

## *FBNR Letter*

# **FIXED BED NUCLEAR REACTOR – FBNR**

<http://www.rcgg.ufrgs.br/fbnr.htm>

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Dear coworkers and potential coworkers around the world,

As the number of coworkers is increasing, we are issuing a circular letter to communicate about the matters of general interest to the FBNR project. Please consider this as a personal letter to yourself. Those who are not involved in the project as yet may participate at any appropriate moment. The project has manifold aspects including scientific, technological, economical, political, and sociological.

A new era of nuclear energy is emerging. The International Atomic Energy Agency has committed itself to “Help to ensure that nuclear energy is available to contribute in fulfilling energy needs in the 21<sup>st</sup> century in a sustainable manner; and to bring together both technology holders and technology users to consider jointly the international and national actions required to achieve desired innovations in nuclear reactors and fuel cycles.”- IAEA-TECDOC-1362.

The objective is to develop an innovative nuclear reactor to be inherently safe, passively cooled, small, modular, and simple in design with integrated primary circuit. Safety is achieved by design, and has reduced adverse impact on environment. It is to meet the requirements of GEN IV and IAEA-INPRO as being economic, safe, proliferation resistant and sustainable.

The FBNR may be called People’s Reactor. It is intended to be developed by the peoples for the peoples of the world in the spirit of cooperation and service to humanity. It is intended to be a near term deployment project. Let us form an international consortium to develop this reactor where all members are stakeholders.

An IAEA Coordinated Research Project (CRP) includes FBNR in its program.

**Participate in the project and make a proposal on a particular activity of your interest.**

**FBNR Letter 12 October 22, 2004**

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*Request for a simplified expression to estimate the criticality behavior of the FBNR.*

Dear coworker or potential coworker around the world,

You are invited to find a simplified (or approximate) solution to the following problem in order to serve as a means of qualitative analysis of the FBNR behavior. The detailed and exact calculations will be performed using reactor codes.

Cordially Yours,  
Sefidvash

The Problem: Find neutron flux distribution  $\Phi(r,z)$  and the critical buckling  $\mathbf{B}^2$ .

Governing equations:

$$\nabla^2 \Phi_1 + K_1^2 \Phi_1 = 0$$

$$\nabla^2 \Phi_2 + \mathbf{B}^2 \Phi_2 = 0$$

$$\nabla^2 \Phi_3 + K_3^2 \Phi_3 = 0$$

Where  $\nabla^2 \Phi = 1/r \cdot \partial/\partial r (r \partial\Phi/\partial r) + \partial^2\Phi/\partial z^2$ , and  $D_1, D_2, D_3, K_1^2, K_3^2$  are given constants.  $\mathbf{B}^2$  is sought after constant. Region 2 is made of nuclear fuel and water while the regions 1 and 3 are mixture of water and metal (see <http://www.rcgg.ufgrs.br/FBNRLetterNo.08.pdf>).

Boundary conditions:

Radial neutron flux :

$$\Phi_1(R_1, z) = \Phi_2(R_1, z)$$

$$\Phi_2(R_2, z) = \Phi_3(R_2, z)$$

$$\Phi_3(R_3, z) = 0$$

Radial neutron current:

$$[ D_1 \partial\Phi_1/\partial r ]_{r=R_1} = [ D_2 \partial\Phi_2/\partial r ]_{r=R_1}$$

$$[ D_2 \partial\Phi_2/\partial r ]_{r=R_2} = [ D_3 \partial\Phi_3/\partial r ]_{r=R_2}$$

$$[ \partial\Phi_1/\partial r ]_{r=0} = 0$$

Axial neutron flux:

$$\Phi_1 ( z = + H/2 ) = \Phi_2 ( z = + H/2 ) = \Phi_3 ( z = + H/2 ) = 0$$

$$\Phi_1 ( z = - H/2 ) = \Phi_2 ( z = - H/2 ) = \Phi_3 ( z = - H/2 ) = A \quad [\text{Use this as a last resource}]$$

