CHAPTER I
INTRODUCTION

Major failures have occurred in steam piping due to wet-steam erosion-corrosion, resulting in a high operating cost and even safety problems. Both nuclear and fossil power plants as well as petrochemical plants are susceptible to this problem. However, the problem can be prevented if either steam quality or void fraction is known. Furthermore, it will then be possible to evaluate pressure drops, heat transfer coefficients and other parameters that are useful for plant design and control.

There are a few techniques that can be applied to measure steam quality. Examples of current practices are a combination of a vortex and another sensing device, a densitometer, separating/accumulating calorimeter, and choke as well as throttling calorimeter. Radiation techniques are particularly attractive because of their non-intrusive nature. There is a study of void fraction by various radiation beams; beta particles, gamma rays, neutrons, and x-rays (Abdullah, 1992). Among the existing techniques, gamma ray and neutron approaches are suited for non-intrusive measurements of a two-phase flow in a metallic structure. Gamma-ray techniques are widely used for void fraction measurements in low-pressure systems. In high-pressure systems, a large strength source is required to overcome the photon attenuation caused by metallic walls. Therefore, neutron techniques can be applied for the systems operating at high pressure since neutrons are not greatly affected by the metallic walls.

The aim of this work was to develop a scatterometer for measuring the void fraction or, equivalently, steam quality (mass of vapor/mass of mixture) at high pressure and temperature in a 0.5 inch outside diameter stainless steel pipe installed in a high-pressure water system. The scatterometer design is based on previous work. The feasibility of the design was evaluated with a Monte Carlo method. The device was tested in both static and dynamic experiments.