## Field Measurement of Light Penetration (SECCHI Depth and Transparency)

##### Use in conjunction with:

###### FT 1000 General Field Testing and Measurement

###### FQ 1000 Field Quality Control Requirements

###### FS 1000 General Sampling Procedures

###### FS 2100 Surface Water Sampling

###### FD 1000 Documentation Procedures

##### Light penetration is an indicator of habitat conditions for submersed plants, algae, and other photosynthetic organisms. FT 1710 includes direct measurement of photosynthetically active radiation (PAR) at depth, which can be used to calculate the light attenuation coefficient (light extinction coefficient), Kd. FT 1720 outlines the measurement of Secchi depth, an estimate of light availability using a Secchi disk.

### PAR/Transparency

##### Definitions

##### PAR: Photosynthetically active radiation, the range of solar radiation that plants use for photosynthesis, within the visible light range of 400-700 nanometers (nm). PAR is reported in units micromole or microEinsteins of photons per meter squared per second (µmol/m2/sec or µE/ m2/sec).

##### Kd: The light attenuation (extinction) coefficient, the amount of light lost with depth in the water column. Kd is calculated based on two or more PAR measurements at known depths in a vertical water column profile, and reported as unit per meter (/m).

##### Sensor: Individual quantum measurement device designed to measure PAR at 400-700 nm either in air or underwater with 2π (flat) or 4π (spherical) design.

##### Detector: A complete data logging instrument that collects, stores, and/or transmits information about its surroundings as directed by the user. May consist of interchangeable or fixed probes/sensors.

##### Equipment and Supplies

##### Underwater quantum sensor(s) capable of measuring PAR underwater.

##### To only measure light coming from a direct source overheard, use a 2π quantum sensor with a filter to only measure light between 400-700nm.

##### To measure all reflected and overhead light, use a 4π quantum sensor with a filter to only measure light between 400-700nm.

##### Air/deck quantum sensor capable of measuring PAR in air on a deck, pier or vessel recorded concurrently with each underwater depth reading (µM). Air/deck sensor measurements are used to correct underwater measurements relative to changes in ambient light from one underwater measurement to the next. It is required when the operator is taking multiple consecutive underwater readings.

##### Detector capable of displaying or logging PAR data from multiple sensors simultaneously.

##### Underwater Frame: simple or multibranched fabricated device that holds one or more underwater sensors at known distances from one another and with depth markings relevant to measurement depths of the project. See Figure FT 1700-1 for an example set-up.

##### If using 4π sensors, all parts of the frame must be black in color to reduce light reflection.

##### If using multiple sensors, the sensors must be offset from each other to prevent shadowing.

##### Use of a weight on the bottom of the frame and removable buoy at the desired water surface can help stabilize the frame at the desired sampling depth.

Preventative Maintenance: Refer to FT 1000, section 3.

##### Follow assembly instructions outlined in instrument user manual.

##### Calibration and Verification

##### All sensors must be factory calibrated.

##### Recommended factory calibration to occur at a frequency of every two years or more frequently depending on manufacturer requirements.

##### A log tracking the calibration history and status of the sensors must be maintained.

##### Prior to sampling, samplers must verify the sensor operation by connecting the underwater sensor(s) and the optional deck sensor to the corresponding ports of the detector and power on. Check battery level and the condition of the battery before taking measurements and replace it, if necessary. Cover the sensor to see if the output is zero. Then place the sensor under a light source to verify that it has a positive reading.

##### A negative reading indicates that the polarity of the sensor is reversed, and the cables should switch ports.

##### A very positive or negative reading under darkness indicates a possible short in the cable. When this occurs, be sure to replace the cable and recheck the sensor operation.

##### Measuring PAR

##### General Considerations for Sampling with Single or Multiple Sensors

##### A single or multi sensor device may be used for the measurement of PAR.

##### Measure underwater PAR only when the solar angle is ≥30 degrees above the horizon, generally from 9 AM to 3 PM. The time window when solar angle is ≥30 degrees changes throughout the year, based on latitude and day length.

PAR must be measured from the sunny side of a deck, pier or vessel. Sensor(s) must be placed away from the shadow of both the vessel and the analyst.

Lower underwater frame without putting the weight of the frame assembly on the cable connecting the sensor(s) to the detector.

##### Exercise care to avoid resuspending bottom sediments with the sampling frame. Should sediment resuspension occur, sufficient time should be allowed for conditions to return to normal before collecting water column measurements.

When using a 4π quantum sensor, highly reflective bottom substrates (e.g., white sand) will result in higher PAR measurements compared to darker substrates.

Select PAR measurement depths to ensure representation of the photic zone and address project objectives. If calculating the percent light that reaches a particular depth, a subsurface measurement typically within the top 0.3 m of the water column is required for comparison with the light at depth measurement.

It can be challenging to keep the underwater frame at a constant depth during high wind or wave conditions. Document field conditions to inform appropriate uses of the data.

##### Single underwater sensor

##### Mount the deck sensor in a location that is level and unobstructed by shadows.

##### Ensure the underwater sensor is positioned properly on the lowering frame.

##### Connect the underwater sensor and deck sensor to the corresponding ports of the detector, and power on. Ensure the settings on the detector are correct for the intended data collection.

##### Lower the frame until the sensor is below the surface of the water and simultaneously record the deck sensor and the underwater readings.

##### Lower the frame further and take subsequent measurements at depths appropriate to the monitoring project and location.

##### Record underwater and deck sensor readings simultaneously at each measured depth.

##### Measure the depth of each measurement using a calibrated pole, non-stretching rope, or verified depth sensor.

##### Check the proper functioning of the meters by verifying that the deck sensor has a higher PAR value than the underwater sensor, and the underwater sensor output decreases with depth.

##### The deck sensor reading should be consistent throughout the assessment. If the sunlight changes too much during the profile, it may be necessary to repeat the measurement(s).

##### Multiple underwater sensors

##### Ensure the underwater sensors are positioned as desired for the project objectives on the underwater frame.

##### Connect the underwater sensors to the corresponding ports of the detector, and power on. Ensure the settings on the detector are correct for the intended data collection.

##### Lower the frame until the uppermost sensor is just below the surface of the water and take PAR readings. Document depth of the uppermost sensor below the water surface and the distance between the sensors.

##### Record measurement depth using a calibrated pole, non-stretching rope, or verified depth sensor.

##### Lower the frame further and take subsequent measurements at depths appropriate for the project and monitoring location. If measurements will be taken at different depths at different times, a deck sensor must be used as described in 4.2 above.

* + - * 1. Use of PAR data

If calculating the percent light that reaches a particular depth, a subsurface measurement typically within the top 0.3 m of the water column is required for comparison with the light at depth measurement. Check project-specific requirements.

##### Various approaches can be taken to calculate Kd from PAR measurements. Kd is most commonly calculated as a semi-log regression of the PAR values along the depth profile. At least two measurements are required for the calculation of Kd, and a minimum of three is recommended. The light extinction rate can change with depth, so the PAR measurement depths should be determined in a manner that will yield results representative of the photic zone. Site factors such as turbidity, color, and productivity should be considered when selecting appropriate calculations.

##### Documentation

##### Field Instrument Calibration Documentation: Document acceptable factory calibration for each instrument unit and field test or analysis, linking this record with affected sample measurements.

##### Retain vendor certifications of all factory-calibrated instrumentation.

##### Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument unit used.

##### Record manufacturer name, model number and identifying number such as a serial number for each instrument unit.

##### Retain manufacturers’ instrument specifications.

##### Document any corrective actions taken to correct instrument performance according to records requirements of FD 3000, including date and time of corrective action.

##### Note any incidence of discontinuation of use of the instrument due to factory calibration failure.

##### Record all project and monitoring location information, to include the following:

###### Project name

###### Monitoring location identification and description

###### Latitude and longitude of monitoring location

###### Estimated percent cloud cover

###### Total Depth

##### Record all field-testing measurement data, to include the following:

###### Date and time of measurement or test (including time zone)

###### Initials or name of analyst performing the measurement

###### Unique identification and type of the specific sensor(s) used for the test(s)

* + Indication that the sampler checked that the sensors were operating correctly
	+ Analyte or parameter measured

###### Depth of each measurement

###### PAR measurement result for each underwater depth. Indicate if the result is a single measurement or an average of more than one measurement. If an average, document the number of measurements and the time between measurements.

* + Deck PAR measurement result corresponding to each underwater result (if required). Indicate if the result is a single measurement or an average of more than one measurement. If an average, document the number of measurements and the time between measurements.

###### Reporting units

* + If PAR data are used in any calculations, all inputs to the calculations must be documented. Indicate whether time of day or locational adjustments were used to calculate Kd.

### Measurement of Secchi Depth

##### Introduction: This SOP applies when the Secchi depth is the only parameter being measured; i.e., the other light penetration measurements are not included in the scope of the project. In such occasions, the only equipment from this SOP that is needed in the field is the Secchi disk.

##### Procedure

* 1. Remove sunglasses. If using a boat, conduct the measurements over the shaded side of the boat or with the sun to the observers back.
	2. Clip the calibrated chain or rope to the Secchi disk. Make sure the chain is attached so that depth is determined from the upper surface of the disk.
	3. Slowly lower the Secchi disk in the water, visually observe the disk sectors, and record the depth at which the disk disappears.
		1. If the Secchi disk is visible on the bottom (VOB) of the waterbody, record the total depth at the station where the measurement was taken, and use the “S” data qualifier code (see 62-160.700, F.A.C., Table 1).
	4. Lower the disk beyond the point recorded in section 2.3 above. Slowly raise the disk and record the depth at which it reappears. The Secchi depth is the average of the two readings.
	5. Note any conditions that might affect the accuracy of the measurement in the field sheet. If the disappearance depth is < 1.0 m, determine the depth to the nearest 0.05 m by marking the chain at the nearest depth marker and measuring the remaining length with a tape measure.
1. Documentation: See FT 1000, section 4 for additional details

##### Record all field-testing measurement data, to include the following:

###### Project name

###### Date and time of measurement or test (including time zone, if applicable)

###### Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)

* + Latitude and longitude of sampling source location (if required)

###### Analyte or parameter measured

###### Measurement or test sample value

###### Reporting units

“S” qualifier if Secchi disk was VOB

###### Initials or name of analyst performing the measurement



Figure FT 1700-1 Example of an underwater frame with offset sensor placement.