

A SIMPLIFIED LMFBR CONCEPT (SFR)

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Summary

Introduction

NNC Ltd. are currently looking at concepts that could provide the basis of the next generation of advanced fast reactors. The SFR concept reflects the views of NNC's former Managing Director, Derek Taylor who believed that existing designs were unnecessarily complicated as a consequence of unrealistic design targets and that considerable simplification was essential. Therefore, although the concept is largely based on NNC's extensive experience of developing commercial LMFBR's (CDFR and EFR), many of the original design bases have been re-addressed to simplify the concept.

SFR plant concept

SFR consists of a very compact, loop type reactor. The secondary sodium circuit has been eliminated and the vessels are located in individual vaults containing an inert nitrogen atmosphere.

Currently the fuel is based on the classic LMFBR design but with a reduced core outlet temperature and a smaller gas plenum. The lower operating temperature improves structural integrity by keeping below the creep range of the materials. It also allows a more cost effective SG system to be adopted that eliminates the need for a secondary sodium circuit and its ancillaries. The SG system used incorporates an innovative Cu bonded concept.

The Cu bonded SG consists of two separate sets of tubes closely integrated to form a bundle. One of the tube sets contains water/steam and the other the sodium coolant. The two sets of tubes are separated by a solid Cu layer, so that three boundaries separate the primary sodium from the water/steam. In order to prevent leakage along the tube/Cu interface should a tube fail and to maximise heat transfer, the tubes and Cu matrix are mechanically bonded through the use of HIPing (hot isostatic pressing).

The SFR refuelling scheme involves the provision of a single, removable plug on which the UIS is mounted. During refuelling the plug and the UIS are lifted clear of the roof and placed in a park position. Once the core is exposed a rail-mounted charge machine is brought into operation via the opening in the roof. A nitrogen filled fuel handling vault is provided over the roof area in which all the fuel handling operations are carried out remotely.

Economic perspective

Although SFR is based largely on well developed technology, it incorporates a number of innovative features which offer the potential for significant reduction in capital cost. These include:

- A significant reduction in the building size
- The elimination of secondary sodium circuit and associated ancillaries
- The elimination of separate SG buildings
- The elimination of rotating plugs
- Reduced inspection and maintenance costs
- High plant availability

The SFR concept embodies the many benefits of existing knowledge but is further advanced by incorporation of the philosophy of simplification and the addition of some innovative ideas. This philosophy reduces the complexity of the arrangement, the severity of the operating parameters and simplifies the choice of the materials, the design, the fabrication, the construction and the operation.