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**D E C I S I O N**  
**of 14 February 2002**

**Case Number:** T 0672/97 - 3.4.1

**Application Number:** 92102529.2

**Publication Number:** 0501259

**IPC:** G21C 3/324

**Language of the proceedings:** EN

**Title of invention:**

Fuel assembly with channel box

**Patentee:**

Hitachi, Ltd., et al

**Opponent:**

Framatome ANP GmbH

**Headword:**

Fuel assembly with channel box/HITACHI, LTD.

**Relevant legal provisions:**

EPC Art. 56

**Keyword:**

"Inventive step (no; main request and auxiliary request)

**Decisions cited:**

-

**Catchword:**

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Case Number: T 0672/97 - 3.4.1

**D E C I S I O N**  
of the Technical Board of Appeal 3.4.1  
of 14 February 2002

**Appellant:** Framatome ANP GmbH  
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**Respondent:** Hitachi, Ltd.  
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**Representative:** Beetz & Partner  
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**Decision under appeal:** Decision of the Opposition Division of the  
European Patent Office posted 18 April 1997  
rejecting the opposition filed against European  
patent No. 0 501 259 pursuant to Article 102(2)  
EPC.

**Composition of the Board:**

**Chairman:** G. Davies  
**Members:** H. K. Wolfrum  
M. G. L. Rognoni

## Summary of Facts and Submissions

- I. The appellant (opponent) lodged an appeal against the decision of the opposition division, dispatched on 18 April 1997, rejecting the opposition against European patent No. 0 501 259. The notice of appeal and the statement setting out the grounds of appeal were received on 17 June 1997, the prescribed fee being paid on the same day.
- II. Opposition had been filed against the patent as a whole and based *inter alia* on Article 100(a) together with Articles 52(1) and 56 EPC.
- III. Oral proceedings were held on 14 February 2002.
- IV. The appellant requested that the decision under appeal be set aside and that the patent be revoked. Reference was specifically made to the following documents:
- D1:** EP-A-0 315 929;
- D4:** US-A-3 715 274;
- D5:** US-A-4 749 544; and
- D6:** US-A-4 749 543.
- V. The respondent requested that the appeal be dismissed and that the patent be maintained on the basis of claims 1 to 10 filed on 14 January 2002 and description and figures to be adapted (main request) or claims 1 to 8 filed in the oral proceedings (auxiliary request).

VI. **Claim 1** of the main request reads as follows:

"1. A fuel assembly comprising

an upper tie plate (7),

a lower tie plate (8),

a plurality of fuel rods, wherein each of upper end and lower end of the fuel rod (3) are supported by said upper tie plate (7) and said lower tie plate (8), respectively, having at least a natural uranium region (4B) containing natural uranium at lower end portion, and a region (4A) containing enriched fissile material above the natural uranium region (4B),

a channel box (2, 2A), which is fixed to said upper tie plate (7), surrounding the bundle of said fuel rods (3) and said lower tie plate (8), and

the wall thickness at the lower thick wall region (2a) of said channel box (2, 2A) is thicker than the wall thickness at the region (2c) located upward from the lower thick wall region (2a) and between the corner portions (2b) of said channel box (2, 2A), characterized in that

the wall thickness of said lower thick wall region (2a) is uniform all through its cross-sectional circumference,

*the upper end (12) of said lower thick wall region (2a) is located above the top side of said lower tie plate (8) and below the upper end of said natural uranium region (4B), and in that*

*the axial length (Ld) of the lower thick wall region (2a) is larger than the axial length (H) of the fitting of the channel box (2) with the lower tie plate (8)."*

Claim 1 of the auxiliary request further defines that *"the axial length (Ld) of the lower thick wall region (2a) is at least 1.5 times of an axial length (H) of the fitting of the channel box (2, 2A) with the lower tie plate (8) in an assembled state."*

VII. The appellant argued that the subject-matter of claim 1 was rendered obvious by the prior art as given by documents D1 and D4 to D6.

The patent addressed several technically unrelated problems. One aspect concerned the stability of the channel box of a fuel assembly against mechanical loads caused internally by radiation effects and a pressure differential between the inside and the outside of the channel or externally during an earthquake. In particular, as a consequence of the pressure load, the channel box could be deflected away from the lower tie plate resulting in an undesirable variation of the leakage flow of the coolant between the channel box and the lower tie plate. Another aspect was fuel economy. These two aspects constituted conflicting requirements because material added to the walls of the channel box for increasing the mechanical stability thereof would

act as a parasitic absorber of neutrons and thus reduce the fuel economy. The invention concerned an optimization between these requirements. However, because of the fact that both problems and the principles of their solutions were known in the prior art, the invention was a non-inventive agglomeration of known measures and did not involve any combinatory effect. More specifically, document D4 taught to increase the wall of the channel box in the region of interface with the lower tie plate so as to keep constant the leakage flow during the lifetime of the fuel assembly. From documents D5 and D6, the skilled person knew about the conflict between the need for improving the mechanical stability by reinforcing the structure of the channel box and the desire to reduce parasitic neutron absorption by the walls of the channel box, as well as about the solution principle to reduce the wall thickness specifically in the region of overlap with the fuel where mechanical stress was lowest. Finally, document D1 taught that fuel rods having natural uranium regions at their ends showed a reduced leakage of neutrons in axial directions and thus an increased fuel economy.

The additional feature of claim 1 according to the auxiliary request did not concern a universally valid teaching because the total length of the thickened wall region for which no further reduction in the variation of the leakage flow was observed depended on various parameters which were not addressed in the claim and the patent, such as the absolute thickness of the wall or the length of overlap between the channel box and the lower tie plate. Moreover, the claimed feature related to a straightforward task of properly dimensioning the region of increased wall thickness. In

this context, D5 indicated an extension of a region of increased thickness at the bottom of the channel box which appeared to lie within the claimed range.

VIII. The respondent disputed the appellant's view, relying on the following arguments:

The appellant's line of reasoning did not do justice to the invention since it had failed to identify the closest prior art and to properly assess the objective problem. The cited prior art documents related to isolated teachings, respectively, and did not provide any pointers to the claimed subject-matter. The invention was based on fuel assemblies of fuel rods having natural uranium regions at their ends. Although document D1 referred in passing to fuel rods with natural uranium ends, it did not mention a channel box at all. On the other hand, none of documents D4 to D6, which were concerned with details of the structure of the channel box, taught to use fuel rods of this specific type. Since in fuel rods of conventional design the fuel extended close to the lower tie plate, structural reinforcements of the channel box had to be limited to the region of overlap with the lower tie plate so as not to impede the flux of neutrons by the material of the channel box. An example for such a channel box, in which the lower thick wall had to end at the top side of the lower tie plate, was given by document D4. It was only the specific choice of fuel rods with natural uranium ends which allowed to contemplate an extension of the reinforcement above the top side of the lower tie plate so as to reduce undesirable variations of the leakage flow. Therefore, the two measures, i.e. the use of the specific type of fuel rods and the extension of the thick wall region

above the top side of the lower tie plate but not so far as the upper end of the natural uranium region at the lower ends of the fuel rods, were closely related. Since one measure presupposed the other, the invention was based on a combination of features having a synergistic effect which was not foreseen in any of the prior art fuel assemblies. In distinction to the prior art design of the channel box, the provision of a thick wall region of extended length at the bottom of the channel box allowed to reduce the wall thickness and thus to closer pack the fuel assemblies in a reactor.

Claim 1 of the auxiliary request further emphasized the distinction between the claimed design of the channel box and the conventional design having reinforcements only in the region of overlap with the lower tie plate. The inventors had undertaken detailed experiments to determine at which limit an increase in the length of the thickened region would not improve the long term stability of the leakage flow.

### **Reasons for the Decision**

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC and is therefore admissible.
2. *Amendments*

Claim 1 of the main request is based on claim 1 of the patent as granted and amended by the addition of features concerning the uniformity of the wall thickness and the relationship between the axial length of the lower thick wall region and the axial length of the fitting of the channel box with the lower tie

plate. The first feature is disclosed in column 5, lines 37 to 41, and Figure 4 of the published application documents, whereas the second feature is unambiguously apparent from original Figure 5.

The additional feature given in claim 2 of the main request and claim 1 of the auxiliary request is based on Figure 10 and the corresponding description in column 8, lines 53 to 56 of the application as published by a uniform wall thickness if the corner portions would have a different thickness.

Further amendments made in the requests on file are of clerical nature.

The Board is thus satisfied that, for the purpose of this decision, the proposed amendments comply with the requirements of Articles 123(2) and 123(3) EPC.

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

3.1 Main request

3.1.1 In view of the fact that the characterizing part of claim 1 is exclusively concerned with the design of the channel box and that the added features specifically serve for the purpose of safeguarding a constant leakage flow of the coolant throughout the fuel cycle, the Board considers document D4, which addresses the same problem, to constitute the closest prior art.

Document D4 (cf. claims 1 and 4; Figures 4a, 5a and 7 with the corresponding description and in particular column 2, lines 34 to 39, and column 4, lines 35 to 54) shows a fuel assembly comprising an upper tie plate, a

lower tie plate, a bundle of fuel rods, the upper and lower ends of which are supported by the upper tie plate and the lower tie plate, respectively, and a channel box (termed "*flow channel*"), which is fixed to the upper tie plate and surrounds the bundle of fuel rods and the lower tie plate. D4 teaches to increase the wall thickness of the channel box at the bottom thereof in the region of the interface with the lower tie plate so as to keep constant the gap between the inner wall of the channel box and sidewall of the lower tie plate, and thus the leakage flow of the coolant, throughout the fuel cycle lifetime. In this context, D4 shows in Figures 4a and 5a specific embodiments for which the wall thickness of the lower thick wall region is uniform all through its cross-sectional circumference.

3.1.2 The subject-matter of new claim 1 differs from the fuel assembly known from D4 in that

- (a) the fuel rods have a natural uranium region at their lower end portions, and
- (b) the upper end of the lower thick wall region is located below the upper end of the natural uranium region.

In this context, it is noted that the last feature of the characterizing part of claim 1 relating to the axial length of the lower thick wall region is to be considered as an immediate consequence of the preceding feature specifying the location of the upper end of the lower thick wall region and, thus, does not define an additional technical aspect of the claimed subject-matter.

3.1.3 As regards difference (a), the teaching of document D4 is exclusively concerned with the design of the channel box and is silent on the type of fuel rods to be used for the assembly. Hence, in order to complete the known fuel assembly, the skilled person is faced with the task to select a suitable type of fuel rods. Since the structure of the known channel box is obviously applicable to any type of nuclear fuel rods to be held between upper and lower tie plates, no inventive skill would be required to choose among conventional designs of fuel rods and thus to select for instance a type known from document D1 (cf. in particular Figure 8 and column 13, lines 29 to 33) to possess a natural uranium region at its lower end portion, thereby promising a reduced leakage rate of neutrons downward and outward from the reactor core and thus an improved fuel economy.

3.1.4 The technical effect associated with aforementioned difference (b), and thus

the main aspect of the objective problem underlying the invention, is a further enhancement of the mechanical stability of the bottom of the channel box by avoiding, however, an increased parasitic neutron absorption by the walls of the channel box.

In this context, it is noted that the teaching of D4 is not specific as to the exact location of the upper end of the thick wall region. As a matter of fact, the corresponding indication in D4 (cf. column 2, lines 34 to 39) "*providing reinforcing ... of the lower end of the flow channel in the region of the interface between the flow channel and the lower tie plate to enhance control of leakage flow between the channel and*

*the lower tie plate*" is not a precise definition of the length of the thick wall region with respect to the top side of the tie plate and, therefore, cannot be interpreted as a strict requirement that the upper end of the thick wall region would have to coincide with the top side of the tie plate. For the skilled person, when increasing the wall thickness at the bottom of the channel box in the fuel assembly known from D4 for the purpose of avoiding a bulging of the wall, it would be quite obvious not to stop the mechanical reinforcement exactly at the level of the upper edge of the lower tie plate but to contemplate a certain increase in the length of the thickened region above this level so as to provide at least some safety margin at the upper end of the critical gap between the inner wall of the channel box and the sidewall of the lower tie plate. This is all the more true as the skilled person, in view of document D6 relating to a further development of the design of the channel box according to document D4, would have been aware of the fact that the pressure difference and thus the mechanical stress on the channel wall would be highest at the level of the upper edge of the lower tie plate (cf. Figure 3 in document D6).

Moreover, the skilled person knows from document D5, which relates to a still further development of the design of the channel box according to document D4, about the conflicting requirements of mechanical stability and parasitic neutron absorption by the walls of the channel box. In this context, document D5 (cf. in particular the abstract; column 1, lines 7 to 25; column 1, line 59 to column 2, line 13; column 2, lines 32 to 55; column 3, lines 11 to 39; column 5, lines 46 to 50; column 7, lines 16 to 20; and column 8,

lines 19 to 24) discloses a fuel assembly with a channel box designed to withstand seismic loads and to ascertain a constant leakage flow of the coolant whilst simultaneously reducing parasitic absorption of neutrons by the channel walls. Mechanical reinforcement is mainly provided by thickened corner sections, whereas those regions of the side walls which do not experience high mechanical stresses are thinned. Taking the general design principles known from document D5 into consideration for the design of the channel box according to document D4, in which the wall thickness of the lower thick wall region is uniform all through its cross-sectional circumference including the corner portions, it is immediately apparent for the skilled person that the thick wall region may extend above the top side of the lower tie plate, as long as the increased wall thickness does not interfere with the regions of enriched fuel within the fuel rods.

For these reasons, aforementioned feature (b) would be the result of straightforward considerations concerning the necessary compromise between the conflicting requirements of high mechanical stability and reduced parasitic neutron absorption.

- 3.1.5 The respondent's submission that the teaching of document D4 would explicitly require that the lower thick wall had to end at the top side of the lower tie plate is based on the expression "*region of the interface between the flow channel and the lower tie plate*" repeatedly used in D4. However, in the Board's opinion, the term "*region of interface*" is not so precise that it would be interpreted by the skilled person as defining an exact location for the upper end of the lower thick wall region. Furthermore, the

skilled person would be aware of the fact that a limited extension of the lower thick wall region above the level of the top side of the lower tie plate would not lead to an increased neutron absorption because, contrary to the impression given by the respondent, even for fuel rods without natural uranium ends, the regions of fissile material would not extend down to the top side of the lower tie plate (cf. in this respect Figure 2 of D4). Therefore, the Board cannot accept the argument that the use of fuel rods having natural uranium ends would be a prerequisite for contemplating an extension of the lower thick wall region above the top side of the lower tie plate.

Finally, as regards the respondent's submission that the inventive idea of increasing the extension of the thick wall region above the lower tie plate had allowed for an overall reduction in the thickness of the walls of the channel box, the Board notes that no corresponding teaching is to be found in the patent specification or the originally-filed application documents.

### 3.2 Auxiliary request

The additional feature given in claim 1 of the auxiliary request defines a lower limit for the ratio of the axial length of the lower thick wall region and the fitting length of the channel box and the lower tie plate.

According to the respondent, it was implied by the experimental results shown in Figure 10 of the patent that the variation of the leakage flow did not significantly change above this limit so that it

indicated the optimum compromise between the conflicting requirements of high mechanical stability and reduced parasitic neutron absorption.

In this respect, the Board notes that the optimum ratio, above which variations in the leakage flow would no longer occur, would in fact depend on a variety of parameters, such as the absolute values of the wall thickness and the fitting length. Clearly, for a thicker wall, a negligible variation in the leakage flow would be obtained already at a shorter axial length of the lower thick wall region than for a thinner wall. It follows that the claimed ratio of 1.5 does not constitute a universally valid value defining the optimum compromise but is an exemplary result observed under specific, albeit unspecified circumstances.

In the Board's view, it would be a matter of routine experimentation for the skilled person, knowing from the prior art about the aforementioned conflicting requirements and their principles of solution, ie a mechanical reinforcement by increasing the wall thickness of the channel box wall, on the one hand, and a reduction of parasitic neutron absorption by reducing the wall thickness in the region of the fissile material where reduced stress is expected, on the other hand, to determine the optimum value for the axial length of the lower thick wall region and the corresponding ratio with the fitting length for any given wall thickness.

- 3.3 For the above reasons, no exercise of inventive step would have been required for the skilled person to devise a fuel assembly according to claims 1 of the

main and auxiliary requests.

The respondent's requests thus do not comply with the requirements of Articles 52(1) and 56 EPC having regard to inventive step.

**Order**

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

The decision of the opposition division is set aside.

The patent is revoked.

The Registrar:

The Chairman:

R. Schumacher

G. Davies