Process Control: Radiometer Best Practices

Use a radiometer & monitor frequently!

9 Keys to Successful Use of Radiometers

1. **Select the Appropriate Radiometer Configuration for Your System**

   Different curing system configurations and applications require different styles of radiometers:

   - Puck-style configurations are ideal for use in conveyor and flood chamber curing system applications.
   - Hand-held/wand configurations can be used for some conveyor and flood system measurements, but are more suit for spot and end-of-wand curing system configurations.

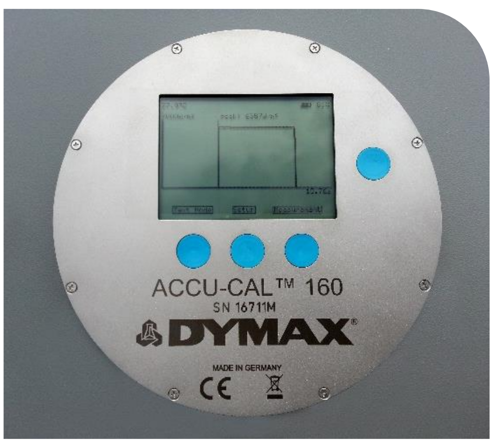

Figure 1. Puck-Style Radiometer

Figure 2. Hand-Held Radiometer

2. **Select a Radiometer with the Correct Frequency Sensativity Range**

   Curing systems emit energy over a wide spectral range, therefore it is important to use a radiometer that is designed to measure the same spectral range that your curing system is emiting.

   - Conventional lamp sytems emit energy over a wide spectral range across the UV and visible portions of the spectrum. ACCU-CAL™ 50 and ACCU-CAL™ 160 models are designed to measure all energy across these same regions (~310 – 395 nm).

- LED curing systems have much narrower frequency emission ranges, making the ACCU-CAL™ 50-LED and ACCU-CAL™ 160 L the appropriate models to insure accurate measurements within the 350 – 450 nm portion of the spectrum.

3. **Handle Your Radiometer Carefully**

   Radiometers are delicate instruments and need to be handled carefully. Sharp blows or dropping will affect accuracy/calibration, and may also permanently damage the instrument.

4. **Get Your Radiometer Calibrated**

   Radiometers need to be calibrated periodically, typically every 6 months or a year. Calibration times should be included in the user guide for your particular radiometer.

   The next calibration due date can be found on a calibration sticker, the calibration certificate, or for some radiometers, such as the ACCU-CAL™ 160, it appears on the display screen.

5. **Keep You Radiometer Clean**

   It is imporatant to keep your radiometer clean, as debris deposited onto the surface of the sensor will reduce the energy reaching the device. To keep this area clean, wipe the sensor with a soft, lint-free cloth dampened with >90% isopropyl alcohol. Also ensure that the emitting-end optics of the lightguide are clean and detector is not loose on the wand.

6. **Ensure Consistency**

   Two calibrated radiometers could *potentially* experience >10% difference when compared to each other. Dymax radiometers are calibrated to a controlled standard with a maximum acceptable deviation of +/- 7.1% (<3% is typical). Dymax recommends using only one radiometer for daily use.

   Repeatable Measurement Orientation:

   - Spots – consistent lightguide orientation and form (bent or straight)
   - Floods and conveyors – consistent position beneath lamp
   - All – Consistent/same radiometer sensor rotational position orientation

7. **Replace Batteries as Needed**

   Radiometers are typically powered by batteries. Replace them as needed to ensure top performance. Most radiometers have low battery indicators.

8. **Never Swap Detectors or Adapters**

   The detector, meter, and in cases where adapters are included, are all calibrated as a matched set, so they cannot be switched or shared by other meters. Unmatched sets can provide drastically incorrect measurements.

9. **Avoid Over-Exposing the Sensor**

   Sensors are sensitive and can be damaged by prolonged exposure to high intensity UV + heat. Customers should use an exposure time <5 seconds during their radiometer measurement routine, especially when measuring high intensity light sources.

Radiometer Modes

Primary Mode: Intensity

- Ideal for establishing intensity levels for curing application, and subsequent measurements to identify changes with distance, position, intensity setting and component degradation variables
- Best for process set up and verification of stability
- Ideal for safety demonstrations

Less Used Mode: Peak Intensity

- Eliminates flutter sometimes seen in “intensity” mode
- Easier for an operator to record a measurement – but does not represent accurate intensity over longer exposure times
- Radiometer will only display highest measurement even if peak was only for a moment

Alternative Mode: Dose

- Measurement of energy collected during a specific time in mJ/cm^2 or J/cm^2
- Good for a product in motion such as with a conveyor, or determining total energy impinged onto exposure site
- Joules = Intensity * Time   e.g.: 212 mW/cm^2 * 6 seconds= 1.2 J/cm^2
- Not the best option for process creation – low intensity over a very long time can accumulate the same dosage but may not yield the same cured mechanical properties such as proper depth of cure.

Understanding Radiometer Calibration

- **Accuracy Specification**: This is stated as +/-0.5%. This is the accuracy of multiple measurements. Multiple measurements should not vary more than +/-0.5%.
- **Incoming Maximum Deviation**: This is stated as +/-10%. This is in reference to the “As-Is” condition of a radiometer received in our lab for calibration. This measurement is taken prior to any cleaning of the radiometer and detector, with the intention of witnessing what the customer would witness during measurement.
    - The radiometer should not be more than +/-10% deviation from the Calibration Standard after 12 months of use in the field.
    - Contributing factors to a radiometer that exceeds 10% deviation during 12 months of use include debris build up on the detector sensor window, exposure to high temepratures, and/or rough handling during use.
    - Measurements “as is” of 10% or more are considered out of tolerance (“OOT”) and the customer is notified.
- **Post-Calibration Maximum Deviation**: This is stated as +/- 7.1%. After a radiometer is calibrated, it shall not exceed a +/-7.1% deviation from the Standard before return shipment to the customer. Contributing factors to a radiometer that will not calibrate are damage to the detector sensor, and/or damage to the meter.

- **Spectral Response Curve:** Included with the purchase of a new ACCU-CAL™ series radiometer is a graph which represents the spectral response of the UV detector. This graph is like the "fingerprint" for each detector and illustrates how the detector responds to the range of wavelengths. Natural variations in the detector will give it unique properties, which are then accounted for and corrected during the calibration process. When the radiometer has been calibrated to function with a specific detector's "fingerprint", changing the detector to a un-matched detector will change the calculation and drastically alter the displayed measurements.

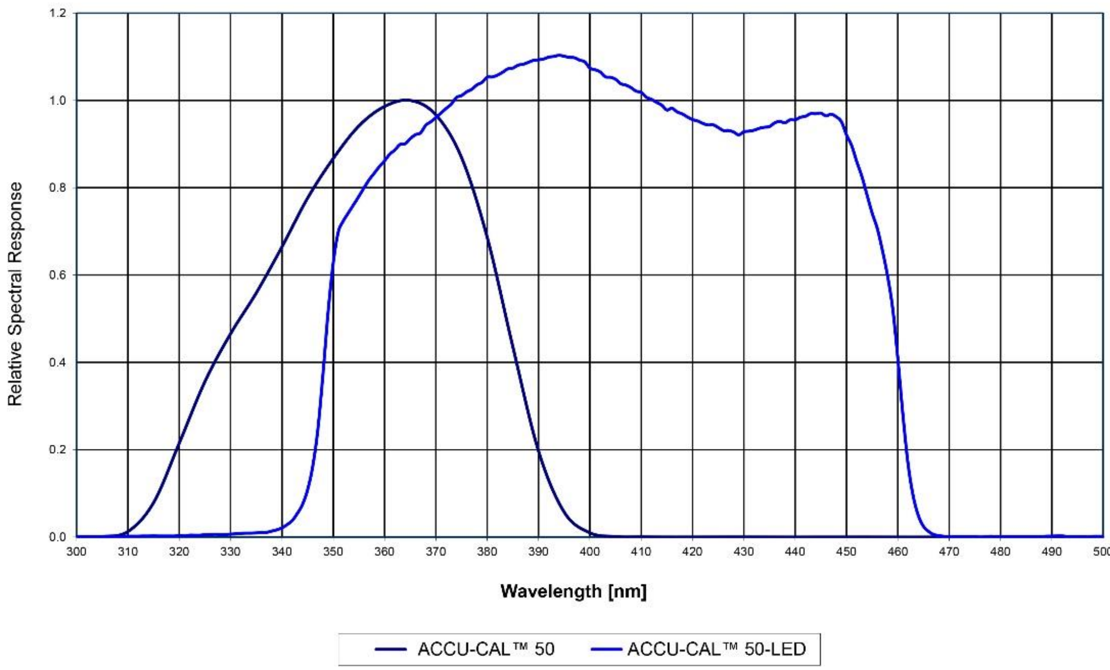

Figure 3. Typical spectral response for an ACCU-CAL™ 50-LED radiometer (350 - 450 nm) and ACCU-CAL™ 50 UVA radiometer (320 - 395 nm)