Sonoma Technology

Standard Operating Procedures for the Belfort Model 6400 Visibility Sensor

October 31, 2024

STI-6991

APPROVED:

Sonoma Technology	date
Fenceline Monitoring Refinery Representative	date

Contents

Summary

This document describes the steps necessary to calibrate and maintain the Belfort Instrument Visibility Sensor Model 6400. The procedure is intended to verify that the equipment is performing to expectations and the detection and communication links are functioning correctly. Hard copies of this procedure and associated audit forms will be kept on site. Upon completion of the audit procedure, a copy of the audit form showing the results will be sent to the Refinery Project Manager.

Safety

Work should conform to manufacturer guidance and site health and safety practices. Standard refinery personal protective equipment (PPE) should be worn at all times, including laser safety glasses with side shields, a hard hat, goggles, steel-toed boots, hearing protection, fire-retardant clothing (FRC), an H_2S monitor, and appropriate gloves that are adequate for this procedure.

Personnel Qualifications

Installing, operating, and servicing Belfort visibility sensors should only be performed by personnel who are trained in the operation of the system components and are familiar with handling the testing equipment. These procedures should not be performed by personnel who do not understand the system, technology, or hazards of the materials involved.

General Maintenance

Belfort Instrument Company suggests conducting the initial visibility sensor maintenance three months after installation. The technician will need to adjust this time frame based on the individual site environment where the instrument is installed. Factors may include but are not limited to insects at the site, weather conditions, dust, blowing debris, and deposits from water spray. **Table 1** provides a schedule of maintenance activities for the sensor.

The technician should periodically inspect the sensor for dirt, spider webs, bird nests, and other obstructions. When necessary, carefully clean the protective glass windows in the Receiver and Transmitter with a commercially available glass cleaner. When maintenance is complete, the maintenance forms on page 8 of this document should be saved in the maintenance folder for the project located on Sonoma Technology's shared drive.

There are no user serviceable components in the sensor. Should a failure occur, return the sensor to Belfort Instrument for repair. Data will be flagged in a manner consistent with the QAPP if there are issues that cannot be immediately corrected. In the case of extended down time, the sensor should be replaced with a working sensor.

Table 1. Schedule of maintenance activities for the Belfort Model 6400 Visibility Sensor.

Activity	Monthly	Annually
Visually inspect the system, including all cables.	✓	
Inspect optics on detector and clean if necessary.	✓	
Check calibration.		✓

Contact Belfort Instruments or Sonoma Technology to receive a digital copy of the user manual.

Prepare for Calibration

Before beginning the calibration, make sure you have these materials:

- Serial cable with hook or alligator clips
- Opaque filter
- Scatter plate
- Laptop with terminal emulator

If the calibration is being performed in the field, select a clear day with low wind speeds (less than 10 knots). Fog will also affect calibration results, so choose a day that isn't foggy. For calibration to be valid, visibility must be at least 1 mile. The sensor needs to have been powered on for at least 45 minutes before beginning calibration. Check that the sensor windows are clean and clear of any noticeable dirt, spider webs, or other obstructions before getting started.

The technician will need to set up a serial connection with the sensor, perform a zero calibration, and complete a span calibration (in that order).

Set Up the Serial Connection

1. Disconnect the three serial wires connected to the CR310 data logger's terminals and reconnect them to the serial cable with hooks (or alligator clips). Note: the red wire is RX, the brown wire is TX, and the bare wire is the ground. Next, connect the serial cable to a laptop.
2. Use **Device Manager** to check the com port you are connected to under the **Ports** section.
3. Open a terminal emulator, such as **Tera Term**, and set it to the com port you have connected to. Make sure the serial settings match that of the Belfort 6400 (baud rate 9600, 8 bit, no parity, 1 stop bit, no flow control).
4. Test the connection by typing the **FL** command into the terminal without pressing Enter. Immediately, a list of values should be returned similar to this:

   P,00223, 1, 0.19333965, 40.33408642, 1.45484,Mi, 1.281314 0000

If nothing is returned, try swapping the red and brown wires. If it still doesn't work, check the serial settings to make sure they are correct.

5. Before the calibration commands can be entered, the terminal must be given super user privilege. Hold down the **Ctrl** key and press the **V** key. Then type in the appropriate password (which can be provided by the Field Staff Manager) and press **Enter**. You should see the message, "Password accepted, Operator is now Super User." To stop being a super user at any time, press **Ctrl-V** and then **Enter** again without entering the password. Turning the sensor off and on will also end super user status. **DO NOT USE ANY COMMANDS NOT STATED IN THIS SOP WHILE IN SUPER USER MODE**. Doing so could compromise the sensor's functionality.

Zero Calibration

1. Push the black foam opaque filter into the receiver hood, which is the hood on the left when facing the front of the sensor (see **Figure 1**). You are facing the front when you can see the "Belfort" logo on the device. Make sure the filter is completely blocking the receiver window. *Warning:* the hood might be hot to the touch if the heaters are on.
2. In the terminal emulator, enter the command **FZ**. The sensor will ask for verification before starting the calibration routine. Type the letter **Y** to accept (or **Esc** to abort).
3. The zero calibration routine will run for 3 minutes, allowing the sensor to reach a stable zero state, after which it will run for 2 more minutes while taking an average of the zero offset.
4. At the end of the zero calibration routine, the operator will be prompted to accept the new zero offset value. If the operator does not respond within 3 minutes, the sensor aborts the calibration (discarding the value generated). After accepting the new value, record it along with the previous value in eSIMS or a laboratory/field notebook.
5. Do not forget to remove the opaque filter after doing the zero calibration, as failure to do so will result in constant high visibility readings regardless of actual conditions.

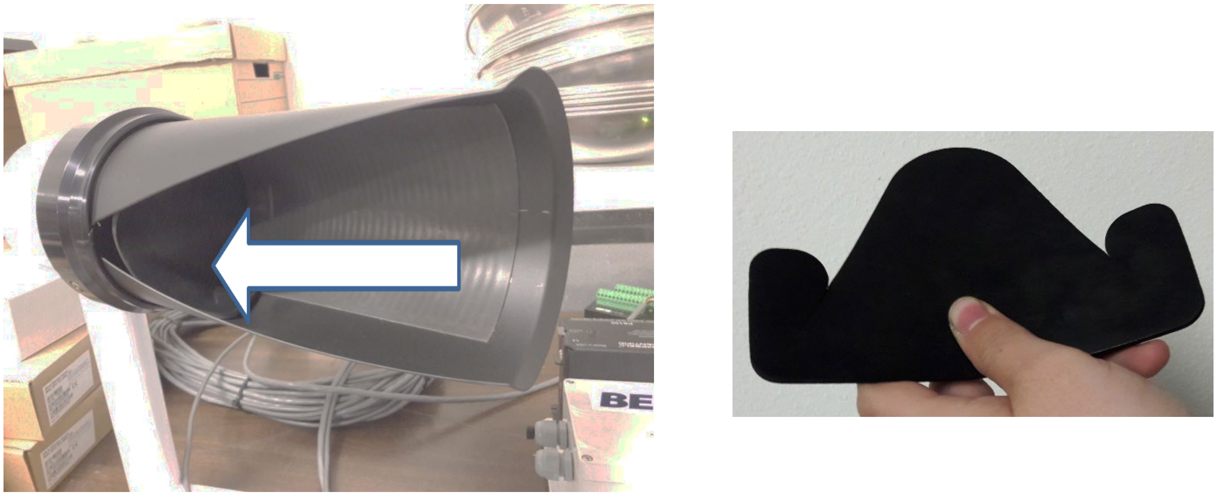

Figure 1. Inserting the opaque filter.

Span Calibration

1. Make sure the opaque filter has been removed from the receiver hood. Check the scatter plate for smudges and scratches. Clean off any smudges with a commercial glass cleaner (**do not use harsh solvents, as they will melt the plastic on the scatter plate**). If the scatter plate is badly scratched, contact the manufacturer before use.

2. Carefully hang the scatter plate on the sensor by hooking the top bracket over the top of the sensor's cross arm. Center the scatter plate on the cross arm an equal distance from the edge of each hood to the plate. Make sure the plate is secure and not swinging or rotating on the sensor's cross arm (see **Figure 2**).

3. In the terminal emulator, enter the command FN. A list of configuration parameters will be returned. Verify that the value of Cal_ExtCo (Calibration Extinction Coefficient) is equal to the value marked on the scatter plate's label. If they do not match, enter the command FC. A similar list of parameters will appear, followed by a prompt to change them. The prompt will go through each parameter one by one. Press Enter to go to the next parameter until you reach the Cal_ExtCo parameter. Enter the value found on the scatter plate's label and press Enter. Then press Esc. **DO NOT CHANGE ANY OTHER PARAMETERS**. Doing so could compromise the sensor's functionality.

4. Enter the FS command. When the sensor asks for verification before starting the calibration routine, type the letter Y to accept (or Esc to abort).

5. The span calibration routine will run for 3 minutes, allowing the sensor to reach a stable span state, after which it will run for 2 more minutes making periodic adjustments to the slope as it attempts to minimize the error.

6. At the end of the span calibration routine, the operator will be prompted to accept the new span factor value. If the operator does not respond within 3 minutes, the sensor aborts the

calibration (discarding the value generated). After accepting the new value, record it along with the previous value in eSIMS or a laboratory/field notebook.

7. Do not forget to remove the scatter plate from the sensor and carefully put it away in a safe place.
8. Record the procedure details, results, date, operator name, etc., in eSIMS or a laboratory notebook.

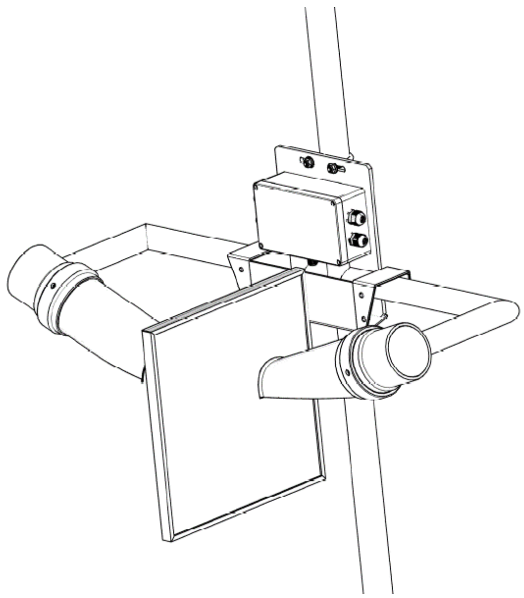

Figure 2. Scatter plate mounting.

Completing the Process

1. Disconnect the serial cable from the laptop, disconnect the Belfort 6400's three serial wires from the cable, and reconnect them to the CR310 data logger. The red wire goes to the **C1** terminal of the CR310, the brown wire goes to the **C2** terminal, and the bare wire goes to the **G** terminal.
2. Connect to the CR310 through Loggernet (either via a micro-USB cable connected to a field laptop, or via the DMZ server connection) and check to see if values are coming in and if they make sense. Note: the values might initially be lower than expected, so wait 5 to 10 minutes for the sensor to adjust.

Belfort Model 6400 Visibility Sensor Audit Record

DATE:_______________ Location: ____________________________

Test Technician 1 :_________________________
Test Technician 2 :_________________________

Zero State Calibration

Start Time: __________________________________

Previous Zero Offset: _________________________

New Zero Offset: _____________________________

Stop Time: ___________________________________

Notes:

Span Calibration

Start Time: ___________________________

Scatter Plate ExCo: ____________________

Span Factor: _________________________

New Span Factor: _____________________

Stop Time: ___________________________

Notes: