PATENT SPECIFICATION (11) 1 567 949

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(21) Application No. 33674/76 (22) Filed 12 Aug. 1976
(23) Complete Specification Filed 3 Aug. 1977
(44) Complete Specification Published 21 May 1980
(51) INT. CL.[3] G21C 9/00
(52) Index at Acceptance
G6C 39Y 405 63X 680 684 FA

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(54) LIQUID METAL COOLED NUCLEAR REACTOR CONSTRUCTIONS

(71) We, NUCLEAR POWER COMPANY LIMITED, 1, Stanhope Gate, London, W1A E1H, a British Company do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described and and by the following statement:

This invention relates to liquid metal cooled nuclear reactor constructions.

In one well known example of liquid metal cooled nuclear reactor construction the reactor is submerged in a pool of coolant contained in a primary vessel. The primary vessel is housed in a concrete containment vault and is suspended from the roof of the vault. There is a leak jacket or catchpot surrounding the primary vessel for catching coolant in the event of leakage. The core is carried on a diagrid which depends from the roof of the vault by tie rods and the roof carries control rods which are vertically insertable in the core to control reactivity. In the event of displacement of the core relative to the control rods during operation of the reactor core the resultant change of reactivity could have serious consequences and it is an object of the present invention to provide a construction of liquid metal cooled nuclear reactor having means for limiting uncontrolled displacement of the core relative to the control rods.

According to the invention in a liquid metal cooled nuclear reactor construction wherein the reactor core is submerged in a pool of coolant in a primary vessel, the primary vessel being suspended from the roof structure of a containment vault and surrounded by a leak jacket, there being control rods supported from the roof structure and insertable in the core, the reactor core is supported from the wall of the base region of the primary vessel and there is means in the interspace between the primary vessel and leak jacket for limiting the extent of downward deflection of the base region of the primary vessel. Thus in the event of deflection of the wall of the primary vessel such as would allow downward displacement of the reactor core relative to the control rods, the leak jacket provides secondary support means for the core and limits its displacement.

A constructional example of liquid metal cooled nuclear reactor embodying the invention is described, by way of example, with reference to the sole drawing accompanying the Provisional Specification and which is a diagrammatic sectional view.

In the construction shown in the drawing the reactor core 1 is submerged in a pool 2 of liquid sodium in a primary vessel 3. The primary vessel is suspended from the roof structure 4 of a containment vault 5 the rim of the primary vessel being sealed to the roof structure in order to contain an inert cover gas for the pool of coolant. There is a leak jacket 6 suspended from jacking means 4a of the roof structure by tie members 7 and it surrounds the primary vessel in order to catch any liquid metal coolant which may leak from the primary vessel. A plurality of control rods 8 (only one being shown in the drawing) is supported by the roof structure of the vault and the rods are insertable in the core to control reactivity. The reactor core is supported from the wall of the base region of the primary vessel by means of a strongback 9 diagrid 13 combination, the strongback 9 having an annular foot 10 which is secured to the primary vessel. Within the interspace designated 11 between the primary vessel 3 and the leak jacket 6 there is an annular shoe 12 disposed immediately below the foot 10 and there is a clearance designated 'C' between the shoe 12 and the external surface of the primary vessel. The clearance 'C' is adjustable by the jacking means 4a. In the event of deflection

of the wall of the primary vessel downward displacement of the core relative to the control rods is limited to the clearance 'C' and thereby avoids serious reactivity instability. In more detail, the nuclear reactor core 1 is a fast breeder reactor comprising a plurality of upstanding fuel element assemblies arranged side-by-side on the diagrid which serves as a coolant inlet plenum for the core. The core is surrounded by a shroud 14 or core tank and there is an intermediate annular neutron shield 15. Four pumps 16 and four heat exchangers 17 (only one of each being shown in the drawing) depend from the roof of the vault and are immersed in the pool of coolant. The pumps are arranged to deliver coolant drawn from the outer regions of the pool to the core by way of the diagrid 13. The coolant is heated in passage through the core and flows upwardly through the shroud 14 thence outwardly to the heat exchangers 17 subsequently being returned to the pool. The strongback has four arms 18 mounted on an annular skirt 19 which carried the foot 10. The diagrid 13 is of frustro-conical shape and sits within a complementary socket defined by the strongback the socket having an annular shoe 20. The diagrid 13 is carried from the strongback by an annular skirt 21 such that there is a clearance between the shoe 20 and the diagrid 13. The skirt 21 and strongback 9 are imperforate to prevent downward flow of coolant from inside the shroud and the strongback is of double skin construction. The primary vessel houses a tray 22 for the collection of core debris and the primary vessel is externally clad with thermal insulation 23 to reduce heat transfer to the concrete vault structure 5.

In the event of failure of the support skirt 21 for the core, displacement of the core is limited to the clearance between the diagrid 13 and the shoe 20. Instrumentation (not shown in the drawing) is provided for monitoring the clearances between the shoe 20 and the diagrid 13 and between the shoe 12 and the primary vessel 3. In the described construction both clearances are 6 mm.

WHAT WE CLAIM IS:

1. A liquid metal cooled nuclear reactor construction comprising a reactor core submerged in a pool of coolant in a primary vessel which is suspended from the roof structure of a containment vault and surrounded by a leak jacket, and control rods supported from the roof structure and insertable in the core, wherein the reactor core is supported from the wall of the base region of the primary vessel and there is means in an interspace between the primary vessel and the leak jacket for limiting the extent of downward deflection of the base region of the primary vessel.

2. A liquid metal cooled nuclear reactor construction according to claim 1 wherein the means for limiting the extent of downward deflection of the base region of the primary vessel comprises an abutment member attached to the leak jacket in manner providing a clearance between the member and the primary vessel.

3. A liquid metal cooled nuclear reactor construction according to claim 2 wherein the leak jacket is suspended from jacking means of the roof structure by tie members, and the clearance between the abutment member and the primary vessel is adjustable by the jacking means.

4. A liquid metal cooled nuclear reactor construction according to any one of the preceding claims wherein the reactor core is supported from the wall of the base region of the primary vessel by means of a strongback and diagrid combination which has means for limiting downward displacement of the diagrid relative to the strongback.

5. A liquid metal cooled nuclear reactor construction substantially as hereinbefore described with reference to the drawings accompanying the Provisional Specification.

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Printed for Her Majesty's Stationery Office,
by Croydon Printing Company Limited, Croydon, Surrey, 1980.
Published by The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.

1567949 PROVISIONAL SPECIFICATION
1 SHEET This drawing is a reproduction of the Original on a reduced scale