Maintenance Procedure for Visibility Sensor Cleaning and Calibration Check

Procedure Number: SOP 6.3.2.1.3
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1. Title

SOP # 6.3.2.1.3 Maintenance Procedure for Visibility Sensor Cleaning and Calibration Check

2. Purpose

This standard operating procedure (SOP) documents the process for conducting maintenance of the Vaisala FS11 visibility sensor. The maintenance involves cleaning the sensor's transmitter and receiver lenses of any dirt or contamination and an annual calibration check and mechanical alignment procedure. These procedures must be completed to ensure optimal visibility measurements.

3. Background/History

CO-OPS installed the first operational visibility sensors within the PORTS network at Pinto Island and Middle Bay Port, Mobile Bay, AL in December 2009 and January 2010. The Vaisala FS11 visibility sensor is a smart sensor and corrects for window contamination, allowing the sensor to compensate for dirty optics. The Vaisala Owner's manual recommends cleaning the sensor as needed and suggests calibrating annually or as needed.

Based on initial field tests to evaluate maintenance intervals, the Ocean Systems Test and Evaluation Program (OSTEP) developed a maintenance procedure to ensure optimal performance.

4. Scope/Applicability

This SOP applies to all CO-OPS Field Operations Division (FOD) field crews and contractors who conduct maintenance on these sensors.

5. Main Processes

The following procedures are based on information from the Vaisala User's Manual, 2006, and the suggested schedule is based on extensive OSTEP testing in near shore environments.

Clean the sensor at installation, once per month for the first three months, and every three months for the remainder of the first year. After one year, clean the sensor every six months. Conduct a calibration check both annually and at installation to ensure that no damage occurred in shipping. CIL/SIL will provide the maintenance calibration kit. If you note damage or change a component, then also check the calibration.

1. Check Sensor Status
2. Clean Sensor Windows
3. Check Sensor Zero
4. Check Calibration
5. Check Alignment
6. Complete the Maintenance Checklist for Visibility Sensors (appendix A) and submit to the Operational Engineering Team (OET).

6. Detailed Sub-processes/Checklists

Supplies

- Spray bottle with distilled or de-ionized (DI) water
- Cleaning solution, preferably a 50:50 mix of isopropyl alcohol and DI water. Windex, or like solution, is acceptable if you do not have access to the isopropyl/DI water solution
- Lint free lens cleaning paper or Kimwipe™
- Sensor maintenance interface cable
- Sensor calibration kit (fig. 1 - If a calibration test is needed, this is required)
- Step ladder that will allow you to safely reach the sensor head at approximately 11 feet off the ground
- Computer with Procomm or like program to communicate with the sensor
- Maintenance Checklist (appendix A) and this Maintenance Procedure

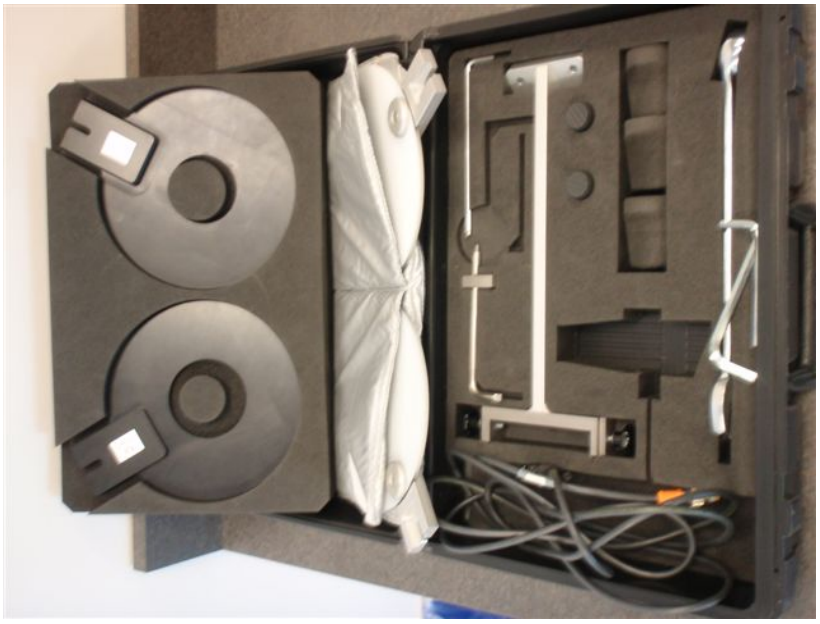

Figure 1. Sensor calibration kit

Caution

You must remove the step ladder after each maintenance step to ensure accurate calibration.

Procedure 1 Check Sensor Status

1. Connect the sensor interface cable to the maintenance port (fig. 2 and fig. 3).
2. Connect sensor interface cable.

Figure 2. Sensor interface cable

Figure 3. Visibility sensor maintenance port with dust cap removed.

3. Start the computer and load a terminal emulator, such as Procomm. Set at 8N1 9600 baud.
4. Once you are connected, type: **open ***
5. Then press CR

> **NOTE:** CR stands for carriage return. The Mac and Linux operating systems use CR. In the Windows operating system, CR means to press the ENTER key.

6. No indication of this typing will appear on the screen until you connect with the system (fig. 4).

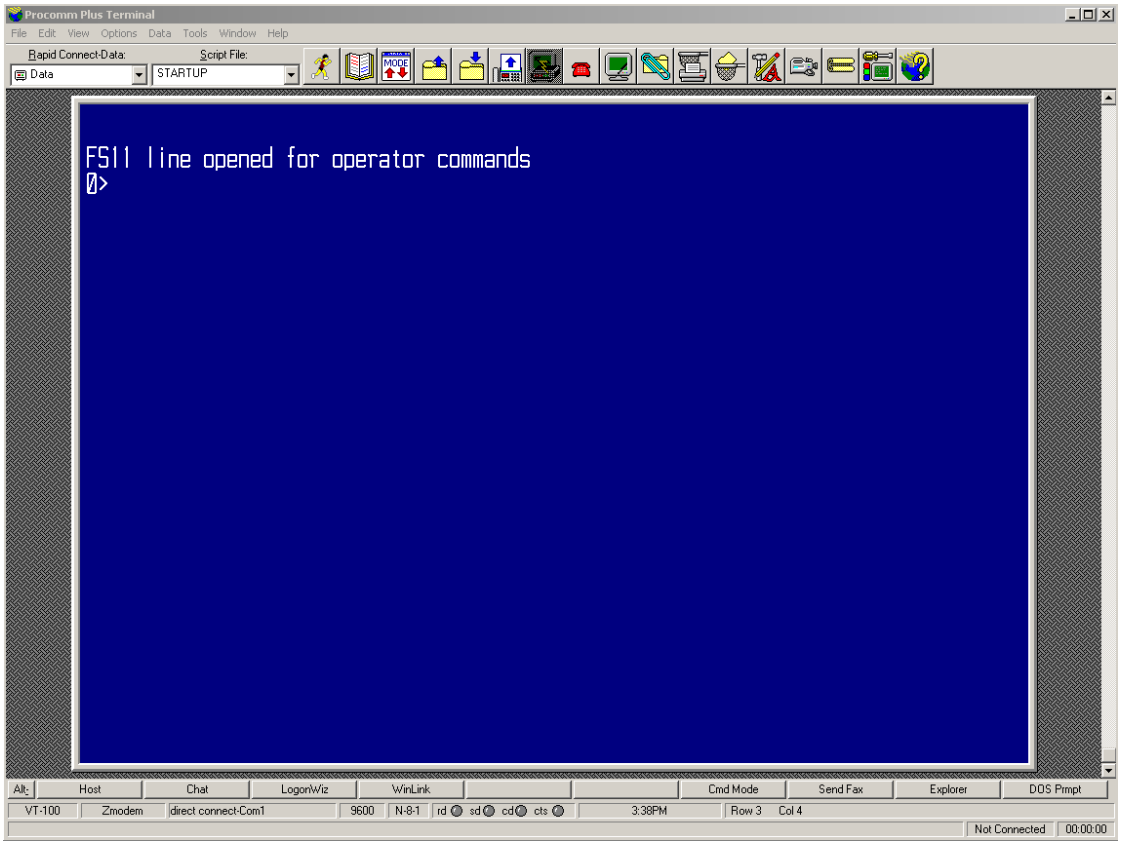

Figure 4. Shows the sensor connection.

7. Type: **status check**
8. Then press CR (fig. 5)
9. If measurement and interface unit do not check out OK, then check all connections and repeat the **status check** command.
10. If all connections are secure and there are no visible issues, contact CIL/SIL personnel for help in troubleshooting.
11. If **Step 9** or **Step10** rectifies the issue, proceed to **Step12**.

Figure 5. Satisfactory status check.

12. Type: **message 3**
13. Then press CR (fig. 6). This command will display the status message (fig. 7).
14. Perform a screen capture on this screen and retain for records.
15. Note the receiver and transmitter window cont: values for future reference.

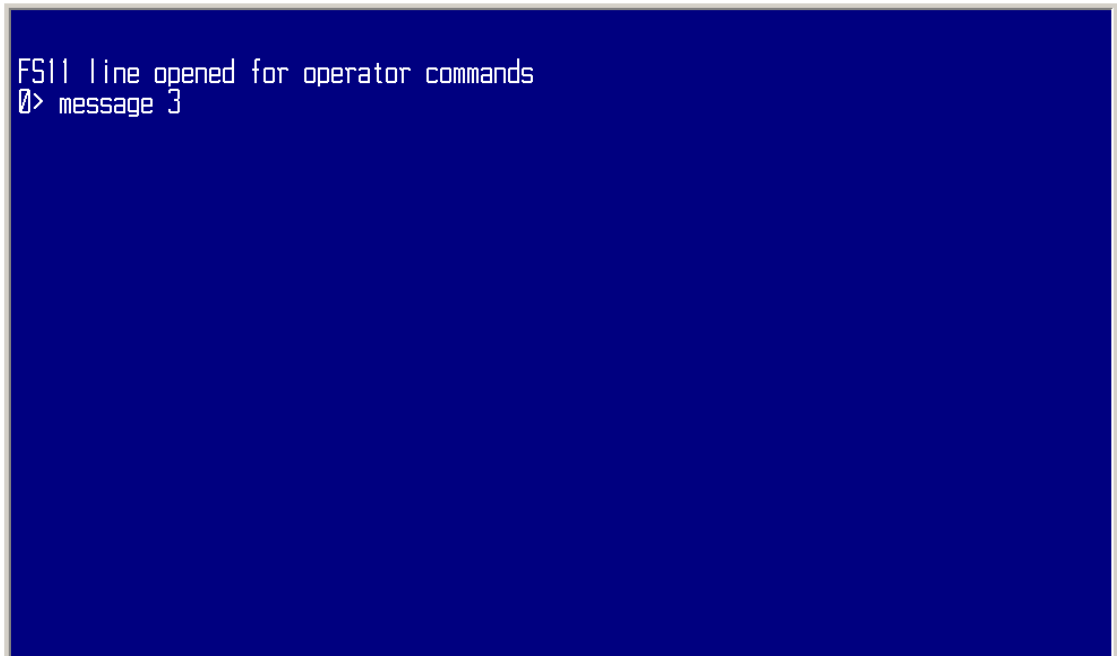

Figure 6. You should see all messages typed from now on.

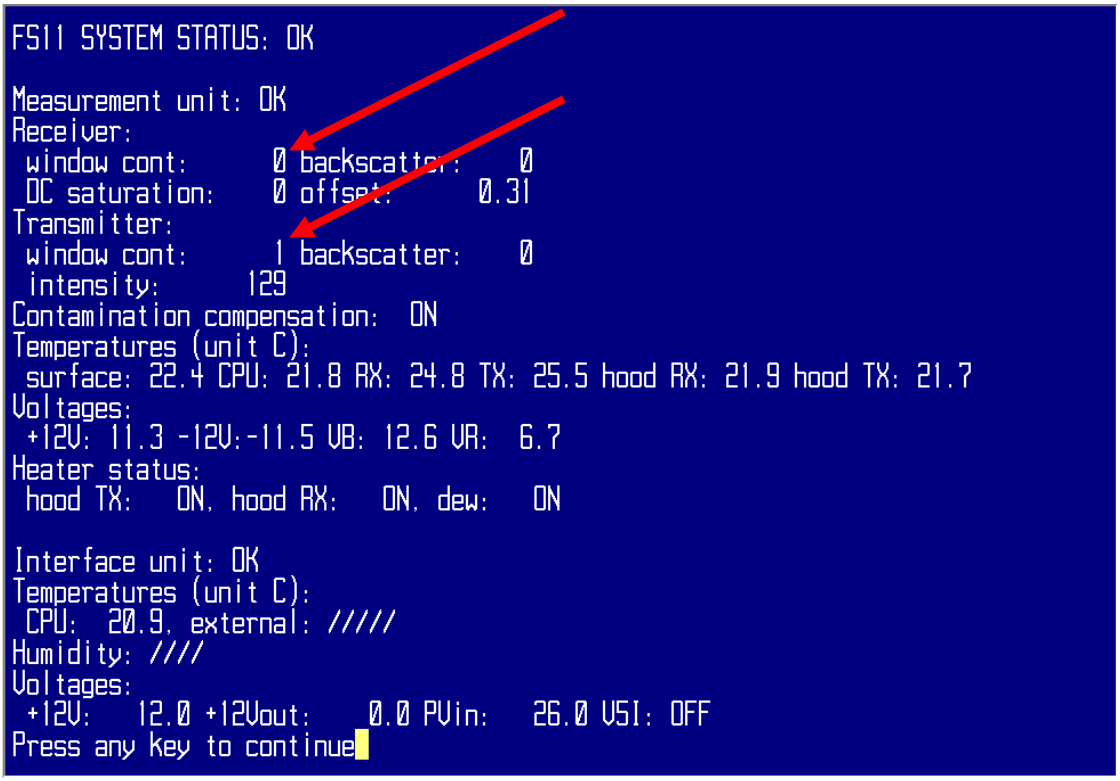

Figure 7. This is message 3, or the status message. Screen capture this for your records.

Procedure 2 Clean Sensor Windows

1. Safely set up the step ladder for easy access to the hoods.
2. Verify that the hoods are free of ice and water and that the assembly is free of damage.
3. Rinse the windows and hoods with DI water to remove any salt build up or heavy dirt before cleaning.
4. Rinse the windows with the 50:50 alcohol/DI water solution and wipe the lenses with soft, lint-free wipes. The lenses should dry rapidly, which also verifies that the lens heaters are working properly.
5. Wipe dust and dirt from the inner and outer surfaces of the hoods and the sensor. Do not damage the hood heaters on the underside of the hoods (fig. 8).

   NOTE: Do not use any sharp tools to clean or work on the hoods.

6. Once cleaning is complete, remove the ladder to prevent any possible interference in the sensor sample area.
7. Type: **message 3**
8. Then press CR

The receiver and transmitter window cont: (value in message 3) should be close to zero. If the value is close to zero and the lenses are clear, no further cleaning is required. If this is not the case, repeat Procedure 2, Steps 1-6 until you get a value close to zero.

9. If this is a 6-month check and the window contamination value is zero, the maintenance is complete.
10. If this is an annual check or, if after repeated cleanings, the window contamination (window cont.) is still not close to zero, proceed to the Procedure 3.

Figure 8. Heaters on the underside of the hood.

Procedure 3 Check Sensor Zero

1. **DO NOT PROCEED IF YOU HAVE NOT COMPLETED PROCEDURE 2.**
2. Remove the step ladder from the area in front of the sensor.

   NOTE: Cleaning and calibration functions can only be accessed at the Operating level 1.

3. Type: **level 1**
4. Then press CR
5. The following message “Operator level set to: 1” will confirm access. (fig. 9).

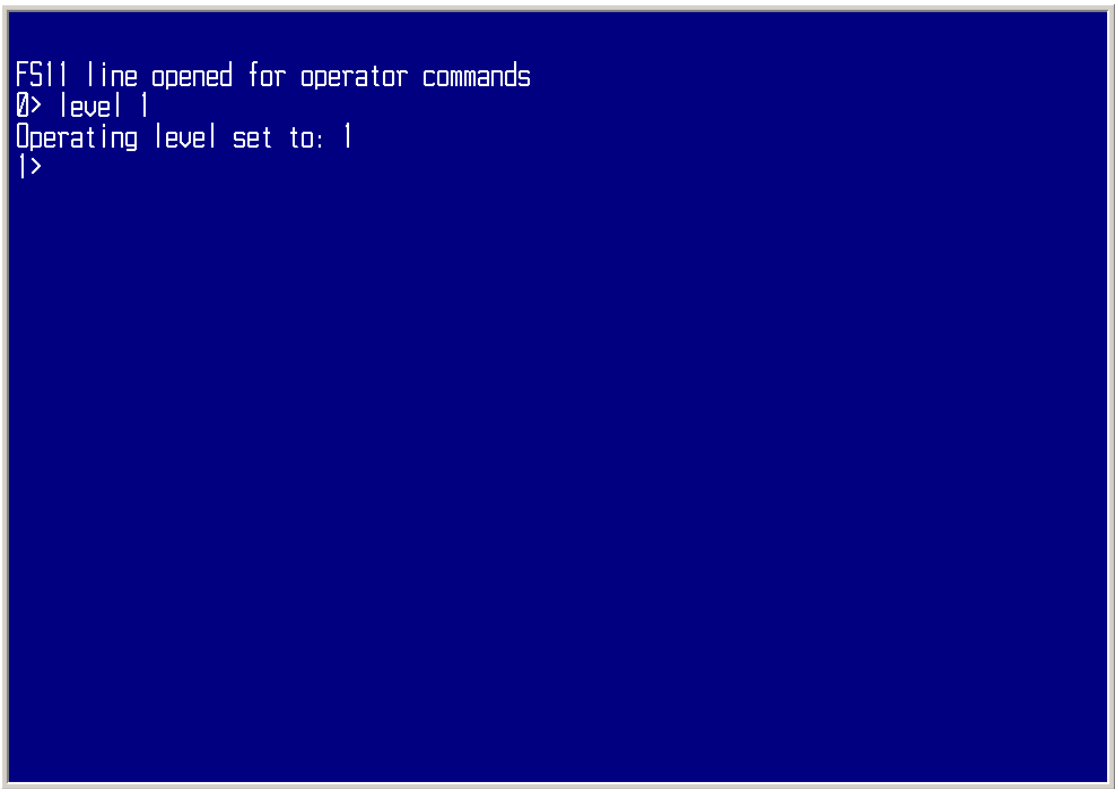

Figure 9. Operating Level 1

6. Make sure that the sensor head area is clear of any interference.
7. Type: **calibrate window_clean visibility_sensor**
8. Then press CR
9. A “**DONE**” notice will appear when finished (after about 90 seconds) (fig. 10).
10. Type: **message 3**
11. Then press CR
12. Check that the receiver and transmitter window values are zero.

NOTE: Be sure that you have completely cleaned and have not damaged the lenses or windows. This step will affect the existing calibration.

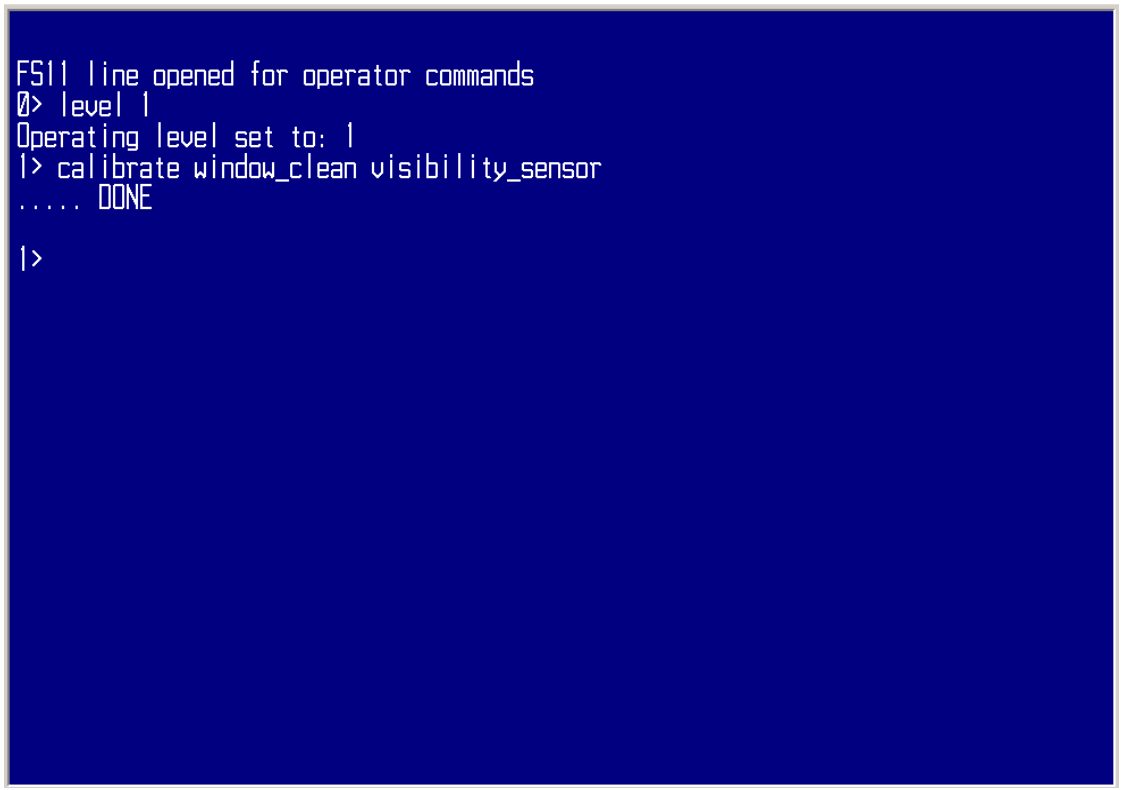

Figure 10. Window cleaning calibration

13. If performing annual calibration, then proceed to **Procedure 4**.
14. If this is a routine cleaning, then:

    Type: **close** (fig. 11)

    Press CR

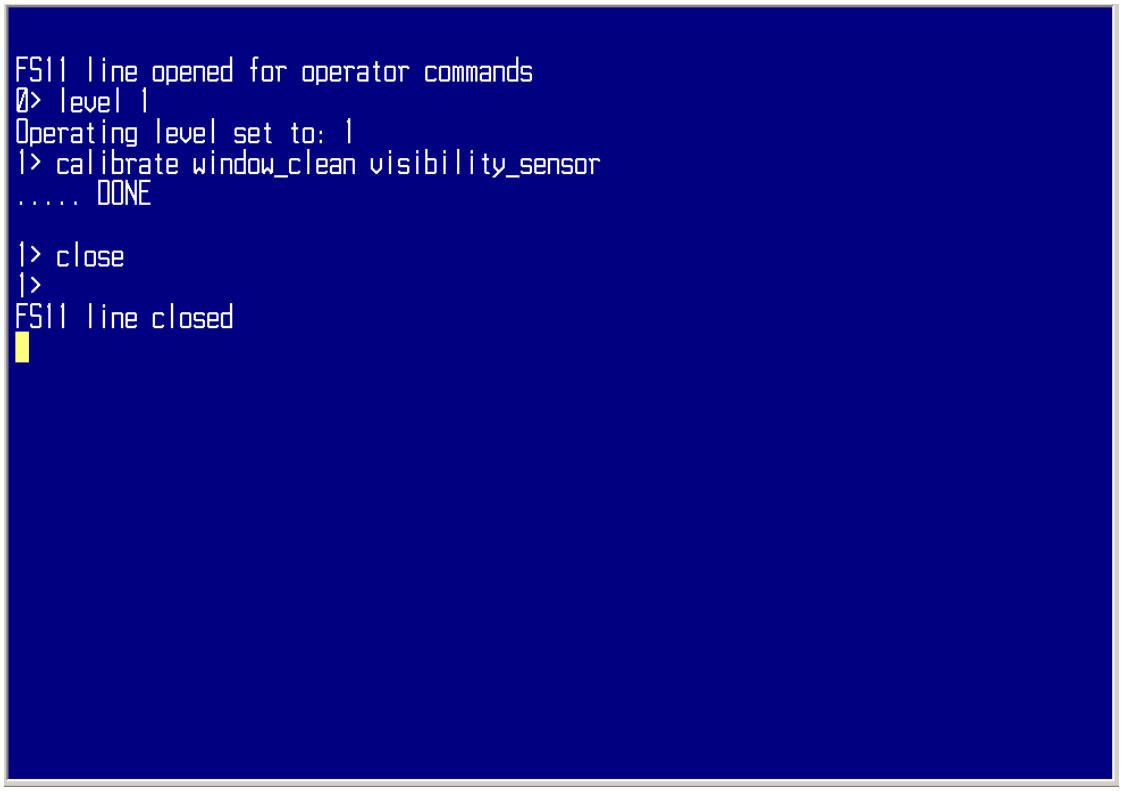

Figure 11. Close.

15. Remove interface cable.
16. Replace maintenance plug.
17. Secure the sensor. Sensor cleaning is now complete.

Procedure 4 Check Calibration

1. Replace the step ladder to access both hoods again.
2. Remove the blanking plugs from the calibration kit and install one in each hood.

   NOTE: The calibration kit contains three plugs. This sensor configuration requires only two plugs (fig. 12).

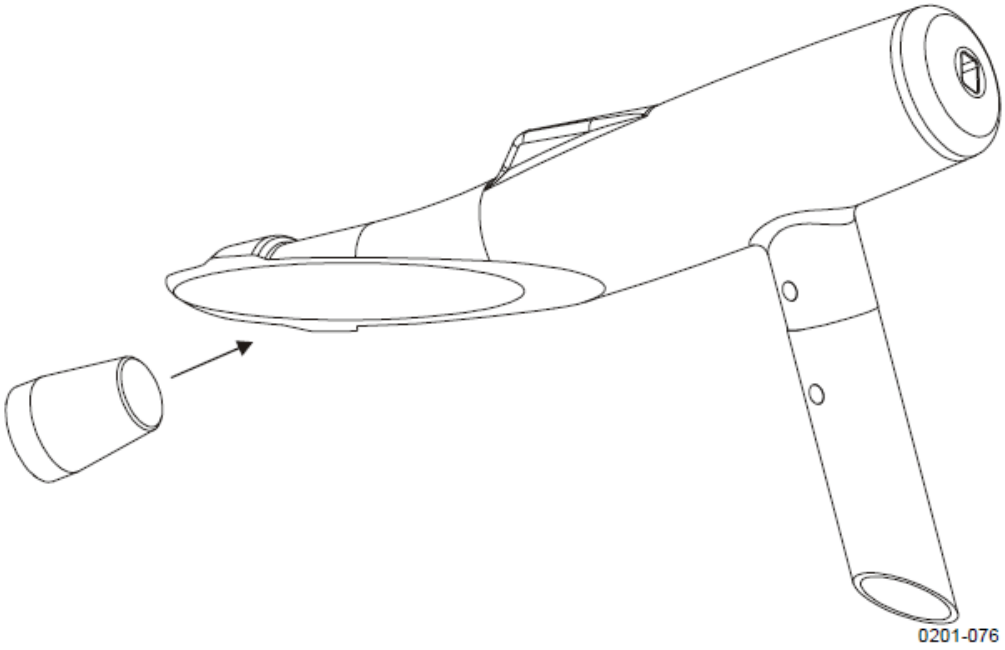

Figure 12. Blanking plug insert (from Vaisala User's Manual 2006).

   Note: Once the plugs are in place, you may need to re-enter command level 1 as described in **Procedure 3**, **Step 5**. The system automatically logs you out after 5 minutes of no activity.

3. At level 1 with the plugs in place:

   Type: **calibrate check**

   Then press CR (no underscore, just space between calibrate and check) (fig. 13).

   This will take about 90 seconds to perform. The value returned must be approximately +/-0.0001. If this is not the case, there may be a hardware problem. (fig. 14). Call the CIL/SIL if you suspect a hardware problem.

4. Repeat **Step 3** to confirm. The two resulting numbers should be close (fig. 15).

Figure 13. Calibrate Check

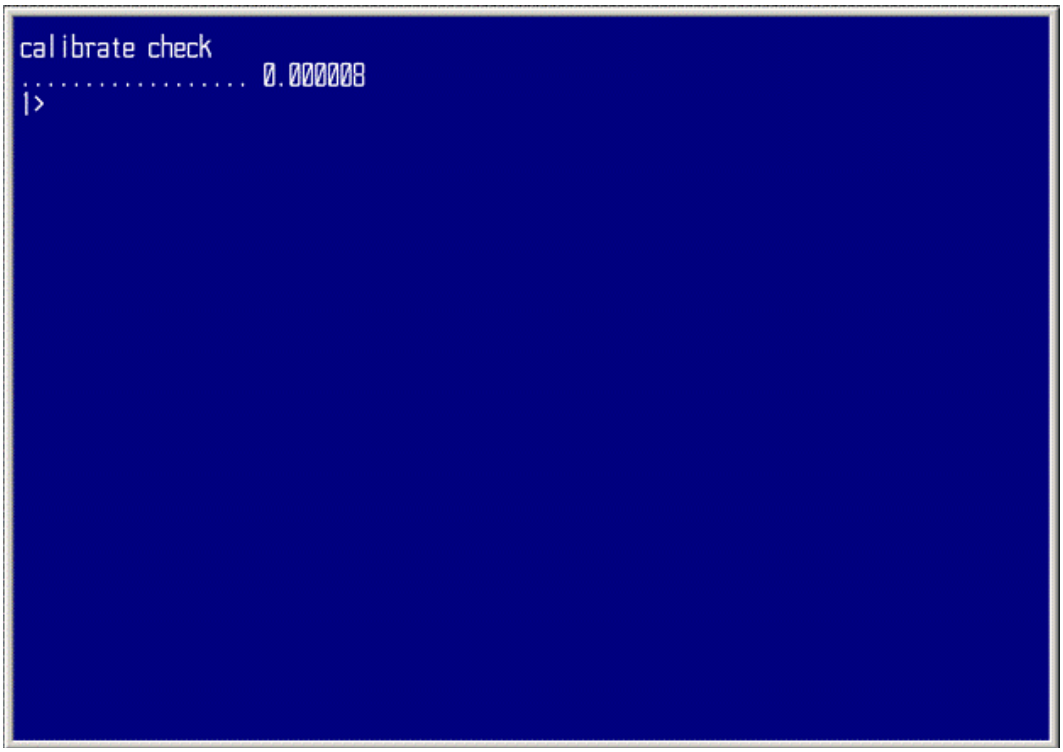

Figure 14. Blanking plugs - this number is a good value.

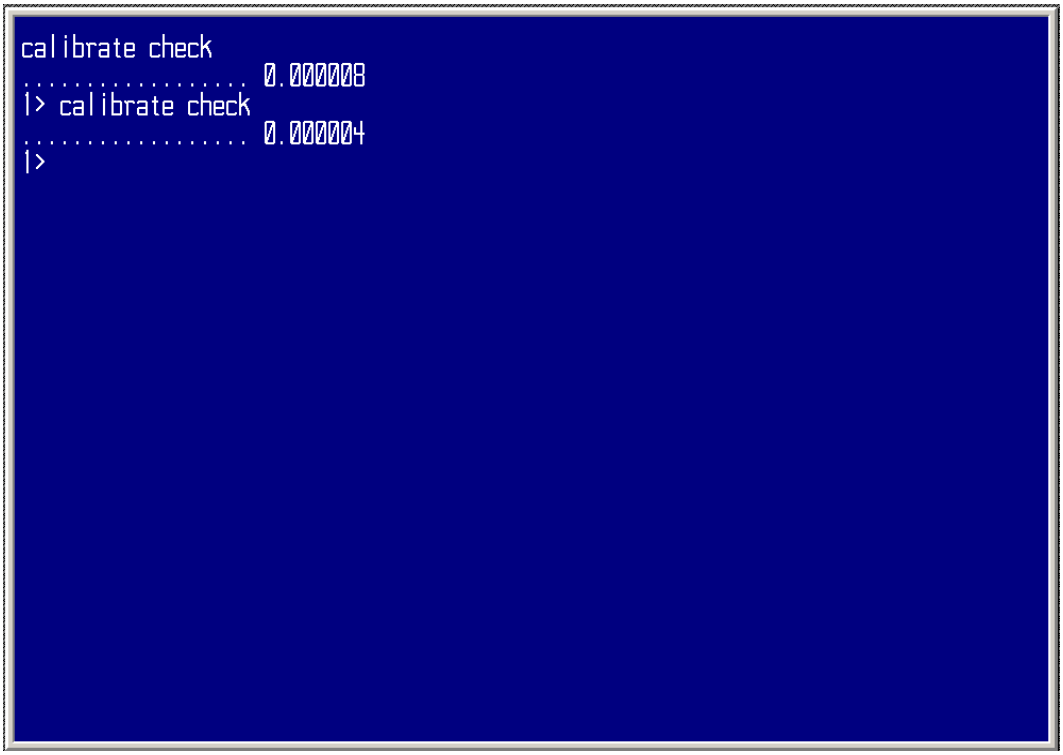

Figure 15. Calibrate check repeated with blanking plugs in place.

5. Remove the blanking plugs and the small plastic protective cover with the proper Allen wrench contained in the calibration kit (fig. 16). Removing this plate will allow the installation of the calibration plates. (fig. 17).

Figure 16. Plastic protective cover

NOTE: The plates are marked for left and right and will only fit correctly on the appropriate side. Also, be careful not to scratch the calibrated glass plates.

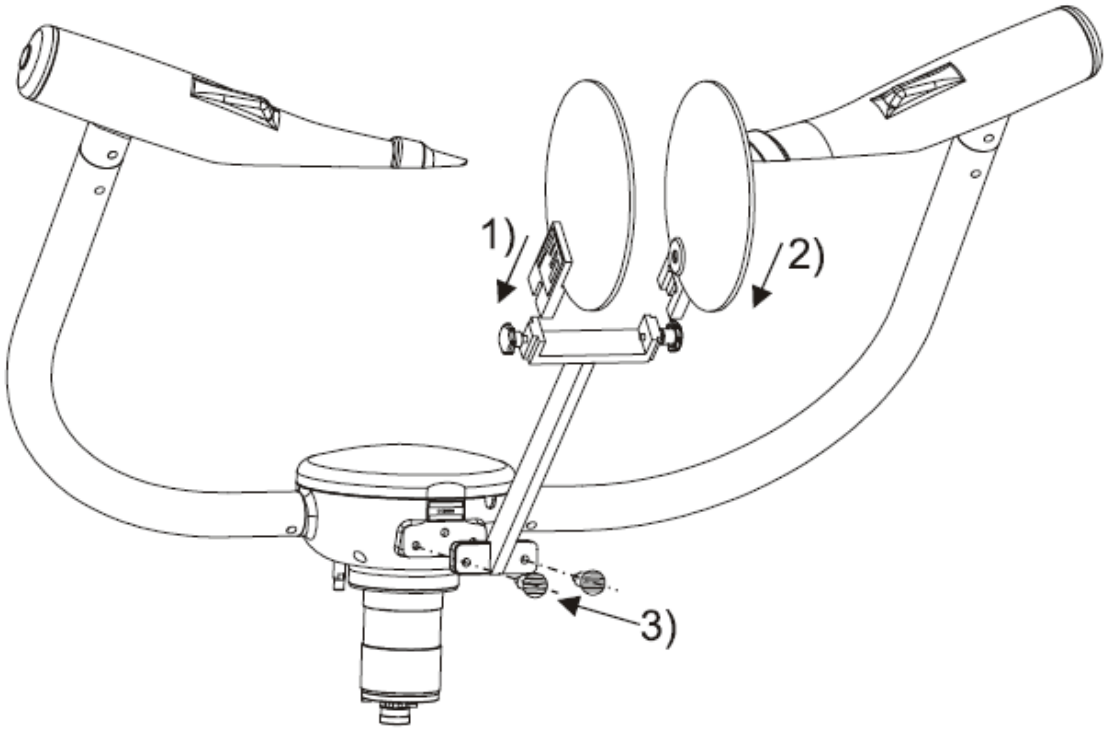

Figure 17. Calibration plate support and plates (from the Vaisala User's Manual 2006).

6. Once you have installed the calibration plates, remove the step ladder again.
7. Type: **calibrate check**
8. Then press CR. The value returned should be less than 3% of the plate value. If this value is less than 3%, proceed to the mechanical alignment check (**Procedure 5**). If more than 3%, then the instrument calibration needs to be adjusted (continue to **Step 9** on next page - fig. 18).

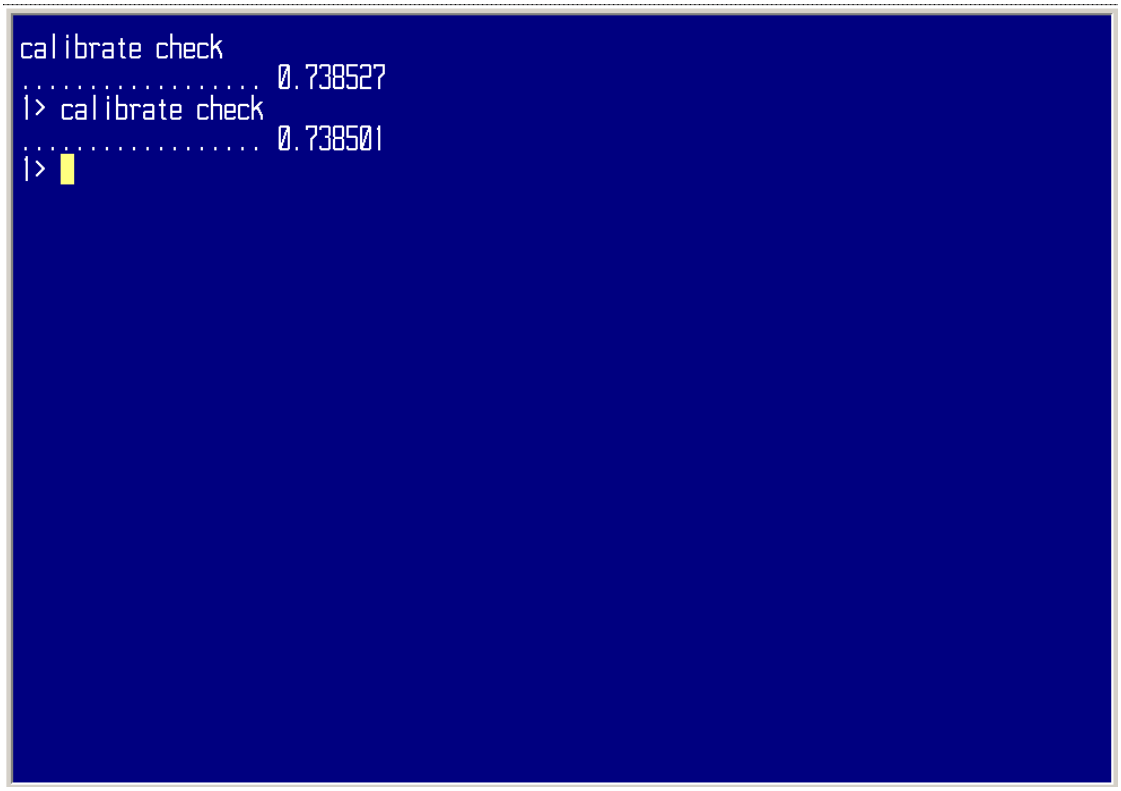

Figure 18. This is the calibrate check repeated with glass plates in place (NOTE: This value is nearly identical to that of this calibration kit.

> **NOTE:** Be sure that you have completed all steps correctly before proceeding because each step affects the calibration of this instrument.

9. With glass calibration plates in place and the area cleared:

   Type: **CALIBRATE VISIBILITY** calibrator_value (i.e., calibrate visibility 0.7376)

   Then press CR

   > **NOTE:** Calibrator value is on each glass plate Each set of plates is different (fig. 19).

10. Repeat the **calibrate check** command and note that value should be ±3% as noted before (fig. 20).

11. If the value is not ±3%, contact the CIL/SIL.

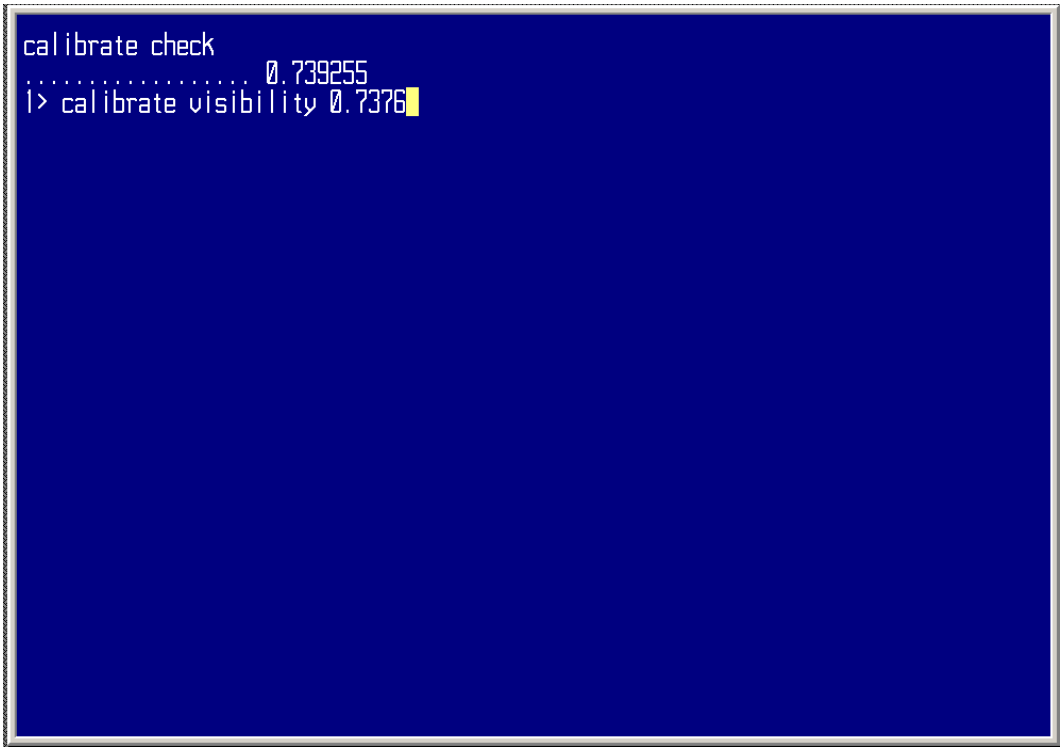

Figure 19. Calibration value

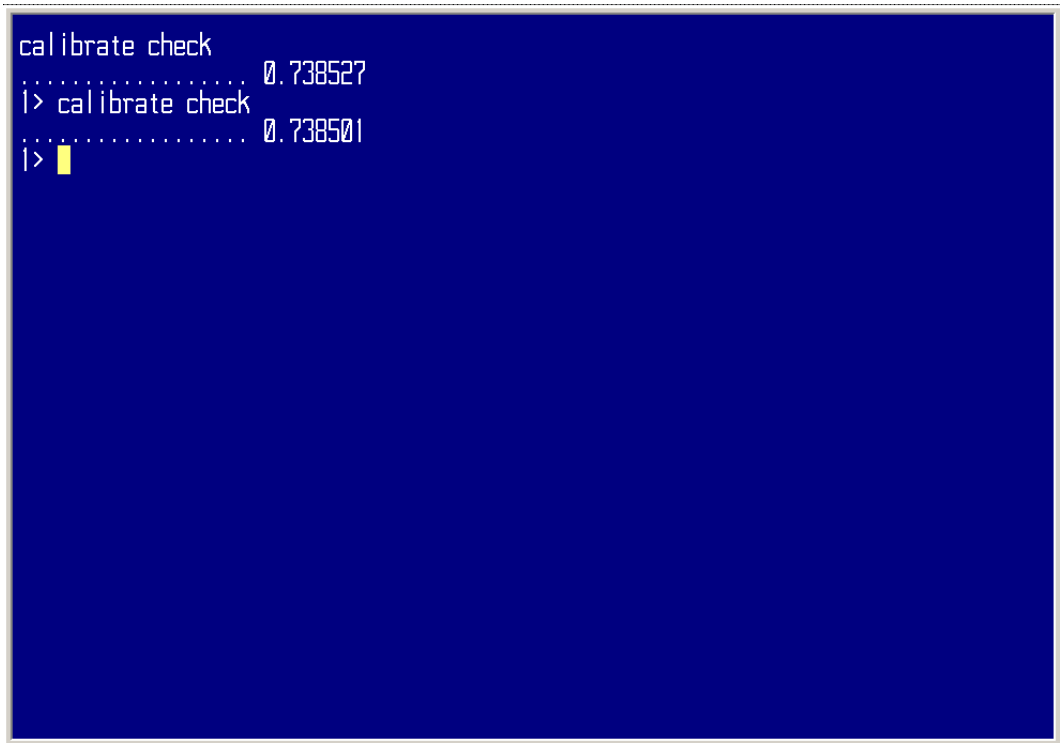

Figure 20. Calibration value is good.

Procedure 5 Check Alignment

This procedure is to check the mechanical alignment of the sensor head.

1. With the calibration plates in place install the masking plates. (fig. 21). The masking plates have small tape pads in place to keep from scratching the glass calibration plates. **Do not** remove this tape. Once the masking plates are installed, remove the step ladder from the area before proceeding.

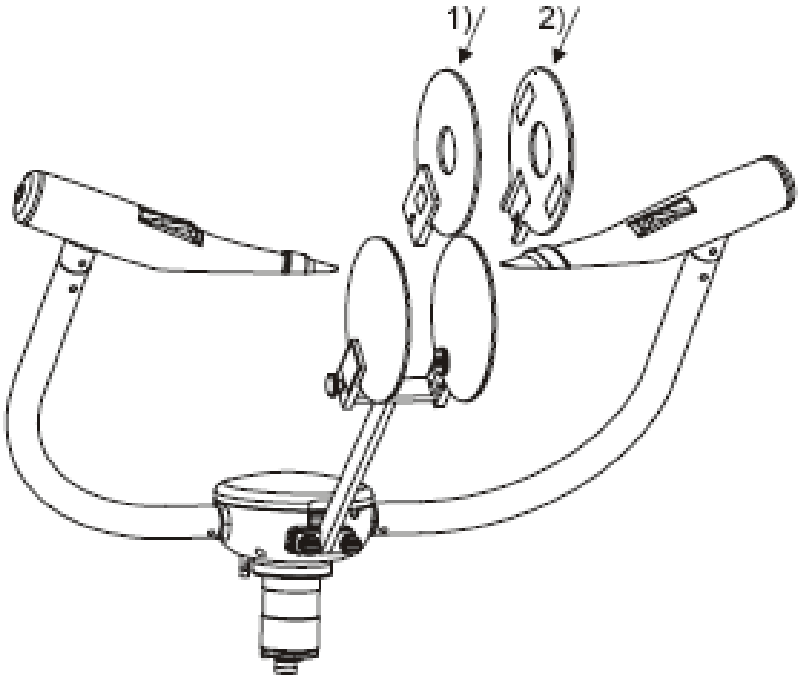

Figure 21. Masking plates for alignment check.

2. Type: **calibrate check**
3. Then press CR. Again, this will take about 90 seconds.
4. Record the value. This value should be 85% of the calibration plate value received in the previous step.
5. If the value is greater than 85% of the recorded value without the mask plates, the mechanical alignment is correct.
6. If the value is consistently less than 85%, then contact the CIL/SIL for guidance. (fig. 22).

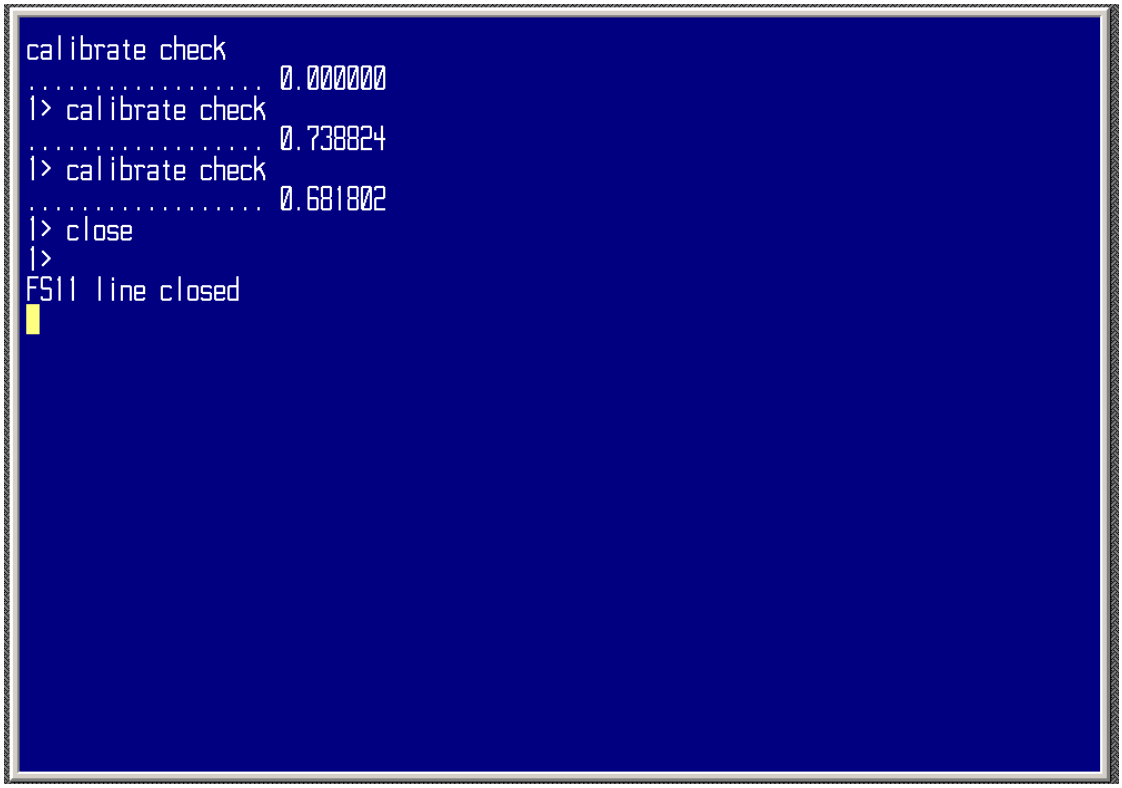

Figure 22. This is a good setting.

7. Once Steps1-6 are complete:

   Type: **message 3**

   Then press CR (fig. 23) for a final status message. Perform a screen capture and retain for records and submittal.

Figure 23. Final status message

8. Type: **close**
9. Then press CR to log out of the instrument. (fig. 24).

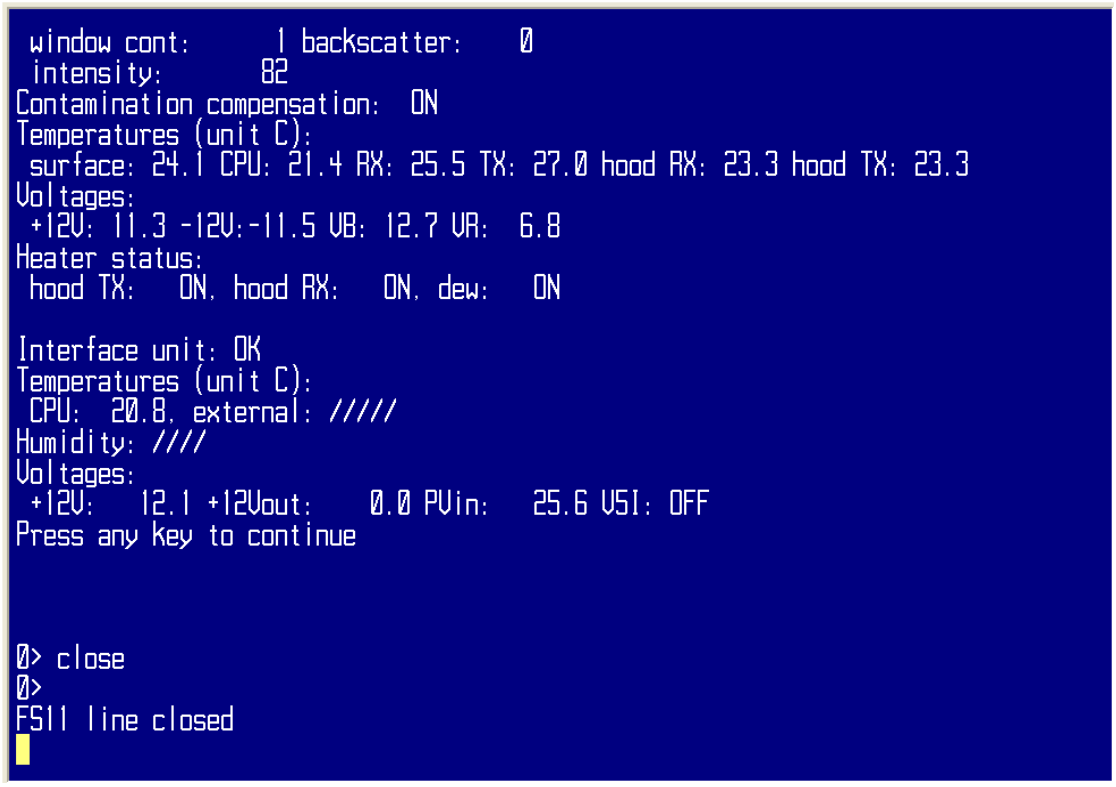

Figure 24. Logging off the sensor.

10. Disconnect the interface cable from the sensor and replace the dust plug.
11. Remove calibration plates and equipment from the sensor and carefully place in the calibration kit, making sure not to damage the glass plates.
12. Replace the plastic protective cover on the sensor head.

References: Vaisala User's Manual, 2006.

7. Quality Assurance/Control

The Field Crew Chief oversees the maintenance procedures on-site and ensures that all field and documentation requirements are met. The Data Monitoring and Assessment Team (DMAT) identifies any alarm codes or errors in the data.

8. Management/Responsibility

The FOD Branch Chiefs who oversee field work are responsible for ensuring that CO-OPS field crews are properly equipped and trained to perform this maintenance and for supervising their performance. Task Managers are responsible for oversight of contractors to ensure CO-OPS requirements are met as noted in the Statement of Work.

Appendix A Maintenance Checklist

Maintenance Checklist for Visibility Sensor

REV 1.1
03/02/2011

Station Name | Station Number

Field Party Chief | Date Inspected

Field Party

Comments:

System Inspection *(Check for loose wires, connections)*

Sensor Serial Number | Controller Serial Number

Modem Telephone Number | DCP RS232 Port Number

Battery Install Date | Battery Voltage

AT/RH Sensor S/N: (if present)

☐ Desiccant Replaced

System Cleaning: (Cleaning every 3 months)

☐ Status Check ☐ Measurement Unit OK ☐ Interface Unit OK ☐ Message 3 or Status Message

Receiver Window Contamination (value before cleaning)

Transmit Window Contamination (value before cleaning)

☐ Sensor Cleaned

Receiver Window Contamination (value after cleaning)

Transmit Window Contamination (value after cleaning)

System Calibration Check: (Calibration Check Annual)

☐ Blanking Plugs Blanking Plug Value Value should be +/- 0.0001 or better

Glass Calibration Plate Scatter Value (this is noted on the plate itself)

Calibration Check Value (value from calibration check)

Mechanical Alignment Check Value (value from calibration check)

Print Form Reset Form