SECTION V. MAINTENANCE

9.5.1 INTRODUCTION

This section provides the preventive and corrective maintenance procedures for the ceilometer. Preventive maintenance consists of those procedures performed on a periodic basis to keep the ASOS operational, which includes routine cleaning and inspection. Corrective maintenance consists of those procedures required to isolate a fault in the ceilometer down to the field replaceable unit (FRU) level.

9.5.2 PREVENTIVE MAINTENANCE

9.5.2.1 **General**. Preventive maintenance for the ceilometer consists of two basic procedures, which are listed in table 9.5.1. The maintenance log should be updated after each procedure to record any problems or repairs that were required.

Table 9.5.1. Ceilometer Preventive Maintenance Schedule

Interval	What To Do	How To Do It
90 days	Routine inspection and cleaning	Paragraph 9.5.2.2
	Ceilometer cleaning and window conditioner checks	Paragraph 9.5.2.3
Semiannually	Check ceilometer calibration	Paragraph 9.5.2.4
Annually	Clean snow radiation shield	Paragraph 9.5.2.5

9.5.2.2 **Routine Inspection**. Routine visual inspection of the ceilometer should be performed every 90 days or each time the technician visits the installation site. This inspection consists of checking the ceilometer for signs of physical damage, wear, mold, mildew, or corrosion.

CAUTION

Mold or mildew can form at base of ceilometer near top of the mounting pole. Examine for mold or mildew. If present, remove with a putty knife and scrub area with a detergent/water solution. Treat any rust present in accordance with paragraph 1.5.3.4.

Any debris from insects, animals, or such that may potentially degrade performance should be removed. All power and signal cabling to the ceilometer should be checked to ensure that it is secure and undamaged.

9.5.2.3 **Ceilometer Cleaning and Window Conditioner Checks**. Cleaning the ceilometer windows, blowers, and exhaust screens and checking the operation of the window conditioner are maintenance procedures vital to optimum ceilometer performance. These procedures are provided in table 9.5.2.

9.5.2.4 **Calibration**. The calibration of the ceilometer must be checked every 180 days or after replacing Transmitter Board A7 or Receiver Board A6. Before the sensor can be calibrated, it must be properly installed and must pass its ASOS diagnostic checks. Table 9.5.3 provides the procedure to check ceilometer calibration.

9.5.2.5 **Clean Snow Radiation Shield**. The snow radiation shield must be cleaned annually, in the fall, prior to the winter season. The snow radiation shield cleaning procedure is contained in table 9.5.4.

Table 9.5.2. Cleaning and Inspection

Step	Procedure
	WARNING Do not look into the ceilometer optics with magnifying glass, binoculars, or any other magnifying optics. The transmitter emits an invisible infrared laser pulse that can cause damage to human eyes. Death or severe injury may result if power is not removed from sensor prior to maintenance activities. Ensure that heater and primary power circuit breakers (located in DCP) are set to off (right) position.
1	Inside DCP equipment cabinet, set circuit breakers on ceilometer circuit breaker module to off (right) position.
2	Visually inspect ceilometer windows for damage (scratches, chips, or cracks) and dirt (film, streaks, or particles). Replace damaged windows by replacing the ceilometer electronics assembly.
3	Disconnect window conditioner by unplugging the cable from connector J2 located on the underside of the equipment cabinet assembly.
4	Loosen four knurled screws securing window conditioner to equipment cabinet assembly.
5	Carefully lift window conditioner from equipment cabinet assembly and gently set on the ground. Check that heater resistance between pins B and C of the window conditioner cable is 22 ±3 ohms. If resistance is not within tolerance, replace window conditioner assembly.
6	Using soft brush or clean linen cloth, gently dust off all loose particles from windows.
7	Using cleaning alcohol, soak window surfaces, allowing the surface to remain damp for a few minutes.
	CAUTION Avoid rubbing window surface to prevent scratching the window.
8	Gently wipe cleaning alcohol from windows. Turn cloth over and wipe the surface dry.
9	Inspect window conditioner for signs of obvious wear or damage.
10	Check thickness of rubber foam strips located on the underside of the heater/blower subassembly base plate. Replace compressed or worn strips using NWS ASN K220-1B1MP1. Brown burn marks in top of equipment cover indicates that the rubber foam strips need to be replaced.
11	Remove heater/blower subassembly and inspect for insects or other debris, especially at the blower exhaust screens. Remove any accumulated foreign material.
	CAUTION Be aware of razor-sharp edges on subassembly screens.
12	Carefully install window conditioner on equipment cabinet assembly and tighten four knurled screws.
13	Connect window conditioner cable to connector J2 on the underside of equipment cabinet assembly.
14	The operation of the blower can be observed by listening to the sound of the blower motor and feeling the air movement across the surface of the windows.

Table 9.5.3. Ceilometer Calibration Check Procedure

Step	Procedure
	Tools required: CTX-16 ceilometer calibration kit Small flat-tipped screwdriver Laptop interface (Y-shaped) cable Laptop null cable Laptop computer with PROCOMM Plus installed Two jumper wires
	INITIAL SETUP PROCEDURE
1	Remove ceilometer window conditioner, clean windows, and reinstall window conditioner in accordance with table 9.5.2.
2	**CAUTION** The CTX-16 reflector hood attenuates the ceilometer laser beam and reflects it back to the receiver. Damage to inside surfaces of hood will alter the transmissivity characteristics and recalibration may be necessary. Use special care when assembling or disassembling instrument. Open CTX-16 calibration kit and remove folded reflector hood. Unfold hood and set it on its edge.
3	**CAUTION** Do not disturb position of hex nuts at ends of two male and two female rods. Hex nuts at end of four rods are factory adjusted so that after reflector hood is assembled, two top panels are at a 90-degree angle to each other. Remove two female rods and two male rods from calibration kit. Do not disturb position of hex nuts on ends of four rods. Connect one female rod to one male rod at their knurled ends. Repeat to connect second pair of rods.
4	Insert both ends of one male/female rod assembly through holes on one side of reflector hood. Secure ends of rod assembly by loosely installing two 3/8-inch wingnuts from calibration kit. Repeat to install other rod assembly on other side of calibration reflector. Tighten all wingnuts.
5	Mount CTX-16 calibration reflector hood on top of ceilometer.
6	Inside DCP equipment cabinet, identify fiberoptic module dedicated to ceilometer. If necessary, perform the following: a. Refer to sensor configuration page on OID (sequentially press REVUE-SITE-CONFG-SENSOR function keys from 1-minute display). b. Refer to Chapter 3, Section IV to identify corresponding fiberoptic module.
7	Using small flat-tipped screwdriver, disconnect DB-9 connector from ceilometer fiberoptic module in DCP.
8	Using small flat-tipped screwdriver, install jumper between TB1-1 (on orange terminal block) on ceilometer fiberoptic module (A1) and TB1-1 on adjacent fiberoptic module. Install second jumper between terminals TB1-2 of ceilometer fiberoptic modules and adjacent module containing first jumper.
9	Using laptop interface (Y-shaped) cable and laptop null cable, connect RS-232C (COM1) port of laptop computer to DB-9 connector of ceilometer fiberoptic module.
10	Turn on laptop computer and initialize the PROCOMM Plus program. After program initializes, press any key to enter terminal mode (blank) screen.

Table 9.5.3. Ceilometer Calibration Check Procedure - CONT

Step	Procedure
11	Using ALT-S command (setup facility), set up the following TERMINAL OPTIONS: a. Terminal emulation: VT220 b. Duplex: FULL c. Soft flow control (XON/XOFF): OFF d. Hard flow control (CTS/RTS): OFF e. Line wrap: ON f. Screen scroll: ON g. CR translation: CR h. BS translation: NON-DESTRUCTIVE I. Break length (milliseconds): 350 j. Enquiry: OFF k. EGA/VGA true underline: OFF l. Terminal width: 80 m. ANSI 7 or 8 bit commands: 7 BIT
12	Press ESC key to exit to terminal mode (blank) screen.
13	Using ALT-P command (line/port option), set CURRENT SETTINGS as follows: a. Baud rate: 2400 b. Parity: NONE c. Data bits: 7 d. Stop bits: 1 e. Port: COM1
14	Press ESC key to exit to terminal mode (blank) screen.
	CALIBRATION PROCEDURE
	NOTE All commands used in this procedure (except SEND) require an open line to ceilometer. Line, when opened, times out after 30 seconds. Throughout this procedure, it may be necessary to use OPEN command before issuing other commands.

1	Turn Caps Lock ON. Type OPEN <CR>. Ceilometer responds with LINE OPENED FOR OPERATOR COMMANDS. Type PAR <CR>. Parameter values are displayed. Verify that the values are as follows:
	
	`CLIM 0.1000`
	`SLIM 0.2000`
	`NSCA 4.5000`
	`SCAL 100.0000`
	`TOTAL 10.0000`
	`HOFF 0`
	`DATA UNIT FT`
	`POLLED MESSAGES`
	
	If the stored parameter values do not agree with those listed above, enter the above values.

2	Mount CTX-16 calibration reflector. Allow ceilometer to be powered up for at least 10 minutes in automatic mode so that laser power can stabilize. Perform the following steps as one sequence within 60 seconds so that laser power does not change significantly during test.
3	Type AUTO OFF <CR> to set ceilometer to maintenance mode.
4	Type GAIN 0 to set ceilometer to Gain 0.
5	Activate measurement cycle in ceilometer by typing MEAS 12 command and using MES command to observe output. Use commands at least twice to verify that measurement is stable.

Table 9.5.3. Ceilometer Calibration Check Procedure - CONT

Step	Procedure
6	Use the STA command and from output, record values for FREQ and LLAS.
7	Type LNOR <CR>. Ceilometer responds with current laser normal (LNOR) value (e.g., LASER NORM LNOR 134). Subtract 5 from LNOR value and record LNOR - 5 value (e.g., 134 - 5 = 129).
8	Using FREQ value recorded above, obtain corresponding relative frequency percentage as follows: FREQ — RELATIVE FREQUENCY (%) 0 — -0.195 1 — -0.143 2 — -0.078 3 — 0.0 4 — +0.078 5 — +0.182 6 — +0.299 7 — +0.455

9	Calculate and record adjusted LLAS value by multiplying recorded LLAS value by relative frequency value obtained above, and subtracting result from original LLAS value. That is:
	LLAS (adj) = LLAS - [(relative freq) * LLAS]
	
	For example, if LLAS is 117 at FREQ = 5, then
	
	LLAS (adj) = 117 - [(.182)(117)] = 117 - 21 = 96
	
	If sign of relative frequency value is negative, then negative value sign must be included in calculation (result is added instead of subtracted).
	
	For example, if LLAS is 117 at FREQ = 2, then
	
	LLAS (adj) = 117 - [(-0.078)(117)] = 117 + 9 = 126

10	Calculate and record percentage difference of operating laser power (LLAS) from nominal (LNOR - 5) by subtracting LLAS (adj) value from LNOR - 5 value, dividing result by LLAS (adj) value, and multiplying by 100 to obtain percentage. That is: PCT DIFF = [((LNOR-5) - LLAS (adj))/LLAS(adj)] * 100 For example, if LNOR = 134, then LNOR - 5 = 129. If LLAS(adj) is 96 as above, then: PCT DIFF = [((129 - 96)/96] *100 = 0.34 * 100 = 34%

Table 9.5.3. Ceilometer Calibration Check Procedure - CONT

Step	Procedure

11	Type MES <CR>. Ceilometer responds with printout of two status lines followed by 13 data lines (numbered 0 through 12) in the following format:
	
	`30 00050 00050 ///// ///// 0000010011`
	`0 3 0.01 747 7 100 22.0 1.46 10 98`
	`0D1B61F 2 7 5 5 0 2 2 4 1 0 2 3 2 1 1 2 3`
	`1`
	`2`
	`3`
	`4`
	`5`
	`6 (DATA PRINTOUT)`
	`7`
	`8`
	`9`
	`10`
	`11`
	`12 6 6 6 7 7 6 7 7 6 7`

12	Using reflector response percentage table supplied with calibration kit, locate first two digits from data line 0 (e.g., D1 above) on list along top of form.
13	Locate second two digits from line 0 (e.g., B6 above) on list along left side of reflector response percentage table.
14	Record sensitivity (S) value at intersection of top column and left row noted above.
15	Type DEV <CR>. Ceilometer responds with current device scale (DEV) value (e.g., DEVICE SCALE DEV 1.0908). Record displayed DEV value. If DEV value is lost, refer to table 9.5.3a.
16	Calculate and record scaled sensitivity value for ceilometer by multiplying S value obtained from reflector response percentage table by DEV value obtained above. For example, if value from table was 71 and DEV was as above: S (scaled) = (71) * (1.0908) = 77.4
17	Calculate final sensitivity by adding PCT DIFF value (from calibration step 10 above) to S (scaled) value. That is: S (final) = S (scaled) + PCT DIFF For example: S (final) = 77.4 + 34 = 111.4
18	Verify that S (final) value is 100 ±15%.
19	If S (final) value is not within tolerance, replace transmitter board and recalibrate. If resulting S (final) value is still not within tolerance, replace receiver board.
20	Type AUTO ON to return ceilometer to automatic mode. **NOTE** Failure to perform step 20 to return the ceilometer to automatic mode will result in the ceilometer erroneously reporting the calibration values obtained in this calibration procedure as cloud data. ASOS will not detect this false condition.

Table 9.5.3. Ceilometer Calibration Check Procedure - CONT

CALCULATIONS	
1	At DOS prompt, type ASOS <CR> to initialize the ASOS calibration program.
2	Enter menu item 4 of the ASOS calibration program.
3	Enter the recorded LLAS, FREQ, and LNOR values when prompted, pressing <CR> after each entry.
4	The program will calculate the adjusted LLAS (LLAS [adj]) and percentage difference (PCT DIFF) and display them on the next line. Record these values.
5	Enter the recorded LLAS, FREQ, and LNOR values when prompted, pressing <CR> after each entry.
6	Enter the DEV value at the prompt and press <RT>.
7	The program calculates the scaled sensitivity and displays the result on the next line.
8	The program will then calculate and display the final sensitivity and verify that the S (final) value is 100 ±15%. If the value is within tolerance, a message will appear stating that the value is within tolerance. If the value is higher or lower than the tolerance, the program will beep and display a warning message.
TEARDOWN	
1	Remove, disassemble, and store reflector hood, hardware, and instructions in calibration kit carrying case.
2	At laptop computer, use ALT-X (exit) command to exit PROCOMM Plus.
3	Turn off laptop computer.
4	Disconnect cables between laptop computer and fiberoptic module.
5	Remove two jumpers between fiberoptic modules.
6	Using small flat-tipped screwdriver, install DB-9 connector to ceilometer fiberoptic module in DCP.

Table 9.5.3a. Device Scale Calculation Procedure

NOTE All lenses and windows must be cleaned before starting this procedure.	
1	Mount CTX-16 Calibration Reflector hood on top of ceilometer. Allow ceilometer to be powered up for at least 15 minutes in the Automatic Mode so that Laser Power can stablilize. Perform the following steps as one sequence within 60 seconds so that the Laser Power does not change significantly during test.
2	Type AUTO OFF <CR> to set ceilometer to enter maintenance mode.
3	Type DEV 1.0000 <CR>.
4	Type GAIN 0 <CR> to set ceilometer Gain
5	Type MEAS 12 to activate measurement cycle.

Table 9.5.3a. Device Scale Calculation Procedure - CONT

6	Type MES <CR>. Ceilometer responds with a printout of status lines followed by 13 data lines (numbered 0 thru 12) in the following format: 30 0050 0050 //// //// 0000010011 0 3 0.01 747 7100 22.0 1.46 10 98 0D1B61F 2 7 5 5 0 2 2 4 1 0 2 3 2 1 1 2 3 1 2 3 4 5 6 7 8 9 10 11 12 6 6 6 7 7 6 7 7 6 7
7	Using the Reflector Response Percentage Table supplied with the Calibration Kit, locate the first two digits from the data line 0 (e.g., D1, above and underlined) along TOP of percentage table.
8	Locate second two digits from data line 0 (e.g., B6, above and underlined) along LEFT side of percentage table.
9	Record SENSITIVITY (S) value at intersection of TOP column and LEFT row.
10	This value is (S) WITH COVERS, record this value.
11	Type AUTO ON >CR< to set ceilometer to automatic mode.
12	Remove CTX-16 Calibration Reflector Hood.
13	Turn DCP ceilometer circuit breakers to OFF.
14	Remove both ceilometer equipment cabinet covers as described in table 9.5.13. Turn DCP ceilometer circuit breakers to ON.
15	Mount CTX-16 Calibration Reflector Hood on top of ceilometer.
16	Repeat Steps 1 thru 12, this second value is (S) WITHOUT COVERS, record this value.
17	Calculate the DEVICE SCALE factor by dividing (S) WITHOUT COVERS by (S) WITH COVERS. Example: 105 / 98 = 1.0714 (DEV)
18	Type OPEN <CR>.
19	Type DEV X.XXXX <CR> (X.XXXX is the value in step 17). Record this value for future reference. If the DEV exceeds 1.2500 the window cover needs to be replaced.
20	Turn DCP ceilometer circuit breakers to OFF.
21	Reinstall ceilometer equipment cabinet covers as described in table 9.5.13.
22	Turn DCP ceilometer circuit breakers to ON.

Table 9.5.4. Snow Radiation Shield Cleaning Procedure

Step	Procedure
	Tools required: Clean clothes Portable vacuum cleaner 3-inch brush
1	Remove snow radiation shield from the ceilometer using the procedure in table 9.5.33.
2	Clean bottom of ceilometer and entire snow radiation shield with a damp cloth.
3	Remove dust and debris from external temperature sensor housing using a portable vacuum cleaner and 3-inch brush.
4	Install snow radiation shield onto ceilometer using the procedure in table 9.5.33.

9.5.3 **CORRECTIVE MAINTENANCE**

The ceilometer is supported by a set of internal automatic diagnostics that are executed by the ceilometer processor board and reported in the data messages transferred to the DCP and ultimately reported to the ACU. These diagnostic messages provide the basis for all corrective maintenance for the ceilometer. If the operation of the ceilometer is questionable, yet no alarm messages are received, an intermittent fault or data transfer fault may exist. In either case, the maintenance technician must perform troubleshooting of the ceilometer to isolate and replace the faulty FRU and return the system to operation.

9.5.3.1 **Fault Symptoms**. The symptoms of a fault involving the ceilometer generally fall under one of the following four categories:

a. Data Message Contains Alarm. This symptom is reported to the operator on the ceilometer page display at the operator interface device (OID).

b. RS-232C Interface Nonoperational. This symptom is evidenced by loss of reports (data missing) from the ceilometer, which may be consistent or intermittent.

c. Cloud Detection Missing. This symptom is evidenced by the ceilometer reporting no clouds present, when the observer knows that there is cloud cover.

d. Superfluous Detection. This symptom is evidenced by conflicts in ceilometer reports, such as drastic, unrealistic changes in the detected cloud bases.

The troubleshooting and repair procedures for the ceilometer are performed by identifying the fault symptom from one of those listed in table 9.5.5. The table defines the detailed fault isolation procedures to be followed. These procedures are provided in the following paragraphs. These procedures isolate the fault to the FRU level. The replacement procedures for each FRU are provided at the end of this section.

9.5.3.2 **Data Message Contains Alarm**. When the automatic self-test routine of the ceilometer detects a malfunction, it is reported to the operator on the OID ceilometer page display. The alarm status indicators include: hardware alarm, supply voltage alarm, laser power low alarm, and temperature alarm. In addition to these alarms, the same display indicates the status of the following ceilometer components: solar shutter (optional) on/off, blower on/off, heater on/off, pulse frequency (pulse repetition frequency) value, and gain (receiver amplifier gain) value.

9.5.3.2.1 **Hardware Alarm**. A hardware alarm is indicated by an F in the HARDWARE field on the OID ceilometer page. When a general hardware alarm is detected by the system, the maintenance technician should open a line of communication (direct dialogue mode) with the ceilometer and request status from the processor. Direct dialogue mode is entered by using the DIALG key at the OID display. Direct dialogue mode is also available when using the maintenance laptop computer. The status of the ceilometer is requested by entering the STA command in the ENTER COMMAND area on the display. The status message reply from the ceilometer may contain one or more of the messages listed in table 9.5.6. The status message displayed should be located in the table and the verification and replacement procedures provided for the identified FRU's performed. If none of these messages apply, the direct dialogue RESET command should be entered at the OID (or ceilometer power is cycled for a moment). When the ceilometer initialization sequence is complete, the startup message should be observed. If the ceilometer initialization sequence detects an error, the message received may contain one of the messages identified in table 9.5.7. The error message should be located in the table and the verification and replacement procedures provided for the identified FRU's performed. If no error message is displayed, the system may have detected a temporary or intermittent fault. If so, the ceilometer should be reset and its operation observed. If an intermittent fault is still observed, troubleshooting should be performed using the theory of operation as the basis for fault analysis and the verification and replacement procedures for isolating the fault and replacing the FRU performed.

Table 9.5.5. Ceilometer Troubleshooting

Symptom	What to Do	How to Do It
Data message contains hardware alarm	Isolate fault using direct dialogue.	Paragraph 9.5.3.2.1
Data message contains supply voltage alarm	Isolate fault using direct dialogue.	Paragraph 9.5.3.2.2
Data message contains laser power low alarm	Isolate fault using direct dialogue.	Paragraph 9.5.3.2.3
Data message contains temperature alarm	Isolate fault using direct dialogue.	Paragraph 9.5.3.2.4
No response from ceilometer module	Check fiberoptic.	Chapter 1, Section IV
	Replace fiberoptic module.	Paragraph 9.5.4.13
	Check ceilometer RS-232C interface.	Paragraph 9.5.3.3
	Check ac/dc power.	Paragraph 9.5.3.2.2
	Replace Processor Board, A1.	Paragraph 9.5.4.1
Ceilometer not detecting clouds	Troubleshoot	Paragraph 9.5.3.4
Superfluous cloud detections	Troubleshoot	Paragraph 9.5.3.5

Table 9.5.6. General Hardware Alarm Messages

Message	Suspect FRU
SKY MONITOR SUSPECTED	A5, A6, or A1
AD MONITOR ERROR	A1
SEQUENCE ERROR	A1
INTERNAL HEATING SUSPECTED	T1, R1, R2, A1, or A2
BLOWER/HEATER ERROR	B1, PS1, TS1, or A1
SHUTTER CONTROL SUSPECTED	K1 or A5

Table 9.5.7. Initialization Error Messages

Message	Suspect FRU
EX XXXXX XX XX (X=hex char.)	A1
OFFSET ERROR	A1
AMPLIFIER ERROR	A1
NOISE ERROR	A1, A6, or W8
SEQ RAM NOT CLEARED	A1
SEQ PULSE COUNTER ERROR	A1
ANALOG MONITOR ERROR	A1
LASER POWER LOW	A7, A5, K1, or PS1
SEQUENCE HALT	A1
EEPROM ERROR	A1
SIGNAL ERROR	A1

9.5.3.2.2 **Supply Voltage Alarm**. A supply voltage alarm is indicated by an F in the SUPPLY VOLTAGE field on the OID ceilometer page. When a supply voltage alarm is detected by the system, the maintenance technician should open a line of communication (direct dialogue mode) with the ceilometer and request status (STA command) from the processor board. The displayed status message contains one or more voltages that are detected as being below the alarm limit (as set by the ALIM command). The voltage(s) that triggered the alarm are identified by an asterisk (*) after the voltage value. Table 9.5.8 provides the voltage levels that should be detected at each power supply monitoring point. The voltage points are also depicted on the

detailed block diagram (figure 9.4.4 sheet 3). If the voltage displayed is within the specified limits, the alarm limit specified for the system should be checked (using the ALIM command). If the specified alarm limit is correct (within the normal operating range specified in the table), connector faults or line voltage variances are possible. If a specified voltage point is out of limit, reference should be made to table 9.5.9, which identifies the ac power inputs, fuses, and loads associated with each monitored dc power point. The maintenance technician should manually check the power supply points at the ceilometer installation site to isolate the fault. Table 9.5.10 provides a general troubleshooting procedure for the power supplies.

Table 9.5.8. Power Supply Monitored Voltage Levels

Voltage Point	Normal Value	Alarm Limit	Acceptable Max
P20I	+20 vdc	+15 vdc	+24 vdc
P10X	+10 vdc	+7.5 vdc	+12 vdc
M20A	-20 vdc	-15 vdc	-24 vdc
P10R	+10 vdc	+7 vdc	+13 vdc
MRHV*	-300 vdc	-150 vdc	-450 vdc
P12M	+12 vdc	+8 vdc	+15 vdc
P10D	+10 vdc	+6.5 vdc	+12 vdc
P25V	+25 vdc	+20 vdc	+30 vdc
PXHV*	+130 vdc	+52 vdc	+200 vdc
P20A	+20 vdc	+15 vdc	+24 vdc
M20I	- 20 vdc	-15 vdc	-24 vdc

* These voltages are temperature-dependent and are adjusted at 72°F (22°C) to the values marked on the respective circuit boards.

Table 9.5.9. Monitored Power Test Points, Fuses, and Loads

Voltage Point	Check Fuses	Voltage Test Point	AC Input at A2	Power Loads
P10D	A2F3	A2TP4	8 vac	A1
P20I	A2F6 or F7	A2TP3	30 vac	A1
M20I	A2F6 or F7	A2TP2	30 vac	A1
P25V	A2F1	A2TP1	20 vac	R1, R2, A1, A5, T1, or PS1
M20A	A2F4 or F5	A2TP5	30 vac	A1
P20A	A2F4 or F5	A2TP6	8 vac	A1
P12M	A2F8	A2TP7	10 vac	A1
P10X	A2F9	A2TP9	8 vac	A1 or A7
PXHV	PS1F1	PS1 A1 J8	N/A	A7
P10R	A2F2	A2TP8	8 vac	A1 or A6
MRHV	PS1F2	PS1 TP1-TPGND	N/A	A6

Table 9.5.10. Power Supply General Troubleshooting Procedure

Step	Procedure
1	Check fuse(s) and replace if blown.
2	If replaced fuse blows, remove circuit load(s).
3	If fuse blows without load, suspect unregulated power supply board A2 (except for high voltage power points PXHV and MRHV, where power supply PS1 is suspect).
4	Replace suspected FRU as cause of blown fuse.
5	If voltage at test point is low and its ac input is okay, suspect unregulated power supply A2 (except for high voltage points PXHV and MRHV, where power supply PS1 is suspect).
6	If single or several ac inputs are low while ac line input is 103 vac or better, suspect power supply PS1 (except for P25V ac point, where temperature compensation transformer T1 is suspect).
7	If PXHV at high voltage power supply PS1 connector J8 is above alarm limit but alarm persists, check for bad ground connection through W9.
8	If MRHV at high voltage power supply board PS1A1 test points TP1 and TP2 is above alarm limit but alarm persists, check for bad ground connection through W8.
9	If all voltages check within limits but alarm persists, suspect processor board A1.
10	If input line voltage is below 103 vac, check ac input power from DCP.

9.5.3.2.3 **Laser Power Low Alarm**. A laser power low alarm is indicated by an F in the LASER POWER field on the OID ceilometer page. This alarm displays when the light monitor board detects a low value of average laser power (LLAS). A laser power low alarm normally indicates a failure of either the transmitter board or the light monitor board. When a laser power low alarm is detected by the system, the maintenance technician should open the direct dialogue mode with the sensor and request the sensor status (STA) command. The measured value for LLAS is included in the status display.

9.5.3.2.3.1 **LLAS Value Close to Zero**. If the LLAS value (indicated in the STA display) is close to zero, the following should be performed:

a. Inspect to ensure that there are no obstructions between the transmitter lens and the light monitor board (especially at the solar shutter, if installed).

b. Check the value of the laser normal (LNOR) parameter through direct dialogue using the PAR or LNOR command. Verify that displayed LNOR is same as factory-calibrated mark on the transmitter board (record number from transmitter board for future use). The LNOR value should be entered as required to match the transmitter board marking.

c. If there is no obstruction and the LNOR parameters match, check the supply voltages to the transmitter board and the light monitor board.

d. Check the voltages on Transmitter Board A7 test points TP4, TP7, TP3, and TP6-TP5 in accordance with paragraph 9.5.4.6.1.

e. Ensure that laser is on (AUTO ON) and check the following test points on Light Monitor Board A5:

(1) Measure TP3 (+) to TP5 (-) (GND) for 17 ±1 vdc. If not in range, measure cathode of diode D7 (or connector J2-1) for +25 vdc. If +25 vdc is present but TP3 is not present or out of tolerance, replace Light Monitor Board A5. If +25 vdc is not present, suspect Unregulated Power Supply Board A2.

(2) If ceilometer is providing positive cloud detection (with clouds in sky), measure TP1 (+) to TP5 (-) (GND) for between 1.5 and 4 vdc (with laser on). If not correct, suspect Light Monitor Board A5. If in tolerance, suspect Unregulated Power Supply Board A2 or Processor Board A1.

f. If above checks do not identify fault, replace Transmitter Board A7 and recheck laser power level. If fault remains, replace Light Monitor Board A5.

9.5.3.2.3.2 **LLAS Value Not Close to Zero**. If the LLAS value (indicated in the STA display) is below the alarm limit but not close to zero, the following should be performed:

a. Using direct dialogue, check that the pulse repetition frequency parameter is set to maximum (FREQ = 7). If it is, verify LNOR is the proper value. Replace Transmitter Board A7 if LNOR was correct.

b. Check that the value of the laser temperature (TL in STA output) is less than 140 degrees F. If temperature is above this value, interrupt operation (AUTO OFF) for a few minutes to allow ceilometer to cool. After cooling, set AUTO ON and allow ceilometer to run for a few minutes and check the temperature and power alarm again. If the temperature again is high, the transmitter board is suspect.

c. If TL value is well below 140 degrees F and the alarm persists, check calibration of ceilometer in accordance with paragraph 9.5.2.4. If ceilometer calibration is out of tolerance, replace Transmitter Board A7. If ceilometer calibration is within tolerance, proceed to next step.

d. Ensure that laser is on (AUTO ON). If ceilometer is not reporting cloud detection (while clouds are present), replace transmitter board. If ceilometer is reporting clouds, measure the following on Light Monitor Board A5:

(1) Measure TP3 (+) to TP5 (-) (GND) for 17 ±1 vdc. If not in range, measure cathode of diode D7 for +25 vdc. If +25 vdc is present but TP3 is not present or out of tolerance, replace Light Monitor Board A5. If +25 vdc is not present, suspect Unregulated Power Supply Board A2.

(2) If ceilometer is providing positive cloud detection, measure TP1 (+) to TP5 (-) (GND) for between 1.5 and 4 vdc (with laser on). If not correct, suspect Light Monitor Board A5. If in tolerance, suspect Unregulated Power Supply Board A2 or Processor Board A1.

e. If above checks do not identify fault, replace Transmitter Board A7 and recheck laser power level. If fault remains, replace Light Monitor Board A5.

9.5.3.2.4 **Temperature Alarm**. A temperature alarm is indicated by an F in the TEMPERATURE field on the OID ceilometer page. Temperature alarms result when the processor board senses component temperatures or temperature differences that are above the specified alarm limit parameters (ALIM). When a temperature alarm is detected, the maintenance technician should open direct dialogue with the ceilometer to request status (STA). The resulting status display identifies the detected temperature alarm sensed point by an asterisk (*) after the sensed value. Table 9.5.11 lists the temperature references, their normal stable

value range, and their alarm limit values. If the sensed temperature is within the limits of the table, the alarm limit parameter (ALIM) should be checked. If both of these values are correct, a wiring or connector fault is probable. If the sensed temperature is abnormal or out of limits, the associated sensor and wiring should be checked. The temperature sensors convert heat energy to electrical energy, using the following formula to convert temperatures expressed in degrees Celsius to the equivalent temperatures expressed in degrees Fahrenheit:

T(degrees Fahrenheit) = 1.8 x T(degrees Celsius) + 32

A temperature alarm occurs if the sensed voltage exceeds the preset alarm limit. An open temperature sensing circuit indicates an approximate temperature reading of 200°C (a sensed voltage of 5 vdc). The voltage output of an operational temperature sensor is expressed as:

V = (T(degrees Celsius) + 273) x 10 mV

Table 9.5.11. Temperature Alarm References

Temperature Reference	Normal Range (Stabilized)	Alarm Limit (Specified)
TE	Up to 5°C above ambient	100°C
TI	+5°C to +15°C above ambient when ambient is above 0°C, or +10°C to +30°C above ambient when ambient is below 0°C	100°C
TL	Equal to TI (±5°C)	70°C
TB	Up to 20°C above TE when unit is in sunshine with heaters and blower both off. Up to 5°C above TE when heaters are off and blower is on. Between 5°C and 10°C above TE with both heaters and blower on.	80°C

The following are typical values for reference purposes:

Temperature (T)		Sensor
Degrees Fahrenheit	Degrees Celsius	Voltage (vdc)
+140	+60	+3.33
+104	+40	+3.13
+68	+20	+2.93
+32	+0	+2.73
-4	-20	+2.53
-40	-40	+2.33

If, after sufficient stabilization time (minutes for the TE and TB references and hours for the TI and TL references), the temperature alarm persists, the course of action is determined by the category of the sensed temperature. If a high temperature is sensed (close to 200°C may indicate an open circuit), table 9.5.12 should be referenced for voltage test points. If the sensed temperature seems to be within reasonable range yet the alarm persists, table 9.5.13 should be used for fault isolation procedures. The cables and connectors referenced in these tables are depicted in the ceilometer detailed block diagram (figure 9.4.4).

Table 9.5.12. Temperature Alarm With High Temperature

Temperature Reference	Check Test Points
TL	A7, TP6 - TP5; A2J1, A13 - C13; connectors A7J2, A2J8, A2J1, and A1J1; Cable W7
TE	A2J9, 1 - 2;A2J1, a14 - c14; connectors TS1P1, A2J9, A2J1, and A1J1
TI	None, replace A1
TB	B1E1, 8 - 9; A2J1, a15 - c15; connectors B1E1, B1P1, W2J2, W2P1, PS1J2, PS1P2, A2J11, A2J1, and A1J1; cables W2 and B1W1

Table 9.5.13. Temperature Alarm With Reasonable Temperatures

Temperature Reference	Procedure
TL > 70°C (158°F)	If ambient temperature is close to 49°C (120°F) and solar radiation is intense, check that window conditioner blower is on and heat is off. If not, troubleshoot window conditioner.
TB > 80°C (176°F) or TB-TE > 40°C (72°F)	Check that the window conditioner or blower is on and functional. If not, troubleshoot window conditioner.

9.5.3.3 **RS-232C Interface Nonoperational**. The RS-232C interface of the ceilometer is the primary data communications interface for the ASOS configuration. This interface is connected to a fiberoptic module added to the ceilometer to provide the fiberoptic link with the DCP. A failure in this link could cause a total loss of communications with the ceilometer or cause intermittent data transfer errors with the sensor. If communications with the ceilometer become difficult, the maintenance technician should troubleshoot the data link starting at the DCP. (Chapter 1 provides instructions for testing the DCP fiberoptic modules.) If the DCP tests okay, the ceilometer must be checked. Before the RS-232C interface is checked at the ceilometer, the ceilometer equipment cabinet covers must be removed as described in table 9.5.14 to gain access to the electronics. Once the covers are removed, the line voltage indicator (DS1) and the equipment circuit breakers (CB1 and CB2) on high voltage power supply (PS1) are checked. The line voltage indicator should be illuminated and both circuit breakers in the ON (up) position. If power is available to the ceilometer, the ERROR and OK indicators (D4 and D5) on Processor Board A1 should be checked. The OK indicator should be flashing (about 1 Hz rate) and the ERROR indicator should be extinguished. If the ERROR indicator is illuminated, then reset the processor board using the RESET switch located on the board. If the ERROR indicator remains illuminated, then replace the processor board. If both the ERROR and OK indicators are extinguished, then perform power checks on the processor board (refer to paragraph 9.5.4.1) and the unregulated power supply board (refer to paragraph 9.5.4.2). Should the indicators and power check out okay, the ceilometer detailed block diagram (figure 9.4.4) should be referenced to check the wiring and connectors along the RS-232C data path.

9.5.3.4 **Cloud Detection Missing**. If clouds are definitely present and within the detectable range of the ceilometer but are not reported by the ceilometer, the message reports from the ceilometer must be checked for any alarm messages. It may be necessary to reset the ceilometer (by using the RESET command in direct dialogue mode or by cycling power) and check the status messages upon initialization. Using direct dialogue with the ceilometer, the parameters should be checked (using the PAR command) to verify that they are correct for the current configuration of the system. Any incorrect value should be adjusted as required. The ceilometer windows and lenses should be checked for possible obstructions. If these activities do not correct the problem, the transmitter, receiver, and processor boards are suspect. The technician should check for proper operation by referring to the theory of operation provided in Section IV and to the board verification and replacement procedures provided in this section.

Table 9.5.14. Ceilometer Equipment Cabinet Cover Removal and Installation

Step	Procedure
	REMOVAL
	Tools required: None **WARNING** Death or severe injury may result if power is not removed from sensor prior to maintenance activities. Ensure that heater and primary power circuit breakers (located in DCP) are set to off (right) position. **CAUTION** Prevent dust, precipitation, dirt, or other obstructions from accumulating on the ceilometer windows and lenses. Damage to the optics may render the ceilometer inoperable.
1	Inside DCP equipment cabinet, set circuit breakers on ceilometer circuit breaker module to off (right) position.
2	Disconnect window conditioner by unplugging cable from connector J2 located on the underside of the equipment cabinet assembly.
3	Loosen four knurled screws securing window conditioner to equipment cabinet assembly.
4	Carefully remove window conditioner by lifting from equipment cabinet assembly and gently set on the ground.
5	Release two latches at the lower edge of the ceilometer equipment cabinet cover.
6	Carefully raise equipment cabinet cover over the ceilometer electronics assembly and set on the ground.
	INSTALLATION
	WARNING Death or severe injury may result if power is not removed from sensor prior to maintenance activities. Ensure that heater and primary power circuit breakers (located in DCP) are set to off (right) position.
1	Inside DCP equipment cabinet, ensure that circuit breakers on ceilometer circuit breaker module are set to off (right) position.
2	Carefully install ceilometer equipment cabinet cover over ceilometer electronics assembly and lower to its normal position.
3	Secure two latches at lower edge of ceilometer equipment cabinet cover.
4	Carefully install window conditioner on equipment cabinet assembly.
5	Tighten four knurled screws securing window conditioner to equipment cabinet assembly.
6	Connect window conditioner cable to connector J2 located on underside of equipment cabinet assembly.
7	Inside DCP equipment cabinet, set circuit breakers on ceilometer circuit breaker module to on (left) position.

9.5.3.5 **Superfluous Detection**. If repeated miss-hits are reported by the ceilometer with no apparent cause, the system could possibly be experiencing intermittent malfunctions. The first step in isolation of these malfunctions is to check the alarm messages received from the ceilometer. It may be necessary to reset the ceilometer (by using the RESET command or by cycling power) to check the status messages reported by system initialization. The ceilometer parameters should also be checked (using the PAR command) to verify that they are correct for the current configuration of the system. If the system checks out without alarms or parameter problems and the malfunction persists, the maintenance technician should refer to the theory of operation provided in this chapter as well as the board verification and replacement procedures to troubleshoot the system.

9.5.4 BOARD VERIFICATION AND REPLACEMENT PROCEDURES

The following paragraphs provide detailed procedures to verify the operation of the ceilometer circuit boards. Procedures are also provided for the removal and replacement of each board. To perform the verification and replacement procedures, the ceilometer equipment cabinet cover must be removed to gain access to the electronics. Table 9.5.14 provides the procedures to remove and install the ceilometer equipment cabinet cover.

9.5.4.1 **Processor Board A1 Verification and Replacement**.

9.5.4.1.1 **Verification**. The processor board is a microprocessor-based design that functions as the central control element of the ceilometer. In some instances, the actual malfunction may be caused by a temporary condition that confuses the processing software. Therefore, it is recommended that the ceilometer first be reset (using the RESET command, cycling power, or activating the reset switch on the processor board) and then observed to check if the condition is corrected. The microprocessor-based design also provides the onboard processor capability of detecting the majority of faults through self-test diagnostics. These tests report detected failures through hardware alarm messages that are displayed as previously described. Several onboard voltage regulator circuits provide electrical power and reference voltages to the processor board. The source power for these local regulators is monitored by the sensor software and can be observed using the STA (status) command in the direct dialogue mode. The local regulator outputs can be checked at the points provided in table 9.5.15. If any of the onboard voltages is out of tolerance, the processor board should be replaced.

9.5.4.1.2 **Replacement**. The processor board removal and installation procedures are provided in table 9.5.16.

Table 9.5.15. Processor Board Operating Voltage Checkpoints

Checkpoint	Voltage	Description
J6 pin 8	+5 ±0.25	Logic supply
J5 pin 10	+12.2 ±0.8	Interface supply
J5 pin 9	-12.2 ±0.8	Interface supply
J9 pin 5	+9 ±0.5	Flash A/D supply
J14 pin 2	+12.7 ±0.8	Analog high supply
J19 pin 6	-12.7 ±0.8	Analog high supply
J19 pin 3	+6.1 ±0.3	Analog low supply
J19 pin 4	-6.1 ±0.3	Analog low supply
J6 pin 7	+5 ±0.05	Monitor A/D reference
J9 pin 4	+8.3 ±0.1	Flash A/D high reference
J9 pin 3	+1.7 ±0.05	Flash A/D low reference
J9 pin 2	+0.9 ±0.1	Flash A/D input
J16 pin 10	+7.1 ±0.3	Level shift source
J16 pin 9	+1.9 ±0.3	Level shift return
J19 pin 7	-4.3 ±0.3	Amplifier test point 2
J19 pin 5	+3 ±0.5	Amplifier test point 1

Table 9.5.16. Processor Board Removal and Installation

Step	Procedure
	REMOVAL
	Tools required: None **NOTE** A laptop computer initialized as DCP OID (Chapter 3, Section III) or any other available OID may be used for the following steps.
1	Using ceilometer dialog page, enter the following command: LNOR For measurement normalization during installation of the new processor board, record LNOR parameter displayed; then, enter the following command: DEV
2	Record LNOR and DEV values returned. If the values are not returned, proceed to step 3.
3	Disconnect ac power from ceilometer and remove ceilometer equipment cabinet covers as described in table 9.5.14.
4	Unplug cable W8 from connector J22 on the processor board.
5	Unplug cable W9 from connector J26 on the processor board.
6	Disconnect processor board A1 from unregulated power supply board.
7	Remove processor board from ceilometer.
	INSTALLATION
	Tools required: None
1	Ensure that all jumpers on new processor board are positioned the same as the processor board being replaced.
2	Connect new processor board into its connector on unregulated power supply board.
3	Connect cables W8 and W9 to connectors J22 and J26, respectively, on the processor board.
4	Apply power to the ceilometer and observe LED indicators D4 and D5 on Processor Board A1. The red LED (D4) should be extinguished and the green LED (D5) should blink about once per second.

5	Using the PAR (parameter) command, verify that the following system parameters values are stored:
	`CLIM 0.1000`
	`SLIM 0.2000`
	`NSCA 4.5000`
	`SCAL 100.0000`
	`TOTAL 10.0000`
	`HOFF 0`
	`DATA UNIT FT`
	`POLLED MESSAGES`
	
	If stored parameter values do not agree with those listed above, then enter the above values.

Table 9.5.16. Processor Board Removal and Installation -CONT

Step	Procedure
6	If LNOR and DEV values were recorded in step 2 of removal procedure, proceed to step 7. If LNOR and DEV values were not recorded in step 2 of removal procedure, or have not been previously recorded, disconnect AC power form the ceilometer. Remove U5 from new processor board installed in step 1 above, and U5 from processor board removed in Removal step 7; swap U5's. Reapply power, use the ceilometer dialogue page to enter the following commands: LNOR DEV Record LNOR and DEV. Disconnect AC power form the ceilometer, and swap U5's to their original boards. Reapply power.
7	Use ceilometer dialogue page to enter the following commands: LNOR XXX (where XXX is the LNOR value recorded in step 6 of the installation procedure, or step 2 of the removal procedure, or the logged values). DEV X.XXXX (where X.XXXX is the DEV value recorded in step 6 of the installation procedure, or step 2 of the removal procedure, or the logged values).
8	If LNOR for the system cannot be retrieved by the above methods, the ceilometer transmitter board must be replaced with a new board using the transmitter board removal and installation procedures. This will establish a new correct LNOR for the system.
9	Install ceilometer equipment cabinet covers as described in table 9.5.14 and apply power to ceilometer.
10	Perform the offset calibration procedures as described in table 9.5.35.

9.5.4.2 **Unregulated Power Supply Board A2 Verification and Replacement**.

9.5.4.2.1 **Verification**. Malfunctions involving the unregulated power supply board are generally detected by supply voltage alarms reported by the ceilometer. A supply voltage alarm is indicated by an F in the SUPPLY VOLTAGE field on the OID ceilometer page. When a supply voltage alarm is detected by the system, the technician should open a direct dialogue line with the ceilometer (select OID dialogue page) and request status (STA command) from the processor board. The displayed status message contains one or more voltages that are detected as being below the alarm limit (as set by the alarm command). The voltage(s) that triggered the alarm are identified by an asterisk (*) after the voltage value. Table 9.5.17 provides the voltage levels that should be detected at each power supply monitoring point. If the voltage displayed is within the limits shown in the table, the technician should check the alarm limit entered into the system (using the ALIM command). If the system alarm limit is correct (within the normal operating range specified in the table), connector faults or line voltage variances are possible. If one specific voltage point is out of limit, reference should be made to table 9.5.18, which identifies the ac power inputs, fuses, and loads associated with each monitored dc power point. The technician should check corresponding fuses and manually check the power supply points at the ceilometer to isolate the fault. Table 9.5.10 provides additional information on checking system power supplies. In addition to the power supplies, the unregulated power supply board provides an extensive number of signal paths between the other circuit boards in the ceilometer. These signal paths can be verified by checking their continuity using an ohmmeter. The temperature control relays on the unregulated power supply board can only be checked by simulating heating conditions using a cold spray to cool the temperature sensor (U16 on Processor Board A1). The operation of the relays may be heard, and after the relays are energized, the voltage outputs can be checked using a multimeter.

9.5.4.2.2 **Replacement**. The unregulated power supply board removal and installation procedures are provided in table 9.5.19.

Table 9.5.17. Unregulated Power Supply Voltage Limits

Voltage Point	Normal Value	Alarm Limit	Acceptable Max
P20I	+20 vdc	+15 vdc	+24 vdc
P10X	+10 vdc	+7.5 vdc	+12 vdc
M20A	-20 vdc	-15 vdc	-24 vdc
P10R	+10 vdc	+7 vdc	+13 vdc
P12M	+12 vdc	+8 vdc	+15 vdc
P10D	+10 vdc	+6.5 vdc	+12 vdc
P25V	+25 vdc	+20 vdc	+30 vdc
P20A	+20 vdc	+15 vdc	+24 vdc
M20I	-20 vdc	-15 vdc	-24 vdc

Table 9.5.18. Unregulated Power Supply Voltage Test Points and Loads

Voltage Point	Check Fuses	Voltage Test Point	AC Input at A2	Power Loads
P10D	A2F3	A2TP4	8 vac	A1
P20I	A2F6 or F7	A2TP3	30 vac	A1
M20I	A2F6 or F7	A2TP2	30 vac	A1
P25V	A2F1	A2TP1	20 vac	R1, R2, A1, A5, T1, or PS1
M20A	A2F4 or F5	A2TP5	30 vac	A1
P20A	A2F4 or F5	A2TP6	8 vac	A1
P12M	A2F8	A2TP7	10 vac	A1
P10X	A2F9	A2TP9	8 vac	A1 or A7
P10R	A2F2	A2TP8	8 vac	A1 or A6

Table 9.5.19. Unregulated Power Supply Board Removal and Installation

Step	Procedure
	REMOVAL
	Tools required: No. 1 Phillips screwdriver Needle-nosed pliers
1	Disconnect ac power from ceilometer and remove ceilometer equipment cabinet covers as described in table 9.5.14.
2	Disconnect Processor Board A1 and I/O Connector Board A3 from unregulated power supply board as described in tables 9.5.16 and 9.5.21.
3	Disconnect all cables and wiring harnesses from unregulated power supply board connectors.
4	Remove four screws securing unregulated power supply board to frame.
5	Unplug unregulated power supply board from two plastic standoffs, using pliers to press plastic springs.

Table 9.5.19. Unregulated Power Supply Board Removal and Installation -CONT

Step	Procedure
	INSTALLATION
	Tools required: No. 1 Phillips screwdriver Needle-nosed pliers
1	Ensure that new unregulated power supply board has switch S1 set to ON position and switch S2 set to NORMAL position.
2	Install new unregulated power supply board on two plastic standoffs using pliers to press plastic springs.
3	Install four screws securing unregulated power supply board to frame.
4	Connect all cables and wiring harnesses to unregulated power supply board connectors as required.
5	Connect Processor Board A1 and I/O Connector Board A3 to unregulated power supply board as described in tables 9.5.16 and 9.5.21.
6	Install the ceilometer equipment cabinet covers as described in table 9.5.14 and apply power to ceilometer.
7	Perform the offset calibration procedures provided in table 9.5.35.

9.5.4.3 **I/O Connector Board A3 Verification and Replacement**.

9.5.4.3.1 **Verification**. The supply voltage test points for the I/O connector board are identified in table 9.5.20. The only supply voltage on the board is the +5 vdc supply. Continuity checks on the RS-232 transmit (TXD) and receive (RXD) data signal paths can be performed by referring to detailed block diagram, figure 9.4.4.

9.5.4.3.2 **Replacement**. The removal and replacement procedures for the I/O connector board are provided in table 9.5.21.

Table 9.5.20. I/O Connector Board Voltage Test Points

Voltage Reference	Test Point	Value
+5V	J2-9	+5 vdc
GND	J2-5	Ground ref

Table 9.5.21. I/O Connector Board Removal and Installation

Step	Procedure
	REMOVAL
	Tools required: None
1	Disconnect ac power from ceilometer and remove ceilometer equipment cabinet covers as described in table 9.5.14.
2	Disconnect cable W3 from connector J2 on I/O connector board.
3	Unplug I/O Connector Board A3 from Unregulated Power Supply Board A2.
	INSTALLATION
1	Plug I/O Connector Board A3 on unregulated power supply board.
2	Connect cable W3 to connector J2 on output interface board.
3	Install ceilometer equipment cabinet covers as described in table 9.5.14 and apply power to ceilometer.

9.5.4.4 **Light Monitor Board A5 Verification and Replacement**.

9.5.4.4.1 **Verification**. Before the light monitor board can be checked, there should be no obstructions that would prevent the board from monitoring the laser transmitter light or the ambient sky light. The supply voltage test points for the light monitor board are listed in table 9.5.22. Both the laser power level voltage and the sky light level voltage are monitored by the processor board. If either of these circuits should malfunction, the processor board issues an alarm message for display. The solar shutter driver and optional solar shutter can be verified using the SHUT ON and SHUT OFF commands in direct dialogue with the ceilometer if the shutter option is installed. The solar shutter driver can be further checked by covering D3 and checking that the voltage at TP4 is approximately 2v ±0.1v. Adjustment is made at R13 if necessary. Driver Q2 should be fully conducting (i.e., solenoid is energized and flap is open); if it is not, force on signal SSON is verified as low. If force is low, A5 should be replaced; otherwise, A1, A2, or W5 may be faulty. Processor control status should be verified as SHUTTEROFF. If the shutter driver must be replaced, the procedure in table 9.5.23 is performed.

9.5.4.4.2 **Replacement**. The light monitor board removal and installation procedures are provided in table 9.5.24.

Table 9.2.22. Light Monitor Board Voltage Test Points

Voltage reference	Test point	Value
P25V	J2-1	+25 vdc
+17V	TP3	+17 vdc (±1 vdc)
GNDP	TP5	Ground ref

Table 9.5.23. Solar Shutter Driver Removal and Installation

Step	Procedure
	REMOVAL
	Tools required: No. 10 flat-tipped screwdriver Allen wrench (.050)
1	Disconnect power from ceilometer and remove ceilometer equipment cover as described in table 9.5.14. **NOTE** The shutter flap is in the closed position when ceilometer power is OFF. The flap is open when power is ON and the light intensity threshold is not exceeded.
2	Place protective cloth over lens to protect lens from any tools or hardware that may be inadvertently dropped on lens during removal procedure.
3	Disconnect solar shutter driver (i.e., solenoid) cable from connector J1 on light monitor board.
4	Loosen sleeve at solenoid end of flexible coupling using .050 Allen wrench.
5	Remove two screws that secure solenoid to ceilometer frame and remove solenoid from ceilometer.
6	Move flap back and forth by hand to ensure that flap is unobstructed.
	INSTALLATION
1	Slide armature of solenoid into coupling sleeve. Leave sleeve loose.
2	Secure solenoid to frame with two machine screws.
3	Tighten sleeve on coupling.
4	Reconnect solenoid cable to connector J1 on light monitor board.
5	Replace ceilometer equipment cover in accordance with procedure in table 9.5.14.
6	Turn ON ceilometer power.

Table 9.5.24. Light Monitor Board Removal and Installation

Step	Procedure
	REMOVAL
	Tools required: No. 1 Phillips screwdriver
1	Disconnect power from ceilometer and remove ceilometer equipment cabinet covers as described in table 9.5.14.
2	Disconnect cable W5 from connector J1 on light monitor board.
3	Disconnect solar shutter relay solenoid cable (if installed) from connector J2 on light monitor board.
4	Place protective cloth over lens to protect lens from any tools or hardware that may be inadvertently dropped during this procedure.
5	Remove two screws securing light monitor board to optics frame assembly.
6	Lift light monitor board from electronics assembly.
	INSTALLATION
1	Place protective cloth over lens to protect lens from any tools or hardware that may be inadvertently dropped during this procedure.
2	Install new light monitor board. Install two screws securing light monitor board to optics frame assembly.
3	Connect solar shutter relay solenoid cable (if installed) to connector J2 on light monitor board.
4	Connect cable W5 to connector J1 on light monitor board.
5	Install ceilometer equipment cabinet covers as described in table 9.5.14 and apply power to ceilometer.

9.5.4.5 **Receiver Board A6 Verification and Replacement**.

9.5.4.5.1 **Verification**. The same verification and replacement procedure is used for the standard and tropical receiver boards. The supply voltage test points for the receiver board are listed in table 9.5.25. In addition to these supply voltages, the high voltage power can be checked at test point TP2. The value of the high voltage power is temperature dependent. The receiver board is factory calibrated at 25°C (77°F) and the TP2 voltage for this temperature is identified by a sticker located on the board. With the voltage/temperature relationship of 2.3 volts/°C (1.3 volts/°F), the voltage that should be measured at test point TP2 can be calculated using the following equations:

$$V(TP2) = V_b + ((T_p(°C) - 25) \times 2.3)$$
$$V(TP2) = V_b + ((T_p(°F) - 77) \times 1.3)$$

where: V(TP2) = Voltage measured at TP2
V_b = Voltage on board sticker
T_p = Present temperature

If the voltage level measured is not close to the calculated level, high voltage power supply PS1 or cable W10 is suspect. The receiver photodiode can also be checked by measuring the voltage between test points TP1 and TP2. With the receiver lens covered, this value should be less than 1 millivolt. With the lens uncovered in bright daylight, the level may be as high as 0.5 volt, but not significantly higher. Artificial light may be used in instances when bright daylight is not available.

9.5.4.5.2 **Replacement**. The receiver board removal and installation procedures are provided in table 9.5.26. Use extreme care when removing the receiver board. Damage to fiberoptic connectors can be prevented by removing the receiver housing.

Table 9.5.25. Receiver Board Voltage Test Points

Voltage Reference	Test Point	Value
WARNING High voltage is accessible on the receiver board.		
+5V	TP3	+5 vdc (+0.5 vdc)
P10R	J1-1	+10 vdc (+2 vdc)
GNDR	TP GND	Ground ref

Table 9.5.26. Receiver Board Removal and Installation

Step	Procedure
	REMOVAL
	Tools required: 9/32-inch open end wrench
1	Disconnect ac power from ceilometer and remove ceilometer equipment cabinet covers as described in table 9.5.14.
	CAUTION Use extreme care when removing receiver board. Damage to fiberoptic connectors can be prevented by removing receiver housing.
2	Disconnect cable W8 from connector J3 on receiver board.
3	Disconnect cable W6 from connector J1 on receiver board.
4	Disconnect cable W10 from connector J2 on receiver board.
5	Remove hex spacer nuts securing receiver board to optics frame assembly.
	CAUTION Avoid touching the mirror-like infrared light interference filter when installing receiver board. Upon removal of receiver board from optics frame assembly, immediately store board in a bag or box to protect light filter from damage.
6	Carefully lower receiver board to clear the long screws and remove board from optics frame assembly.
	INSTALLATION
	Tools required: 9/32-inch open end wrench
	CAUTION Avoid touching the mirror-like infrared light interference filter when installing receiver board. **NOTE** Install tropical receiver board (part No. 62828-90112-11 on ceilometers equipped with solar shutter assembly and standard receiver board (part No. 62828-90112-4) on ceilometers that are not equipped with solar shutter assembly.
1	Install receiver board in optics frame assembly by raising into position over the long screws.
2	Install hex spacer nuts securing receiver board to optics frame assembly.

Table 9.5.26. Receiver Board Removal and Installation -CONT

Step	Procedure
3	Connect cable W10 to connector J2 on receiver board.
4	Connect cable W6 to connector J1 on receiver board.
5	Connect cable W8 to connector J3 on receiver board.
6	Install ceilometer equipment cabinet covers as described in table 9.5.14 and apply power to ceilometer.
7	Perform offset calibration procedures as provided in table 9.5.35.
8	Verify ceilometer calibration in accordance with table 9.5.4.

9.5.4.6 **Transmitter Board A7 Verification and Replacement**.

9.5.4.6.1 **Verification**. The absence of laser power can be detected by persistent missing cloud returns or by a low monitored laser power level (LLAS). The ceilometer processor board monitors the LLAS voltage signal and issues an alarm message when LLAS is low. The supply voltage test points for the transmitter board are listed in table 9.5.27. If the voltage level measured at TP4 is too low, Unregulated Power Supply Board A2 or wiring harness W7 is suspect. If the high voltage input at TP7 is too low, high voltage power supply PS1 or cable W11 is suspect. In addition to these supply voltages, the high voltage power can be checked at test point TP3. This voltage should be checked with laser power off (use AUTO OFF command). The value of the high voltage power at TP3 is temperature dependent. The transmitter board is factory calibrated at 21°C (70°F) and the TP3 voltage for this temperature is identified by a sticker located on the board. With the voltage/temperature relationship of 1.8 volt/°C (1.0 volt/°F), the voltage that should be measured at test point TP3 can be calculated using the following equations:

$$V(TP3) = V_b + ((T_p(°C) - 21) \times 1.8)$$
$$V(TP3) = V_b + (T_p(°F) - 70)$$

where: V(TP3) = Voltage measured at TP3
V_b = Voltage on board sticker
T_p = Present temperature

If the voltage level measured is not close to the calculated level, high voltage power supply PS1 or cable W11 is suspect. If the high voltage measured at TP7 is okay, but TP3 is close to zero, power should be removed from the unit for a few seconds and then reapplied. TP7 and TP3 should then be rechecked. If TP3 is still close to zero, Transmitter Board A7 should be replaced. The laser temperature sensor voltage can be measured across TP6-TP5. At 70°F, the voltage at TP6 should be +2.94 vdc. The voltage level at TP6-TP5 is temperature sensitive, with a temperature coefficient of 5.5 mv/°F (10 mv/°C). If the voltage measured at TP6 is too low, Processor Board A1, Unregulated Power Supply Board A2, or cable harness W7 is suspect.

9.5.4.6.2 **Replacement**. The transmitter board removal and installation procedures are provided in table 9.5.28.

Table 9.5.27. Transmitter Board Voltage Test Points

Voltage reference	Test point	Value
WARNING High voltage is present on the transmitter board.		
+10VX	TP4	+10 (±1.5) vdc
+260V	TP7	+260 (±40) vdc
GNDX	TP GND	Ground ref

Table 9.5.28. Transmitter Board Removal and Installation

Step	Procedure
	REMOVAL
	Tools required: 9/32-inch open end wrench
1	Disconnect ac power from ceilometer and remove ceilometer equipment cabinet covers as described in table 9.5.14. Remove transmitter cover (black knob underneath).
2	Disconnect cable W11 from connector J3 on transmitter board.
3	Disconnect cable W7 from connector J2 on transmitter board.
4	Disconnect cable W9 from connector J1 on transmitter board.
5	Remove three hex spacer nuts securing transmitter board to optics frame assembly.
6	Carefully lower transmitter board to clear the long screws and remove from optics frame assembly.
	INSTALLATION
	Tools required: 9/32-inch open end wrench
1	Install transmitter board in optics frame assembly by raising into position over the long screws.
2	Install three hex spacer nuts securing transmitter board to optics frame assembly.
3	Connect cable W9 to connector J1 on transmitter board.
4	Connect cable W7 to connector J2 on transmitter board.
5	Connect cable W11 to connector J3 on transmitter board.
6	Note the diffuser value marked on the diffuser and install diffuser over transmitter lens such that the four notches in the diffuser ring are lined up with the three pairs of support screws on the lens plate (diffuser ring must rest flat on the lens plate).
7	Install ceilometer equipment cabinet covers as described in table 9.5.14 and apply power to ceilometer.
8	Allow ceilometer to warm up for at least ½ hour with equipment cabinet covers in place.
	NOTE LNOR is used by the system to adjust the laser output power to a standard value. Standard laser power is essential to uniform cloud detection. The uniform power provides a consistent result among LBC's and the sky condition is reported consistently between ASOS systems. LNOR should be determined only when a new transmitter board is installed. That value of LNOR should be used throughout the life of that transmitter board. A new LNOR should not be determined using a transmitter that has been used in the system. New transmitter cards have a calibrated standard output power and can be used to establish LNOR for the LBC system. Laptop computer, initialized as DCP OID (Chapter 3, Section III) or any other available OID, may be used for the following steps.

Table 9.5.28. Transmitter Board Removal and Installation - CONT

Step	Procedure
9	At OID, display ceilometer dialogue page.

10	Using ceilometer dialogue page, enter the following commands:
	`AUTO OFF` (which enters maintenance mode)
	`FREQ 3`
	`SEQ ON`
	`LASE ON`
	`AN LLAS`

11	Observe laser power level values displayed to visually estimate the average value. If the average displayed value does not match the value listed on the diffuser (tolerance = ±3), terminate the output by pressing ESC and enter the following commands according to the observed display values:
	
	If displayed average is less than diffuser value, enter:
	`FREQ 4`
	`SEQ ON`
	`LASE ON`
	`AN LLAS`
	
	If displayed average is greater than diffuser value, enter:
	`FREQ 2`
	`SEQ ON`
	`LASE ON`
	`AN LLAS`

12	Observe the values displayed to visually estimate the average value. Repeat steps 10 and 11 as necessary, each time increasing or decreasing the FREQ value by one, until the average value matches the diffuser value (±3).
13	When the displayed average value and the diffuser value match, do not terminate the output display on the maintenance monitor terminal.
14	**WARNING** The high voltage ac and dc power are accessible on the ceilometer electronics assembly. Use extreme caution when removing the equipment cabinet covers with power applied to the ceilometer. Remove equipment cabinet covers.
15	**CAUTION** When removing diffuser from lens plate, avoid scratching the lens or hitting the light monitor board. Carefully remove diffuser from lens plate.
16	Observe LLAS values displayed on screen to visually estimate the average value displayed.
17	Terminate the display output.
18	Increase the average value determined in step 16 by adding five (LLAS + 5).
19	Using ceilometer dialogue page, enter the following command: LNOR XXX where: XXX = the value obtained in step 18 Record the LNOR value in a permanent log book for the transmitter card.
20	Observe that the system displays the same value. If not, repeat step 19.

Table 9.5.28. Transmitter Board Removal and Installation - CONT

Step	Procedure
21	Using ceilometer dialogue page, enter the following command to return ceilometer to normal operation: AUTO ON
22	Install equipment cabinet covers and perform offset calibration procedures as provided in table 9.5.35.
23	Verify ceilometer calibration in accordance with table 9.5.3.

9.5.4.7 **High Voltage Power Supply PS1 Verification and Replacement**.

9.5.4.7.1 **Verification**. The operation of the high voltage power supply is verified by checking the input ac power and the power supply outputs. The point-to-point wiring of the high voltage power supply is depicted on the ceilometer detailed block diagram (figure 9.4.4), which should be referenced when checking the power supply. The operation of the window conditioner heater and blower relays that are a part of the high voltage power supply can also be verified. The following commands are entered at the maintenance monitor terminal: AUTO OFF (to enter the maintenance mode), BLOW ON, and HEAT ON. These commands instruct the processor to activate the relays and turn the window conditioner blower and heater on.

9.5.4.7.2 **Replacement**. The high voltage power supply removal and installation procedures are provided in table 9.5.29.

Table 9.5.29. High Voltage Power Supply Removal and Installation

Step	Procedure
	REMOVAL
	Tools required: 5mm hex key wrench
1	Disconnect ac power from ceilometer and remove ceilometer equipment cabinet covers as described in table 9.5.14.
2	Disconnect cable W1 from connector J1 on high voltage power supply.
3	Disconnect cable W2 from connector J2 on high voltage power supply.
4	Disconnect temperature compensation transformer T1 wiring harness from connector J3 on high voltage power supply.
5	Disconnect cable W10 from connector J7 on high voltage power supply.
6	Disconnect cable W11 from connector J8 on high voltage power supply.
7	Using Allen (hex) key, remove four screws from front and two screws from rear securing high voltage power supply to frame assembly.
8	Slide high voltage power supply out from front of cabinet.

Table 9.5.29. High Voltage Power Supply Removal and Installation -CONT

Step	Procedure
	INSTALLATION
	Tools required: 5mm hex key wrench
1	Install high voltage power supply from front of cabinet.
2	Using Allen (hex) key, install four screws at front and two screws at rear securing high voltage power supply to frame assembly.
3	Connect cable W11 to connector J8 on high voltage power supply.
4	Connect cable W10 to connector J7 on high voltage power supply.
5	Connect temperature compensation transformer T1 wiring harness to connector J3 on the high voltage power supply.
6	Connect cable W2 to connector J2 on high voltage power supply.
7	Connect cable W1 to connector J1 on high voltage power supply.
8	On high voltage power supply PS1, adjust R13 to its maximum (fully clockwise) limit.
9	Install ceilometer equipment cabinet covers as described in table 9.5.14 and apply power to ceilometer.
10	Perform the offset calibration procedures as provided in table 9.5.35.

9.5.4.8 **Temperature Compensation Transformer T1 Verification and Replacement**.

9.5.4.8.1 **Verification**. The temperature compensation transformer is verified by checking the voltage output to the unregulated power supply board. The transformer output (secondary) should provide 20 vac (±3 vac). The input voltage to the transformer can be verified at connector J3 of the high voltage power supply. These voltage levels are provided on the ceilometer detailed block diagram (figure 9.4.4).

9.5.4.8.2 **Replacement**. The temperature compensation transformer removal and installation procedures are provided in table 9.5.30.

Table 9.5.30. Temperature Compensation Transformer Removal and Installation

Step	Procedure
	REMOVAL
	Tools required: Diagonal cutting pliers No. 2 Phillips screwdriver
1	Disconnect ac power from ceilometer and remove ceilometer equipment cabinet covers as described in table 9.5.14.
2	Disconnect wiring harness from connector J3 on unregulated power supply board.
3	Disconnect wiring harness from connector J3 on high voltage power supply.
4	Open cable clamp securing transformer secondary wiring harness to optics frame assembly.
5	Cut wiring bundle ties securing transformer primary wiring harness to optics frame assembly.
6	Lift plastic feed-through bushing that guides transformer secondary wiring harness through the top of optics frame assembly.
7	Feed transformer secondary wiring harness through the top of optics frame assembly.
8	Remove two screws securing temperature compensation transformer to optics frame assembly and remove transformer.

Table 9.5.30. Temperature Compensation Transformer Removal and Installation -CONT

Step	Procedure
	INSTALLATION
	Tools and materials required: Diagonal cutting pliers No. 2 Phillips screwdriver Cable ties
1	Install new temperature compensation transformer using two screws to secure the transformer to the optics frame assembly.
2	Feed transformer secondary wiring harness through the top of optics frame assembly.
3	Install plastic feed-through bushing that guides transformer secondary wiring harness through the top of optics frame assembly.
4	Close cable clamp securing transformer secondary wiring harness to optics frame assembly.
5	Connect transformer secondary wiring harness to connector J3 on unregulated power supply board.
6	Connect transformer primary wiring harness to connector J3 on high voltage power supply.
7	Install wiring bundle ties securing transformer primary wiring harness to optics frame assembly.
8	Install ceilometer equipment cabinet covers as described in table 9.5.14 and apply power to ceilometer.

9.5.4.9 **Cabinet Heaters R1 and R2 Verification and Replacement**.

9.5.4.9.1 **Verification**. The cabinet heaters are resistive heater elements whose operation can be verified by checking their resistance values. The heater elements must be disconnected from unregulated power supply board connectors J2 and J4 before resistance is measured. The resistance measured across the heater element should read 10 ohms ±5%.

9.5.4.9.2 **Replacement**. The cabinet heater removal and installation procedures are provided in table 9.5.31.

Table 9.5.31. Cabinet Heater Removal and Installation

Step	Procedure
	REMOVAL
	Tools required: No. 1 Phillips screwdriver
1	Disconnect ac power from ceilometer and remove ceilometer equipment cabinet covers as described in table 9.5.14.
2	Disconnect heater element wiring harness from unregulated power supply board (connector J2 for heater R1 and connector J4 for heater R2).
3	Pull out feed-through bushing from hole in optics frame assembly.
4	Remove two screws securing heater to optics frame assembly. Remove heater.
	INSTALLATION
1	Transfer as much of the heat conducting silicon grease as possible from replaced heater to new heater, adding more grease as necessary.
2	Install heater on optics frame assembly and secure using two screws.
3	Install feed-through bushing in hole in optics frame assembly.
4	Connect heater element wiring harness to unregulated power supply board (connector J2 for heater R1 and connector J4 for heater R2).
5	Install ceilometer equipment cabinet covers as described in table 9.5.14 and apply power to ceilometer.

9.5.4.10 **External Air Temperature Sensor TS1 Verification and Replacement**.

9.5.4.10.1 **Verification**. The external air temperature sensor is verified by checking power (voltage and current) levels where it interfaces with the unregulated power supply board (connector J9). The voltage level present across the sensor is a function of the air temperature. At 70°F (21°C), the voltage level between pins J9-1(+) and J9-2(-) should be approximately 2.94 ±0.020 vdc. The voltage level that should be measured at other temperatures can be calculated according to the following equations:

$V_t = 2.94 + (T_a - 70) \times 0.0055$ for Fahrenheit
$V_t = 2.94 + (T_a - 21) \times 0.010$ for Celsius

where: V_t = Voltage measured for that temperature
T_a = Present air temperature

If the voltage measured does not match the calculated value, the sensor should be disconnected from connector J9 of the unregulated power supply board, and the voltage level across pins 1 and 2 of connector J9 should be checked. The voltage should measure approximately 5 vdc. The current level measured across shorted pins 1 and 2 of connector J9 should measure 2 milliamps. If either the voltage or current level is not correct, Processor Board A1 or Unregulated Power Supply Board A2 is suspect. If both voltage and current level are correct, the sensor TS1 should be replaced.

9.5.4.10.2 **Replacement**. The external air temperature sensor removal and installation procedures are provided in table 9.5.32.

Table 9.5.32. External Air Temperature Sensor Removal and Installation

Step	Procedure
REMOVAL	
Tools required: Diagonal cutting pliers	
1	Disconnect ac power from ceilometer and remove ceilometer equipment cabinet covers as described in table 9.5.14.
2	Disconnect temperature sensor wiring harness from connector J9 on unregulated power supply board.
3	Cut wiring harness bundle ties.
4	Remove air filter from cabinet air vent.
5	Lift temperature sensor from cabinet air vent.
INSTALLATION	
Materials Required: Cable ties	
1	Install temperature sensor in cabinet air vent.
2	Install air filter in cabinet air vent.
3	Connect temperature sensor wiring harness to connector J9 on Unregulated Power Supply Board A2.
4	Install new wiring harness bundle ties securing temperature sensor wiring harness as required.
5	Install ceilometer equipment cabinet covers as described in table 9.5.14 and apply power to ceilometer.

9.5.4.10.3 **Removal and Installation of Snow Radiation Shield**. The snow radiation shield is held in place by a tab on the edge of the shield. It is installed on the under side of the ceilometer with one edge parallel to the edge of the ceilometer base and the other edge with the tab against the pedestal top plate. The tab fits between the top of the pedestal and the bottom of the ceilometer. It is mounted at the end opposite from the fan cable and connector. It is mounted midway between the sides and over top of the ambient air sensor housing which protrudes out of the bottom of the ceilometer. See figure 9.1.2. The snow radiation shield removal and installation procedures are provided in table 9.5.33.

Table 9.5.33. Snow Radiation Shield Removal and Installation

Step	Procedure
REMOVAL	
Tools required: 5mm hex key	
1	Coordinate with site observer, if applicable, and make an entry in SYSLOG.
2	Locate end of ceilometer opposite fan cable entry on bottom of ceilometer. Remove two screws that secure ceilometer to pedestal on that end of ceilometer.
3	On end of the ceilometer where fan cable enters ceilometer base, loosen, but do not remove two screws which secure this end to pedestal. Loosen so there is about 1/16 inch between head of screw and pedestal.
4	Ensure that thumbscrews which secure blower assembly and two latches which secure ceilometer cover to base plate are in place and tight.
5	Locate end of ceilometer where temperature sensor housing is located (same end where two screws were removed). Ceilometer will be tilted away from this end.
6	In one hand, hold snow radiation shield. With other hand, lift at side of ceilometer while placing your shoulder against side of ceilometer to aid in lifting and pushing (if lifting hand is at end of ceilometer, it will be in the way when shield is being removed.). Tilt ceilometer away from you.
7	Remove shield from between inside edge of ceilometer and pedestal top assembly. Lower ceilometer.
8	Install two screws that were removed in step 3.
9	Tighten four screws that secure ceilometer to pedestal.
10	Coordinate with site observer, if applicable, and clear any maintenance flags generated, making an entry in SYSLOG.
INSTALLATION	
Tools required: 5mm hex key	
1	Coordinate with site observer, if applicable, and make an entry in SYSLOG.
2	Locate end of ceilometer opposite fan cable entry on bottom of the ceilometer. Remove two screws that secure ceilometer to pedestal on that end of ceilometer.
3	On end of ceilometer where fan cable enters ceilometer base, loosen, but Do not remove two screws which secure this end to pedestal. Loosen so there is about 1/16 inch between head of screw and pedestal.
4	Ensure thumbscrews which secure blower assembly and two latches which secure ceilometer cover to base plate are in place and tight.
5	Locate end of ceilometer where temperature sensor housing is located (same end where two screws were removed). Ceilometer will be tilted away from this end.

Table 9.5.33. Snow Radiation Shield Removal and Installation -CONT

Step	Procedure
6	In one hand, hold snow radiation shield so that tab is toward pedestal, and ceilometer is tilted away. With other hand, lift at side of ceilometer while placing shoulder against side of ceilometer to aid in lifting and pushing. (If lifting hand were at the end of ceilometer, it would be in the way when shield is put in place.)
7	Insert shield between inside edge of ceilometer and pedestal top assembly so tab fits over top of pedestal. Lower ceilometer to secure snow radiation shield.
8	Check that shield is positioned midway with respect to sides of ceilometer. Move as necessary by sliding.
9	Install two screws that were removed in step 3.
10	Tighten four screws that secure ceilometer to pedestal.
11	Coordinate with site observer, if applicable, and clear any maintenance flags generated, making an entry in SYSLOG.

9.5.4.11 **Window Conditioner Verification and Replacement**.

9.5.4.11.1 **Verification**. The operation of the window conditioner blower and heater can be verified through software commands to the ceilometer using direct dialogue in maintenance mode. In maintenance mode (AUTO OFF), the window conditioner BLOW ON and HEAT ON commands force the window conditioner blower and heater on. Within a few minutes, the blower temperature displayed (TB) should read approximately 12°F (7°C) above the ambient temperature display (TE). If the temperature rises considerably more, blower operation is suspect. If the temperatures read approximately the same value, heater operation is suspect. The isolation of the fault to the window conditioner can be performed by resistance checks across the blower and heater circuits. These circuits are depicted in point-to-point wiring on the ceilometer detailed block diagram (figure 9.4.4). With the window conditioner cable disconnected from connector J2 on the ceilometer, the blower circuit and the heater circuit should measure approximately 60 ohms and 22 ohms, respectively. If these resistance levels check okay, high voltage power supply PS1, Processor Board A1, or Unregulated Power Supply Board A2 is suspect.

9.5.4.11.2 **Replacement**. The window conditioner removal and installation procedures are provided in table 9.5.34.

Table 9.5.34. Window Conditioner Removal and Installation

Step	Procedure
	REMOVAL
	Tools required: Diagonal cutting pliers Small flat-tipped screwdriver **WARNING** Death or severe injury may result if power is not removed from sensor prior to maintenance activities. Ensure that heater and primary power circuit breakers (located in DCP) are set to off (right) position. **CAUTION** Prevent dust, precipitation, dirt, or other obstructions from accumulating on the ceilometer windows and lenses. Damage to the optics may render the ceilometer inoperable.
1	Inside equipment cabinet, set circuit breakers on ceilometer circuit breaker module to off (right) position.

Table 9.5.34. Window Conditioner Removal and Installation -CONT

Step	Procedure
2	Disconnect window conditioner by unplugging cable from connector J2 located on underside of equipment cabinet assembly.
3	Loosen four knurled screws securing window conditioner to equipment cabinet assembly.
4	Carefully remove window conditioner by lifting from equipment cabinet assembly and gently set on the ground.
5	Remove window conditioner cable from the guiding clamp inside the cover.
6	Remove four screws securing heater-blower to cover housing.
7	Remove heater-blower from cover housing.
	INSTALLATION
	Tools required: Small flat-tipped screwdriver **WARNING** Death or severe injury may result if power is not removed from sensor prior to maintenance activities. Ensure that heater and primary power circuit breakers (located in DCP) are set to off (right) position.
1	Inside equipment cabinet, ensure that circuit breakers on ceilometer circuit breaker module are set to off (right) position.
2	Install new heater-blower in cover housing and install four screws securing heater-blower.
3	Install window conditioner cable in the guiding clamp inside the cover.
4	Carefully install window conditioner on equipment cabinet assembly.
5	Tighten four knurled screws securing window conditioner to equipment cabinet assembly.
6	Connect window conditioner cable to connector J2 located on the underside of the equipment cabinet assembly.
7	Inside equipment cabinet, set circuit breakers on ceilometer circuit breaker module to on (left) position.

9.5.4.12 **Offset Calibration**. The ceilometer instrument offset has been factory calibrated and under normal circumstances requires no need for recalibration. However, the replacement of any part of the ceilometer that has an effect on internal noise behavior requires recalibration after restoring to operation. Parts influencing noise behavior are:

a. Processor Board A1
b. Unregulated Power Supply Board A2
c. Receiver Board A6
d. Transmitter Board A7
e. High voltage power supply PS1
f. Receiver low-voltage cable W6
g. Transmitter low-voltage cable W7
h. Receiver signal cable W8
i. Transmitter control cable W9

A recalibration may also be performed to correct operations where the cloud data are excessively noisy. The procedures for performing the offset calibration are provided in table 9.5.35.

Table 9.5.35. Offset Calibration Procedures

Step	Procedure
	Tools and materials required: Small flat-tipped screwdriver Laptop computer w/Procomm Y-interface cable Laptop null cable Dark non-reflective cloth
1	Inside equipment cabinet, identify fiberoptic module dedicated to ceilometer. If necessary, perform the following on an OID: a. Refer to sensor configuration page on OID (sequentially press REVUE-SITE-CONFG-SENSOR function keys from 1-minute display). b. Refer to Chapter 3, Section IV to identify corresponding fiberoptic module.
2	Using small flat-tipped screwdriver, disconnect DB-9 connector from ceilometer fiberoptic module.
3	Using small flat-tipped screwdriver, install jumper between TB1-1 (on orange terminal block) on ceilometer fiberoptic module (A1) and TB1-1 on adjacent fiberoptic module. Install second jumper between terminals TB1-2 of ceilometer fiberoptic modules and adjacent module containing first jumper.
4	Using laptop interface (Y-shaped) cable and laptop null cable, connect RS-232C (COM1) port of laptop computer to DB-9 connector of ceilometer fiberoptic module.
5	Turn on laptop computer and initialize the PROCOMM Plus program. After program initializes, press any key to enter terminal mode (blank) screen.
6	Using ALT-S command (setup facility), set up the following TERMINAL OPTIONS: a. Terminal emulation: VT220 b. Duplex: FULL c. Soft flow control (XON/XOFF): OFF d. Hard flow control (CTS/RTS): OFF e. Line wrap: ON f. Screen scroll: ON g. CR translation: CR h. BS translation: NON-DESTRUCTIVE i. Break length (milliseconds): 350 j. Enquiry: OFF k. EGA/VGA true underline: OFF l. Terminal width: 80 m. ANSI 7 or 8 bit commands: 7 BIT
7	Press ESC key to exit to terminal mode (blank) screen.
8	Using ALT-P command (line/port option), set CURRENT SETTINGS as follows: a. Baud rate: 2400 b. Parity: NONE c. Data bits: 7 d. Stop bits: 1 e. Port: COM1
9	Press ESC key to exit to terminal mode (blank) screen.
10	Turn Caps Lock ON.
11	From the laptop computer, check that noise conditions are such that the difference between the two smallest numbers (average and minimum) seen with command NOIS are 8 or higher (with GAIN of 2) and 2 or higher (with GAIN of 0.) Use artificial light into the receiver if necessary.

Table 9.5.35. Offset Calibration Procedures -CONT

Step	Procedure
12	With equipment in normal operating configuration, cover the transmitter aperture of the window conditioner with a dark, nonreflecting cloth.

13	**NOTE**
	This procedure requires stable ambient light conditions. If performed outdoors, wait for a clear sky or a long break in the clouds if there is broken cloud cover. If performed indoors, use a steady light source such as a desk lamp positioned over the receiver.
	
	From the ceilometer dialogue page, perform the following command sequence:
	`AUTO OFF`
	`GAIN 0`
	`LASE ON`
	`SEQ ON`
	`CAL 240`

14	After 4 minutes, the unit has performed the calibration and responds with: `OFFSET TO EEPROM` and starts listing the offset values obtained. The listing may be interrupted by pressing the <ESC> key.

15	From the ceilometer dialogue page, enter the following commands to return the unit to normal operation:
	
	`AUTO ON`
	`CLOS`

16	Observe the performance of the unit for a period of time to verify its operation.
17	At laptop computer, use ALT-X (exit) command to exit PROCOMM Plus.
18	Turn off laptop computer.
19	Disconnect cables between laptop computer and fiberoptic module.
20	Remove two jumpers between fiberoptic modules.
21	Using small flat-tipped screwdriver, install DB-9 connector to ceilometer fiberoptic module in DCP.

9.5.4.13 **Fiberoptic Module Removal and Replacement**. The fiberoptic module removal and replacement procedures are provided in table 9.5.36.

Table 9.5.36. Fiberoptic Module Removal and Installation

Step	Procedure
	REMOVAL
	Tools required: Small flat-tipped screwdriver
1	Disconnect ac power from ceilometer and remove ceilometer equipment cabinet covers as described in table 9.5.14.
2	Using small flat-tipped screwdriver, loosen two retaining screws on DB-9 connector located on top of fiberoptic module. Remove connector DB-9.
3	Using clockwise (cw) rotation, remove two fiberoptic cables from fiberoptic module. Install protective plastic covers over fiberoptic connectors.
4	Using small flat-tipped screwdriver, remove four screws, four lockwashers, and two gaskets securing fiberoptic module to mounting plate.

Table 9.5.36. Fiberoptic Module Removal and Installation -CONT

Step	Procedure
	INSTALLATION
	Tools required: Small flat-tipped screwdriver
1	Ensure that ac power is disconnected and ceilometer equipment cabinet covers are removed as described in table 9.5.14.
2	Using small flat-tipped screwdriver, install four screws, four lockwashers, and two gaskets securing fiberoptic module to mounting plate.
3	Remove protective plastic covers from fiberoptic connectors and connect receive (RX) cable to receive connector on fiberoptic module (nearest DB-9 connector) and transmit (TX) cable to transmit connector on fiberoptic module.
4	Install signal cable on connector DB-9 on fiberoptic module and using small flat-tipped screwdriver, tighten two retaining screws.
5	Install ceilometer equipment cabinet covers as described in table 9.5.14 and apply power to ceilometer.