Geoprobe® Optical Image Profiler (OIP)

Standard Operating Procedure

Revision 2.2
PREPARED: October 2021

⚠CAUTION

CAUTION indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.

⚠WARNING

WARNING indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.

⚠DANGER

DANGER indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.

1.0 Objective

This document serves as the standard operating procedure for the Geoprobe® Optical Image Profiler (OIP) system. In this procedure, the OIP system is used to measure the fluorescence response of polyaromatic hydrocarbons (PAHs) in the soil excited by ultraviolet (UV) light or green light for identifying non-aqueous phase liquid (NAPL) hydrocarbon fuels, oils, and tars. Additional information about the application of the OIP-UV system is available in an Open Access publication (McCall et al. 2018).

⚠CAUTION

- **The Optical Image Profiler UV (OIP-UV) probe contains an ultra-violet (UV) light source. Looking at the UV light source without proper UV eye protection will be harmful to your sight and should be avoided.**
- **The Optical Image Profiler Green (OIP-G) probe contains a green laser diode. The OIP-G is a Class 1 laser product (see below). Avoid exposure to the beam. Do not stare into the beam or view directly with optical instruments.**

See Appendix 2 for OIP-G output parameters

See Appendix 3 for OIP-G labels and label locations

2.0 Background

2.1 Definitions

Geoprobe®*: A brand of high quality, hydraulically-powered machines that utilize both static force and percussion to advance sampling and logging tools into the subsurface. The Geoprobe® brand name refers to both machines and tools manufactured by Geoprobe Systems®, Salina, Kansas. Geoprobe® tools are used to perform soil core and soil gas sampling, groundwater sampling and testing, electrical conductivity and contaminant logging, grouting, and materials injection.

**Geoprobe® and Geoprobe Systems® are registered trademarks of Kejr, Inc., Salina, Kansas.*

Optical Image Profiler (OIP) System: A system developed by Geoprobe Systems® for the detection of non-aqueous phase liquid (NAPL) hydrocarbon fuels, oils, and tars in the subsurface. The OIP system uses an UV or green light source to induce fluorescence of the polyaromatic hydrocarbons (PAHs) of the fuels, oils, and tars present in the soil. A down hole camera captures an image of the induced fluorescence. The captured image is then analyzed to determine the area of fluorescence. The NAPL hydrocarbon fuel, oil, or tar is measured as the percent area within the image that contains fluorescence.

Hydraulic Profiling Tool (HPT) System: A system manufactured by Geoprobe Systems® to evaluate the hydraulic behavior of subsurface soil. The tool is advanced through the subsurface at a constant rate while water is injected through a screen on the side of the probe. An in-line pressure sensor measures the pressure response of the soil to water injection. The pressure response identifies the relative ability of a soil to transmit water. Both pressure and flow rate are logged versus depth.

Optical Image Hydraulic Profiling Tool (OIHPT) System: A system manufactured by Geoprobe Systems® which combines the OIP system and HPT system. The tool allows for the collection of both OIP data and HPT data in a single advancement of the tool into the subsurface.

Class 1 Laser Product: Any laser product which during operation does not allow access to laser radiation in excess of the accessible exposure limit of Class 1 for the specific wavelength and emission duration. Accessible exposure limits are set by the IEC60825-1 and FDA 21 CFR standards. Class 1 is the lowest possible class for a laser product. Class 1 laser products are considered safe during operation, even in the case of directly viewing the beam.

2.2 Introduction

The OIP system has been developed by Geoprobe® for the detection of NAPL hydrocarbon fuels, oils, and tars present in the soil. NAPL may be detected as layers, ganglia, blebs or droplets of product in the formation matrix. The OIP probe includes an electrical conductivity (EC) array to measure bulk formation EC as the probe is advanced at a rate of 2 to 4ft/min. The OIP probe and logging system can quickly provide logs that are easily interpreted. The OIP system provides logs of percent area of fluorescence (%AF) along with images of fuel fluorescence with depth. The %AF logs and images are used to indicate the presence of NAPL and the EC logs may help define lithology.

The OIHPT-UV probe (Fig. 2.1) uses an UV light emitting diode (LED) with maximum intensity at 275nm (nanometers). The UV light from the LED passes through the sapphire window and onto the soil. If fuels (gasoline, diesel, etc.) are present in the soil the contained PAHs will absorb the UV light and emit fluorescence, often in the visible range. The camera captures the image of the visible fuel fluorescence. The captured image is then analyzed to determine the number of pixels in the image that indicate fluorescence typical of Light NAPL fuels and oils.

The OIHPT-G probe (Fig. 2.2) uses a green laser diode light source with maximum intensity at 520nm. The green light passes through the sapphire window and onto the soil. If coal tars, creosote or any heavy fuels or oils are present in the soil the contained PAHs will absorb the green light and emit fluorescence, typically in the orange to red wavelength range. An optical filter on the camera excludes any reflected green light from the light source. The orange to red wavelength fluorescence passes through the optical filter and the camera captures an image of the fluorescence. The captured image is then analyzed by the software to determine the number of pixels in the image that indicate fluorescence typical of heavy NAPL fuels, oils, and tars.

A Hydraulic profiling port is built into the OIHPT probe. Hydraulic profiling of the subsurface occurs as water is injected out of an injection screen in the side of the probe (above and opposite of the OIP Window). Water is injected at a set flow rate and the controller varies the pressure required to inject the water at the rate initially set. Soils comprised of sands and gravels require very little pressure to inject this water while those with increasing silt and clay particles require more pressure to inject water at the set flow rate.

An EC array is built into the OIHPT probe. This allows the user to collect bulk formation EC data for lithologic interpretation. In general, the higher the electrical conductivity value, the smaller the grain size, and vice versa. However, other factors can affect EC, such as mineralogy, pore water chemistry (brines, extreme pH, seawater) as well as metallic objects in the soil. Targeted core samples should be collected to confirm lithologic interpretations based on EC logs.

Data is collected and is viewed in real time through the DI Acquisition software. The field instrument collects the electrical conductivity, probe rate, diagnostic parameters, and depth. The optical

interface collects the fluorescence images. The field instrument and optical interface send the collected data to the laptop computer. The laptop computer stores and displays the collected data with depth through the DI Acquisition software. The laptop computer analyzes and stores the fluorescence images and displays the percent fluorescence with depth.

For OIHPT see the HPT Standard Operating Procedure (SOP) for operating the HPT system.

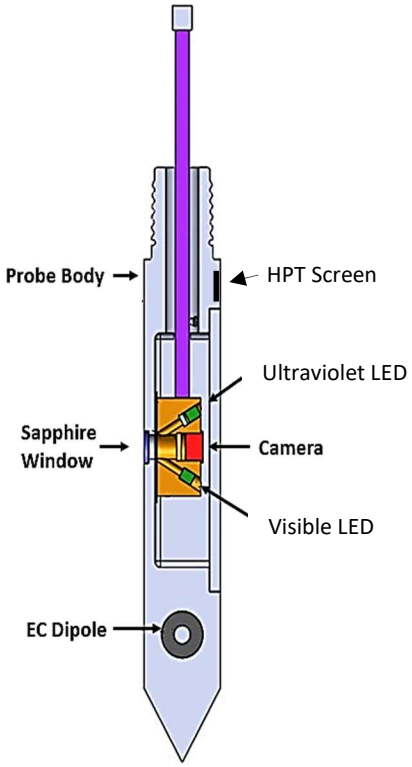


Figure 2.1 Drawing of the OIHPT-UV Probe

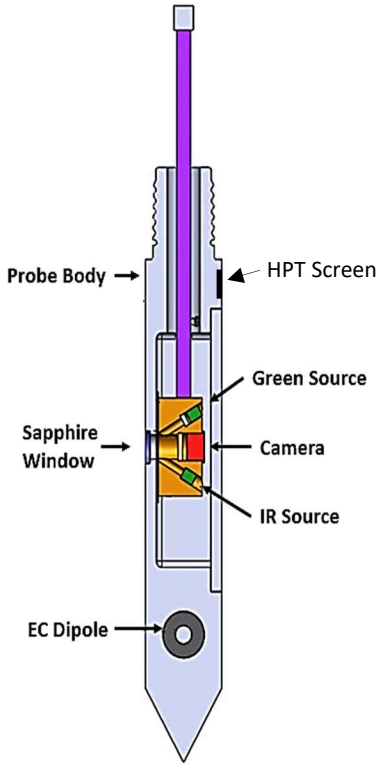


Figure 2.2 Drawing of the OIHPT-G Probe

3.0 Tools and Equipment

The following equipment is required to perform and record an OIP log using a Geoprobe® 66- or 78-Series Direct Push Machine. Refer to Appendix I for identification of the specified parts.

Basic OIP System Components	Quantity	Material Number
Field Instrument, 120V (Model FI6000)	-1-	213940
Field Instrument, 220V (Model FI6003)	*	213941
OIP Interface	-1-	224720
HPT Flow Module, 120V (Model K6300)	-**-	214091
HPT Flow Module, 220V (Model K6303)	*	214093
DI Acquisition Software	-1-	130063
OIP-UV Probe, OP6560	-x-	224739
OIHPT-UV Probe, OP6570	-1-	227466
OIP-UV Power Supply	-x-	224692
OIHPT-UV Power Supply	-**-	228265
OIP-G Probe, OP6710	-x-	228267
OIHPT-G Probe, OP6720	-**-	231346
OIP-G Power Supply	-x-	230392
OIHPT-G Power Supply	-**-	231345
1.75 in Connection Tube	-1-	219594
1.75 in Connection Tube with Friction Reducer	(optional)	225827
Drive Head 1.5 in Pin x 1.75 in SL Box	-1-	220545
Drive Head 1.75 in Pin x 1.75 in SL Box	-***-	220130
Trunkline Seal Spacer (pair)	1	207596
Trunkline Seal Yellow	1	207773
Trunkline Seal Red	-**-	211768
OIP Trunkline 150 ft.	-x-	226362
OIHPT Trunkline 150 ft.	-1-	228254
OIP Service Kit	-1-	226361
HPT Service Kit	-**-	205599
HPT Reference Tube 1.75 in Probe	-**-	212689
HPT Reference Tube 2.25 in Probe	**	211762
Stringpot, 100-inch	-1-	214227
Stringpot Cordset, 65-feet (19.8 m)	-1-	202884

*Use in place of 120V components if desired.

** For OIHPT

*** For use with 1.75 in rods

x No longer available. All OIP probes will be sold as OIHPT-UV or G probes.

3.1 Computer Hardware Requirements

Minimum	Recommended or Higher
i3 4th Generation 2.0GHz Processor 4Gb of RAM Windows 7	i5 6th generation 2.4GHz Processor 8Gb of RAM Windows 10

The latest DI software can be downloaded from the Geoprobe website

4.0 OIP Assembly

Probe Assembly

Refer to Appendix 1

4.1 Threading the Rods

1. Protect the ends of the trunkline to be threaded through the rods with electrical tape.

2. Probe rods must alternate directions prior to threading the trunkline.

3. The end of the OIHPT trunkline with longer leads to the chrome connectors is the downhole or probe end.

4. The probe end of the trunkline will always enter the male end and exit the female end of the probe rods.

5. The instrument end of the trunkline (shorter leads to the chrome connectors) will always enter the female end and exit the male end of the probe rods.

6. After the trunkline is through the probe rods make sure the downhole end is threaded through the male end of the drive head and connection tube prior to connecting to the probe.

7. The trunkline is now ready to connect to the OIP Interface and to the OIHPT Power Supply and probe.

4.2 Instrument Setup

1. Connect the Field Instrument (FI6000), OIP Interface (OP6100), and laptop to an appropriate power source.

2. Connect the FI6000 to the OP6100 using the 62-pin communication cable inserted into the acquisition port of each instrument. See figure 4.1 for the OP6100 cables.

3. Connect the OIP EC Breakout Cable to the green terminal block connector on the FI6000 and OP6100.

4. For Revision C OIP Interfaces connect a USB cable from the back of the FI6000 to the back of the OP6100. For Revision D OIP Interfaces connect the USB cable from the back of the FI6000 to the field laptop. See Figure 4.2 for identifying the OIP Interface Revision.

5. Connect the OIP Video/EC Cable to the OP6100 and to the up-hole end of the OIP Trunkline designated by a yellow, orange, brown and 2 red wires.

6. Connect the OIP Control Cable to the OP6100 and to the up-hole end of the OIP Trunkline designated by a white, grey, blue, green and black wire.

7. For Revision C OIP Interfaces connect two USB cables to the front of the OP6100. Wait before connecting the USB cables to the field laptop. For Revision D OIP Interfaces connect the front Video USB to the field laptop.

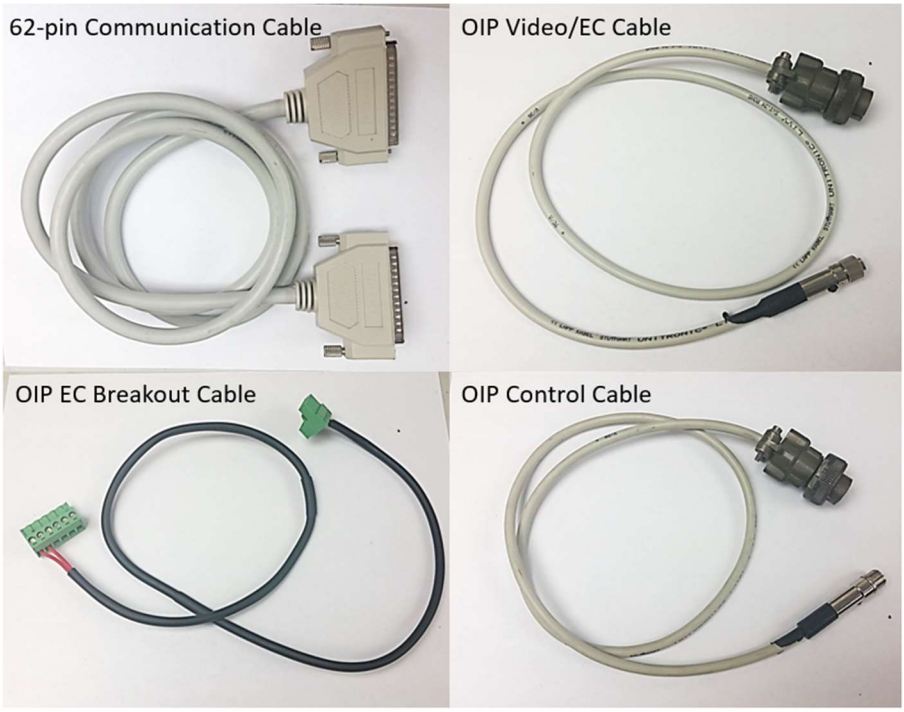


Figure 4.1 OP6100 cables excluding USB cables

Figure 4.2 OIP Interface. (Left Revision C, Right Revision D)

4.3 Connecting the OIHPT Probe to the Trunkline

1. Connect the OIHPT Power Supply water lines to the OIHPT Probe and OIHPT Trunkline (Fig. 4.3). Use a clamp over the barb fittings to ensure the water line does not disconnect during logging.

2. Connect the longer OIHPT Probe chrome connector lead to the OIHPT Power Supply. This connector pair is unique and will not connect to any other chrome connector (Fig. 4.4). This side includes the white, blue, red, green, and black wires.

3. Connect the shorter OIHPT Probe chrome connector lead to the OIHPT Trunkline chrome connector with the longest lead (Fig. 4.4). This side includes the yellow, black, and 2 red wires.

4. Connect the OIHPT Power Supply to the OIHPT Trunkline chrome connector with the shorter leads (Fig 4.4). The wires here will include the white, blue, green and black wires.

5. Wrap the collar of each of the chrome connector pairs with electrical tape (Fig. 4.5). This step will help to stop the chrome connector pairs from disconnecting during logging.

6. Loop and tape the wires of the OIHPT chrome connectors (Fig. 4.6).

7. Loop and tape the trunkline wires above the OIHPT Power Supply (Fig 4.7) such that the overall length from the top of the OiHPT probe to the jacket of the OIHPT trunkline does not exceed 2 ft.

8. Cover the connections with a 2ft. protective sleeve, such as a LB Liner Tube (MN223827) shown in Figure 4.8.

9. It is recommended to create a strain relief using tape below the water seal (Fig. 4.9).

Figure 4.3 OIHPT Water Line Connections

Figure 4.4 OIP Probe, OIP Power Supply and OIP Trunkline Connections

Figure 4.5 Taped Chrome Connector

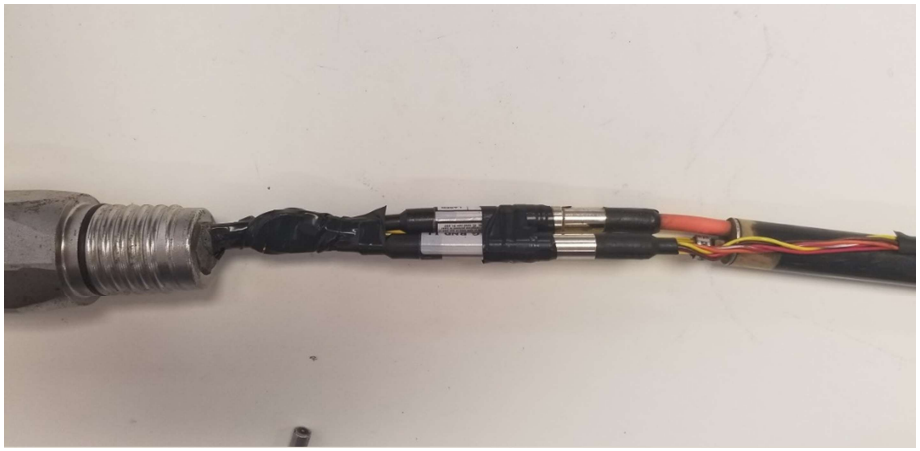


Figure 4.6 Looped OIP Probe Leads

Figure 4.7 Looped OIP Trunkline Leads

Figure 4.8 Connection Liner Tube Sleeve

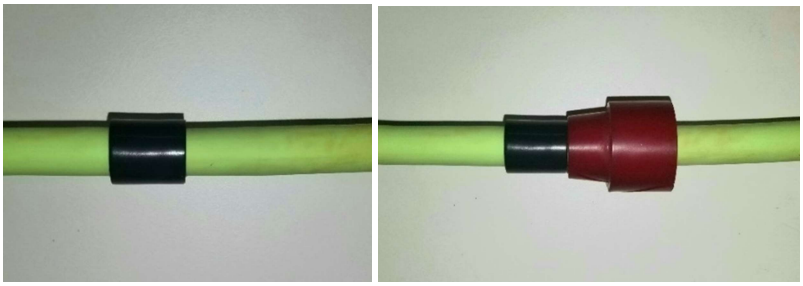


Figure 4.9 Trunkline Strain Relief and Water Seal

5.0 Field Operation

5.2 Starting the Software

1. *Only required for OIP Interface Revision C:* Make sure the FI6000 and OP6100 are powered down. Make sure the two USB cables connected to the front of the OP6100 are not connected to the laptop.

2. Power on the FI6000.

3. Connect the USB cables to the field laptop. For Revision C connect the two USBs from the front of the OIP Interface to the field laptop. For Revision D connect the FI6000 and the 1 USB from the front of the OIP Interface to the field laptop. Wait for at least 1 minute or for the all the device drivers to install.

4. Power on the OP6100.

5. Start the DI Acquisition Software. DI Acquisition should open in OIP mode (Fig. 5.1).

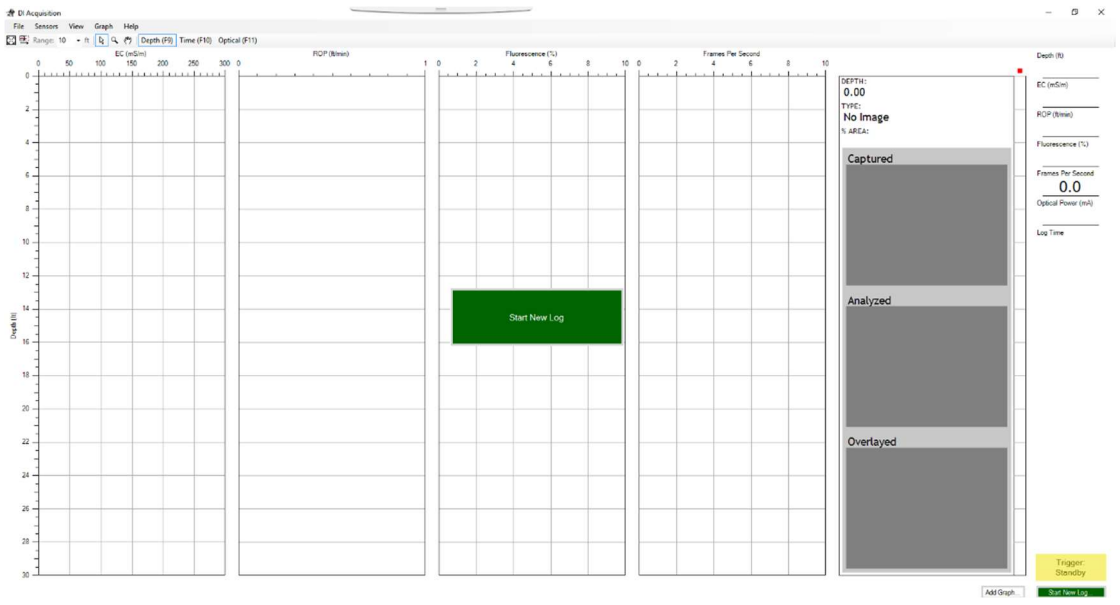


Figure 5.1 DI Acquisition in OIP mode

5.3 Running the Software

1. Select “Start New Log”. The software will request log information which will be stored in the log file. Select “Browse” to name the log file and select the storage location (Fig. 5.2).

2. Select “Next”. If the software has been run before it will show a list of previous settings including Stringpot length and rod length. If any of these have changed or you are unsure, select “No”. If they are all the same select “yes”. If you select “No” the software will have you select the proper settings after the quality assurance (QA) testing, if you selected “Yes” the selection of these settings will be bypassed.

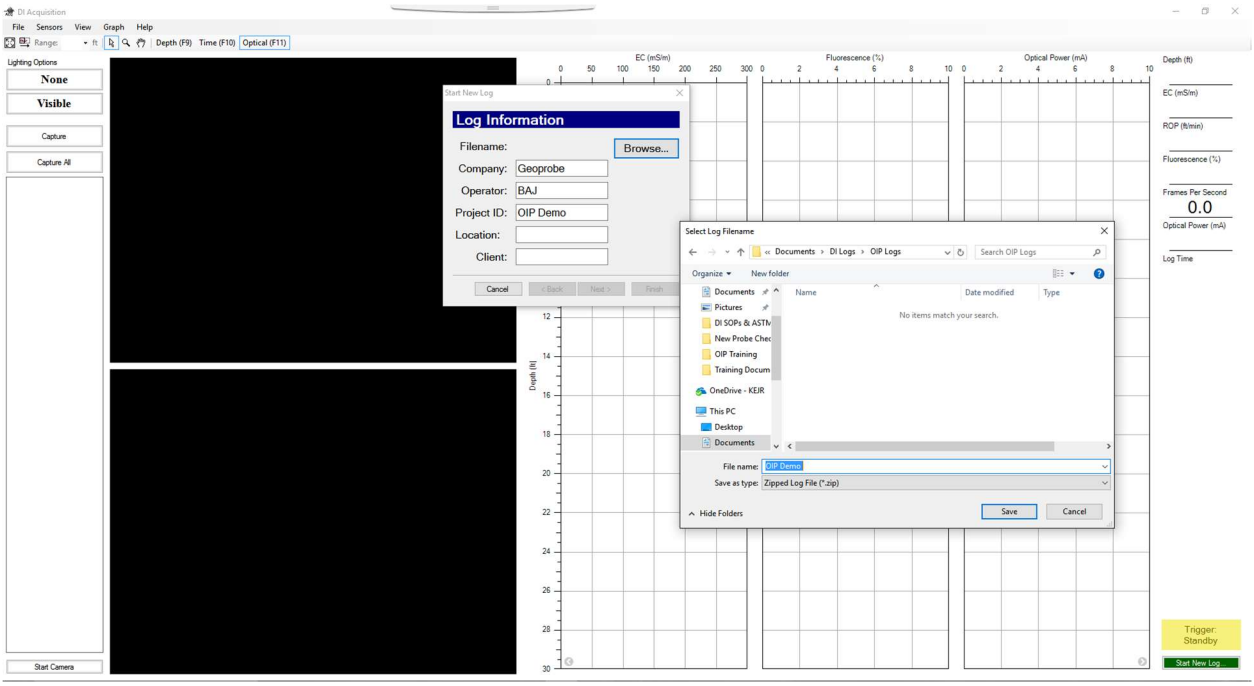


Figure 5.2 DI Acquisition Starting New Log

5.4 QA Testing the EC and OIP Systems

Both the electrical conductivity (EC) and OIP components must be tested before and after each log. This is required to ensure that the equipment is working properly and is capable of generating good data before and after the log.

For OIHPT see the HPT SOP for how to perform the HPT reference test and details for operation of the HPT system (Geoprobe 2015).

A. EC Load Test (Fig. 5.3)

1. Clean and dry the EC dipole as well as the probe body around the pin.

2. Place the low (brass) side of the EC Dipole test jig between the EC dipole and body of the probe and run the low test, hold for 5 seconds until the system captures the data.

3. Place the high (stainless steel) side of the EC Dipole test jig between the EC dipole and body of the probe and run the high test, hold for 5 seconds until the system captures the data.

If either the low or high test fail, see section 7.2 for troubleshooting assistance

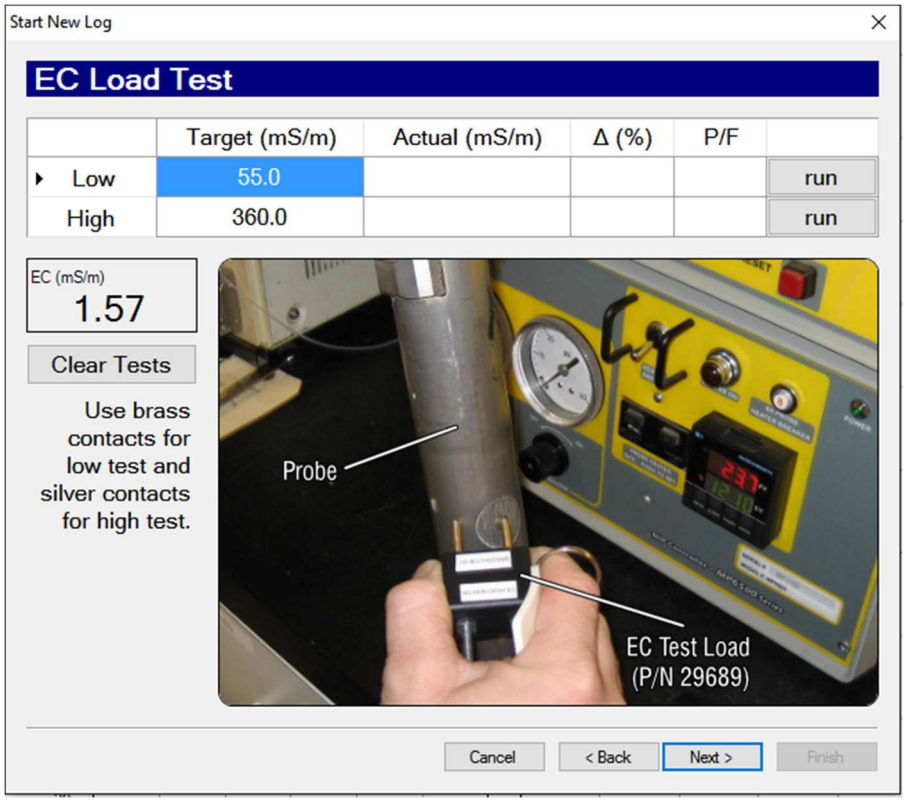


Figure 5.3 EC Load Test Window

B. Optical Test (Fig. 5.4)

The optical testing is done to ensure that the camera and light sources are working properly. The visible target is used to verify the camera's functionality and image focus. The black box test is used to verify that there are no objects or contaminants on the inside of the OIP window which could result in false positives. Diesel and motor oil are used to check the functionality of the UV

light source and the camera detection. Please note, the optical test recommended values are not pass-fail and it is up to the operator to determine if the OIP probe is working properly.

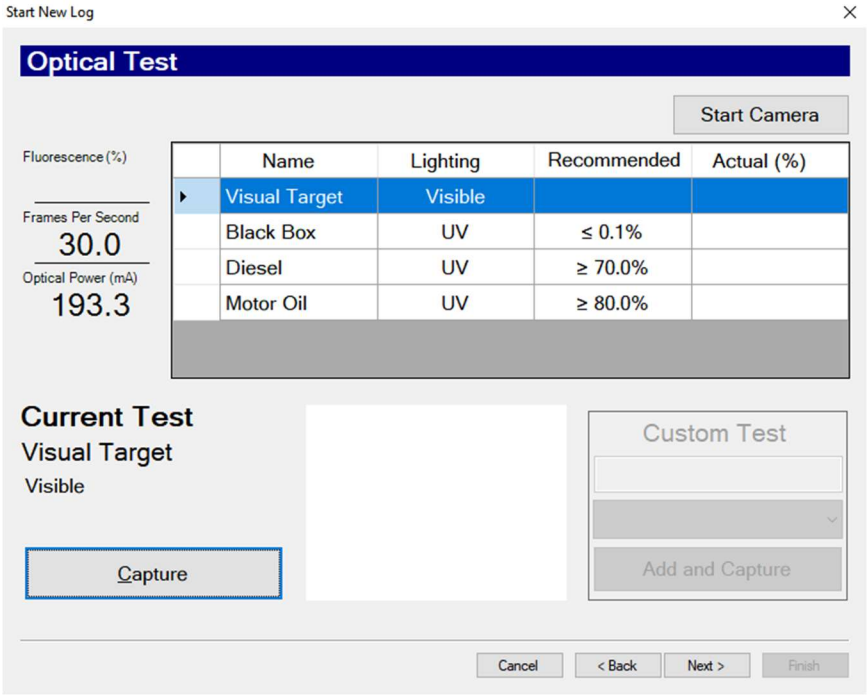


Figure 5.4 Optical Test Window

1. Fill two cuvettes with diesel and motor oil (Fig. 5.5)

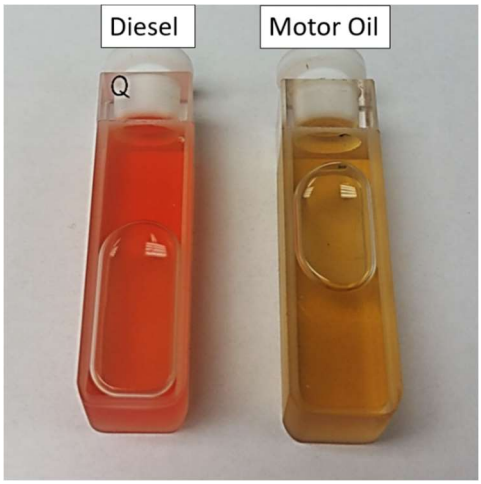


Figure 5.5 Cuvettes of Diesel and Motor Oil

2. Insert diesel and motor oil cuvettes in to the cuvette holder (Fig. 5.6)

Figure 5.6 Cuvette Holder Assembly

3. Place the visual target on the Cuvette Holder or a business card over the window. Using the camera display, verify that the image on the card is in focus and displaying the proper color. Capture the image for the visible target test (Figure 5.7).

4. Place an empty side of the Cuvette Holder over the window. Use the camera display to ensure that no external light is passing through the cuvette holder over the window (Fig. 5.8). Capture the image for the black box test. The measured fluorescence should be less than 0.1%.

5. Place diesel side of the Cuvette Holder over the OIP window. Use the camera display to ensure the cuvette is centered over the window (Fig. 5.9). Capture the image for the diesel test. The measured fluorescence should be greater than 70%.

6. Place motor oil side of the Cuvette Holder over the OIP window. Use the camera display to ensure the cuvette is centered over the window (Fig. 5.9). Capture the image for the motor oil test. The measured fluorescence should be greater than 80%.

7. Click “Finish” to complete the QA testing

If any of the fluorescence readings are outside of the expected ranges or the if the visible image is not in focus, see section 7.3 for troubleshooting assistance

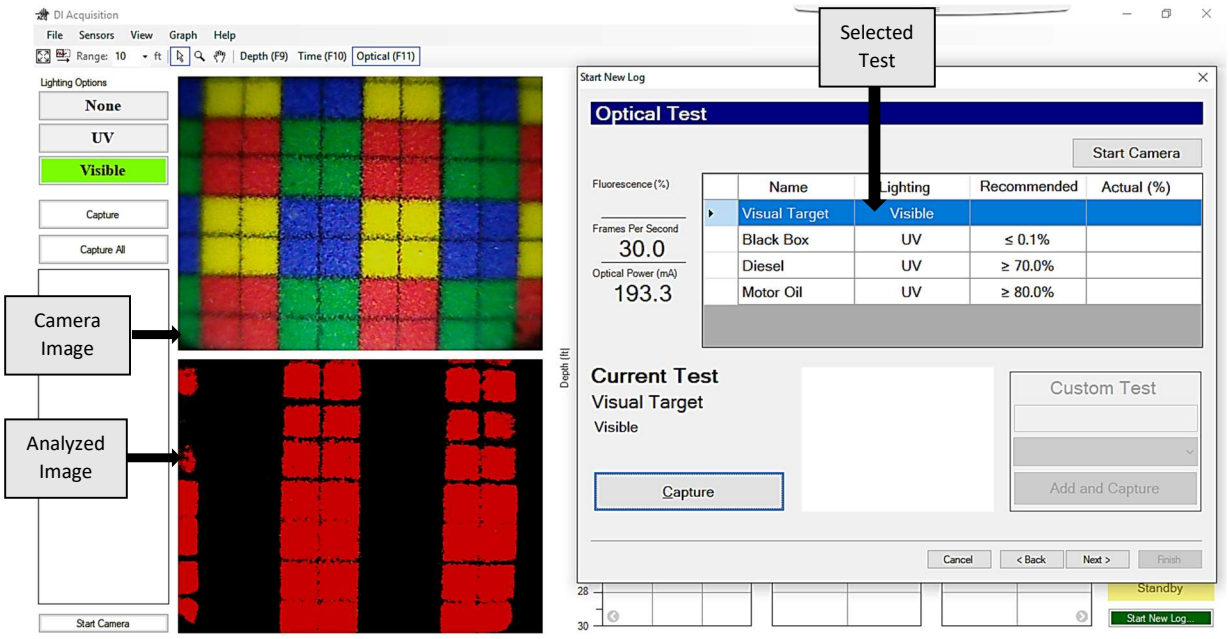


Figure 5.7 DI Acquisition OIP QA Screen with Visible Target

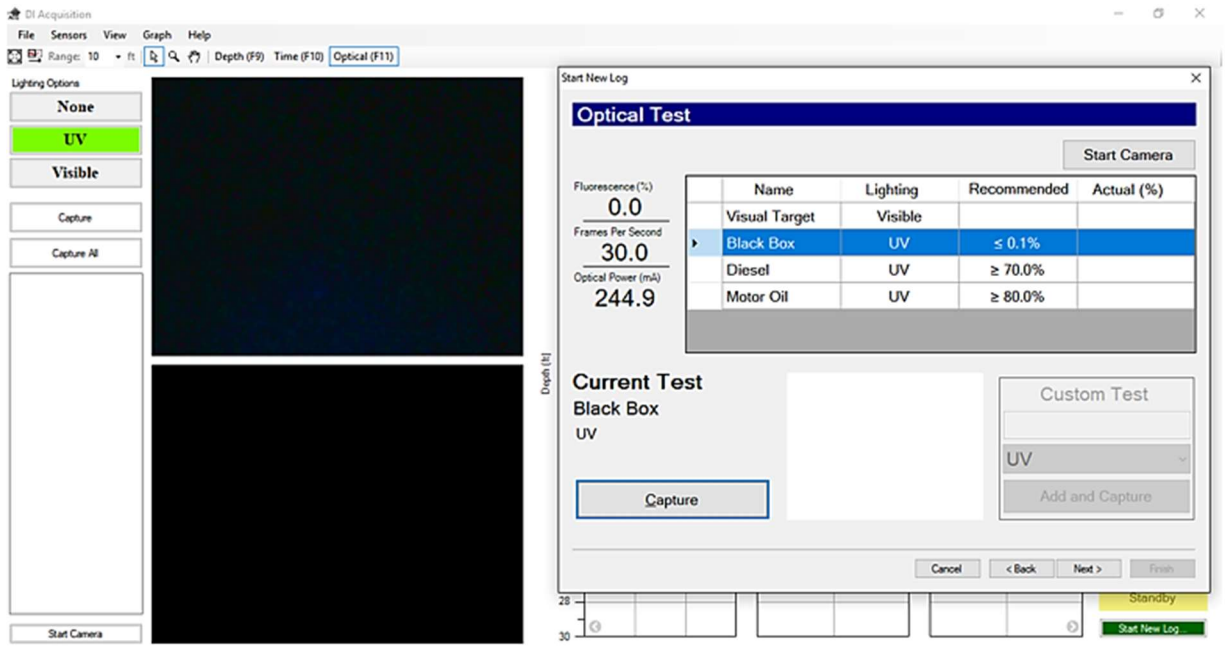


Figure 5.8 DI Acquisition OIP QA Screen with Black Box

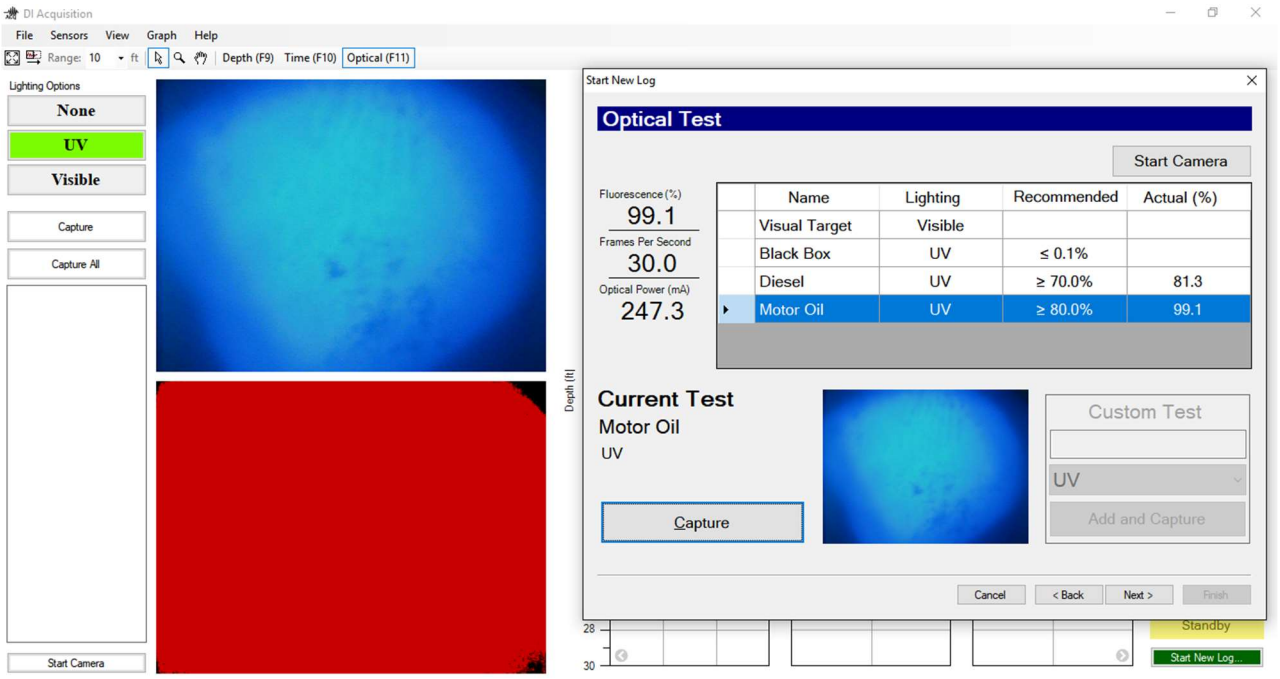


Figure 5.9 DI Acquisition OIP QA Screen with Motor Oil Cuvette

A. HPT Reference Test (Fig. 5.10)

Reference testing is done to ensure that the HPT pressure sensor is in working order and to evaluate the condition of the HPT injection screen. The HPT reference test calculates atmospheric pressure which is required to obtain static water level readings and to determine the estimated K values for the log in our post log processing software the DI Viewer.

Each OIHPT sensor is individually calibrated and comes with a calibration sheet (Fig. 5.11) which has calibration values that must be entered into the DI Acquisition software with the OIHPT Power Supply serial number.

In the DI Acquisition software when starting a new log and select No when asked if you want to use the parameters used in the previous log (rod and stringpot length, HPT sensor serial number). Now the ability to add a new OIHPT Power Supply serial number and calibration is open when the "Sensor Configuration" (Fig. 5.12) screen opens. Select "Edit Sensors" then "(new)" and then enter the serial number of the OIHPT Power Supply which is printed on the sensor and will have an "OH" at the end of the serial number. Then enter your x1 and x0 values into the calibration tabs from the calibration sheet (Fig. 5.11). After the values have been entered verify the correct HPT sensor serial number is selected under "HPT Sensor" on the "Sensor Configuration" screen. Now you can proceed to the HPT reference test.

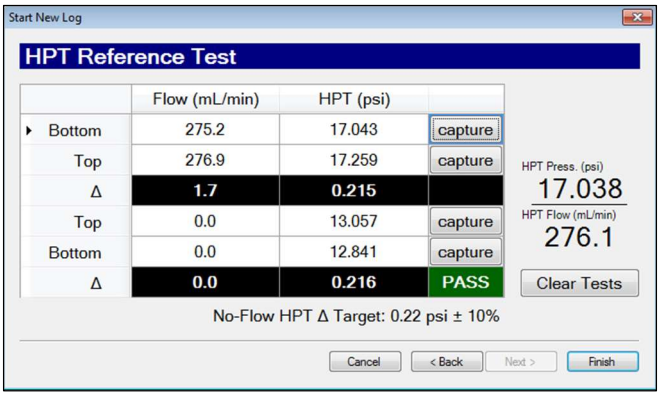
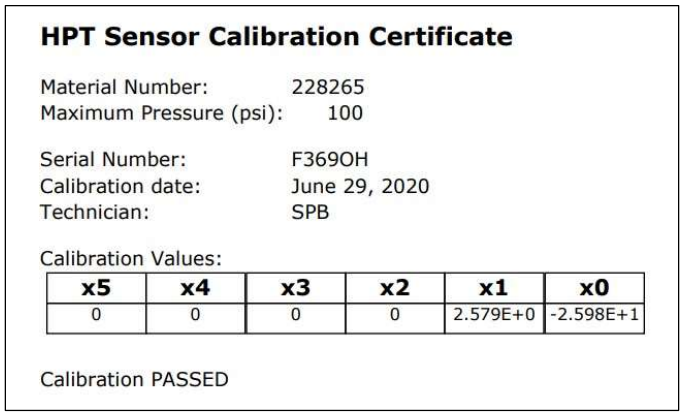


Figure 5.10 HPT Reference Test Screen



HPT Sensor Calibration Certificate

Material Number: 228265
Maximum Pressure (psi): 100

Serial Number: F369OH
Calibration date: June 29, 2020
Technician: SPB

Calibration Values:

x5	x4	x3	x2	x1	x0
0	0	0	0	2.579E+0	-2.598E+1

Calibration PASSED

Figure 5.11 HPT Sensor Calibration Certificate

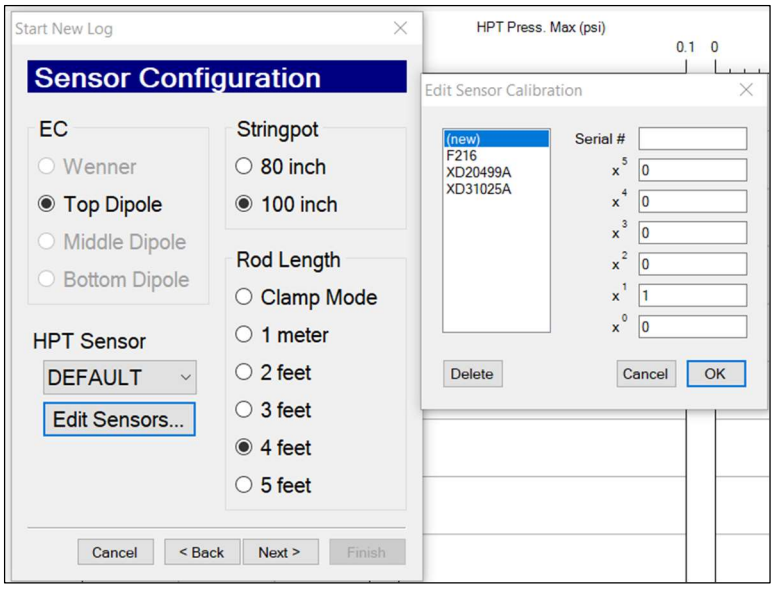


Figure 5.12 HPT Sensor Configuration Screen

HPT Reference Test Procedure

1. Connect a clean water source to the HPT controller and turn on the pump.
2. Allow water to flow through the system long enough so that no air remains in the trunkline or probe (air in the system can cause inaccurate flow and pressure measurements).
3. Insert the probe into the HPT reference tube and allow the water to flow out the valve adjusting the flow rate to between 200-300ml/min (Fig. 5.14). Ensure that the reference tube is close to vertical.
4. With a stable pressure reading and the water flowing out of the valve select “capture” - bottom with
5. Close the valve and allow the water to overflow the top of the tube. When the pressure stabilizes select “capture” - top with flow.
6. Shut off the water flow. When the pressure stabilizes select “capture” - top flow = 0.
7. Open the valve and allow the water to drain out. When the pressure stabilizes select “capture” - bottom flow = 0.

The HPT reference test reading flow = 0 is the true test of the condition of the pressure sensor and is the only sensor test to have a pass/fail reading on it. Ideally, the pressure difference between the top and bottom values will be 0.22 psi (1.52kPa). Typical pressure readings of the sensor will be in the 12PSI-15PSI (83kPa-104kPa) range.

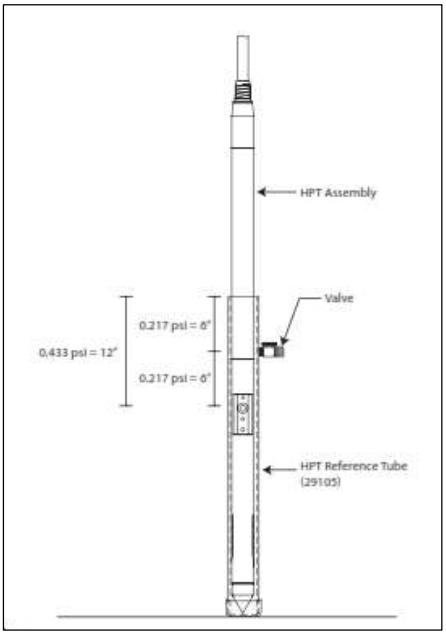


Figure 5.13 HPT Reference Test Setup

5.5 Running an OIP Log

It is strongly recommended to pre-probe the first 1-2 feet of each hole. Pre-probing each hole can help to avoid unnecessary stresses to the OIHPT probe components from hammering at the surface.

1. Place the rod wiper on the ground over the probing location and install the drive cushion in place of the anvil of the probing machine.

2. Place the probe tip in the center of the rod wiper and place the slotted drive cap on top of the OIHPT probe.

3. Adjust the probe so that it is vertical and advance the probe until the OIP Window is at the ground surface.

4. If running with HPT, turn on the HPT pump and flow.

5. Click the trigger button in the lower righthand corner of computer screen. (The Trigger label will flash and the background will change from yellow to green).

6. Advance the probe at a rate of 2-4 ft./min (1-2 cm/s). If necessary, feather the hammer to maintain this advance rate.

7. After completing the log, press the trigger button again and select “Stop Log”.

8. Pull the rod string using either the rod grip pull system or a slotted pull cap. Run a post-log EC load test, optical test, and HPT reference test. (Section 5.4).

5.6 Still Captures

A still image can be captured at any depth during a log for each available light source. Still images allow for clearer images of the soil and hydrocarbon fluorescence. Only one still image for each available light source will be captured per .05 feet of depth. During the log, the DI Acquisition software will automatically capture a still image for each available light source during a rod change.

1. Stop the advancement of the probe

2. Select “Capture all” to capture a still image for each available light source. If the “Capture” button is selected a still image for the only current light source will be captured.

3. Wait for the captured stills to appear bellow the capture options (Fig. 5.10) and the light source to return to UV.

4. Restart the advancement of the probe

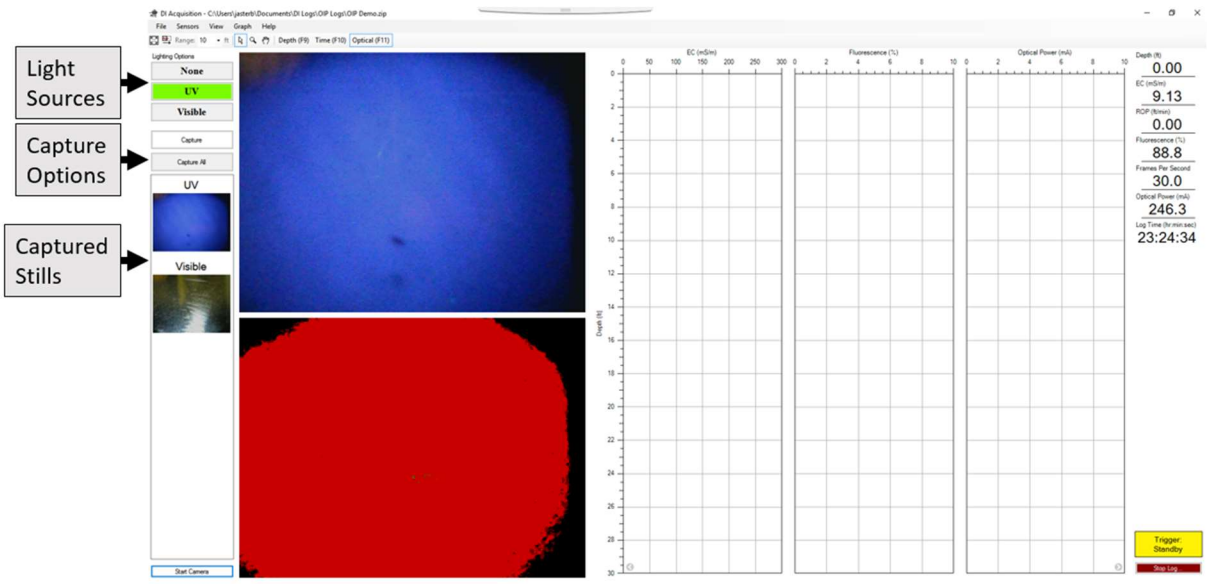

Light Sources
Capture Options
Captured Stills
None
UV
Visible
Capture
Capture All
UV
Visible
Start Camera
Depth (ft)
0.00
EC (mS/m)
9.13
ROP (ft/min)
0.00
Fluorescence (%)
88.8
Frames Per Second
30.0
Optical Power (mA)
246.3
Log Time (hr:min:sec)
23:24:34
Trigger Standby
Stop Log

Figure 5.10

6.0 Maintenance

Maintenance should be performed in event that the optical cavity or window become contaminated with soil, water, or NAPL hydrocarbon or in the event of reduced or poor optical QA responses.

Turn off or disconnect power to the green laser diode anytime the OIP window is removed.

6.1 Cleaning the Optical Cavity

1. Remove the OIP window and window seal from the OIHPT Probe.

2. Turn the OIHPT probe so that the optical cavity is pointed down. Flush the optical cavity with water by using a syringe or squirt bottle to remove dirt and other particles (Fig 6.1). Wipe the internal surfaces with a Q-tip or soft brush.

3. Continue to flush and wipe the internal surfaces of the optical cavity until all dirt and other particle are removed.

4. Flush the optical cavity with methanol or alcohol to remove excess water and water spots from the internal surfaces (Fig 6.2).

5. Clean the optical lens in the optical cavity (Section 6.2).

6. Let the OIHPT probe dry for 1-2 hours before re-inserting the window seal and OIP window.

Figure 6.1: Flushing the optical cavity with water

Figure 6.2: Flushing the optical cavity with alcohol

6.2 Cleaning the Lens in the Optical Cavity

1. Wash the lens surface with methanol or alcohol and a Q-tip.

2. Allow the lens to dry.

3. Wipe and the lens with a clean dry Q-tip to remove any remaining surface spots.

6.3 Cleaning the OIP Window

1. Wash the backside of the OIP window with water or soapy water and a Q-tip (Fig. 6.3)
   If false positive fluorescence is present on the window in the black box test it may be necessary to use a mild abrasive cleaner such as “Comet” along with some water and a Q-tip to remove.

2. Flush the backside of the OIP window with methanol or alcohol to remove water and or soap.

3. Allow the OIP window to dry.

4. Wipe the backside of the OIP window with a clean Q-tip to remove any remaining surface spots.

Figure 6.3 Cleaning the OIP Window is soapy water

7.0 Troubleshooting

7.1 Bypassing the Trunkline

For testing and troubleshooting the OIHPT probe and OIHPT Power Supply the OIHPT trunkline can be bypassed.

1. Disconnect the trunkline from the OIP Video/EC cable and OIP Control cable connected to the back of the OP6100.

2. Connect the OIP Video/EC cable directly to the OIHPT Probe.

3. Connect the OIP Control Cable directly to the OIHPT Power Supply.

4. Connect the OIHPT Power Supply to the OIHPT Probe.

7.2 EC QA Troubleshooting

1. On the EC load test window (Fig. 5.3) select "Finish". The EC troubleshooting test (Fig. 7.1) will run if either EC load test has failed. The EC troubleshooting test will verify the FI6000's 10, 100, and 1000ohm EC calibration.

2. If any of the instrument calibration tests fail, the FI6000 will need to be recalibrated.

3. If all the instrument calibration tests pass, select the "back" button.

4. Verify the connections to the back of the FI6000 and OP6100 are securely connected (Section 5.1). The EC Breakout Cable must be connected between the FI6000 and OP6100 to read EC.

5. Clean and dry the EC dipole and re-run the EC load tests (Section 5.4.A).

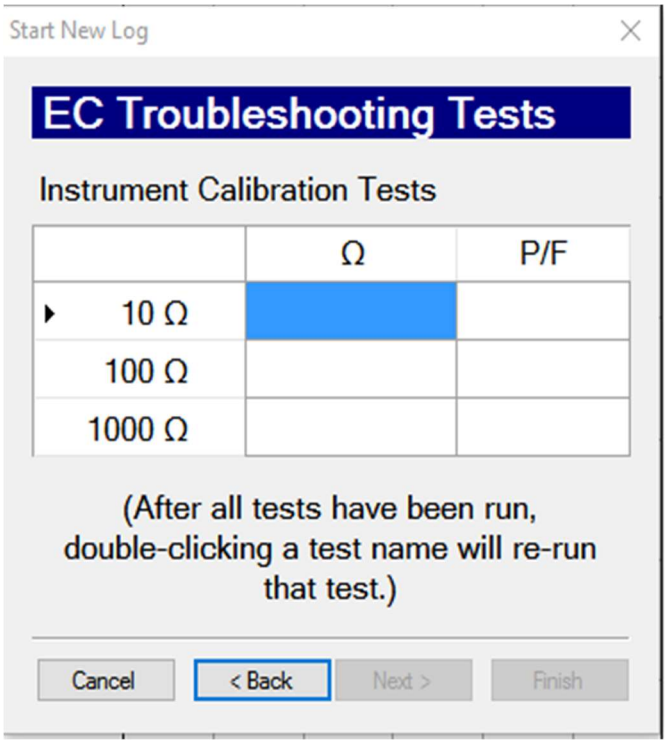


Figure 7.1

6. If the EC load tests continue to fail, bypass the OIHPT trunkline (Section 7.1) and retest the OIHPT Probe again.

7.3 Optical Troubleshooting

A. Zero Frames per second (FPS) or No Camera Display

The measured FPS in the Direct Image Acquisition Software is a measurement of the FPS the computer receives from the frame grabber in the OIP Interface. The DI Acquisition software will measure 0 FPS and trigger a warning alarm if communication with the frame grabber is lost or if the frame grabber is not receiving video from the downhole camera.

No Frame Grabber Feed Detected

1. Confirm that the optical power measurement is greater than 180mA. If the optical power measurement is less than 180mA, the camera is not powering on. Use Section 7.3.B to troubleshoot the low optical power.

2. Check the "Devices and Prints" in the "Control Panel" of the field computer that the SensorRay 2253 driver is present and working properly. The status of the device driver can be confirmed by right clicking the device, selecting "Properties", and selecting the "Hardware" tab.
3. If the device driver is present and working properly, select the "Start Camera" button at the bottom left of the DI Acquisition screen or the top right of the OIP QA window.

No Down Hole Camera Feed Detected

1. Verify the connections to the Video/EC cable connected to the OIP Interface.

2. Bypass the OIP Trunkline (Section 7.1) and select "Start Camera". If the video feed recovers, the problem is like in the OIP Trunkline.

B. Low Optical Power

See Table 7.1 for the typical expected optical power readings

Table 7.1 Typical Optical Power Readings – OIHPT Power Supply				
Individual Component Power Consumption			Mode Power Consumption	
275nm UV LED	~40mA		UV LED Mode	~260mA
Visible LED	~10mA		Visible LED Mode	~200mA
SM Camera	~180mA		No LED Camera Only	~210mA
OIP Power Supply	~20mA		LED but no Camera	~80mA
HPT	~10mA		OIP Power Supply Only	~30mA

Low optical power alarms will trigger if the optical power measurement drops below 150mA in any light source mode. The alarm will also trigger if the light source mode is in UV mode and the optical power measurement goes below 220mA.

OIP Test Module

The OIP Test Load (Fig 7.2) can be used to verify the functionality of the OIP Interface, OIHPT Trunkline, and OIHPT Power Supply. The expected response when using the OIP Test Load can be seen in Table 7.2. Connecting the OIP Test Load to the probe side of the OIHPT Trunkline or to the Control Cable of the OIP Instrument will test down hole power and light source selection. Connecting the OIP Test Load to the OIHPT Power Supply will test power to the OIHPT Probe components.

Figure 7.2 OIP Test Module MN228240

Table 7.2 OIP Test Module					
Connected to instrument or TL				**Connected to OIP Power Module**	
UV Mode	1 light	~190mA		UV Mode	~250mA
Visible Mode	2 lights	~190mA		Visible Mode	~205mA
No Source Mode	0 lights	~190mA		No Source Mode	~225mA

UV mode with power <220mA

1. Disconnect the OIP Control cable from the OIHPT trunkline. Wait for 30 seconds before reconnecting the OIP Control cable back to the OIP trunkline.

2. Verify the OIP Interface by connecting the OIP Test Load or by bypassing the trunkline (Section 7.1) and connecting a different OIHPT probe and OIHPT Power Supply directly to the OP6100. If the optical power measurements respond correctly the problem is likely in the trunkline or probe connections.

3. Connect the OIP Test Load to the probe side of the OIHPT Trunk line. If the optical power measurements and test lights respond correctly, the problem is likely in the OIHPT Power Supply

or OIHPT Probe. Alternatively, the OIHPT Trunkline can be bypassed (Section 7.1) with the OIHPT Probe and OIHPT Power Supply in question. If the optical power measurements respond correctly, the problem is likely in the trunkline.

4. Connect the OIP Test Load to the probe side of the OIHPT Power Supply. If the optical power measurements respond correctly, the problem is likely in the OIHPT Probe wires or OIHPT Probe components. Check for any damage to the OIHPT Probe wires. Alternatively, with the Trunkline bypassed (Section 7.1) with the OIHPT Power Supply and OIHPT Probe in question, switch out the OIHPT Power Supply. If the optical power measurement recovers, the OIHPT Power Supply in question may be damaged.

5. If the Power levels do not recover, switch out the OIHPT Probe. If the optical power measurement recovers, the OIHPT Probe in question may be damaged.

C. Black box and Visible Target QA Tests

If the black box shows fluorescence or the visible target image is not in focus the optical cavity will need to be cleaned.

1. Clean the inside of the OIP Window (Section 6.3)

2. Rerun the optical tests (Section 5.4.B).

3. If the probe tests continue to fail, clean the Optical lens inside the optical cavity (Section 6.2).

4. Rerun the optical tests (Section 5.4.B).

D. Diesel and Motor Oil Fluorescence

1. Verify the optical power measurement is greater than 235 mA, see table 7.1 for typical optical power readings.

2. Verify the black box and visible target tests pass.

3. Refill the two cuvettes of diesel and motor oil (SAE 30) with fresh fuel.

7.4 HPT System Trouble Shooting

Please see the HPT SOP for troubleshooting guidance for the HPT system (Geoprobe 2015).

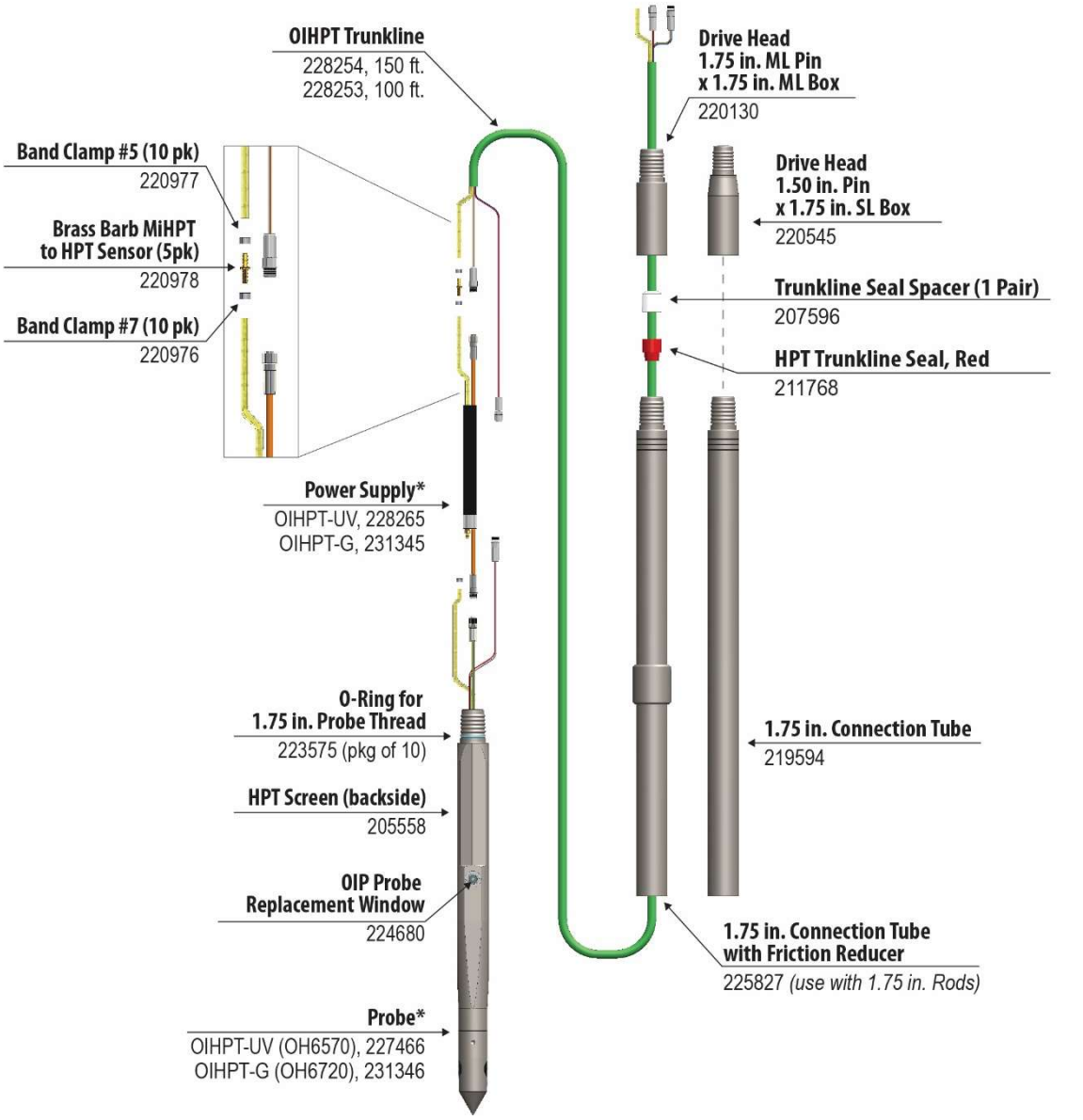
References

Geoprobe 2015. Geoprobe® Hydraulic Profiling Tool (HPT) System, Standard Operating Procedure. Technical Bulletin No. MK3137. January.

McCall, Wesley, Thomas M. Christy, Daniel A. Pipp, Ben Jaster, Jeff White, James Goodrich, John Fontana and Sheryl Doxtader. 2018. Evaluation and application of the optical image profiler (OIP) a direct push probe for photo-logging UV-induced fluorescence of petroleum hydrocarbons. Environmental Earth Sciences, Vol. 77:374. https://doi.org/10.1007/s12665-018-7442-2

APPENDIX 1

OIP Tool Configuration



*Switching from UV to G is a swap of only the probe and power supply.

**Running OIP Only

To run OIP only you need to plug off the HPT port on the probe and use the tools above or can substitute with the following:

- OIP only Power Supply UV-230392 or G-224692
- OIP only trunkline 100ft (224730), 150ft (226362), or 200ft (224731).
- A yellow water seal (207773) would be used with this trunkline.

APPENDIX 2

OIHPT-G Laser Output Parameters

Avoid exposure to the beam. Do not stare into the beam or view directly with optical instruments. Only use the associated OIHPT-G Power Supply with the OIHPT-G probe. Use of any other OIP Power supply may damage the OIHPT-G probe.

Laser Product Class: Class 1

Wavelength: 520nm ± 10

Max Optical Energy: 1.92µJ

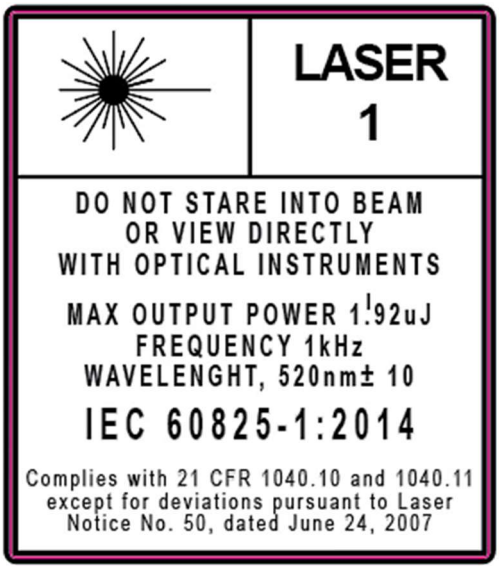
Pulse Frequency: 1 kHz

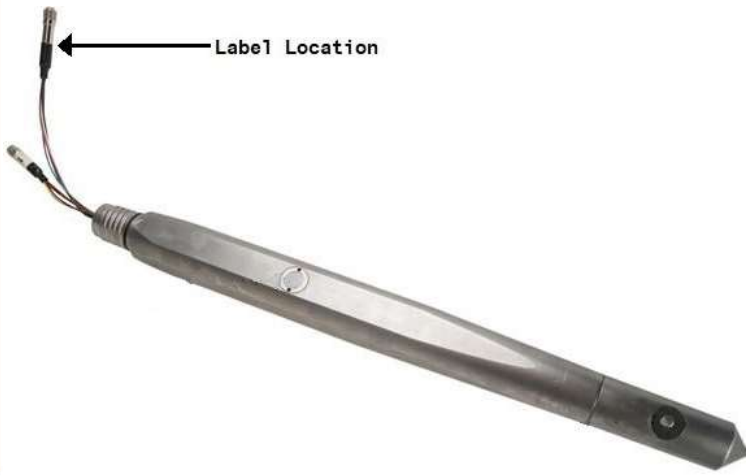
Pulse Duration: 400µS

Max Optical Energy through 7mm Aperture (aperture of the eye): 0.88µJ

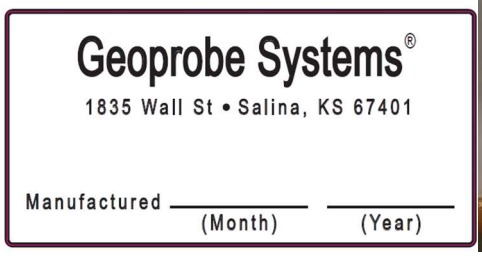
APPENDIX 3

OIP-G Labels and Label locations





Warning and Certification Label and Label Location



Identification Label and Label Location

Note: The Identification label has been placed on the OIP-G product box due limited available space on the probe.

OIP-G Labels and Label locations

Aperture Label and Label Location

A DIVISION OF KEJR, INC.
-Corporate Offices-
1835 Wall Street • Salina, KS 67401
1-800-436-7762 • Fax 785-825-2097
www.geoprobe-DI.com