## 1 Background and Introduction

In support of Sandia's neutron generator manufacturing obligation, work within Center 9100 has been continuing to develop modeling and simulation capabilities for the process of encapsulating the neutron generator. The critical reliability issues associated with this component require a detailed understanding of the manufacturing process and its relation to factors such as resulting particle concentration profile. The lower portion of the unit, the power supply (MC4368), is encapsulated in an epoxy loaded with aluminum oxide (ALOX). The upper portion of the unit, the neutron tube (MC4277), is encapsulated in an epoxy loaded with glass microballoons (GMB). In the encapsulation process, the particle-loaded mixture flows into a mold containing the neutron generator. First the ALOX-loaded suspension is introduced to the level just above the power supply as indicated in Step 1 below. The GMB-loaded suspension is then immediately introduced through the same port to encapsulate the rest of the unit (Step 2). The part is then cured according to a temperature schedule optimized for the given epoxy system.

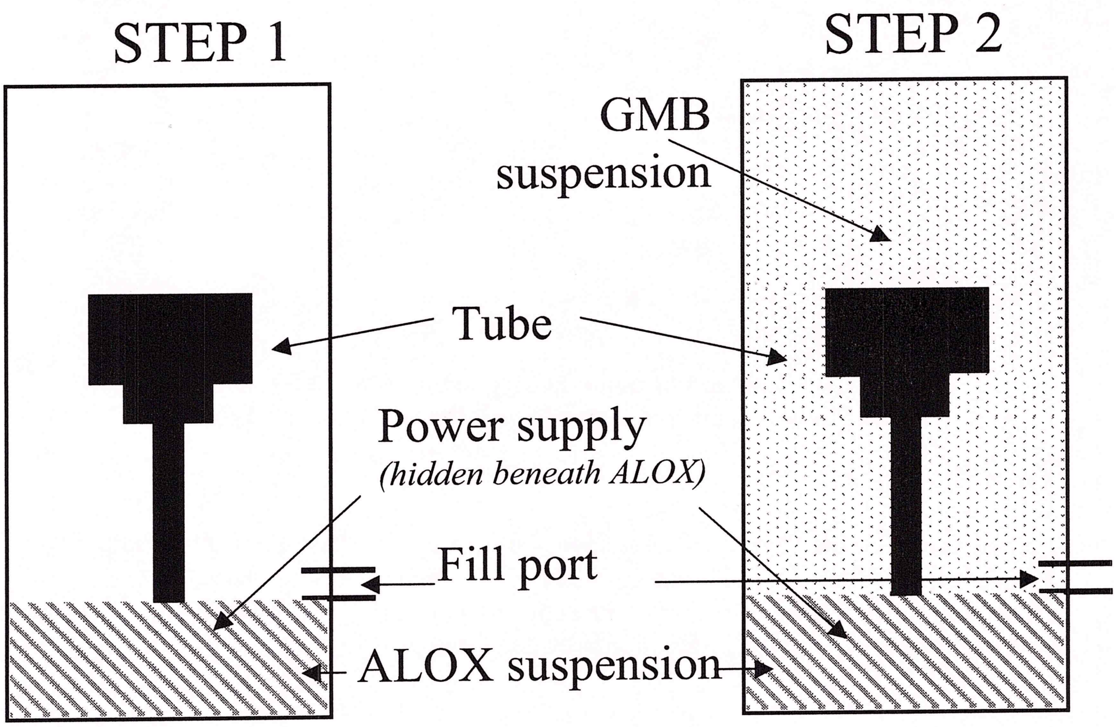


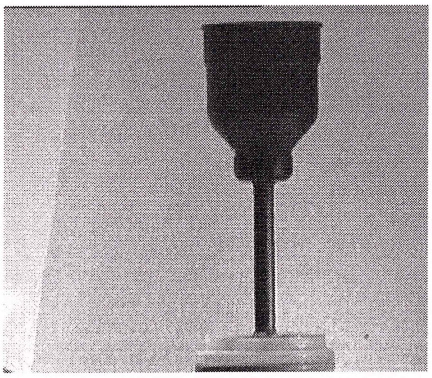

**Figure 1. Encapsulation Process**



Real Time Visualization & pressure diagnostics for N.G. encapsulation
– work done in FY 2000

The finite element code, GOMA [1], solves the general Navier Stokes equations and, with the correct constitutive models for hydrodynamic diffusion, can simulate the motion of fluid and migration of particles during the mold filling and subsequent early curing. Density differences between the particles and the entraining fluid can cause particle migration prior to curing. Shear gradients introduced in a flowing suspension can also cause migration of particles across streamlines [2] and, in particular, when the particle loadings (volume fractions) of suspensions exceed 0.4, such as is the case for the neutron generator encapsulants, the effect of a shear stress gradient can, in fact, dominate the flow [3]. Various methods of incorporating the physics of shear enhanced particle migration, and hindered settling behavior of suspensions are in the literature [4,5]. The GOMA development team is working to incorporate the suspension physics into the finite element code.

This work was undertaken to provide experimental validation data for the neutron generator mold fill process. A Lucite™ model of the MC4380 neutron generator that was manufactured by the Neutron Generator Manufacturing Department, was used in this work. This component is unclassified but the neutron tube region is similar in shape to the production component MC4277. The power supply portion is replaced by a stem to support the unit. The mold and mock component have been meshed for use by GOMA,



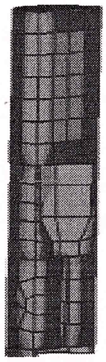


**Figure 2. Photograph of mock neutron generator (left). Finite element mesh of mock neutron generator mold space (right)**

as shown in Figure 2.

Validation of GOMA's treatment of suspension flow can be strengthened by comparing experimental results and simulations of identical geometry. Additionally, flow visualization in a geometry similar to the actual component may provide insight into the phenomena occurring in the production process.