

# **Protocols for the Operation of Solar Radiation Sensors**

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*Prepared by:*

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Comments, questions or suggestions regarding the content of this document may be directed to:

Jennifer Lang-Gorman  
Agriculture and Forestry  
McIntyre Centre – Building 1, Main Floor  
4816 – 89 Street  
Edmonton, Alberta T6E 5K1  
Phone: (780) 427-3559  
Email: Jennifer.Lang@gov.ab.ca

Additional copies of this document may be obtained by contacting:

Information Centre  
Alberta Environment and Parks  
Main Floor, Oxbridge Place  
9820 – 106 Street  
Edmonton, Alberta T5K 2J6  
Phone: (780) 427-2700  
Fax: (780) 422-4086  
Email: env.infocent@gov.ab.ca

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## **1.0 INTRODUCTION**

Solar radiation is monitored throughout the province of Alberta at select climate monitoring stations that are owned and operated by different organizations. It is important to keep these sensors in optimal working condition to ensure that the data being collected is accurate. The data collected from these sensors is used with other climate data to analyze, model, and forecast weather conditions. The incoming radiation data is also used as a standalone parameter to be viewed at near-real-time station available on-line to the public and are relied upon year round. Keeping these sensors in good working order is in the best interest of Alberta Climate Information Service (ACIS) network to continue to provide high quality data.

No official formal standard operating procedure (SOP) for the measurement of solar radiation has been written by the Government of Alberta. Most knowledge has been passed on through demonstration, collaboration, and mentorship. Guidance was gained from the equipment manuals, as well as informal training from the vendor and other staff.

The objectives of this document are to record the SOP throughout the network and to ensure that each technologist adheres to these standards. The data collected from these sensors becomes part of the provincial archives and is used in many high level applications relating to climate data. The proper implementation of the standards will ensure the integrity of the network and the quality of data for the ACIS.

## **2.0 SOLAR RADIATION**

### **2.1 Purpose**

Incoming radiation is measured with various types of solar sensors. ACIS network has two models of pyranometers in operation manufactured by Kipp & Zonen: the SP Lite and the SP Lite2. They collect incoming solar radiation data that is ingested into the data network and used for modeling, research and forecasting purposes.

### **2.2 General Information**

Solar sensors are checked with a calibrated solar standard twice a year in the field and are routinely swapped out for lab recalibration every four years. The physical sensor itself is manually wiped during these site visits to clear the sensor of any debris that might impede the reading. The field standards used to check the sensors installed at the station are calibrated yearly in a professional calibration lab.

The solar sensors installed in the network are mounted on an extended base which prevents the buildup of snow on the sensor (Figure 1). The bases are mounted at approximately 2 m either on their own or with another sensor to the North with a distance apart so it does not cast a shadow on the solar sensor.

The stations in the ACIS network are operated in conjunction with data loggers manufactured by Campbell Scientific (Canada) Corp. The current data loggers installed at the stations are CR10X and CR1000. It is recommended that each technologist becomes familiar with the Loggernet software as well as the programs used throughout the network. A working knowledge of the operations, locations and supplemental documentation (constant sheets) is an asset when conducting any station maintenance.



**Figure 1.** SP Lite Incoming Solar Radiation Sensor Installed on Extended Platform.

### 2.3 Equipment

The following describes the major types of equipment required to operate the solar sensors:

- LiCor logger, display and calibrated standard sensor
- Water and cloth for wiping field sensor
- Calibrated constants for each sensor installed in the field (found on spreadsheet managed by Alberta Agriculture and Forestry staff)
- Step ladder to reach solar sensor
- Small level for checking sensor
- Tools to remove and mount sensors: small wrench and screwdriver
- Computer with Loggernet software (Figure 2) and CSI cable to connect to Logger or Hand held display with cable for logger. The displays for the CR1000 and CR10X are called CR1000KD and CR10XKD (Figure 3), a RS232 cable is also required to connect to the logger with these keyboard displays.

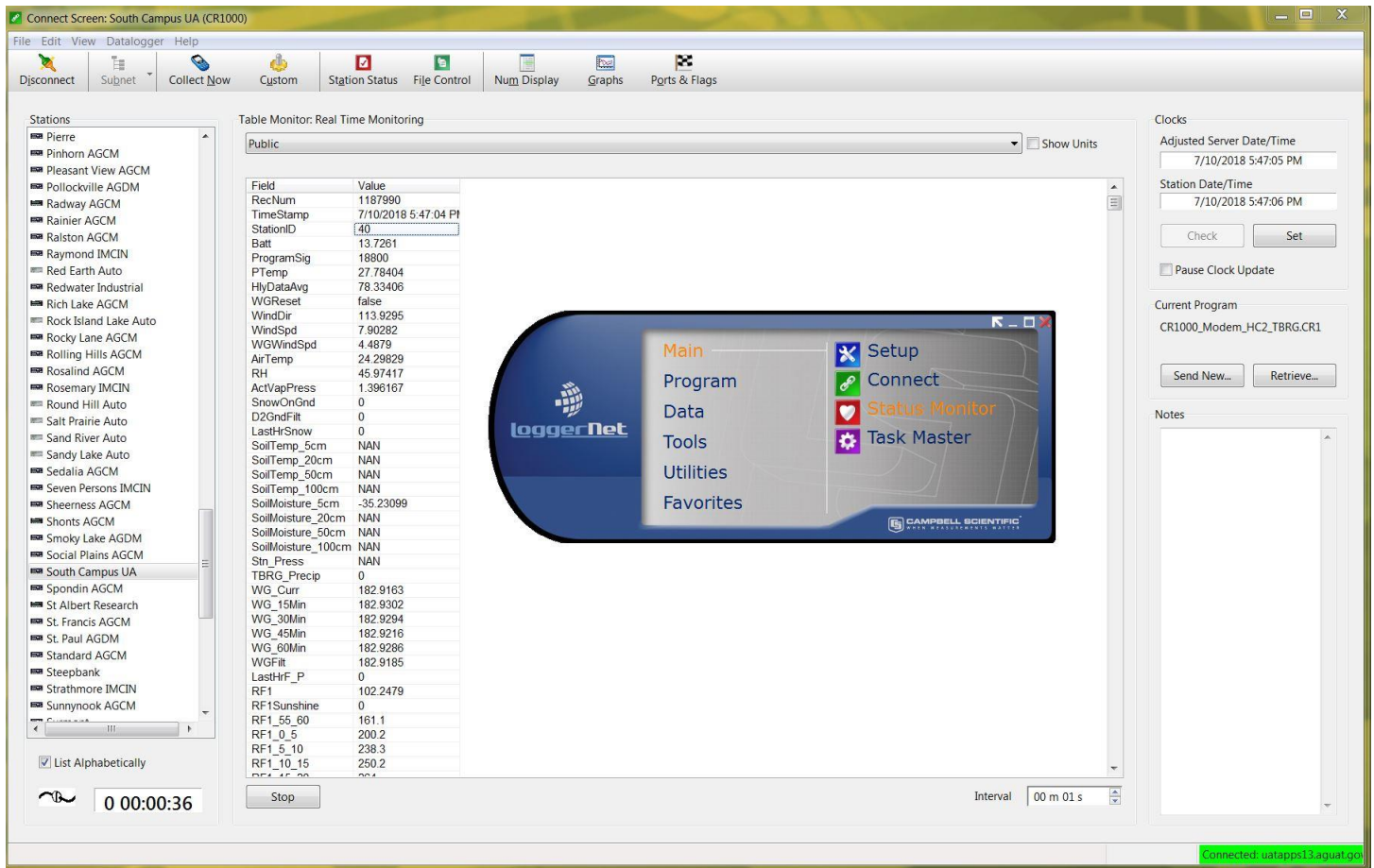


Figure 2. Screenshot of Loggernet Software.



Figure 3. Logger Keyboard Displays: CR1000KD (Left) and CR10XKD (Right) Produced by Campbell Scientific.

## 2.4 Procedure

Incoming radiation data is one of the most important parameters recorded in the network in regards to climate monitoring for agricultural purposes. The comprehensive maintenance and calibration procedures ensure the data collected is of high quality. There are some differences between logger models and their programs in this procedure. It is imperative that the correct steps are taken for the correct logger/program.

1. The incoming radiation sensor is installed on a non-reflective base and the actual sensor is elevated from the base by two long bolts. The level of the sensor needs to be checked to ensure the sensor is taking the proper readings. A small level or the bubble level on most of the SP Lite2's can be used to check the level.
2. The standard pyranometer and LiCor logger display unit will show the output of the standard and this is to be compared to the station sensors' reading. The standard is checked and recalibrated each year under a controlled light source and new constants are provided by the vendor. The constants are inputted and saved to a spreadsheet for field reference. Follow the instructions in the display logger manual to input and display the IR output.
3. It is imperative that the standard sensor be level to achieve a correct reading, the closer in proximity the standard is to the field sensor the better (in height and sky coverage). It may take a few minutes to achieve a steady reading depending on the day and sky cover conditions.
4. Sky conditions that are clear and constant are ideal for standard checks with the incoming radiation sensors. Rapidly changing sky cover can make it difficult to get a good reading between the standard and the field sensor.
5. Part of the maintenance routine for the incoming radiation sensor is the routine cleaning of the sensor. Prior to each standard check, the sensor is to be wiped with water and a soft cloth to remove any buildup or debris on the surface of the sensor. Wiping time should be recorded on the field sheet and noted when wiped for data management in Greenwich Mean Time (GMT).
6. The acceptable range is within 10 % of standard. Readings outside of the accepted parameters warrant a sensor swap out. The new sensors' constants will have to be inputted into the logger program. The record of constants can be found on the constants spreadsheet which is maintained and managed by Alberta Agriculture and Forestry staff.
7. The mounting hardware for the SP Lite sensor can be removed with a small wrench. The sensor level should be checked after it is replaced and fine adjustments can be made using the nuts on the mounting bolt. The level can be checked with a small level on the sensor collar.
8. Updating the constant in the logger program can be done by two methods. One is by using the Loggernet software provided by Campbell Scientific (Canada) Corp. and connecting to the logger with a special serial cable. The other way is to use the handheld keyboard display.
  - a. *For the CR10X:*
    - i. **Using Loggernet**- connect CSI serial cable to computer and logger, open the connect screen and connect to the desired station.
    - ii. Select the Datalogger tab in the top left of the screen, scroll down the list and select Terminal Emulator.
    - iii. In Terminal Emulator select the "open terminal" button in the bottom right, top status bar should change from not active to active.
    - iv. Place cursor in the command screen area and click, type \*7H and press enter (this will activate the command screen).
    - v. Type \*135 and press enter (this will take you to table 1 location 35). Continue to press enter until you see 24 in location 2 (this could be 35-2, 36-2, 37-2, or 38-2 depending on the individual program in the logger). The number 5 location is where the multiplier from the constant sheet is inputted.



- vi. Pressing enter after you have typed the new constant and then \*0 will write to the program. A display of LOG12 in the command window indicates that the program has been updated, you can now close the terminal and proceed with regular operations.
- vii. **Using CR10XKD**- plug the display into the logger with an RS232 cable.
- viii. The key strokes are the same as using Terminal Emulator other than “A” is advance and “B” is back.
- ix. Type \*135 and press “A” (this will take you to Table 1, location 35). Continue to press “A” until you see 24 in location 2 (this could be 35-2, 36-2, 37-2, or 38-2 depending on the individual program in the logger). The number 5 location is where the multiplier from the constant sheet is inputted.
- x. Pressing “A” after you have typed the new constant and then \*D and \*0 will write to the program. A display of LOG12 in the command window indicates that the program has been updated, you can now close the terminal and proceed with regular operations.

*b. For CR1000:*

- i. **Using Loggernet**- connect CSI serial cable to computer and logger, open the connect screen and connect to the desired station.
  - ii. Select the Datalogger tab in the top left of the screen, scroll down the list and select Terminal Emulator.
  - iii. Place cursor in the command screen area and click, type 7H and press enter (this will activate the command screen).
  - iv. Type \*C and then enter to scroll down the list to the IR input.
  - v. Input the sensitivity matching the sensors corresponding serial number from the constant sheet. (This number is also usually affixed to the side of the sensor as well).
  - vi. Type \*0 to write and save.
  - vii. **Using CR1000KD** plug the display into the logger with an RS232 cable.
  - viii. Press the “Home” button.
  - ix. Scroll down to “Configure, Settings” with arrow buttons on pad and press enter.
  - x. Scroll to “Constant Table” and press enter.
  - xi. Select “RF1Sens” and press enter.
  - xii. Enter new sensitivity value found on constant sheet and press enter.
  - xiii. Press Esc to return to main menu, will prompt to see if you want to save changes, select yes and press enter.
9. Be sure to check the newly installed solar sensor with your standard and record your findings in the field sheet.
10. Solar sensors installed in the ACIS network are routinely swapped out for maintenance every four years.

### 3.0 ACKNOWLEDGEMENTS

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