

lates into the preparation of 738 samples. Dependent on the complexity of the dispensing and mixing steps and whether or not the samples will be centrifuged, each sample will require approximately 10 min to complete, which leads to an estimate of 123 hr (5-1/8 days) of robotic time. Approximately 2 hr of technician time is required for each day (24 hr of continuous, unattended operation) of robot time. Thus, the initial samples for this evaluation will require approximately 1 technician-day and 1 robot-week to complete. Additional samples may be required to pinpoint critical regions of the phase boundary, as described in the following discussion.

## 2. Weighing Out Components

Pharmaceutical topicals may contain fluid liquids, semisolids, amorphous solids, crystalline solids, or any combination thereof. Because the raw materials for topicals vary greatly in their physical properties, a number of different dispensing techniques must be employed to evaluate topical formulations. Solids are generally dispensed by a vibrating robotic hand, whereas liquids and semisolids are dispensed from automatic syringes. Materials that are not readily dispensed by either of these methods can be added by hand. Conceptual details of each of these dispensing methods are described below.

*Solids.* To deliver powders using robotics, a tube filled with solid is tilted and vibrated in discrete pulses. The vibration causes the solid to flow from the tube into an appropriate, tared container before being weighed. Although, in theory, this may seem a simple task, in practice, it can be very demanding. Accurate delivery of solids depends on a number of factors, including vibration intensity, grip location, vibration duration, tube diameter, and tilt angle. The vibration intensity is usually varied during the course of powder addition. At the beginning of powder addition, the intensity is at a preset value near, but not necessarily at, the maximum possible. However, as the target weight is approached the intensity is reduced, allowing more control over the amount of solid added. For best results, the tube containing the powder should be gripped near the base, resulting in maximum transfer of energy from the hand to the powder in the tube. This ensures that the solid is added continuously. Vibration duration is also varied over the course of addition, decreasing as one reaches the target weight. The amount of variation is dependent on the nature of the powder being added. For crystalline solids, the duration is reduced, whereas for amorphous solids, a longer vibration time is required. The diameter of the tube being used to dispense the powder should be smaller than the opening of the container receiving