NIP Calibration Using a Cavity Radiometer (CALF)

I. Purpose:

The purpose of this procedure is to describe the steps performed by the RESET team to field calibrate the NIP using a Hickey-Friedan Cavity Radiometer. **Note: this procedure is not yet normally performed during routine RESET visits.**

II. Cautions and Hazards:

- The Control Unit for the Cavity Radiometer runs on 110 Volt AC power (240 V internal).
- These procedures must be conducted by RESET team member trained in electrical safety.
- These procedures can be conducted if there is no reasonable chance of rain.
- Must have clear, stable atmosphere with minimal circumsolar radiation during data collection.

III. Requirements:

- Two people are needed for actual mounting of the Cavity to the tracker (one to hold the instrument and the other to mount to tracker)
- Absolute Cavity Radiometer (Hickey-Friedan).
- Control Unit and Two Cables (Two pair 12ft or 20ft, Cavity and Serial Communications Cables)

  NOTE: fuse for Control Unit: 312 2 Amp, 250 V
- Calibration Laptop (with power adapter, terminal emulator, and cavity radiometer software)
- Protective enclosure for laptop computer and cavity control unit (shipping box is work)
- Solar Tracker Mounted NIP
- Clock set to GMT time
- 3/16" and 3/32" allen wrenches
- Small flat head screwdriver

NOTE: Although the manual states that the control unit runs on 50 Hz (110V) power, we were unable to run the unit at Nauru installation until we connected it to 60 Hz (110V) power.

IV. Procedure:

A. Cavity Radiometer:

NOTE: Before proceeding, set watch to within one (1) second of GMT(you may get time from ADaM or MACS GPS times).

1. Run A/C Power either 50 or 60 Hz to SKYRAD stand to power control unit and laptop computer.
2. Put computer and control unit in protective enclosure.
3. Connect 2 cables from control unit to laptop computer (25 pin connector control unit with a 9 pin D connector to COM1, and special pcmcia connector to COM2).
4. Remove comparison NIP from solar tracker, if necessary.
5. If window is not on the cavity go indoors and attach window (six screws with 3/32" allen wrench).
6. Clean window with rubbing alcohol and Kimwipes.
7. Attach Cavity to Brusag Solar Tracker and align (see below)(This is a two man job).
8. Make final alignment using sun target with three alignment screws 3/16" on base of cavity mount.
9. Connect control unit to Absolute Cavity (2 connectors at each end). **Note**: make sure the small ground wires are attached at both end to nearby case screws.
10. Turn ON switch control unit (see set for Control Unit below) and DMM switch (make sure Control Unit A/M Switch is on Automatic [A]).

<u>Setup for Controller</u>

11. Heater 1 & 2 switches OFF.
12. Switch on A (note: this disables rotary switch with positions like TPI , so any position is OK).
13. Power ON unit.
14. Meter connection on middle pair (Input) red to high (Hi), black to low (Lo).
15. Power ON meter (lower left button. (It should read DC V; if not, turn OFF and ON again to reset.)
16. Heater 1 & 2 switches off.
17. Shutter runs automatically (light ON means shutter closed and only uses shutter 1).

Alignment of Cavity After Mounting on Brusag Tracked

18. Loosen screws holding aluminum brackets for NIP or Cavity.
19. Remove reference NIP if necessary (two people necessary).
20. Mount Cavity and tighten bracket screws until instrument is firmly held and balanced (two people necessary).
21. Align Cavity using two sets of three screws at the bottom part of Cavity, and solar illumination ring attached to the Cavity side flange.
22. Alternately loosen and tighten opposing sets of screws until sun dot is directly in the center of the solar illumination ring. Be sure all screws are tight after alignment.

Data Collection

23. Wait for one (1) hour for Cavity temperature to stabilize.
24. Power up computer. (Bar switch, top left near screen.)
25. Run Windows.
26. Run Cavity Control Program (double click on icon and continue).
27. Input Cavity information or load from file (example: serial number of cavity?30494.cav).
28. Do not select window mounted (even though the TWP Cavity always has a window to protect from rain).
29. Set correct time and date by clicking on Date Window and then Time (displays date and time). Click on text box to change date and time (use GMT time to within one (1) second).
30. Enter Site information (example twp-manu.sit).
31. Enter Data Collection setup (click "field cal" button then OK). Now the system runs by itself. It takes about four (4) minutes for electronic calibration. Messages and switch setting letters change as the system runs automatically. The calibration sensitivity is then displayed (example 0.01033 mV/mW/cm2), and then the unit proceeds to take data.
32. Three files are produced (A...., C...., and D.....files)
    - A-average data (1 minute average) (example A980115.dat)

      (Same in C and D files.)

      Header consists of 8 fields which are:

      a) decimal hour

      b) time in hh:mm:ss

      c) date mm-dd-yy

d) day of year (sometimes called Julian day)

e) site latitude in degrees

f) site longitude in degrees

g) window factor (should be 1)

h) site name

Followed by 7 fields:

a) Start time in seconds since midnight.

b) End time in seconds since midnight.

c) Solar elevation in degrees.

d) Solar azimuth in degrees.

e) Irradiance in watts/m^2

f) Millivolt raw signal.

g) Temperature at last calibration in K.

[This is the file that is included in ARCS.exe to combine radiance file to produce .out files to be sent to mentors.]

- C-calibration data (start time, end time, and 10 fields of calibration data [field 10 is sensitivity]).
- D-raw data

Data field with same header and 2 fields:

a) Irradiance in watts/m^2.

b) Time in seconds since midnight.

33. Follow shade sun-unshade procedure (PSP)006.002 For five (5) min shade, five (5) min. unshade.
34. Check the cavity alignment and computer status every 30 minutes. If out of alignment realign. If program stops reboot computer and start again (Cntrl Alt Delete). A symptom that the computer has stopped is lack of change of values or the mouse cursor doesn't move. Also, if the displayed irradiance is unreasonable (e.g., 20234 W/ m^2). [This can happen if a cloud passes during a 4 minute calibration period] Click on "pause" and "calibrate and continue." Normal values for irradiance is between 700 and 1200 W/ m^2.
35. Data should be collected until sunset or sky conditions deteriorate (sun remains behind clouds or rain is possible).
36. Follow ARCS Radiometer Field Test Software Procedure PRO(RAD)-00?.???

37. Follow Communication of Data Procedure PRO(CAL)-00?.???

To Stop Taking Data

38. Click on Pause.
39. Pause data collections (don't power-off unless absolutely necessary, e.g., unexpected rain storm).
40. Can now select normal shutdown (performs another calibration and stops) [usually best option], or Calibrate and Continue (recalibrate if calibration sensitivity seems strange), or Fast Shutdown (no secondary calibration performed).
41. Click on Quit.
42. To shut down computer, click on “Program Manager” and under “File” exit windows or quit.
43. Turn OFF meter (Important: otherwise internal battery depleted).
44. Power down. Note: If it begins to rain take Control Unit and computer inside first. Then bring in Cavity (the Cavity has a window but still should not be left out in rain).
45. To copy files to send to mentor, look under source/ahf a files to RADIOM for comparison (see attachment 1).

B. Packing:

1. First wrap Control Unit and Cavity in Plastic Bags.
2. Place Control Unit into bottom of Control Unit Box.
3. Put in a layer of foam on top and then cables, and then a layer of foam on top.
4. Place Cavity in Cavity Box and place foam to tightly seal.

V. References:

1. Cornwall, C., "Recommended Radiometer Calibration Procedures for ARM/ARCS," NREL June 16, 1995.

VI. Attachments:

1. ARCS Radiometer Field Test Software Text
2. FM(NIP)-001 Cavity Radiometer Calibration Form
3. Example of Completed Form

Attachment 1: ARCS Radiometer Field Test Software

This document describes the software developed by Chris Cornwall at the National Renewable Energy Laboratory for use by the Atmospheric Radiation Measurement (ARM) Atmospheric Radiation and Cloud System's (ARCS) Regional Service Team (RESET) to evaluate radiometer performance in the field. The software consists of two programs. The first, ARCS.EXE, concatenates raw data files from the different Coastal Environmental Systems (CES) data loggers into one large file. The second program, ARCSPLOT.EXE, creates data files and templates for Golden Software's GRAPHER for DOS, and allows the user to view and print summary plots of radiation data for the days of interest.

These programs are designed to be used during site visits by the RESET. The plots created should be useful in exposing instrument failures and calibration shifts. It is expected that RESET has the time and appropriate weather to perform tests on the instruments, such as running the absolute cavity radiometer, and running the GroundRad station with its PIR and PSP inverted to measure whole-sky irradiance. The software recognizes these different operating conditions and plots the data accordingly.

Plots created using this software can be faxed to NREL for further examination. In the event that NREL cannot cull sufficient information from the faxes, the raw data files may be emailed to NREL for further examination. NREL personnel provide feedback to the technicians in the field, suggesting swaps, recalibrations, or further testing of questionable instruments. If software is already installed, skip to collecting Data from Data Loggers (these programs probably work with Windows ’95, but the cavity program that runs the cavity does not work with Window ’95.

Installing the ARCS.EXE and ARCSPLOT.EXE Software

The software may be installed on any PC system running DOS 3.2 or greater. If desired, the ARCS and ARCSPLOT software can be installed on the laptop computer used for controlling the Absolute Cavity Radiometer.

To install, insert the disk labeled "NREL Routines for Examining ARM-ARCS Radiometer Data..." into the computer's floppy disk drive. Make the floppy drive the active disk by typing the drive letter of the floppy followed by a colon. (For example: A:↵) Next, simply type INSTALL ↵ and the INSTALL.BAT file copies the files for both programs into the following directory structure:

Directory:	Files Copied:
C:\RADIOM\DATA\	ARCS.EXE
C:\RADIOM\PLOT\	ARCSPLOT.EXE, its template files (GRAPHI A.TPL, GRAPHIB.TPL, GRAPH2.TPL, GRAPH3.TPL, RAPH4.TPL, GRAPH5A.TPL, GRAPHSB.TPL, GRAPH6.TPL, GRAPH7.TPL, GRAPH8.TPL, GRAPH9A.TPL, and GRAPH9B.TPL), and Grapher for DOS executable and support files (including GRAPHER.EXE, VIEW.EXE, and PLOT.EXE).

Collecting Data from Data Loggers

If possible, use this same computer to collect raw data from each of the CES data loggers being used. Connect the PC to the data logger via a serial cable and download the data as instructed in the CES documentation. Copy these data files (and only these data files) to the C:\RADIOM\DATA\ subdirectory. Check that the current data files are the only files in this directory with a .DAT file extension. The ARCS.EXE program searches the specified directory for any file with a .DAT extension, and merges it into the output file. So if old data files are present, they are included in the final plots.

Running ARCS.EXE

Once all of the data files are located in the proper directory, you can run the ARCS.EXE program to merge them into one file. Change directories to the C:\RADIOM\DATA directory. The command-line syntax for the program is:
ARCS [input directory] [output file name]

Both command line parameters shown are optional, but if not entered on the command line, the user is prompted to input them. The input directory should be the full path name of the directory containing the data logger raw data files. Usually this is C:\RADIOM\DATA\, but if you prefer to use a different directory, this is where you would place the directory name.

The output file name can be anything, except it should not end in .DAT, .GRF, or .PLT, as these extensions are reserved for different types of files in subsequent processing steps. A good output file name could be 9601A.OUT for the first (A) set of data collected in January (01) of 1996 (96).

Using these conventions, the command line could look like this:
ARCS C:\RADIOM\DATA 9601A.OUT

The program indicates its status by displaying information on the screen. It displays the data file that is currently being read, the year, day, and time for each hour of data being read, and a letter ("v" for cavity data, "c" for CalRad data, "g" for GroundRad data, or "s" for SkyRad data) for each minute of data merged into the output file. When it is done, it prompts the user to press any key for normal program termination.

Move Output File

Before running the ARCSPLOT program, the output file from ARCS.EXE should be copied to the C:\RADIOM\PLOT\ directory:

COPY C :\RADIOM\DATA\9601 A.OUT C :\RADIOM\PLOT

If disk space permits, do not delete the raw data files or the ARCS.EXE output file until the end of the site visit. NREL may request that one or all of these files be e-mailed to them if the data plots do not provide sufficient information.

Running ARCSPLOT.EXE

Before running the ARCSPLOT software, be aware that it deletes or writes over any existing files with a .DAT, .GRF, .PLT, or .GDT file extension. This is why the ARCS.EXE output file cannot end with those file extensions.

If you wish to preserve graph, plot, or data files from a previous run of ARCSPLOT, you may create a backup subdirectory and copy the files into it before running ARCSPLOT again. This would be accomplished by a set of DOS commands like these:

CD C:\RADIOM\PLOT
MKDIR 9601A
COPY *.DAT 9601A
COPY *.GRF 9601A
COPY *.PLT 9601A

NOTE: Be sure you do not delete any of the Grapher template files from the C:\RADIOM\PLOT directory. They are: GRAPHIA.TPL, GRAPHIB.TPL, GRAPH2.TPL, GRAPH3.TPL, GRAPH4.TPL, GRAPH5A.TPL, GRAPH5B.TPL, GRAPH6.TPL, GRAPH7.TPL, GRAPH8.TPL, GRAPH9A.TPL, and GRAPH9B.TPL. If any of these files are not present, the program does not create the Grapher files and plots. To restore these files, re-install the software from the floppy disk as instructed above.

Once you are satisfied that the program will not write over any critical files, check to make sure you copied the ARCS.EXE output file into the C:\RADIOM\PLOT directory. Then, from that same directory, run the ARCSPLOT.EXE program. The only command line argument is the ARCS.EXE output file:

ARCSPLOT [ARCS.EXE output file]

Again, the command line argument is optional, and the program prompts for the file name if none is given. Continuing our example from the ARCS.EXE section above, the command would be:
ARCSPLOT 9601A.OUT

The program provides a brief introductory screen and asks the user to confirm that they want to continue. Hitting N or ESC quits the program. Pressing Y causes the program to continue.

Next the program asks if you wish to create .DAT files. These are required to create Grapher files. However, if you wish to view and plot the data from a previous run of ARCSPLOT, you can select “No” here and the program proceeds to the next section: creating Grapher files. Usually, though, you want to create the .DAT files from the file input on the command line, so you select “YES.”

At this point, the program requires the user to input the site latitude and longitude where the data were collected. Input these quantities as prompted, in decimal degrees. For example, the Sandia Integration Site has latitude of 35.05167 degrees (+ to North), and longitude of -106.5358 degrees (+ to East). These numbers are used for calculating solar position and zenith angle for certain calculations. Input them as accurately as possible, as these numbers affect the data plots.

Now the program reads through the input file and creates three data files (file extension .DAT) for each day contained in the input file. The program writes periods to the screen to indicate activity during this process, with +'s output when a new day is encountered.

Next the program asks if you wish to create graph files. Again, this step is not required, but normal operation is to answer Y (yes). The program then cycles through all .DAT files in the directory and creates twelve .GRF files for each day. The .GRF files are modified versions of the .TPL files, which must be present for the program to run correctly. After each .GRF file is created, a DOS system call runs the GRAPHER.EXE program to create a .PLT file for each .GRF file.

Once all of the .GRF and .PLT files are created, several system calls to the DOS COPY command are used to concatenate the .PLT files into three plots per day. These three pages of plots contain twelve graphs each.

Once these plot files are created, the program gives you the opportunity to view the plots. If you reply with a Y, it calls the Grapher VIEW.EXE program with each plot file (three per day) that it created. In the VIEW program, you can zoom and scroll to look at the plot in more detail. To quit the VIEW program, press the ESC key, then Q.

Next, the program allows you to configure the Grapher PLOT.EXE program with your printer information. This should be done the first time you run on a new computer or a new printer. After that, the program defaults to the previously used configuration. If you are not sure which printer is selected, press “Y” to view or change the current configuration.
Finally, the program allows you to print the plots. You can choose to print all daily summary plots (three per day) or just certain plots. The daily summary plots are named using the following convention: P#-YYDDD.PLT, where # is the type of plot (1, 2 or 3); YY is the two-digit year (96 for 1996); and DDD is the three-digit, day-of-year (28 August = 240 in a nonleap year).

The three types of summary plots are: 1) full page three-component + UV time series plot; 2) four intercomparison plots for PIRs, 3-component, and NIP versus Cavity, PIR error from average, and net radiometer versus Eppley net radiation; 3) Calibration Factor plots for NIP, Global PSP on SkyRad, and PSP on GroundRad, if it is inverted and looking at the sky. The final graph on 3 is a smaller version of plot 1. Examples of all of these are included in following pages.

A flow chart for each program is included following this report. **Raw Data Files**
The raw data files downloaded from the data loggers and the cavity control comp must be placed in a single directory and must all have the .DAT file extension.

Sky Rad Files	**Ground Rad Files**	**Surface Met Files**	**Cavity Average Files**
SKYRAD 1 .DAT	GNDRAD 1 .DAT	SMET 1 .DAT	AYYMMD 1 .DAT
SKYRAD2.DAT	GNDRAD2.DAT	SMET2.DAT	AYYMMD2.DAT
SKYRADN.DAT	GNDRADN.DAT	SMETN.DAT	AYYMMDN.DAT

ARCS.EXE

ARCS.EXE reads each *.DAT file in the specified directory and copies the raw data to the appropriate place in the output file. Data are matched up by date and time. Data within 2 seconds of the minute are assigned to that minute to allow for slight differences in data logger clocks. Larger time differences prompt the user for approval before widening the acceptable time window.

Only the data averages are copied to the output file. Standard deviation, max and min data are not used in creating the plots.

BIGFILE.OUT

BIGFILE.OUT

↓

Move BIGFILE.OUT to directory containing ARCSPLOT.EXE and Grapher template files: graphla.tpl, graphlb.tpl, graph2.tpl, ... graph4.tpl, graph5a.tpl, graphSb.tpl, graph6.tpl, ... graph8.tpl, graph9a.tpl, graph9b.tpl.

ARCSPLOT.EXE
BIGFILE.OUT

ARCSPLOT prompts the user for the latitude and longitude of the site from which the data originated. This is needed to calculate solar zenith.

Next the program creates three (3) data files for each day of data:

DATYYDDD.DAT, ERRYYDDD.DAT, CFVWDDD.DAT
where YY = year, DDD = day of year. Ex: 30 June 1996 = 96182

These files contain raw data, error data, and cal factor data to be graphed.

↓

Now the program cycles through every *.DAT file and creates the appropriate Grapher files by copying from the template files and placing new information in the correct fields. Plot files are then created for each *.GRF file through a system call to Grapher.

Creates 12 grapher files and 12 plot files for each day of data:

G1 AYYDDD.GRF/PLITG4-YYDDD.GRF/PLT G7-YYDDD.GRF/PLT
G1BYYDDD.GRF/PLTG5AYYDDD.GRF/PLTG8-YYDDD.GRF/PLT
G2-YYDDD.GRF/PLT G5BYYDDD.GRF/PLTG9AYYDDD.GRF/PLT
G3-YYDDD.GRF/PLT G6-YYDDD.GRF/PLT G9BYYDDD.GRF/PLT

↓

A DOS call then concatenates .plt files into three (3) plot files for each day of data:
P1 -YYDDD.PLT P2-YYDDD.PLT P3-YYDDD.PLT

↓

View and/or Plot the files using Grapher for DOS VIEW and PLOT programs.

Data File Formats:

The following are the different data file formats used with ARCS.EXE and ARCSPLOT.EXE. The input files to ARCS.EXE are defined by the hardware that creates them, i.e., the Coastal data logger and the Cavity Radiometer. Other file formats were defined by NREL for efficiency and expandability.

Data File Source: SKYRAD Data Logger Input to: ARCS.EXE
Number of Fields: 68

Format:

Field	Description
1	Text Header including station name, software version, and date (YY/MM/DD)
2	Time in GMT (hh:mm:ss)
3	flags
4	PSP_G Average ? average of sixty one-second values of global PSP
5	PSP_G Std Dev -- standard deviation of sixty one-second values of global PSP
6	PSP_G Max -- maximum value of sixty one-second values of global PSP
7	PSP_G Min -- minimum value of sixty one-second values of global PSP
8	PIR G E1 -- instantaneous value of unshaded PIR at 10 seconds after the minute
9	PIR G E2 -- instantaneous value of unshaded PIR at 30 seconds after the minute
10	PIR_G E3 -- instantaneous value of unshaded PIR at 50 seconds after the minute
11	Rgcl -- instantaneous value of unshaded PIR case thermistor at 10 sec after the minute
12	Rgc2 -- instantaneous value of unshaded PIR case thermistor at 30 sec after the minute
13	Rgc3 -- instantaneous value of unshaded PIR case thermistor at 50 sec after the minute
14	Rgdl -- instantaneous value of unshaded PIR dome thermistor at 10 sec after the minute
15	Rgd2 -- instantaneous value of unshaded PIR dome thermistor at 30 sec after the minute
16	Rgd3 -- instantaneous value of unshaded PIR dome thermistor at 50 sec after the minute
17	PIR G Average -- average of sixty one-second values of unshaded PIR
18	PIR G Std Dev -- standard deviation of sixty one-second values of unshaded PIR
19	PIR G Max -- maximum value of sixty one-second values of unshaded PIR
20	PIR G Min -- minimum value of sixty one-second values of unshaded PIR
21	IRTup Average -- average of sixty one-second values of upward pointing IRT
22	IRTup Std Dev -- standard deviation of sixty one-second values of upward pointing IRT
23	IRTup Max -- maximum value of sixty one-second values of upward pointing IRT
24	IRTup Min -- minimum value of sixty one-second values of upward pointing IRT
25	UVBT1 -- instantaneous value of UVB temperature signal at 10 seconds after the minute
26	UVBT2 -- instantaneous value of UVB temperature signal at 30 seconds after the minute
27	UVBT3 -- instantaneous value of UVB temperature signal at 50 seconds after the minute
28	UVB 1 -- instantaneous value of UVB signal at 10 seconds after the minute
29	UVB2 -- instantaneous value of UVB signal at 30 seconds after the minute
30	UVB3 -- instantaneous value of UVB signal at 50 seconds after the minute
31	UVB Average -- average of sixty one-second values of upward pointing UVB
32	UVB Std Dev -- standard deviation of sixty one-second values of upward pointing UVB
33	UVB Max -- maximum value of sixty one-second values of upward pointing UVB
34	UVBMin -- minimum value of sixty one-second values of upward pointing UVB
35	PSP_D Average -- average of sixty one-second values of diffuse PSP
36	PSP_D Std Dev -- standard deviation of sixty one-second values of diffuse PSP
37	PSP_D Max -- maximum value of sixty one-second values of diffuse PSP

Field	Description
38	PSP_D Min -- minimum value of sixty one-second values of diffuse PSP
39	PIR_G E1 -- instantaneous value of shaded PIR at 10 seconds after the minute
40	PIR_G E2 -- instantaneous value of shaded PIR at 30 seconds after the minute
41	PIR_G E3 -- instantaneous value of shaded PIR at 50 seconds after the minute
42	Rdc1 -- instantaneous value of shaded PIR case thermistor at 10 sec after the minute
43	Rdc2 -- instantaneous value of shaded PIR case thermistor at 30 sec after the minute
44	Rdc3 -- instantaneous value of shaded PIR case thermistor at 50 sec after the minute
45	Rdd1 -- instantaneous value of shaded PIR dome thermistor at 10 sec after the minute
46	Rdd2 -- instantaneous value of shaded PIR dome thermistor at 30 sec after the minute
47	Rdd3 -- instantaneous value of shaded PIR dome thermistor at 50 sec after the minute
48	PIR_D Average -- average of sixty one-second values of shaded PIR
49	PIR_D Std Dev -- standard deviation of sixty one-second values of shaded PIR
50	PIR_D Max -- maximum value of sixty one-second values of shaded PIR
51	PIR_D Min -- minimum value of sixty one-second values of shaded PIR
52	NIP Average -- average of sixty one-second values of NIP
53	NIP Std Dev -- standard deviation of sixty one-second values of NIP
54	NIP Max -- maximum value of sixty one-second values of NIP
55	NIP Min -- minimum value of sixty one-second values of NIP
56	Int Temp -- data logger internal temperature
57	Batt Int -- data logger internal battery voltage
58-68	Miscellaneous Labels

Example:

TWP-Manus.skyrad V960207.00 96/02/07,OO:00: 59,41000,80.86,1.00,82.04,78.58,- 140.62, -140.64,-140.68,13630.73,13653.11,13653.11,13802.17,13824.87,13824.87,269.72,1.32,271.41, 267.01,-54.23,1.34,-52.25,-55.53,24.86,24.46,24.96,0.0007,0.0007,0.0005,0.0010,0.0005,0.0017, 0.0005,26.97,0.17,27.24,26.64,-141.87,-141.91,-141.98,13533.09,13533.09,13555.29,13824.87, 13533.09,13555.29,273.80,1.24,275.79,271.18,474.89,7.89,486.41,463.29,24.07,12.40,13.46, PIRG_Rc:, PIRG_Rd:, PIRG_Tc:, PIRG Td:, PIRG cor:, UVB_cor:, PIRD_Rc:, PIRD Rd:, PIRD_Tc:, PIRD_Td:, PIRD_cor:,

Data File Source: GNDRAD Data Logger Input to: ARCS.EXE
Number of Fields: 36

Format:

Field	Description
1	Text Header including station name, software version, and date (YY/MM/DD)
2	Time in GMT (hh:mm:ss)
3	flags
4	PSP Average -- average of sixty one-second values of PSP
5	PSP Std Dev -- standard deviation of sixty one-second values of PSP
6	PSP Max -- maximum value of sixty one-second values of PSP
7	PSP Min – minimum value of sixty one-second values of PSP
8	PIR_dn E1 -- instantaneous value of PIR at 10 seconds after the minute
9	PIR_dn E2 -- instantaneous value of PIR at 30 seconds after the minute
10	PIR_dn E3 -- instantaneous value of PIR at 50 seconds after the minute
11	Rc 1 -- instantaneous value of PIR case thermistor at 10 sec after the minute
12	Rc2 -- instantaneous value of PIR case thermistor at 30 sec after the minute
13	Rc3 -- instantaneous value of PIR case thermistor at 50 sec after the minute
14	Rd1 -- instantaneous value of PIR dome thermistor at 10 sec after the minute
15	Rd2 -- instantaneous value of PIR dome thermistor at 30 sec after the minute
16	Rd3 -- instantaneous value of PIR dome thermistor at 50 sec after the minute
17	PIR_dn Average -- average of sixty one-second values of PIR
18	PIR_dn Std Dev -- standard deviation of sixty one-second values of PIR
19	PIR_dn Max -- maximum value of sixty one-second values of PIR
20	PIR_dn Min -- minimum value of sixty one-second values of PIR
21	IRT_dn Average -- average of sixty one-second values of downward pointing IRT
22	IRT_dn Std Dev -- standard dev of sixty one-second values of downward pointing IRT
23	IRT_dn Max -- maximum value of sixty one-second values of downward pointing IRT
24	IRT_dn Min -- minimum value of sixty one-second values of downward pointing IRT
25	NET Average -- average of sixty one-second values of Net Radiometer
26	NET Std Dev -- standard dev of sixty one-second values of Net Radiometer
27	NET Max -- maximum value of sixty one-second values of Net Radiometer
28	NET Min -- minimum value of sixty one-second values of Net Radiometer
29	Int Temp -- data logger internal temperature
30	Batt Int -- data logger internal battery voltage
31	Batt Ext -- data logger external batter voltage
32-36	Miscellaneous Labels

Example:

TWP-Manus.gndrad V960206.00 96/02/07,00:00:59,1000,70.23,0.86,71.29,68.18,- 140.82,
-140.74,-139.98,14039.23,14062.40,14085.61,14069.50,14069.50,14069.50,260.41,0.56,261.93,
259.51,10.95,0.17,11.46,10.62,-23.75,0.16,-23.48,-24.07,23.82,12.45,13.16, Rc:, Rd:, Tc:, Td:, PIR:,

Data File Source: CALRAD Datalogger Input to: ARCS.EXE
Number of Fields: 52

Format:

Field	Description
1	Text Header including station name, software version, and date (YY/MM/DD)
2	Time in GMT (hh:mm:ss)
3	Flags
4	PSP_G Average -- average of sixty one-second values of global PSP
5	PSP_G Std Dev -- standard deviation of sixty one-second values of global PSP
6	PSP_G Max -- maximum value of sixty one-second values of global PSP
7	PSP_G Min -- minimum value of sixty one-second values of global PSP
8	PIR G E1 -- instantaneous value of unshaded PIR at 10 seconds after the minute
9	PIR_G E2 -- instantaneous value of unshaded PIR at 30 seconds after the minute
10	PIR G E3 -- instantaneous value of unshaded PIR at 50 seconds after the minute
11	Rgc1 -- instantaneous value of unshaded PIR case thermistor at 10 sec after the minute
12	Rgc2 -- instantaneous value of unshaded PIR case thermistor at 30 sec after the minute
13	Rgc3 -- instantaneous value of unshaded PIR case thermistor at 50 sec after the minute
14	Rgd1 -- instantaneous value of unshaded PIR dome thermistor at 10 sec after the minute
15	Rgd2 -- instantaneous value of unshaded PIR dome thermistor at 30 sec after the minute
16	Rgd3 -- instantaneous value of unshaded PIR dome thermistor at 50 sec after the minute
17	PIR_G Average -- average of sixty one-second values of unshaded PIR
18	PIR Std Dev -- standard deviation of sixty one-second values of unshaded PIR
19	PIR_G Max -- maximum value of sixty one-second values of unshaded PIR
20	PIR G Min -- minimum value of sixty one-second values of unshaded PIR
21	IRT Average -- average of sixty one-second values of upward pointing IRT
22	IRT Std Dev -- standard deviation of sixty one-second values of upward pointing IRT
23	IRT Max -- maximum value of sixty one-second values of upward pointing IRT
24	IRT Min -- minimum value of sixty one-second values of upward pointing IRT
25	UVBT1 -- instantaneous value of UVB temperature signal at 10 seconds after the minute
26	UVBT2 -- instantaneous value of UVB temperature signal at 30 seconds after the minute
27	UVBT3 -- instantaneous value of UVB temperature signal at 50 seconds after the minute
28	UVB1 -- instantaneous value of UVB signal at 10 seconds after the minute
29	UVB2 -- instantaneous value of UVB signal at 30 seconds after the minute
30	UVB3 -- instantaneous value of UVB signal at 50 seconds after the minute
31	UVB Average -- average of sixty one-second values of upward pointing UVB
32	UVB Std Dev -- standard deviation of sixty one-second values of UVB
33	UVB Max -- maximum value of sixty one-second values of UVB
34	UVB Min -- minimum value of sixty one-second values of UVB
35	NIP Average -- average of sixty one-second values of NIP
36	NIP Std Dev -- standard deviation of sixty one-second values of NIP
37	NIP Max -- maximum value of sixty one-second values of NIP
38	NIP Min -- minimum value of sixty one-second values of NIP
39	NET Average -- average of sixty one-second values of Net Radiometer
40	NET Std Dev -- standard dev of sixty one-second values of Net Radiometer
41	NET Max -- maximum value of sixty one-second values of Net Radiometer
42	NET Min -- minimum value of sixty one-second values of Net Radiometer
43-46	Other data
47-	Miscellaneous Labels

Field	Description
52	

Example:

TWP-Manus.calrad V960207.00 96/02/07,15 :58:00,27001,349.91,0.81,351.44,348.01,-115.92, -115.35,-114.89,19688.75,19688.75,19652.38,19329.13,19329.13,19293.66,235.96,9.89,342.12227.81,56.13,42.36,267.53,31.26,148.21,97.53,67.43,0.7254,0.4685,0.3618,0.2846,0.0360, 0.3746,0.2470,0.88,0.43,1.46,0.11,-1102.01,318.91,1135.37,-1156.24,0.00,0.00,0.00,0.00, PIRC_Rc:, PIRC_Rd:, PIRC_Tc:, PIRC_Td:, PIRC_cor:, UVB_cor:,

Data File Source: Cavity Radiometer Software Input to: ARCSPLOT.EXE
Number of Fields:

Format:

Header:

Field	Description
1	decimal hour start time
2	start time (hh:mm:ss)
3	date (MM-DD-YYYY)
4	day of year
5	Site Latitude in decimal degrees + to north
6	Site Longitude in decimal degrees + to west
7	Window Correction Factor (1.0 for no window, ~1.055 for window)
8	Site Name

Data:

Field	Description
1	start time of average data in seconds since midnight
2	end time of average data in seconds since midnight
3	solar elevation in degrees above horizon
4	solar azimuth in degrees from south (+ to west)
5	Average Irradiance in W/m^2
6	Standard Deviation of Irradiance
7	Temperature (K) at last electrical calibration

Example:
Header:
15.75625 15:45:22 02-07-1996 3835.06 106.54 1 Sandia
Data:
57000.00 57060.06 19.07558 -53.67737 292.3032 837.8485 1.252698E-02 292.3032

Data File Source: ARCS.EXE Input to: ARCSPLOT.EXE
Number of Fields: 36

Format:

Field	Description
1	Record ID -- dummy variable, used for input to DQMS
2	Year
3	Jday -- day of year
4	hhmm -- time in hour-minute
5	dectime -- time in decimal hours
6	SPSP_G Average -- SKYRAD PSP Global avg. of sixty one-second values
7	SPIR G Average -- SKYRAD PIR unshaded avg. of sixty one-second values
8	SIRT_up Average -- SKYRAD IRT avg. of sixty one-second values
9	SUVB Average -- SKYRAD UVB avg. of sixty one-second values
10	SPSP_D Average -- SKYRAD PSP Diffuse avg. of sixty one-second values
11	SPIR_D Average -- SKYRAD PIR shaded avg of sixty one-second values
12	SNIP Average -- SKYRAD NIP avg of sixty one-second values
13	GPSP_dn Average -- GNDRAD PSP avg of sixty one-second values
14	GPIR_dn Average -- GNDRAD PIR avg of sixty one-second values
15	GIRT_dn Average -- GNDRAD IRT avg of sixty one-second values
16	GNET Average -- GNDRAD NET avg of sixty one-second values
17	Mprecip Average -- SMET data, not used in this version
18	Mtemp Average -- SMET data, not used in this version
19	Mrelhum Average -- SMET data, not used in this version
20	Mvapprs Average -- SMET data, not used in this version
21	MWS1vec Average -- SMET data, not used in this version
22	MWS 1ar Average -- SMET data, not used in this version
23	MWD1 Average -- SMET data, not used in this version
24	MWS2vec Average -- SMET data, not used in this version
25	MWS2ar Average -- SMET data, not used in this version
26	MWD2 Average -- SMET data, not used in this version
27	Mpress Average -- SMET data, not used in this version
28	CPSP Average -- CALRAD PSP avg. of sixty one-second values
29	CPIR Average -- CALRAD PIR avg. of sixty one-second values
30	CIRT Average -- CALRAD IRT avg. of sixty one-second values
31	CUVB Average -- CALRAD UVB avg. of sixty one-second values
32	CNET Average -- CALRAD NET avg. of sixty one-second values
33	CNIP Average -- CALRAD NIP avg. of sixty one-second values
34	VAZ Average -- Cavity solar azimuth
35	VEL Average -- Cavity solar elevation
36	VIrr Average -- Cavity Irradiance average of sixty one-second values

Example:

101,1996,037,0005,0.0833,31.75,275.61,-56.09,0.0005,30.75,278.65,3.56,5.35,361.09,9.57,
-37.14,-6999.00,-6999.00,-6999.00,-6999.00,-6999.00,-6999.00,-6999.00,-6999.00,-6999.00,
-6999.00,-6999.00,-6999.00,-6999.00,-6999.00,-6999.00,-6999.00,-6999.00,-6999.00,-6999.00, -6999.00

File Name: DATYYDDD.DAT
Data File Source: ARCSPLOT.EXE Input to: Grapher

Number of Fields: 10

Format:

Field	Description
1	Day of Year
2	dectime -- decimal hour of day
3	PSP_G -- SKYRAD Global PSP Average
4	PIR G -- SKYRAD unshaded PIR Avg.
5	UVB -- SKYRAD UVB Avg.
6	PSP_D -- SKYRAD Diffuse PSP Avg.
7	PIR_D -- SKYRAD shaded PIR Avg.
8	NIP-- SKYRAD NIP Avg.
9	PIR_dn -- GNDRAD PIR Avg.
10	NET -- GNDRAD Net Radiation Avg.

Example:
037,0.0333,38.12,277.01,0.0017,36.65,279.95,7.00,362.53,-31.19

File Name: ERRYYDDD.DAT
Data File Source: ARCSPLOT.EXE Input to: Grapher
Number of Fields: 10

Format:

Field	Description
1	Day of Year
2	dectime -- decimal hour of day
3	ghi_err -- error between GHI measured and GHI calculated from diffuse and NIP direct
4	net_err -- error between Eppley calculated net radiation and Net radiometer
5	pirg_err -- error between unshaded PIR and average of PIR D and PIR_G
6	pird_err -- error between shaded PIR and average of PIR D and PIR G
7	Pirdn_err -- error between down pointing PIR and avg of all three PIRs
8	nip_err -- error between NIP and Cavity Irradiance
9	calc_net -- calculated net radiation from Eppley instruments
10	gnet -- net radiation measurement from net radiometer

Example:

037,0.1667,-6999.00,0.33,0.00,0.00,-0.17,-6999.00,-50.07,-33.53

Note: Eppley calculated Net Radiation goes to zero when GroundRad instruments are inverted for comparison with CalRad. Field 7 is included for times when the instruments are inverted and all three PIRs can be intercompared. Field 8 appears as missing flag when cavity data is not present. Fields 9 and 10 are included here even though they are not error values because they are plotted on the same axes as the Net Radiation error.

File Name: CFVYYDDD.DAT Input to: Grapher
Data File Source: ARCSPLOT.EXE

Number of Fields: 9

Format:

Field	Description
1	Day of Year
2	dectime -- decimal hour of day
3	zenith -- solar zenith angle in degrees
4	nip_cf -- ratio of NIP irradiance to cavity irradiance
5	pspg_cf -- ratio of PSP_G irradiance to PSP_D + Cavity Irradiance * cos (zenith)
6	pspdn_cf -- ratio of PSP_dn irradiance to PSP_D + Cavity Irradiance * cos (zenith)
7	nipc_cf -- ratio of NIP irradiance to comparison NIP irradiance
8	pspgc_cf -- ratio of PSP_G irradiance to comparison PSP
9	pspdnc_cf -- ratio of PSP_dn irradiance to comparison PSP

Example:

037,18.3331,53.~)0,0.99,1.00,-6999.00,-6999.00,-6999.00,-6999.00

Note: Values compared to cavity radiometer are flagged as missing data during times when the cavity is not running. Values compared to CalRad comparison radiometers are similarly flagged when CalRad is not running. The PSP_dn signals are flagged as missing when the GroundRad PSP is not inverted to measure global horizontal irradiance.

Attachment 2: FM(NIP)-001 Cavity Radiometer Calibration Form

ARCS NIP/Cavity Radiometer Calibration Check Form

I. **Calibration information**

This is a (check which):	Calibration	Calibration Check	Field Calibration
		X	

Date:	GMT Begin Time:	GMT End Time:	ARCS #

Instrument / System:	TWP OMS Part Number(s):	TWP OMS Serial Number(s):

Location	Participant(s):	Issued by:	Signature(s):

Reference Instrument(s):	TWP OMS Part Number(s):	TWP OMS Serial Number(s):
Cavity Radiometer	Cavity	30494

Current Configuration Version:	New Configuration Version

II. **Initial Values**

Sensor/Element:	Reference (Cavity)	Reading	Reference	Reading	Reference	Reading

III. **Final Values**

UNCHANGED: ☐ CHANGED: ☐

Sensor/Element:	Reference (Cavity)	Reading	Reference	Reading	Reference	Reading
NIP SKYRAD						

IV. **Statistics**(if applicable)

No. of Samples:	Std. Dev.	CF Range %	Uncertanty %

V. **Calilbration Change**(if applicable)

Sensor or Parameter	Sensor Serial No.	Internal Resistance (Ohms)	Original Sensitivity (Volts/Unit)	Offset	Quadratic
	Old	Old	Old	Old	Old
	New	New	New	New	New

Document(s) Referenced:	Document(s) Updated:
PRO(IRT)-005.001	

PROBLEMS:

NOTES:

Attachment 3: Example of Completed Form

ARCS NIP/Cavity Radiometer Calibration Check Form

I. Calibration information

This is a (check which):

Calibration	Calibration Check	Field Calibration
	X	

Date:	GMT Begin Time:	GMT End Time:	ARCS #
11/15/1998 to 11/16/1998	21:00	3:00	2

Instrument / System:	TWP OMS Part Number(s):	TWP OMS Serial Number(s):
NIP SKYRAD	NIP	29937E6

Location	Participant(s):	Issued by:	Signature(s):
Nauru	W. Porch	W. Porch	
	D. Scott		

Reference Instrument(s):	TWP OMS Part Number(s):	TWP OMS Serial Number(s):
Cavity Radiometer	Cavity	30494

Current Configuration Version:	New Configuration Version
V981111.00	no change

II. Initial Values

Sensor/Element:	Reference (Cavity)	Reading	Reference	Reading	Reference	Reading
NIP SKYRAD	899	928	914	943	917	946

III. Final Values

UNCHANGED: [x] CHANGED: [ ]

Sensor/Element:	Reference (Cavity)	Reading	Reference	Reading	Reference	Reading
NIP SKYRAD						

IV. Statistics(if applicable)

No. of Samples:	Std. Dev.	CF Range %	Uncertanty %
3			

V. Calilbration Change(if applicable)

Sensor or Parameter	Sensor Serial No. Old/New	Internal Resistance (Ohms) Old/New	Original Sensitivity (Volts/Unit) Old/New	Offset Old/New	Quadratic Old/New

Document(s) Referenced:
PRO(IRT)-005.001

Document(s) Updated:

PROBLEMS:
The cavity was also set up on 11/13 and we could not get the cavity controller to work. We found that the power at the stand 110 V 50 Hz was causing the problem and running an extesion cord with 110V 60 HZ solved the problem (however the procedure says that 50 Hz is OK for the controller). Will check with mentor.

NOTES: