the claimed spectroscopic arrangement is not limited to the detection of specific radionuclides as

long as their gamma-rays are not pairs of annihilation photons. Nor would the spectroscopic arrangement known from O1 miss the gamma-ray counts from any type of radionuclide. Secondly, it is not conceivable that the skilled person in the technical field at issue would be unaware of the nature and type of fission products generated in the fuel elements and the associated type of radioactivity. Hence being faced with the task to detect fission radionuclides by means of their characteristic gamma radiation, the skilled person would have all the necessary spectroscopic information at his disposal.

- 3.8 For the above reasons, the Board comes to the conclusion that the teaching of document O1 together with that of either O2 or O3 in combination with common general knowledge would lead the skilled person to a gamma-ray spectrometric arrangement falling within the terms of claim 1 under consideration. of the patent as granted.

Therefore, the subject-matter of claim 1 does not involve an inventive step as required by Articles 52(1) and 56 EPC.

4. Accordingly, the respondent's request is not allowable.

Order

For these reasons it is decided that :

1. The decision of the opposition division is set aside.
2. The patent is revoked.

The Registrar

The Chairman

A. Vottner

G. Davies