**Item:** Battery Charger

**Manuf/Model:** Statpower / TrueCharge 10

**Description:**
A microprocessor-controlled three-stage charger. This charger requires 110 volts of AC power which is obtained by plugging the charger's power cord into a Tripp-Lite surge protector outlet strip which in turn is connected to metered power supplied by the local utility company. At CRN sites the charger is connected to a 12 volt, 100 Amp Hour (Ah) battery connected in parallel to an adjacent 12 volt, 100 Ah battery (equivalent to one 12 volt, 200 Ah battery). The battery charger and two batteries are located in an aluminum enclosure that utilizes convection air circulation for thermal management.

Output Current Continuous: 10 amps
Input Voltage Range: 90 to 135 volts AC
Output Voltage (charge): 14.2 to 14.4 volts DC
Output Voltage (float): 13.5 to 13.8 volts DC
Recommended Battery Size: 12 volt; 25 Ah to 200 Ah
Temperature Range (operational): 0 $^{o}$C to 40 $^{o}$C

**Installation Procedures:** The battery charger is mounted vertically to the left wall on the inside of an aluminum enclosure. Connect the positive lead from the battery charger (identified by red heat shrink) to battery terminal marked "+". Connect the negative lead from the battery charger to the battery terminal marked "-". Plug the charger's power cord into the Tripp-Lite surge protector outlet strip.

**Why measure this parameter?:**
This parameter is not measured.

**How is data recorded?:**
No data is recorded for this item.

**How is data computed?:**
No data is computed for this item.

**What data / information is stored on the data logger?:**
No data pertaining to this item is stored in the datalogger.

**What values are transmitted?:**
No data pertaining to this item is transmitted.

**Item:** Battery

**Manuf/Model:** East Penn Manufacturing Co., Inc. / Deka Unigy I, 12GVR-100

**Description:**
A gel-type, valve-regulated battery developed specifically for telecommunications. At CRN sites, two such batteries are used (equivalent to one 12 volt, 200 amp-hour battery). The batteries are located in an aluminum enclosure that utilizes convection air circulation for thermal management.

Nominal Voltage: 12 volts
Output Voltage (charge): 13.5 volts
Output Voltage (float): 13.8 volts
Temperature Range (operational): -20 $^{o}$C to 25 $^{o}$C
Weight: 72.6 lbs (33.0 kg)

**How is it installed?:**
Two Batteries are mounted inside the Battery Box. The grounded aluminum enclosure also houses the Battery Charger, Isobar Power Strip, and the Low Voltage Disconnect. The Batteries are wired directly to the Charger and the Disconnect.

**Why measure this parameter?:**
Battery voltage is measured to determine charge status and to diagnose power-related problems.

**How is data recorded?:**
Battery voltage is measured by the P1 command (voltage measurement command in the CR23X, reference page 9-1 'CR23X Micrologger Operator's Manual' revised 3/00) in the CSI CR23X data logger. A resistor divider circuit composed of two resistors with resistances of 10k and 105k reduces the voltage to a measurable range.

**How is data computed?:**
Values are measured every two seconds and multiplied by .012 to convert the readings to DC volts. These two-second values are averaged at the end of the hour.

**What data / information is stored on the data logger?:**
The hourly average of the battery voltage is sent to the CR23X data logger final storage.

**What values are transmitted?:**
The average hourly battery voltage is transmitted.

**Item:** Tower

**Manuf/Model:** Climatronics Corporation / C-33HD Bottom section with a B-18 Base.

**Description:** An 18 inch (45.7 cm) tapered triangular section 10 feet (3 m) tall bolted to a three-post base anchored in a 3ft x 3ft x 4ft (0.91 m x 0.91 m x 1.23 m) concrete block.

**Material:** Welded aluminum, with all stainless steel above ground base and stainless steel fasteners.

**Wind Loading:** 110 mph for a 33-foot (10 m) tower with five square feet of equipment.

**How is it installed?;**
Earth is excavated to allow a 3ft x 3ft x 4ft deep concrete block to be poured. A form is constructed to shape the concrete and position the tower. The tower is positioned in the form to orient one side of the tower to the west. This allows the correct orientation of the mounted instrumentation. The base allows the tower to swivel to a horizontal position for future instrument installation or service. The base should be oriented to allow the tower to swivel to the northeast direction. The concrete is poured and the tower leveled, then secured.

**Item:** Surge Suppressor

**Manuf/Model:** Tripp-Lite / Isotel 4 Ultra

**Description:**
A four-outlet, diagnostic surge suppressor.

Rated Input Voltage: 105 to 135 VAC, 60 Hz
AC Energy Absorption: 2700 Joules
Amp Spike Protection: 92,000 amps
Transient Response Time: Instantaneous
UL 1449 & UL 1283 listed

**Installation Procedure:** The surge suppressor is mounted inside an aluminum enclosure (which also contains the True Charge 10 battery charger and the two, 12 volt, 100 Ah batteries) on the back wall of the enclosure above the low voltage disconnect. Plug the power cord from the True Charge 10 battery charger and the power cord from the CH12R battery charger (located inside the enclosure that houses the CR23X datalogger) into the surge suppressor.

**Why measure this parameter?:**
No data measured for this item.

**How is data recorded?:**
No data recorded for this item.

**How is data computed?:**
No data computed for this item.

**What data / information is stored on the data logger?:**
No data pertaining to this item is stored in the data logger.

**What values are transmitted?:**
No data pertaining to this item transmitted.

**Item:** GOES Satellite Transmitter

**Manuf/Model:** Manufactured by Seimac Limited, and distributed by Campbell Scientific / Model SAT HDR GOES

**Description:**

A transmitter with non-volatile memory for configuration information and two 16 Kb RAM buffers to store data, capable of transmitting at 100, 300, or 1200 bps. The 1200 bps setting is being used for CRN sites. Data may be transmitted in ASCII or binary format. One of the buffers is used to store information for scheduled transmissions, and the second buffer stores information for random transmission. The CRN stations do not transmit on random channels at this time.

Power requirements: 9.6 to 12 VDC
1 ma quiescent
350 ma during GPS fix
< 4 amps during transmission

Temp. Range: -40 $^{o}$C to 50 $^{o}$C / 0 to 99% RH

Data is transferred to the transmitter each hour from the CR23X by software commands. A configuration file is loaded from a laptop computer during site installation that sets the NESDIS ID and transmission times for the station.

**How is data recorded?:**

The CR23X can communicate with the transmitter using software commands. Information requested is stored in input locations of the CR23X.

**What data / information is stored on the data logger?:**

At 55 minutes into each hour an instruction is executed by the CR23X that requests the last message status from the transmitter. The information returned is stored in input locations of the CR23X and includes the following:

1. Command result Code
2. Message type: Self-timed or Random
3. Size of message in bytes
4. Forward power in tenths of watts
5. Reflected power in tenths of watts
6. Power supply voltage under full load, in tenths of volts
7. GPS acquisition time in tens of seconds

8. Oscillator drift (signed, hundreds of Hzs)
9. Latitude degrees
10. Latitude minutes
11. Latitude seconds
12. Longitude degrees
13. Longitude minutes
14. Longitude seconds

This information remains in the input locations until overwritten by the next request for information, which occurs one hour later at 55 minutes into the hour.

**What values are transmitted?:**

Battery voltage in tenths of volts during transmission for the previous hour is transmitted in the data stream.


**Sensor:** Wind Speed

**Manuf/Model:** Met One, Model 014A

**Description:**
A 3-cup anemometer assembly with magnet-reed switch which produces contact closures whose frequency is proportional to wind speed.

Range: 0 to 60 meters per second with starting speed approximately 0.5 meters per second
Accuracy: ± 1.5%
Temp. Range: -50$^{o}$C to 85$^{o}$C
Distance Constant: < 15 feet

**How is it installed?**
The anemometer is mounted vertically upright near the end of one of the 3-meter cross-member arms, about 1.5 meters above the surface of the ground. The sensor is inserted into a Holleander tubing cross fitting perpendicular to the 3-meter cross-member. The sensor is level and held in position by set screws.

**Why measure this parameter?**
Wind speed is measured, along with solar radiation and ground surface (skin) temperature, to provide information to allow for correction of observed air temperature data due to solar heating. Wind speed will also be useful in interpreting the "catch" of the precipitation gauge(s), which may be affected by aerodynamics or other factors related to the wind speed.

**How are data recorded?**
Each revolution of the anemometer's cup assembly produces two contact closures. These contact closures are recorded using the CSI 23X data logger and the P3 (pulse count) command.

**How are data computed?**
The number of counts recorded via the P3 (pulse count) command for each two-second period is inserted into an equation obtained by an individual calibration performed in a wind tunnel. The equation obtained from the calibration is a linear trend line. The process used for calibration is based on ASTM Test Method D5096-96: Standard Test Method for Determining the Performance of a Cup Anemometer or Propeller Anemometer.

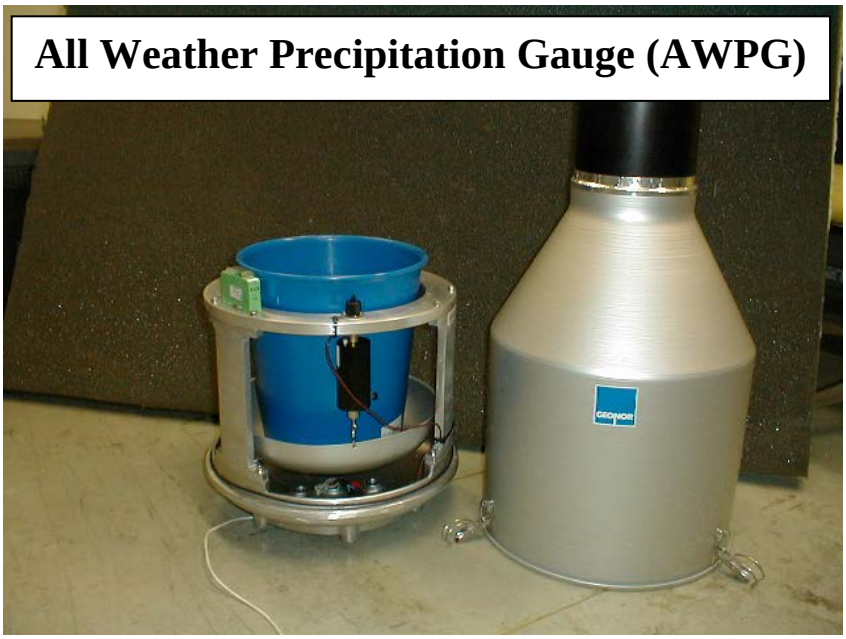
**What data/information are stored on the data logger?**
A P71 (average) command is used to average the two-second values every five minutes. Then the twelve five-minute periods are averaged to obtain an average wind speed for the hour. The average wind speed value and the standard deviation (computed from the twelve five-minute periods, P82 command, reference page 11-7 of the 'CR23X Micrologger Operator's Manual' revised 3/00) are stored in the data logger.

**What values are transmitted?**
Two values pertaining to the wind speed are in the data stream.

- The average hourly wind speed.

- The standard deviation.

# All Weather Precipitation Gauge (AWPG)




**Sensor:** All Weather Precipitation Gauge

**Manuf/Model:** GEONOR, T-200B

**Description:**
The GEONOR precipitation gauge is a weighing type gauge. The T-200B uses vibrating wire strain gauges to continuously weigh the collection bucket. The 12-liter collection bucket is suspended by three vibrating wire sensors.

**How is it installed?**
The gauge is mounted via a Holleander pedestal mount to a 6-foot long 2" aluminum pipe. This pipe is mounted 3.5 feet deep in 2' x 2' x 3'deep poured concrete block. The poured concrete is extended to 2 feet above the surface at a diameter of 1.25 feet. The gauge is bolted to the pedestal and all sensors, surge suppressors, and weighing bucket mounts are attached. The sensors and suppressors are connected electrically to their appropriate positions. The bucket is added to the bucket mount and the bucket is leveled via the adjustment nuts on the strain gauges. The sensors are then calibrated using the 'GEONOR Rain Gauge Calibration Procedure'. The gauge is surrounded by a Small DFIR and Single Alter wind/snow shield. A controlled heater device is attached to the gauge.

**Why measure this parameter?**
Precipitation amounts (accumulations) are a primary measurement for the USCRN Program.

**How are data recorded?**
The vibrating wire, when excited with 12V DC, outputs a frequency (Hz) relative to the weight in the collection bucket. The actual frequency measured for the sensor is averaged each hour and

the hourly frequency maximum and minimum is calculated. These calculations are done for each of the three sensors and reported independently.

**How are data computed?**
For each of the three vibrating wires, the frequency is measured every two seconds using the CR23X period average command with the frequency output option (P27). A running average of the last 30 samples of the frequency is calculated using a CR23X P52 running average command. This is done to decrease false reports of precipitation caused by wind noise. The frequency is converted into a measure of the precipitation level in the bucket using the formula P= A(f-f0)+B(f-f0)**2, where P is the precipitation level in the bucket in cm, A and B or sensor constants determined by calibrations and entered into the program, f0 is the sensor frequency with the bucket empty, and f is the measured frequency average of the last 30 samples. The result is converted to mm by multiplying by 10.

The Geonor measures the precipitation level in the bucket, thus the amount of precipitation that occurred in the last 15 minutes is calculated at the end of each 15 minute period. Small fluctuations occur in the measured precipitation level in the bucket due to temperature changes and sensor variations, thus a minimum change of .25 mm (.01 inch) is required to cause precipitation to be reported. The CR23X calculates a term referred to as the "last level". The last level is initialized to the current precipitation level when the CR23X is first programmed. At the end of each 15 minute period the calculated precipitation level is compared to the last level. If the precipitation level is greater than the last level by more than .25 mm, the difference is reported as precipitation and the last level is reset to the current precipitation level. If the precipitation level has decreased by more than .25 mm the last level is reset to the current precipitation level. This could be due to evaporation or emptying of the bucket by the site operator. Any decrease in the precipitation level is reported as zero precipitation.

At the end of each 15 minute period the 15 minute calculated precipitation amount is stored according to the quarter hour past. The last calculated precipitation depth is recorded. At the end of each hour the four 15 minute precipitation amounts are totaled.

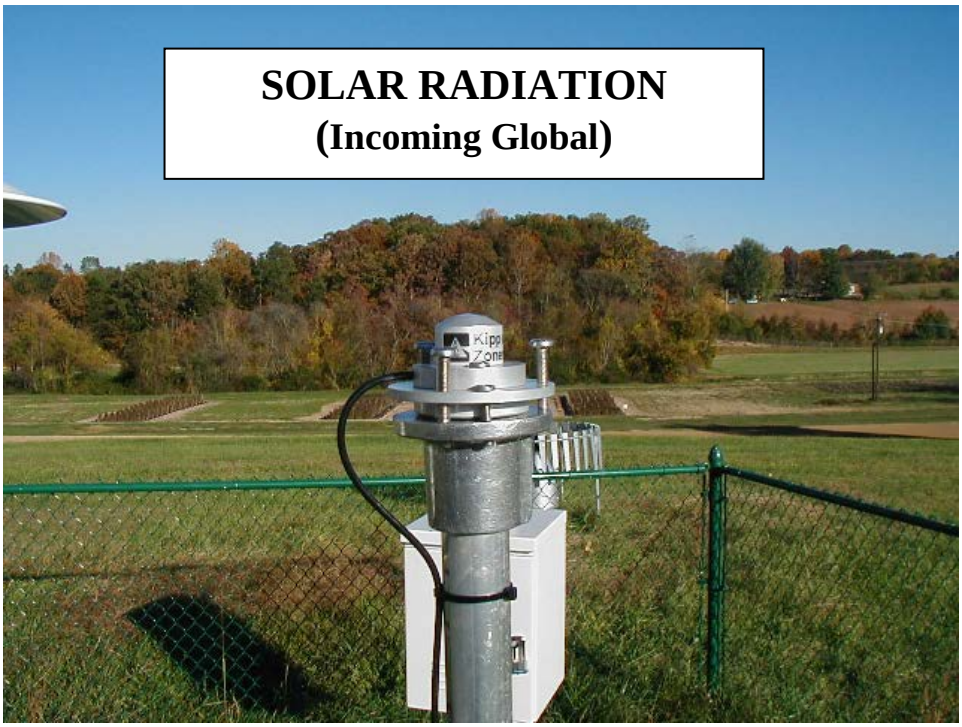
**What data/information are stored in the data logger?**
Each 15 minute calculated precipitation amount according to the quarter hour past, the last calculated precipitation depth, the hourly total from the four 15 minute precipitation amounts, and the associated hourly average, maximum, and minimum frequency values for each of the three vibrating wires are stored in the data logger.

**What values are transmitted?**
For each of the three vibrating wires:

- The hourly average, maximum, and minimum frequencies.

- The calculated precipitation for 0-15, 15-30, 30-45, and 45-60 minutes, and the Hourly Total.

- The calculated precipitation level at the end of each 15 minute period.




**Sensor:** Solar Radiation

**Manuf/Model:** Kipp & Zonen, Pyranometer Model SP Lite

**Description:**
The SP Lite is a silicon pyranometer that measures solar radiation from the entire hemisphere. The sensor consists of a photodiode shunted by a resistor, housing, and cable.

Sensitivity: 100 μV per $W/m^2$
Response Time: < 1 second
Stability: ± 2% per year
Non-linearity: <1% up to 1000 $W/m^2$
Temperature Dependence: ± 0.15% per $^oC$
Temp. Range: -30$^o$C to 70$^o$C

**How is it installed?**
The SP Lite sensor mounted vertically upward near the end of one of the 3-meter cross-member arms, about 1.5 meters above the surface of the ground. The SP Lite is mounted on a leveling plate by cap screws. This plate is mounted onto a Holleander end cap which is mounted on a 0.4 meter tubing. Adjustment screws are used to level the SP Lite to allow full exposure.

**Why measure this parameter?**
Solar radiation is measured, along with wind speed and ground surface (skin) temperature, to provide information to allow for correction of observed air temperature data due to solar heating.

**How are data recorded?**
The photodiode is shunted by a resistor, which produces a voltage output. Using the CSI CR23X data logger and the P2 command (voltage measurement command in the CR23X, reference page 9-1 of the 'CR23X Micrologger Operator's Manual' revised 3/00), the voltage output is measured every two seconds.

**How are data computed?**
The voltage obtained via the P2 command for each two-second interval is converted to $W/m^2$ by a linear regression equation (voltage vs. $W/m^2$) obtained through an individual calibration.

**What data/information are stored on the data logger?**
The P71 command (averaging command in the CR23X, reference page 11-3 in the 'CR23X Micrologger Operator's Manual' revised 3/00) is used to average the two-second values every five minutes. The twelve five-minute periods are then averaged to obtain the hemisphere solar radiation for the hour. This hourly value and the standard deviation (computed from the twelve five-minute periods, P82 command, reference page 11-7 of the 'CR23X Micrologger Operator's Manual' revised 3/00) are stored in the data logger.

**What values are transmitted?**
Two values pertaining to the solar radiation are in the data stream.

- The average hourly hemisphere solar radiation value.

- The standard deviation.


**Sensor:** Ground Surface (Skin) Temperature

**Manuf/Model:** Apogee Instruments Inc., Model IRTS-P

**Description:**
The IRTS-P is a precision infrared temperature sensor that consists of two type K thermocouples.

Accuracy: ± 0.2$^{o}$C from 15 to 35$^{o}$C & ± 0.3$^{o}$C from 5 to 45$^{o}$C
Repeatability: 0.05$^{o}$C from 15 to 35$^{o}$C
Response Time (target): < 1 second
Response Time (body): 2 minutes
Optimum Temp. Range: 0$^{o}$C to 50$^{o}$ C
Field of View: 1 to 1 or 1.3 meter diameter circle

**How is it installed?**
The IRTS-P sensor is mounted vertically downward near the end of one of the 3-meter cross-member arms, 1.3 meters above the ground surface. The sensor is inserted into a Holleander tubing cross fitting perpendicular to the 3-meter cross-member and pointed downward. The sensor is held in position by set screws.

**Why measure this parameter?**
This temperature is measured to determine the effective "skin temperature" of the "field of view" ground surface. Ground Surface (Skin) Temperature, along with wind speed and solar radiation provide information to allow for correction of observed air temperature data due to solar heating.

**How are data recorded?**
The thermocouple temperature is obtained every two seconds.

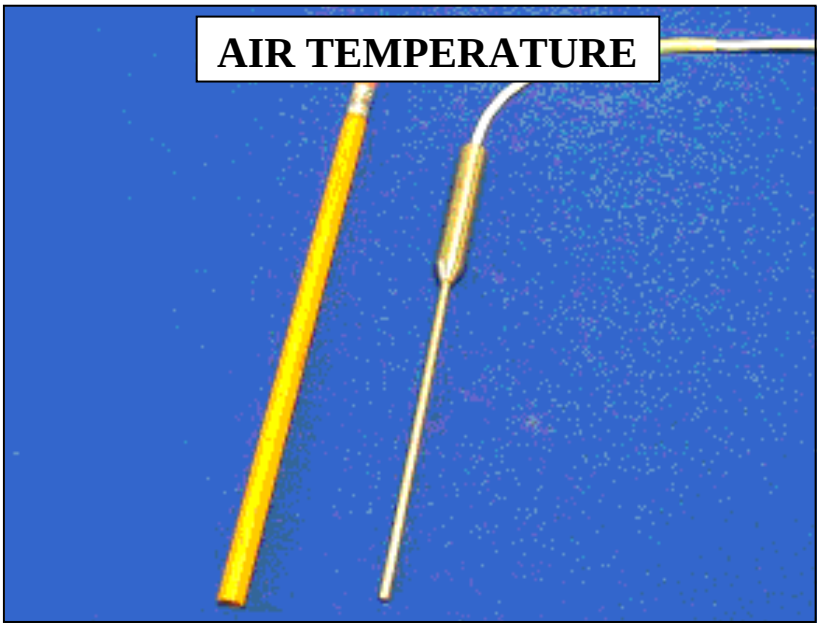
**How are data computed?**
When the observed temperature of the ground is less than 15$^{o}$C, the surface temperature is obtained by the CSI CR23X data logger using the P14 command (thermocouple temperature measurement command reference page 9-10 in the 'CR23X Micrologger Operator's Manual' revised 3/00). When the surface temperature is greater than or equal to 15$^{o}$C, a correction is applied to the measurement described above. The manufacturer supplies the equations for the correction (reference article 'Evaluation and Modification of Commercial Infra-red Transducers for Leaf Temperature Measurement' from the 'Advanced Space Research, Vol. 22, No. 10, pp.1425-1434, 1998'.

**What data/information are stored on the data logger?**
The P71 command (the averaging command for the CR23X, reference page 11-3 in the 'CR23X Micrologger Operator's Manual' revised 3/00) is used to average the two-second values every five minutes. Then the twelve five-minute periods are averaged to obtain the hourly average surface (skin) temperature. The hourly value and the standard deviation (computed from the twelve five-minute periods, P82 command, reference page 11-7 of the 'CR23X Micrologger Operator's Manual' revised 3/00) are stored in the data logger.

**What values are transmitted?**
Two values pertaining to the surface (skin) temperature are in the data stream.

- The average hourly ground surface (skin) temperature.

- The standard deviation.




**Sensor:** Surface Air Temperature

**Manuf/Model:** Thermometrics Corporation

**Description:** The Platinum Resistance Thermometer (PRT) is a precision temperature sensor with the following specifications:

Type: Platinum 1000 ohm ± 0.04% at 0°C (per IEC-751, Class A accuracy)
Temperature Coefficient: 0.00385 (per IEC-751 and ASTM E-1137)
Range: -60°C to +300°C
Sheath: Type 316 stainless steel, 0.125 inches diameter ± 0.010 inches (per ASTM A632) by 4 inches long, filled with MgO powder and vibro-compacted; sealed with epoxy at the leads.
Leads: Three-wire type, 22 AWG silver-coated copper wires with Teflon insulation, with aluminized Mylar shield and drain wire
Each probe etched with lot number for traceability
Repeatability and Stability: Better than ± 0.01°C per year
Accuracy: ±0.04% over full range
Time Constant: 63% of thermal response in 13 sec when immersed from 20°C air into 50°C water flowing at 0.2 m/s

**How is it installed?**
Three completely independent PRTs are used. Each PRT probe is installed in a pair of clips inside its own mechanically (fan) aspirated radiation shield (Met One model 076B/7308). Each shield is mounted vertically downward from its own 3 m long cross-member arm, about 1.5 m above the surface of the ground. Each shield is leveled and held in position by set screws.

**Why measure this parameter?**
Surface Air Temperature is one of the primary measurements for USCRN.

**How are data recorded?**
Each of the three PRT probes are polled every two seconds by a Campbell Scientific CSI 23X data logger using the P7 command to determine the ratio of the sensor resistance to a known resistance (refer to 'CR23X Micrologger Operator's Manual', revised 3/00). A three-wire half-bridge circuit with a 1000 ohm ± 0.01% precision resistor is used; a second voltage-sensing wire compensates for the effects of the lead resistance. The measurement sequence is to apply an excitation voltage, make a single-ended measurement on the first channel, and then repeat the process using an excitation voltage of opposite polarity. The same sequence is then applied to the second single-ended channel. This sequence is used to remove any offset voltages.

**How are data computed?**
The ratio obtained via the P7 command is applied in an equation obtained from a calibration performed in a precision temperature bath. The equation is a second-order polynomial. At the end of every five minutes the average temperature (command P71) is determined for the five-minute period. For each PRT, the average hourly temperature (P71), the minimum (P74) and maximum (P73) temperatures determined for the twelve five-minute averages for the hour, and the standard deviation (P82) are computed (refer to 'CR23X Micrologger Operator's Manual', revised 3/00).

**What data/information are stored on the data logger?**
Values for <u>each of the three sensors</u>: The average hourly temperature (command P71, computed from the 12 five minute averages ), the minimum (P74) and maximum (P73) temperatures for the hour (determined from the twelve five-minute averages for the hour), the time of occurrence of the maximum and minimum temperature values, and the standard deviation (P82, computed from the twelve five-minute periods (reference page 11-7 of the 'CR23X Micrologger Operator's Manual' revised 3/00)), are stored in the data logger. In addition, the five-minute average temperature for the last five-minute period of the hour is stored in the data logger (per NWS request).

**What values are transmitted?**
Seven values <u>for each of the three temperature sensors</u> (21 total values) are in the data stream.

- The hourly average temperature.

- The hourly maximum and minimum temperatures and the time of their occurrence.

- The standard deviation.

- The five-minute average temperature for the last five-minute period in the hour (NWS request).

**Item:** Aspirated Solar Shield

**Manuf/Model:** Met One / 076B 7308

**Description:**
A white-painted aspirated solar shield containing a 12-volt DC-powered fan (Papst 4212) to aspirate the air temperature sensor.

Radiation Error: < 5% under max solar radiation of 1116 W per $m^2$
Shield Temp. Range: $-50^o$ C to $85^o$ C
DC FAN Temp. Range: $-20^o$ C to $75^o$ C
DC Fan Flow: 97.1 CFM
Power Requirement: 4.3 watts

**Installation Procedures:**
Horizontally attach 5 ft x 1 in. ∅ conduit piece to south leg and east leg of tower at a height of 80.5 in. above the ground using two 1 in. x 1 in. offset cross assemblies supplied by Holleander. Horizontally attach 3 ft x 1 in. ∅ conduit piece to north leg of tower and to 5 ft x 1 in. ∅ conduit piece, using two 1 in. x 1 in. offset cross assemblies supplied by Holleander, and placing below the 3 ft arm and making one end of the pipe flush with outer edge of offset cross assembly attached to the 5 ft x 1 in. ∅ conduit piece. Attach 1 in. x 1 in. offset crosses supplied by Holleander to tips of the 5 ft arm and the of 3 ft arm. Assemble Aspirated Solar Radiation Shields. Attach a 1 ft x 1 in. ∅ piece of aluminum conduit to flange on top of each aspirated shield. Insert aforementioned 1 ft x 1 in. ∅ pieces of conduit into offset crosses on tips of five ft and three ft conduit arms. Position intake of middle (south) shield 1.5 m above ground and use laser level to get other two shields to same height and level shields so that the tube shaped part of the aspirated shield is vertical. Attach power cables for aspirated shield fans to aspirated shields. Connect clear wire from the east shield power cable to CR23X control port five. Connect clear wire from the south shield power cable to CR23X control port six. Connect clear wire from the

west shield power cable to CR23X control port seven. Connect red wire from each shield power cable to a tab on the 12V fuse block and insert 3-amp fuse into accompanying slot. Connect black, green, and bare wires from shield power cables to ground terminal strip.

**Why measure this parameter?:**
A solar shield is required to keep incoming solar radiation from affecting the air temperature sensors by day, and to keep outgoing infrared radiation from cooling the air temperature sensors at night. The shield should be fan-aspirated to insure its internal temperature is very close to the ambient air temperature. Data from the shield fan is recorded to verify that the fan is operating at the proper rotational speed.

**How is data recorded?:**
The DC fan outputs two pulses for every rotation of the fan blade. The CR23X data logger records the number of pulses that occur over a two second interval and multiplies it by 0.5. At the top of every hour, the CR23X averages the samples to obtain the average number of pulses per second over the hour interval. The average number of pulses per second over the hour interval is then stored in the CR23X final storage (used by the CR23X for long term storage).

**How is data computed?:**
See above.

**What data / information is stored on the data logger?:**
See above.

**What values are transmitted?:**
One value for each of the three shields is in the data stream. The average number of pulses per second for the previous hour for each of the three shields is transmitted. The number of pulses per second represents two times the fan blade revolutions per second.

Inside the shield

**Item:** Datalogger

**Manuf/Model:** Campbell Scientific, Inc. / CR23X

**Description:** The CR23X micrologger is the data acquisition system used for the CRN station. It is a user programmable precision measurement device that combines recording, processing and control capabilities in a single unit.

**Standard Configuration:** The CR23X measures sensors, reduces data, controls external devices, stores both data and programs in either non-volatile Flash memory or battery-backed SRAM, and transfers data to GOES Satellite transmitter. The standard SRAM 1 Mbyte memory stores 500,000 data points in two final storage areas. Final storage area 1 is used to store data to be transmitted via GOES, final storage area 2 is used to store data for on site retrieval. At the present time over 5 months of data can be stored before being overwritten.

The CR23X's operating system includes a comprehensive set of measurement, processing, and output/program control instructions to create a datalogger program. Measurement instructions specific to 2-, 3-, 4-, and 6-wire bridge configurations, voltage output, vibrating wire sensors, pulse counting, and other common measurements are standard.

Processing instructions support algebraic, statistical and transcendental functions allowing data reduction on-site. Output/program control instructions control external devices and process data over time (e.g. averages, maxima, minima).

A battery-backed (lithium) clock assures accurate timekeeping. The multi-tasking operating system allows simultaneous communication and measurement functions.

**Analog Inputs:** Twenty-four single-ended (twelve differential) channels measure voltage levels with 15-bit resolution on five software-selectable voltage ranges.

**Pulse Counting Channels:** The CR23X has four 8-bit pulse channels for measuring switch closures, low-level AC pulses, and high frequency pulses.

**Digital Input/Output Ports:** The CR23X has eight digital input/output control ports. All of the ports can be used for output control and to sense status of external devices. Ports 5 through 8 can be configured as pulse counters.

**Switched Excitation Outputs:** Four outputs provide precision excitation voltages for resistive bridge measurements. The excitation voltage is programmable over a ± 5000 mV range.

**Power Connections:** The continuous 5 V and 12 V terminals are for connecting sensors and non-CSI peripherals. The switched 12 V terminal is program controlled.