3.2 Balances

3.2.1 Use and Principles of Operation

Balances are accurate and precise instruments used to measure the weight or mass of a substance or material. The ability to measure material as large as 50kg and as small as 10µg makes them quite common.

There are two main categories of balances, mechanical and electromagnetic. Mechanical balances tend to be the simpler of the two. They generally consist of springs or lever arms, and use either a known force or mass to determine the unknown measurement.

Electromagnetic balances are a little more complex, but generally more user friendly. They are often based on measuring the current needed to levitate the pan and mass. A wire is attached to the weighing pan. The wire is placed between two poles of a permanent magnet. When a substance is placed in the pan, the wire is displaced and additional current is required to return the wire to its original resting state. This difference in current is measured internally and used to determine the mass of the substance in the pan.

3.2.2 Common Problems

Internal problems with an electromagnetic balance cannot usually be repaired by the field engineer in the developing world. Mechanical balances are very reliable and rarely need major repairs. Therefore, the most likely problems to occupy the engineer working in the developing world are minor in nature.

The most common problems associated with an electromagnetic balance are the result of environmental factors and user error. The primary environmental factors leading to poor results from the balance are temperature, static electricity, vibration, out of level (tilted), and wind. If the readings are inaccurate or erratic, any one of these can be the cause. Shielding the balance from vibration, static electricity and air currents are easily accomplished and may solve the problem. Leveling the scale is also easily accomplished. Controlling the temperature, on the other hand, may be problematic. If you find that the balance operates correctly at night or in the early morning, but not at mid day, you may have to restrict its use to periods when the room temperature is stable and low.

The most common problem with mechanical balances is environmental factors and maintenance. The movements of the mechanical balance must be free of dirt and other residue. If a mechanical balance is yielding erratic readings, clean and oil all moving parts before attempting any other diagnosis or repair.

3.2.3 Suggested Testing

Balances are so reliable, that the technician may not know how to perform a calibration. However, a crude calibration is very straightforward. First, place a clean container in the center of the weighing pan. If the balance has a case, close the door. Zero the balance by pushing the TARE button (a long rectangular bar, a twist of a dial, or, if the TARE is absent, jot down the reading of the balance with the container). Place a known volume of water on the scale. In most cases, the most accurate way to add the desired amount of water is to use a syringe. Now read the balance. (If there was no TARE, subtract your original measurement). Compare the reading to the actual weight of the water (water weighs one gram per milliliter). The precision of the balance will probably exceed the precision of your water volume measurement, so repeat the measurement four or five times.