This paper describes the vibration study results of a mixing tee under consideration for the Intermediate Heat Transport System of the Clinch River Breeder Reactor Plant (CRBRP/IHTS). Fig. 1 shows the quarter-scale test model of the mixing tee. Flow enters through two opposite (180°) inlet-legs, and exits from the branch of the tee. A perforated plate is installed in each inlet-leg to promote mixing. Each plate has seven orifice holes and stiffeners at the upstream side.

A series of vibration tests were performed on the quarter-scale model to investigate the potential for flow-induced vibrations of the perforated plates, and thus in conjunction with the thermal-hydraulic test results contribute to the reliability assessment of the tee.

The vibration tests consisted of the free vibration tests and the flow tests. The free vibration characteristics (Fig. 2) of the perforated plates in air and in water were determined by means of the shaker tests and the impact tests. Added mass effects reduced the in-water frequencies to about 65% of the in-air frequencies. The natural frequencies of the plates for a full size CRBRP tee (0.61 m diameter) are expected to be reduced by a factor of 4 from these values.

During the flow tests the model was instrumented with water-proofed accelerometers and hot-film anemometers, and installed into the flow loop of room-temperature water. The test section was isolated from external excitations and the test loop water was deaerated as much as possible. The flow rates at both inlet-legs were balanced except a few test runs with...
intentionally unbalanced flowrates. The average flow-velocity was varied up to the CRBRP/IHTS sodium velocity (3.46 m/sec at each inlet-leg), and the loop pressure level was varied up to the maximum allowable pressure (~600 kPa at the inlet-legs) of the test loop.

Data on anemometer signals at the wake region of the selected orifice holes indicated no predominant frequency band and imply that the fluid excitation is a turbulent pressure fluctuation rather than a vortex-shedding phenomena through the orifice holes. The plate response spectra were characterized by distinct, lightly damped resonances at their natural frequencies for all flowrates with high loop pressure. However, as the pressure level was lowered the spectra became less distinct due to a cavitation-type phenomena. The perforated plate vibrations are generally small; less than 0.0025 mm RMS at all tested flowrates, and occurred mostly at the fundamental natural frequency of about 740 Hz corresponding to a simple dishing type modal deformation. On the basis of idealized scale-model criteria, the vibration amplitudes of the full size plates are expected to be 4 times larger than the case of the quarter-scale model.

At intermediate flowrates (1.6 ~ 2.3 m/sec) the perforated plates were excited into resonance-type vibrations which never lasted for more than one or two seconds, i.e., the system never locked into steady resonance.

A cavitation-type phenomena as well as a resonance-type phenomena were dependent upon the loop flow velocity and loop pressure level. However, the source of these two phenomena was not identified, thus it is not possible to predict whether these will occur under CRBRP conditions. The CRBRP mixing tee design pressure is much higher than the maximum test loop pressure achieved. Therefore, it can be speculated that a CRBRP mixing tee of this design may not experience the cavitation-type excitation, and the
perforated plate vibration level may be even less than that of 4 times of the quarter-scale model case.


Fig. 1. Mixing Tee Model with Instrumentation