Calibrating Radiometrics MP-xx00A Radiometers with Liquid Nitrogen

Radiometrics Microwave Profiling radiometers measure atmospheric radiation temperature (brightness temperature) in the range of -270° C to +50° C. To calibrate the instrument over this temperature range, two "microwave targets" (microwave loads) of known temperature are used. The instrument has a built-in ambient temperature target that can be used for one of the two targets (warm target). An external cryogenic target filled with liquid nitrogen (LN2) provides the second (cold target). When LN2 is placed in a cryogenic target containing *microwave load material*, the target emits microwaves at the black body temperature of the boiling LN2 (-195° C).



Figure 1 Cryogenic Target used to calibrate Microwave Profiling Radiometers

The mechanism for switching between the hot and cold targets is the 45° rotating reflector shown in Figure 2. When this reflector is pointed down, as it is in Figure 2, the radiometer µwave antenna is pointed to the Ambient target. When this reflector is rotated 180° to point up, the radiometer µwave antenna points to the zenith sky through the Radome. When a calibration is performed, the cryogenic target is placed on top of the radiometer, above the radome as shown in Figure 3.



Figure 2 MP-3000A radiometer on the left; MP-3000A with hood removed on the right

NOTE: Nitrogen is the most abundant naturally occurring gas in the earth's atmosphere (78%). When we breathe, we breathe mostly nitrogen into our lungs. It is not toxic in normal concentrations. LN2 is used for many industrial and medical purposes. Because it is so abundant and non-toxic, it is relatively easy to manufacture and use. It is readily available from any industrial gas supplier.



Figure 3 Radiometer with Saddle and Cryogenic target in place

The Saddle is used to position the Cryogenic Target above the radiometer radome. It also forms a wave guide that serves to minimize extraneous microwave emissions (warm bias) reaching the antenna. The radiometer "views the target" through a Radiometrics patented microwave transparent window in the bottom of the target.



Figure 4 Dewars used for storing and handling LN2

LN2 is typically delivered from suppliers in large (160 liter) dewars, but can also be purchased in smaller quantity. For short term use, dewars can be rented from many industrial gas suppliers. Dewars are also available for sale. See for example:

http://www.cryodewars.com/index.php?cPath=1_2&osCsid=b1aec344da2e6894b38852e881b617c7



Figure 5 Left: Filling Cryogenic Target; Right: Pouring residual LN2 into dewar after calibration is finished

Safety Considerations

As noted above, nitrogen is not a toxic gas, but it is very cold. Because it is very cold, it can cause severe damage to the human body, particularly to the skin and eyes. To avoid the risk of a cryogenic burn, LN2 should always be handled with care and respect. Handlers should wear appropriate protective clothing, gloves and goggles. Handlers must also take precautions to insure adequate ventilation. The gas is not toxic, but at high concentrations, it reduces the available oxygen in the air. For more information on LN2 safety practices, see any of the many web resources, such as:

http://engineering.dartmouth.edu/microeng/ln2.html

http://www-safety.deas.harvard.edu/services/nitrogen.html

http://www.mcg.edu/services/ehs/chemsafe/liqnitro.htm