SOLRMAP

Solar **R**esource and **M**eteorological **A**ssessment **P**roject
National Renewable Energy Laboratory

Station Maintenance and Training Guide

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Introduction

An accurate measure of solar intensity is important for a variety of purposes, ranging from agricultural applications to architecture to power plants that convert solar energy to electricity. Knowledge of the solar resource allows scientists, engineers, and analysts to understand and quantify the effects of solar energy for specific applications in the world around us.

The intensity of solar energy is measured by a *radiometer*, which converts the sun's energy into other fundamental forms of energy that can be directly measured, such as heat, physical movement, or – most commonly – very small electric currents. By measuring the electrical output of a radiometer with a high precision voltmeter and applying a factor that relates that output to the sun's intensity, we can measure and record solar energy at a particular location.

We measure three fundamental components of solar radiation – *Direct Normal Irradiance (DNI),* that which emanates directly from the sun; *Diffuse Horizontal Irradiance (DHI),* that coming from the sky dome, but excluding the sun itself; and *Global Horizontal Irradiance (GHI),* which is the total of both diffuse and direct normal irradiance. The Rotating Shadowband Radiometer (RSR) measures GHI and DHI, and mathematically calculates the DNI. When the shadowband is at rest, the instrument measures global irradiance. When the shadowband rotates, it momentarily blocks the sun from the sensor, and the instrument measures the diffuse irradiance. DNI is then calculated from GHI and DHI. Some RSR instruments hold a second sensor that measures only GHI, which is a redundant measurement used for data quality assessment.

To obtain the best solar measurements, it is necessary to properly calibrate the instrument to assure the relation between output voltage and solar intensity remains valid. Also necessary to maintain that relationship is proper cleaning and other routine maintenance. The maintenance process includes:

- *Checking the level of the sensor*. Sensor tilt – even if only slight – skews the amount of energy measured by the instrument and degrades the quality of the data. The sensor should be checked periodically to assure it remains level.

- *Cleaning the instrument optics*. To properly measure the solar intensity, no contaminant should block or reduce the amount of sunshine falling on the instrument. The outdoor environment provides many sources of such contamination, such as dust, precipitation, dew, plant matter, or bird droppings. The sensors should be cleaned regularly to minimize the effect of contaminants on the measurements.

- *Documenting the condition of the instrument.* For analysts to understand limitations of the data, conditions that affect the measurement must be documented. This not only includes substandard conditions, but it is just as important to document proper operations to add credibility to the data set. Your observations and notes provide a critical record of conditions that both positively and negatively affect data quality.

- *Documenting the environment.* As a consistency check, sky and weather conditions are useful when interpreting data from the instrument, including unusual measurements.

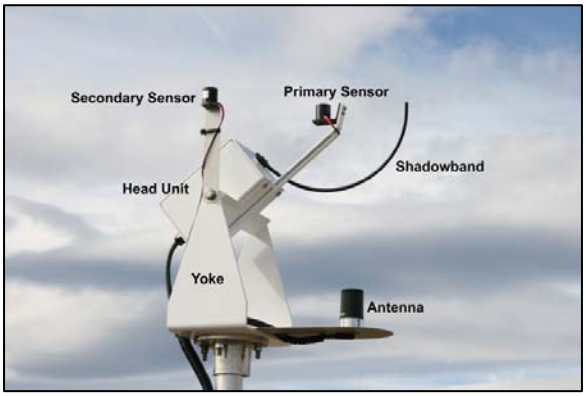
- *Documenting the infrastructure*. The measurement station as a whole should be examined for general robustness. Any defects should be noted and corrected.

Site Maintenance Procedure
When arriving on site, prepare the log sheet for the visit. Make entries for:

- Date
- Time (local standard time)
- Technician name

For each item below, make the observation and perform any necessary corrections. Make a note in the log about the observed condition and any corrective action. All uncorrectable problems should be reported immediately.

- **Security** - Examine the perimeter fence and gate to assure that the site is secure and that no animals or unauthorized people have entered, possibly disrupting operations.
- **Tower** - Examine the tower for rigidity and vertical stature. Inspect the guy wires to assure they remain taught.
- **Wind Instruments** - Observe the wind vane and anemometer cups or propeller to assure that their movements are consistent with apparent wind. Although exact wind speed is hard to determine, erratic, binding, or noisy operation should be noted and reported.
- **Sky Conditions** - Observe the sky and clouds. Make a note of approximate cloud cover in the log using the sky conditions code.
- **Radiometer Mount** - Examine the radiometer tripod and assure that all anchors, tie downs, and attachments are secure (radiometer head, antenna, logger box, cabling, etc.)
- **PV Panel** - Note the cleanliness of the PV panel using the dirt code on the log sheet (this is an important indicator of dust, which may not be as easily observed on the white radiometer sensors). Clean the panel with a soft moist rag.
- **Radiometer Operation** - Watch the radiometer and confirm that the shadowband rotates on at least a 30-second interval. It may occasionally rotate more frequently when passing clouds cause varying solar intensity. Note any noisy or erratic behavior.
- **Soiling** - Using a small step ladder adequate to safely reach the necessary height, examine each radiometer sensor and note any dirt or other debris. Use the condition code to log your observation. *Do not lean or pull on the radiometer tripod when climbing the ladder.*
- **Leveling and Cleaning Radiometer** –
    - Gently place an opaque cover over the secondary sensor to stop rotation. Confirm that the instrument stops rotating, thus allowing you to access the sensor without risk of injury or damage.
    - Place the bubble level on the primary sensor and check for level. Use the bubble level code on the log sheet to document the magnitude and direction of an unlevel condition. If the bubble is across or beyond the center circle, adjust the sensor level. If both sensors are out of level, adjust the primary sensor first.



        - To adjust the primary sensor, loosen the small lock and pivot bolts for east-west leveling, or the main yoke bolts for north-south leveling. When the bubble is centered within the inner circle, tighten the bolts and re-check the level (tightening may affect the level). Loosening the yoke bolts will likely affect the level of the secondary sensor.
        - To adjust the secondary sensor, loosen the east yoke bolt for north-south adjustment or gently bend the support for east-west adjustment. When loosening the yoke bolt, take care to move *only* the secondary sensor mount and not the radiometer head unit. When the bubble is centered within the inner circle, tighten the bolt and re-check level of both sensors.
    - *Soiling of the white radiometer sensors is usually difficult to visually detect; thus the sensors should be cleaned at each visit even if they don't appear dirty*. Clean the sensor by squirting with distilled water and gently wipe with a lint-free cloth or soft swab. Be careful not to disturb the level of the sensor. Squirt again with distilled water and dry with canned compressed air to remove all traces of lint.
    - Remove the opaque cover and place it over the primary sensor. Be ready for unexpected shadowband rotation..
    - Remove the opaque cover and confirm that the shadowband resumes normal rotation within 30 seconds.
    - Repeat the level check and cleaning steps for the secondary sensor

Be sure to make a note in the log of any unusual conditions observed (such as flies, frost, heavy dew, smoke/haze, high winds, etc.). Use the comments section or direct attention to an attached sheet if necessary.

File the log sheet in a safe place for transmittal to NREL.