



Radiometer Calibration and Characterization (RCC) User's Manual

Windows Version 4.0

Afshin M. Andreas and Stephen M. Wilcox
National Renewable Energy Laboratory

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List of Acronyms

ACM	Combo ACO and digital voltmeter
ACO	Automatic ACR control unit
ACR	Absolute cavity radiometer
AIM	Atmospheric Radiation Measurement Program Instrument Management system
AOD	Aerosol optical depth
ASR	Atmospheric stability monitor
BAR	Barometer
BORCAL	Broadband Outdoor Radiometer Calibration
CAL	Calibration
CALDAT	Calibration data
CAV	Cavity
CD-ROM	Compact disk read-only memory
CFG	Configuration
DC	Direct current
DIR	Direct normal (beam) pyrheliometer
DMM	Digital multimeter
DSN	Data source name
DVM	Digital voltmeter
ENICR	Effective net infrared corrected responsivity
GPIB	General purpose interface bus
GPS	Global Positioning System
HUM	Hygrometer
ID	Identification
INV	Inventory
IR	Infrared
ISO	International Organization for Standardization
JBOX	Junction box
LGR	Data logger
LW	Longwave
MCO	Manual ACR control unit
MET	Metrological
PDF	Portable Document Format
PWV	Precipitable water vapor
PYG	Pyrgeometer
RAP-DAQ	Reda-Afshin-Pete Data Acquisition model
RCC	Radiometer Calibration and Characterization software
REF	Reference
RES	Resistance (two-wire)
RES4	Resistance (four-wire)
RH	Relative humidity
RLY	Relay (for data logger)
RS	Responsivity
SHD	Shaded test pyranometer

SPA	Solar position algorithm
STD	Standard (control) instrument
SW	Shortwave
THM	Thermistor
TOT	Total (global) pyranometer
TP	Thermopile
TST	Test instrument
USB	Universal serial bus
VDC	Direct current voltage
WRR	World Radiometric Reference

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1 Introduction

The Radiometer Calibration and Characterization (RCC) software is a data acquisition and data archival system for performing Broadband Outdoor Radiometer Calibrations (BORCAL). RCC provides a unique method of calibrating broadband atmospheric longwave (LW) and solar shortwave (SW) radiometers using techniques that reduce measurement uncertainty and better characterize a radiometer's response profile. RCC automatically monitors and controls many of the components that contribute to uncertainty in an instrument's responsivity.

The word *characterization* in RCC refers in part to the generation of multiple responsivities for an instrument based on solar position, atmospheric conditions, and/or environmental conditions. The characterization is not exhaustive, and other factors can affect an instrument's responsivity. Additionally, RCC maintains a database that holds historical information about each instrument and its calibration profile. A long-term calibration history can be used to analyze an instrument's response characteristics by comparing current results to previous results.

1.1 Database

RCC is built around a Microsoft Access database that serves not only as an archive of historical instrument calibration information but also forms the basis of the BORCAL event configuration.

RCC treats the BORCAL process in a hierarchical fashion, and the storage of the information for a BORCAL follows in much the same manner:

- For a given calibration center, there may be multiple BORCALs.
- For a given BORCAL, there may be multiple data acquisition sessions.
- For a given session, there may be multiple scan groups with a variety of configurations.
- For a given scan group, there may be multiple instruments.
- For a given instrument, there will be multiple data points and associated reference, measurement equation, and/or environmental data.

In addition, a BORCAL can be either LW or SW. Both types possess the same hierarchy mentioned above.

The RCC database maintains information about all levels of this hierarchy, and it can yield information relating to any level. For example, for any data acquisition session, information would be available for scan groups, their configuration, the instruments within the group, and even for the data collected. Other information at the same level may be extracted (for example, from other sessions) or from different levels in the hierarchy.

Although instruments appear at the bottom of this hierarchy, the database was designed around the need for information about instruments. To meet this need, the database contains information about all instruments ever calibrated by RCC, starting with the most fundamental information:

- Manufacturer and model
- Customer

- General comments about the instrument.

In addition, information specific to an instrument's calibration history is available:

- Raw data from the instrument
- All previous responsivities
- Associated statistics for the responsivities (number of data points, uncertainty, etc.)
- The RCC configuration for every data point used to determine any responsivity including:
 - Reference instruments
 - Sample interval
 - Physical location of each instrument and its signal-cabling details
 - Other instruments in the same scan group
 - Operator(s) on duty during the calibration event.

The database also allows inspection of data from the perspective of a BORCAL:

- Site location
- Average temperature, humidity, and other atmospheric conditions.

The database is designed as a documentation tool for instrument calibration. To this end, the database includes open-ended comment fields that allow operators to enter detailed documentary information about an instrument, a BORCAL, or even comments unique to a particular instrument's performance in a specific BORCAL. The comments are permanently stored in the database, and they are included in the printed calibration reports.

1.2 Shortwave Data Acquisition

The RCC data acquisition module controls the scanning of instruments by the data logger and does real-time analysis of incoming instrument data for anomalous or undesirable conditions.

Information in the database specified by the BORCAL-SW operators is used to configure a data acquisition session. This configuration information includes the identification of reference instruments, control instruments, all test instruments, instrument tilt, specified scan intervals, and instrument cabling. Test instruments may be configured independently from one another (for example, at different tilts). The data acquisition sessions range in time from a few minutes to perhaps several hours. During a session, the configuration of the instruments remains static: no instruments may be added, moved, or deleted, and no other parameters may be changed.

Prior to the first BORCAL-SW data acquisition session, RCC automatically segregates instruments into scan groups by instrument type (manufacturer and model), tilt configuration, and associated pyrometer (if used) for the best data acquisition uniformity. A scan group is a collection of instruments that are sampled one immediately after the other by the data logger during a period of 1 to 2 seconds. Scanning is the fastest way to obtain measurement data by the logger, yet scans still require a finite amount of time to measure each instrument. To minimize

the amount of time between the scan of the reference instruments and that of the test instruments, RCC scan groups are limited in size to 10 instruments. To further minimize the time differential between the reference instruments and the test instruments, the system initiates the reference absolute cavity radiometer (ACR) reading at the same time it initiates a scan of the test instrument group, and the two diffuse reference instruments are included in the scan group of the test instruments.

Atmospheric stability plays a significant role in the calibration of solar radiometers. Because of variations in the response times of different instrument types to changes in the solar irradiance, a stable atmosphere is critical for valid comparisons between test and reference instruments. A fast-responding, silicon-based radiometer along with the cavity and diffuse radiometers are sampled by RCC up to 60 times per minute to provide information on the stability of the solar radiation intensity being sensed by all instruments in a BORCAL. The output from this atmospheric stability radiometer (ASR) group is analyzed and scored for variability. The ASR score for each measurement is stored with the data record and used to filter undesirable data from that used to determine an instrument's responsivities. It is also part of the uncertainty estimate for the measurement.

As revealed by the hierarchy described above, the smallest unit of data acquisition is a measurement from a test instrument coupled with the associated data from the reference and ASR instruments. At this level, RCC examines the data for its suitability for inclusion in the final data set used to determine responsivities. The purpose of this examination is twofold: first, when the signal from an instrument strays from expected values, the data will be flagged as questionable, and, second, the BORCAL-SW operator will be alerted to a potential problem. Typical situations that should be detected include tracker misalignment (for both the direct normal and the shaded disk reference instruments), foreign matter or objects obstructing an instrument's field of view (such as airborne material, birds, or insects), and signal cable problems. This system of alarms and flagging helps prevent bad data from being included in the computation of a calibration factor and speed rectification of the problem that caused the alarm and thus prevent further data loss.

To aid in identifying data acquisition problems, RCC provides real-time graphing of the incoming data. This capability allows the operators to monitor the output of any instrument and compare it to similar instruments that should show a corresponding measurement profile. In addition, the system provides information about error conditions, such as the instruments involved, time of the error, and the associated data. This helps the operators troubleshoot the error and speed resolution of the problem.

During a period of 1 hour or more, the responsivity of the ACR tends to shift (particularly with ambient temperature and irradiance level), adding error to the responsivities derived for the test instruments. To minimize these errors, data acquisition sessions must be periodically stopped for a short time to recalibrate the ACR. This calibration is scheduled at specified intervals, and it is performed automatically by RCC. The operator has the option of overriding the scheduled calibration to perform an ACR calibration at any time; however, the system schedules the calibrations to maximize the quantity of data available for the responsivity calculations.

The software mandates an electrical calibration of the ACR at the beginning and end of each data acquisition session. To minimize the effect of any drift, the calibration factors for the ACR are interpolated between session beginning and end. RCC accomplishes the electrical calibration process by directly controlling the ACR's operating mode and making direct readings from the radiometer's digital voltmeter. The voltages are rapidly sampled during a short period of time for an average value, and all of the readings are stored with the session data for archival purposes.

1.3 Longwave Data Acquisition

The RCC data acquisition module controls the scanning of instruments by the data logger and does real-time analysis of incoming instrument data for anomalous or undesirable conditions.

Information in the database specified by the BORCAL-LW operators is used to configure a data acquisition session. This configuration information includes the identification of reference instruments, control instruments, all test instruments, specified scan intervals, and instrument cabling. One data acquisition session consists of an entire night (or less if the data collection is stopped). During a session, the configuration of the instruments remains static: no instruments may be added, moved, or deleted, and no other parameters may be changed.

For BORCAL-LW, all instruments are scanned in one group; they are not segregated into groups like BORCAL-SW because the LW radiation does not change as rapidly as the SW radiation. Also, RCC conducts a scan of the reference prior to and after scanning the instruments. If the change in reference conditions exceeds the configured threshold, the data will be rejected during final processing. For data that is accepted, the average of the two reference scans is taken.

As revealed by the hierarchy described above, the smallest unit of data acquisition is a measurement from a test instrument coupled with the associated data from the reference and ambient temperature. At this level, RCC examines the data for potential problems, but it does not flag or reject test instrument data (unless there are stability problems with one or more reference instruments during the duration of the scan). RCC will only produce alarms for stability issues of test instruments and large deviations of test case temperature (and dome temperature if available) compared to ambient temperature. Because the LW events are at night, these alarm conditions are also recorded to disk for review the next day for potential problems.

To aid in identifying data acquisition problems, RCC provides real-time graphing of the incoming data. This capability allows the operators to monitor the output of any instrument and compare it to similar instruments that should show a corresponding measurement profile. In addition, RCC provides information about error conditions, such as the instruments involved, time of the error, and the associated data. This helps the operators troubleshoot the error and speed the resolution of the problem.

1.4 Shortwave Instrument Responsivities

An instrument's responsivity is defined as the signal generated by the radiometer (microvolts) per unit of input stimulus (solar irradiance in W/m^2). Conventional calibration procedures produce a single responsivity for an instrument, and RCC produces this conventional number for both pyranometers and pyrheliometers. In addition, RCC makes a significant impact on reducing measurement uncertainty by characterizing the instrument's sensitivity to variations in the

position of the sun relative to the instrument. Solar radiometers typically exhibit a characteristic response profile that varies with solar azimuth and zenith angles. By deriving responsivities for multiple azimuth and zenith combinations, the opportunity is provided to reduce the uncertainty of subsequent measurements of solar radiation.

RCC provides several responsivities for instruments; each are derived using a different method, and each characterizes the instruments in different ways. (Each characterization is duplicated for instruments configured for the Effective Net Infrared Corrected Responsivity, or ENICR.)

- Single-number responsivities
 - Forty-five-degree responsivity: the instrument's responsivity at a zenith angle of $45^\circ \pm 0.3^\circ$. This narrowly characterized number minimizes the variables that can affect responsivity, and it is useful for illuminating a shift in sensitivity over time. This number *may not* be representative of the instrument's responsivity at other zenith angles.
- Multidimensional responsivities
 - Two-degree responsivities: a set of responsivities derived at $\pm 0.3^\circ$ from even zenith angles in the BORCAL event's zenith angle range (e.g., 0° , 2° , 4° ... 90°). There are two sets of two-degree responsivities: one for a.m. and one for p.m.
 - Two-degree a.m./p.m. averaged responsivities: provided to the user as a convenience and do not appear in the calibration certificate (only in the Atmospheric Radiation Measurement Program Instrument Management System (AIM database) or as requested)
 - Missing bins within the range of valid zenith angle bins are interpolated between existing values (for both a.m. and p.m.).
 - Missing bins beyond the range of valid zenith angle bins are extrapolated by repeating the same value that is available at the beginning and end of each available range for both a.m. and p.m.
 - Finally, the a.m. and p.m. values for the same bin are averaged together to produce the final result for every bin between 0 and 90.
 - Spline fit for the a.m. and p.m. two-degree responsivities in the traceable valid zenith angle range.
- Multidimensional responsivities for pyranometers (obsolete)
 - Responsivity function: a 49-degree polynomial in cosine (z) fitted to all available two-degree responsivities plus three extrapolated values at -2° , 92° , and 94° .¹
 - Missing bins within the range of valid zenith angle bins are interpolated between existing values.
 - Missing bins beyond the range toward -2 degrees are extrapolated along a cosine curve for both a.m. and p.m. bins, then the a.m. and p.m. values for

¹ These are obsolete results, and they are not included in the calibration certificate; however, they are posted in the AIM database. In a future release of RCC, these results will be removed.

each bin are averaged, and that average is used for both the a.m. and p.m. bin values.

- Missing a.m. and p.m. bins beyond the range toward 94° are extrapolated independently along a cosine curve. The curves are prevented from going negative or from continuing with a positive slope beyond 86°. In such cases, the curve is “mirrored” or reversed.
- Latitude-optimized: a set of weighted numbers by latitude derived by including only the solar geometry characteristics encountered at a given latitude. (These are derived from the responsivity function.)²

1.5 Longwave Instrument Coefficients

RCC uses multivariate linear regression to calculate three coefficients (four for instruments with dome temperature) to produce results with higher accuracy. In addition, RCC uses a unique method for data rejection. After rejecting data when reference conditions are unstable, the post-processing routine will iteratively compute the residual (i.e., reference irradiance minus test irradiance) using computed coefficients then reject data points that fall outside the configured standard deviations (typically three times standard deviation). The final data set will be used for the regression to calculate the final reported coefficients. This assumes that a higher percentage of the data is acceptable when rejected data could have occurred because the sensors were not clean or because the atmospheric conditions were not stable.

RCC provides two sets of coefficients: one with the K0 coefficients forced to zero and the other with a value. Although the K0-forced to-zero method may not be as accurate, some end users prefer this option.

1.6 Reporting

The RCC system provides several reporting functions:

- Calibration certificates: documents that conform to International Organization for Standardization (ISO) 17025 standards for reporting calibration results, calibration environment, and ancillary data. These include a plot of the calibration data and a table of two-degree responsivities for BORCAL-SW.
- Suggested deployment methods: data sheets that describe the various responsivity characteristics noted above (optional, for BORCAL-SW only)
- Full report: a document that compiles the certificates and suggested deployment methods for all instruments in a BORCAL along with the BORCAL operator logs (for BORCAL-SW only) and instrument comments
- Customer report: a document similar to the full report but containing only information for a customer’s particular instruments.

In addition to the above hard-copy reports, RCC allows an analyst to examine instrument data on-screen.

² These are obsolete results, and they are not included in the calibration certificate; however, they are posted in the AIM database. In a future release of RCC, these results will be removed.

2 Hardware and System Requirements

The RCC system runs under Microsoft Windows XP 32-bit, 7 32-bit, and 7 64-bit (XP 64-bit, Vista, 8, and 10 have not been tested).

- Required
 - Dual-core central processing unit with speed as required by the operating system (Four-core or more is recommended.)
 - Minimum 1 gigabyte memory for 32-bit operating system and 2 gigabyte memory for 64-bit operating system (Four gigabyte or more is recommended.)
 - Compact disk read-only memory (CD-ROM), universal serial bus (USB), or network connectivity for initial installation
 - Disk drive with several hundred free megabytes
 - Monitor with minimum resolution of 1,024 x 768
 - General purpose interface bus (GPIB) or RS-232 communications ports as required
 - Data logger with low voltage measurement capability (resistance also required for BORCAL-LW)
 - Fluke Helios Plus 2287A (obsolete)
 - National Renewable Energy Laboratory's Reda-Afshin-Pete Data Acquisition model RAP-DAQ (contact NREL for more details)
 - Eppley HF ACR with one of the following:
 - Eppley Model 406 control unit with HP34401A or DP100 voltmeter (obsolete)
 - Eppley 408M control unit
 - National Renewable Energy Laboratory's model Reda control unit (contact NREL for more details).
 - National Instruments LabWindows/CVI SQL Database Driver Run-Time License (777151-011)
- Optional
 - Global Positioning System (GPS) unit for maintaining computer clock time
 - Hewlett-Packard or Symmetricom 58533A (obsolete)
 - Symmetricom XLi Time and Frequency System with GPS timing engine and lightning arrestor (1510-602, 87-8028-2, 150-709).
 - Temperature, humidity, and barometric pressure sensors (BORCAL-LW requires the temperature sensor.)
 - Microsoft Word for viewing this document online

- BullZip Portable Document Format (PDF) printer driver for generating PDF versions of reports
- Adobe Acrobat Reader (or compatible viewer) for viewing PDF reports
- Uninterruptible power supply for maintaining computer operations and data integrity in the event of a power failure
- Fast printer (color laser preferred) for printing reports.

3 Program Installation

RCC is provided on a CD-ROM. To install the program, insert the CD into the drive. If the install screen does not appear within a few seconds, navigate from the *Start*→*Run* menu to the *setup.exe* program in the CD root directory, and run the program by double-clicking on the setup icon.

3.1 Standard Setup

When the install wizard appears after running the setup program, you may change the default installation directory by entering a new name in the field for the Installation Directory.

Click on *Finish* to install the RCC. When the installation is complete, a pop-up message will appear stating that the installation was successful. In some cases, the program may indicate that you need to reboot your computer. Click on *Okay*, and if necessary reboot your computer.

The setup program creates a shortcut in the start menu, but it does not install a shortcut on the desktop. If desired, you may create a desktop icon for RCC:

- Navigate to the *Start*→*RCC*→*RCC* icon.
- Right-click on the icon, drag it to the desktop, and release.

3.2 Custom Setup

If you want to install multiple copies of RCC (for instance, when maintaining more than one calibration facility, each with its own database and data files), you will need to install the program for each facility.

You must first create a temporary installation directory to run the setup program:

- Insert the CD in the drive. If the installation program self-starts, cancel the installation.
- Using Windows Explorer, create a temporary installation directory (this directory cannot have a space character in its name), and copy all files from the CD root directory to the temporary installation directory.
- Using Windows Explorer, navigate to the CD. Right-click on *Open the CD* to open a browser window from its root directory.
- Using Windows Explorer, change the read-only attribute of the *rcc_db.ini* file (on the file name or icon, right-click on *Properties*, and uncheck the *Read-Only* attribute).

For each installation, follow these steps using the temporary installation directory created above:

- Open the *rcc_db.ini* file by double-clicking on the file name.
- Look for the line *DSN=RCC*, and change *RCC* to a unique name related to the facility (such as *RCC_Site_A*). Make a note of this name for use in a following step.
- Change the description line if desired.
- Save the edited *rcc_db.ini* file.

- Run the setup program from the same temporary directory.
- In the Setup screen, change the default directory to a unique name related to the facility, and click on *Finish*.
- After the installation is complete, click on *Okay*.
- Navigate to the *Start*→*RCC*→*RCC* icon. Right-click on the icon, and drag it to the desktop to create a shortcut.
- From the desktop, right-click on the RCC shortcut icon, and select *Properties*. In the Target field, append a space and a command-line argument to the existing program name (right after *RCC.exe*) using the same unique name entered on the DSN line in the *rcc_db.ini* file edited above. Click on *Okay*.
- From the desktop, right-click on the RCC shortcut icon, and select *Rename*. Enter a unique name for the shortcut.

Note that each installation will overwrite the RCC icon in the start menu so it is necessary to copy each installed icon to the desktop before starting another installation.

3.3 Initial Configuration

When RCC is first installed, most data tables are empty. When RCC is run under these conditions, some database error messages may appear until the first BORCAL is established. These messages can be ignored.

Follow these steps to properly initialize the data tables:

- In *Edit*→*Database*→*Facility*, configure your calibration site.
- In *File*→*New Borcal*, create a new BORCAL *without using the template*.
- In the resulting Session Configuration screen, select the newly established calibration facility in the Facility Name field.

The session configuration screen can be closed at this point, and the start-up error messages should no longer appear.

3.4 Uninstalling RCC

- Select *Start*→*RCC*→*Uninstall* (or if multiple copies are installed, navigate to the directory containing the version to be uninstalled and double-click on the *Uninstall* icon).
- When asked about removing the LabWindows Runtime Engine, click on *No* if other versions of RCC or other LabWindows programs are installed.

The uninstaller will not remove data files. You must remove those using Windows Explorer.

4 Program Start-Up

To start RCC, double-click on its program icon on the desktop or navigate from the conventional Windows program start menu to the RCC program. This brings up the RCC main window, shown below. All menu items are described later in this manual.

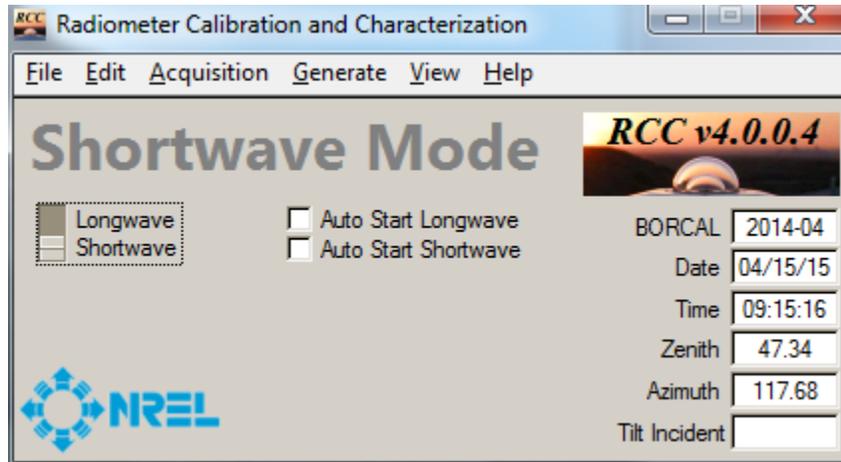


Figure 4-1. RCC's main window

5 BORCAL Event Types

There are two BORCAL event types: BORCAL-SW and BORCAL-LW. BORCAL-SW and BORCAL-LW events can occur simultaneously, and they can start and stop independently. BORCAL-SW and BORCAL-LW events are configured separately. These events will have the same event numbers, but the *SW* and *LW* nomenclature is used to distinguish between them. However, data collection does *not* occur simultaneously: SW data collection occurs during the daytime, and LW data collection occurs during the nighttime.

An automatic feature will start and stop the events at the proper zenith angle as configured in the system configuration. If the user wants to manually start the collection, configure an event, or perform data processing, the user must first select the proper mode by using the switch on the left of the main window for either LW or SW. The menu structure will change appropriately when the user changes this switch.

6 BORCAL Configuration

A BORCAL event consists of multiple data acquisition sessions. Each session is configured prior to starting with all information necessary to correctly record measurements from the BORCAL instruments. The session configuration is stored as a permanent record in the database.

A BORCAL-SW session, typically approximately 1 hour in length, is usually terminated for one of three reasons: (1) the need for an ACR calibration, (2) increasing clouds or other unfavorable conditions, or (3) the end of the day. A BORCAL-LW session, typically approximately 1 night in length, is usually terminated for only one reason (although rare): unfavorable conditions. During a session, no changes may be made to the instrument's configuration or any other data acquisition parameters. If such a need arises, the session must be terminated before the changes can be made.

6.1 Session Configuration Overview

Prior to running a session, the operator must establish a session configuration. The session configuration is a procedure by which the operator identifies the reference, ASR (for BORCAL-SW only), test, control, and meteorological instruments as well as the conditions under which the data acquisition proceeds.

The session configuration includes the following information:

- Reference and test instruments' serial numbers
- Cabling and data logger channel configuration
- Instruments' locations
- Instruments' scan intervals.

During an ongoing BORCAL, a new session is typically configured exactly as the previous session, and no additional information is required; the operator needs only to start a session, and the previous configuration is used. Additionally, for BORCAL-SW, a scheduled ACR calibration will automatically end a session and start a new session without operator intervention.

However, the first session of the BORCAL must be completely configured using the session configuration editor. The configuration can be started, saved, and later reopened for additional work. If changes are made in instrumentation during a BORCAL (such as the addition or removal of a test instrument), the changes must be reflected by editing the session configuration.

6.2 Minimum RCC Configuration for BORCAL-SW

A minimum RCC session configuration for BORCAL-SW requires the following instruments:

- An ACR and its associated control unit
- A diffuse pyranometer (mounted under a tracking disk)
- A silicon detector ASR (e.g., LI-COR LI-200)

- Two test instruments (at a minimum, these would be configured as the two control instruments listed below; typically, other test instruments would be included.)
- One control pyranometer (See Section 6.4 on Shortwave BORCAL-SW Control Instruments.)
- One control pyrhelimeter (See Section 6.4 on Shortwave BORCAL-SW Control Instruments.)
- A data logger
- One or more pyrgeometers if any test instruments are configured for ENICR.

If the configuration does not contain the required instruments listed above, RCC will not commence a session.

The following instruments are optional:

- Temperature sensor
- Humidity sensor
- Barometric pressure sensor
- GPS receiver.

Although the meteorological instruments are optional, temperature and humidity should be omitted only because of extraordinary circumstances. RCC derives aerosol optical depth (AOD) estimates from these measurements, which contain valuable calibration environmental data.

The figure below shows a schematic of the hardware components of RCC.

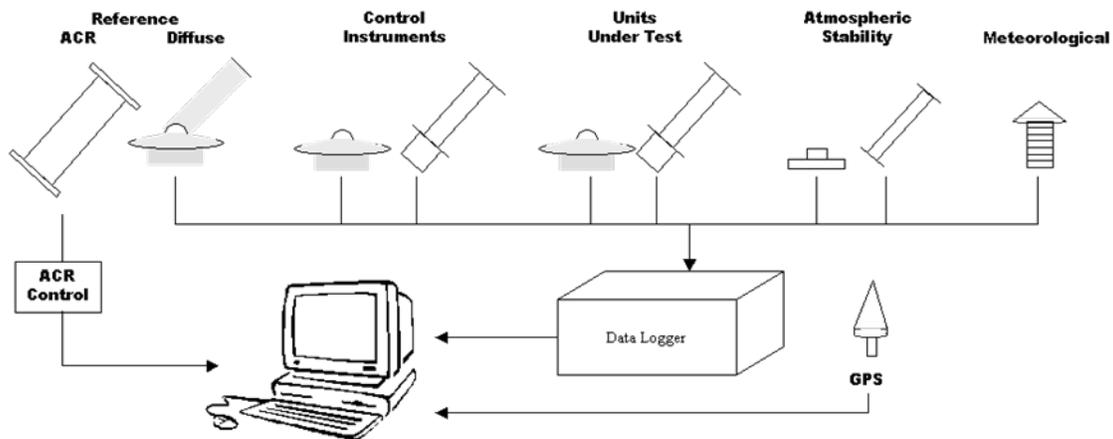


Figure 6-1. Schematic of RCC'S BORCAL-SW hardware components

6.3 Minimum RCC Configuration for BORCAL-LW

A minimum RCC session configuration for BORCAL-LW requires the following instruments:

- At least one reference pyrgeometer

- At least one test pyrheliometer
- A data logger
- A temperature sensor.

If the configuration does not contain the required instruments listed above, RCC will not commence a session.

The following instruments are optional:

- Humidity sensor
- Barometric pressure sensor
- GPS receiver
- A test pyrheliometer designated as a control. (See Section 6.5 on BORCAL-LW Control Instruments.)

Although some meteorological instruments are optional, humidity should be omitted only because of extraordinary circumstances. RCC derives precipitable water vapor (PWV) estimates from this measurement, which contain valuable calibration environmental data.

The figure below shows a schematic of the hardware components of RCC.

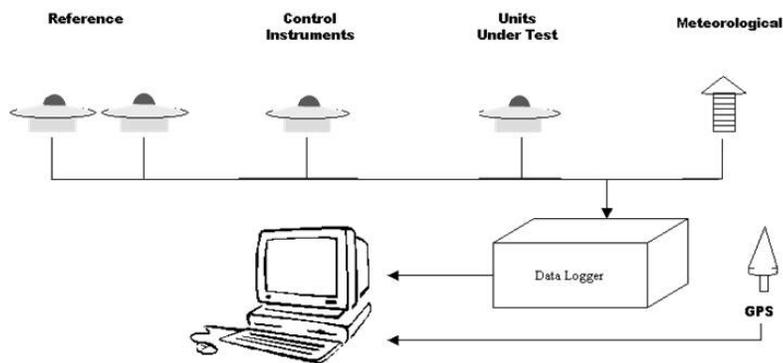


Figure 6-2. Schematic of RCC's BORCAL-LW hardware components

6.4 BORCAL-SW Control Instruments

BORCAL-SW control instruments are configured in the BORCAL as test instruments except that they have the additional designation as control instruments. These instruments, which are used only for calibration control, have a known and trusted calibration history and are included in every BORCAL. This allows you to check the validity of the BORCAL results based on the consistency of the control instrument calibration results. Although any instrument previously calibrated by RCC can be designated as a control instrument, control instruments should be selected based on a consistent and well-characterized calibration history that indicates stability among calibration events.

Because control instruments are used to demonstrate consistency from one calibration event to the next, no provision in RCC is made to enter responsivity information for control instruments. This restriction is enforced by mandating that a control instrument be included in a previous calibration event. This restriction brings up the question of how to run the first BORCAL at a calibration facility. Because the first-time start-up is a rare event, no formal provision has been made for such an initial BORCAL. However, a special start-up BORCAL can be performed with the assistance of the National Renewable Energy Laboratory that allows a site to create a set of qualifying control instruments. The special start-up BORCAL includes:

- Importing temporary calibration records for the control instruments using nominal but inaccurate responsivity values
- Running data acquisition under carefully monitored conditions. The resulting data set will have many flags because the control instrument's responsivities will create a mismatch when used to compare a control instrument's measured irradiance to the reference irradiance.
- Forcing the inclusion of flagged data during processing and reporting.

This process creates a valid calibration record for each control instrument and allows a conventional BORCAL to commence.

This restriction also underscores the need to designate spare control instruments that have a current and representative calibration in the database. If a control instrument fails, the backup could be placed into service without the need for the special start-up BORCAL procedure.

BORCAL-SW control instruments are treated identically to test instruments with two exceptions: (1) they are used for real-time quality checks of the reference instruments during data acquisition, and (2) their current responsivity in the database is not updated (with this exception: current responsivities for test instruments are made known by updating the Current BORCAL field in the Radiometer Inventory table). However, the control instrument's responsivities for the calibration event are included in reports along with other test instruments. This approach prevents an errant or flawed calibration event from corrupting the control instrument's responsivities and adversely affecting the real-time quality checks of future events.³

If the need arises to update a control instrument's responsivity, this is easily accomplished by editing the Current BORCAL field for that instrument in the Radiometer Inventory table.

6.5 BORCAL-LW Control Instruments

BORCAL-LW control instruments are configured in the BORCAL as test instruments except that they have the additional designation as control instruments. These instruments, which are used only for calibration control, have a known and trusted calibration history and are included in every BORCAL. This allows for checking the validity of the BORCAL results based on the

³ The calibration history of all control reports are shown on all customer reports and on the full report in the section on "Control Instrument History Plots," which starts on page 4 of these reports.

consistency of the control instrument's calibration results. Although any instrument can be designated as a control instrument, control instruments should be selected based on a consistent and well-characterized calibration history that indicates stability among calibration events. BORCAL-LW control instruments are treated identically to test instruments with no exceptions.⁴

6.6 Preliminary Information

Prior to configuring a BORCAL-SW session (particularly the first session of a BORCAL), locate all of the SW instruments involved. The test instruments, reference and control instruments, ASR instrument, and pyrgeometer if required should be mounted on the calibration platform or trackers; the diffuse pyranometer(s) should be mounted under the tracking disk; and the meteorological instruments should be installed. The pyrgeometer(s) should be mounted unshaded as close as possible to the instruments using ENICR, and it should be ventilated if the ENICR instruments are ventilated. Cable all instruments, and make data logger channel assignments. Note all of the instruments locations, cable numbers (if applicable), and channel assignments. The reference ACR should not be mounted until right before the data acquisition starts, but its control unit configuration should be determined, and connections should be made to the RCC computer. In a BORCAL-LW, all test and reference instruments should be collocated and unshaded.

All configuration data are entered into the database using the database maintenance functions. These functions are available by navigating from the *Edit*→*Data Base* menu or the *Edit*→*Borcal/Session* menu. See Section 10.2 on Database Maintenance for a description of entering or modifying database information.

Use the following guidelines to prepare the preliminary information.

6.6.1 Customers

These are the people or agencies who delivered the instruments for calibration. Provide each customer's name, contact person, address, and phone number. It is possible that the customer for a particular instrument may change from one BORCAL to another. No specific provision is made to track changes of the customer for each instrument; however, the customer history is maintained in a field in the session configuration records for each BORCAL. Only the latest information entered is retained in the instrument inventory table, and each instrument's customer defaults to this information when subsequently configured.

6.6.2 Location

This is the calibration facility at which the BORCAL is conducted. You must include the site's latitude and longitude in decimal degrees (to two decimal places), contact person, time zone, elevation in meters, temperature in degrees Celsius, and station barometric pressure in millibars. Latitude is entered as a positive number in the northern hemisphere and as a negative number in the southern hemisphere. Longitude is negative west of the prime meridian and positive east of the prime meridian. The time zone is the difference in hours between Greenwich Time and the site's local standard time, and by convention it is negative west of Greenwich and positive east

⁴ The calibration history of all control reports are shown on all customer reports and on the full report in the section on "Control Instrument History Plots," which starts on page 4 of these reports.

of Greenwich. Average temperature and barometric pressure are the nominal long-term average values for the site.

6.6.3 Operators

These are the people who will be running the BORCAL data acquisition sessions. Include their names.

6.6.4 Instrument Types

RCC requires an entry for each type of instrument included in a BORCAL including reference instruments, cavity control units, and meteorological instruments. An instrument's type is defined by its manufacturer and model. In addition, enter a descriptive name for the instrument. This is usually based on the manufacturer's descriptive name—for example, *precision spectral pyranometer*. For each type of radiometer, specify a maximum output voltage in millivolts for the thermopile and the maximum resistance for the case and dome thermistors in kilo-ohms. This is used for data logger scaling. It should be set so that the output voltage or resistance will never exceed this value (which will cause data acquisition errors), and it should not be set too high and force the logger to measure at a scale that is too high (causing an increase in measurement uncertainty). If an instrument type can be configured for ENICR, then its infrared (IR) correction should be enabled and the Generic Rnet value must be entered. The field for the estimated thermal offset error is optional and used only for reporting purposes. Finally, determine how the instrument will be used in the system. The table below lists and describes the available uses.

Table 6-1. Instrument Types

Use Code	Description
TOT	Total global (hemispherical) pyranometer
DIR	Direct normal (beam) pyrheliometer
SHD	Test pyranometer mounted under a shading disk (different from diffuse reference instruments)
MCO	Manual ACR control unit
ACO	Automatic ACR control unit
ACM	Combo automatic ACR control unit and digital voltmeter
CAV	ACR
PYG	Pyrgeometer
LGR	Data logger (combo multimeter and relay system)
RLY	Data logger (relays only)
TEM	Thermometer
HUM	Hygrometer
BAR	Barometer
DVM	Digital multimeter for cavity or data logger relays
GPS	GPS receiver

6.6.5 Data Logger

In addition to the data logger's serial number, RCC requires the following information:

- Unit number: For relay (RLY) data loggers (that have a separate digital multimeter, or DMM), this indicates the unit number, which is a number based on the physical wiring of the relay/DMM to the available channels at the calibration facility. Multiple RLY-type loggers are supported, and the unit numbers must be sequential starting with zero (the highest unit number must be less than the total number of units). Combo loggers (LGR) must be assigned unit number zero, and only one LGR-type logger is supported.
- System Offsets
 - Volts DC: volt direct-current (DC) offset of the data logger system as a whole (including meters, relays, and signal cabling) as determined during system short testing
 - Two-wire resistance: two-wire resistance offset of the data logger system as a whole (including meters, relays, and signal cabling) as determined during system short testing
 - Four-wire resistance: four-wire resistance offset of the data logger system as a whole (including meters, relays, and signal cabling) as determined during system short testing
- Calibration dates: date and due date of the instrument's calibrations (including calibration of multimeter and short tests if applicable)
- Communications parameters: parameters for the RS-232 communications port or GPIB protocol for both the multimeter and relays (if equipped).

6.6.6 Reference Absolute Cavity Radiometer (BORCAL-SW Only)

In addition to the ACR's serial number, RCC also requires specific information about the ACR:

- Unwindowed WRR reduction factor: World Radiometric Reference (WRR) or intercomparison factor
- Unwindowed WRR uncertainty: uncertainty of the unwindowed WRR factor
- Windowed WRR factor: If the ACR is supplied with a window, enter the WRR factor determined with the window mounted. If a window is not supplied with the ACR, use 1.0 for the correction factor.
- Windowed WRR uncertainty: uncertainty of the windowed WRR factor
- Manufacturer's correction factor: supplied by the manufacturer
- Heater resistance: resistance of the cavity heater (supplied by the manufacturer)
- Heater lead resistance: resistance of the heater leads (supplied by the manufacturer)
- Default sensitivity: ACR's nominal sensitivity in $\text{mV}/\text{mW}/\text{cm}^2$ (supplied by the manufacturer)
- Maximum voltmeter scale: lowest possible scale without risking overvoltage readings

- Calibration dates: date and due date of the instrument's calibration (calibration of electrical components or comparison to WRR).

6.6.7 Cavity Control Unit (BORCAL-SW Only)

In addition to the control unit's serial number, RCC requires the following information:

- Current shunt: resistance of the current sensing resistor used in the calculation to determine the power (current multiplied by resistance) dissipated by the cavity heater. The Eppley Laboratory normally supplies cavity radiometer systems with this resistance specified as a nominal value; however, some systems are supplied with a value determined by an accurate measurement. Regardless of the value specified by the manufacturer, the correct resistance value for RCC is the exact value used when the ACR WRR factor or windowed WRR factor (described above) was determined.
- Circuit resistance: overall resistance of the cavity heater circuit excluding the heater and heater lead resistances
- Communications parameters: parameters for the RS-232 communications port or GPIB protocol for both the cavity control unit and the voltmeter.

6.6.8 Reference Diffuse Pyranometer (BORCAL-SW Only)

For the shaded disk pyranometer, RCC requires:

- Serial number: instrument's serial number
- Responsivity: instrument's most recent calibration responsivity
- Shading disk size: diameter of the shading disk in centimeters
- Arm length: length of the shading disk arm in centimeters
- Uncertainty: instrument's calibration uncertainty expressed in percent and thermal offset in W/m^2 (two numbers)
- Calibration date: date and due date of the instrument's calibration
- Location: position of the instrument and its tracker in the outdoor instrument setup
- Cable/signal box: cable number and junction box connector number (optional)
- Channel: data logger channel assignment

6.6.9 Atmospheric Stability Radiometers (BORCAL-SW Only)

Two parameters are set for the ASR functions:

- Scan interval: number of seconds between scans of the ASR instruments (typically 1 second)
- Stability number: number of measurement samples in the stability analysis (typically 60).

In addition, information about the two ASR radiometers is required. (*Global* refers to a silicon pyranometer, and *direct* refers to a silicon pyrhemliometer or reference ACR.)

- Serial number: instrument's serial number

- Location: instrument's outdoor location on the radiometer table or tracker
- Cable/signal box: cable number and junction box connection (optional)
- Channel: data logger channel assignment.

The ASR instruments must have been previously calibrated by the RCC system.

6.6.10 Test Instruments

Each test instrument must be described with the following information. (Items marked with an asterisk may already be stored in the database if the instrument was entered at an earlier time and does not need to be entered again.)

- Serial number: instrument's serial number
- Location: location on the instrument's table or tracker
- Cable/signal box: cable number and junction box connector (optional)
- Channel: data logger channel assignment(s) for thermopile and (if used) case and dome thermistors
- Rnet: instrument's ENICR. This is required only if the instrument is configured for ENICR. If it is not specified, this value defaults to a generic Rnet for the instrument type. ENICR does not apply to BORCAL-LW, and it will not appear in configuration screens.
- Rnet uncertainty: uncertainty of the Rnet value (percent)
- Calibration date (Rnet): date the instrument's Rnet value was determined
- Pyrgeometer: instrument's identification (serial number and manufacture/model) of the IR correcting pyrgeometer. This is required only if the instrument is configured for an ENICR.
- Control: indicator if the instrument is included in the BORCAL as a control (See Section 6.2 on Minimum RCC Configuration for BORCAL-SW.)
- *Customer: customer supplying the instrument for calibration
- *Factory Calibration: instrument's factory responsivity
- Scan: scan interval in seconds for this instrument (typically 30 seconds).

6.6.11 Reference Pyrgeometers

These are required for BORCAL-LW, but they are required for BORCAL-SW only if the test instruments are configured for an ENICR. More than one pyrgeometer may be required if multiple instrument types are configured for the corrected responsivity.

- Serial number: pyrgeometer's serial number
- Location: physical location of the instrument
- Calibration coefficients: K0, K1, K2, K3 and Kr coefficients with traceability to the World Infrared Standard Group.

- Calibration dates: date and due date of the pyrgeometer’s calibration
- Channel: data logger channel assignment for thermopile, case, and (if used) dome thermistors or resistance temperature detectors
- Cable/signal box: cable and junction box connector for thermopile, case, and (if used) dome thermistors (optional).

6.6.12 Meteorological Instruments

Three types of meteorological instruments are accepted by RCC: temperature, humidity, and barometric pressure. Each requires the following information:

- Serial number: instrument’s serial number
- Location: physical location of the instrument
- Cable/signal box: cable and junction box connector (optional)
- Channel: data logger channel assignment
- Offset: additive scaling offset to convert to measurement units (Use zero if not specified.)
- Scale: scaling slope to convert to measurement units (Use 1.0 if not specified.)
- Scan: scan interval in seconds for the met instruments (typically 300 seconds).

6.7 Configuring a New BORCAL-SW

Use the Session Editor to construct the data acquisition environment (configure the system) so that the software is prepared to accept and acquire data from the appropriate instruments.

Be sure the BORCAL type is set to *Shortwave*.

If you are starting a new BORCAL, select *File*→*New BORCAL* from RCC’s main window.

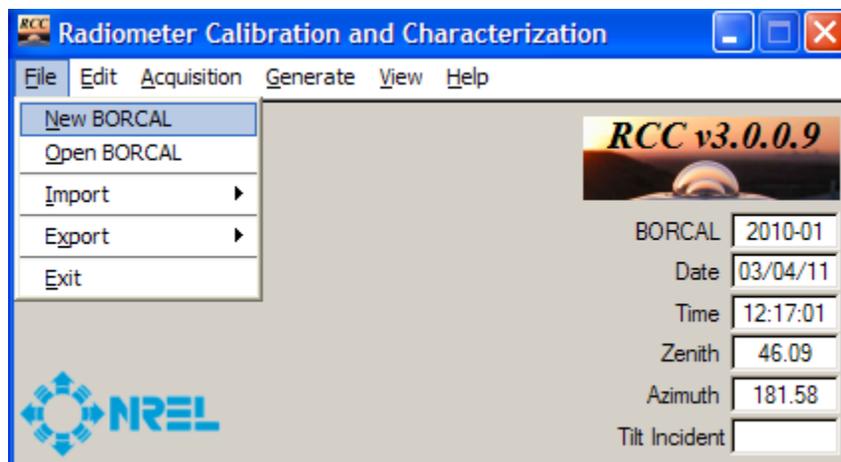


Figure 6-3. Selecting a new BORCAL from RCC’s main window

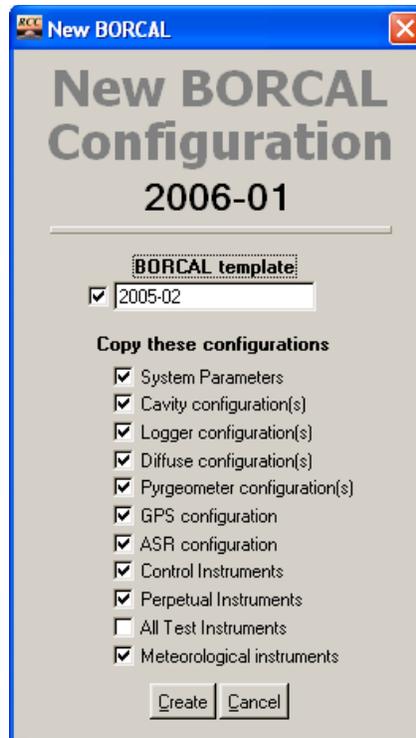


Figure 6-4. New BORCAL Configuration window

You have the option of using a previous BORCAL as a template for the new BORCAL, which will save time if that BORCAL was similarly configured. When you check the box for *Select a BORCAL as a Template*, double-click on the field below it, and choose a BORCAL from the pop-up list. With this option checked, the fundamental configurations are presented under Copy These Configurations. For each option selected, the new BORCAL will contain the final configuration parameters from the indicated template BORCAL. If the box for *Perpetual Instruments* is checked, all instruments designated as such will be carried forward. Perpetual instruments are test instruments that are usually included in each BORCAL and would otherwise need to be configured for each BORCAL. If the *All Test Instruments* box is checked, all test instrument configurations carry forward from the template BORCAL. If all boxes are checked, the result will be a copy of the template BORCAL.

After selecting any desired configurations to copy, click on *Create* to create a new BORCAL. This brings up the BORCAL Configuration window shown below, which displays a functional summary of the configuration. (The figure below shows blank fields, indicating no carryover configurations.) BORCAL configuration is accomplished by completing the required information for all instruments and system parameters.

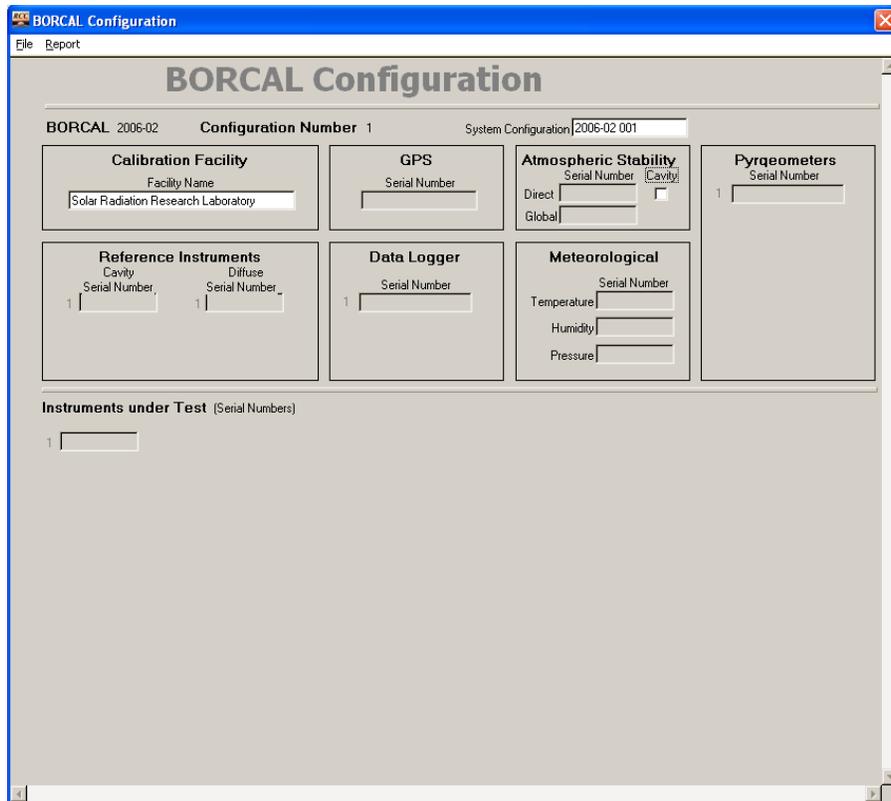


Figure 6-5. BORCAL-SW Configuration window

6.7.1 Steps for BORCAL Configuration

When configuring a new BORCAL, follow this general outline of steps:

- Calibration facility designation
- System configuration
- Reference ACR configuration
- Reference diffuse configuration
- ASRs
- Pyrgometers (if used for ENICR)
- Meteorological instruments (optional)
- GPS configuration (optional)
- Test instrument configuration
- Data logger.

In most cases, when the database does not have an item (for example, an instrument or calibration facility), a new record can be added by clicking on *New* when viewing the database Table Selection window for that item. See Section 10.2 on Database Maintenance for additional instructions.

Many fields in the configuration windows are subject to validity checks, which occur when you click on *Accept* on a configuration window. If a field value is out of range, a pop-up window displays the name(s) of the field(s) with the invalid value and shows the range of acceptable values. You cannot close this window until all fields are within range.

6.7.2 Facility

Double-click on *Facility Name* under Calibration Facility on the configuration screen. This brings up a list of configured calibration facilities. Select the desired facility, and click on *Select*.

6.7.3 System Configuration

To enter the system parameters, double-click on the *System Configuration* field. This presents the System Configuration window (shown below), which contains several categories of parameters. (The figure below shows all fields configured; when starting without a configuration template from a previous BORCAL, the fields are filled with zeroes.)

System Configuration
BORCAL 2011-01 Configuration Number 4

Delta Thresholds	ASR Setup	Uncertainty	Clock
Temp(x) - Temp(x-1) 3.0	Scan Rate (s) 1	Zenith Angle (deg) 0.003	Reset Interval (m) 7
Hum(x) - Hum(x-1) 10.0	ASR Readings 2	Decimal Precision 2	Warning Threshold (s) 1
Bar(x) - Bar(x-1) 2.0	Threshold 1 (Blue) 1.00	45° Neg. Offset -10.0	Delta UT1 (s) -0.200
Thm(x) - Thm(x-1) 5.0	Threshold 2 (Green) 2.00	45° Pos. Offset 10.0	
Thm (Dome-Case) 3.0	Threshold 3 (Brown) 3.00	Min. Legal Direct 700	
Case Thm (Inst-Pyrg) 5.0	Diffuse Scaling Factor 0.25	Max. Legal Diffuse 150	
		Max. Diffuse/Direct (%) 30.00	
% Error Thresholds	Auto Mode	Scan Rate (sec)	Solar Position Algorithm
Cav1 / Cav2 1.0	Startup Zenith Angle 85	Radiometers 30	Delta T (s) 66.184
Dif1 / Dif2 7.0	Shutdown Zenith Angle 85	Meteorological 300	Atmos. Refraction (deg) 0.5667
Global Ctrl / Ref 5.0			
Direct Ctrl / Ref 5.0			
Test(x) / Test(x-1) 1.2			
Intervals	Incoming IR Thresholds	Tilt	Precipitable Water
Cavity Calibration (m) 60	Minimum W in 150	Active <input type="checkbox"/>	Slope 1.83
Operator Log (m) 20	Maximum W in 450	Zenith 0.00	Intercept 1.00
		Azimuth 0.00	

Comments
Accept Cancel

Figure 6-6. BORCAL-SW System Configuration window

Each category is described below. (The values shown in the window are the suggested defaults except for the site-specific water vapor values noted below.)

- Delta thresholds: alarm difference threshold for each real-time quality check. These values are the absolute difference between the two listed measurements determined as $|M1 - M2|$ in the units of the measurement.
- Percent error thresholds: alarm ratio threshold parameter for each real-time quality check. The value entered is the percent difference between the two listed measurements ($M1$ and $M2$), determined as $|M1 - M2| / M1 \times 100$. In all cases except Test(x), the two parameters are simultaneous measurements from different instruments. In the case of Test(x) / Test(x-1), the measurements are from adjacent data scans of the same instrument (the current scan and the previous scan).
- ASR setup
 - Scan rate: approximate interval between scans in seconds
 - ASR readings: number of readings used to form the ASR scan set
 - Threshold 1 (Blue): upper threshold (W/m^2) in variability among readings for the ASR score in the blue category. Likewise for Threshold 2 (Green) and Threshold 3 (Brown). Variability beyond Threshold 3 is scored as ASR Red. Diffuse Scaling Factor is a multiplier that transforms the diffuse variability to the three thresholds described above (e.g., if Threshold 2 is 2 and the scaling factor is 0.5, then the active threshold for diffuse variability is $1.0 W/m^2$). Variability in W/m^2 is determined by the greatest difference among the readings in the ASR scan set for each measurement. The thresholds are then applied to the variability to determine the ASR score.
- Automatic mode: parameters that specify the zenith angle thresholds for system start-up and shutdown in automatic mode.
- Intervals: intervals for automatic ACR calibrations and operator logs
- Uncertainty: parameters for expressing the uncertainty of the results
 - Zenith angle (degrees): uncertainty of the zenith angle calculation of the solar position algorithm in use (NRELSPA)
 - Decimal precision: number of digits past the decimal point 45° negative offset that determines the low end of the uncertainty zenith angle range by adding the value to 45°
 - 45° positive offset: determines the high end of the uncertainty zenith angle range by adding the value to 45. For example, values of -15 and $+15$, respectively, would result in an uncertainty range of 30° to 60° .
 - Minimum legal direct: threshold (W/m^2) below which no uncertainties are reported
 - Maximum legal diffuse: threshold above which a measurement is not included in any results

- Maximum diffuse/direct: argument used in an equation to calculate a threshold ratio (in percent) above which a measurement is not included in any results. The actual threshold is calculated as $\text{Threshold} = \text{Argument} \cdot e^{(-\cos(\text{Zenith}))}$.
- Scan rate: scan rates for radiometers under test and meteorological instruments
- Incoming IR thresholds: minimum and maximum values allowable for the measured incoming IR values from the pyrgeometer
- Clock
 - Reset interval: number of minutes between automatic clock-reset operations. A value of zero disables the automatic clock-setting function.
 - Warning threshold: magnitude of a clock correction (in seconds) allowed before the operator is warned of the impending correction. (Clock setting can be accomplished by either the operator or, if configured, a GPS unit.)
 - Delta UT1: positive or negative correction (seconds) to be added to Coordinated Universal Time to adjust for an irregular earth rotation rate.
- Solar position algorithm
 - Delta T: difference in seconds between the earth's rotation time and terrestrial time from the observation
 - Atmospheric refraction: atmospheric refraction in degrees at sunrise and sunset.
- Tilt: parameters for tilted instrument calibrations in degrees
 - Zenith: amount of tilt from the zenith (horizontal = 0, vertical [pointing toward the horizon] = 90)
 - Azimuth: position the tilted instrument faces relative to north. Azimuth is undefined for a tilt of zero, but by convention it is set to zero.⁵
- Precipitable water: site-specific parameters for estimating precipitable water from vapor pressure⁶ (itself estimated from temperature, humidity, and barometric pressure). Precipitable water (pw) in centimeters is calculated using vapor pressure (vp), a slope coefficient (m), and a intercept offset (b) as: $\text{pw} = (\text{vp} \times \text{m} + \text{b}) / 10$. In the configuration, use the table below to determine the site-specific slope and intercept values. Depending on location, the slope parameter is either taken directly from the Slope (m) column or calculated from the M and B columns using $M \times \text{site elevation} + B$. The intercept parameter is set to the Intercept (b) column in the table.

⁵ This capability has not been tested for recent program revisions.

⁶ For more information, see “Estimation of Precipitable Water over the United States for Application to the Division of Solar Radiation into its Direct and Diffuse Components” by J.D. Garrison and G.P. Adler in *Solar Energy* 44 (1990): 225–241.

Table 6-2. Precipitable Water: Slope and Intercept Values for Site-Specific Locations

Region	Slope (m)	M	B	Intercept (b)
Alaska	1.45			1.0
U.S. longitude < 95°W	1.45			2.0
U.S. longitude > 95°W and latitude < 41°N	Calculated from elev., M, and B	0.0004	1.1	1.0
U.S. longitude > 95°W and latitude > 41°N	Calculated from elev., M, and B	0.0004	1.1	2.0
Saudi Arabia	Calculated from elev., M, and B	0.0003	1.3	1.0

The precipitable water value is not directly saved or reported by RCC; rather, it is used as an input to the AOD calculation. For the AOD estimates, algorithms from the Bird Clear Sky model are used to calculate direct normal transmittances for ozone absorption (T_O) (using a nominal value of 0.33 cm for column ozone), Rayleigh scattering (T_R), absorption of uniformly mixed gases (T_{UM}), and water vapor absorption (T_W). These are combined to obtain a value for molecular transmittance (T_M) as:

$$T_M = T_O T_R T_{UM} T_W$$

Aerosol transmittance is then calculated as:

$$T_A = I_N / I_0 T_M$$

where I_N is the measured direct normal irradiance, and I_0 is the extraterrestrial direct normal irradiance. Finally, an inversion of Beer's Law is used to compute broadband AOD τ_A as:

$$\tau_A = -\ln T_A / m$$

where m is the relative air mass.

When all system parameters have been entered and you want to close the window, click on *Accept*. Click on *Cancel* if you want to leave all parameters unchanged.

6.7.4 Test Instruments

To enter a test instrument in the BORCAL, double-click on the gray field for the serial number below Instruments under Test in the BORCAL Configuration window. This action displays the Test Instrument Configuration window, which is shown below.

Figure 6-7. BORCAL-SW Test Instrument Configuration window

In the region labeled *Instrument*, double-click on the field for *Serial Number* (or *Manufacturer* or *Model*). This displays the Radiometer Inventory window, which is shown below. Locate the desired instrument by either scrolling through the list or by clicking in the box and typing the serial number. (See additional information in Section 10 on Database Editing Tools.)

When typing the serial number, the active selection tracks each keystroke to the first instrument with a serial number that matches the typed characters so far. If typing is delayed for more than 1 or 2 seconds, the search resets.

When an instrument is found, you can modify the current customer by double-clicking on the customer field. To select the instrument for the configuration, click on *Select*, or double-click on the instrument in the list.

The screenshot shows a software window titled "Data Table Maintenance" with a sub-header "Table selection" and "Radiometer Inventory". A text box labeled "Table" contains the value "RAD_INV". Below it is a "Select Instrument" list box containing several entries, with "000019 Kipp & Zonen CM22" selected. To the right of the list are "Cancel" and "Select" buttons. Below the list are "New", "Cancel", and "Done" buttons. The form contains several input fields: "Serial Number" (000019), "Manufacturer" (Kipp & Zonen), "Model" (CM22), "Factory Cal" (9.300), "Current BORCAL" (2006-02), and "Current Customer" (Ibrahim Reda). There is an unchecked "Comments" checkbox. At the bottom, a section titled "Instrument's Current Effective IR Response" contains fields for "RS Net" (0.0800), "Uncert (%)" (10.000), "RS Net Date" (03/03/2006), and "Correcting Pyrgometer" (010547 Kipp & Zonen CG4).

Figure 6-8. Radiometer Inventory window

If the instrument is not known to the system, you can enter it by clicking on *New* in the Radiometer Inventory window. Fields for which information is mandatory are highlighted in yellow. Fields that require selections from other lists (related fields) are highlighted in blue.

When entering the serial number, manufacturer, or model, you cannot use these characters: /, \, :, *, ?, ", <, >, or |. This is because the Windows operating system does not allow these characters in file names, and the system creates file names based in part on these fields.

When the desired instrument is selected or entered, click on *Select*, and continue to enter the remaining information in the Test Instrument Configuration window.

If the RCC system for your site includes the Location Lookup feature, you can right-click on any of the fields labeled *Location*, *Channel*, *Cable*, or *Signal Box*. This allows you to select a predetermined configuration from a pop-up menu, and all of these fields will be automatically completed. See Section 6.11 on Location Lookup for more information about this.

Six check boxes appear on the Test Instrument Configuration window: Tilt, Active, Control, Perpetual, IR Correction, Ventilated, and Comments.

- Click on the *Tilt* box to designate that the instrument is deployed at the tilt entered in the system configuration tilt and azimuth specifications.
- The *Active* box is normally checked (and must be checked to include the instrument in data acquisition), but it can be unchecked to temporarily exclude the instrument from the data acquisition. This may be valuable if an instrument is included in a period of desired data acquisition, but it must be removed for other purposes. If the instrument is deleted from the configuration, it may not appear in the calibration reports (depending on the final data selection).
- Click on the *Control* box to configure the instrument as a control instrument. A control instrument must have been previously calibrated by the system.
- Click on the *Perpetual* box if the instrument is to be included in the next BORCAL. This check box, in conjunction with checking that for *Perpetual Instrument* when creating a new BORCAL, allows the instrument's configuration to carry forward without needing to reconfigure it.
- Click on the *Ventilated* box if the instrument is installed in a ventilator. This information aids in configuration validation and appears in the report to document that the instrument was calibrated with a ventilator.
- Click on the *Comments* box to enter or read comments about the instrument's configuration. If comments exist, the box will contain a check mark.
- Click on the *IR Correction* box to designate and configure the instrument for an ENICR. This is explained further below.

The *Case Thermistor* and *Dome Thermistor* check boxes appear on the right side under Cabling. Clicking on these boxes indicates that the instrument is equipped with the specified thermistor(s). When indicated, the channel and cabling fields become active to configure the connections for the thermistors.

A check box appears under IR Correction to designate and configure the instrument for an ENICR. When this box is checked, the fields below it for Rnet, Rnet Uncertainty, and Cal Date become active. These values are pulled from the instrument's record in the Radiometer Inventory database table. You may enter new values in these fields, which will replace the generic values for the instrument in its Radiometer Inventory record. (See Section 6.6.4 on ENICR generic values.)

The Pyrgeometer field holds the instrument's identification of the correcting pyrgeometer as configured in the instrument's record in the Instrument Inventory field. If no pyrgeometer has been designated for the instrument, or if the specified pyrgeometer is not in the list of configured pyrgeometers, a message will appear instructing you to configure or select an instrument. (See Section 6.7.7 on Pyrgeometer Configuration.)

When all information is complete, click on *Accept*. By doing this, you:

- Enter the instrument in the BORCAL configuration.
- Clear the fields for the next instrument to be configured.

When all instruments have been entered, click on *Done* to return to the BORCAL Configuration window.

Note the distinction between *Accept* and *Done*: although using either will allow you to enter and save the configuration information, *Accept* clears all fields and allows you to continue with another instrument, and *Done* exits the test instrument configuration.

6.7.5 Cavity

Configure ACR instruments by double-clicking on the gray field for the serial number under Reference Instruments in the BORCAL Configuration window.

The screenshot shows the 'Cavity Configuration' window with the following fields and values:

Cavity		Control Unit	
Serial Number	[Empty]	Serial Number	[Empty]
Manufacturer	[Empty]	Manufacturer	[Empty]
Model	[Empty]	Model	[Empty]
Location	[Empty]	Current Shunt	-9.000
Unwindowed WRR	-9.000000	Cal Date	[Empty]
Windowed WRR	-9.000000	Circuit Resist	-9.000
Unwindowed Uncert (%)	-9.00	Cal Due Date	[Empty]
Windowed Uncert (%)	-9.00		
Heater Resistance	-9.00		
Heater Lead Resistance	-9.00000		
Mfg Calibration Factor	-9.000000		
Default Sensitivity	-9.000000		
Cal Date	[Empty]		
Cal Due Date	[Empty]		

Additional settings in the window:

- Window in Use:
- Active:
- Calibration Waits (Seconds): TP-solar: -1, TP-heated: -1, TP-zero: -1, Dwell: -1
- Comments:
- Communications: DMM (RS-232 selected), Control Unit (RS-232 selected)
- Port: 1, Baud: 9600, Parity: None, Stop Bits: 1, Data Bits: 8, Board: 0

Buttons at the bottom: Accept, Done, Cancel

Figure 6-9. Cavity Configuration window

The Cavity Configuration window groups information into three categories:

- Cavity: identification, traceability, and calibration parameters for the ACR
- Control unit: identity and internal electrical parameters for the control unit associated with the ACR
- Communications: the GPIB or RS-232 communications settings for the ACR voltmeter and automatic control unit (when appropriate).

Fields may be accessed in a fashion similar to the test instrument configuration wherein information in the blue fields is entered by double-clicking on them and selecting an instrument from a list, and the yellow fields hold mandatory information.

When an ACR is specified in the field for Serial Number, the fields on the lower left of the Cavity section are filled in using data in the Cavity Inventory data table. Likewise, when a control unit is selected, the fields in the lower part of the Control Unit section will be filled in using data from the Control Unit Inventory table. These values may be modified if desired, and any changes will be reflected in the corresponding inventory record for that instrument.

The fields for Calibration Waits are described below. (These values must be the same as those used when the ACR WRR is determined.)

- TP-Solar: number of seconds to wait for thermopile stability after the shutter is opened. (This field may be set to zero if the ACR is installed with the shutter open, and it is used for routine measurements with the shutter open. Under these conditions, the thermopile will always be in a stable state prior to the calibration.)
- TP-Heated: number of seconds to wait for thermopile stability after the shutter is closed and the heater circuit is closed
- TP-Zero: number of seconds to wait for thermopile stability after the heater circuit is opened and the shutter is closed
- Dwell: number of seconds to wait for operational stability after the cavity is returned to its measurement state (heater off, shutter open). This field may be set to zero if the period of the ASR cycle (scan rate multiplied by the number of measurements) is greater than the time required for ACR stability.

Two other check boxes appear on the window:

- Uncheck the *Active* box if you want to temporarily remove the instrument from the configuration for data acquisition. This may be valuable if multiple cavities are configured and one of them temporarily cannot be operated (e.g., an unwinded ACR in windy conditions). This allows for a quick connect/disconnect without having to reconfigure the ACR parameters. (The check box affects the ACR and the control unit).
- Use the *Comments* box to enter or read comments about the instrument's configuration. If comments exist, the box will contain a check mark.

Up to two ACRs may be configured for a BORCAL event, and each is entered by clicking on the gray field for the serial number in the BORCAL Configuration window. Note that the gray box moves to the second position after the first ACR is configured.

When all information is complete, click on *Accept*. By doing this, you:

- Enter the instrument in the BORCAL configuration.
- Clear the fields for the next instrument to be configured.

When all instruments have been entered, click on *Done* to return to the BORCAL Configuration window.

6.7.6 Diffuse Radiometer Configuration

A diffuse reference instrument is configured by double-clicking on the gray field for the serial number under Diffuse Serial Number in the Reference Instrument box in the BORCAL Configuration window. This presents the Diffuse Reference Configuration window, as shown below.

Figure 6-10. Diffuse Reference Configuration window

As described with other instrument configurations, the blue fields are configured by double-clicking on them and selecting an instrument from a list.

When an instrument is selected, the system will fill in the responsivity, calibration dates, and uncertainty fields using data from the Diffuse Reference Configuration data table. These fields may be modified, and any changes will be reflected in the corresponding record in the Diffuse Configuration data table.

Note that when entering the shading disk information, the value in the field for Subtended Angle is computed from the disk diameter and arm radius; it cannot be configured by the user.

Cabling information and the Location Lookup feature are described in Section 6.7.4 on Test Instruments.

When all information is complete, click on *Accept*. By doing this, you:

- Enter the instrument in the BORCAL configuration.
- Clear the fields for the next instrument to be configured.

When all instruments have been entered, click on *Done* to return to the BORCAL Configuration window.

6.7.7 Pyrgeometer Configuration

Configure a pyrgeometer by double-clicking on the gray field for the serial number under Pyrgeometers. This brings up the Pyrgeometer Configuration window, which is shown below.

Pyrgometer Configuration Entry

Pyrgometer Configuration
BORCAL 2011-01
Configuration Number 2

Serial Number
Manufacturer
Model
Cal Date: Cal Due Date
Location

Calibration Coefficients

K0
K1
K2
K3
Kr
Uncertainty (W/m²)

Active
Ventilated
Comments

Cabling

Themopile

Channel
Cable
Signal Box
Case Themistor
Channel
Cable
Signal Box

Dome Themistor

Channel
Cable
Signal Box

Figure 6-11. Pyrgometer Configuration window

As described with other instrument configurations, configure the blue fields by double-clicking on them and selecting an instrument from those available in the Pyrgeometer Inventory table.

When an instrument is selected, the system will fill in the coefficients, calibration dates, and uncertainty fields using data from the instrument's record in the Pyrgeometer Inventory table. These fields may be modified, and any changes will be written to the instrument's record in the Pyrgeometer Inventory table.

The location, channel, and cabling information must be completed.

All available pyrgeometer thermistors must be configured into RCC.

6.7.8 Data Logger Configuration

Configure the data logger(s) by clicking on the gray field for the serial number under Data Logger. This presents the Data Logger Configuration window, which is shown below.

Data Logger Entry

Data Logger Configuration

BORCAL 2011-01
Configuration Number 2

Serial Number

Manufacturer

Model

DMM Unit Number

Location

Cal Date

Cal Due Date

Comments

System Offsets

Volts DC (μV)

2-Wire Res. (mOhms)

4-Wire Res. (mOhms)

Communications

	DMM	Relay
RS-232	<input checked="" type="radio"/>	<input checked="" type="radio"/>
GPIB	<input type="radio"/>	<input type="radio"/>
Port	<input type="text" value="1"/>	<input type="text" value="1"/>
Baud	<input type="text" value="9600"/>	<input type="text" value="9600"/>
Parity	<input type="text" value="None"/>	<input type="text" value="None"/>
Stop Bits	<input type="text" value="1"/>	<input type="text" value="1"/>
Data Bits	<input type="text" value="8"/>	<input type="text" value="8"/>
Board	<input type="text" value="0"/>	<input type="text" value="0"/>

Figure 6-12. Data Logger Configuration window

As described in previous configurations, double-click on the blue fields to select a data logger from the Data Logger Inventory table. This brings forward the instrument make, model, and calibration date information. Other fields are described below:

- Unit number: For Relay (RLY) data loggers (with separate DMM), this indicates the unit number, which is a number based on the physical wiring of the Relay/DMM to the available channels at the calibration facility. Multiple RLY-type loggers are supported, and the unit numbers must be sequential starting with zero (the highest unit number must be less than the total number of units). Combo loggers (LGR) must be assigned unit number zero, and only one LGR-type logger is supported.
- DMM: The DMM is physically wired to the Relay data logger and should be left blank for combo loggers (LGR).
- Location: physical location of the logger
- System offsets (volts DC, 2-wire resistance, and 4-wire resistance): maximum offset of the instrument for uncertainty calculations
- Communications
 - DMM: configuration information for the DMM or combo logger
 - Relay: configuration information for the relay unit. (This column of fields will be dimmed for combo loggers.)

6.7.9 ASR Instruments

Select the ASR instrument in a manner similar to that used for the diffuse configuration by double-clicking on the empty field.

When all information is complete, click on *Accept*.

6.7.10 Other Instrument Configurations

Complete the BORCAL configuration by entering the configuration information for the meteorological instruments and GPS (if available). When all required instruments are entered, the BORCAL Configuration windows will look similar to the window shown below.

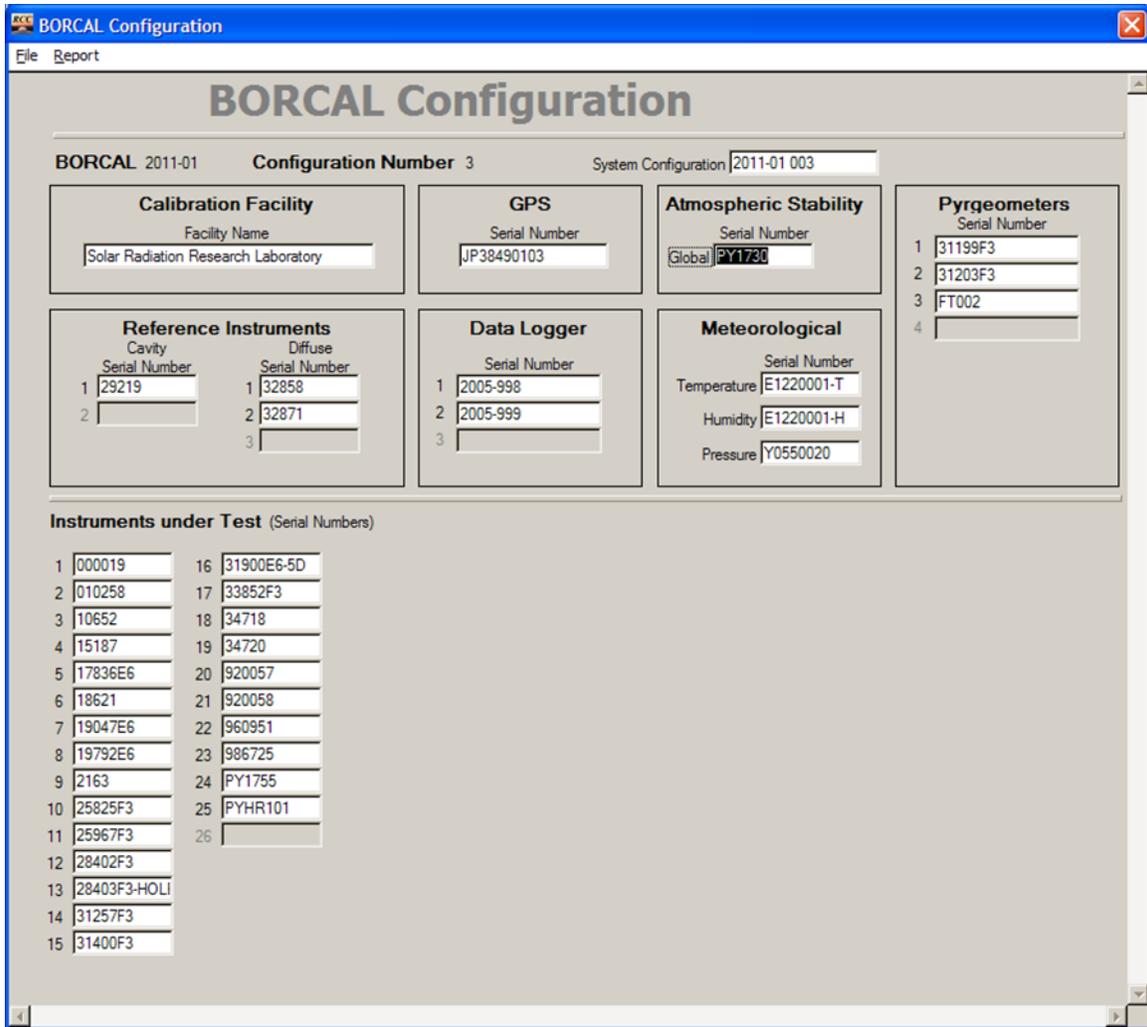


Figure 6-13. BORCAL-SW Configuration window

6.7.11 Editing or Removing Instruments

To edit information for an instrument already entered, double-click on its serial number in the BORCAL Configuration window. This brings up the Instrument Configuration window already described. Make the necessary changes to the configuration parameters, and close the Instrument Configuration window.

To remove an instrument from the configuration, right-click on its serial number in the BORCAL Configuration window; when prompted, confirm its removal.

6.8 Configuring a New BORCAL-LW

Use the Session Editor to construct the data acquisition environment (configure the system) so that the software is prepared to accept and acquire data from the appropriate instruments.

Ensure that the BORCAL type is set to LW.

If you are starting a new BORCAL, select *File*→*New BORCAL* from RCC's main window.

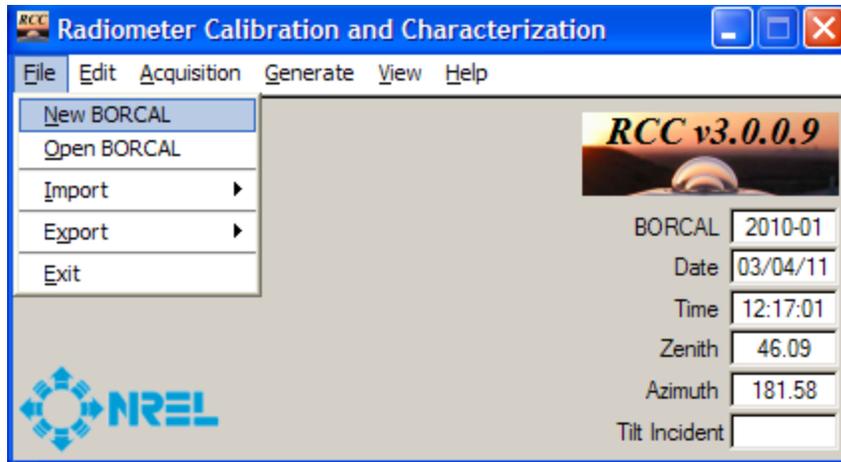


Figure 6-14. Selecting a new BORCAL-LW from RCC's main window

This action brings up the New BORCAL window, which is shown below.



Figure 6-15. New BORCAL-LW Configuration window

You have the option of using a previous BORCAL as a template for the new BORCAL, which will save time if that BORCAL was similarly configured. When you check the box for *Select a BORCAL as a Template*, double-click on the field below it, and choose a BORCAL from the pop-up list. With this option checked, the fundamental configurations are presented under Copy These Configurations. For each option selected, the new BORCAL will contain the final

configuration parameters from the indicated template BORCAL. If the box for *All Test Instruments* is checked, all test instrument configurations will be carried forward from the template BORCAL. If all boxes are checked, the result will be a copy of the template BORCAL. After selecting any desired configurations to copy, click on *Create* to create a new BORCAL. This brings up the BORCAL Configuration window, shown below, which displays a functional summary of the configuration. (The figure below shows blank fields indicating no carryover configurations.) BORCAL configuration is accomplished by completing the required information for all instruments and system parameters.

The screenshot shows a software window titled "Longwave BORCAL Configuration". At the top, there is a menu bar with "File" and "Report". Below the menu bar, the main title "Longwave BORCAL Configuration" is displayed in a large font. Underneath the title, there are three fields: "BORCAL 2015-03", "Configuration Number 1", and "System Configuration". The main area is divided into several sections:

- Calibration Facility:** A box containing a "Facility Name" field with the text "Solar Radiation Research Laboratory".
- GPS:** A box containing a "Serial Number" field.
- Pyrgometers:** A box containing a "Serial Number" field with a "1" to its left.
- Meteorological:** A box containing three fields: "Temperature", "Humidity", and "Pressure", each with a "Serial Number" label above it.
- Data Logger:** A box containing a "Serial Number" field with a "1" to its left.
- Instruments under Test (Serial Numbers):** A section at the bottom with a "1" and a blank field.

Figure 6-16. BORCAL-LW Configuration window

6.8.1 Steps for BORCAL Configuration

When configuring a new BORCAL, follow this general outline of steps:

- Calibration facility designation
- System configuration
- Reference pyrgeometers
- Meteorological instruments (temperature required, others optional)
- GPS configuration (optional)
- Test instrument configuration
- Data logger.

In most cases, when the database does not have an item (for example, an instrument or calibration facility), a new record can be added by clicking on *New* when viewing the database Table Selection window for that item. See Section 10.2 on Database Maintenance for additional instructions.

Many fields in the configuration windows are subject to validity checks, which occur when you click on *Accept* on a configuration window. If a field value is out of range, a pop-up window displays the name(s) of the field(s) with the invalid value and shows the range of acceptable values. You cannot close this window until all fields are within range.

6.8.2 Facility

Double-click on the field for the *Facility Name* under Calibration Facility on the configuration screen. This brings up a Table Selection list of configured calibration facilities. Select the desired facility, and click on *Select*.

6.8.3 System Configuration

To enter the system parameters, double-click on the field for *System Configuration*. This presents the System Configuration window (shown below), which contains several categories of parameters. (The figure below shows all fields configured; when starting without a configuration template from a previous BORCAL, the fields are filled with zeroes.)

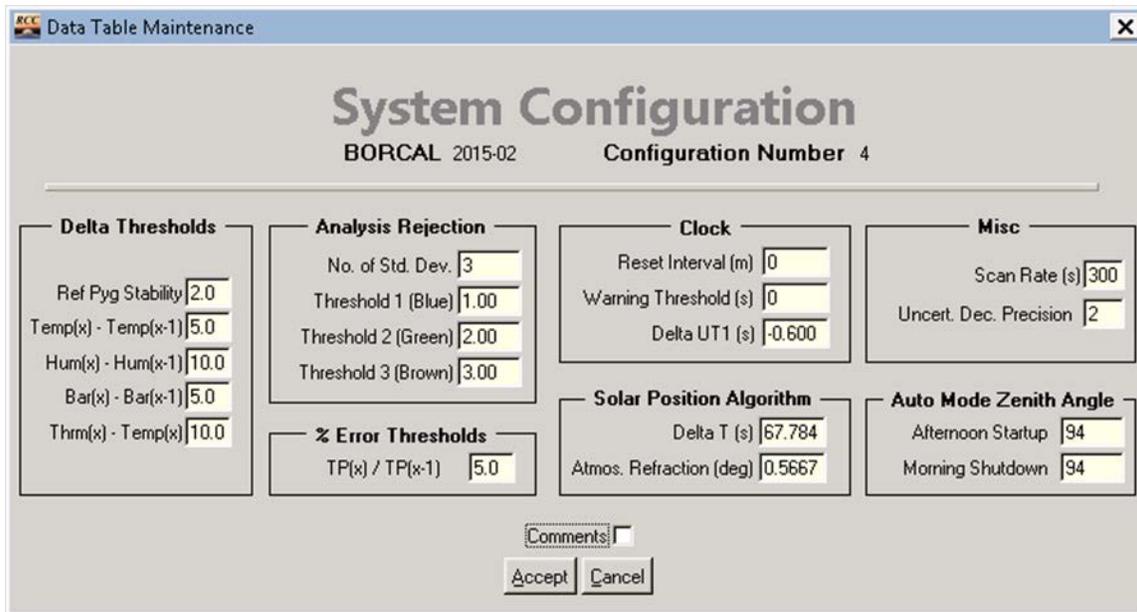


Figure 6-17. BORCAL-LW System Configuration window

Each category is described below. (The values in the window are the suggested defaults except for the site-specific water vapor values noted below.)

- Delta thresholds: alarm difference threshold for each real-time quality check. These values are the absolute difference between the two listed measurements, determined as $|M1 - M2|$, in the units of the measurement.
- Analysis rejection
 - Number of standard deviations: number of standard deviations to allow when rejecting test instrument data based on residuals of reference irradiance minus calculated test irradiance
 - Threshold 1 (Blue), Threshold 2 (Green), and Threshold 3 (Brown): selectable threshold limits (in W/m^2) for rejecting data based on the delta of two or more reference instruments acquiring data simultaneously.
- Percent error thresholds: alarm ratio threshold parameter for each real-time quality check. The value entered is the percent difference between the two listed measurements (TP(x) and TP(x-1)), determined as $100 \times \text{Test}(x) / \text{Test}(x-1)$. The measurements are from adjacent data scans of the same instrument's thermopile (the current scan and the previous scan).
- Clock
 - Reset interval: number of minutes between automatic clock-reset operations. A value of zero disables the automatic clock-setting function.
 - Warning threshold: magnitude of a clock correction (in seconds) allowed before the operator is warned of the impending correction. (Clock setting can be accomplished by either the operator or, if configured, a GPS unit.)

- Delta UT1: positive or negative correction (seconds) to be added to Coordinated Universal Time to adjust for an irregular earth rotation rate.
- Solar position algorithm
 - Delta T: difference in seconds between the earth's rotation time and terrestrial time from the observation
 - Atmospheric refraction: atmospheric refraction in degrees at sunrise and sunset.
- Miscellaneous
 - Scan rate: scan rate for radiometers under test and meteorological instruments
 - Uncertain decimal precision: number of digits past the decimal point for reporting uncertainties.
- Automatic mode zenith angle: parameters that specify the zenith angle thresholds for system start-up and shutdown in automatic mode.

When all system parameters have been entered and you want to close the window, click on *Accept*. Click on *Cancel* if you want to leave all parameters unchanged.

6.8.4 Test Instruments

To enter a test instrument in the BORCAL, double-click on the gray field for the serial number below *Instruments under Test* in the BORCAL Configuration window. This action displays the Test Instrument Configuration window, which is shown below.

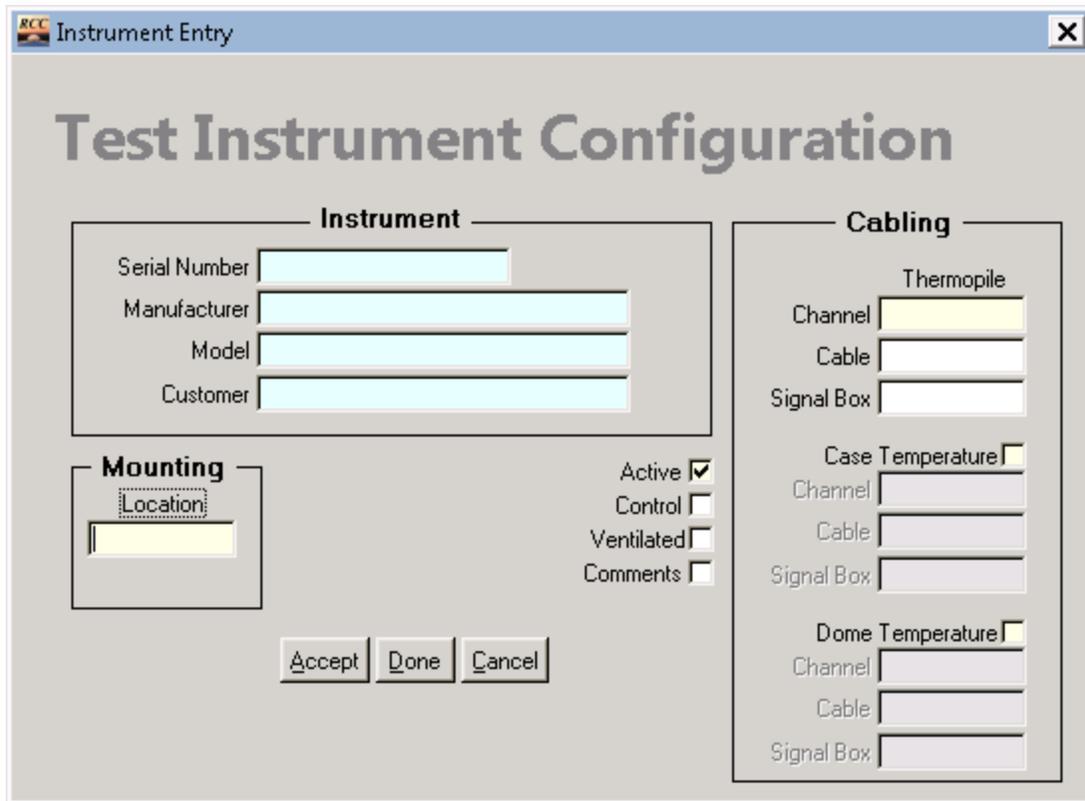


Figure 6-18. BORCAL-LW Test Instrument Configuration window

In the region labeled *Instrument*, double-click on the field for *Serial Number* (or *Manufacturer* or *Model*). This displays the Radiometer Inventory selection window, which is shown below. Locate the desired instrument by either scrolling through the list or by clicking in the box and typing the serial number. (See additional information in Section 10 on Database Editing Tools.)

When typing the serial number, the active selection tracks each keystroke to the first instrument with a serial number that matches the typed characters so far. If typing is delayed for more than 1 or 2 seconds, the search resets.

When an instrument is found, you may modify the current customer by double-clicking on the customer field. To select the instrument for the configuration, click on *Select*, or double-click on the instrument in the list.

Figure 6-19. Radiometer Inventory window

If the instrument is not known to the system, you may enter it by clicking on *New* in the Radiometer Inventory window. Fields for which information is mandatory are highlighted in yellow. Fields that require selections from other lists (related fields) are highlighted in blue.

When entering the serial number, manufacturer, or model, you cannot use these characters: /, \, :, *, ?, ", <, >, or |. This is because the Windows operating system does not allow these characters in file names, and the system creates file names based in part on these fields.

When the desired instrument is selected or entered, click on *Select*, and continue to enter the remaining information in the Test Instrument Configuration window.

If the RCC system for your site includes the Location Lookup feature, you can right-click on any of the fields for *Location*, *Channel*, *Cable*, or *Signal Box*. This allows you to select a predetermined configuration from a pop-up menu, and all of these fields will be automatically completed. See Section 6.11 on Location Lookup for more information about this.

Four check boxes appear on the Test Instrument Configuration window: Active, Control, Ventilated, and Comments.

- The *Active* box is normally checked (and must be checked to include the instrument in data acquisition), but it can be unchecked to temporarily exclude the instrument from the data acquisition. This may be valuable if an instrument is included in a period of desired data acquisition, but it must be removed for other purposes. If the instrument is deleted from the configuration, it may not appear in the calibration reports (depending on the final data selection).
- Click on the *Control* box to configure the instrument as a control instrument. A control instrument must have been previously calibrated by the system.
- Click on the *Ventilated* box if the instrument is installed in a ventilator. This information aids in configuration validation and appears in the report to document that the instrument was calibrated with a ventilator.
- Click on the *Comments* box to enter or read comments about the instrument's configuration. If comments exist, the box will contain a check mark.

The Case Temperature and Dome Temperature check boxes appear on the right side under Cabling. Clicking on these boxes indicates that the instrument is equipped with the specified temperature sensor(s). When indicated, the channel and cabling fields become active to configure the connections for the thermistors.

When all information is complete, click on *Accept*. By doing this, you:

- Enter the instrument in the BORCAL configuration.
- Clear the fields for the next instrument to be configured.

When all instruments have been entered, click on *Done* to return to the BORCAL Configuration window.

Note the distinction between *Accept* and *Done*: although using either one will allow you to enter and save the configuration information, *Accept* clears all fields and allows you to continue with another instrument, and *Done* exits the test instrument configuration.

6.8.5 Reference Pyrgeometer Configuration

Configure a pyrgeometer by double-clicking on the gray field for the serial number under Pyrgeometers. This brings up the Pyrgeometer Configuration window, which is shown below.

Pyrgeometer Configuration Entry

Pyrgeometer Configuration

BORCAL 2011-01
Configuration Number 2

Serial Number

Manufacturer

Model

Cal Date Cal Due Date

Location

Calibration Coefficients

K0

K1

K2

K3

Kr

Uncertainty (W/m²)

Active

Ventilated

Comments

Cabling

Themopile

Channel

Cable

Signal Box

Case Thermistor

Channel

Cable

Signal Box

Dome Thermistor

Channel

Cable

Signal Box

Figure 6-20. Pyrgeometer Configuration window

As described with other instrument configurations, configure the blue fields by double-clicking on them and selecting an instrument from those available in the Pyrgeometer Inventory table.

When an instrument is selected, the system will fill in the coefficients, calibration dates, and uncertainty fields using data from the instrument's record in the Pyrgeometer Inventory table. These fields may be modified, and any changes will be written to the instrument's record in the Pyrgeometer Inventory table.

The location, channel, and cabling information must be completed.

All available pyrogeometer thermistors must be configured into RCC.

6.8.6 Data Logger Configuration

Configure the data logger(s) by clicking on the gray field for the serial number under Data Logger. This presents the Data Logger Configuration window, as shown below.

The screenshot shows a software window titled "Data Logger Entry" with a close button in the top right. The main heading is "Data Logger Configuration" with the text "BORCAL 2011-01" and "Configuration Number 2" below it. The form contains several input fields: "Serial Number" (blue), "Manufacturer" (blue), "Model" (blue), "DMM" (blue), "Unit Number" (0), "Location" (yellow), "Cal Date" (yellow), "Cal Due Date" (yellow), and "Comments" (checkbox). There are two sections: "System Offsets" and "Communications". "System Offsets" includes "Volts DC (µV)" (-1.0), "2-Wire Res. (mOhms)" (-1.0), and "4-Wire Res. (mOhms)" (-1.0). "Communications" is split into "DMM" and "Relay" columns. Each column has radio buttons for "RS-232" (selected) and "GPIB", and input fields for "Port" (1), "Baud" (9600), "Parity" (None), "Stop Bits" (1), "Data Bits" (8), and "Board" (0). At the bottom are "Accept" and "Cancel" buttons.

Figure 6-21. Data Logger Configuration window

As described in previous configurations, double-click on the blue fields to select a data logger from the Data Logger Inventory table. This brings forward the instrument make, model, and calibration date information. Other fields are described below:

- Unit number: For Relay (RLY) data loggers (with separate DMM), this indicates the unit number, which is a number based on the physical wiring of the Relay/DMM to the available channels at the calibration facility. Multiple RLY-type loggers are supported, and the unit numbers must be sequential starting with zero (the highest unit number must be less than the total number of units). Combo loggers (LGR) must be assigned unit number zero, and only one LGR-type logger is supported.

- DMM: The DMM is physically wired to the Relay data logger and should be left blank for combo loggers (LGR).
- Location: physical location of the logger
- System offsets (volts DC, two-wire resistance, and four-wire resistance): maximum offset of the instrument for uncertainty calculations
- Communications
 - DMM: configuration information for the DMM or combo logger
 - Relay: configuration information for the relay unit (this column of fields will be dimmed for combo loggers).

6.8.7 Other Instrument Configuration

Complete the BORCAL configuration by entering the configuration information for the meteorological instruments and GPS (if available). When all required instruments are entered, the BORCAL Configuration window will look similar to the window below.

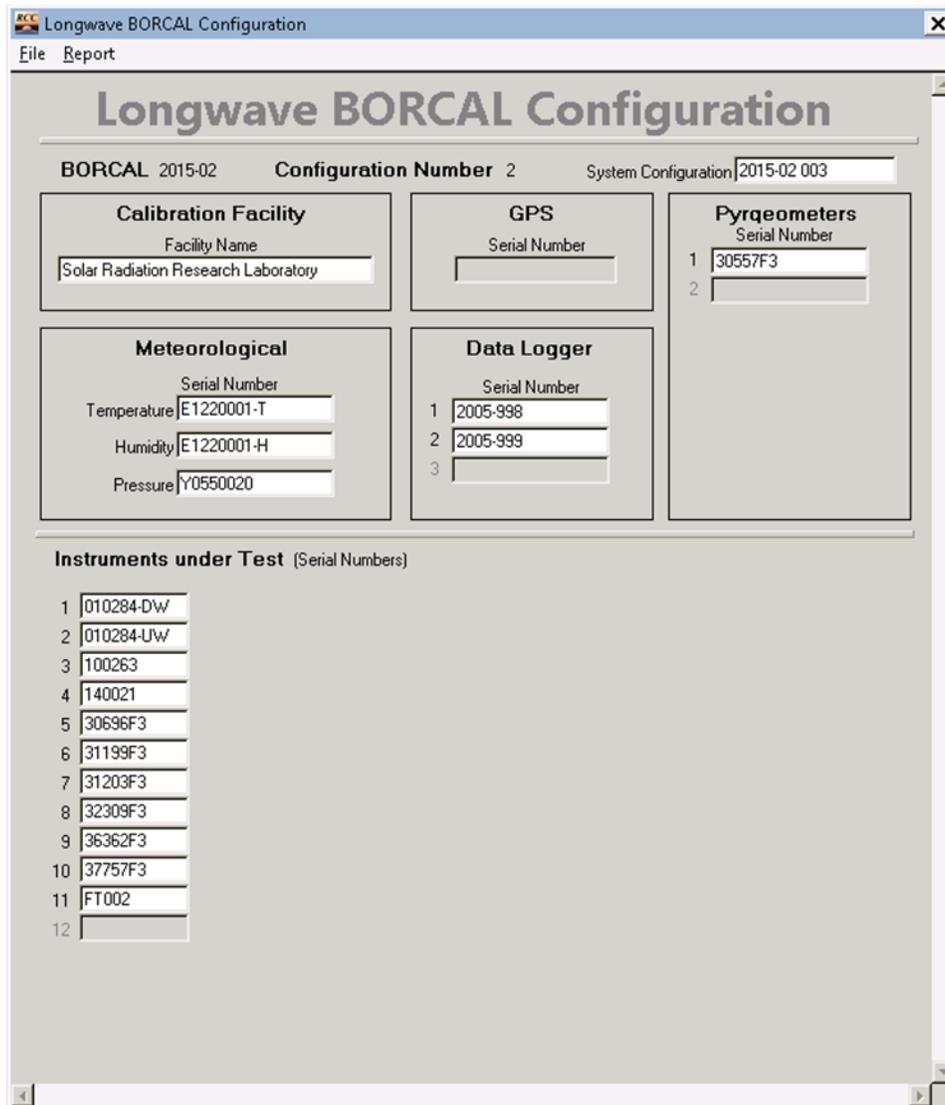


Figure 6-22. BORCAL-LW Configuration window

6.8.8 Editing or Removing Instruments

To edit information for an instrument already entered, double-click on its serial number in the BORCAL Configuration window. This brings up the Instrument Configuration window already described. Make the necessary changes to the configuration parameters, and close the Instrument Configuration window.

To remove an instrument from the configuration, right-click on its serial number in the BORCAL Configuration window, and when prompted, confirm its removal.

6.9 Editing a BORCAL Configuration

If you want to edit or extend an existing configuration, select *Edit*→*BORCAL/Session* from the RCC's main window. This brings up the BORCAL Configuration window, which is accessed

and edited as described in the section above. All previously configured instruments will appear as entered and can be modified, and additional instruments can be added.

When the configuration is opened for editing as described here, all instruments will be sorted by serial number. This may differ from the order in which they appeared when originally entered.

6.10 Configuration Audit

Use Configuration Audit to provide a summary of the event configuration. You can print this information to serve as a reference for instrument type, channels, and so on.

The configuration audit is intended as a tool to assist with validating the BORCAL configuration. Although some checks are done for completeness during generation of the report, the automated checks are not comprehensive. The operators should use this tool to carefully validate the entire BORCAL configuration for correct entries.

In the BORCAL Configuration window (LW or SW), select the *Report*→*Configuration Audit* pulldown menu.

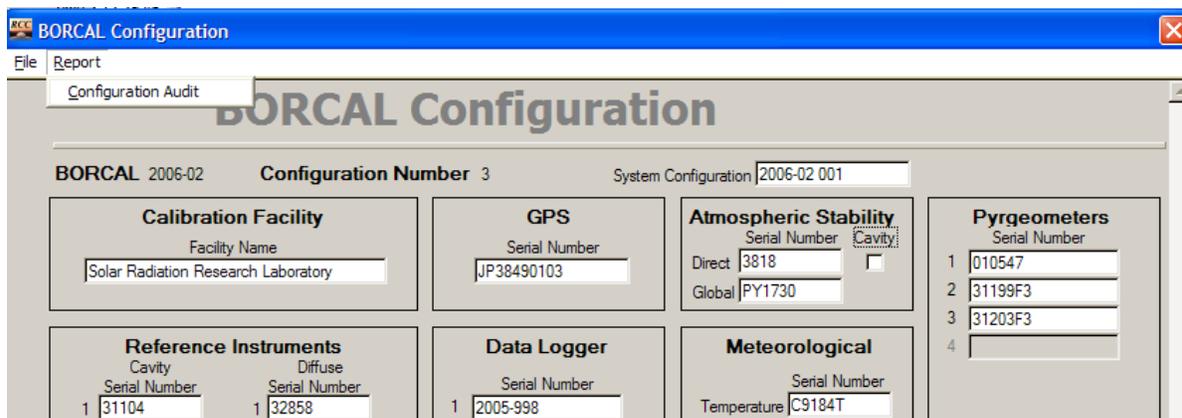


Figure 6-23. Selecting an audit report from the configuration window

This performs a check of the system configuration. If any improper or missing configuration parameters are found, a pop-up message indicates which parameters require correction. When all parameters are correct, the audit automatically generates an onscreen display when complete. A partial screen report for SW is shown below.

Audit Report
03/04/2011 13:33 **BORCAL 2011-01 Session Configuration Audit Report** Print Next Page

LOCATION

Facility	Facility Abbrev.	Contact	Latitude	Longitude	Elevation (m)	Avg press (mbr)	Avg temp (C)	Time zone	ISO
Solar Radiation Research Laboratory	SRRL	Tom Stoffel	39.742	-105.180	1828.8	835.0	10.0	-7.0	<input checked="" type="checkbox"/>

SYSTEM

% Error Thresholds		Scan Rate (sec)		Clock	
Cav 1 / Cav2	1.0	Radiometers	30	Reset Interval (m)	7
Dif 1 / Dif2	7.0	Meteorological	300	Warning Threshold (s)	1
Global Ctrl / Ref	5.0	ASR Setup			
Direct Ctrl / Ref	5.0	Scan Rate (s)	1	Zenith Angle (deg)	0.003
Test(x) / Test(x-1)	1.2	ASR Readings	2	Decimal Precision	2
Delta Thresholds		Threshold 1 (Blue)	1.000	45° Offsets: -	-10.00
Temp(x) - Temp(x-1)	3.0	Threshold 2 (Green)	2.000	+	10.00
Hum(x) - Hum(x-1)	10.0	Threshold 3 (Brown)	3.000	Min. Legal Direct	700
Bar(x) - Bar(x-1)	2.0	Diffuse scaling factor	0.25	Max. Legal Diffuse	150
Thm(x) - Thm(x-1)	2.0	Uncertainty			
Thm (Dome-Case)	3.0	PW: Slope	1.83	Intercept	1.00
Case Thm (Inst-Pyrg)	5.0	Tilt: Zenith	0.00	Azimuth	0.00
		W in: Min	150	Max	450
		Zenith Angle (Auto Mode): Startup	85	Shutdown	85
		Intervals (m): Cavity Calibration	60	Oper. Log	20
		SPA: Atmos. Refraction	0.5667	Delta T	66.184

ASR RADIOMETERS

Channel	Junction Box	Cable	Location
ASR 1: PY1730 Licor LI200			
40	10-00		Tbl-01-00
ASR 2: None			

METEOROLOGICAL INSTRUMENTS

Channel	Junction Box	Cable	Location
Temperature: E1220001-T Vaisala HMP155-T			
78	13-08		Tbl-02-18
Humidity: E1220001-H Vaisala HMP155-H			
79	13-09		Tbl-02-19
Barometer: Y0550020 Vaisala PTB101B			
127		P-07	Datalab

GPS TIME RECIEVER

Type	Port	Baud	Parity	Stop bits	Data bits
JP38490103 Hewlett Packard 58533A					
RS232	1	9600	D	1	8

DATALOGGER

Figure 6-24. Sample BORCAL-SW Session Configuration Audit Report

The report contains multiple pages that can be accessed by clicking on *Next Page* or *Previous Page*. You can print the entire report by clicking on *Print*.

6.11 Location Lookup

This feature allows you to quickly enter data on an instrument's mounting location, hookup, and logger channel during the configuration.

6.11.1 Accessing the Location Lookup Feature

During configuration, the Location Lookup feature is accessed from the Instrument Configuration screen (for all instruments except ACR, data logger, and GPS) by right-clicking on any one of these fields:

- *Location*
- *Cable*
- *Junction Box*
- *Channel*

This action presents a two-tiered pop-up menu from which the user can select a mounting location that will then fill in all of the above fields with the preconfigured information.

The figure below shows a typically configured pop-up menu hierarchy for the Location Lookup feature.

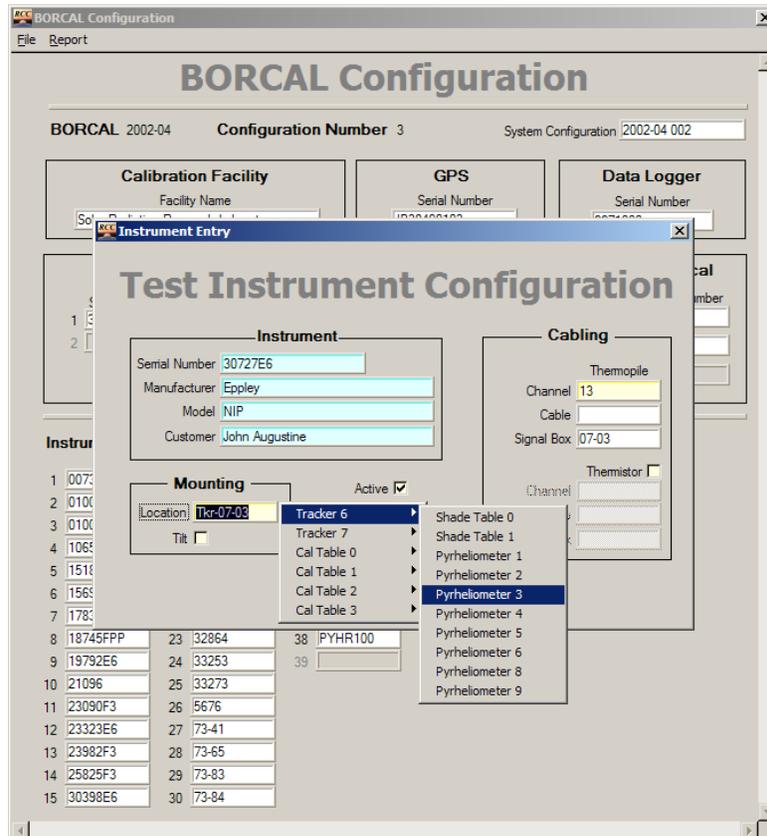


Figure 6-25. Location lookup pop-up menu

6.11.2 Configuring the Location Lookup Feature

The Location Lookup information is stored in a text file located in the BORCAL\CONFIG folder. The operator must initially configure the file with information specific to the calibration site according to the instructions below. The file is named:

[ssss]_LOCATION_LOOKUP.TXT

where [ssss] is the facility abbreviated name. The file consists of a header record documenting the data structure followed by any number of data lines. A vertical bar delimits fields within the record, and blank fields are allowed (designated by no characters in the field). The fields (as designated in the file header) are described as follows (in order from left to right):

- Platform: text used for populating the first-tier pop-up menu; a broad grouping of locations, such as an instrument table or a tracker
- Position: text used for populating the second-tier pop-up menu; designates the position of the location within the platform

- Location: location name. This text is copied directly to the *Location* field of the Instrument Configuration window.
- TP cable: cable name for the position. This text is copied directly to the thermopile Cable field of the Instrument Configuration window.
- TP jbox: junction box name for the position. This text is copied directly to the thermopile Signal Box field of the Instrument Configuration window.
- TP chan: thermopile channel number for the position. This text is copied directly to the thermopile Channel field of the Instrument Configuration window.
- Case cable: case thermistor cable name for the position. This text is copied directly to the thermistor Cable field of the Instrument Configuration window.
- Case jbox: case thermistor junction box name for the position. This text is copied directly to the thermistor Signal Box field of the Instrument Configuration window.
- Case chan: case thermistor channel number for the position. This text is copied directly to the thermistor Channel field of the Instrument Configuration window.
- Dome cable: dome thermistor cable name for the position. This text is copied directly to the thermistor Cable field of the Instrument Configuration window.
- Dome jbox: dome thermistor junction box name for the position. This text is copied directly to the thermistor Signal Box field of the Instrument Configuration window.
- Dome chan: dome thermistor channel number for the position. This text is copied directly to the thermistor Channel field of the Instrument Configuration window.

When creating this file, group all identical first-tier Platform designations together, and within that group, enter the second-tier Position designations in the order they should appear on the pop-up menu.

When creating the pop-up menus, the system will group identical adjacent platform designations under a single title on the first-tier menu and create second-tier menu items in the order they appear within that group in the file. The next first-tier menu item is created when the designation changes. No effort is made to sort items in the file; hence, any first-tier item out of order will result in additional menu items.

The figure below shows a sample lookup configuration file with the header line and six first-tier items, each with multiple second-tier items.

```

Platform|Position|Location|TP cable|TP Jbox|TP chan|case cable|case jbox|case chan|dome
cable|dome jbox|dome chan
Tracker 4|T27|T27|T27||146|||
Tracker 4|T28|T28|T28||157|||
Tracker 4|T29|T29|T29||182|||
Tracker 4|T30|T30|T30||187|||
Tracker 4|T31|T31|T31||188|||
Tracker 4|T32|T32|T32||158|||
Tracker 4|T33|T33|T33||167|||
Tracker 4|T34|T34|T34||185|||
Tracker 4|T35|T35|T35||190|||
Tracker 4|T36|T36|T36||191|||
Tracker 5|T5-1 (LW)|T5-1|1|1|1|1|0|1|2
Tracker 5|T5-2 (LW)|T5-2|2|5|2|4|2|6
Tracker 5|T5-3 (LW)|T5-3|3|9|3|8|3|10
Tracker 6|T6-1 (LW)|T6-1|1|13|1|12|1|14
Tracker 6|T6-2 (LW)|T6-2|2|17|2|16|2|18
Tracker 6|T6-3 (LW)|T6-3|3|21|3|20|3|22
Tracker 7|T7-1 (LW)|T7-1|1|25|1|24|1|26
Tracker 7|T7-2 (LW)|T7-2|2|29|2|28|2|30
Tracker 7|T7-3 (LW)|T7-3|3|33|3|32|3|34
Tracker 8|T8-1 (LW)|T8-1|1|37|1|36|1|38
Tracker 8|T8-2 (LW)|T8-2|2|41|2|40|2|42
Tracker 8|T8-3 (LW)|T8-3|3|45|3|44|3|46
Tracker 9|T9-1 (LW)|T9-1|1|49|1|48|1|50
Tracker 9|T9-2 (LW)|T9-2|2|53|2|52|2|54
Tracker 9|T9-3 (LW)|T9-3|3|57|3|56|3|58

```

Figure 6-26. Sample lookup configuration file

6.12 Instrument Validation Test

Use the Instrument Validation Check to verify each instrument’s serial number to confirm that it is correctly connected to the system.

The Instrument Validation Check requires two people: an operator at the computer and an assistant at the instrument being checked. These two people should be in easy communication with each other.

The data acquisition system will not run until all the instruments are verified using the Instrument Validation Check. When an instrument configuration is modified (for example, by adding an instrument or changing an existing instrument), the instrument will be marked as unverified and must be re-verified with this procedure.

From RCC’s main window, first select the proper BORCAL type (SW or LW), then select *Acquisition*→*System Test*, as shown below.

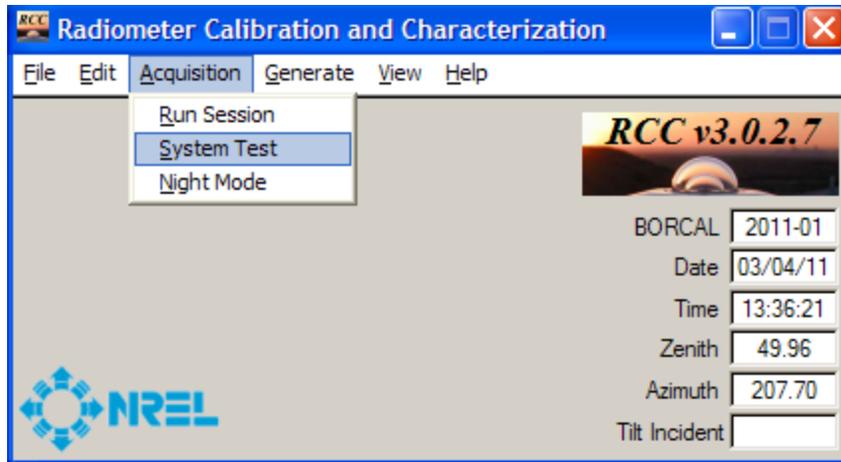


Figure 6-27. Selecting a system test from RCC's main window

The Instrument Validation Check window appears and displays a graph and instrument list, as shown below. Units are in millivolts for radiometer thermopiles, the appropriate measurement units for meteorological instruments, and degrees Celsius for case and dome thermistors. The check boxes at the bottom of the window are enabled automatically based on the type of instrument selected.

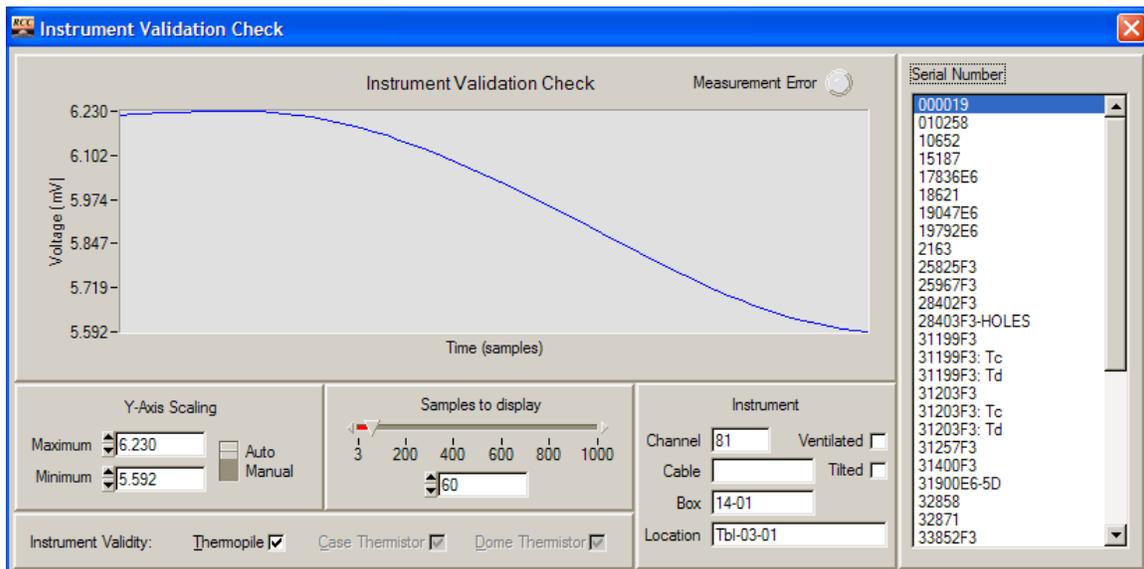


Figure 6-28. Instrument Validation Check window

The following sequence describes the operator and assistant actions to conduct the system test:

- Assistant: Read the serial number from the tag on the installed instrument, and convey it to the operator.
- Operator: Enable the instrument by selecting its serial number from the onscreen list.
- Assistant: Shade the instrument dome or window for thermopile tests. For thermistors, chill the thermistors by spraying compressed air on the case and dome. Alternative thermistor test: The assistant should trace the signal cable and disconnect the appropriate cable so that the operator can verify that the data acquisition produces an infinite result or measurement error for the channel that was disconnected.
- Operator: Verify that the onscreen graph reflects the appropriate change.

The operator and assistant should also verify that the cable, junction box, tilt, ventilation, and location are all correct. (Only the shading and response are required for correct connections.) When an instrument's response to the shading is verified (or a reasonable value from the meteorological instruments or case thermistors is measured), the operator should click on the *Valid* field. Serial numbers for instruments that have not been verified appear in the list in red; after the verification is performed, the serial number color changes to black.

Instruments with case or dome thermistors appear in the list two or three times: once with their serial number and the second or third time with a "-Tc" (for case) or "-Td" (for dome) appended to the serial number. When the native serial number is selected, the graph displays the thermopile output. When the "-T" version is selected, the graph shows the thermistor output (in degrees Celsius). The Verify check box is active only when the thermopile data are selected; check box verification for the thermistor is accomplished using the thermistor designation.

The graphing window allows the operator to scale each axis independently by choosing minimum and maximum values (Y axis) or the number of samples to display (X axis). The system samples the selected instrument at approximately 1-second intervals. The graph resets when another instrument is selected.

7 BORCAL-SW Data Acquisition

Data acquisition is accomplished by running multiple data acquisition sessions (referred to in this manual as a *session*). This section provides details for running a session.

7.1 Starting a Session

From RCC's main window, select the SW BORCAL type, then select *Acquisition*→*Run Session*. The software performs an automatic check of the system's integrity. If a configuration discrepancy is found, an alert appears in a pop-up window, and the operator should correct the problem. The system will not initiate data acquisition if a configuration discrepancy is found.

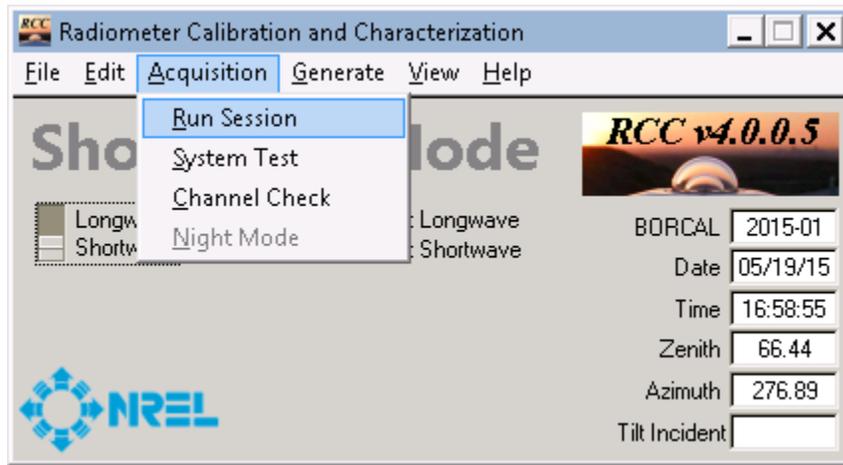


Figure 7-1. Starting a BORCAL-SW session from RCC's main window

If the configuration passes the system integrity check, the Data Acquisition window appears, as shown below.

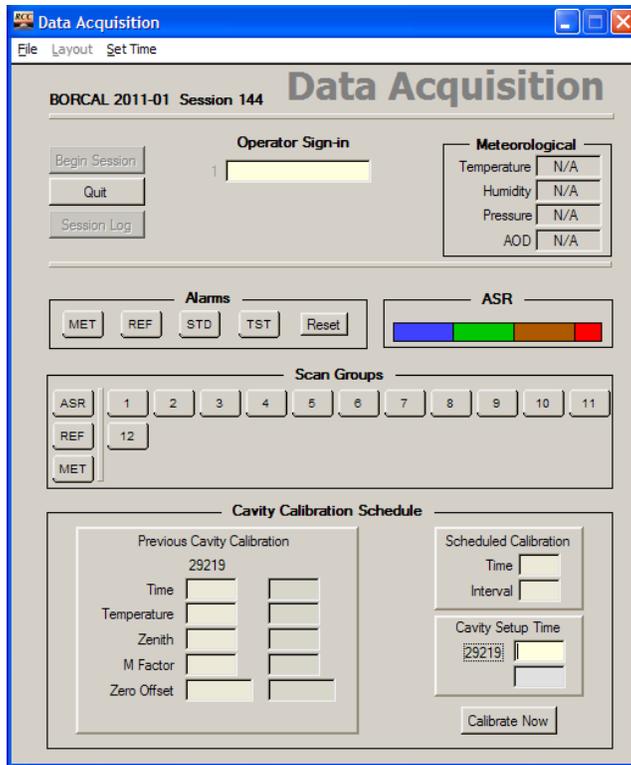


Figure 7-2. BORCAL-SW Data Acquisition window

7.1.1 Operator Sign-In

The operator must sign in by clicking on the input box and selecting the appropriate operator name(s) from the list. The name of a new operator may be entered in the system by clicking on *New* on the Operator Selection window. At least one operator must be selected before you can continue, and up to three operator names may be selected at one time.

The RCC operator is a special user name that causes the system to run in a “silenced” mode. In silent mode:

- Audible alarms are disabled. (Visual alarms are not affected.)
- The computer clock is silently adjusted if the GPS is attached. (There are no out-of-bounds warnings.)
- Both the audible and visual prompts for the Operator Logs are disabled. (However, the log may be accessed as usual.)
- An automatic backup will be performed at shutdown.

The system will not run until at least one operator has signed in.

7.1.2 Cavity Setup Time

Enter the ACR setup time(s) in the appropriate field in the lower right portion of the window. This time is when the ACR was first set up on the current day. This information is stored with

the operator logs. RCC will retain the setup time from one session to another until the program is closed.

7.1.3 Start Data Acquisition

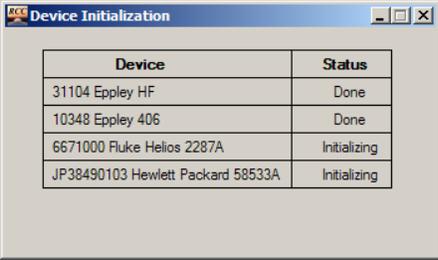
Click on *Begin Session* to initiate data acquisition. The following events occur:

- Device initialization
- System time check
- ACR calibration begins and is monitored.
- ASR instruments take data for approximately 1 minute.
- The system begins scanning instruments by group.

The last three events in the list above repeat according to the ACR calibration schedule specified in the system configuration. During this time, you can monitor incoming data.

7.1.3.1 Device Initialization

All devices attached to the system are initialized prior to data acquisition. During the initialization sequences, a status window is posted. If any of the initializations fail, a message is displayed on the status window.



Device	Status
31104 Eppley HF	Done
10348 Eppley 406	Done
6671000 Fluke Helios 2287A	Initializing
JP38490103 Hewlett Packard 58533A	Initializing

Figure 7-3. BORCAL-SW Device Initialization window

If any device shows a *Failed* status, check all connections and the communications configuration.

The GPS unit model 58533A may need several minutes to initialize. If it shows a *Failed* status and the GPS status indicator light is red, RCC will issue a device initialization command. It may take several minutes (less than 10) for the device to respond, during which time the Device Initialization window will show a *Failed* status for the GPS unit. When this occurs, wait several minutes until the GPS indicator light turns green before trying to restart data acquisition. If you attempt to restart data acquisition before the indicator light turns green, the GPS initialization process and wait period restarts. If the light fails to turn green, check all connections and configuration settings, power down, and restart the GPS unit.

7.1.3.2 System Time Check

7.1.3.2.1 System Time Check

Prior to data acquisition, the system attempts to determine the correct time. Depending on the configuration, the time will come from either the system operator or from an attached GPS unit.

The manual time set function does not allow viewing or correcting the date (although this information is visible on the RCC's main window). To avoid entering very large correction numbers (that would span days), the operator should use the Windows clock to correct the date if necessary. The GPS time-setting function will also check and set the date.

7.1.3.2.2 Manual Time Check

If no GPS unit is attached, the operator is prompted for a time check with a dialog box as shown below.

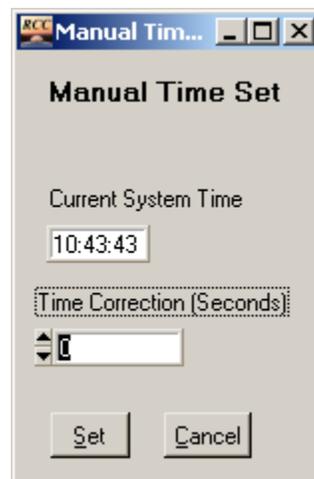


Figure 7-4. Manual Time Set window

The operator should compare the displayed time to a known reference time source and determine if any correction is required. The correction is not entered as conventional time but rather as an offset (in seconds). For example, if the system clock is leading the reference by 3 seconds, a time correction of -3 seconds should be entered. Click on *Set* to correct the time. It is not possible to set the clock to an accuracy of less than 1 second (for example, a .5-second correction).

7.1.3.2.3 Automatic Time Set

If a GPS unit is attached, the system polls the receiver for the correct time. If a time discrepancy is detected, the correction is made automatically without operator intervention (unless the correction exceeds the Clock Correction Threshold specified in the system configuration and the system is not in automatic mode).

7.1.3.2.4 Correction Threshold

If the correction from either the operator or the GPS unit is outside the limits of the Clock Correction Threshold (system setup), the operator will be asked to confirm the correction. This alerts the operator to a potential existing gross error in time and prevents an erroneous correction from being entered.

7.1.3.2.5 On-Demand Clock Setting

The operator can set the clock on demand by accessing the time functions from the Set Time pulldown menu. The Automatic and Manual selections work as described above. If no GPS unit is configured, the selection for the Automatic time setting is disabled (gray).



Figure 7-5. Setting the clock

7.1.3.2.6 Clock-Setting Interval

This is the interval for setting the clock (either automatically or manually) set in the system configuration Clock Reset Interval parameter.

7.1.3.3 ACR Calibration

The ACR self-calibration is initiated by giving the operator the opportunity to override the calibration with a previous calibration. Although the ACR calibration should generally be allowed to commence automatically, there are times when the automatic sequence should be overridden—for instance, when a calibration has just been performed and for some reason the session was stopped immediately and restarted).

Prior to starting the automated calibration sequence, the system posts the following dialog box, which allows the operator several seconds to bypass the automatic calibration and select a previous calibration.

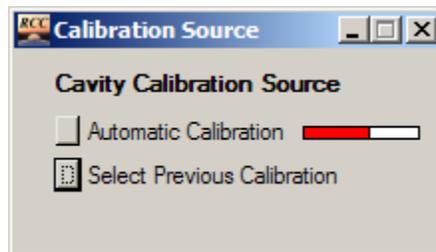


Figure 7-6. Cavity Calibration Source window

A red countdown bar indicates the amount of time left for the operator to make a selection. Click on *Automatic Calibration* to proceed with the automatic calibration. If the operator does not intervene, the automatic calibration will commence within approximately 10 seconds. Clicking on the red countdown bar can start or stop its progress. Click on *Select Previous Calibration* to choose from among historical calibrations. If the operator chooses to select a previous calibration, the following Calibration Selection window appears.

31104

Sess	Date	Time	TPz (uV)	M Factor	Irradiance	Temp
38S	2002/09/02	16:35:46	-0.99	952.15	692.8	30.0
37S	2002/09/02	15:32:44	-0.44	952.48	823.2	30.0
36S	2002/09/02	14:32:42	-0.31	953.01	900.2	28.9
35S	2002/09/02	13:23:40	-0.06	953.80	934.1	27.9
34S	2002/09/02	12:23:39	-0.35	954.32	957.5	26.7
33S	2002/09/02	11:03:38	-0.22	954.82	969.9	24.8
33S	2002/09/02	10:07:36	0.19	955.56	961.5	23.3
31S	2002/08/30	13:00:58	-0.16	953.62	934.0	30.7
30S	2002/08/30	12:03:56	-0.12	954.42	940.5	29.3
29S	2002/08/30	11:03:55	-0.26	955.33	955.4	27.3
28S	2002/08/30	10:00:53	-0.43	956.12	942.8	25.1
27S	2002/08/30	09:00:51	-0.27	957.57	897.9	22.7
26S	2002/08/30	08:02:50	-0.33	958.44	841.9	19.7

Figure 7-7. Previous Cavity Calibration Selection List window

This list includes all ACR calibrations for the current BORCAL. Highlight the desired calibration (or calibrations, if more than one ACR is in use), then click on *Select*. If more than one ACR is in use, both cavities will receive the same options for calibration (either an automatic self-calibration or a past calibration). It is not possible to calibrate one and select a past calibration for the other.

By selecting an entry from the list, you will be providing ACR calibration information that was not determined by an automatic calibration. If the selected entry is not representative of the current state of the ACR, it will cause incorrect reference irradiance readings. Do not use a previous calibration as an effort to save time by bypassing the electrical calibration. A previous calibration should be used only when you are sure that the selected entry represents the current state of the ACR and there is reason to bypass the calibration—for example, when a session was stopped (with a terminating calibration) and a new session started immediately.

During the automatic ACR calibration, a status screen appears, as shown below.

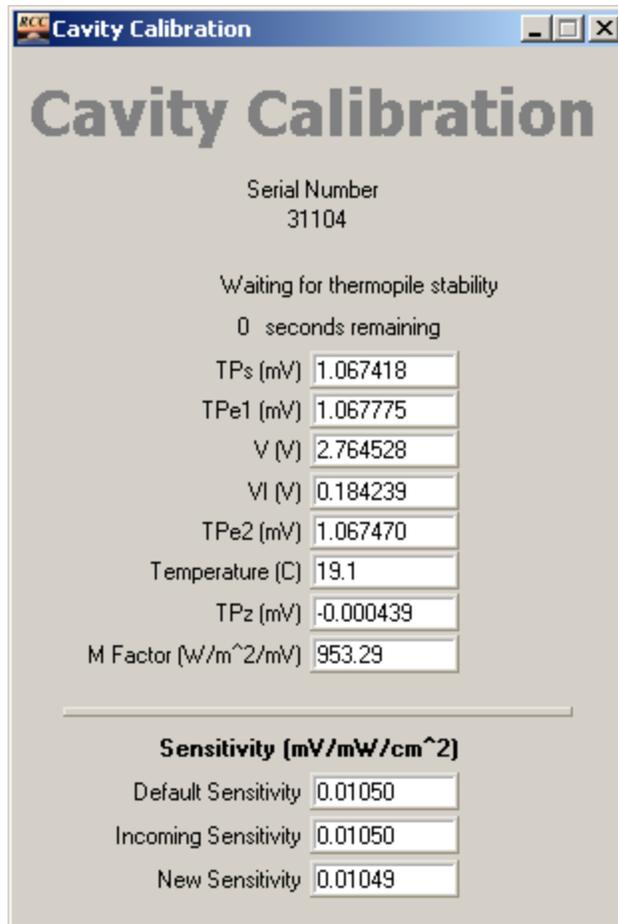


Figure 7-8. Cavity Calibration window

Fields for the ACR calibration are filled in by the system as the calibration progresses. When the calibration process is complete, the full information is displayed for about two seconds, and then the window is removed from the screen. All ACR calibration parameters are written to the session file. If the operator chooses to use a previous calibration, that information is written to the file with the actual date and time that the previous ACR calibration was performed.

7.2 Acquiring Data

When the ACR calibration sequence completes, the active Data Acquisition window appears.

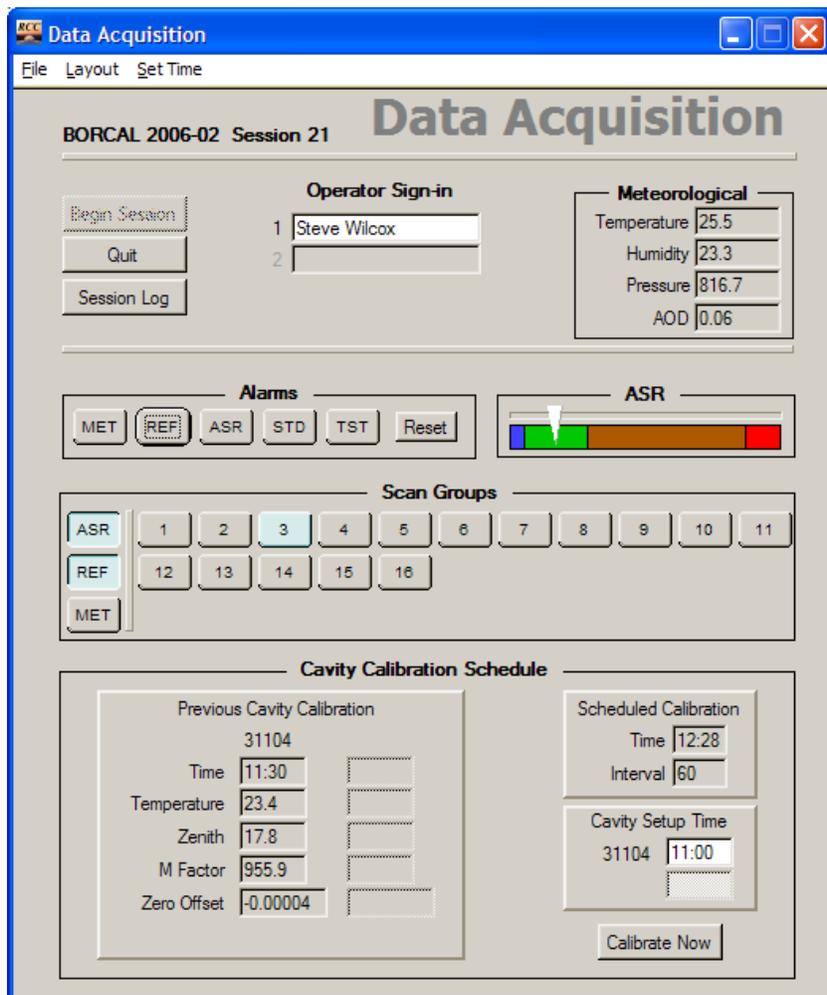


Figure 7-9. Active BORCAL-SW Data Acquisition window

This screen shows several sections:

- Operator sign-in
- Meteorological
- Alarms
- ASR
- Scan groups
- Cavity calibration schedule.

7.2.1 Operator Sign-In

The fields in the Operator Sign-In section are active continuously and can be updated as operators change during the course of data acquisition. Up to three operators may be logged in and out at one time. To log an operator out, right-click on the name, and a pop-up window will appear to allow the user to log out. The system will not allow a log out if only one operator is logged in (at least one operator must be logged in at all times). To log in a new operator, double-click on the next gray field, and select the operator's name from the list presented.

The name of a new operator can be added at this point by clicking on *New* on the Operator Table List window that appears when logging in an operator.

7.2.2 Meteorological

This field displays the meteorological observations and the estimated AOD. This is updated at the interval specified in the system configuration Meteorological Scan Rate.

7.2.3 Alarms

Alarms, indicated by a button illuminated in on the window and a periodic audible beep, are triggered by data acquisition discrepancies for any of the following:

- Meteorological instruments
- Reference instruments
- Standard instruments
- Test instruments.

When an alarm is generated, the cause can be investigated by clicking on the red button. A window appears that lists all alarm instances and describes the condition that triggered the alarm.

Based on the information provided, take the appropriate action to correct the condition. When the error is corrected, click on *Clear* to clear the alarm. Click on *Reset* on the Data Acquisition window to clear alarms for all instruments. Clearing an alarm removes all entries from the Alarm window and mutes the audible beep.

All information about alarms described in this section is written to alarm files in the BORCAL\DATA_SW\[BORCAL_ID]\ALARMS directory. Formats are the same as those shown in the figure in each section, and the files are named according to the following convention:

AAASSS.YYYY-DD

Where

- SSS is the session number
- YYYY-DD is the BORCAL identification number
- AAA is an alarm type designation according to this table.

Table 7-1. BORCAL-SW Alarm Type File Name Designations

Designation	Description
TST	Test instruments
REF	Reference instruments
STD	Standard control instruments
MET	Meteorological instruments

The alarm windows are described further below.

7.2.3.1 Reference Alarms

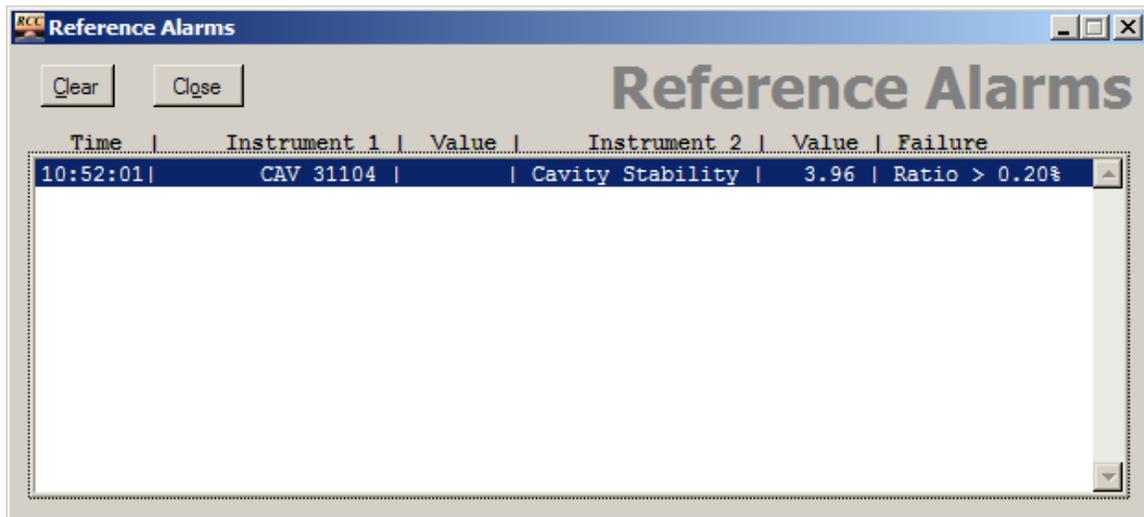


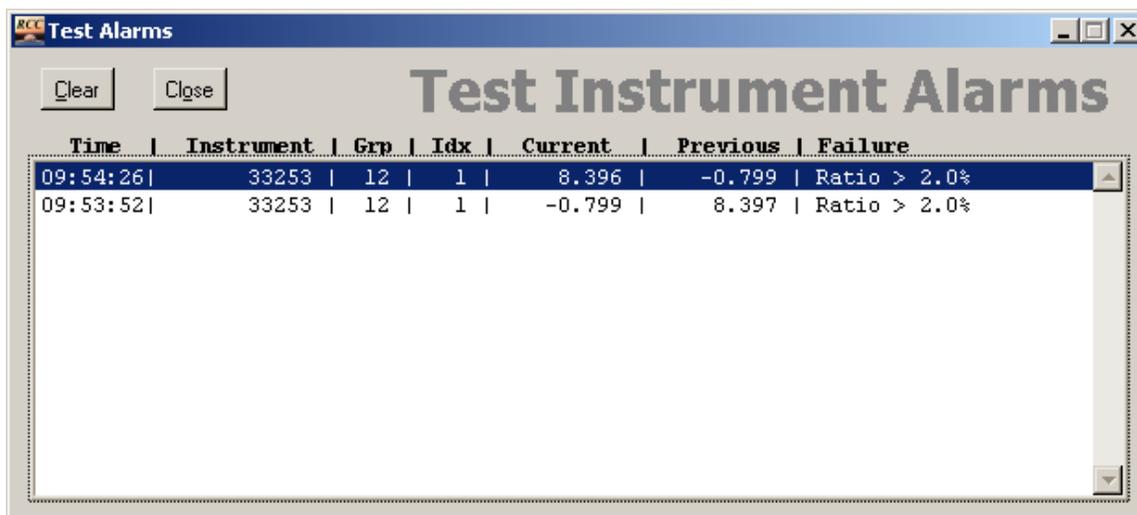
Figure 7-10. BORCAL-SW Reference Alarms window

The window above shows the time of the alarm, the two instruments and values involved, and the test that caused the alarm.

Reference alarms can be triggered by several tests:

- Multiple reference: If more than one ACR or more than one diffuse reference instruments are deployed, simultaneous readings from each instrument must be within the bounds specified in the system configuration. The failure is described with the threshold ratio.
- Cavity stability: If the ACR stability score exceeds the threshold in the system configuration, the ACR will be listed under Instrument 1 (with no value), and the Cavity Stability notation will be listed under Instrument 2 with the actual ratio as the Instrument 2 value. The failure is described with the threshold ratio.

7.2.3.2 Test Instrument Alarms



Time	Instrument	Grp	Idx	Current	Previous	Failure
09:54:26	33253	12	1	8.396	-0.799	Ratio > 2.0%
09:53:52	33253	12	1	-0.799	8.397	Ratio > 2.0%

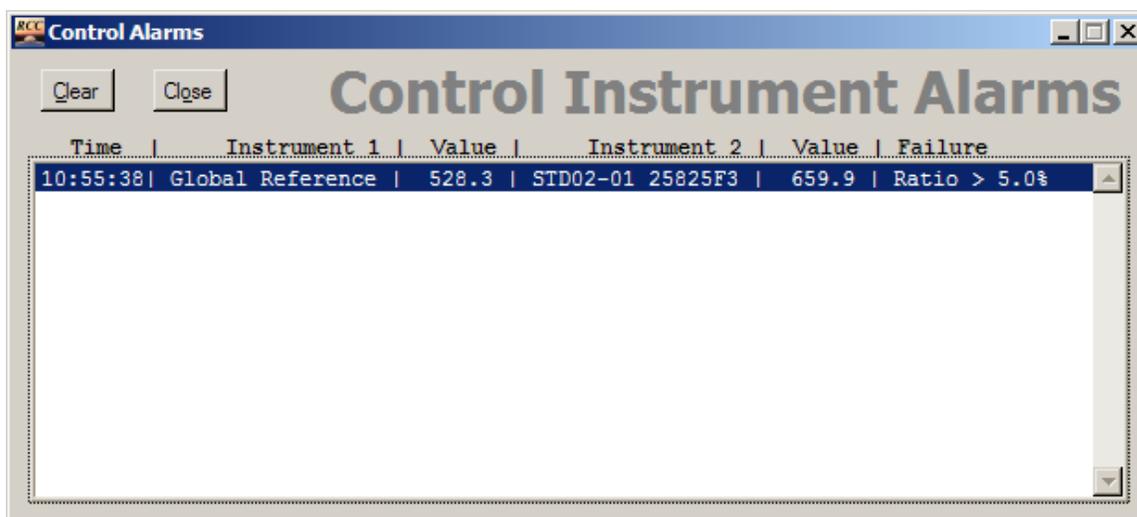
Figure 7-11. BORCAL-SW Test Instrument Alarms window

Test instrument alarms are generated when the ratio between the adjacent responsivity results for an instrument differs by a value greater than the threshold set in the system configuration. When this occurs, the time of the event is listed along with the serial number of the instrument, its scan group and index, and the two readings (current and previous) that triggered the alarm. The failure is described with the threshold ratio.

7.2.3.3 Meteorological Instrument Alarms

Meteorological instrument alarms are similar to the Test Instrument Alarms described above.

7.2.3.4 Control Instrument Alarms



Time	Instrument 1	Value	Instrument 2	Value	Failure
10:55:38	Global Reference	528.3	STD02-01 25825F3	659.9	Ratio > 5.0%

Figure 7-12. BORCAL-SW Control Instrument Alarms window

Control instrument alarms are generated when the difference in measured irradiance of a control instrument and the reference irradiance is greater than the threshold specified in the system configuration. When this occurs, Instrument 1 will indicate either the global or direct reference and the value, and Instrument 2 will show the control instrument affected (listed as a standard control instrument, or STD, with its group, index, and serial number) and its irradiance measurement. The failure is described with the threshold ratio.

Frequent control instrument alarms could indicate that the responsivity of the instrument has changed since its designated calibration.

7.2.4 ASR

The atmospheric stability is monitored via the ASR display on the Data Acquisition window. This sliding indicator shows the current ASR score (color-coded) and the relative position of the stability within that score.

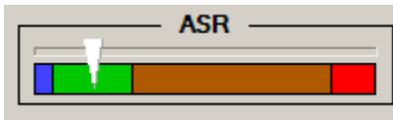


Figure 7-13. ASR score indicator

The display is updated at the rate specified for the Stability Interval in the system configuration.

7.2.5 Scan Groups

Several options to view data are accessible from the Scan Group section.

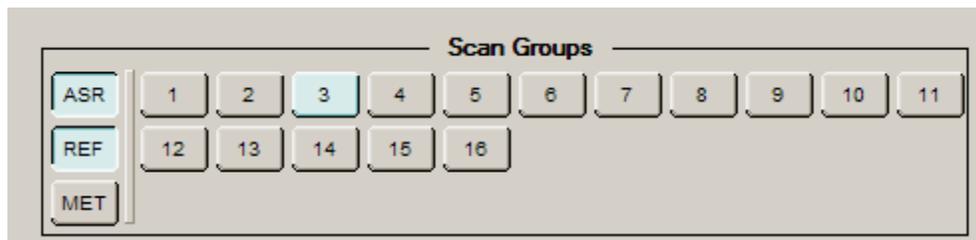


Figure 7-14. BORCAL-SW scan groups buttons

Click on the *Scan Groups* title to display a window that shows a reference list of all groups and the types of instruments in each group, as shown below. The group number in this list corresponds to the numbers shown on the scan group buttons.



Figure 7-15. BORCAL-SW Instrument Types window

7.2.5.1 Scan Buttons

The scan buttons indicate when an instrument group is being scanned by changing from gray to blue. Click on *Scan* of any instrument group to graph data from that group. A graph appears that displays the following information:

- Instrument responsivity (selectable)
- Irradiance (selectable)
- Instrument voltage (millivolts) (selectable)
- ASR conditions
- Alarm conditions.

If the instrument group is configured for ENICR, additional graphs are available:

- Corrected responsivity, irradiance, and voltage (toggle)
- Effective Net Infrared Irradiance for the pyrgeometer and instruments with case thermistors (selectable)
- Pyrgeometer and instrument case temperature (selectable)
- Pyrgeometer and instrument dome temperature (selectable).

Click on the *Scan Groups* title to view the list of instrument types in each scan group. A typical instrument group plot is shown below.

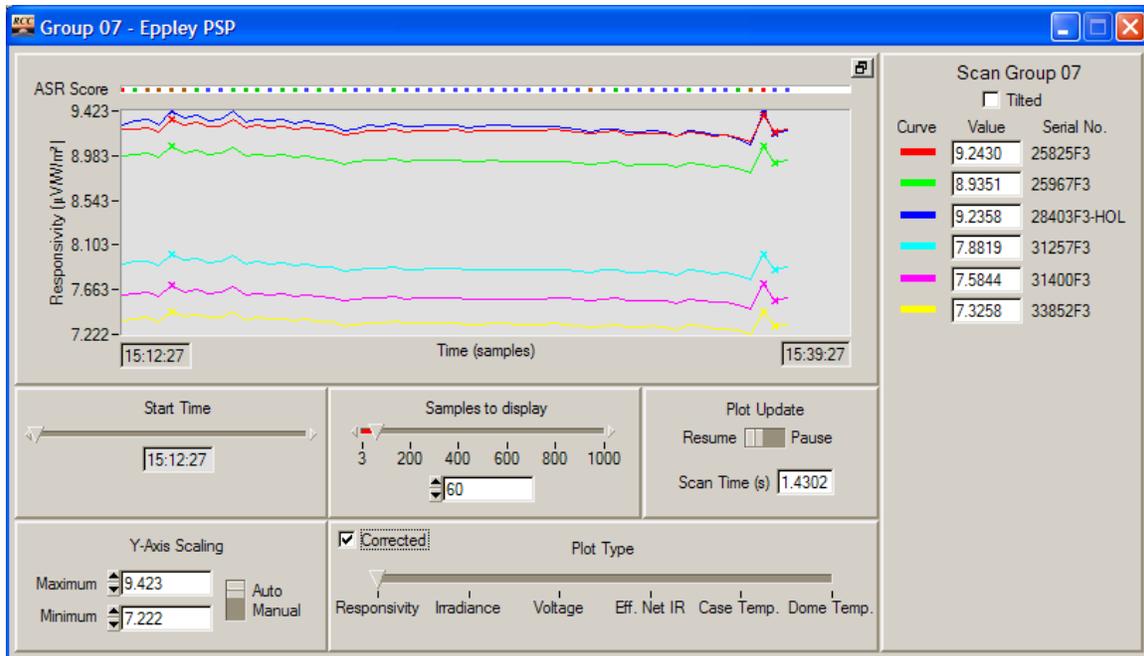


Figure 7-16. BORCAL-SW instrument group plot

The areas of this window are described as follows:

- The group number and instrument type are displayed in the window title bar.
- The plot area shows the history of data acquisition for the selected group. Data from the entire day will be plotted (see scaling options below) unless the BORCAL configuration is modified. In this case, only data since the configuration change will be plotted. If alarm conditions were encountered, the data point is marked by an *X* on the plot in the same color as the trace.
- The instrument key (by trace color) is shown at the right of the window along with the most recent data value for each measurement.
- Select from among the parameters by using the Plot Type selector:
 - Responsivity: shows the current estimated instrument responsivity. (This may differ slightly from the final responsivities because of interpolation of the reference cavity M factor across the session.)
 - Irradiance: plots the reference instrument data (direct beam and diffuse), the calculated global reference irradiance, and the irradiance data from the control instruments if any are included in the scan group.
 - Voltage: plots the output voltage for each instrument. If the group is configured for ENICR, additional selections will be available. Click on the *Corrected* check box to toggle between the display for the corrected and uncorrected values for responsivity and voltage.
 - Effective net infrared: displays the effective net infrared irradiance as measured by the pyrgeometer and instrument case temperatures (if so configured).

- Case temperature and dome temperature: display the pyrgometer and instrument case and dome temperatures, respectively.
- Use the controls for *Y-Axis Scaling*, *Start Time*, and *Samples to Display* to scale and position the plot.
- Pause or restart the plot by using the *Plot Update* control.
- The ASR score for each data acquisition scan is displayed next to the color at the top of the plot.
- If the instrument is configured for a tilt calibration, the Tilted box in the upper right corner is checked.
- Click on the button in the upper right corner of the plot to toggle between the full view (as shown) or a condensed window that shows only the plot. This allows more plots to be viewed on the desktop at the same time.
- Click on the serial number or colored graph key next to the serial number to display a responsivity history plot for any instrument in the scan group plot. This plot is similar to the plots that appear in the BORCAL reports (see figure below). Dismiss the plot by clicking on the *X* in the upper right corner.
- Close the graph by using the standard window close button (*X* in upper right corner of window).

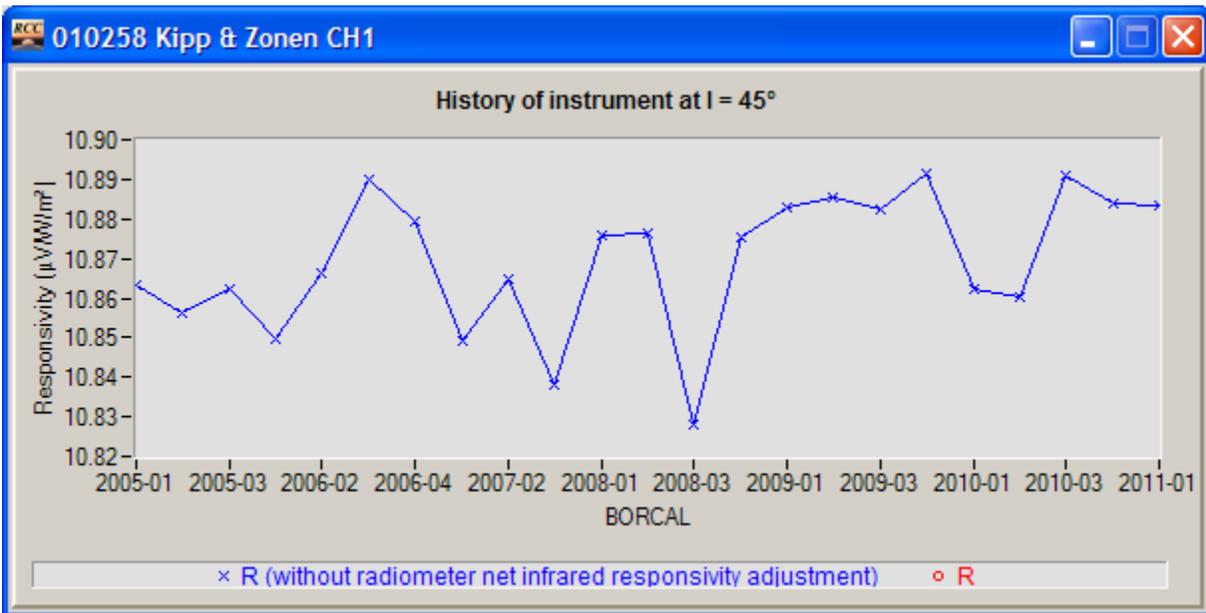


Figure 7-17. BORCAL-SW History of Instrument pop-up window

7.2.5.2 Meteorological Data

Click on *MET* from among the Scan Group buttons to access a plot similar to the scan group test instrument plots. Controls are similar to those described for the scan group, but the Plot Type selector chooses parameters from among Temperature, Humidity, Pressure, and Aerosol Optical Depth.

7.2.5.3 Reference Instruments

In addition to the irradiance plots described in the Scan Group section, the most recent measurements for reference instruments are available from the reference display. Access the display by clicking on *REF* from among the Scan Group buttons. This brings up the window shown below.

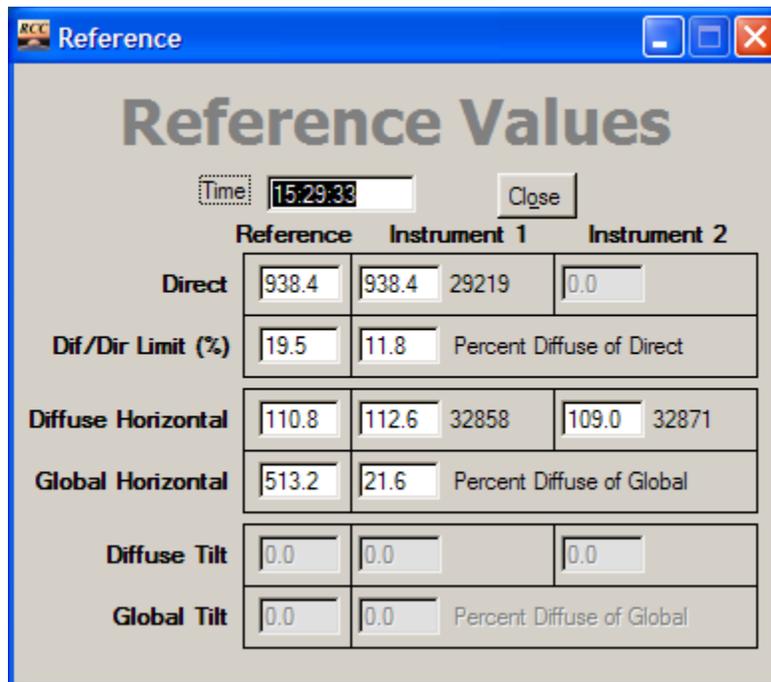


Figure 7-18. BORCAL-SW Reference Values window

This window shows the following information. (When more than one reference instrument of each type is in use, the individual instruments are listed under the appropriate instrument column.)

- Time: time of the most recent measurement by the reference instruments.
- Direct: direct normal (ACR) reading. (When more than one reference instrument of each type is deployed, as shown with the diffuse in the example above, the individual instruments are listed under the appropriate instrument column. The average of the two instruments is shown in the Reference column.)
- Diffuse/direct limit (percent): current calculated ratio limit (left) and actual ratio (right). The calculated limit is based on the Diffuse/Direct Maximum Limit as specified in the system configuration and the current zenith angle. See discussion of *Max Diffuse/Direct* in Section 6.7.3 on System Configuration.
- Diffuse horizontal: reference diffuse horizontal measurement
- Global horizontal: calculated global horizontal irradiance using the direct and diffuse horizontal reference measurements
- Diffuse tilt: reference diffuse measurement on a tilt (if configured)

- Global horizontal: calculated global irradiance on a tilt using the direct and diffuse tilt reference measurements
- Percent diffuse of global: ratio of diffuse divided by global.

This information can be helpful when troubleshooting reference alarms.

7.2.5.4 ASR Data

Click on *ASR* from among the Scan Group buttons to monitor the readings from the ASR instruments. A sample plot is shown below.

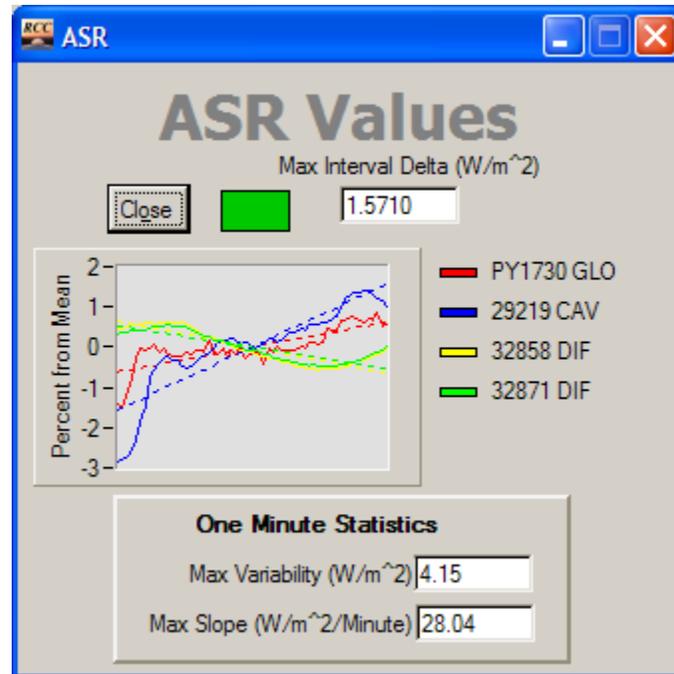


Figure 7-19. ASR Values window

This plot shows the ASR slope and variability readings during 60-second interval. The data in each curve has been normalized to the mean of the respective data sets to allow for uniform plotting. The dotted lines show a least-squares regression line through the respective data sets. The plots display the percent deviation from the mean for each instrument. Plot scaling is automatic and may change abruptly during times of rapidly varying atmospheric stability.

The window also shows the color-coded ASR score at the top. In all cases, the smaller the number, the more stable the solar signal. (The color will be white until an ASR score is determined at the start of a session.) The following values are listed at the bottom of the window:

- Maximum variability: greatest variability among all instruments in the ASR group
- Maximum slope: greatest slope (in $W/m^2/minute$) among all instruments in the ASR group.

7.2.6 Cavity Calibration Schedule

This section displays information on the current and scheduled ACR calibration. It includes the following:

- Previous cavity calibration: shows several cavity parameters at the most recent self-calibration
- Scheduled calibration: shows the time of the next calibration and the calibration interval
- Cavity setup time: shows the setup time(s) for the ACR(s)
- Calibration now: initiates an ACR calibration manually when clicked.

7.2.7 Session Log

The operator can make notes at any point during data acquisition by accessing the Session Log. By clicking on *Session Log*, an editing window appears that includes a record of several current measurements and allows the operator to enter text. A typical log entry screen is shown below.

The screenshot shows the 'Operator Session Log' window with the following fields and data:

- Date: 04-13-2002
- BORCAL: 2002-01
- Session: 8
- Session Start Time: 07:30:20
- Session End Time: 08:33:22
- Operator 1: Steve Wilcox
- Serial Number: 30713 (Cavity 1), 31104 (Cavity 2)
- Setup Time: 5:58 (both)
- Multiplier (beginning): 956.0 (Cavity 1), 955.2 (Cavity 2)
- Multiplier (ending): 955.3 (Cavity 1), 954.8 (Cavity 2)
- Observation Time list: 07:46:40, 07:49:17, 08:11:04
- Selected Observation Time: 07:46:40
- Sky Conditions / Comments: Winds 8-10 m/s from the west. The cavities are tracking each other quite well... staying within a fraction of a watt. Skies are clear; slight cirrus to the north, cumulus still at mountain top level to the west. Cavity 30713 lost a data point. I saw it do this yesterday... not sure what's going on.
- Zenith: 62.66
- ASR: [Blue bar]
- Direct: 891.2
- % Diffuse: 14.4
- Buttons: Cancel, Done

Figure 7-20. Operator Session Log window

If configured, the system will prompt the operator for a log entry at regular intervals (set in the system configuration). When the specified interval has passed, the Session Log button will blink yellow and make a sound to indicate that a log entry should be made.

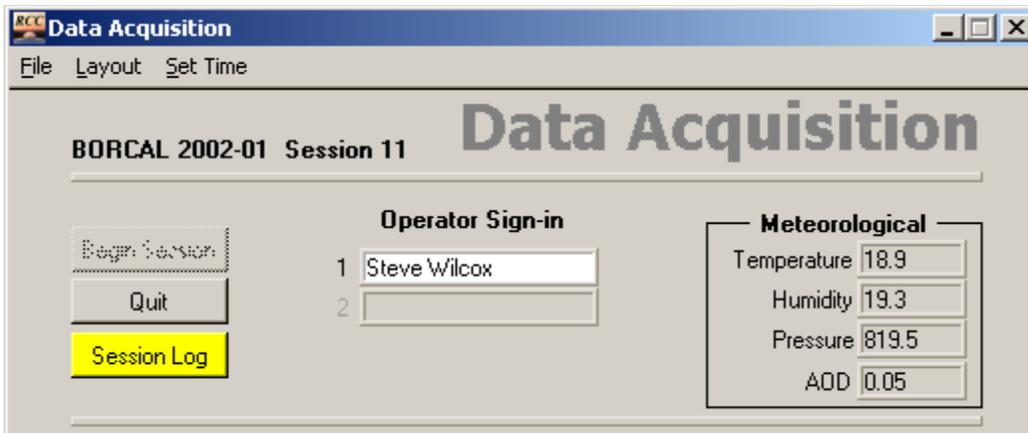


Figure 7-21. BORCAL-SW Data Acquisition window showing the highlighted Session Log button

The interval timer resets when the session log is completed and closed.

Comments entered by the operator in the Session Log will appear in the Final Report (but not in the Customer Reports). Efforts should be made to use correct spelling and grammar and to limit topics and phraseology to those consistent with an official distributed document.

7.2.8 Layout

When an operator has configured a convenient positioning of all plots and displays on the screen, the layout can be saved by accessing the Layout pulldown menu.



Figure 7-22. Selecting a layout for data acquisition

Save the layout by choosing *Save Layout* and giving it a name in the subsequent dialog box. Retrieve a layout by choosing *Get Layout* and selecting the desired layout name from the subsequent dialog box. When a layout is retrieved, the configuration of windows and plots on the screen is restored to that at the time the layout was saved. If the number of windows has changed (for example, because of a differing number of instrument groups from one BORCAL to the next), both nonexistent and surplus windows will be ignored. In such cases, the configuration should be resaved after the desired layout is configured.

7.2.9 Quit

End the data acquisition session by clicking on *End Session* on the Data Acquisition window. Prior to ending the data acquisition, a confirmation message appears as shown below.

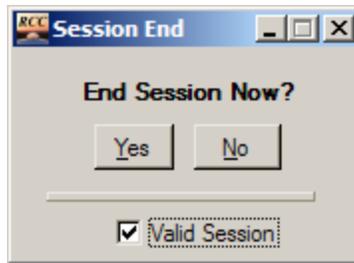


Figure 7-23. End Session Now? window

Designate the session validity by checking the *Valid Session* box. End the session by clicking on *Yes*. To continue with uninterrupted data acquisition, click on *No*.

By indicating an invalid session, no data are lost. The operator may later change the session status by using the session validity editor under the main Edit menu.

If you choose to end the session, the system performs an ACR calibration (and includes the option to select a historical calibration, as described in Section 7.1.3.3 on *ACR Calibration* above). When the ACR calibration is complete, the Data Acquisition window is removed from the screen.

8 BORCAL-LW Data Acquisition

Data acquisition is accomplished by running multiple data acquisition sessions (referred to in this manual as a *session*). This section provides details for running a session.

8.1 Starting a Session

From RCC's main window, select the LW BORCAL type, then select *Acquisition* → *Run Session*. The software performs an automatic check of the system integrity. If a configuration discrepancy is found, an alert appears in a pop-up window, and the operator should correct the problem. The system will not initiate data acquisition if a configuration discrepancy is found.

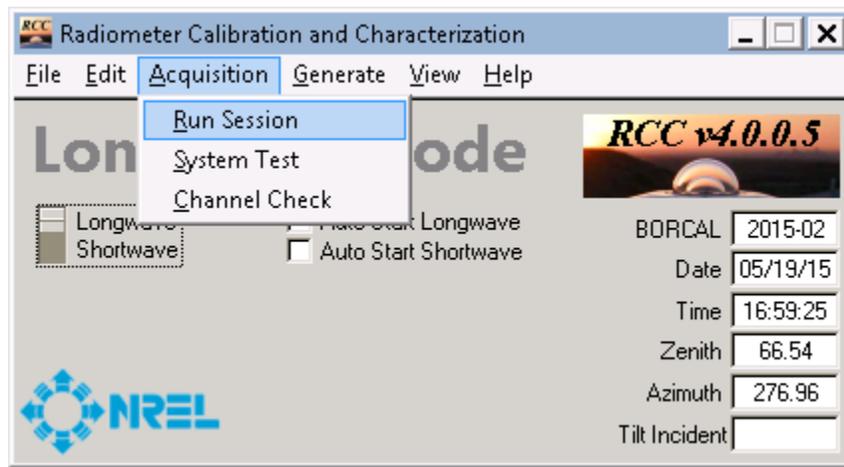


Figure 8-1. Starting a BORCAL-LW session from RCC's main window

If the configuration passes the system integrity check, the Data Acquisition window appears, as shown below.

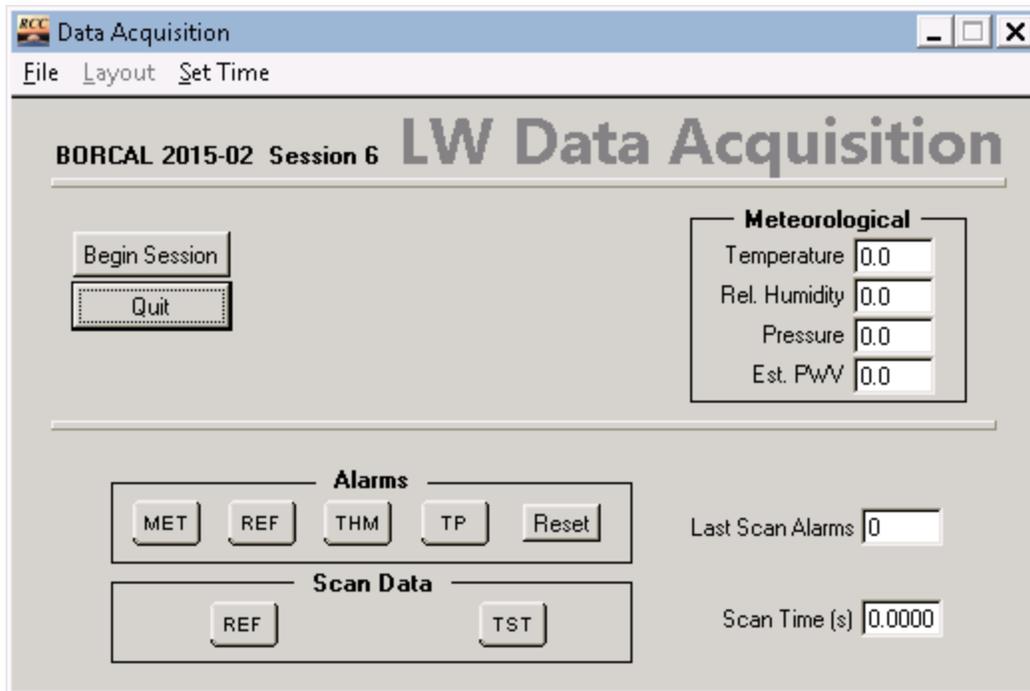


Figure 8-2. BORCAL-LW Data Acquisition window

8.1.1 Start Data Acquisition

Click on *Begin Session* to initiate data acquisition. The following events occur:

- Device initialization
- System time check
- The system begins scanning instruments.

8.1.1.1 Device Initialization

All devices attached to the system are initialized prior to data acquisition. If any of the initializations fail, a message is displayed in an error window.



Figure 8-3. Sample BORCAL-LW device initialization error message

If necessary, check all connections and the communications configuration related to the device.

The GPS unit model 58533A may need several minutes to initialize. If it shows a *Failed* status and the GPS status indicator light is red, RCC will issue a device initialization command. It may take several minutes (less than 10) for the device to respond, during which time the Device Initialization window will show a *Failed* status for the GPS unit. When this occurs, wait several minutes until the GPS indicator light turns green before trying to restart data acquisition. If you attempt to restart data acquisition before the indicator light turns green, the GPS initialization process and wait period restarts. If the light fails to turn green, check all connections and configuration settings, power down, and restart the GPS unit.

8.1.1.2 System Time Check

8.1.1.2.1 System Time Check

Prior to data acquisition, the system attempts to determine the correct time. Depending on the configuration, the time will come from either the system operator or from an attached GPS unit.

The manual time set function does not allow viewing or correcting the date (although this information is visible on RCC's main window). To avoid entering very large correction numbers (that would span days), the operator should use the Windows clock to correct the date if necessary. The GPS time-setting function will also check and set the date.

8.1.1.2.2 Manual Time Check

If no GPS unit is attached, the operator is prompted for a time check by the dialog box shown below.

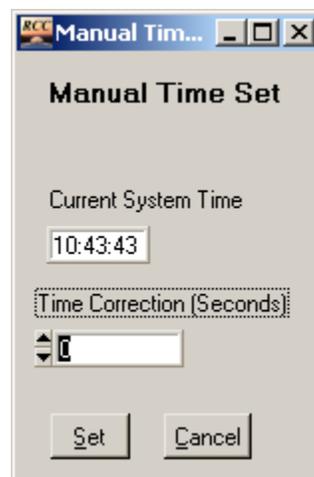


Figure 8-4. Manual Time Set window

The operator should compare the displayed time to a known reference time source and determine if any correction is required. The correction is not entered as conventional time but rather as an offset (in seconds). For example, if the system clock is leading the reference by 3 seconds, a time correction of -3 seconds should be entered. Click on *Set* corrects the time. It is not possible to set the clock to an accuracy of less than 1 second (for example, a .5-second correction).

8.1.1.2.3 Automatic Time Set

If a GPS unit is attached, the system polls the receiver for the correct time. If a time discrepancy is detected, the correction is made automatically without operator intervention (unless the correction exceeds the Clock Correction Threshold specified in the system configuration and the system is not in automatic mode).

8.1.1.2.4 Correction Threshold

If the correction from either the operator or the GPS unit is outside the limits of the Clock Correction Threshold (system setup), the operator will be asked to confirm the correction. This alerts the operator to a potential existing gross error in time and prevents an erroneous correction from being entered.

8.1.1.2.5 On-Demand Clock Setting

The operator can set the clock on demand by accessing the time functions from the *Set Time* pulldown menu. The Automatic and Manual selections work as described above. If no GPS unit is configured, the selection for Automatic time setting is disabled (gray).

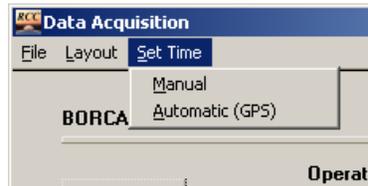


Figure 8-5. Setting the clock

8.1.1.2.6 Clock-Setting Interval

This is the interval for setting the clock (either automatically or manually) set in the system configuration Clock Reset Interval parameter.

8.2 Acquiring Data

The Data Acquisition window is shown below.

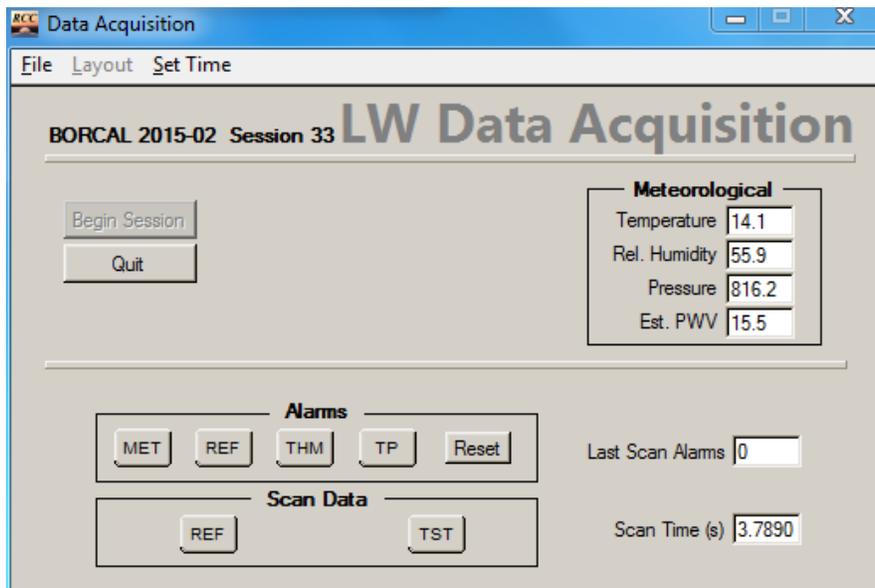


Figure 8-6. Active BORCAL-LW Data Acquisition window

This screen shows the following sections:

- Meteorological
- Alarms
- Scan data.

8.2.1 Meteorological

This section displays the meteorological observations and the estimated PWV. This is updated at the same interval as the test instruments.

8.2.2 Alarms

Alarms, indicated by a button illuminated in red on the window and a periodic audible beep, are triggered by data acquisition discrepancies for any of the following:

- Meteorological instruments
- Reference irradiance
- Thermistor temperature (reference or test)
- Thermopile signal (reference or test).

When an alarm is generated, the cause can be investigated by clicking on the red alarm button. A window appears that lists all alarm instances and describes the condition that triggered the alarm.

Based on the information provided, take the appropriate action to correct the condition. When the error is corrected, click on *Clear* to clear the alarm. Click on *Reset* on the Data Acquisition window to clear the alarms for all instruments. Clearing an alarm removes all entries from the Alarm window and mutes the audible beep.

All information about alarms described in this section is written to alarm files in the BORCAL\DATA_LW\[BORCAL_ID]\ALARMS directory. Formats are the same as those shown in the figure in each section, and the files are named according to the following convention:

AAASSS.YYYY-DD

Where

- SSS is the session number
- YYYY-DD is the BORCAL identification number
- AAA is an alarm type designation according to the table below.

Table 8-1. BORCAL-LW Alarm Type File Name Designations

Designation	Description
_TP	Thermopile signal
REF	Reference irradiance
THM	Thermistor temperature
MET	Meteorological instruments

The alarm windows are described further below.

8.2.2.1 Reference Alarms

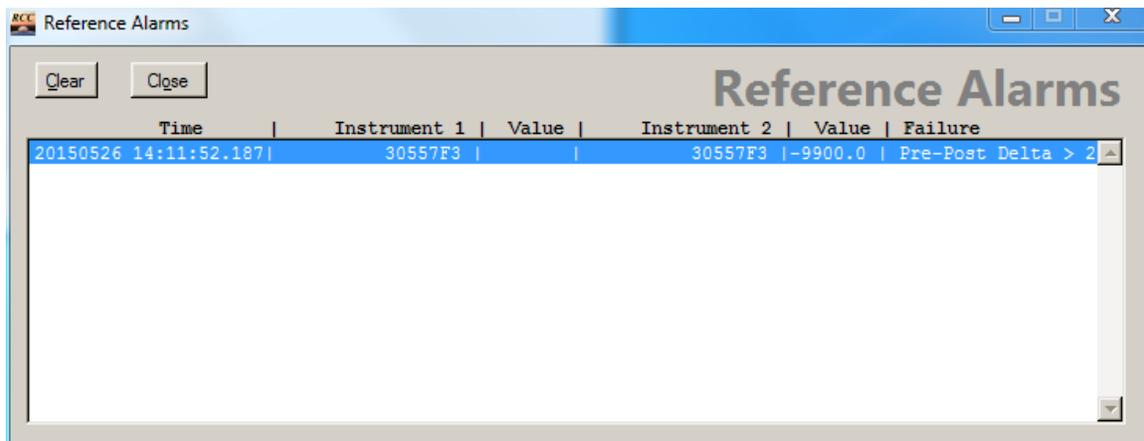


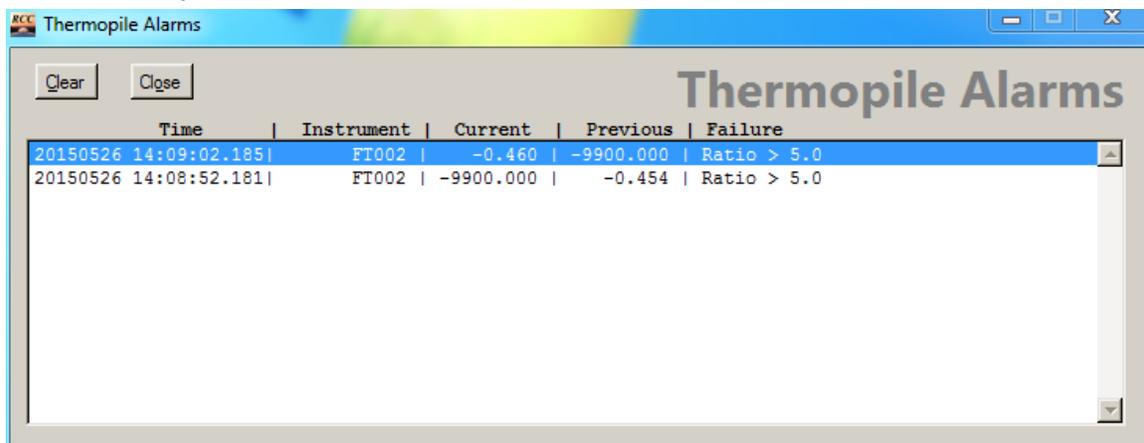
Figure 8-7. BORCAL-LW Reference Alarms window

This window shows the time of the alarm, the two instruments and values involved, and the test that caused the alarm.

Reference alarms can be triggered by several tests:

- Multiple reference: If more than one reference pyrheliometer is in use, simultaneous readings from each instrument must be within the bounds specified in the system configuration. If not, the time of the event is listed along with the serial number of the instrument and the two readings that triggered the alarm. The failure is described with the threshold ratio.
- Reference stability: Reference irradiance is measured before and after measuring test instruments. If this delta exceeds the threshold in the system configuration, the time of the event is listed along with the serial number of the instrument and the difference between the two pre and post readings that triggered the alarm. The failure is described with the threshold ratio.

8.2.2.2 Thermopile Alarms

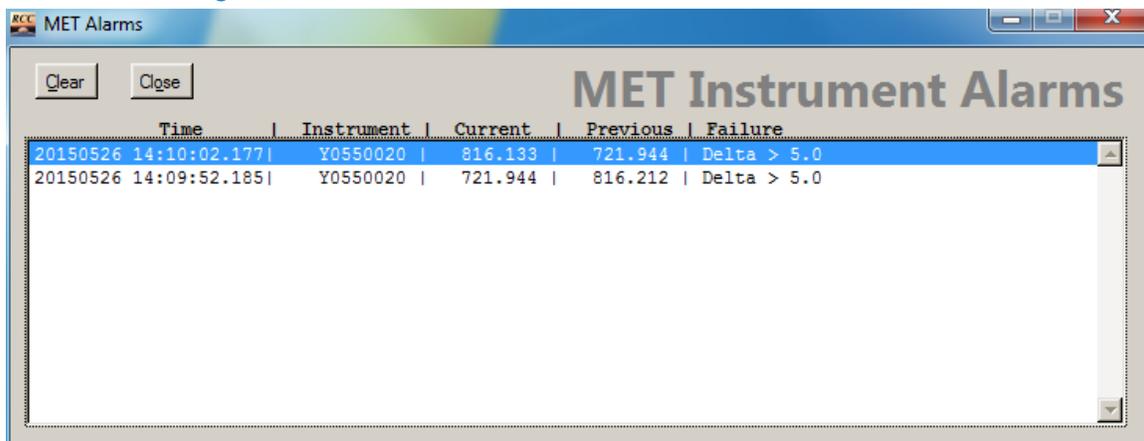


Time	Instrument	Current	Previous	Failure
20150526 14:09:02.185	FT002	-0.460	-9900.000	Ratio > 5.0
20150526 14:08:52.181	FT002	-9900.000	-0.454	Ratio > 5.0

Figure 8-8. BORCAL-LW Thermopile Alarms window

Thermopile alarms (both test and reference) are generated when the ratio between the adjacent responsivity results for an instrument differs by a value greater than the threshold set in the system configuration. When this occurs, the time of the event is listed along with the serial number of the instrument and the two readings (current and previous) that triggered the alarm. The failure is described with the threshold ratio.

8.2.2.3 Meteorological Instrument Alarms



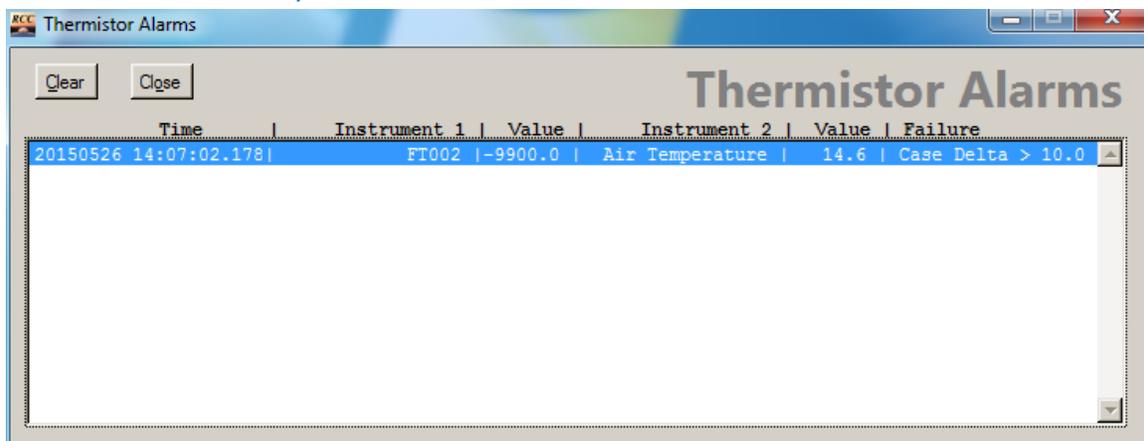
The screenshot shows a window titled "MET Alarms" with a "Clear" and "Close" button. The main area contains a table with the following data:

Time	Instrument	Current	Previous	Failure
20150526 14:10:02.177	Y0550020	816.133	721.944	Delta > 5.0
20150526 14:09:52.185	Y0550020	721.944	816.212	Delta > 5.0

Figure 8-9. BORCAL-LW Meteorological Alarms window

Meteorological instrument alarms are similar to the Test Instrument Alarms described above.

8.2.2.4 Thermistor Temperature Alarms



The screenshot shows a window titled "Thermistor Alarms" with a "Clear" and "Close" button. The main area contains a table with the following data:

Time	Instrument 1	Value	Instrument 2	Value	Failure
20150526 14:07:02.178	FT002	-9900.0	Air Temperature	14.6	Case Delta > 10.0

Figure 8-10. BORCAL-LW Thermistor Alarms window

All instrument case and dome temperatures are compared to ambient air temperature. Thermistor temperature alarms (both test and reference) are generated when the difference in thermistor temperature and air temperature is greater than the threshold specified in the system configuration. When this occurs, Instrument 1 will indicate the serial number of the instrument and the value, and Instrument 2 will show the air temperature. The failure is described with the threshold ratio.

8.2.3 Scan Data

Two options to view data are accessible from the Scan Data section.



Figure 8-11. BORCAL-LW Scan Data buttons

Click on *TST* to graph data from all instruments. A graph appears that displays the following information:

- Reference irradiance (selectable)
- Instrument voltage (millivolts) (selectable)
- Reference and test instrument case temperature with air temperature (selectable)
- Reference and test instrument dome temperature with air temperature (selectable)
- Relative humidity (selectable)
- Pressure (selectable).

A typical instrument plot is shown below. (Case temperature is selected.)

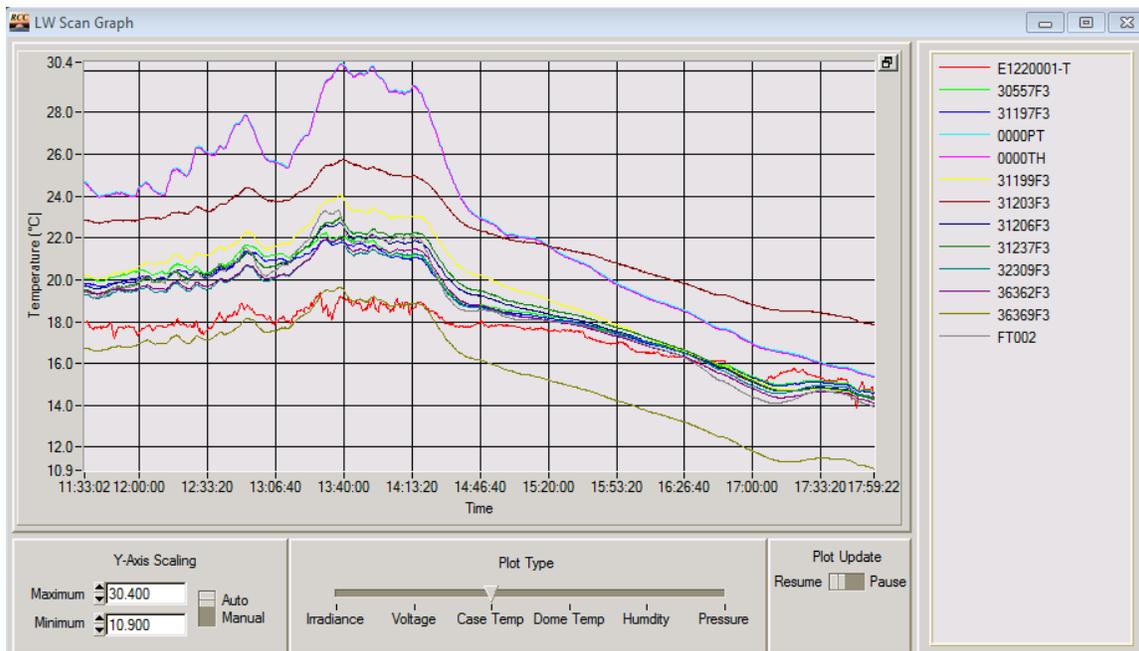


Figure 8-12. BORCAL-LW Scan Graph window

Each area of the window is described below:

- The plot shows the history of data acquisition for the selected group. Data from the entire session will be plotted (see scaling options below) unless the session is interrupted. In this case, only data during the current session will be plotted.
- The instrument key (by trace color) is shown at the right of the window.

- Select from among the parameters by using the Plot Type selector.
 - Irradiance: plots the reference instrument data
 - Voltage: plots the output voltage for each instrument including the reference
 - Case temperature and dome temperature: display the case and dome temperatures, respectively, for all instruments. The air temperature is included for comparison.
 - Humidity and pressure: display the metrological data from those sensors.
- Use the controls for *Y-Axis Scaling*, *Start Time*, and *Samples to Display* to scale and position the plot.
- Pause or restart the plot using the *Plot Update* control.
- Click on the button in the upper right corner of the plot allows the window size to be toggled between full view (as shown) or a condensed window showing only the plot. This allows more plots to be viewed on the desktop at the same time.
- Right-click on the items in the legend to change attributes of each curve (such as visibility, color, line type).
- Close the graph by using the standard window close button (X in upper right corner of window).

In addition to the irradiance plots described in the Scan Group section, the most recent measurements for reference instruments are available from the reference display. Access the display by clicking on *REF* from among the Scan Group buttons. This brings up the display shown below.

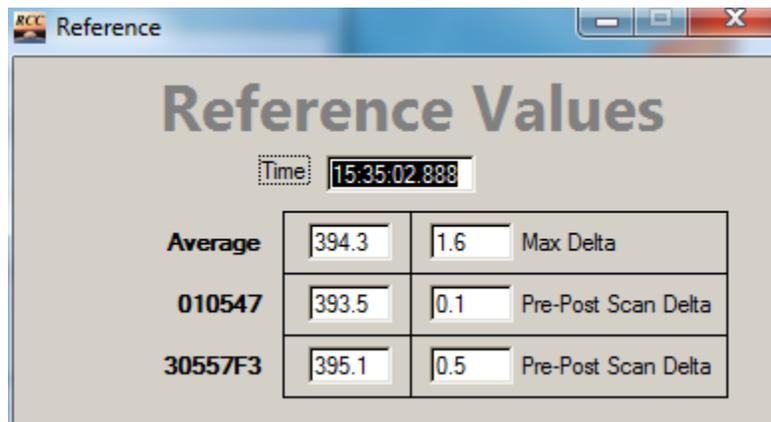


Figure 8-13. BORCAL-LW Reference Values window

This shows the following information. (When more than one reference instrument of each type is in use, the individual instruments are listed under the appropriate instrument column.)

- Time of the most recent measurement by the reference instruments
- Average irradiance of all reference instruments followed by the maximum difference observed between any references. Both in W/m^2 .

- Irradiance of the first reference instrument followed by the difference between the pre and post scan of that reference. (This is then repeated for any additional references that are configured.) Both in W/m^2 .

This information can be helpful when troubleshooting reference alarms.

8.2.4 Quit

End the data acquisition session by clicking on *Quit* on the Data Acquisition window. Prior to ending the data acquisition, a confirmation message appears, which is shown below.

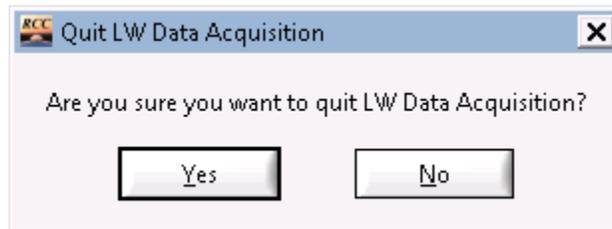


Figure 8-14. BORCAL-LW Quit Data Acquisition confirmation message

9 Data Collection Automatic Start and Shutdown

RCC version 4.0 supports data collection automatic start-up and shutdown. Because there are two BORCAL types (LW and SW) and there is the nighttime requirement for LW, which is usually unattended, the preferred RCC data collection mode is automatic; however, manual start-up (as discussed in previous sections) is still supported.

The zenith angles at which the LW and SW events begin and finish are configured in the system configuration screen of each LW and SW event. These zenith angles are already configured and will be copied when the user creates a new event. These values should not be changed unless instructed to do so by the BORCAL technical manager or deputy.

Data collection for the SW and LW events can be started (or stopped) manually; however, under all conditions (automatic or manual), the event will stop at the configured zenith angle (typically just before sunset for SW and just before sunrise for LW). In addition, if the user attempts to manually start a SW or LW event at the wrong zenith angle, the software may immediately terminate the data collection. For example, if you start a SW event between sunset and midnight, the software will automatically terminate it; and if you start a LW event between sunrise and solar noon, the software will automatically terminate it. Also, the software will not allow SW and LW to collect data simultaneously (automatic or manual).

For automatic start-up, the user must enable this feature the first time RCC is launched (or after making configuration changes or data processing); it is not enabled by default. This is enabled by placing a check mark next to the box for *Auto Start Longwave* and/or *Auto Start Shortwave* on RCC's main window.

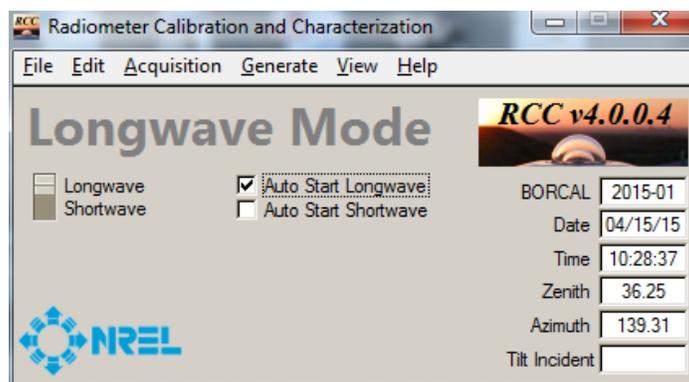


Figure 9-1. Enabling automatic start on RCC's main window

The position of the LW/SW mode switch (on the far left) does not matter; the software will automatically change it at the appropriate zenith angle.

It is important to ensure that the automatic start is enabled if you expect the software to automatically start data collection; therefore, ensure that it is checked daily or after any of the following events take place:

- RCC is restarted

- Computer is restarted
- A user makes any selections in the menu (such as configuration, shade/unshade, database modifications, exporting, data processing, report generation)
- The software encounters an irrecoverable error during data acquisition (such as a problem with the data collection hardware)
- The operator did not validate all instruments and sensors during the shade/unshade (also known as a light/dark) test.

If the user manually stops data collection after it has started automatically, the software will restart data collection (if you are still in the valid zenith angle range). Therefore, if you must stop data collection, first uncheck the *Auto Start Longwave* and/or *Auto Start Shortwave* from the main window, then stop the data collection from the Data Acquisition window.

Conditions under which an automatic start or manual start can occur:

- Automatic SW launch will occur only from sunrise⁷ to solar noon
- Automatic LW launch will occur only from sunset⁷ to midnight
- Manual SW launch is permitted only from midnight to sunset⁷ (and no data collection is currently running)
- Manual LW launch is permitted only from solar noon to sunrise⁷ (and no data collection is currently running).

For example, based on the conditions above, if SW data collection is not currently running and the user needs to launch it after solar noon, they must manually start it first, and then enable the *Auto Start Shortwave* check box after data acquisition has started. If the user were to simply enable the check box (without manually starting data acquisition first), the software would wait until the next day to automatically launch the SW data acquisition.

⁷ The zenith angle for sunrise and sunset are defined in the SW and LW system configuration.

10 Database Editing Tools

Use the tools described in this section to view, change, or add information to the data tables or system parameters.

Some tables contain system-generated information that can be viewed but not edited. In general, you can edit only operator-generated information in tables. Event configuration edits must be accessed through the BORCAL configuration process.

10.1 Overview

10.1.1 Field Colors

The color of a field indicates its status (see Table 10-1). Blue and yellow fields must contain information (i.e., they are mandatory fields). White fields contain optional information (i.e., information that is not necessary to complete system tasks).

Table 10-1. Color-Coding as Related to Field Status

	Mandatory Fields	Optional Fields
Related (may not be edited)	Blue	
Nonrelated (editable)	Yellow	White

Blue fields indicate that the field contents are obtained from values in other system tables (related tables); they may not be directly edited.

Yellow fields indicate that the field contents do not relate to values in other system tables; you can directly enter or edit these fields.

White fields indicate optional information; you can edit these fields.

10.1.2 Valid Ranges

Many fields have an error-checking feature to validate the range entries. If you enter a value outside of the valid range, the field acquires a red border when you click on *Accept*. In addition, a pop-up menu appears that indicates the acceptable ranges for the field; enter a value within this range, and click on *Accept*.

10.2 Database Maintenance

The RCC database holds information about instruments, customers, and the BORCAL configuration. In addition, the database contains certain information that is created by the system, such as data acquisition records and calibration results. As a general rule, those sections can be viewed, but they are not editable by the system operators.

All data tables have a field for comments in each record. These allow the operator to enter free-form text to document any aspect of the BORCAL event or make specific instrument notes. The comments from most tables will appear in the Final Report and the Customer Report; hence, efforts should be made to use correct spelling and grammar (RCC does not have a spell-checker) and limit topics and phraseology to those consistent with an official distributed document.

10.2.1 Editing Overview

Select *Edit*→*Data Base* from the main window.

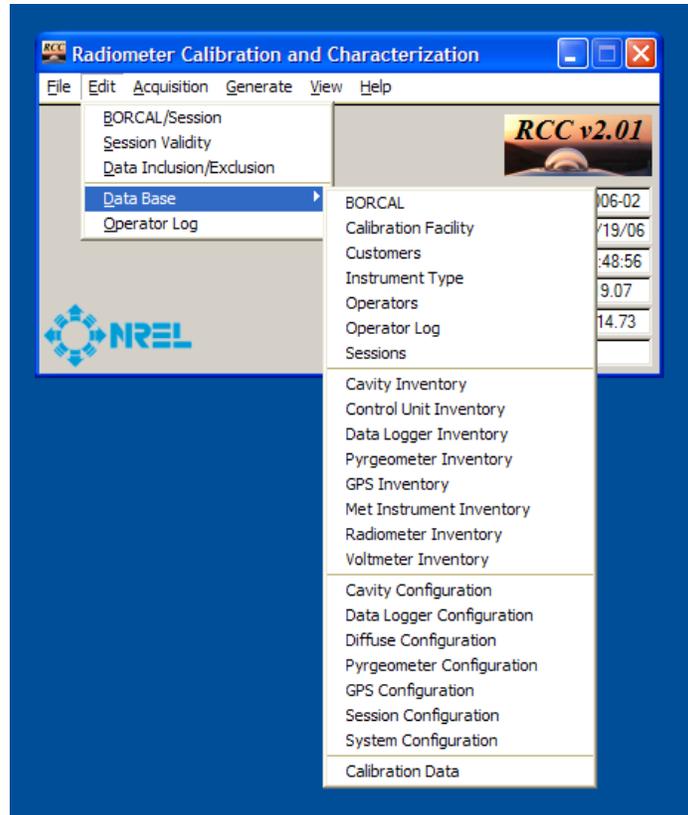


Figure 10-1. Database maintenance menu selections

From the pull-down menu, select the specific table. The Database Maintenance window for the selected table appears. (The available tables in the menu will change depending on what BORCAL type is selected [SW or LW]. Only tables that pertain to the BORCAL type will be shown.) As an example, the window for the Instrument Type table maintenance is shown below.

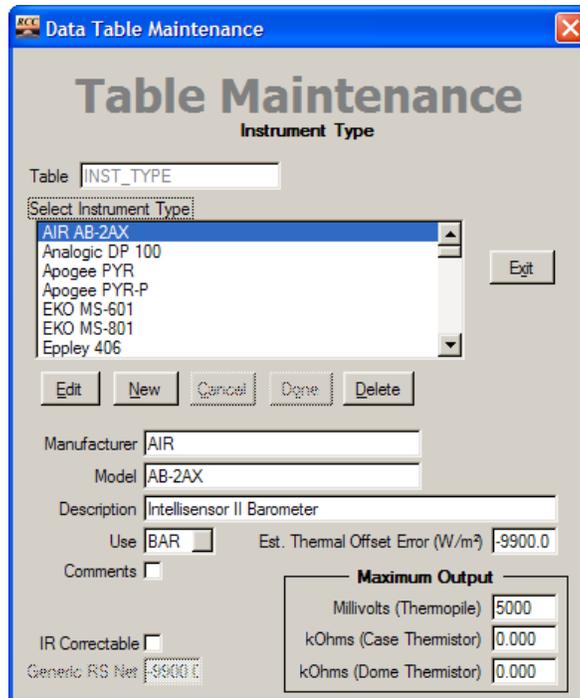


Figure 10-2. Example Table Maintenance window

The Table Maintenance window shows the table name at the top under the title. The window lists all records in a given table, which are accessible by scrolling to locate a record. Click on the record entry to display its information. The window contains the following options:

- Edit
- New
- Delete
- Exit
- Cancel (Edit and New modes only)
- Done (Edit and New modes only).

10.2.1.1 Edit, New, Done, and Cancel

Select *Edit* to change one or more values in the displayed fields or *New* to add a record. When either *Edit* or *New* is selected, the window appearance changes to allow you to enter new fields in a record or edit the existing fields. The color coding of the fields is described below:

- Yellow fields: type information (such as the instrument’s serial number) directly into the field.
- Blue fields: click on the field to obtain a list of valid entries; select the appropriate item for the field from the list.
- White fields: this is optional.

In addition, the *Done* and *Cancel* buttons on the window are enabled. Not all fields are editable (generally, those generated by the system are not), and in such cases the editing capabilities of the field will be locked and will not respond to editing.

To exit either the Edit or New modes, do one of the following:

- Select *Done* to save the information. If all values are acceptable (pass validity checks), the system saves the changes and the record appears highlighted on the onscreen list.
- Select *Cancel* to exit the Edit mode without saving the information.

10.2.1.2 Delete

The *Delete* function allows you to remove a record from the data table. In cases when a record is related to another part of the database, removing a record will be blocked. For example, if you attempt to remove an instrument type record that is referred to by one or more records in the instrument inventory, the action will not be allowed. This is because all instruments must have an Instrument Type designation, and allowing the removal of an in-use instrument type would leave some instruments without a value in a mandatory field.

10.2.2 Data Table Overview

The following table lists and briefly describes all tables in the RCC database.

Table 10-2. RCC Database Tables

Table Name	Description
BORCAL	Top-level information about each BORCAL-SW (date, report status, meteorological means)
BORCAL_IR	Top-level information about each BORCAL-LW (date, report status)
CALDAT	BORCAL-SW calibration results (responsivities, uncertainties, validity)
CALDAT_IR	BORCAL-LW calibration results (coefficients, uncertainties, validity)
CAVCFG	ACR configuration parameters (WRR numbers, uncertainty, electrical characteristics,
CAV_INV	Cavity instrument inventory (calibration parameters and calibration dates)
CON_INV	Cavity control unit inventory (operating parameters and calibration dates)
CUSTOMER	Customer names and contact information
DIFCFG	Diffuse reference instrument configuration (responsivities, calibration dates, shading disk geometry)
DVM_INV	Digital voltmeter inventory
FACILITY	Calibration facility name and geographic and environmental information
GPSCFG	SW GPS configuration parameters (communications parameters)
GPSCFG_IR	LW GPS configuration parameters (communications parameters)

Table Name	Description
GPS_INV	GPS inventory
INST_TYPE	Instrument type definitions (manufacturer, model, output voltage, and RCC deployment type)
LOGCFG	SW data logger configuration parameters (calibration due dates, communications parameters)
LOGCFG_IR	LW data logger configuration parameters (calibration due dates, communications parameters)
LOGGER_INV	Data logger inventory (type and calibration dates)
MET_INV	Meteorological instrument inventory for temperature, humidity and pressure probes (offset and scale parameters)
OPERATOR	SW operator names
OPERATOR_LOG	SW operator log-in information (time and date for log in and log out)
PYG_CFG	Configuration parameters for each reference pyrgeometer included in the BORCAL-SW (configuration information, instrument identification number, calibration data)
PYG_CFG_IR	Configuration parameters for each reference pyrgeometer included in the BORCAL-LW (configuration information, instrument identification number, calibration data)
PYG_INV	Inventory of reference pyrgeometers (instrument type, calibration data)
RAD_INV	Radiometer inventory (instrument type, current customer, current valid BORCAL for responsivity)
SESSION	SW session information (start and end times, configuration pointers, software version stamp)
SESSION_IR	LW session information (start and end times, configuration pointers, software version stamp)
SESS_CONFIG	SW configuration parameters for each instrument (deployment, tilt, grouping, location, channel/cabling, thermistor parameters)
SESS_CONFIG_IR	LW configuration parameters for each instrument (deployment, tilt, grouping, location, channel/cabling, thermistor parameters)
SYSTEM	SW system configuration parameters (error thresholds, scan rates, tilt parameters)
SYSTEM_IR	LW system configuration parameters (error thresholds, scan rates, tilt parameters)

Each data table is fully described in the following sections. Only fields indicated with a check mark (✓) are editable.

10.2.3 BORCAL-SW Table

Data Table Maintenance

Table Maintenance

BORCAL

Table:

Select BORCAL

- 1997-01
- 1997-02
- 1997-03
- 1997-04
- 1997-05
- 1998-01
- 1998-02

BORCAL:

Facility:

Start Date: End Date:

Comments:

Responsivity Generation Date/Time:

Report Generation Date/Time:

Report Cover Date:

Mean Values

Temperature (C)	<input type="text" value="15.1"/>
Humidity (%)	<input type="text" value="33.3"/>
Pressure (mbr)	<input type="text" value="9900.0"/>
Turbidity	<input type="text" value="0.078"/>

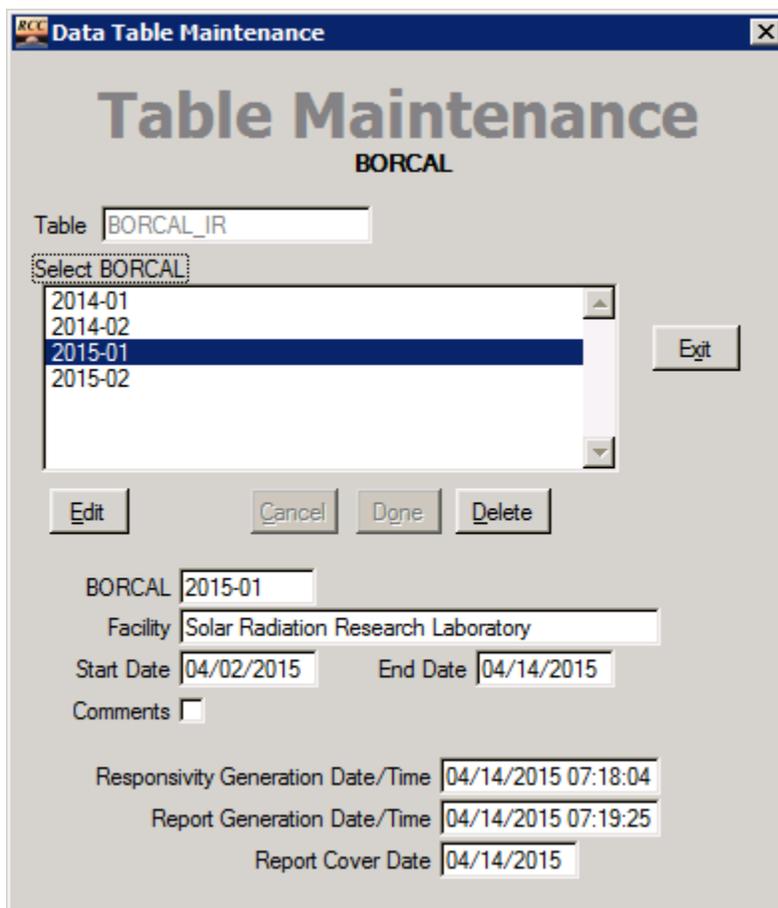
Figure 10-3. BORCAL Table Maintenance window

Table 10-3. BORCAL Table Fields

Field	Editable	Description
Select BORCAL		Click on the desired BORCAL, and the remaining fields will be filled in from the selected data record.
BORCAL		BORCAL designation
Facility		Calibration facility
Start/End Date		First and last day of data acquisition (determined by all valid sessions)
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.
Responsivity Generation Date/Time		Date and time that the responsivities for the BORCAL were generated
Report Generation Date/Time		Date and time that the full report for the BORCAL was generated (It will always be later than the responsivity generation time.)
Report Cover Date		Date entered by the user during report generation
Temperature, Humidity, Pressure, Humidity		Mean values of the observations from all valid sessions

√ Indicates editable field

10.2.4 BORCAL-LW Table



Data Table Maintenance

Table Maintenance

BORCAL

Table

Select BORCAL

- 2014-01
- 2014-02
- 2015-01**
- 2015-02

BORCAL

Facility

Start Date End Date

Comments

Responsivity Generation Date/Time

Report Generation Date/Time

Report Cover Date

Figure 10-4. BORCAL_IR Table Maintenance window

Table 10-4. BORCAL_IR Table Fields

Field	Editable	Description
Select BORCAL		Click on the desired BORCAL, and the remaining fields will be filled in from the selected data record.
BORCAL		BORCAL designation
Facility		Calibration facility
Start/End Date		First and last day of data acquisition (determined by all valid sessions)
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.
Responsivity Generation Date/Time		Date and time that the coefficients for the BORCAL were generated.
Report Generation Date/Time		Date and time that the full report for the BORCAL was generated (It will always be later than the responsivity generation time.)
Report Cover Date		Date entered by the user during report generation

√ Indicates editable field

10.2.5 BORCAL-SW Calibration Data Table

Table Maintenance
Instrument Calibration Data

Table: CALDAT

Select Instrument:

- 2010-03 18621 Eppley 8-48
- 2010-03 19047E6 Eppley NIP
- 2010-03 19792E6 Eppley NIP
- 2010-03 2163 Schenk Star
- 2010-03 24191F3 Eppley PSP
- 2010-03 25825F3 Eppley PSP
- 2010-03 25954F3 Eppley PSP

Buttons: Edit, Cancel, Done, Exit

BORCAL: 2010-03 Validity: Marginal ASR Filter: Green Use: TOT Tilt: 0.0 Azimuth: 0.0 Comments: Corrected:

Serial Number: 25825F3
Manufacturer: Eppley
Model: PSP

Calibration Label Values

R @ 45°: 9.184
Uncorrected R @ 45°: 9.017
Rnet: 0.720
Rnet Date: 02/28/2006

Responsivity Bins / Coefficients

2 Degree
Latitude-Optimized
Function Coefficients

	Spline Responsivity		R@45°	
	Fit	Function		
Type-A, u(int)	0.17	0.21	N	13
Type-B, u(B)	0.61	0.61	Type-B, U(B) ±	0.99
Combined, u(c)	0.63	0.64	Offset, U(off) +	2.36
Expanded U95	1.23	1.26	Expanded, U +	3.35
Degrees of Freedom, DF(c)	229203.03	91831.46	DF	+Inf
Coverage factor, k	1.96	1.96	k	1.96

	Minimum	Maximum
	All Data AM	20.4
All Data PM	20.4	61.7
Fit/Function AM	22	72
Fit/Function PM	22	62
R@45°	50.0	72.0

Figure 10-5. CALDAT Table Maintenance window

The figure above shows the data layout for a pyranometer. The layouts for pyrhemimeters and shaded pyranometers differ slightly. (Some fields or buttons are grayed out, and some labels have different text.)

Table 10-5. CALDAT Table Fields

Field	Editable	Description
Select Instrument		Click on the desired BORCAL/instrument, and the remaining fields will be filled in from the selected data record
BORCAL		BORCAL designation
Validity	√	Calibration validity flag (valid, marginal, invalid)
ASR Filter		ASR filter designation used when the calibration results were calculated
Use		RCC calibration type: TOT (global), DIR (direct), or DIF (diffuse)
Tilt		Calibration tilt
Azimuth		Calibration azimuth
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.
Corrected		Indicates if the instrument was configured for an ENICR
Serial Number, Manufacturer, Model		Instrument serial number, manufacturer, and model
Responsivity Function Coefficients (button access)		Displays a table of coefficients for the responsivity function (plottable—see <i>Responsivity Function Plotting</i> below)
2-Degree Responsivities (button access)		Displays a table of the 2-degree responsivity data points (plottable—see <i>Responsivity Function Plotting</i> below)
Latitude-Optimized Responsivities (button access)		Displays table of latitude-optimized responsivities
Calibration Label Values		Responsivity at 45-degrees, uncorrected responsivity at 45-degrees (only appears for uncorrected instruments), Rnet (the instrument's response to net IR), and the Rnet calibration date
Uncertainties		All uncertainty values associated with the spline fit, responsivity function, and the R at 45 degrees
Valid Incident Angle Ranges		Minimum and maximum a.m. and p.m. zenith angles, applicable to the fit/function and the R at 45 degrees, as well as the range of all data collected

√ Indicates editable field

The instrument records will not appear in the database until the calibration results have been generated. If the calibration results for the instrument are not valid, missing values (–9900) will appear in the fields, and the plots will be blank.

RCC will also plot the spline fit or responsivity function overlaid with the two-degree bin data points used to derive the function. To access the plot, click either the *2-Degree Responsivities* or *Responsivity Function Coefficients* from the Instrument Calibration Data Table Maintenance window. This brings up the corresponding tabular data. At the bottom of the table display, click on *Plot*, which will display a plot of the responsivity function and the two-degree bin data points. A slider switch appears in the lower right corner to allow you to toggle between the spline fit and the responsivity function plots.

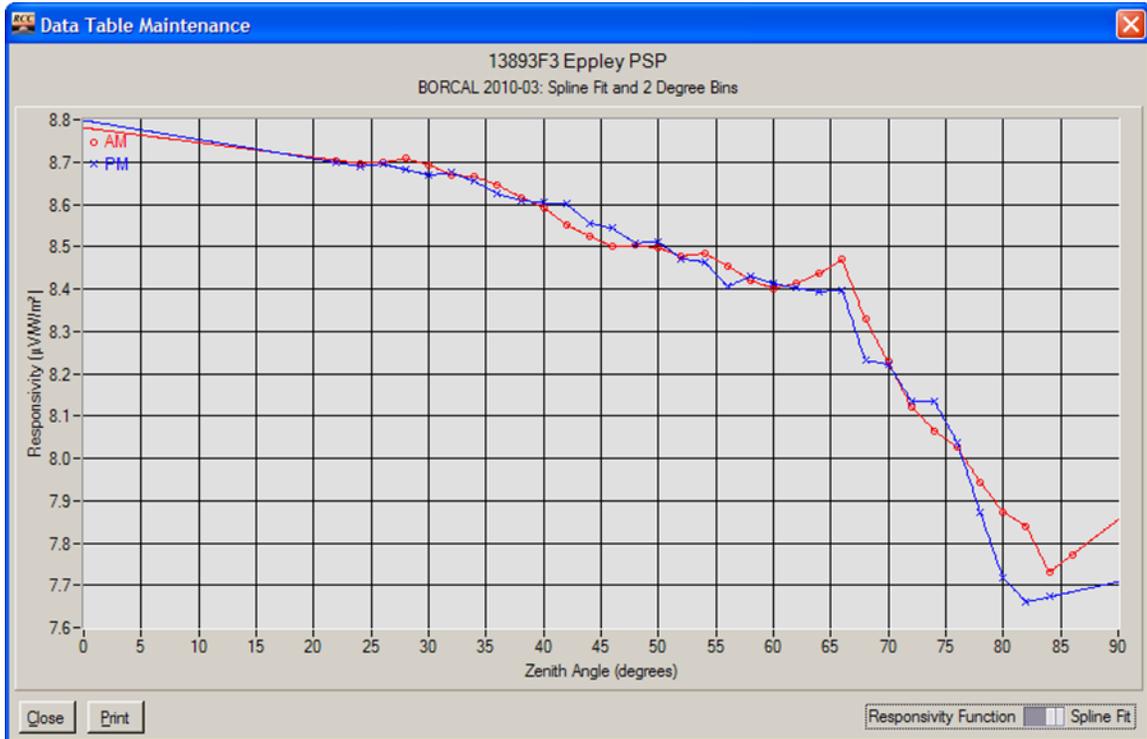


Figure 10-6. Spline fit and responsivity function plot

10.2.6 BORCAL-LW Calibration Data Table

Data Table Maintenance

Table Maintenance

Instrument Calibration Data

Table: CALDAT_IR

Select Instrument:

- 2014-02 FT002 Kipp & Zonen CG4
- 2015-01 140021 Kipp & Zonen CGR4
- 2015-01 29926F3 Eppley PIR
- 2015-01 30696F3 Eppley PIR
- 2015-01 32309F3 Eppley PIR
- 2015-01 36362F3 Eppley PIR
- 2015-01 37757F3 Eppley PIR

Buttons: Edit, Cancel, Done, Exit

BORCAL: 2015-01 Validity: Valid Comments:

Serial Number: 29926F3
 Manufacturer: Eppley
 Model: PIR

Calibration Results		Calibration Results (K0 = 0)	
K0	-9.06345	K0	0.00000
K1	0.27830	K1	0.27626
K2	1.02843	K2	1.00048
K3	-3.97835	K3	-3.81122
Kr	7.044E-4	Kr	7.044E-4
Mean	0.00000	Mean	-0.02541
N	1355	N	1381
Type-A, u(A) ± (W/m²)	0.51	Type-A, u(A) ±	0.51
Type-B, u(B) ± (W/m²)	0.87	Type-B, u(B) ±	0.87
Combined, u(c) ± (W/m²)	1.00	Combined, u(c) ±	1.13
Expanded, U95 ± (W/m²)	1.97	Expanded, U95 ±	2.22
Degrees of Freedom, DF	+Inf	DF	+Inf
Coverage factor, k	1.96	k	1.96

Figure 10-7. CALDAT_IR Table Maintenance window

Table 10-6. CALDAT_IR Table Fields

Field	Editable	Description
Select Instrument		Click on the desired BORCAL/instrument, and the remaining fields will be filled in from the selected data record
BORCAL		BORCAL designation
Validity	√	Calibration validity flag (valid, marginal, invalid)
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.
Serial Number, Manufacturer, Model		Instrument serial number, manufacturer, and model
Calibration Results		All calibration results (when K0 is not forced to zero) including: coefficients, mean of residuals, number of data points (N), uncertainties (Type A/B, combined, expanded), degrees of freedom, and coverage factor
Calibration Results (K0 = 0)		All calibration results (when K0 is forced to zero) including: coefficients, mean of residuals, number of data points (N), uncertainties (Type A/B, combined, expanded), degrees of freedom, and coverage factor

√ Indicates editable field

The instrument records will not appear in the database until the calibration results have been generated. If the calibration results for the instrument are not valid, missing values (–9900) will appear in fields.

10.2.7 Cavity Configuration

Table Maintenance
Cavity Configuration

Table: CAVCFG

Select Configuration:

- 1997-01 01 28964 Eppley HF
- 1997-02 01 28964 Eppley HF
- 1997-03 01 28964 Eppley HF
- 1997-04 01 28964 Eppley HF
- 1997-05 01 28964 Eppley HF
- 1998-01 01 31104 Eppley HF
- 1998-02 01 31104 Eppley HF

Buttons: Edit, Cancel, Done, Exit

BORCAL: 1997-01 Configuration Number: 1

Cavity		Control Unit	
Serial Number	28964	Serial Number	9827
Manufacturer	Eppley	Manufacturer	Eppley
Model	HF	Model	406
Unwinded WRR	0.998430	Current Shunt	10.000
Windowed WRR	1.000000	Circuit Resist	-9900.01
Unwinded Uncert (%)	0.31	Cal Date	05/02/1997
Windowed Uncert (%)	0.31	Cal Due Date	05/02/1998
Heater Resistance	151.60	Communications	
Heater Lead Resistance	0.0660	DMM	Control Unit
Mfg Calibration Factor	1.99000	RS-232	RS-232
Default Sensitivity	0.01048	GPiB	GPiB
Cal Date	05/02/1997	Port	Port
Cal Due Date	05/02/1998	Baud	Baud
		Parity	Parity
		Stop Bits	Stop Bits
		Data Bits	Data Bits
		Board	Board

Calibration Waits (Seconds)

TP-solar: 0
TP-heated: 45
TP-zero: 60
Dwell: 0

Window in Use:
Comments:

Figure 10-8. CAVCFG Table Maintenance window

Only the comments fields are editable in this table. All changes to the configuration are accomplished with the Configuration Editor, which is described in Section 6.7.5 on Cavity Configuration.

10.2.8 Cavity Inventory

The screenshot shows a software window titled "Data Table Maintenance" with a sub-header "Table Maintenance Cavity Inventory". The window contains the following elements:

- Table: CAV_INV
- Select Instrument list:
 - 28964 Eppley HF
 - 30713 Eppley HF
 - 31104 Eppley HF
- Buttons: Edit, New, Cancel, Done, Delete, Exit
- Input fields:
 - Serial Number: 28964
 - Manufacturer: Eppley
 - Model: HF
 - Unwindowed WRR: 0.99847
 - Windowed WRR: 1.00000
 - Unwindowed Uncert (%): 0.31
 - Windowed Uncert (%): 0.00
 - Heater Resistance: 151.60
 - Heater Lead Resistance: 0.0660
 - Mfg Calibration Factor: 1.99790
 - Default Sensitivity: 0.01048
 - Cal Date: 04/01/1997
 - Cal Due Date: 05/01/1997
 - Comments:

Figure 10-9. CAV_INV Table Maintenance window

Table 10-7. CAV_INV Table Fields

Field	Editable	Description
Select Instrument		Click on the desired instrument, and the remaining fields will be filled in from the selected data record.
Serial Number, Manufacturer, Model	√	Instrument serial number (see note in the box below), manufacturer, and model
Unwindowed WRR	√	WRR reduction factor (This is the WRR or intercomparison factor.)
Windowed WRR	√	If the cavity is supplied with a window, the WRR factor is determined with the window mounted. If a window is not supplied with the cavity, use 1.0 for the correction factor.
Unwindowed Uncert	√	Uncertainty of the unwindowed WRR factor
Windowed Uncert	√	Uncertainty of the windowed WRR factor
Heater Resistance	√	Resistance of the cavity heater
Heater Lead Resistance	√	Resistance of the heater leads
Mfg Calibration Factor	√	Multiplier supplied by the manufacturer for the aperture variance
Default Sensitivity	√	Cavity's nominal sensitivity in mV/mW/cm ²
Cal Date	√	Date of calibration or intercomparison
Cal Due Date	√	Date the calibration expires
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.

√ Indicates editable field

Changes made to this record are not reflected in the current cavity configuration. Changes made using the Session Configuration editor are reflected in both the cavity configuration table and the applicable fields in this table.

When entering the serial number, you cannot use these characters: /, \, :, *, ?, ", <, >, or |. This is because the Windows operating system does not allow these characters in file names, and the system creates file names based in part on these fields.

When changes are made to instrument parameters by editing the Cavity Inventory table using the Database Maintenance capabilities, these changes are *not* reflected in the current BORCAL configuration. You must delete the instrument from the configuration and reconfigure it to bring in the current values from the Cavity Inventory table—or (and this is highly recommended)—change the parameters for the instrument by editing the current BORCAL configuration, which also updates the Cavity Inventory table.

10.2.9 Control Unit Inventory

Data Table Maintenance

Table Maintenance

Control Unit Inventory

Table:

Select Instrument:

- 10348 Eppley 406
- 9827 Eppley 406
- US37019579 NREL Reda

Buttons: Edit, New, Cancel, Done, Delete, Exit

Serial Number:

Manufacturer:

Model:

DVM:

Current Shunt:

Circuit Resist:

Cal Date:

Cal Due Date:

Comments:

Figure 10-10. CON_INV Table Maintenance window

Table 10-8. CON_INV Table Fields

Field	Editable	Description
Select Instrument		Click on the desired instrument, and the remaining fields will be filled in from the selected data record.
Serial Number, Manufacturer, Model	√	Instrument serial number, manufacturer, and model
DVM	√	Digital voltmeter installed in the control unit
Current Shunt	√	Resistance of the current sensing resistor used in the calculation to determine the power dissipated by the cavity heater. The Eppley Laboratory normally supplies cavity radiometer systems with this resistance specified as a nominal value. However, some systems are supplied with a value determined by an accurate measurement. Regardless of the value specified by the manufacturer, <i>the correct resistance value for the RCC system is the exact value used when the cavity WRR factor or windowed WRR factor was determined.</i>
Circuit Resist	√	Overall resistance of the cavity heater circuit without the heater and heater lead resistances.
Cal Date	√	Date of calibration or intercomparison
Cal Due Date	√	Date the calibration expires
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.

√ Indicates editable field

Changes made to this record are not reflected in the current cavity configuration. Changes made using the Session Configuration editor are reflected in both the cavity configuration table and the applicable fields in this table.

When changes are made to instrument parameters by editing the Control Unit Inventory table using the Database Maintenance capabilities, these changes are *not* reflected in the current BORCAL configuration. You must delete the instrument from the configuration and reconfigure it to bring in the current values from the Control Unit Inventory table—or (and this is highly recommended)—change the parameters for the instrument by editing the current BORCAL configuration, which also updates the Control Unit Inventory table.

10.2.10 Customer Data Table

Data Table Maintenance

Table Maintenance

Customers

Table:

Select Name:

- A. J. McDanal
- Apogee Instruments
- APS-STAR
- Arizona Public Service Company
- Ame Jacobson
- Bill Conant
- Bill Marion

Name:

Company:

Department:

Address (1):

Address (2):

Address (3):

City:

State/Province:

Zip/Postal Code:

Country:

Phone:

Fax:

Email Address:

Comments: ISO Customer Report:

Figure 10-11. CUSTOMER Table Maintenance window

Table 10-9. CUSTOMER Table Fields

Field	Editable	Description
Select Name		Click on the desired customer, and the remaining fields will be filled in from the selected data record.
Name	√	Customer's full name
Company	√	Company or institute represented by the customer
Department	√	Customer's department within the company
Address (1, 2, 3)	√	First, second, and third lines (as needed) for the customer's address
City	√	City of address
State	√	State of address
Zip/postal Code	√	Zip code or other postal routing code
Country	√	Country of the address
Phone	√	Customer's telephone number
Fax	√	Customer's fax number
Email Address	√	Customer's email address
ISO Customer Report	√	Customer has selected ISO reports for all instruments
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.

√ Indicates editable field

10.2.11 Diffuse Configuration Table

Data Table Maintenance

Table Maintenance

Diffuse Radiometer Configuration

Table:

Select Configuration

- 1997-01 01 17802F3 Eppley PSP
- 1997-01 01 28402F3 Eppley PSP
- 1997-02 01 17802F3 Eppley PSP
- 1997-02 01 28402F3 Eppley PSP
- 1997-03 01 19381F3 Eppley PSP
- 1997-04 01 17802F3 Eppley PSP
- 1997-04 01 28402F3 Eppley PSP

BORCAL: Configuration Number:

Serial Number:

Manufacturer:

Model:

Responsivity:

Cal Date: Cal Due Date:

Comments:

Shading Disk

Diameter (cm):

Arm Length (cm):

Subtended Angle:

Uncertainty

Percent:

Offset (W/m²):

Figure 10-12. DIFCFG Table Maintenance window

Only the comments fields are editable in this table. All changes to the configuration are accomplished with the Configuration Editor, which is described in Section 6.7.6 on Diffuse Radiometer Configuration.

10.2.12 Voltmeter Inventory Table

Figure 10-13. DVM_INV Table Maintenance window

Table 10-10. DVM_INV Table Fields

Field	Editable	Description
Select Instrument		Click on the desired instrument, and the remaining fields will be filled in from the selected data record.
Serial Number, Manufacturer, Model	√	Instrument serial number, manufacturer, and model
Cal Date	√	Date of calibration or intercomparison
Cal Due Date	√	Date the calibration expires
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.

√ Indicates editable field

10.2.13 Calibration Facility Table

Data Table Maintenance

Table Maintenance

Calibration Facility

Table: FACILITY

Select Facility:

- Solar Radiation Research Laboratory

Exit

Edit New Cancel Done Delete

Facility Name: Solar Radiation Research Laboratory

Facility Abbreviation: SRRL

Contact: Afshin M. Andreas

Latitude: 39.742

Longitude: -105.18

Elevation (m): 1828.8

Avg. Pressure (mbr): 835.0

Avg. Temperature (C): 10.0

Time Zone: -7.0

ISO SW Full Report

ISO LW Full Report

Comments

Figure 10-14. FACILITY Table Maintenance window

Table 10-11. FACILITY Table Fields

Field	Editable	Description
Select Facility		Click on the desired facility, and the remaining fields will be filled in from the selected data record.
Facility Name	√	Full name of the selected facility
Facility Abbreviation	√	Short name of the selected facility (See note in the box below.)
Contact	√	Contact person at the facility
Latitude	√	Facility latitude (decimal degrees, negative south of the equator)
Longitude	√	Facility longitude (decimal degrees, negative west of the prime meridian)
Elevation	√	Elevation above sea level (meters)
Average Pressure	√	Long-term site average barometric pressure (mBar)
Average Temperature	√	Long-term site average temperature (°C)
Time Zone	√	Time zone of the site (offset in hours between Greenwich Meant Time and site, negative west of Greenwich)
ISO SW Full Report	√	SW Full Report will be in ISO format for this facility.
ISO LW Full Report	√	LW Full Report will be in ISO format for this facility.
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.

√ Indicates editable field

When entering the facility abbreviation, you cannot use these characters: /, \, :, *, ?, ", <, >, or |. This is because the Windows operating system does not allow these characters in file names, and the system creates file names based in part on these fields.

10.2.14 GPS Configuration Table (BORCAL-SW and BORCAL-LW)

Figure 10-15. GPSCFG Table Maintenance window

There is a GPS Configuration table for both BORCAL-SW and BORCAL-LW; the structures of both are identical.

Only the comments fields are editable in this table. All changes to the configuration are accomplished with the Configuration Editor, which is described in Section 6.7.10 on Other Instrument Configuration for SW and Section 6.8.7 on Other Instrument Configuration for LW.

10.2.15 GPS Inventory Table

Figure 10-16. GPS_INV Table Maintenance window

Table 10-12. GPS_INV Table Fields

Field	Editable	Description
Select Instrument		Click on the desired instrument, and the remaining fields will be filled in from the selected data record.
Serial Number, Manufacturer, Model	√	Instrument serial number, manufacturer, and model
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.

√ Indicates editable field

10.2.16 Instrument Type Table

Data Table Maintenance

Table Maintenance

Instrument Type

Table:

Select Instrument Type:

- Eppley EPLAB MAN
- Eppley FPP
- Eppley GPP**
- Eppley HF
- Eppley NIP
- Eppley NIP-B
- Eppley PIR

Manufacturer:

Model:

Description:

Use TOT Est. Thermal Offset Error (W/m²):

Comments Kr: Case Coefficient (K/μV):

IR Correctable

Generic Rnet:

Maximum Output

Millivolts (Thermopile)	<input type="text" value="50"/>
kOhms (Case Thermistor)	<input type="text" value="99.000"/>
kOhms (Dome Thermistor)	<input type="text" value="99.000"/>

Figure 10-17. INST_TYPE Table Maintenance window

Table 10-13. INST_TYPE Table Fields

Field	Editable	Description
Select Instrument Type		Click on the desired instrument, and the remaining fields will be filled in from the selected data record.
Manufacturer	√	Instrument manufacturer (see note in the box below)
Model	√	Instrument model (see note in the box below)
Description	√	Brief description of the instrument
Max Millivolts	√	<i>Maximum</i> output voltage in millivolts. This is used for data logger scaling. It should be set so that the output voltage will never exceed this value (which will cause data acquisition errors), and it should not be set too high and force the logger to measure at a scale that is too high (causing an increase in measurement uncertainty).
kOhms (Case Thermistor)	√	<i>Maximum</i> resistance of the case thermistor (kΩ)
kOhms (Dome Thermistor)	√	<i>Maximum</i> resistance of the dome thermistor (kΩ)
Use	√	Deployment type (see following table)
Est. Thermal Offset Error	√	(No longer used) Estimate of the thermal offset error without the ENICR (W/m ²)
Kr: Case Coefficient		Case coefficient (Kelvin per microvolt) for pyrgeometer
IR Correctable	√	Indicates whether the instrument type is configurable for an ENICR (For example, silicon instruments are presumed to have no IR offset and are thus not correctable.)
Generic Rnet	√	A generic (default) Rnet for this instrument type to be used in the absence of a measured Rnet ^a
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.

√ Indicates editable field

^a Changes to this value will not update the corresponding value for instruments in the Radiometer Inventory table.

When entering the manufacturer and model, you cannot use these characters: /, \, :, *, ?, ", <, >, or |. This is because the Windows operating system does not allow these characters in file names, and the system creates file names based in part on these fields.

Deployment types (for the *Use* field) are listed below.

Table 10-14. Deployment Types

Use Code	Description
TOT	Total (global) pyranometer
DIR	Direct normal (beam) pyrheliometer
PYG	Pyrgeometer
SHD	Test pyranometer mounted under a shading disk (different from diffuse reference instruments)
MCO	Manual ACR control unit
ACO	Automatic ACR control unit
ACM	Combo automatic ACR control unit and digital voltmeter
CAV	ACR
LGR	Data logger (combo multimeter and relay system)
RLY	Data logger (Relay only)
TEM	Thermometer
HUM	Hygrometer
BAR	Barometer
DVM	Digital multimeter for cavity or data logger relays
GPS	GPS receiver

10.2.17 Logger Configuration Table (BORCAL-SW and BORCAL-LW)

Data Table Maintenance

Table Maintenance
Data Logger Configuration

Table: LOGCFG

Select Configuration:

- 2005-03 01 6671000 Fluke Helios 2287A
- 2005-04 01 2005-998 NREL RAP-DAQ
- 2005-04 01 2005-999 NREL RAP-DAQ
- 2006-01 01 2005-998 NREL RAP-DAQ
- 2006-01 01 2005-999 NREL RAP-DAQ
- 2006-02 01 2005-998 NREL RAP-DAQ
- 2006-02 01 2005-999 NREL RAP-DAQ

Buttons: Edit, Cancel, Done, Exit

BORCAL: 2005-04 Configuration Number: 1

Serial Number: 2005-999

Manufacturer: NREL

Model: RAP-DAQ

DMM: US36000135 Hewlett Packard 34420A Unit Number: 1

Cal Date: 11/22/2005

Cal Due Date: 11/22/2006

Comments:

System Offsets

Volts DC (μ V)	1.37
2-Wire Res. (mOhms)	3450.00
4-Wire Res. (mOhms)	0.21

Communications

DMM		Relay	
RS-232 <input type="radio"/>	RS-232 <input type="radio"/>	RS-232 <input type="radio"/>	RS-232 <input type="radio"/>
GPIO <input checked="" type="radio"/>			
Address: 23	Address: 25	Address: 25	Address: 25
Baud: 19200	Baud: 9600	Baud: 9600	Baud: 9600
Parity: None	Parity: None	Parity: None	Parity: None
Stop Bits: 1	Stop Bits: 1	Stop Bits: 1	Stop Bits: 1
Data Bits: 8	Data Bits: 8	Data Bits: 8	Data Bits: 8
Board: 0	Board: 1	Board: 1	Board: 1

Figure 10-18. LOGCFG Table Maintenance window

There is a Logger Configuration table for both BORCAL-SW and BORCAL-LW, the structure of both are identical.

Only the comments fields are editable in this table. All changes to the configuration are accomplished with the Configuration Editor, which is described in Section 6.7.8 on Data Logger Configuration for SW and Section 6.8.6 on Data Logger Configuration for LW.

10.2.18 Data Logger Inventory Table

Figure 10-19. **LOGGER_INV** Table Maintenance window

Table 10-15. **LOGGER_INV** Table Fields

Field	Editable	Description
Select Instrument		Click on the desired instrument, and the remaining fields will be filled in from the selected data record.
Serial Number, Manufacturer, Model	√	Instrument serial number, manufacturer, and model. (See note in the box below.)
Cal Date	√	Date of calibration
Cal Due Date	√	Date the calibration expires
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.

√ Indicates editable field

When entering the serial number, manufacturer, or model, you cannot use these characters: /, \, :, *, ?, ", <, >, or |. This is because the Windows operating system does not allow these characters in file names, and the system creates file names based in part on these fields.

10.2.19 Met Instrument Inventory Table

Figure 10-20. MET_INV Table Maintenance window

Table 10-16. MET_INV Table Fields

Field	Editable	Description
Select Instrument		Click on the desired instrument, and the remaining fields will be filled in from the selected data record.
Serial Number, Manufacturer, Model	√	Instrument serial number, manufacturer, and model (See note in the box below.)
Offset	√	Additive offset to convert to measurement units
Scale	√	Multiplicative factor to convert to measurement units
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.

√ Indicates editable field

When entering the serial number, manufacturer, or model, you cannot use these characters: /, \, :, *, ?, ", <, >, or |. This is because the Windows operating system does not allow these characters in file names, and the system creates file names based in part on these fields.

When changes are made to instrument parameters by editing the Meteorological Inventory table using the Database Maintenance capabilities, these changes are *not* reflected in the current BORCAL configuration. You must delete the instrument from the configuration and reconfigure it to bring in the current values from the Meteorological Inventory table—or (and this is highly recommended)—change the parameters for the instrument by editing the BORCAL current configuration, which also updates the Meteorological Inventory table.

10.2.20 Operator Table

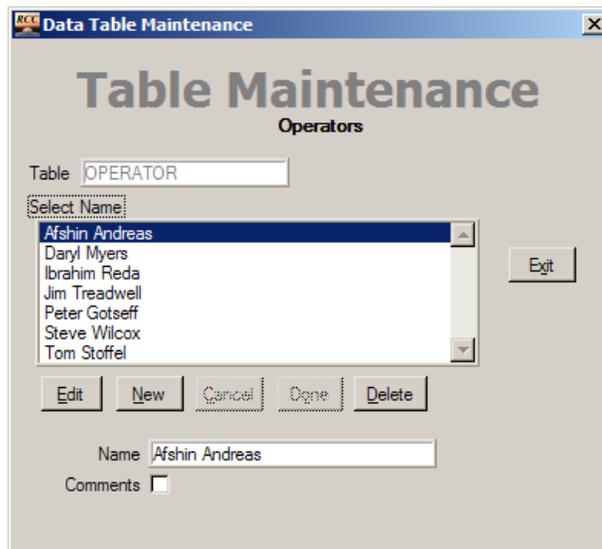


Figure 10-21. OPERATORS Table Maintenance window

Table 10-17. OPERATORS Table Fields

Field	Editable	Description
Select Name		Click on the desired name, and the remaining fields will be filled in from the selected data record.
Name	√	Operator's name, first and last (used for operator selection lists and also in the reports)
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.

√ Indicates editable field

A special RCC operator may be present in the name list. This operator is part of the RCC automatic mode configuration and should not be deleted or changed.

10.2.21 Operator Log Table

Figure 10-22. OPERATOR_LOG Table Maintenance window

Table 10-18. OPERATOR_LOG Table Fields

Field	Editable	Description
Select Log Entry		Log entries are listed by name in this field, but they are further identified by the login and logout times shown in the window. Select the desired log entry, and the remaining fields will be filled in.
Name		Operator's name
BORCAL		BORCAL event identification
Session		Session when the login occurred
Login Date/Time		Date and time the operator logged in
Logout Date/Time		Date and time the operator logged out
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.

√ Indicates editable field

10.2.22 Reference Pyrgometer Configuration Table (BORCAL-SW and BORCAL-LW)

Data Table Maintenance

Table Maintenance

Pyrgometer Configuration

Table: PYGCFG

Select Configuration:

- 2006-01 01 29926F3 Eppley PIR

Exit

Edit Cancel Done

BORCAL: 2006-01 Configuration Number: 1

Serial Number: 29926F3

Manufacturer: Eppley

Model: PIR

Cal Date: 02/24/2006 Cal Due Date: 02/24/2007

Comments:

Calibration Coefficients

K0: -6.00000

K1: 0.26500

K2: 1.01670

K3: -3.18000

Kr: 7.04400E-4

Uncertainty (W/m²): 2.60

Figure 10-23. PYGCFG Table Maintenance window⁸

There is a Reference Pyrgometer Configuration table for both BORCAL-SW and BORCAL-LW; the structures of both are identical.

Only the comments fields are editable in this table. All changes to the configuration are accomplished with the Configuration Editor, which is described in Section 6.7.7 on Pyrgometer Configuration for SW and Section 6.8.5 on Reference Pyrgometer Configuration for LW.

⁸ This table is similar to the Reference Pyrgometer Inventory Table, and it is used to document the instrument parameters used in each BORCAL event.

10.2.23 Reference Pygeometer Inventory Table

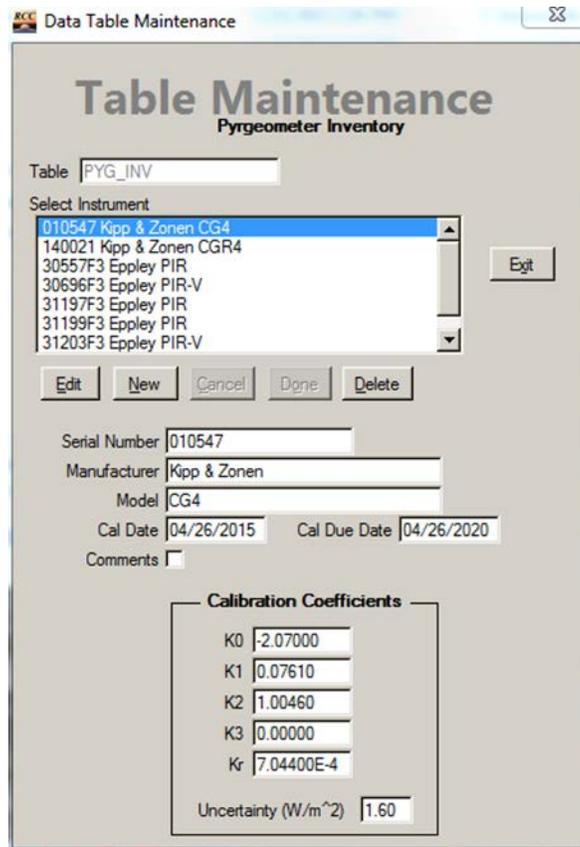


Figure 10-24. PGC_INV Table Maintenance window

Table 10-19. PYG_INV Table Fields

Field	Editable	Description
Select Instrument		Click on the desired instrument, and the remaining fields will be filled in from the selected data record.
Serial Number, Manufacturer, Model	√	Instrument serial number (see note in the box below), manufacturer, and model
Cal Due Date	√	Date the pygeometer was calibrated and when it is due for recalibration
Calibration Coefficients	√	Calibration coefficients from the blackbody calibration
Uncertainty (%)	√	Uncertainty of the calibration
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.

√ Indicates editable field

When entering the serial number, you cannot use these characters: /, \, :, *, ?, ", <, >, or |. This is because the Windows operating system does not allow these characters in file names, and the system creates file names based in part on these fields.

When changes are made to instrument parameters by editing the Pyrgeometer Inventory table using the Database Maintenance capabilities, these changes are *not* reflected in the current BORCAL configuration. You must delete the instrument from the configuration and reconfigure it to bring in the current values from the Pyrgeometer Inventory table—or (and this is highly recommended)—change the parameters for the instrument by editing the current BORCAL configuration, which also updates the Pyrgeometer Inventory table.

10.2.24 Radiometer Inventory Table

Data Table Maintenance

Table Maintenance

Radiometer Inventory

Table:

Select Instrument:

- 000019 Kipp & Zonen CM22
- 0000PT Kipp & Zonen CG4
- 0000TH Kipp & Zonen CG4
- 000240 Kipp & Zonen CH1
- 007148 Kipp & Zonen CM11
- 007153 Kipp & Zonen CM11
- 007156 Kipp & Zonen CM11

Buttons: Edit, New, Cancel, Done, Delete, Exit

Serial Number:

Manufacturer:

Model:

Factory RS (W/m²/μV): Temp Sensor Type:

Current BORCAL: AIM Exportable:

Current Customer:

Comments: Calib. Due Interval (months):

Instrument's Current Effective IR Response

Rnet: Uncert (%): Rnet Date:

Correcting Pyrgeometer:

Figure 10-25. RAD_INV Table Maintenance window

Table 10-20. RAD_INV Table Fields

Field	Editable	Description
Select Instrument		Click on the desired instrument, and the remaining fields will be filled in from the selected data record.
Serial Number, Manufacturer, Model	√	Instrument serial number (see note in the box below), manufacturer, and model.
Factory RS	√	Instrument's responsivity when new as supplied by the manufacturer (W/m ² /microvolt)
Temp Sensor Type		Dropdown menu to select the temperature sensor type installed in the instrument. Available options are 10K Thermistor (2-wire), PT100 (4-wire), and NONE.
Current BORCAL	√	Most recent valid BORCAL in which this instrument was included. This field is updated by the system during the Responsivity Generation procedure, ^a but the designated BORCAL may be overridden by editing this field. This field is used primarily by the system to obtain responsivity values for instruments designated as control or ASR.
AIM Exportable	√	Calibration results from this instrument may be exported to the AIM database.
Current Customer	√	Name of the instrument's current customer
Calib. Due Interval (months)		Interval at which an instrument will be due for the next calibration (used to compute due dates on reports and calibration stickers)
Rnet		Rnet as determined from blackbody characterization (defaults to generic from instrument type)
Uncert (%)	√	Uncertainty of the Rnet (When using a generic Rnet, the default 20% should be used.)
Rnet Date	√	Date the Rnet was determined (When using a generic Rnet, the default 01/01/1970 should be used.)
Correcting Pyrgeometer	√	Instrument identification number of the correcting pyrgeometer
Comments	√	Text comments entered by users (accessed by clicking on the check box). A check mark indicates a comment exists.

√ Indicates editable field

^a This field is not automatically updated for control instruments, which are assumed to have stable responsivity characteristics. This prevents a bad calibration from causing system operations problems in subsequent BORCALs. If a control instrument's responsivity is determined to have changed significantly, this field can be manually updated as required.

When changes are made to instrument parameters by editing the Radiometer Inventory table using the Database Maintenance capabilities, these changes are not reflected in the current BORCAL configuration. You must delete the instrument from the configuration and reconfigure it to bring in the current values from the Radiometer Inventory table—or (and this is highly recommended)—change the parameters for the instrument by editing the current BORCAL configuration, which also updates the Radiometer Inventory table.

When entering the serial number, you cannot use these characters: /, \, :, *, ?, ", <, >, or |. This is because the Windows operating system does not allow these characters in file names, and the system creates file names based in part on these fields.

10.2.25 Session Configuration Table (BORCAL-SW Only)

Data Table Maintenance

Table Maintenance

Instrument Session Configuration

Table:

Select Instrument:

- 2011-01 02 E1220001-T Vaisala HMP155-T
- 2011-01 02 FT002 Kipp & Zonen CG4
- 2011-01 02 JP38490103 Hewlett Packard 58533A
- 2011-01 02 PY1730 Licor LI200
- 2011-01 02 PY1755 Licor LI200**
- 2011-01 02 PYHR101 Licor LI201SB
- 2011-01 02 Y0550020 Vaisala PTB101B

Buttons: Edit, Cancel, Done, Exit

Serial Number:

Manufacturer:

Model:

BORCAL: Ventilated

Config Number:

Customer:

Comments:

Active: Verified: Control: Perpetual: Tilt: Correction Request:

Deployment: Location: Scan Group: Group Index: Standard Flag:

Instrument's Effective IR Response

Rnet: Uncert (%): Rnet Date:

Correcting Pygeometer:

Thermopile

Channel: Junction Box: Cable:

Case Thermistor

Channel: Junction Box: Cable:

Dome Thermistor

Channel: Junction Box: Cable:

Figure 10-26. SESS_CONFIG Table Maintenance window

Only the comments fields are editable in this table. All changes to the configuration are accomplished with the Configuration Editor, which is described in Section 6.7 on Configuring a new BORCAL-SW.

10.2.26 Session Configuration Table (BORCAL-LW Only)

Data Table Maintenance

Table Maintenance

Instrument Session Configuration

Table:

Select Instrument:

- 2015-02 01 30557F3 Eppley PIR
- 2015-02 01 30696F3 Eppley PIR
- 2015-02 01 31199F3 Eppley PIR
- 2015-02 01 31203F3 Eppley PIR
- 2015-02 01 32309F3 Eppley PIR
- 2015-02 01 36362F3 Eppley PIR**
- 2015-02 01 37757F3 Eppley PIR

Buttons: Edit, Cancel, Done, Exit

Serial Number:

Manufacturer:

Model:

BORCAL: Ventilated

Config Number:

Customer:

Comments:

Active:

Verified:

Control:

Deployment:

Location:

Scan Group:

Group Index:

Standard Flag:

Thermopile

Channel:

Junction Box:

Cable:

Case Thermistor

Channel:

Junction Box:

Cable:

Dome Thermistor

Channel:

Junction Box:

Cable:

Figure 10-27. SESS_CONFIG_IR Table Maintenance window

Only the comments fields are editable in this table. All changes to the configuration are accomplished with the Configuration Editor, which is described in Section 6.8 on Configuring a new BORCAL-LW.

10.2.27 Session Table (BORCAL-SW Only)

Data Table Maintenance

Table Maintenance

Session

Table

Select Session:

- 2006-02 022
- 2006-02 023
- 2006-02 024
- 2006-02 025
- 2006-02 026
- 2006-02 027
- 2006-02 028

Exit

Edit Cancel Done

BORCAL

Session Number

Instrument Configuration

System Configuration

Datalogger Configuration

Cavity Configuration

Diffuse Configuration

Pyreometer Configuration

GPS Configuration

Start Date/Time

End Date/Time

Software Version

Validity Level

Comments

Figure 10-28. SESSION Table Maintenance window

Only the comments and validity fields are editable in this table. All other fields are maintained by the system.

10.2.28 Session Table (BORCAL-LW Only)

The screenshot shows a software window titled "Data Table Maintenance" with a sub-header "Table Maintenance Session". The "Table" field is set to "SESSION_IR". A "Select Session" dropdown menu is open, showing a list of sessions from "2014-01 001" to "2014-01 007". Below the list are buttons for "Edit", "Cancel", and "Done". To the right of the list is an "Exit" button. Below the list, the "BORCAL" field is set to "2014-01". Other fields include "Session Number" (1), "Instrument Configuration" (1), "System Configuration" (1), "Datalogger Configuration" (1), "Pyrgometer Configuration" (1), "GPS Configuration" (0), "Start Date/Time" (08/08/2014 16:33:37), "End Date/Time" (08/08/2014 16:46:36), "Software Version" (3.0.3.5), "Validity Level" (Valid), and "Comments" (checkbox).

Figure 10-29. SESSION_IR Table Maintenance window

Only the comments and validity fields are editable in this table. All other fields are maintained by the system.

10.2.29 System Configuration Table (BORCAL-SW Only)

Table Maintenance
System Configuration

Table:

Select Configuration:

- 1997-01 001
- 1997-02 001
- 1997-03 001
- 1997-04 001
- 1997-05 001
- 1998-01 001
- 1998-02 001

BORCAL: Configuration Number: Comments:

Delta Thresholds	ASR Setup	Uncertainty	Clock
Temp(x) - Temp(x-1): <input type="text" value="3.0"/>	Scan Rate (s): <input type="text" value="1"/>	Zenith Angle (deg): <input type="text" value="0.030"/>	Reset Interval (m): <input type="text" value="0"/>
Hum(x) - Hum(x-1): <input type="text" value="7.0"/>	ASR Readings: <input type="text" value="60"/>	Decimal Precision: <input type="text" value="2"/>	Warning Threshold (s): <input type="text" value="0"/>
Bar(x) - Bar(x-1): <input type="text" value="10.0"/>	Threshold 1 (Blue): <input type="text" value="1.00"/>	45° Neg. Offset: <input type="text" value="-15.0"/>	Delta UT1 (s): <input type="text" value="0.000"/>
Thm(x) - Thm(x-1): <input type="text" value="1.0"/>	Threshold 2 (Green): <input type="text" value="2.00"/>	45° Pos. Offset: <input type="text" value="15.0"/>	
Thm (Dome-Case): <input type="text" value="3.0"/>	Threshold 3 (Brown): <input type="text" value="3.00"/>	Min. Legal Direct: <input type="text" value="700"/>	Solar Position Algorithm
Case Thm (Inst-Pyrg): <input type="text" value="3.0"/>	Diffuse scaling factor: <input type="text" value="0.50"/>	Max. Legal Diffuse: <input type="text" value="150"/>	Delta T (s): <input type="text" value="62.290"/>
		Max. Diffuse/Direct (%): <input type="text" value="30.0"/>	Atmos. Refraction (deg): <input type="text" value="0.5667"/>
% Error Thresholds	Auto Mode	Scan Rate (sec)	Tilt
Cav1 / Cav2: <input type="text" value="1.0"/>	Startup Zenith Angle: <input type="text" value="85"/>	Radiometers: <input type="text" value="30"/>	Zenith: <input type="text" value="0.00"/>
Dif1 / Dif2: <input type="text" value="10.0"/>	Shutdown Zenith Angle: <input type="text" value="85"/>	Meteorological: <input type="text" value="300"/>	Azimuth: <input type="text" value="0.00"/>
Global Ctrl / Ref: <input type="text" value="6.0"/>			
Direct Ctrl / Ref: <input type="text" value="6.0"/>	Intervals	Incoming IR Thresholds	Precipitable Water
Test(x) / Test(x-1): <input type="text" value="0.5"/>	Cavity Calibration (m): <input type="text" value="0"/>	Minimum W in: <input type="text" value="150"/>	Slope: <input type="text" value="1.83"/>
	Operator Log (m): <input type="text" value="0"/>	Maximum W in: <input type="text" value="450"/>	Intercept: <input type="text" value="1.30"/>

Figure 10-30. SYSTEM Table Maintenance window

Only the comments fields are editable in this table. All changes to the configuration are accomplished with the Configuration Editor, which is described in Section 6.7.3 on System Configuration.

10.2.30 System Configuration Table (BORCAL-LW Only)

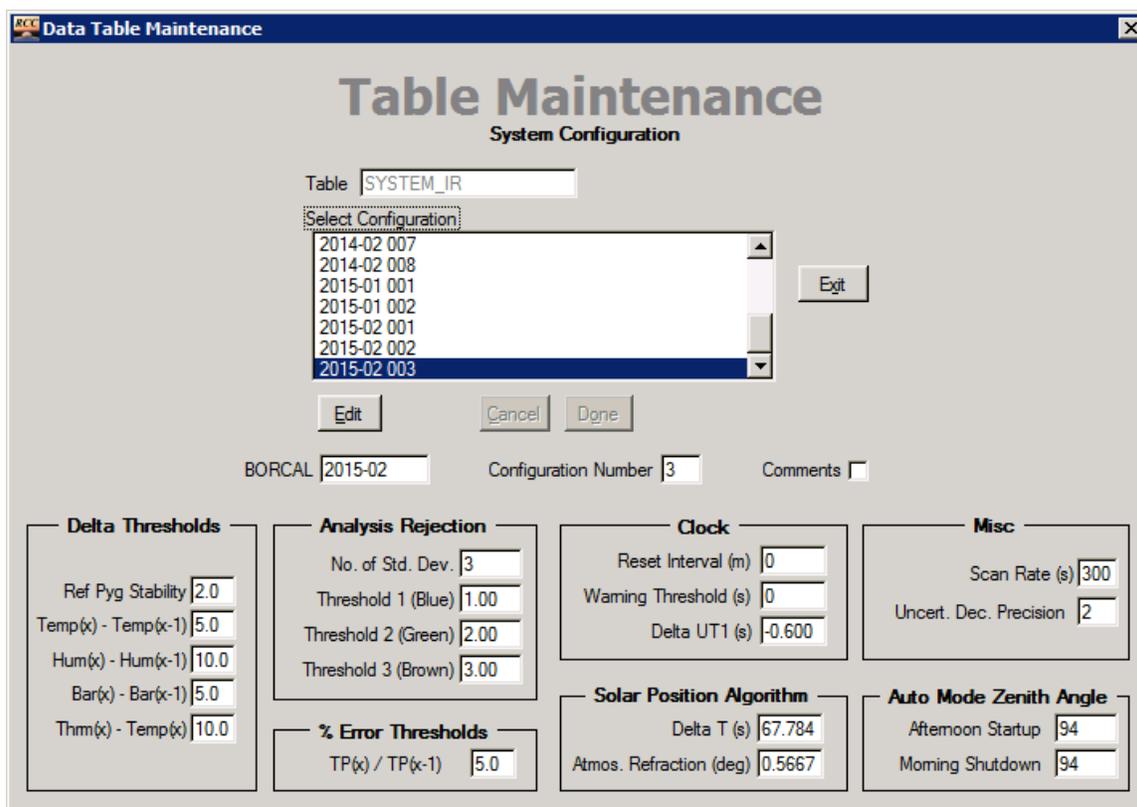


Figure 10-31. SYSTEM_IR Table Maintenance window

Only the comments fields are editable in this table. All changes to the configuration are accomplished with the Configuration Editor, which is described in Section 6.8.3 on System Configuration.

10.2.31 Broad Scope Edits

Sometimes changing information in one field can affect other tables or data files. In these circumstances, the system will make the necessary global changes to maintain the data's integrity. For example, when changing an instrument's serial number, all references to the original serial number within the system will be changed including those within data tables and data files. In such cases, the system may ask for bounding information to limit the scope of the change—for example, to within the selected BORCALs.

Use caution when making edits that cause irrecoverable changes. For example, if two instruments were erroneously entered with their serial numbers swapped—A labeled as B, and B labeled as A—and you renamed A as B, both instruments would then be named B, and there would be no way to distinguish between them to properly rename B as A. In this type of situation, A should be first renamed to X, then B renamed to A, and finally X renamed to B.

Edits that require a change beyond the scope of a single field in the database force a backup of the affected files. These backups are stored under the BACKUPS folder in individual folders

named with the date and time of the edit operation. Although there is no facility for restoring the backups, the backups are copies of the original files prior to the edit, and hence the backup files can be copied back to their original location as a last resort to reverse unwanted changes.

When restoring backup files, all files in the backup directory must be restored to ensure data integrity. This will restore the system to the state *at the time of the backup* and will cause the loss of any data or changes created since that time.

10.3 Editing Session Validity

The operator generally designates session validity at the time of data acquisition. However, it is often desirable to revise decisions about a session after comparing it to other sessions at the end of a BORCAL. Although session validity can be edited directly in the Session Table Maintenance window, a special editing utility is provided that allows you to make changes more easily.

To edit session validity, set the BORCAL type (LW or SW), then select *Edit*→*Session Validity* from RCC's main window.

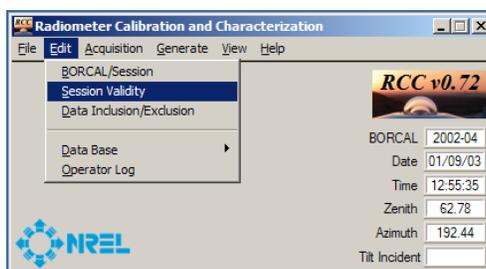


Figure 10-32. Selecting a Session Validity from RCC's main window

This brings up the Session Validity window, as shown below.

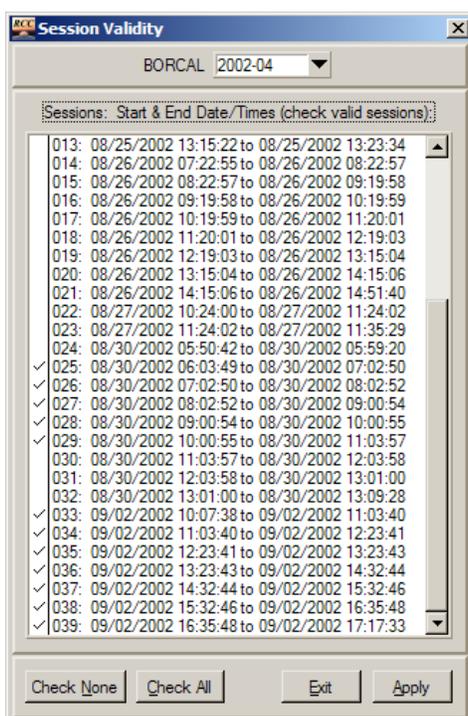


Figure 10-33. Session Validity window

The sessions are labeled by number and time, and a check mark indicates a valid session. Validate or invalidate sessions by clicking in the leftmost column. After making all changes, click on *Apply*.

10.4 Data Inclusion/Exclusion (BORCAL-SW Only)

Editing access to individual data points can be accomplished by using the Data Inclusion/Exclusion tool. This tool allows you to select subsets of data to be designated as unconditionally *excluded* from the data set during the responsivity calculations. Similarly, subsets of data can be designated as unconditionally *included* in the data set, overriding flagging (but not overriding outlier filtering). Specific flags or classes of flags can be unconditionally ignored when designating data to be included. This allows the operator to include data that were improperly flagged as bad under conditions known to be good. This tool allows either excluding all specified data regardless of flags or including data by ignoring specific flags. Data for exclusion or inclusion can be specified for any instrument by specific time to a resolution of 30 seconds.

From RCC's main window, set the BORCAL type to SW, and then select *Edit*→*Data Inclusion/Exclusion*.

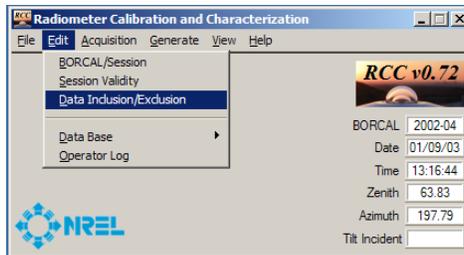


Figure 10-34. Selecting a Data Inclusion/Exclusion from RCC's main window

This brings up the Instrument Inclusion/Exclusion editing window.

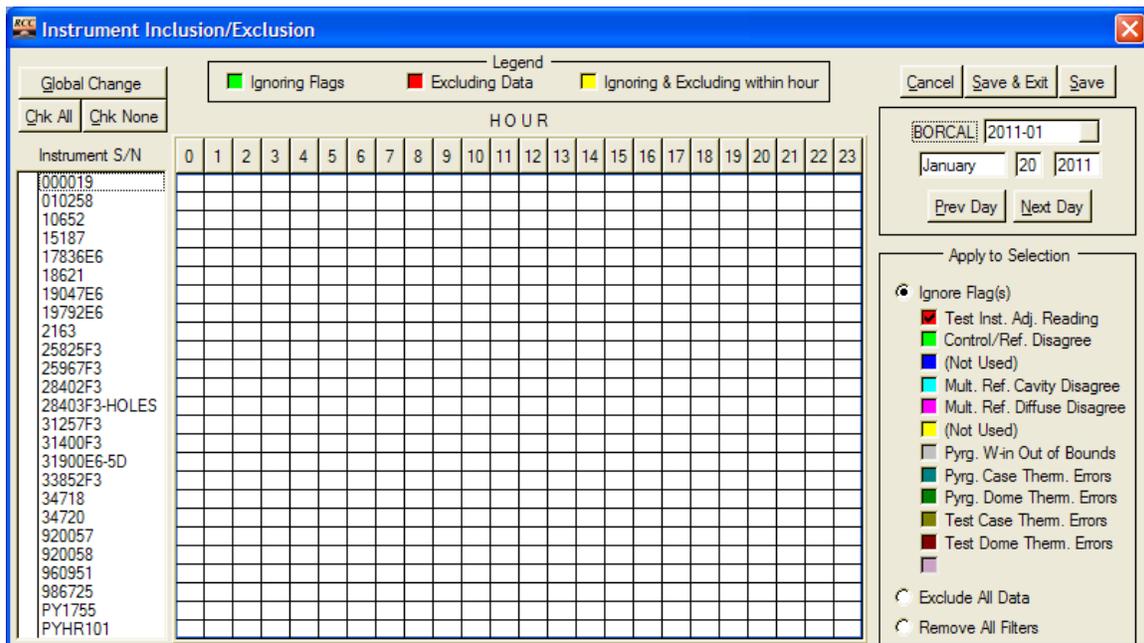


Figure 10-35. Instrument Inclusion/Exclusion window

In this window, hourly segments of data for all instruments are available for editing. At the top right of the window, select the desired day by clicking on *Prev Day* or *Next Day*.

The range of available days is determined by the first and last days of data acquisition, and it may include intervening days for which no data were taken.

10.4.1 Flag Designation

At the right of this window is a section with several colored check boxes corresponding to flags applied to the data during data acquisition. This section contains radio buttons for Ignore Flag(s), Exclude All Data, and Remove All Filters, as shown in the figure below.

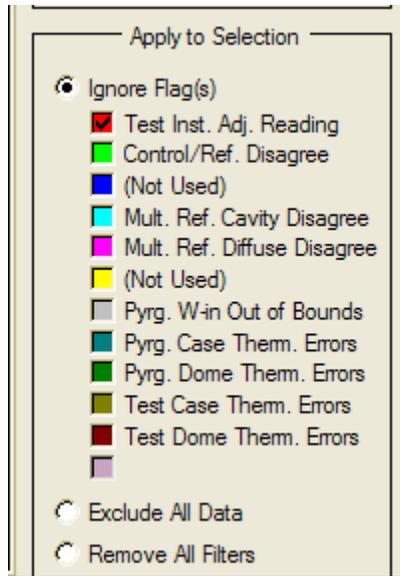


Figure 10-36. Available options for data inclusion and exclusion

Each option is described below:

- **Ignore flag(s):** presents several colored check boxes that correspond to specific data acquisition flags or classes of flags. Selecting this option activates these boxes and allows the operator to choose any combination of flags that should be ignored for the designated instrument and time. If this option is selected, at least one box must be checked.
- **Exclude all data:** unconditionally excludes all data for the designated instrument and time
- **Remove all filters:** removes previously selected exclusions or Ignore Flag settings for the designated instrument and time.

Prior to marking any time segments (described below), click on the check boxes for flags that should be ignored. (If the time segments are defined first, the selection will be lost when clicking on the flag boxes.)

10.4.2 Designating Individual Hours

You can click or drag in the matrix to indicate which instruments and for which times an inclusion or exclusion is desired. Click on *Apply* to mark the data; excluded designations will be marked in red, and flagged designations will be marked in green.

10.4.3 Designating Individual Data Points

Access to individual data points to 30-second resolution is available by double-clicking on an hour in the matrix. This brings up the Minute Selection editing window, as shown below.

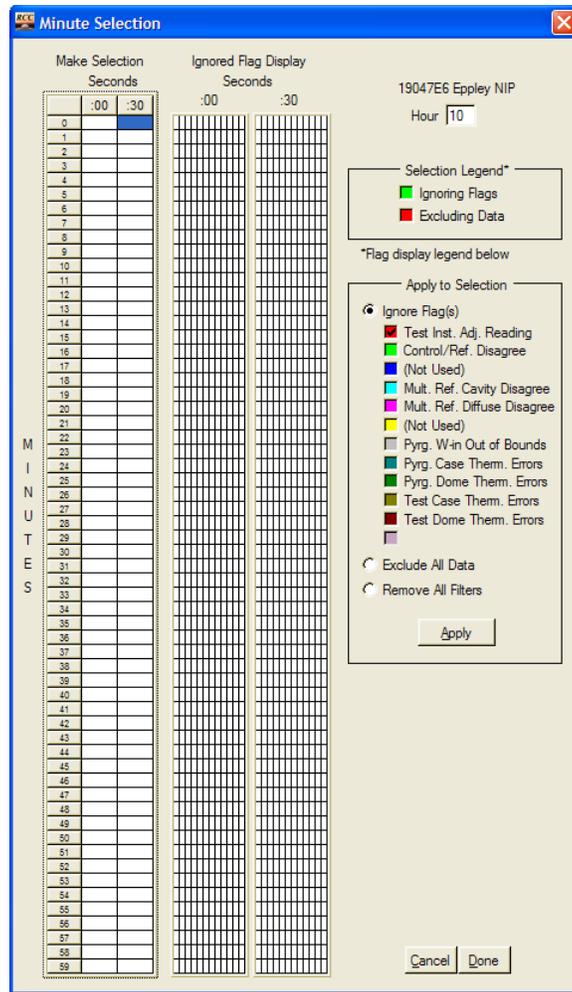


Figure 10-37. Minute Selection window for data inclusion/exclusion

This window allows you to designate a data subset by clicking on or dragging in the matrix by using the minutes label on the left and the seconds label on the top to locate the desired time. If you mark a box in the :00 column, any data point that falls within the range of :00 to :29 seconds for that minute will be affected. If you mark a box in the :30 column, any data point that falls within the range of :30 to :59 seconds for that minute will be affected. Prior to making a time selection, configure the Flag, Exclude, or Remove section on the right. After designating the time, click on *Apply*. Excluded designations will be marked in red and flagged designations will be marked in green on the time matrix. The grid on the right displays each flag designation by color, as shown in the figure below.

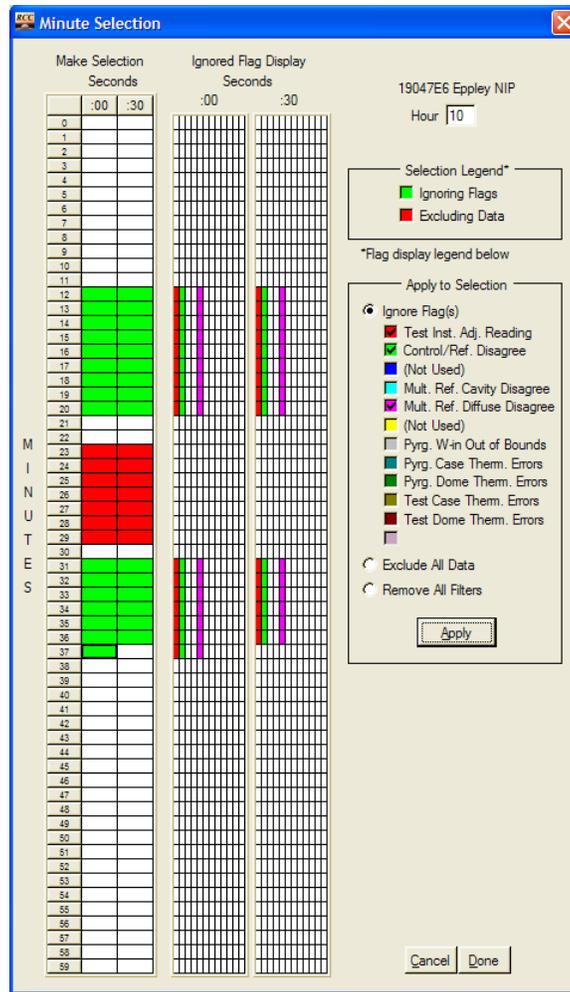


Figure 10-38. Minute Selection window with exclusions applied

Click on *Done* to carry the designation back to the Instrument Inclusion/Exclusion window. Click on *Cancel* to return without retaining the designations. Any portion of an hour designated by a minute selection will be indicated in the Instrument Inclusion/Exclusion window by a marked hour. Hours with mixed flag and exclusion designations will be indicated by a yellow marker.

10.4.4 Global Changes

Broad-brush designations can be made that affect any number of instruments for any continuous span of time within the BORCAL. To make global changes, mark instruments by clicking in the leftmost column in the Instrument Inclusion/Exclusion Window next to any instruments for which the changes apply. (This places a check mark in the column to the left of the instrument's serial number.) Alternatively, you can click on *Chk All* or *Chk None* to mark or unmark all instruments. After marking all desired instruments, click on *Global Change*, which brings up the Checked Instrument Data In/Exclusion window.

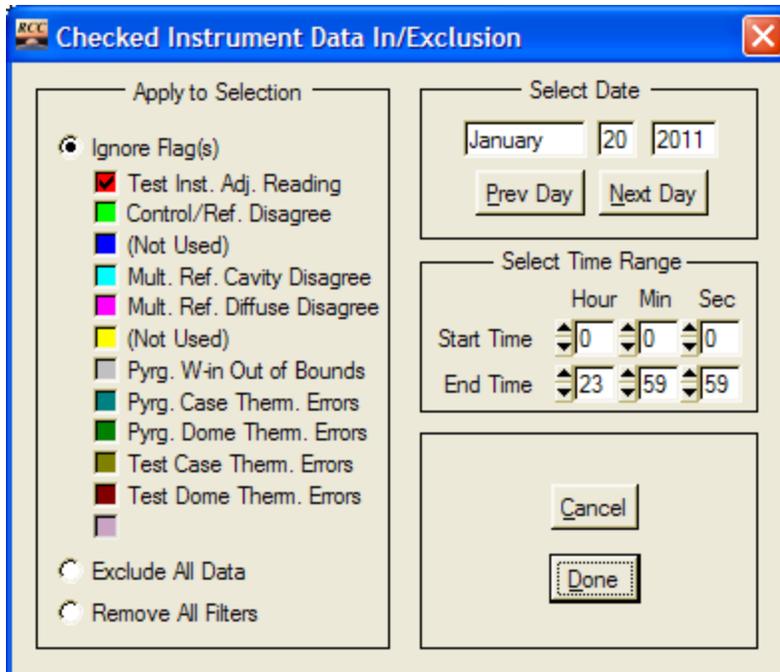


Figure 10-39. Checked Instrument Data Inclusion/Exclusion window

This window allows you to select the date and time range of the inclusion/exclusion designation. For the starting time, the seconds can be 0 or 30; for the ending time, the seconds can be 29 or 59. As described above, use the buttons and colored flag check boxes to select whether to include or exclude the designated data. When the configuration is complete, click on *Done*, and the designation will be updated on the Instrument Inclusion/Exclusion window. Click on *Cancel* to discard the changes.

10.4.5 Saving the Changes

When all designations are complete, exit the Instrument Inclusion/Exclusion window by clicking on *Save*, *Save and Exit*, or *Cancel* at the top left of the window. All saved changes will be available for viewing or revision the next time the Data Inclusion/Exclusion editor is opened.

10.5 Editing the Operator Log (BORCAL-SW Only)

Changes can be made to the Operator Logs by selecting *Edit*→*Operator Log* from RCC's main window when in SW mode. This brings up the Operator Log selection window, as shown below.

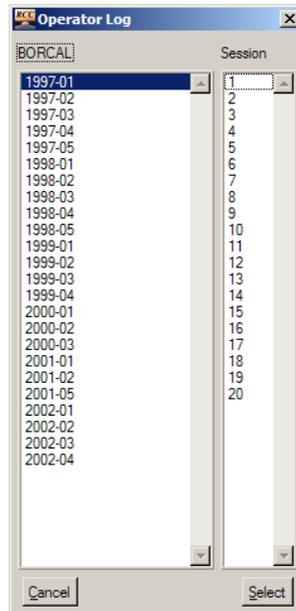


Figure 10-40. Selecting previous operator logs for editing

Select the desired BORCAL on the left, then select the desired session on the right. Click on *Select* (or double-click on the session number), which brings up the Operator Session Log window.

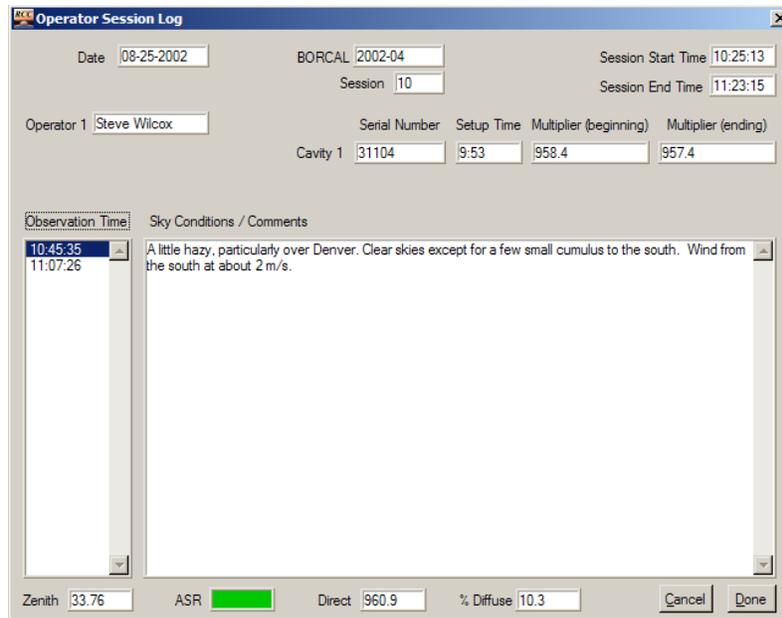


Figure 10-41. Editing previous operator logs

Choose the desired entry by clicking on the corresponding *Observation Time* in the left column. You can use conventional text editing commands to make changes to the comments text. No other fields are editable. When edits are complete, click on *Done* or *Cancel*.

11 Data Imports and Exports

RCC imports test instrument net IR responsivity (Rnet) values as determined by a blackbody calibration.

RCC provides several export functions for calibration data, including:

- Raw or filtered reference and test instrument data
- Meteorological data
- Instrument responsivities and other characterizations.

11.1 Test Instrument Rnet Imports (BORCAL-SW Only)

When instruments are to be configured for an ENICR, to speed the data entry of instrument Rnet values and minimize error, RCC can import the Rnet responsivity values produced by a blackbody characterization. (This process should be completed prior to the BORCAL-SW configuration so that the information is available as each instrument is configured.)

To access this import function, set the BORCAL type to SW, then select *File*→*Import*→*Instrument RSnet*, as shown below.

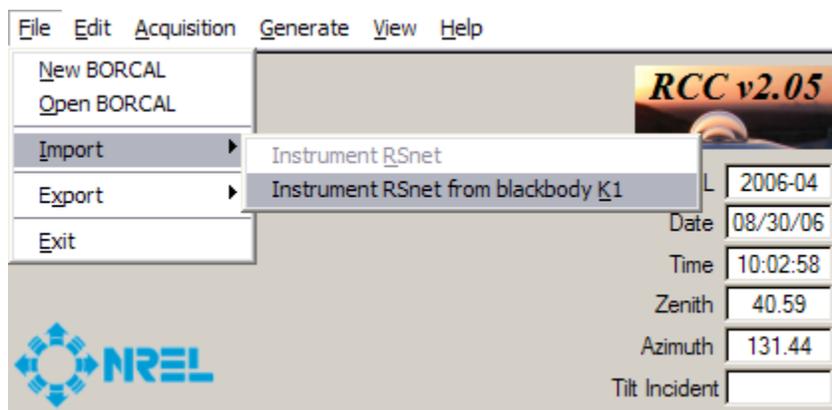


Figure 11-1. Selecting an Rnet import from RCC's main window

This brings up a browser that allows you to select the desired file containing the blackbody K1 values, which are used to compute the Rnet values. The import file must be of the comma-separated format with data columns in the order shown below:

- Calibration Date (MM/DD/YYYY)
- Model and Serial Number in Blackbody format
- Blackbody K1 Value ($W/m^2/\mu V$)
- Uncertainty (U95 %)
- Correcting Pyrgometer^a (Serial Number, Make, Model) in RCC Format

^a The correcting pyrgometer field is an optional field that is not provided by the blackbody characterization. The user can enter this information using text editor or Excel.

When the import file is selected and the information is analyzed by RCC, the summary table shown below is created.

Model & SN	Found Instrument ID	Use	Correctable	BB K1	RS Net	Uncert	Date	Pyrgometer ID (optional)	Import Status
PSP-30652F3	30652F3 Eppley PSP	TOT	Yes	0.411	0.666	10.0	6/7/2006	30696F3 Eppley PIR	OK
PSP-29615F3	29615F3 Eppley PSP	TOT	Yes	0.449	0.648	10.0	6/7/2006	29926F3 Eppley PIR-V	OK
PSP-29610F3	29610F3 Eppley PSP	TOT	Yes	0.432	0.676	10.0	6/7/2006	29926F3 Eppley PIR-V	OK
PSP-30709F3	30709F3 Eppley PSP	TOT	Yes	0.448	0.618	10.0	6/7/2006	29926F3 Eppley PIR-V	OK
PSP-30894F3	30894F3 Eppley PSP	TOT	Yes	0.437	0.648	10.0	6/7/2006	29926F3 Eppley PIR-V	OK
PSP-30940F3	30940F3 Eppley PSP	TOT	Yes	0.466	0.623	10.0	6/7/2006	29926F3 Eppley PIR-V	OK
PSP-31633F3	31633F3 Eppley PSP	TOT	Yes	0.414	0.662	10.0	6/7/2006	29926F3 Eppley PIR-V	OK
PSP-30890F3	30890F3 Eppley PSP	TOT	Yes	0.465	0.597	10.0	6/7/2006	29926F3 Eppley PIR-V	OK
PSP-30666F3	30666F3 Eppley PSP	TOT	Yes	0.421	0.689	10.0	6/7/2006	29926F3 Eppley PIR-V	OK
PSP-30929F3	30929F3 Eppley PSP	TOT	Yes	0.443	0.635	10.0	6/7/2006	29926F3 Eppley PIR-V	OK
PSP-30799F3	30799F3 Eppley PSP	TOT	Yes	0.450	0.625	10.0	6/8/2006		OK
PSP-30950F3	30950F3 Eppley PSP	TOT	Yes	0.453	0.604	10.0	6/8/2006		OK
PSP-14862F3	14862F3 Eppley PSP	TOT	Yes	0.406	0.750	10.0	6/8/2006	29926F3 Eppley PIR-V	OK
PSP-30823F3	30823F3 Eppley PSP	TOT	Yes	0.442	0.636	10.0	6/8/2006	29926F3 Eppley PIR-V	OK
PSP-29279F3	29279F3 Eppley PSP	TOT	Yes	0.460	0.632	10.0	6/8/2006	29926F3 Eppley PIR-V	OK
PSP-30891F3	30891F3 Eppley PSP	TOT	Yes	0.478	0.582	10.0	6/8/2006	29926F3 Eppley PIR-V	OK
PSP-30933F3	30933F3 Eppley PSP	TOT	Yes	0.470	0.591	10.0	6/9/2006	29926F3 Eppley PIR-V	OK
PSP-30665F3	30665F3 Eppley PSP	TOT	Yes	0.420	0.694	10.0	6/9/2006	29926F3 Eppley PIR-V	OK
PSP-30812F3	30812F3 Eppley PSP	TOT	Yes	0.434	0.671	10.0	6/9/2006	29926F3 Eppley PIR-V	OK
PSP-29281F3			No	0.417	0.000	10.0	6/9/2006		Fail - Unknown Inst
PSP-32814F3			No	0.434	0.000	10.0	6/9/2006		Fail - Unknown Inst
PSP-32813F3			No	0.480	0.000	10.0	6/9/2006		Fail - Unknown Inst
PSP-32815F3			No	0.455	0.000	10.0	6/9/2006		Fail - Unknown Inst
PSP-29915F3	29915F3 Eppley PSP	TOT	Yes	0.446	0.650	10.0	6/9/2006	29926F3 Eppley PIR-V	OK
PSP-31289F3	31289F3 Eppley PSP	TOT	Yes	0.444	0.615	10.0	6/9/2006		OK
PSP-31285F3	31285F3 Eppley PSP	TOT	Yes	0.459	0.596	10.0	6/9/2006		OK
PSP-31290F3	31290F3 Eppley PSP	TOT	Yes	0.447	0.603	10.0	6/9/2006	30696F3 Eppley PIR	OK
PSP-31279F3	31279F3 Eppley PSP	TOT	Yes	0.536	0.487	10.0	6/9/2006	29926F3 Eppley PIR-V	OK
PSP-31276F3	31276F3 Eppley PSP	TOT	Yes	0.467	0.573	10.0	6/9/2006	29926F3 Eppley PIR-V	OK
PSP-31274F3	31274F3 Eppley PSP	TOT	Yes	0.461	0.636	10.0	6/13/2006	29926F3 Eppley PIR-V	OK
PSP-31295F3	31295F3 Eppley PSP	TOT	Yes	0.462	0.545	10.0	6/13/2006	30696F3 Eppley PIR	OK
PSP-32018F3	32018F3 Eppley PSP	TOT	Yes	0.436	0.612	10.0	6/13/2006	29926F3 Eppley PIR-V	OK

Figure 11-2. Rnet Import Preview window

This table shows the status of the import process as it attempts to match incoming instrument identification numbers with instruments known to RCC. If the instrument is not in the RCC Instrument Inventory table, the field for Found Instrument ID is blank and the field for Import Status displays a *Fail* message. If the instrument is found, the values for each field are displayed in the line for the instrument indicating the values to be imported to the Instrument Inventory table. If all information is correct, click on *Import to Database*, and the values will be written to each instrument's record in the Instrument Inventory table. To compute the Rnet value from K1, RCC uses the RS@45 value computed during the last valid BORCAL. If this is a new instrument that has never been calibrated using RCC, then it will use the factory RS value entered in the instrument inventory table. If the factory RS is unavailable, then a *Fail* message will be displayed for that instrument. (All of the imported values can be entered or modified manually in the Instrument Inventory table or during the BORCAL configuration.)

11.2 Test Instrument and Meteorological Exports

From RCC's main window, select *File*→*Export*→*Test Instrument* or *File*→*Export*→*Meteorological Instrument*.⁹

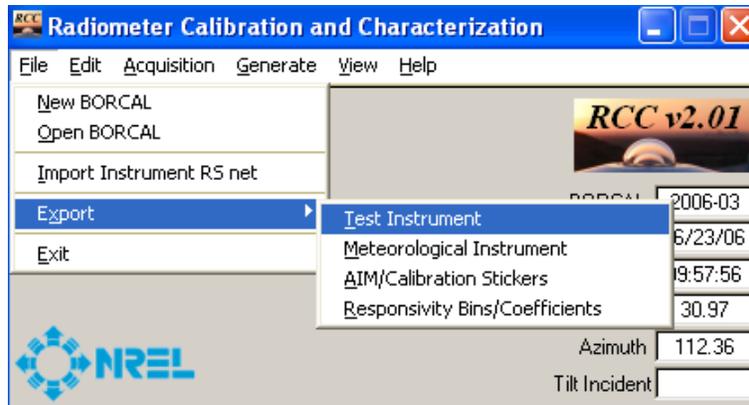


Figure 11-3. Selecting a test instrument export from RCC's main window

This brings up the Test Instrument Export or the Meteorological Export window. The two are very similar, but the Meteorological Export window does not have all options. (Exceptions are noted in the descriptions.)

⁹ RCC does not support exporting BORCAL-LW at this time.

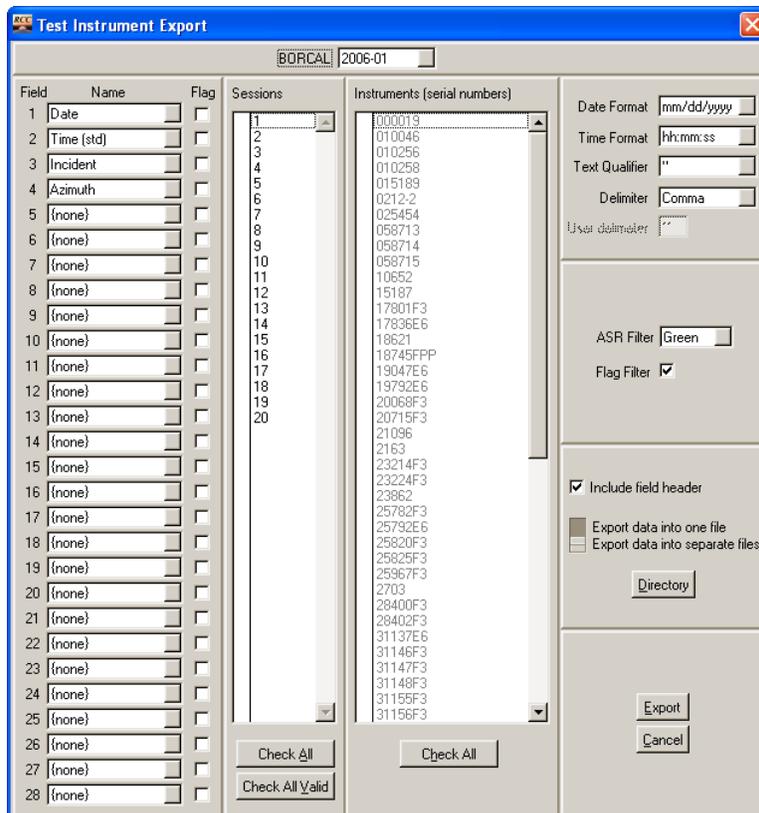


Figure 11-4. Test Instrument Export window

The Test Instrument Export window has the following configuration sections:

- Field selection
- Session selection
- Instrument selection (not available for meteorological exports)
- Format designation
- Filtering options (not available for meteorological exports)
- Output options (not available for meteorological exports).

11.2.1 Field Selection

11.2.1.1 Test Instrument Field Selection

This section allows you to configure the structure of the output record by choosing from among 15 fields:

- Date: calendar date of the measurement
- Time (standard): local standard time of the measurement
- Time (solar): solar time of the measurement
- Zenith: solar zenith angle at the time of the measurement

- Incident: angle of solar incidence between the sun and plane of the instrument
- Azimuth: solar azimuth angle
- Voltage: instrument output voltage
- Voltage (corrected): ENICR instrument output voltage
- Responsivity: calculated responsivity for the observation in $\mu\text{V}/\text{W}/\text{m}^2$
- Responsivity (corrected): ENICR calculated responsivity for the observation in $\mu\text{V}/\text{W}/\text{m}^2$
- Multiplier: calculated multiplicative calibration factor for the observation (reciprocal of the responsivity multiplied by 1,000) in $\text{mV}/\text{mW}/\text{cm}^2$
- Multiplier (corrected): ENICR calculated multiplicative calibration factor for the observation (reciprocal of the responsivity multiplied by 1,000) in $\text{mV}/\text{mW}/\text{cm}^2$
- Reference direct: reference direct beam measurement in W/m^2
- Reference diffuse: reference diffuse measurement in W/m^2
- Reference global: calculated global reference in W/m^2
- Effective Net IR: Effective Net Infrared Irradiance based on Pyrgometer Incoming IR (Win) and Instrument's Wout (if instrument has a case thermistor, otherwise Pyrgometer's Wout) in W/m^2
- Effective Net IR (Pyrgometer Wout): -- Effective Net Infrared Irradiance based on Pyrgometer Incoming IR (Win) and Pyrgometer's Wout in W/m^2
- Pyrgometer thermopile voltage: pyrgometer's thermopile voltage
- Pyrgometer case temperature ($^{\circ}\text{C}$)
- Pyrgometer dome temperature ($^{\circ}\text{C}$)
- Instrument case temperature ($^{\circ}\text{C}$)
- Instrument dome temperature ($^{\circ}\text{C}$)
- ASR score: ASR score during the measurement
- Session: data acquisition session number
- Instrument serial number: serial number of the instrument
- Pyrgometer serial number: serial number of the correcting pyrgometer
- Instrument Rnet: instrument's Effective Net Infrared response (determined by blackbody system)
- Pyrgometer coefficients: K0, K1, K2, K3, and Kr coefficients (each as a separate field).

Only the specified fields will be output, and the record will be formed from left to right on a single line using the specified delimiter (described below).

11.2.1.2 Meteorological Instrument Field Selection

This section allows you to configure the structure of the output record by choosing from among eight fields:

- Date: calendar date of the measurement
- Time (standard): local standard time of the measurement
- Time (solar): solar time of the measurement
- Reference direct: reference direct normal (beam) used for AOD estimation
- Temperature: temperature (°C)
- Relative humidity: relative humidity (%)
- Bar pressure: barometric pressure (mbarr)
- Broadband AOD: estimated broadband AOD (unitless).

The number on the left side of the field indicates the order that the field will appear in the output record. Each field is configured by clicking on the down arrow on the right side of the field and selecting the desired measurement or parameter from the pop-up list.

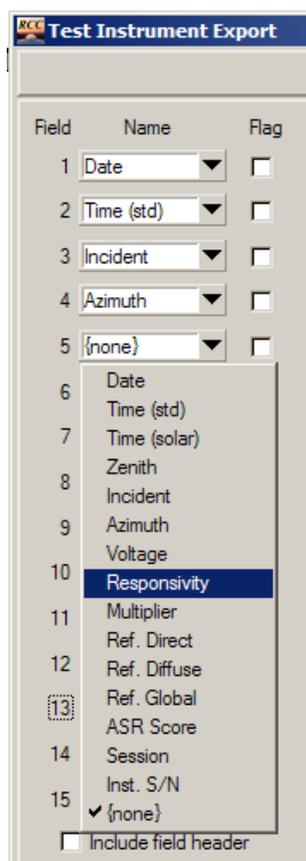


Figure 11-5. Selecting fields for test instrument export

Any parameter can be placed in any field position. Although the first four fields are preconfigured with Date, Standard Time, Incident Angle, and Azimuth Angle, these defaults can be overridden by selecting other parameters for those fields.

Fields designated with *(none)* will not be included in the output record even if such fields are designated between other parameter designations.

If the box for Flag is checked, a flag field will be output following the parameter value. Not all parameters have flags, and if a flag field is specified for such cases, no flag field will be output.

If the box for Include Field Header is checked, the file will contain a header that defines all fields.

11.2.2 Session Selection

You can select the sessions from which the data are read by selecting from among the options in the Sessions list.

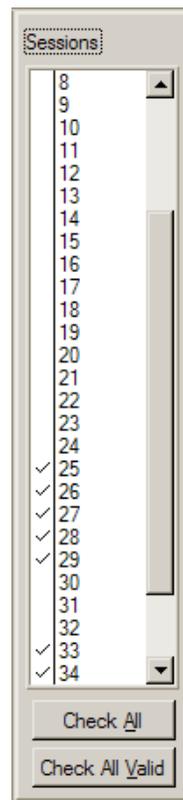


Figure 11-6. Selecting sessions for test instrument export

Select a session by clicking in the leftmost column. A check mark indicates a selected session. Clicking on *Check All* selects all sessions. Selecting *Check All Valid* selects all valid sessions by drawing from the same source as that used for instrument characterizations. (See Section 11.2.5 on Filtering Options.)

11.2.3 Instrument Selection

You can select the instruments to be included in the output file by selecting from among the options in the Instruments list (not available for meteorological exports).

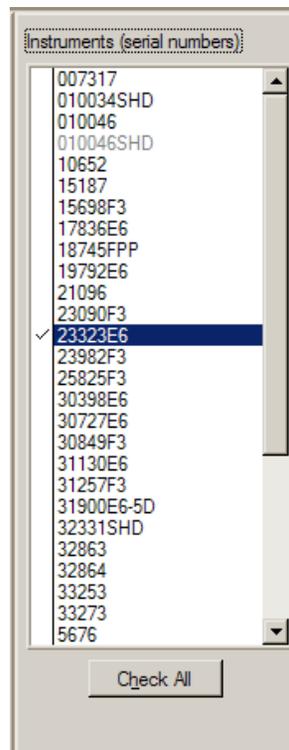


Figure 11-7. Selecting instruments for test instrument export

Select an instrument by clicking in the leftmost column. A check mark indicates a selected instrument. Clicking on *Check All* will select all instruments. If an instrument name in the list appears gray, it means that no data are available for the selected session, and the output file will not contain any data records.

11.2.4 Format Designation

Several options are available for the output file format. These are shown in the upper right corner of the window.

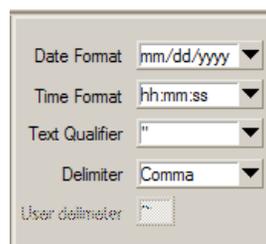


Figure 11-8. Selecting output format for test instrument export

Options are accessible by clicking on the down arrow on the right side of each field. All options are described below.

- Date format
 - mm/dd/yyyy: month-day-year (slash delimited)
 - dd/mm/yyyy: day-month-year (slash delimited)
 - yyyy/mm/dd: year-month-day (slash delimited)
 - yyyymmdd: year-month-day (no delimiter)
 - mmm/dd/yyyy: month abbreviation-day-year (slash delimited)
 - dd-mmm-yyyy: day-month abbreviation-year (dash delimited).
- Time format
 - hh:mm:ss: hour-minute-second (colon delimited)
 - hhmmss: hour-minute-second (no delimiter)
 - hh.dddd: decimal hour.
- Text qualifier (character used to indicate text fields)
 - “: double quote
 - ‘: single quote
 - {none}: no qualifier.
- Delimiter (character used to separate data fields in the output record)
 - Comma
 - Space
 - Tab
 - Semicolon
 - User defined: If this option is selected, a single character can be entered in the box for User Delimiter on the window. This box is dimmed until the option for User Defined is selected.

11.2.5 Filtering Options

This option allows you to filter data by using either the ASR score or the data flag (not available for meteorological exports).

- Choose the desired ASR designation (blue, green, brown, or red) by clicking on the down arrow on the right side of the field and selecting it from the list.
- The Flag option will filter data according to the data flags. Regardless of the output instruments selected, any measurement with an associated abnormal flag will not be output. For example, a test instrument measurement that has associated flagged reference instrument data will be excluded.

Although the data filter that is configurable here is similar to that used for characterizing the instrument responsivity, additional steps occur during the responsivity calculations that are not duplicated here. Thus, it is not possible to ensure that the exported data set is the same as that used for the responsivity calculations. However, the exact data set used for the responsivity calculations for each instrument is located in the data folder for the BORCAL within the CALDAT folder. Although that data set is not configurable for output fields, it is possible to examine those files with a text editor to determine the exact measurements used for the responsivity calculations.

The configuration in the Inclusion/Exclusion section also affects the exported data. However, the processes for data exclusion and ignoring a flag are optimized for internal program responsivity calculations and may sometimes produce unexpected behavior when exporting data. For example, some calculated fields may appear as missing in the export file if necessary fields are not available.

11.2.6 Output Options

You can select naming options for the file output by using the box for Output Options (not available for meteorological exports; data are always put in a single file).

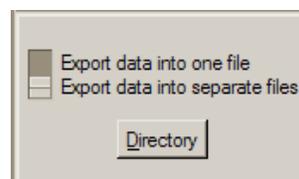


Figure 11-9. Output options for naming the file for test instrument export

Use the slider to select from the following two options:

- Export data into one file: all records are placed in a single file. It is necessary to select Instrument Serial Number as an output field to identify the source of the data record. When this selection is made, the button at the bottom changes to *File Name*, allowing you to specify the output file name and directory. The file output will be grouped by the instrument—i.e., all records for an instrument will be in one group followed by the group of records for the next instrument, etc.
- Export data into separate files: data from each instrument will be placed in a separate file. Files will be named according to the instrument's serial number and type. The button for Directory allows you to choose the directory for the output file from a conventional browsing window.

11.3 AIM Database and Calibration Sticker Data

RCC provides two special-purpose formats for exporting calibration data: the AIM database format and a file formatted for the LabelRIGHT calibration sticker generation program. These output formats are fixed and cannot be modified. Only instruments configured as AIM Exportable in the Radiometer Inventory table will be transferred to the AIM database.

Access these exports from *File*→*Export*→*AIM/Calibration Stickers* on RCC’s main window (for both BORCAL-SW and BORCAL-LW).

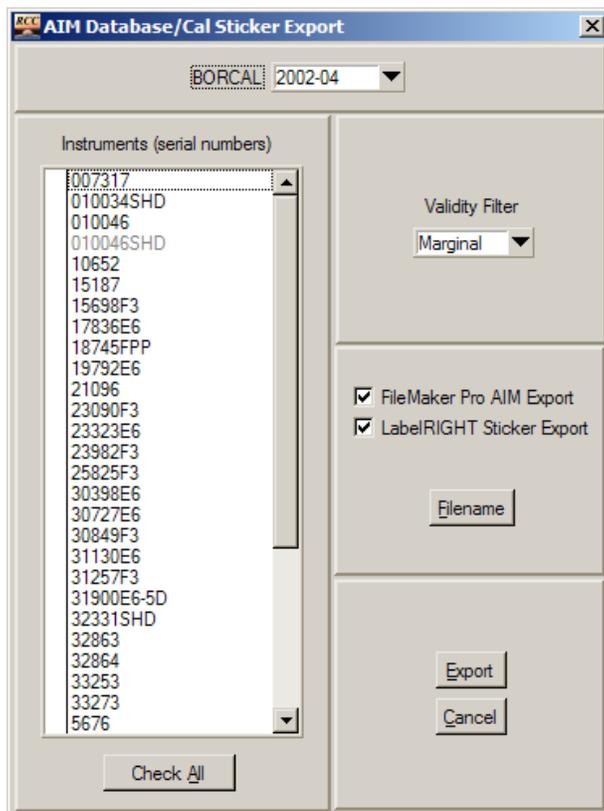


Figure 11-10. AIM Database/Calibration Sticker Export window

In this window, the following options are available:

- Select the desired BORCAL. A window opens with the currently selected BORCAL, but another BORCAL can be selected from the pulldown list at the top of the window, and the instrument list will be updated.
- Select the instruments to include in the export (or click on *Check All* to select all instruments). Instruments with gray lettering have been marked as invalid and cannot be selected for export.
- Set the validity filter. This defaults to *Marginal*, which will include all instruments in the export that have not been marked as invalid. If the valid option is chosen, instruments with a marginal or invalid designation will be excluded from the export.
- Select either or both of the output formats for export.
- Set the file name and output directory. If both formats are selected, they will both have the same file name, but they will have different file name extensions. (AIM exports will have a *.aim.csv* extension, and the label format will have a *.lbl.txt* extension. The default directory is the Export folder located within the current BORCAL data folder.

For BORCAL-SW, The AIM export also creates special files (one per instrument per export type) for use in posting data to the National Renewable Energy Laboratory’s AIM database website. These files are sent to a folder created by RCC on the I: drive. This is intended to be a mapped network drive wherein the web-accessible files for AIM are stored. The folder is named:

I:\<Site>\<Borcal_id>\<Instrument Id>.<Export Code>.txt

Where *Site* is the site-abbreviated name, *Borcal_id* is the BORCAL identification number, *Instrument ID* is the instrument’s serial number and type, and *Export Code* corresponds to the type of export, as shown in the table below.

Table 11-1. BORCAL-SW Export Codes for File Names

Export Type	Export Code
Two-degree bins	2deg
Two-degree bins (avg.)	2avg
Responsivity coefficients	coef
Latitude optimized	lato

Click *Export* to start the export. Click *Cancel* to exit the window without exporting data.

If the I: drive is not accessible during an export for the AIM database, a warning message will be issued. Although these special files will not be generated, the *.aim.csv* and or *.lbl.txt* files will be generated in the specified directory.

11.4 Exporting Responsivity Bin and Coefficients (BORCAL-SW Only)

Responsivity characterizations for a radiometer can be exported to a formatted text file for import to other applications. These are:

- Two-degree responsivities
- Two-degree responsivities (interpolated/extrapolated and averaged)
- Latitude-optimized responsivities
- Responsivity function coefficients.

Access these exports from *File* → *Export* → *Bins/Coefficients* on RCC’s main window (BORCAL-SW only).

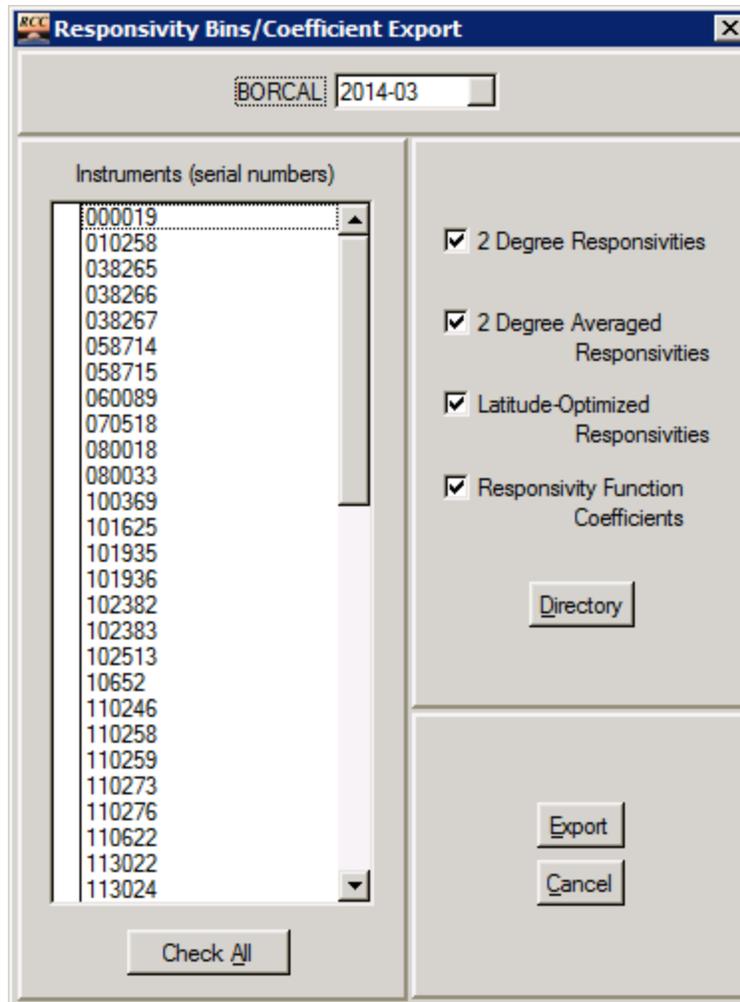


Figure 11-11. Responsivity Bins/Coefficient Export window

In this window, the following options are available:

- Select the desired BORCAL. The window opens with the currently selected BORCAL, but another BORCAL can be selected from the pulldown list at the top of the window, and the instrument list will be updated.
- Select the instruments to include in the export (or click on *Check All* to select all instruments). Instruments with gray lettering have been marked as invalid and cannot be selected for export.
- Select one or multiple export types.
- Use the button for Directory to choose the directory from a conventional browsing window for the output file. The default directory is the Export folder located within the current BORCAL data folder.

The export files (one per instrument per export type) will all reside in the same folder. The files will be named:

<Instrument Id>.<Export Code>.txt

Where *Instrument ID* is the instrument's serial number and type, and *Export Code* corresponds to the type of export, as shown in the table below.

Table 11-2. BORCAL-SW Export Codes for File Names

Export Type	Export Code
Two-degree bins	2deg
Two-degree bins (avg.)	2avg
Responsivity coefficients	coef
Latitude optimized	lato

Below are sample file names from a PSP pyranometer for the four export types:

- 29277F3 Eppley PSP.2deg.txt
- 29277F3 Eppley PSP.2avg.txt
- 29277F3 Eppley PSP.coef.txt
- 29277F3 Eppley PSP.lato.txt.

The file formats are self-documenting in the file header or otherwise explained in the file with plain text. Values are expressed in exponential notation, and missing values are flagged with a value of -9.90000000e+03.

12 Report Generation

RCC provides the capability to generate several reports for examining output or archiving.

- Responsivities or coefficients generation (prior to generating reports)
- Reports
 - Instrument results
 - Full reports
 - Customer reports
 - Calibration certificates
- Operator log (BORCAL-SW only).

12.1 Responsivities or Coefficients

12.1.1 Responsivity Generation (BORCAL-SW Only)

This function does not generate a report per se, but rather it is fundamental and necessary to the data used in other reports. As such, this function must be run before any of the other results reports can be generated. As part of the responsivity generation, the system will update the Calibration Data table with responsivities (see warning below). Calibration data will have an accompanying flag in the data table, which is set according to the rules listed in Table 12-1.

Table 12-1. Flags for BORCAL-SW Responsivity Generation

Condition	Flag
The data set does not include at least some measurements in the zenith angles that range from 0–30 and 75–90 degrees.	Marginal
No data exists (after filtering)	Invalid

The instrument calibration record will receive a valid flag unless the conditions shown in Table 12-1 are met. The operator can override this flag if other conditions are known to exist.

Select *Generate*→*Responsivities* from RCC’s main window (in SW mode) to access the Generate Responsivities window, as shown below.

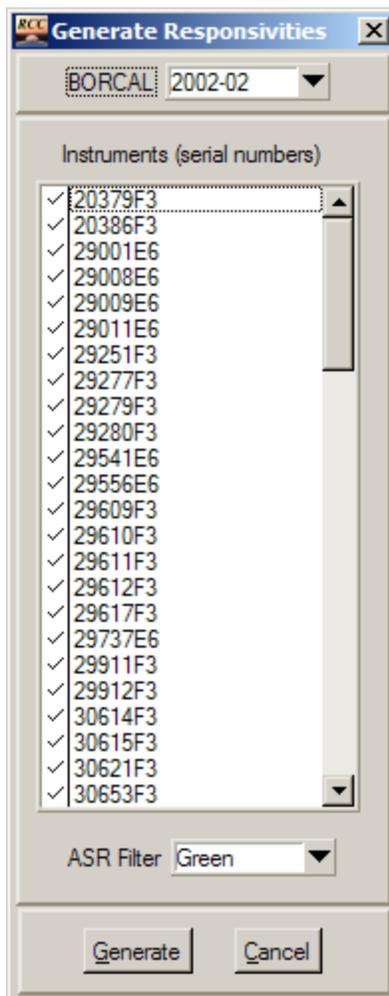


Figure 12-1. BORCAL-SW Generate Responsivities window

In this window, you can configure the responsivity generation by using the following options:

- **BORCAL:** The window opens with the currently selected BORCAL, but this can be changed by accessing a BORCAL list by clicking on the down arrow on the right side of the BORCAL field at the top of the window. The instrument list will be updated if another BORCAL is selected.
- **Instrument selection:** The default is all instruments, but you may deselect any instrument by clicking in the leftmost column to remove the check mark.
- **ASR filter;** This invokes filtering to remove data with ASR scores more severe than that selected. For example, selecting *Green* will remove *Brown* and *Red*, but retain both *Green* and *Blue* because *Blue* is a less severe designation than *Green*.

Click on *Generate* to generate the responsivities. Click on *Cancel* to exit without generating the responsivities.

Warning: When invoking this action, you will destroy any previously generated results for the BORCAL. When running the responsivity generation, the system removes any existing responsivities for all instruments in the selected BORCAL, and the deleted records cannot be reconstructed. Even when an instrument is not selected, data for that instrument will be removed from the database and replaced with a record indicating an invalid result. Additionally, if comments have previously been added to responsivity records for any instrument, those will be removed and replaced with a blank comment field for the newly generated responsivities.

12.1.2 Coefficients Generation (BORCAL-LW Only)

This function does not generate a report per se, but rather it is fundamental and necessary to the data used in other reports. As such, this function must be run before any of the other results reports can be generated. As part of the coefficient generation, the system will update the Calibration Data table with coefficients (see warning below). Calibration data will have an accompanying flag in the data table, set according to the rule listed in Table 12-2.

Table 12-2. Flags for BORCAL-LW Responsivity Generation

Condition	Flag
No data exists (after filtering)	Invalid

The instrument calibration record will receive a valid flag unless the condition shown in Table 12-2 is met. The operator can override this flag if other conditions are known to exist.

Select *Generate* → *Responsivities* from RCC’s main window (in LW mode) to access the Generate Responsivities window.

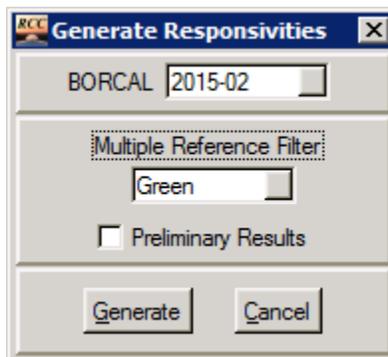


Figure 12-2. BORCAL-LW Generate Responsivities window

In this window, you can configure the coefficient generation by using the following options:

- **BORCAL:** The window opens with the currently selected BORCAL, but this can be changed by accessing a BORCAL list by clicking on the down arrow on the right side of the BORCAL field at the top of the window. The instrument list will be updated if another BORCAL is selected.

- Multiple reference filter: This invokes filtering to remove data when the difference between multiple references exceeds the limit for the color codes as defined in the system configuration
- Preliminary results: This will cause the software to generate the preliminary residual plots using previous BORCAL coefficients (or manufacture single responsivity); see Section 18.2.4 on File Format for more information. No information will be added to the calibration database.

Click on *Generate* to generate the coefficients. Click on *Cancel* to exit without generating the responsivities.

Warning: When invoking this action, you will destroy any previously generated results for the BORCAL. When running the coefficient generation, the system removes any existing coefficients for all instruments in the selected BORCAL, and the deleted records cannot be reconstructed. Even when selecting preliminary results, calibration results for that BORCAL will be removed from the database. Additionally, if comments have previously been added to coefficient records for any instrument, those will be removed and replaced with a blank comments field for the newly generated coefficients.

12.2 Reports

After responsivities have been generated, several methods are available for viewing the results.

If any changes are made to the BORCAL configuration (for instance, adding or deleting an instrument) or additional data are acquired, *you must regenerate the responsivities or coefficients* (as described above). To ensure that the report reflects the current state of the system, report generation is blocked until responsivities are generated or regenerated.

12.2.1 Instrument Results

Two options are available for viewing results for individual instruments by selecting one of the following from RCC's main window:

- *Generate* → *Report* → *Instrument Results* → *by BORCAL*
- *Generate* → *Report* → *Instrument Results* → *by Instrument*.

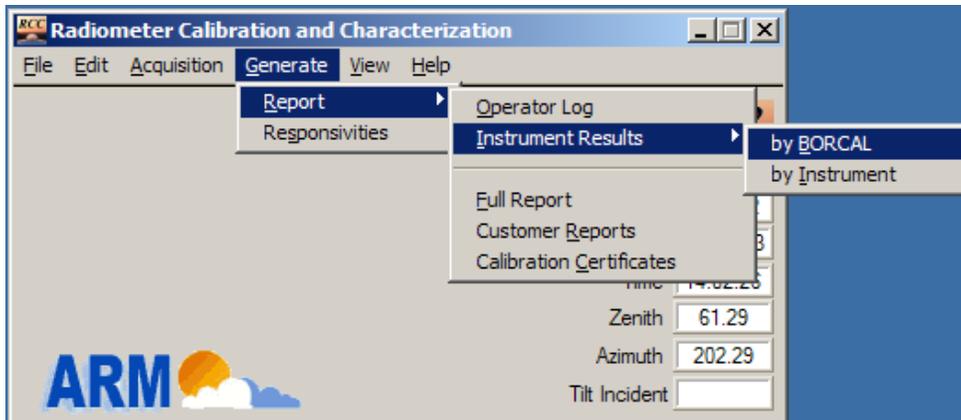


Figure 12-3. Selecting instrument results from RCC's main window

12.2.1.1 By BORCAL

This option allows you to choose from all instruments within a specified BORCAL. See the sample window below.

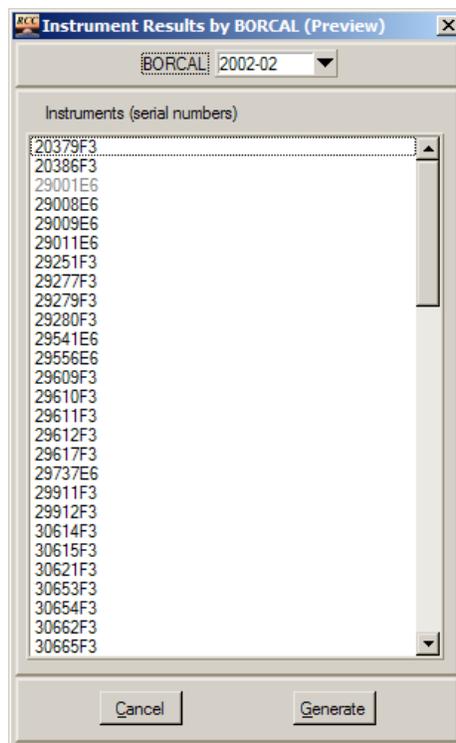


Figure 12-4. Instrument Results by BORCAL window

In this window, click on the desired instrument, and then click on *Generate*.

12.2.1.2 By Instrument

This option allows you to specify an instrument and then choose from among the results for that instrument from all the BORCALs that included it. When using this option, you will first see the window shown below.

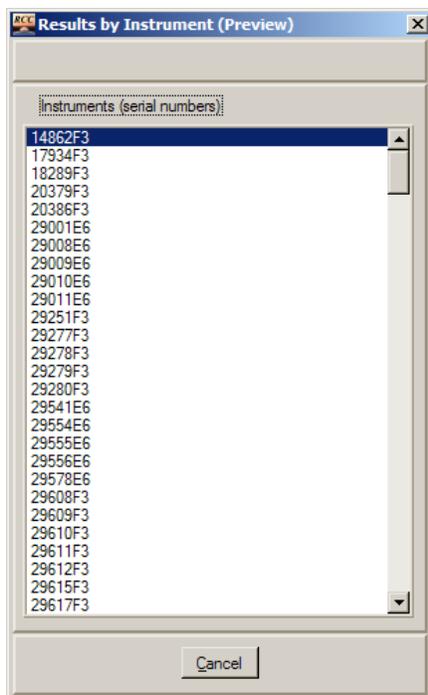


Figure 12-5. Results by Instrument window

Double-click on the desired instrument. When the instrument is selected, you are presented with a list of all BORCALs in which that instrument was included.

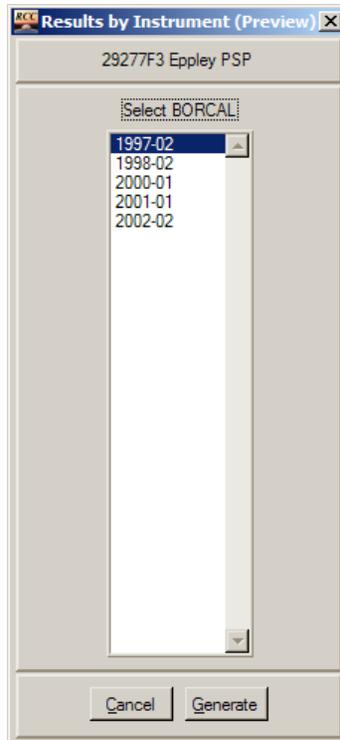


Figure 12-6. BORCAL Results by Instrument window

Select the desired BORCAL, and then click on *Generate*.

12.2.1.3 Instrument Results

When the instrument results have been generated from either of the above two steps, you are presented with previews of the data pages from the standard report for the instrument. Use the buttons at the top and bottom of the window to navigate to other pages in the instrument's report.

12.2.1.4 BORCAL-SW Only

On the second page (titled *Calibration Results*), the plots are color coded to show subsets of data. The left plot (responsivity compared to zenith angle) shows the morning and afternoon data in different colors. The right plot (responsivity compared to local standard time) shows the data from each day in a different color.

The plot on the right side interactively allows you to select a single data point and obtain date and responsivity information. Using the mouse, click near a point of interest, and the cursor will snap to the nearest point. You can then read the date, time, and responsivity values for that point from the display. For example, in the following plot, the user clicked on a data point near noon (the red crosshairs), and the date, time, and responsivity are displayed below the plot.

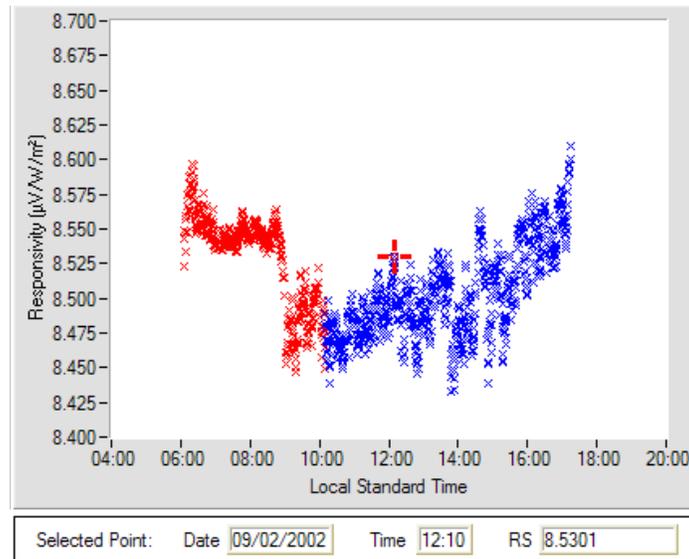


Figure 12-7. Viewing date and time for individual BORCAL-SW responsivities

Due to plot resolution restrictions, the times displayed in the Time field are approximate and sometimes inaccurate by up to 3 minutes. However, the responsivity and approximate time information together is valuable to help pinpoint a measurement in an exported data file wherein the times are exact.

Select other points by using the mouse to click in a different location. Or, by using the keyboard up and down arrow keys, you can move the cursor one point at a time across the plot. The arrow keys move the cursor along data from a single day (a single color); if you want to examine data from a different day, you must use the mouse to click near another data point.

12.2.2 Full Reports

The full report contains all reportable information about a BORCAL including individual instrument results, ancillary data, system notes, and operator logs. To generate the full report, select *Generate*→*Report*→*Full Report* from RCC's main window. This brings up the Full Report Generation window, as shown below.

The screenshot shows a software window titled "Full Report Generation" with a blue header bar. The main content area has a light gray background and is titled "BORCAL 2011-01 Full Report" in large, bold, dark gray text. Below the title are several input fields and a dropdown menu:

- Report Main Title:** A text box containing "National Renewable Energy Laboratory".
- Report Sub Title:** A text box containing "Solar Radiation Research Laboratory".
- Second Sub Title:** A text box containing "Metrology Laboratory".
- Manager Name (Signature):** A text box containing "Ibrahim Reda".
- Title:** A dropdown menu with "Technical Manager" selected.
- Tech. managers contact info:** A text box containing "ibrahim.reda@nrel.gov; 303-384-6385; 1617 Cole Blvd, Golden, CO 80401, U".
- Calibration Procedure:** A text box containing "BORCAL-P00-Calibration and QA Procedure; available upon request."
- Report Date:** A text box containing "03/07/2011".
- Calibration Facility URL:** A text box containing "http://www.nrel.gov/solar_radiation/".
- Additional Notes or Comments:** A large, empty text area.

At the bottom of the window are two buttons: "Generate" and "Cancel".

Figure 12-8. Full Report Generation window¹⁰

¹⁰ The Longwave Full Report screen includes one additional entry for *Longwave Operators*.

This window allows you to customize the title and other portions of the report. Each configurable field is described below:

- Report main title: first line of the title on the calibration certificates
- Report subtitle: second line of the title on the calibration certificates
- Second subtitle: third line of the title on the calibration certificates
- Manager name: manager or deputy signing under the certificate
- Technical manager's contact information: contact information for the technical manager
- Calibration procedures: document name of the current calibration procedure
- Report date: date that appears on the front of the report. This defaults to the current date, but it may be overwritten if desired.
- Calibration facility URL: text of the URL that appears on the last line of the ancillary data page of the calibration certificate as the last part of the following sentence: *For other information about the calibration facility, visit: -----*
- LW operators (BORCAL-LW full report only): names of operators that conducted the BORCAL-LW (It does not require an operator login.)
- Additional notes or comments: text that appears after the boilerplate introductory text on the third page of the report (under the introduction).

When this window appears, all fields except for those for Additional Notes and Comments (which are left blank) default to the values used in the previous BORCAL.

Generate the report by clicking on *Generate*. This action brings up the print dialog box, which allows you to direct the output to a particular printer or other output device, such as an RCC certified PDF writer. Unless otherwise required for special purposes, print the report using the default values for the printer.

12.2.3 Customer Reports

The system will generate reports for individual customers with a subset of data that applies only to the selected customer. These customer reports do not include the session audit report, operator logs, or instrument notes that apply to other customer's instruments.

To help ensure that the customer reports are synchronized with the full report, the customer reports cannot be generated until <i>after</i> the full report has been generated.

To generate a customer report, select *Generate*→*Report*→*Customer Report* from RCC's main window. This brings up a customer selection list, as shown below.

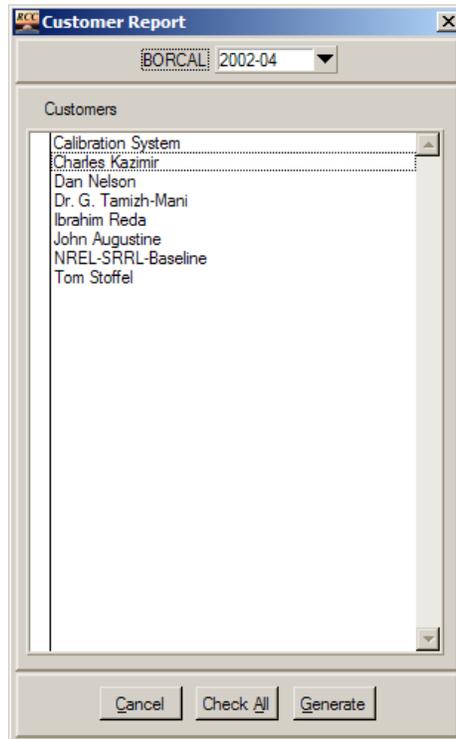


Figure 12-9. Customer Report window

From this list, select the desired BORCAL (at the top) and customer(s) by clicking in the left column. Selected customers are indicated by a check mark. Alternatively, you can click on *Check All* to select all customers. Click on *Generate*, and a separate report will be generated for each customer selected.

The information in this report configuration (such as report date and certificate titles) is drawn from the full report configuration.

As with the full report, you will be presented with a printer dialog box to select the desired printer or other output device.

12.2.4 Calibration Certificates

Generate calibration certificates for each instrument in a BORCAL by selecting *Generate*→*Report*→*Calibration Certificates* from RCC's main window. This brings up the Instrument Certificates window, shown below.

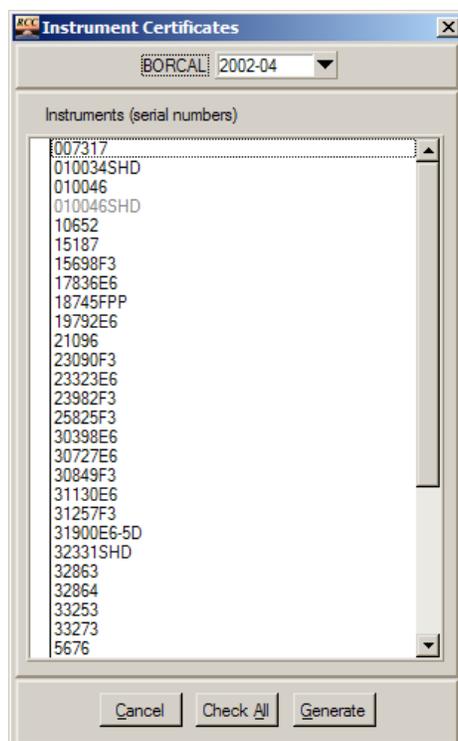


Figure 12-10. Instrument Certificates window

Select the BORCAL in the top field, and then select desired instruments by clicking in the left column beside the instrument name. Selected instruments are indicated by a check mark. Alternatively, click *Check All* to select all instruments. Instruments appearing with gray lettering do not have valid results (i.e., they are invalid) and cannot be selected.

Click on *Generate* to generate a certificate for all selected instruments. As with the report generation functions, you will be presented with a printer dialog box to select the desired printer or other output device.

12.3 Operator Log (BORCAL-SW Only)

You can view and print the BORCAL operator logs by selecting *Generate*→*Report*→*Operator Log* from RCC's main window (in SW mode). This brings up a window that contains all operator log entries for the current BORCAL (use *File*→*Open BORCAL* from RCC's main window if another BORCAL is desired). A sample window is shown below.

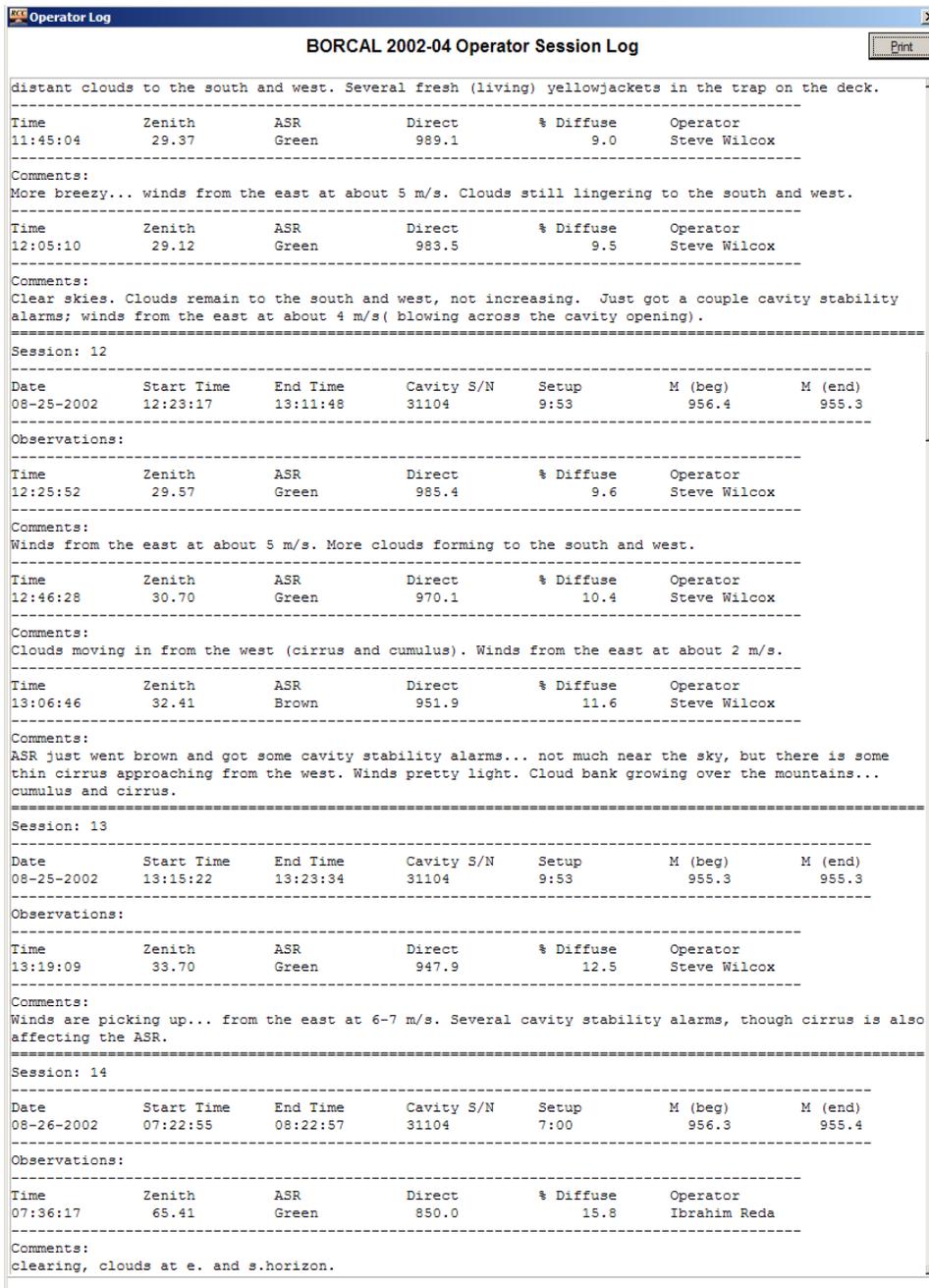


Figure 12-11. Viewing operator logs

Use the scroll bar at the right to navigate through the report. Click on *Print* in the upper right corner to print the report. Close the window by using the conventional Windows close button (X) in the upper right corner.

13 Viewing Time and Geometry Displays

Whenever the system is running, the date, time, and solar geometry displays are updated on RCC's main window. These displays can be removed from view or enlarged (excluding the date) for the operator's convenience.

13.1 Removing or Restoring Displays

From RCC's main window, select *View*→*Date/Time* or *View*→*Solar Geometry*.

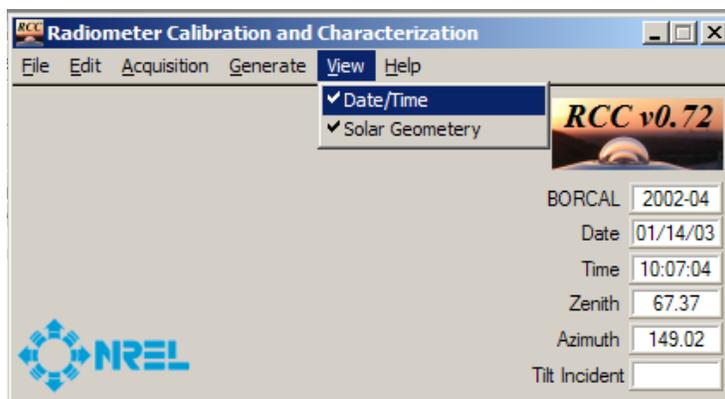


Figure 13-1. Changing the visibility of the date/time and solar geometry

The status of the view is indicated by the check mark next to the menu options. If either option is selected, the designated information will toggle between displayed and hidden.

13.2 Enlarging Displays

You can create portable, resizable displays for the fields for Time, Zenith, Azimuth, or Tilt Incident by double-clicking on the corresponding display on RCC's main window. This action creates a larger window in the middle of the screen that contains the same time or geometry information. As shown below, these windows can be resized and moved anywhere on the desktop.

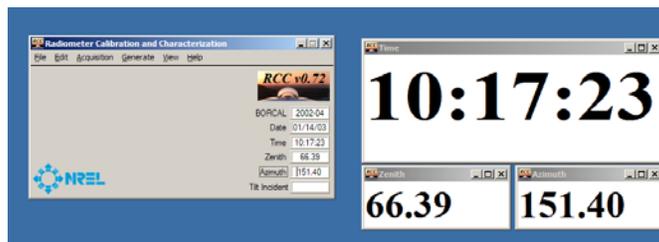


Figure 13-2. Enlarged Time and Solar Geometry windows

Enlarging multiple controls without moving the enlarged versions will cause the windows to stack in the middle of the screen, each one hiding the previous window. Under such circumstances, you must move the windows to view all of them.

These displays are included in the layout configuration during data acquisition and will appear on the screen as they were when the Save Layout command is issued.

14 Data Logger Channel Check

Annual checks of the data logger system must be performed before the calibration season. This tests not only the data logger but all cabling used by the system for all instrumentation (with the exception of the cavity). Prior to starting the channel check in the software, a technician should check that all connections for each instrument are isolated or “open.” This means connecting an ohm meter to each instrument connector on the outdoor platform to verify that the high and low pins are open, high to shield are open, and low to shield are open. If there are additional pins for thermistor channels, then all those combinations should be checked as well.

After the isolation test is completed, the software-based channel check requires two people: an operator at the computer and an assistant at the instrument channel being checked. These two people should be in easy communication with each other.

The channel check consists of placing a short on the high and low pins of each sensor and measuring the offset voltage using the lowest data logger range. In addition for channels that support resistance, the short is placed on those channels, and the resistance offset is measured.¹¹

For facilities that have two independent data loggers for BORCAL-SW and BORCAL-LW, the data loggers must be checked separately; therefore, it is important to select the BORCAL type from the main menu prior to running test.¹²

¹¹ For new installations (or as required by the BORCAL technical manager), additional source tests may be performed by placing a voltage source (such as 5 mV) on each channel and a resistor (such as 10 k Ω or 100 Ω) on channels supporting resistance. The source tests are not required to be conducted on an annual basis.

¹² The Channel Check function supports only the RAPDAQ data logger. Obsolete data acquisition systems supported by RCC must be checked by using a separate software package.

14.1 Performing a Channel Check

From RCC's main window, first select the proper BORCAL type (SW or LW), then select *Acquisition*→*Channel Check*, as shown below.¹³

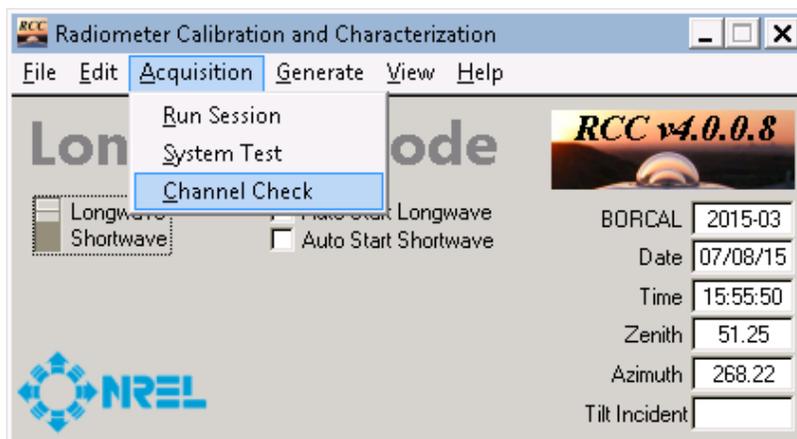


Figure 14-1. Selecting a channel check from RCC's main window

The System Test window appears and requires the user to configure the data logger. The channel check is independent of the BORCAL configuration (and for new facilities, it is run before any BORCAL event is configured); therefore, the user must configure each time the Channel Check is launched.

¹³ For facilities that share the same data logger for both BORCAL-SW and BORCAL-LW, the BORCAL type switch position does not matter.

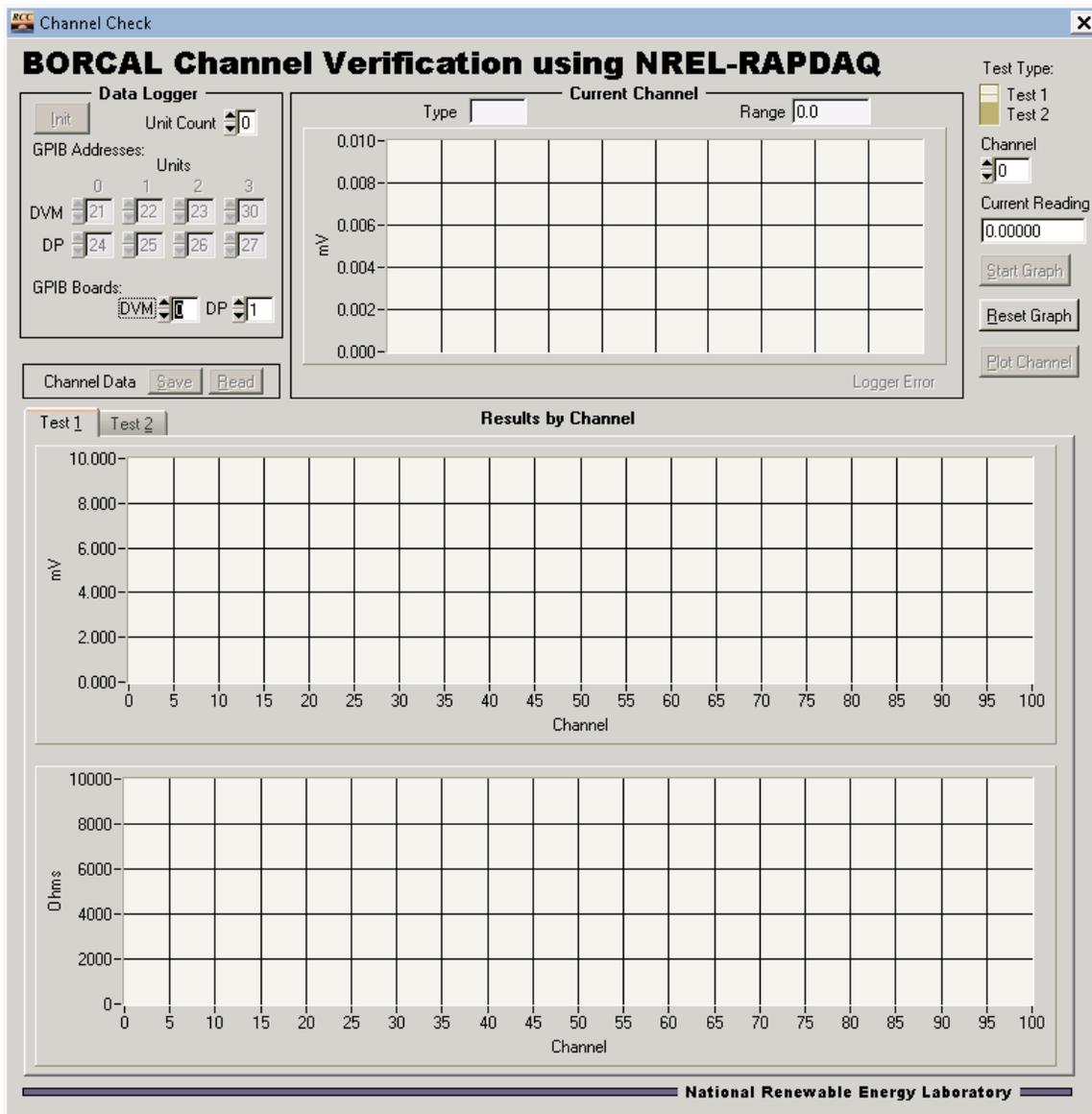


Figure 14-2. BORCAL Channel Verification window

First select the number of RAPDAQ systems that are attached to the system. If the facility has a dedicated RAPDAQ system for BORCAL-LW and BORCAL-SW, then they are tested separately; therefore, enter ONLY the RAPDAQ for the particular dedicated system being tested. Then enter the GPIB addresses for each device and the associated GPIB board numbers. Typically for SW RAPDAQ systems, the default addresses are correct. For BORCAL-LW dedicated systems, the user will need to change the default GPIB addresses appropriately.

After the RAPDAQ has been configured, click on *Init*. If there are any errors, double check the data logger configuration. After initialization is successful, click on *Start Graph*.

The following sequence describes the operator and assistant actions to conduct the system test:

- Assistant: Place a shorting plug on the first position or location that is associated with the RAPDAQ being tested. (The shorting plug should short the pins associated with the both the voltage and resistance measurements if the position supports voltage and resistance using the same connector [facility dependent]. Also, if the facility supports four-wire resistance, a special shorting fixture may be required to properly short all four pins.)
- Operator: Based on the hardware infrastructure at the facility, the operator will look up the voltage channel number associated with the position. Enter that channel number into the Channel box, and view the real-time data on the upper plot (labeled *Current Channel*), or view the current reading listed as *Current Reading*. (The scaling of the upper plot may be maxed out if the channel was over-ranged, which can be caused by reading a previous channel that was open or because the assistant did not have a short plug properly connected. To reset the range (and plot), the operator must click on *Reset Graph*. After 5–10 good data points appear on the upper plot, click on *Plot Channel* to accept the data and plot the resulting average, minimum, and maximum to the appropriate lower plot labeled *Results by Channel*. If bad data has been plotted, simply acquire new data, and click on *Plot Channel* again to replace it.)

Depending on the facility infrastructure, a second test may be required on the same position that is being shorted by the assistant. There are two typical possibilities (facility dependent): (1) that position has a resistance channel assigned to it (a different channel) (Case A), or (2) that position also supports resistance on the same channel (Case B).

For Case A, the operator will change the value in the field for Current Channel to the resistance channel associated with the same position, and the upper plot will plot the resistance in ohms. When sufficient data is obtained, plot the channel using the method described above.

For Case B, the operator will change the Test Type switch from *Voltage* to *Resistance* (the channel remains the same). When sufficient data is obtained, plot the channel using the method described above.

After all tests are complete for the first position, the operator will tell the assistant to move the shorting plug to the next position, and the operator will repeat the measurements for this position. This process continues for all positions.

When all positions have been checked, the operator will save the data to disk by clicking on *Save*. The data should be stored in the appropriate subfolder with file name located in the SystemCheck folder contained in the main BORCAL folder.

If the operator wants to, they can save data at any time, restart the software at a later time, and reload previous data by clicking on *Read* and selecting the previous file that was saved to disk. The results from the channel check (the saved data file) should be given to the BORCAL technical manager so that data logger offsets (for all measurement types) can be computed. This information is required for the BORCAL system configuration and is considered in the uncertainty of the calibrations.¹⁴

¹⁴ In a future release of RCC, the data logger offsets may be computed automatically.

14.2 Configuring the Channel Check

For new facilities (or new data acquisition systems), the function(s) of each channel must be assigned in a text file located in the BORCAL\CONFIG folder.

The operator must initially configure the file with information specific to the calibration site according to the instructions below. The files are named:

- logger_define.SW.txt
- logger_define.LW.txt

There are two files: one for the SW data acquisition and one for the LW data acquisition. If the facility shares the same data acquisition for BORCAL-SW and BORCAL-LW, then simply create one file first AND copy and paste/rename it as the other file so that the file contents are identical.

The first line defines the names of the two tests available at the facility. For example, for Case B described above, the first line might read:

- Channel Voltage Resistance

For Case A, the first line might read (however, the source test type may never be used):

- Channel Source Short

On each line thereafter, you will list the following information for each channel in one line (separated by tabs):

- Channel number
- Measurement type for the first test (VDC, RES, or RES4)
- Measurement range for the first test (in V for VDC and in kilo-ohms for RES or RES4). For voltage, pick the lowest range supported by the data logger. For resistance, pick the lowest range that will not over-range the data logger.
- Measurement type for the second test (VDC, RES, or RES4)
- Measurement range for the second test (in V for VDC and in kilo-ohms for RES or RES4). For voltage, pick the lowest range supported by the data logger. For resistance, pick the lowest range that will not over-range the data logger.

The figure below shows a sample lookup configuration file for a facility that has infrastructure that supports two measurement types (voltage and resistance) for each channel (Case B).

Channel	Voltage	Resistance		
0	VDC	0.001	RES	0.01
1	VDC	0.001	RES	0.01
2	VDC	0.001	RES4	0.001
3	VDC	0.001	RES4	0.001
4	VDC	0.001	RES	0.01
5	VDC	0.001	RES	0.01
6	VDC	0.001	RES4	0.001
7	VDC	0.001	RES4	0.001
8	VDC	0.001	RES	0.01
9	VDC	0.001	RES	0.01
10	VDC	0.001	RES4	0.001
11	VDC	0.001	RES4	0.001
12	VDC	0.001	RES	0.01
13	VDC	0.001	RES	0.01
14	VDC	0.001	RES4	0.001
15	VDC	0.001	RES4	0.001
16	VDC	0.001	RES	0.01
17	VDC	0.001	RES	0.01
18	VDC	0.001	RES4	0.001
19	VDC	0.001	RES4	0.001
20	VDC	0.001	RES	0.01
21	VDC	0.001	RES	0.01
22	VDC	0.001	RES4	0.001
23	VDC	0.001	RES4	0.001
24	VDC	0.001	RES	0.01
25	VDC	0.001	RES	0.01
26	VDC	0.001	RES4	0.001
27	VDC	0.001	RES4	0.001

Figure 14-3. Example channel check configuration file (Case B)

The figure below shows a sample lookup configuration file for a facility that has infrastructure that supports only one measurement type on each channel (voltage or resistance). In this case, the user can assign an optional second test using a different range for a source test (Case A).

Channel	Source	Short		
0	VDC	0.01	VDC	0.001
1	VDC	0.01	VDC	0.001
2	VDC	0.01	VDC	0.001
3	VDC	0.01	VDC	0.001
4	VDC	0.01	VDC	0.001
5	VDC	0.01	VDC	0.001
6	VDC	0.01	VDC	0.001
7	VDC	0.01	VDC	0.001
8	VDC	0.01	VDC	0.001
9	VDC	0.01	VDC	0.001
10	VDC	0.01	VDC	0.001
11	VDC	0.01	VDC	0.001
12	VDC	0.01	VDC	0.001
13	VDC	0.01	VDC	0.001
14	VDC	0.01	VDC	0.001
15	VDC	0.01	VDC	0.001
16	VDC	0.01	VDC	0.001
17	VDC	0.01	VDC	0.001
18	VDC	0.01	VDC	0.001
19	VDC	0.01	VDC	0.001
20	VDC	0.01	VDC	0.001
21	VDC	0.01	VDC	0.001
22	VDC	0.01	VDC	0.001
23	VDC	0.01	VDC	0.001
24	VDC	0.01	VDC	0.001
25	VDC	0.01	VDC	0.001
26	VDC	0.01	VDC	0.001
27	VDC	0.01	VDC	0.001
28	VDC	0.01	VDC	0.001
29	VDC	0.01	VDC	0.001
30	VDC	0.01	VDC	0.001
31	VDC	0.01	VDC	0.001
32	VDC	0.01	VDC	0.001
33	VDC	0.01	VDC	0.001
34	VDC	0.01	VDC	0.001
35	VDC	0.01	VDC	0.001
36	VDC	0.01	VDC	0.001
37	VDC	0.01	VDC	0.001
38	VDC	0.01	VDC	0.001
39	VDC	0.01	VDC	0.001
40	VDC	0.01	VDC	0.001
41	VDC	0.01	VDC	0.001
42	RES	10	RES	0.01
43	RES	10	RES	0.01
44	RES	10	RES	0.01
45	VDC	0.01	VDC	0.001
46	VDC	0.01	VDC	0.001
47	VDC	0.01	VDC	0.001
48	VDC	0.01	VDC	0.001
49	VDC	0.01	VDC	0.001
50	VDC	0.01	VDC	0.001
51	VDC	0.01	VDC	0.001
52	VDC	0.01	VDC	0.001
53	VDC	0.01	VDC	0.001
54	RES	10	RES	0.01
55	RES	10	RES	0.01
56	RES	10	RES	0.01
57	VDC	0.01	VDC	0.001
58	VDC	0.01	VDC	0.001

Figure 14-4. Example channel check configuration file (Case A)

15 RCC Help

Two items exist under the Help menu:

- RCC help: loads this document for viewing (if the system has Microsoft Word or other compatible word processor installed)
- About RCC: a splash screen showing the program attribution and the RCC version number.

16 Error Messages

Most sections of RCC protect against incorrect inputs by posting warning messages that guide the user to correct usage. However, some circumstances are either unanticipated or so rare that they do not warrant extensive error correction. In these cases, an error message is posted notifying the user that an error has occurred that could affect program operation. These messages fall into one of three categories:

- **Fatal error:** *The program has encountered an irrecoverable error condition.* The error is briefly described, and the user is cautioned to halt the program because it is likely that it is no longer operating reliably. These errors can occur if the database is corrupt, and the program cannot correct the problem without analysis from an experienced user.
- **Warning:** *The program has encountered a potential error condition.* The error is briefly described, and the user is urged to continue with caution because it is possible that the program is no longer operating reliably. The user should watch for any unusual behavior. These conditions can arise when data are incomplete but not corrupt or when other unexpected events occur, such as an errant clock setting.
- **Advisory:** *The program has encountered a possible error condition.* The condition is briefly described, and the user is asked to ensure that the condition is consistent with the program's use. Such an error could occur when information is unreliable, but it is likely to capture the attention of the operator at the time it occurs.

When these errors occur and a cause or solution is not immediately obvious, the exact error message along with the circumstances should be sent to the National Renewable Energy Laboratory for analysis.

17 BORCAL-SW Data File Formats

17.1 Test Instrument

Test instrument files hold the raw data and metadata for test instrument measurements during data acquisition. These files also include ACR self-calibration measurements.

17.1.1 File Naming

Files reside in the folder for BORCAL\DATA_SW*<borcal_id>*\DATAFILES, and they are named according to the following convention:

Ggggsss.borcal_id

Where

- *G* is a literal
- *ggg* is the group designator
- *sss* is the session number
- *borcal_id* is the BORCAL identification number.

17.1.2 File Format

Table 17-1. BORCAL-SW G-File Metadata Header

Line	Record	Description
1	Group	Scan group number
2	Session	BORCAL and session
3	Location	Calibration facility
4	Lat/Lon/Tzone/Elev/Temp/Press	Latitude, longitude (decimal degrees), time zone (decimal hours from Greenwich, negative west of Greenwich), elevation (meters), site average temperature (°C), site average pressure (mBar)
5	DeltaT/Refract	Delta T and refraction for solar position
6	Session Start	Session start time as YYYYMMDD HH:MM:SS
7	Session End	Session end time as YYYYMMDD HH:MM:SS
8	Record Count	Count of data records
9	Scan Interval	Period between scans (seconds)
10	Cal Type	Calibration type (TOT = global; DIR = direct, DIF = shaded diffuse)
11	Units	Measurement units (V)
12	Tilt Zenith	Tilt calibration specification for instrument tilt (decimal degrees from zenith)

Line	Record	Description
14	Tilt Azimuth	Tilt calibration specification for instrument azimuth orientation (decimal degrees from north)
14	Logger Count	Number of data loggers
15	Logger Unc 1	Uncertainty of voltage reading (% of reading)
16	Logger Unc 2	Uncertainty of voltage reading, offset (V)
17	Logger Unc 3	Uncertainty of voltage range (V)
18	Logger Unc 4	Uncertainty of 2-wire resistance reading (% of reading)
19	Logger Unc 5	Uncertainty of 2-wire resistance reading, offset (Ω)
20	Logger Unc 6	Uncertainty of 2-wire resistance range (Ω)
21	Logger Unc 7	Uncertainty of 4-wire resistance reading (% of reading)
22	Logger Unc 8	Uncertainty of 4-wire resistance reading, offset (Ω)
23	Logger Unc 9	Uncertainty of 4-wire resistance range (Ω)
The next line is repeated for each data logger in the logger count.		
24**	Lx Data Logger	Data logger instrument identification number*
25**	Zenith Unc	Uncertainty of zenith angle calculation
26**	Cavity Count	Number of cavity radiometers
The next 29 lines (labeled Cx) are repeated for each cavity in the cavity count, with x replaced by the cavity number (1 through count)		
27**	Cx CAV	Cavity instrument identification number*
28**	Cx CON	Cavity control unit identification number*
29**	Cx RI1	Cavity shunt resistance value (Ω)
30**	Cx CIR	Cavity circuit resistance (Ω)
31**	Cx HTL	Cavity heater lead resistance (Ω)
32**	Cx HTR	Cavity heater resistance (Ω)
33**	Cx MCF	Cavity manufacturer's calibration factor
34**	Cx WIN	Window flag (0 = unwindowed; 1 = windowed)
35**	Cx WRR	Cavity WRR reduction factor
36**	Cx UNC	Uncertainty of the cavity WRR factor (%)
37**	Cx OFF	Not used
38**	Cx DSN	Cavity default sensitivity (mV/mW/cm ²)

Line	Record	Description
39**	Cx NSN	Cavity calculated (most recent) sensitivity (mV/mW/cm ²)
40**	Cx TPZ (beg)	Self-calibration TP zero (session start) (V)
41**	Cx TPZ (end)	Self-calibration TP zero (session end) (V)
42**	Cx TPS (beg)	Self-calibration TP solar (session start) (V)
43**	Cx TPS (end)	Self-calibration TP solar (session end) (V)
44**	Cx TPE1 (beg)	Self-calibration thermopile voltage (initial) due to electrical power (session start) (V)
45**	Cx TPE1 (end)	Self-calibration thermopile voltage (initial) due to electrical power (session end) (V)
46**	Cx V1 (beg)	Self-calibration heater voltage (session start) (V)
47**	Cx V1 (end)	Self-calibration heater voltage (session end) (V)
48**	Cx VI1 (beg)	Self-calibration voltage across shunt resistor (session start) (V)
49**	Cx VI1 (end)	Self-calibration voltage across shunt resistor (session end) (V)
50**	Cx TPE2 (beg)	Self-calibration thermopile voltage (final) due to electrical power (session start) (V)
51**	Cx TPE2 (end)	Self-calibration thermopile voltage (final) due to electrical power (session end) (V)
52**	Cx MFAC (beg)	Self-calibration M factor, W/m ² /mV (session start)
53**	Cx MFAC (end)	Self-calibration M factor W/m ² /mV (session end)
54**	Cx TEMP (beg)	Self-calibration temperature (session start) (°C)
55	Cx TEMP (end)	Self-calibration temperature (session end) (°C)
56**	DIF Count	Number of diffuse reference radiometers
The following six lines (labeled Dx) are repeated for each diffuse reference instrument in the DIF count, with x replaced by the diffuse reference number (1 through count).		
57**	Dx ID	Diffuse instrument identification number*
58**	Dx RS	Diffuse instrument responsivity
59**	Dx UP	Diffuse instrument uncertainty (% of reading)
60**	Dx UO	Diffuse instrument uncertainty (offset, W/m ²)
61**	Dx CASE	Flag to include case thermistor reading (1 = yes; 0 = no)
62**	Dx DOME	Flag to include dome thermistor reading (1 = yes; 0 = no)
63**	PYG Count	Number of pyrgeometers (should always be 0 or 1)

Line	Record	Description
The following nine lines (labeled Px) are repeated for each Pyrgeometer in the PYG count, with x replaced by the pyrgeometer number (1 through count).		
64**	Px ID	Pyrgeometer instrument identification number*
65**	Px K0	Pyrgeometer K0 calibration coefficient
66**	Px K1	Pyrgeometer K1 calibration coefficient
67**	Px K2	Pyrgeometer K2 calibration coefficient
68**	Px K3	Pyrgeometer K3 calibration coefficient
69**	Px KR	Pyrgeometer Kr calibration coefficient (receiver)
70**	Px UNC	Uncertainty of the pyrgeometer calibration (%)
71**	Px CASE	Flag to include case thermistor reading (1 = yes; 0 = no)
72**	Px DOME	Flag to include dome thermistor reading (1 = yes; 0 = no)
73**	TST Count	Count of test radiometers
The following six lines (labeled Tx) are repeated for each instrument in the TST count, with x replaced by the instrument number (1 through count).		
74**	Tx ID	Test instrument identification number*
75**	Tx RSNET	Instrument Rnet
76**	Tx RSNDATE	Date Rnet was determined
77**	Tx UCRSNET	Uncertainty of the instrument Rnet
78**	Tx CASE	Flag to include case thermistor reading (1 = yes; 0 = no)
79**	Tx DOME	Flag to include dome thermistor reading (1 = yes; 0 = no)
The remaining lines in the file are data records. They are described in the following table.		

^a All instrument identification numbers are a composite of serial number, manufacturer, and model.

^b Line number will vary according to the number of data logger, reference cavity, diffuse, and pyrgeometer instruments configured. The line numbers shown are valid when one of each instrument is configured.

Table 17-2. BORCAL-SW G-File Data Records

Position	Field	Description
1	Date	Date of data acquisition (YYYYMMNN)
2	Time	Time of data acquisition (HH:MM:SS), local standard time
3	Zenith	Solar incident (zenith) angle (decimal degrees). Takes into account instrument tilt
4	Azimuth	Solar azimuth angle (decimal degrees). Does <i>not</i> take into account instrument tilt

Position	Field	Description
5	ASR	ASR score (0 = blue; 1 = green; 2 = brown; 3 = red)
The following three fields are repeated for each cavity radiometer configured.		
6	Cavity	Cavity number designated as Cx
7	Thermopile	Cavity thermopile reading (V)
8	Flag	Cavity data flag
The following three fields are repeated for each reference diffuse instrument configured.		
9*	Diffuse	Diffuse number designated as Dx
10*	Thermopile	Diffuse thermopile reading (V)
11*	Flag	Diffuse data flag
The following seven fields are repeated for each pyrgeometer instrument configured.		
12*	Pyrgeometer	Pyrgeometer number designated as Px
13*	Thermopile	Pyrgeometer thermopile reading (V)
14*	Flag	Pyrgeometer thermopile data flag
15*	Case	Case thermistor reading (Ω)
16*	Flag	Pyrgeometer case data flag
17*	Dome	Dome thermistor reading (Ω)
18*	Flag	Pyrgeometer dome data flag
The following seven fields are repeated for each test instrument included in the scan group. (The case and dome thermistor data and flag fields are included only if the corresponding CASE or DOME flags are set (1) in the instrument's definition in the header.)		
19*	Test instrument	Test instrument number as designated as Tx in metadata header
20*	Thermopile	Test instrument thermopile reading (V)
21*	Flag	Test instrument data flag (see Table 17-13: BORCAL-SW Data Flag Definitions below)
22*	Case	Case thermistor reading
23*	Flag	Case thermistor data flag
24*	Dome	Dome thermistor reading
25*	Flag	Dome thermistor data flag

* Field number will vary according to the number of reference cavity, diffuse, and pyrgeometer instruments configured as well as the case and dome configuration of the test instruments. The numbers shown are valid for when one ACR, diffuse, and pyrgeometer are configured and the test instrument has both dome and case flags set in the instrument definition.

17.2 Meteorological

Meteorological instrument files hold the raw data and metadata for metrological instrument measurements during data acquisition.

17.2.1 File Naming

Files reside in the folder for BORCAL\DATA_SW*<borcal_id>*\DATAFILES, and they are named according to the following convention:

MET*sss*.*borcal_id*

Where

- *sss* is the session number
- *borcal_id* is the BORCAL identification number.

17.2.2 File Format

Table 17-3. BORCAL-SW MET-File Metadata Header

Line	Record	Description
1	Met Header	Meteorological data file designator
2	Session	BORCAL and session
3	Location	Calibration facility
4	Lat/Lon/Tzone	Latitude, longitude (decimal degrees), time zone (decimal hours from Greenwich, negative west of Greenwich)
6	Session Start	Session start time as YYYYMMDD HH:MM:SS
7	Session End	Session end time as YYYYMMDD HH:MM:SS
8	Record Count	Count of data records
9	Scan Interval	Period between scans (seconds)
10	MET Count	Count of meteorological instruments (always 3)
11	DIR	Cavity identification(s)* of direct normal measurements
12	M1	Description of temperature sensor (instrument identification number, scale slope, and offset)
13	M2	Description of humidity sensor (instrument identification number, scale slope and offset)
14	M3	Description of barometric pressure sensor (instrument identification number, scale slope, and offset)
The remaining lines in the file are data records. They are described in the following table.		

* All instrument identification numbers are a composite of serial number, manufacturer, and model.

Table 17-4. BORCAL-SW MET-File Data Records

Position	Field	Description
1	Date	Date of data acquisition (YYYYMMNN)
2	Time	Time of data acquisition (HH:MM:SS), local standard time
3	DIR	Direct normal measurement label
4	Direct Normal	Direct normal measurement (W/m ²)
5	Flag	Cavity data flag (see Table 17-13: BORCAL-SW Data Flag Definitions below)
6	M1	Temperature measurement label
7	Temperature	Temperature reading (°C)
8	Flag	Temperature data flag (see Table 17-13: BORCAL-SW Data Flag Definitions below)
9	M2	Humidity measurement label
10	Temperature	Humidity reading (%)
11	Flag	Humidity data flag (see Table 17-13: BORCAL-SW Data Flag Definitions below)
12	M3	Barometric pressure measurement label
13	Pressure	Barometric pressure reading (mbarr)
14	Flag	Barometric pressure data flag (see Table 17-13: BORCAL-SW Data Flag Definitions below)
15	AOD	AOD measurement label
16	Optical Depth	Estimated broadband AOD (unitless)
17	Flag	Estimated broadband aerosol optical data flag (see Table 17-13: BORCAL-SW Data Flag Definitions below)

17.3 ASR

ASR files hold the raw data and metadata for the ASR measurements during data acquisition.

17.3.1 File Naming

Files reside in the folder for BORCAL\DATA_SW*<borcal_id>*\DATAFILES, and they are named according to the following convention:

ASR*sss*.*borcal_id*

Where

- *sss* is the session number
- *borcal_id* is the BORCAL identification number.

17.3.2 File Format

Table 17-5. BORCAL-SW ASR-File Metadata Header

Line	Record	Description
1	ASR Header	ASR data file designator
2	Session	BORCAL and session
3	Location	Calibration facility
4	Lat/Lon/Tzone	Latitude, longitude (decimal degrees), time zone (decimal hours from Greenwich, negative west of Greenwich)
6	Session Start	Session start time as YYYYMMDD HH:MM:SS
7	Session End	Session end time as YYYYMMDD HH:MM:SS
8	Record Count	Count of data records
9	Scan Interval	Period between scans (seconds)
10	ASR Count	Count of ASR instruments
11*	ASRx	Identification number of ASR radiometer(s)
12*	Label	“temporary cavity stability file”
The remaining lines in the file are data records. They are described in the following table.		

* Field number will vary according to the number of instruments configured. The numbers shown are valid for when one ASR instrument is configured. (There should always be more.)

Table 17-6. BORCAL-SW ASR-File Data Records

Position	Field	Description
1	Date	Date of data acquisition (YYYYMMNN)
2	Time	Time of data acquisition (HH:MM:SS), local standard time
3	Zenith	Solar incident (zenith) angle (decimal degrees). Takes into account instrument tilt
4	Azimuth	Solar azimuth angle (decimal degrees). Does <i>not</i> take into account instrument tilt
5	ASR	ASR score (0 = blue; 1 = green; 2 = brown; 3 = red 4 = uninitialized)
6*	Ax	ASRx measurement label
7*	Measurement	Instrument reading for ASRx (W/m^2)
8*	Flag	Measurement flag for ASRx (see Table 17-13: BORCAL-SW Data Flag Definitions below)

* Field number will vary according to the number of instruments configured. The numbers shown are valid for when one ASR instrument is configured. (There should always be more.)

17.4 Thermistor

Thermistor files hold the raw data and metadata for the instrument case thermistor measurements during data acquisition (when such instruments are configured).¹⁵

17.4.1 File Naming

Files reside in the folder for BORCAL\DATA_SW\\DATAFILES, and they are named according to the following convention:

THMsss.borcal_id

Where

- *sss* is the session number
- *borcal_id* is the BORCAL identification number.

17.4.2 File Format

Table 17-7. BORCAL-SW THM-File Metadata Header

Line	Record	Description
1	Thermistor Header	Thermistor data file designator
2	Session	BORCAL and session
3	Location	Calibration facility
4	Lat/Lon/Tzone	Latitude, longitude (decimal degrees), time zone (decimal hours from Greenwich, negative west of Greenwich)
5	Session Start	Session start time as YYYYMMDD HH:MM:SS
6	Session End	Session end time as YYYYMMDD HH:MM:SS
7	Record Count	Count of data records
8	Scan Interval	Period between scans (seconds)
9	THM Count	Count of thermistor configured instruments
10	IDs	Identification number of each configured instrument and designated label for data records
The remaining lines in the file are data records. They are described in the following table.		

¹⁵ As of Version 2.00, thermistor files are not created by the system. Instead, the thermistor data are logged with the instrument fields in the group files. (See the test instrument group file format above.) The information below is retained for historical documentation.

Table 17-8. BORCAL-SW THM-File Data Records

Table	Field	Description
1	Date	Date of data acquisition (YYYYMMNN)
2	Time	Time of data acquisition (HH:MM:SS), local standard time
The following three fields are repeated for all instruments designated in metadata line 10.		
5	Tx	Instrument designator label
6	Value	Thermistor reading (Ω)
8	Flag	Measurement flag for instrument (see Table 17-13: BORCAL-SW Data Flag Definitions below)

17.5 CALDAT for BORCAL-SW

CALDAT files hold the graphing data and uncertainty documentation for each test instrument.

17.5.1 File Naming

Files reside in the folder for BORCAL\DATA_SW*<borcal_id>*\DATAFILES\Caldat, and they are named according to the following convention:

- *Instrument_id*.DAT (graphing data)
- *Instrument_id*.TXT (uncertainty data)
- REF_HORIZ.TXT (reference data)
- MET.TXT (meteorological data).

Where *Instrument_id* is the RCC instrument identification number.

17.5.2 File Format: *Instrument_id*.DAT

These files have no metadata or header information. Each line of the file holds a data record, as defined in the following table.

Table 17-9. BORCAL-SW *Instrument_id*.DAT Data Records

Position	Field	Description
1	Date	Date of data acquisition (YYYYMMNN)
2	Time	Time of data acquisition (decimal hours, local standard time)
3	Zenith	Solar incident (zenith) angle (decimal degrees). Takes into account instrument tilt
4	Azimuth	Solar azimuth angle (decimal degrees). Does <i>not</i> take into account instrument tilt
5	Value	Instrument responsivity, $\mu\text{V}/\text{W}/\text{m}^2$ ($R_{\text{net}} = 0$)
6	Value	Instrument ENICR (If missing or instrument is uncorrected, value is -9900.0)

17.5.3 File Format: *Instrument_id.TXT*

Each line of the file holds a data record, as defined in the following table. A header line describes each field. A record exists for each bin with a valid uncertainty.

Table 17-10. BORCAL-SW *Instrument_id.TXT* Data Records

Column	Field	Description
1	Bin	a.m. and p.m. 2-degree and 45-degree (always at end) bin numbers
2	Volt	Percent contribution of voltage measurement to total uncertainty for the bin
3	Dir	Percent contribution of Dir measurement to total uncertainty for the bin
4	Rnet	Percent contribution of Rnet calibration to total uncertainty for the bin
5	Wnet	Percent contribution of Wnet measurement to total uncertainty for the bin
6	Zen	Percent contribution of Zenith calculation to total uncertainty for the bin
7	Dif	Percent contribution of Diffuse measurement to total uncertainty for the bin

17.5.4 File Format: *REF_HORZ.TXT*

These files have no metadata or header information. Each line of the file holds a data record, as defined in the following table.

Table 17-11. BORCAL-SW *REF_HORZ.TXT* Data Records

Position	Field	Description
1	Date	Date of data acquisition (YYYYMMNN)
2	Time	Time of data acquisition (decimal hours, local standard time)
3	Zenith	Solar incident (zenith) angle (decimal degrees). Takes into account instrument tilt
4	Azimuth	Solar azimuth angle (decimal degrees). Does <i>not</i> take into account instrument tilt
5	Ref. Global	Reference global horizontal irradiance (W/m^2)
6	Ref. Direct	Reference direct normal irradiance (W/m^2)
7	Ref. Diffuse	Reference diffuse horizontal irradiance (W/m^2)

17.5.5 File Format: MET.TXT

These files have no metadata or header information. Each line of the file holds a data record, as defined in the following table.

Table 17-12. BORCAL-SW MET.TXT Data Records

Position	Field	Description
1	Date	Date of data acquisition (YYYYMMNN)
2	Time	Time of data acquisition (decimal hours, local standard time)
5	Temp	Air temperature (°C)
6	RH	Relative humidity (%)
7	Pressure	Station pressure (mbar)
8	AOD	Estimated broadband aerosol optical depth

17.6 Data Flag Definitions (BORCAL-SW Only)

The values that appear in the data flag field indicate an error condition status during data acquisition. The values and their descriptions are listed in the table below.

Table 17-13. BORCAL-SW Data Flag Definitions

Flag	Description
0	No errors detected
1	Delta between adjacent readings exceeded the threshold
2	Ratio between reference and control instruments exceeded threshold
3	(Reserved)
4	Ratio between multiple reference instruments exceeded threshold
5	(Reserved)
6	(Reserved)
7	(Reserved)
8	Data acquisition error
9	Data missing

In some cases when more than one error condition may have been detected, only one flag will be reported. The precedence for reporting from among multiple flags is not defined.

18 BORCAL-LW Data File Formats

18.1 Test Instrument

Test instrument files hold the raw data and metadata for test instrument measurements during data acquisition.

18.1.1 File Naming

Files reside in the folder for BORCAL\DATA_LW*borcal_id*\DATAFILES, and they are named according to the following convention:

PYGsss.borcal_id

Where

- *PYG* is a literal
- *sss* is the session number
- *borcal_id* is the BORCAL identification number.

18.1.2 File Format

Table 18-1. BORCAL-LW PYG-file Metadata Header

Line	Record	Description
1	Pyrgeometer Header	Pyrgeometer data file designator
2	Session	BORCAL and session
3	Location	Calibration facility
4	Lat/Lon/Tzone/Elev/Temp/Press	Latitude, longitude (decimal degrees), time zone (decimal hours from Greenwich, negative west of Greenwich), elevation (meters), site average temperature (°C), site average pressure (mBar)
5	DeltaT/Refract	Delta T and refraction for solar position
6	Session Start	Session start time as YYYYMMDD HH:MM:SS
7	Session End	Session end time as YYYYMMDD HH:MM:SS
8	Record Count	Count of data records
9	Scan Interval	Period between scans (seconds)
10	Cal Type	Calibration Type (PYG = pyrgeometer)
11	Units	Measurement units (V and °C)
12	MET Count	Count of meteorological instruments (count is 1, 2, or 3), type is temperature (required), relative humidity, or pressure
The following line is repeated for each meteorological instrument in the MET count, with x replaced by the instrument number (1 through count)		

Line	Record	Description
13**	Mx	Description of meteorological sensor (instrument identification number, scale slope, and offset)
14**	PYG Count	Number of reference pyrgeometers
The following 15 lines (labeled Px) are repeated for each Pyrgeometer in the PYG count, with x replaced by the pyrgeometer number (1 through count)		
15**	Px ID	Pyrgeometer instrument identification number*
16**	Px K0	Pyrgeometer K0 calibration coefficient
17**	Px K1	Pyrgeometer K1 calibration coefficient
18**	Px K2	Pyrgeometer K2 calibration coefficient
19**	Px K3	Pyrgeometer K3 calibration coefficient
20**	Px KR	Pyrgeometer Kr calibration coefficient (receiver)
21**	Px UNC	Uncertainty of the pyrgeometer calibration (%)
22**	Px CASE	Flag to include case thermistor reading (1 = yes; 0 = no)
23**	Px DOME	Flag to include dome thermistor reading (1 = yes; 0 = no)
24**	Px URDVDC	Uncertainty of voltage reading (% of reading)
25**	Px UOFVDC	Uncertainty of voltage reading, offset (V)
26**	Px URGVDC	Uncertainty of voltage range (V)
27**	Px URDRES	Uncertainty of resistance reading (% of reading)
28**	Px UOFRES	Uncertainty of resistance reading, offset (Ω)
29**	Px URGRES	Uncertainty of resistance range (Ω)
30**	TST Count	Count of test radiometers
The following 10 lines (labeled Tx) are repeated for each instrument in TST Count, with x replaced by the instrument number (1 through count)		
31**	Tx ID	Test instrument identification number*
32**	Tx KR	Pyrgeometer Kr calibration coefficient
33**	Tx CASE	Flag to include case thermistor reading (1 = yes; 0 = no)
34**	Tx DOME	Flag to include dome thermistor reading (1 = yes; 0 = no)
35**	Tx URDVDC	Uncertainty of voltage reading (% of reading)
36**	Tx UOFVDC	Uncertainty of voltage reading, offset (V)
37**	Tx URGVDC	Uncertainty of voltage range (V)
38**	Tx URDRES	Uncertainty of resistance reading (% of reading)

Line	Record	Description
39**	Tx UOFRES	Uncertainty of resistance reading, offset (Ω)
40**	Tx URGRES	Uncertainty of resistance range (Ω)
The remaining lines in the file are data records. They are described in the following table.		

* All instrument identification numbers are a composite of serial number, manufacturer, and model.

** Line number will vary according to the number of reference pyrheliometer instruments configured. The line numbers shown are valid when one of each instrument is configured.

Table 18-2. BORCAL-LW PYG-file Data Records

Position	Field	Description
1	Date	Date of data acquisition (YYYYMMNN)
2	Time	Time of data acquisition (HH:MM:SS.SSS), local standard time with decimal seconds
3	Zenith	Solar incident (zenith) angle (decimal degrees). Takes into account instrument tilt
4	Azimuth	Solar azimuth angle (decimal degrees). Does <i>not</i> take into account instrument tilt
The following two fields are repeated for each meteorological instrument configured.		
5*	Met Sensor	Meteorological sensor number designated as Mx
6*	Met Reading	Temperature, relative humidity, or pressure reading (°C, %, or mbarr)
The following four fields are repeated for each pyrgeometer instrument configured. (The case and dome thermistor data fields are included only if the corresponding CASE or DOME flags are set (1) in the instrument's definition in the header.)		
7*	Pyrgeometer	Pyrgeometer number designated as Px
8*	Thermopile	Pyrgeometer thermopile reading (V)
9*	Case	Case temperature reading (°C)
10*	Dome	Dome temperature reading (°C)
The following four fields are repeated for each test instrument configured. (The case and dome thermistor data fields are included only if the corresponding CASE or DOME flags are set (1) in the instrument's definition in the header.)		
11*	Test instrument	Test instrument number as designated as Tx in metadata header
12*	Thermopile	Test instrument thermopile reading (V)
13*	Case	Case temperature reading (°C)
14*	Dome	Dome temperature reading (°C)

* Field number will vary according to the number of meteorological sensors, reference pyrgeometers and test instruments configured as well as the case and dome configuration of instruments. The numbers shown are valid when one meteorological sensor and one reference pyrgeometer (with both case and dome) are configured and the test instrument has both dome and case flags set in the instrument definition.

18.2 CALDAT (for BORCAL-LW)

CALDAT files hold the graphing data, residual data, and preliminary residual plots and for each test instrument.

18.2.1 File Naming

Files reside in the folder for BORCAL\DATA_LW*<borcal_id>*\DATAFILES\Caldat, and they are named according to the following convention:

- Instrument_id.DAT (graphing data)
- Instrument_id K0_non0.TXT (K0 set to non-zero residual data)
- Instrument_id K0_zer0.TXT (K0 set to zero residual data)
- Instrument id K0_zer0.PNG (K0 set to zero preliminary residual plot)
- REF_HORZ.TXT (reference data)
- MET.TXT (meteorological data).

Where *Instrument_id* is the RCC instrument identification number.

18.2.2 File Format: Instrument_id.DAT

These files have no metadata or header information. Each line of the file holds a data record, as defined in the following table.

Table 18-3. BORCAL-LW Instrument_id.DAT Data Records

Position	Field	Description
1	Date	Date of data acquisition (YYYYMMNN)
2	Time	Time of data acquisition (decimal hours, local standard time)
3	Zenith	Solar incident (zenith) angle (decimal degrees). Takes into account instrument tilt
4	Azimuth	Solar azimuth angle (decimal degrees). Does <i>not</i> take into account instrument tilt
5	Wref	Reference Incoming LW irradiance (W/m ²)
6	Vtp	Test instrument thermopile voltage (uV)
7	Wr	Test instrument $W_r = \text{Sigma} * \text{ReceiverTemp}^4$
8	Wd-Wr	Test instrument $W_d - W_r = \text{Sigma} * \text{DomeTemp}^4 - W_r$

18.2.3 File Format: Instrument_id K0_zer0.TXT and Instrument_id K0_non0.TXT

These files have no metadata or header information. Each line of the file holds a data record, as defined in the following table. One file is for the K0 set to non-zero, and one is for the K0 set to zero.

Table 18-4. BORCAL-LW Instrument_id K0_xxx0.txt Data Records

Column	Field	Description
1	Vtp	Test instrument thermopile voltage (uV)
2	Residual	Irradiance residual, reference – test (W/m ²). Test irradiance is calculated using previous BORCAL coefficients or manufacture’s single responsivity.

18.2.4 File Format: Instrument_id K0_zer0.PNG

These are preliminary residual plots that are automatically generated by the system at the end of a BORCAL-LW session (just before sunrise, depending on zenith angle that is in the system configuration). This file can also be generated manually by selecting the “Preliminary” option when generating BORCAL-LW responsivities. These files are used by the BORCAL manager to make a judgment about whether the BORCAL-LW is complete. All data is included for the preliminary plots (except when references disagree).¹⁶

These files are simply plots of the data contained in the Instrument.id K0_zer0.TXT file. Irradiances for the test are calculated using the previous calibration coefficients (or manufacture’s single responsivity if there are no previous BORCAL results), as shown below.

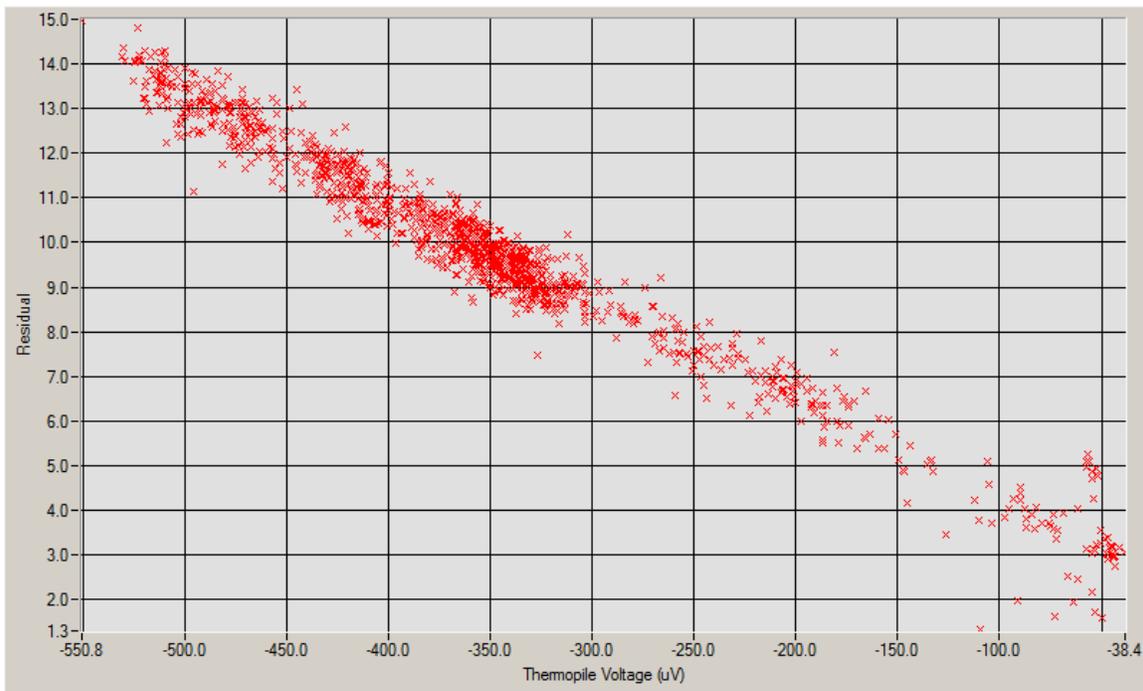


Figure 18-1. Sample BORCAL-LW residual plot

A completed BORCAL would be a complete scatter plot of points that goes from near zero to near the maximum output of the thermopile with no large gaps between.

¹⁶ When final responsivities are generated, these files are also generated; however, data is filtered using the same approach as final coefficient generation.

18.2.5 File Format: REF_HORIZ.TXT

These files have no metadata or header information. Each line of the file holds a data record, as defined in the following table.

Table 18-5. BORCAL-LW REF_HORIZ.TXT Data Records

Position	Field	Description
1	Date	Date of data acquisition (YYYYMMNN)
2	Time	Time of data acquisition (decimal hours, local standard time)
3	Zenith	Solar incident (zenith) angle (decimal degrees). Takes into account instrument tilt
4	Azimuth	Solar azimuth angle (decimal degrees). Does <i>not</i> take into account instrument tilt
5	Irradiance	Reference Incoming LW Irradiance (W/m ²)

18.2.6 File Format: MET.TXT

These files have no metadata or header information. Each line of the file holds a data record, as defined in the following table.

Table 18-6. BORCAL-LW MET.TXT Data Records

Position	Field	Description
1	Date	Date of data acquisition (YYYYMMNN)
2	Time	Time of data acquisition (decimal hours, local standard time)
3	Temp	Air temperature (°C)
4	RH	Relative humidity (%)
5	Pressure	Station pressure (mbarr)
6	PWV	Estimated precipitable water vapor (mm)

19 Directory Structure

BORCAL Root	
— Backups	Backup files from database editing
— Config	Location lookup files; site & ISO logo files; system check define
— Data_SW	Data files specific to each SW BORCAL
└─ [BORCAL-ID]	One directory for each BORCAL event
— Alarms	Alarm files
— Data Files	Scan group, Met, ASR, Thermistor files
└─ Caldat	CALDAT files
— Export	User exports
— Logs	Operator logs
— Nightdata	Data files created by nighttime mode (obsolete)
— PDF	Default location for printing document to PDF
— Data_LW	Data files specific to each LW BORCAL
└─ [BORCAL-ID]	One directory for each BORCAL event
— Alarms	Alarm files
— Data Files	PYG data files
└─ Caldat	CALDAT files
— Export	User exports
— Logs	Operator logs (not used)
— Nightdata	Data files created by nighttime mode (not used)
— PDF	Default location for printing documents to PDF
— DB	Access database
— Layout	User configurable layout files (SW only)
— PGM	RCC program files
— SystemCheck	Location for saving annual FCO data
— UTILS	RCC utility programs (optional site dependent batch files for backups, DAQ power on, preliminary plot transfer, etc.)
— IMPORT	Location for optional Rnet import files (SW only)