# THE SYMMETRY PROPERTIES OF THE FLOW IN A NUCLEAR REACTOR VESSEL

*A round U-turn jet*

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The turbulent flow in a Pressurized Water Reactor vessel is modeled in a small scale experiment. Careful observations and flow control experiments, driven by considerations of symmetry, show that this flow of industrial importance has quite weird properties.

A schematic description is given by fig. 1. The four inlet ducts, called "branches" (1), have nominally identical flow rates. Water is fed from top, then flows down into an annular duct or"downcomer", undergoes a U-turn in a nearly hemispheric "plenum", to eventually flow up through a grid (3) and into a cylindrical duct.

The nominal symmetry group is the four order group, generated by the two mirror symmetries shown on fig. 1 and fig. 2 (dashed lines). The flow exhibits spontaneous symmetry breaking, as shown on fig. 2: one transverse (horizontal) vortex and two longitudinal (vertical) vortices appear. Four configurations are observable, any pair of them being reciprocally symmetrical. The installed configuration depends on initial conditions, and flow history: a commutation technique has been devised, involving a modification of inlet flow rates.

As the vortex pattern is quite indifferent to some large external perturbations, the actual flow would be similar to an easily conceived ideal flow, i. e. a "round U-turn jet", with nominal axial and mirror symmetries. The ideal flow would have only one mirror symmetry (dotted line on fig. 2), and its neutral azimuthal position could be taken as a phase parameter.

The observed phenomena would result from a spontaneous symmetry breaking of the round U-turn jet, under restricted symmetry and special phase dynamics, due to perturbating technical details.

This work results from a cooperative research with FRAMATOME.



*S. Gavrilakis et al. (eds.), Advances in Turbulence VI,* 175-176.

fig. 2

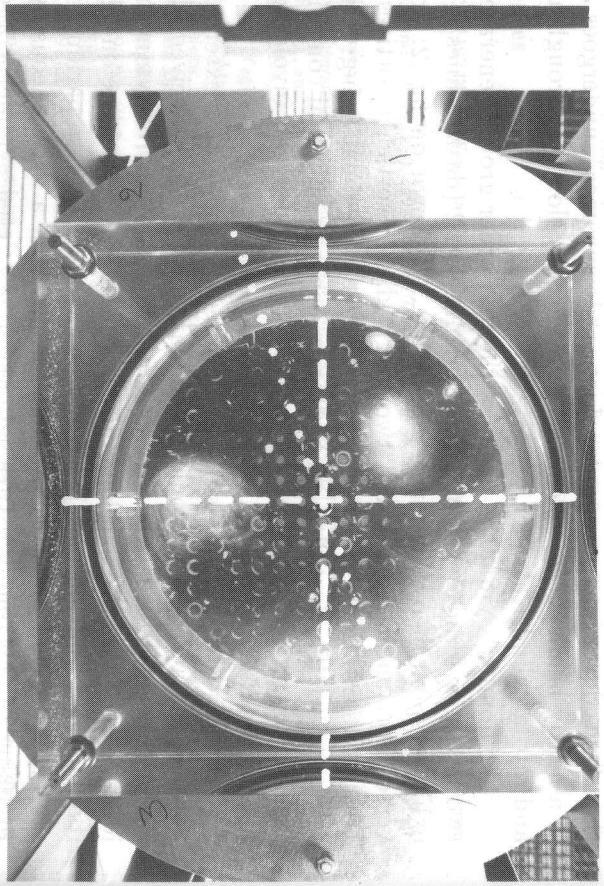

fig. 1