

Liquid Nitrogen (LN₂) Calibration Procedure for MWRP

I. Purpose:

This procedure describes how to calibrate Microwave Radiometer Profiler (MRWP) using liquid nitrogen (LN₂).

II. Cautions and Hazards:

- Potential hazards are listed in the procedure matrix in section **IV.B**.
- This procedure assumes that the microwave radiometer profiler is mounted on a short stand so that an elevated work platform is not required. If the radiometer is mounted on a tall stand, an elevated work platform will be needed.
- To obtain the maximum accuracy of the calibration, the bottom of the cooler must be kept clean. If necessary, the cooler should be cleaned with mild soap and water or with alcohol, and be allowed to thoroughly dry before use.

III. Requirements:

- Number of persons required: 2
- Personal Protective Equipment (PPE):
 - ⇒ Goggles or face shield
 - ⇒ Insulated gauntlet or gloves
 - ⇒ Long-sleeve apron
 - ⇒ Long pants
 - ⇒ Boots or work shoes
- Liquid nitrogen (LN₂)

- Cryogenic safety training: Online course available at <http://www-training.llnl.gov/training/hc/HS5030/index.html> (Module 4 is Cryogenic Safety)
- Tools:
 - ⇒ 10-liter Dewar and 5-liter Dewar – for transferring LN₂ from the 160-liter supply Dewar to the calibration target
 - ⇒ Flexible hose
 - ⇒ Phase separator
 - ⇒ Hair dryer
- Low humidity and low winds typically associated with high-pressure conditions and clear skies

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IV. Procedure:

A. Pre-Calibration Check

1. Have the new small 15-liter target and the saddle near the MWRP. Note: The saddle should also be new.
2. Have the 5-liter and 10-liter Dewars close to the 160-liter supply.
3. Have the wrench ready to connect the flexible hose.

B. Calibration Procedure

SEQUENCE OF JOB STEPS	POTENTIAL HAZARDS	ACTION OR PROCEDURE
1. Power up the radiometer, if it is not already powered.		The radiometer must be at its stable operating temperature to obtain a valid calibration. It should therefore be powered up for at least 30 minutes prior to beginning the calibration procedure. When the computer is started, the profiler program may also start and the radiometer will begin making measurement. If the profiler program does not automatically start, start it now.
2. Don personal protective equipment.		Make sure <i>all</i> exposed skin is covered. (Both persons must wear PPE.)
3. Fill the 10-liter Dewar and the 5-liter Dewar with LN ₂ .	Improper filling may cause splashing of LN ₂ . WARNING: Contact with Liquid Nitrogen (LN₂) may cause burns to exposed skin. Stand <i>up wind</i> of the cooler while filling it to avoid inhaling LN ₂ vapor and to prevent condensation from obscuring your view.	1) Connect the flexible hose to the 160-liter supply Dewar. The Dewar has a 'LIQUID' outlet. The hose should be connected and tightened using a wrench to avoid spilling. 2) Connect the other end of the hose to a phase separator (it may be already connected). Insert that part in the 10-liter Dewar and start filling holding the hose down. 3) Close the valve. 4) Replace the cap on the Dewar. 5) REPEAT STEPS 1-2-3-4 for the 5-liter Dewar.

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SEQUENCE OF JOB STEPS	POTENTIAL HAZARDS	ACTION OR PROCEDURE
<p>4. Transport the 10-liter Dewar and the 5-liter Dewar to the radiometer location.</p>	<p>Rough handling or other jostling of the Dewar and/or cooler while being transported could cause spillage of LN₂.</p>	<p>Make sure the caps are placed to avoid spilling when climbing the stairs.</p>
<p>5. Exit the radiometer measurement mode.</p>		<p>Quit the current procedure by pressing "Q". After completing the current task (which may take several minutes) the program will return to the main menu.</p>
<p>6. Place the metal calibration "saddle" on the radiometer.</p>	<p>Take care not to damage the window! Be sure to orient the saddle so that air flowing from the blower is not blocked. The old saddle used for the old target is now marked as 'OLD'. Make sure to use the NEW saddle that fits the new target.</p>	<p>Unfold the metal "saddle" from its storage position and carefully slide it over the polycarbonate foam "window" of the radiometer. The saddle fits tightly on the radiometer and has a notch to fit on the gold humidity sensor.</p>
<p>7. Fill the target</p>	<p>Improper pouring may cause splashing of LN₂.</p>	<ol style="list-style-type: none"> 1) Remove the target's lid. 2) Add LN₂ from the 10-liter and 5-liter Dewar to the target. Make sure that the liquid level is about one inch above the upper level of blackbody foam. 3) Place the styrofoam lid on the filled target and secure it with the straps.
<p>8. Place the target on top of the saddle.</p>	<p>If the cooler is not maintained in a level position when it is lifted, LN₂ could leak out beneath the lid.</p> <p>If the lid is not securely fastened to the cooler with the straps, the lid could come off and LN₂ could slosh out of the cooler.</p> <p>WARNING: Contact with Liquid Nitrogen (LN₂) may cause burns to exposed skin.</p>	<p>Carefully lift the target by its handles, and place it squarely on the saddle.</p> <p>Care should be taken when lifting the cooler full of LN₂ because the insulating gloves may reduce manual dexterity.</p> <p>Make sure that the target is standing stable on the saddle.</p>

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<p>9. Place the radiometer software in calibration mode.</p>		<ol style="list-style-type: none"> 1) On the PC click on START. 2) Click on RUN. 3) The following line should appear: C:\mwrp\mp_v3.20.exe 4) Return. 5) When the menu appears select choice 3 <i>LN2 Calibration</i> by pressing "3".
<p>10. Discontinue calibration when condensation begins to form on the bottom of the cooler or after about one hour.</p>		<p>Press "Q" to exit the calibration procedure and return to the main menu.</p>
<p>11. Dispose of LN₂</p>	<p>Improper pouring may cause splashing of LN₂.</p> <p>WARNING: Contact with Liquid Nitrogen (LN₂) may cause burns to exposed skin.</p>	<ol style="list-style-type: none"> 1) Carefully remove the target from the saddle. 2) Tighten two long yellow luggage straps to the two handles of the target. 3) Keeping the target evenly balanced lower it from the roof to the ground by holding the belts in your hands and SLOWLY releasing the two straps. 4) Make sure nobody is standing under the target. 5) When the target has reached the ground, untie the straps, lift the target by the handle, and slowly pour the liquid on a corner of the parking lot.
<p>12. Dry the styrofoam coolers before storing them.</p>		<p>After the target warms up, remove the blackbody foam from inside the coolers and let the frost and water dry before storing the coolers.</p>

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<p>13. Check the calibration data for validity.</p>		<p>The calibration results are recorded in a file named <i>mpVndCal.log</i></p> <p>Using an analysis program like Microsoft Excel, the calibration data should be inspected for outliers and for indications that the target temperature had risen due to moisture condensation on the bottom of the cooler or due to depletion of LN₂. The data should be plotted for this determination.</p>
<p>14. Resume normal operations.</p>		<p>Double click on the Desktop icon mwrp.exe. This should resume normal profiling operations.</p>

V. References:

None.

VI. Attachments:

None.