AQUATIC ECO-SYSTEMS

POINT FOUR TRACKER
PORTABLE TGP METER

USER'S MANUAL

IMPORTANT SAFETY INSTRUCTIONS
READ AND FOLLOW ALL INSTRUCTIONS
SAVE THESE INSTRUCTIONS

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P/N 450026 Rev. A 11/15/2017

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1.0 OVERVIEW

1.1 COMPONENTS

The PT4 Tracker is a portable Total Gas Pressure (TGP) meter, consisting of a hand-held meter and a TGP probe which measures total dissolved gas pressure (TDGP often abbreviated as TGP) and temperature. Display parameters of the Tracker are: ΔP (TGP-BP), % saturation, barometric pressure (BP) in mmHg, and temperature in degrees Celsius.

Included components:

- Handheld Tracker Meter
- Total Gas Pressure Probe and Cable
- Charger Cable with AC Adapter
- Plastic Waterproof Pouch
- Manual
- Data Transfer Cable with USB Adapter
- TGP Pressure Test Syringe Kit

Optional components:

- 1SSA006 - Charger Cable with Car Adapter
- 1SSA003 - Replacement TGP Cartridge
- 1SSA009 - TGP Membrane Rewind Kit
- 1SSA015 - Extended Deployment Package

Handheld Meter

TGP Probe and Cable
(5 m / 16.4 ft) optional cable
length up to 300 m/ 984 ft

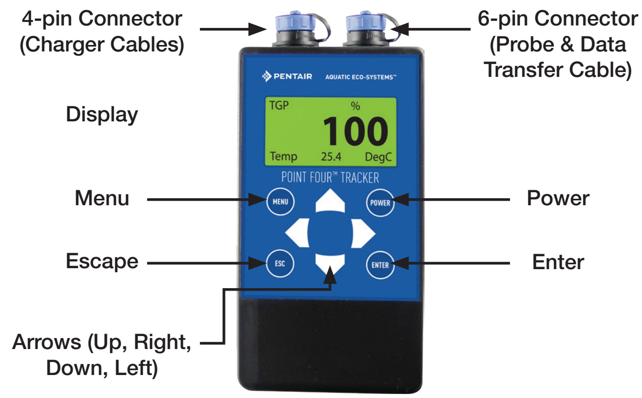
Data Transfer Cable
USB Adapter

AC Charger with
Interchangeable World
Plug Attachments

1.2 KEYPAD

The display area can include up to 6 lines of text. It will also display the larger primary reading when selected to do so.

Each round key (MENU, PWR, ESC and ENTER) will control a number of actions. The arrows (Up, Right, Down and Left) allow for cursor movement within the display area, for increasing and decreasing selected values, or for switching between the "Main Screen" & the "Secondary Screen".



	ABBREVIATION	CALCULATION	UNITS
Measured			
Total Dissolved Gas Pressure	TGP	–	mmHg
Temperature	TEMP	–	deg C
Barometric Pressure	BP	–	mmHg

Derived			
Delta P (dP)	dP or ΔP	TGP - BP	mmHg
TGP in % Saturation	% Sat	TGP/BP x 100	%

1.3 TURNING THE METER ON AND OFF

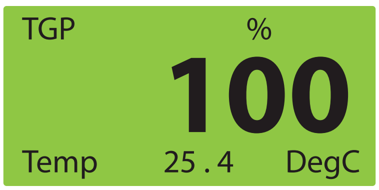
- Attach the probe to the handheld meter before turning meter on. (Right Side Connector)
- Press "**PWR**" to turn the meter on. This will automatically detect the presence or absence of the probe. If the meter is not detecting the probe, turn the meter off (by pressing & holding the **PWR** button), attach the probe again, and turn the meter on.

1.0 OVERVIEW

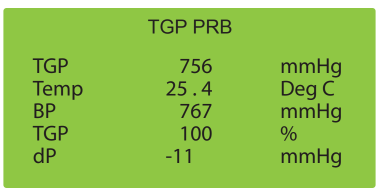
- The main display screen will appear (see Figure 1 as example). The information displayed includes a (user selectable) primary parameter (larger number) and a secondary parameter (smaller number) as selected by the user.

- To view all channels on the same screen (alternative display), press the "**RIGHT ARROW**". The readings for probe measurements are displayed under the title "TGP PRB". To return to the primary display, press the "**LEFT ARROW**".

Figure 1:



Main Screen



Secondary Screen

Main Menu

Press "**MENU**" and use the arrows to select "CALIBRATION", "SET DISP CHs", "SET EXT CHs", or "OPTIONS", and then press "**ENTER**".

*At any time, you can press the "**ESC**" button to return to the previous screen (and press "**ESC**" again to view the Main Screen.)

1.4 CALIBRATION

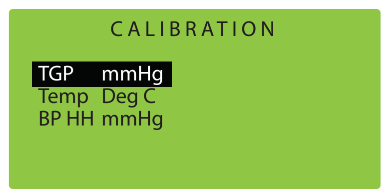
All TGP measurement systems come precalibrated from the factory. Calibration is generally not necessary and should only be undertaken if sensor readings appear to be incorrect. There are three sensors: two pressure sensors [TGP (mmHg), BP (mmHg)] and one Temperature sensor (degC).

To check the calibration of the pressure sensors (BP), obtain a reading of the barometric pressure from the local weather office (convert to mmHg using Table 3) and compare it to the sensor reading. Note that weather office readings are usually referenced to sea level, therefore altitude compensation may be necessary.

When checking or calibrating the TGP reading, leave the TGP probe in air for a minimum of 10 minutes to allow the pressure to equilibrate with atmospheric pressure. Once the probe is dry, continue with the following procedures.

- Press “MENU” and use the arrows to select “CALIBRATION”. Press “ENTER”.

Main Display Parameter



Secondary Display Parameter

- 3 choices will appear on screen: “TGP mmHg”, “Temp DegC”, and “BP HH mmHg”. Use the arrow keys and “ENTER” to select the appropriate measurement calibration.

- Use the arrow keys to highlight “1 Point Cal” and press “ENTER” to begin.

- Use the arrow keys to manipulate the sensor reading and press “ENTER” to accept the reading (after each calibration) and complete the calibration. The mV sensor reading is for diagnostic purposes only.

1.0 OVERVIEW

Calibration Sequence:

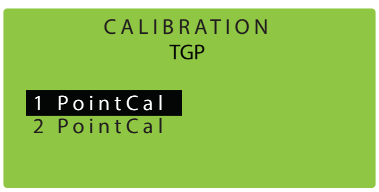
1. Calibrate the Barometric Pressure (BP) using the value in mmHg obtained from the local weather office (modified according to altitude). Press “ENTER”.

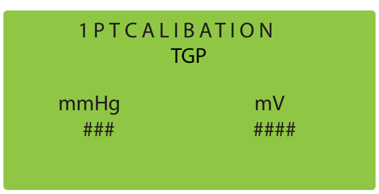
2. Calibrate the TGP using the same value as used for the BP. Press “ENTER”.

3. Calibrate the Temperature if needed. Press “ENTER”.

TEMP 2PT. IN WATER BATH

Due to inherent limitations common to all TGP probes, the probe must be periodically removed from in-situ measurement and dried completely prior to calibrating. In most cases this should be done once every 3 weeks. If the probe is used in water with temperatures above 20 degrees C, this should be done more frequently than every 3 weeks.

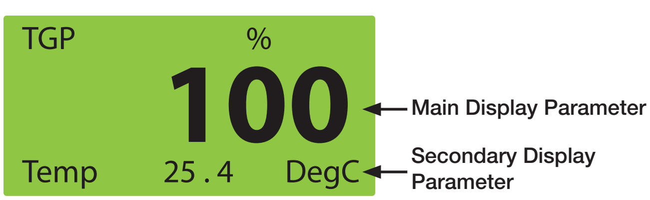




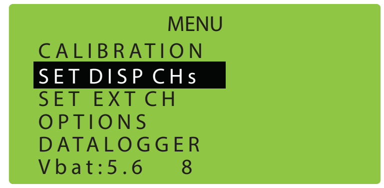
NOTE: A “2 Point Calibration” is generally unnecessary and should not be undertaken without first consulting Pentair Aquatic Eco-Systems Technical Support.

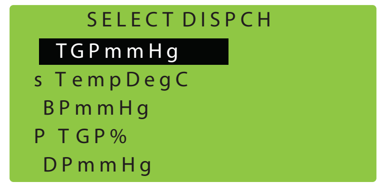
1.5 SET DISPLAY CHANNELS

- This option will allow you to select the main and secondary parameter that will be viewed on the main display screen.



- Press “MENU” and use the arrows to select “SET DISP CHs”, and then press “ENTER”.



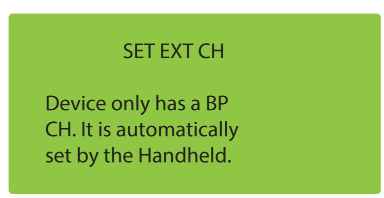


- The 5 channels will appear in a column. On the left of the column, the letters “P” for primary and “s” for secondary show which channels are presently selected.

- To select a new primary and secondary channel, use the up and down arrows to highlight the channel of interest, then press the left arrow to select as secondary or the right arrow to select as primary. Once satisfied with the selections made, press “ENTER” to accept the changes.

1.6 SET EXTERNAL CHANNELS

- This option is not required for the TGP probe used with this meter.

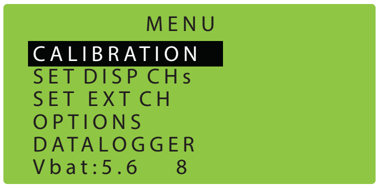


- Press “MENU” and use the arrows to select “SET DISP CHs”, and then press “ENTER”.

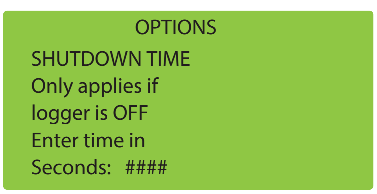
1.0 OVERVIEW

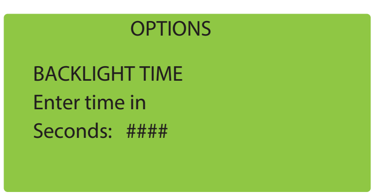
1.7 OPTIONS

- Press “MENU” and use the arrows to select “OPTIONS”, and then press “ENTER”.



- Options include setting a “Shutdown Time” for the meter, as well as setting the time for turning the “Backlight” off.
- The “Shutdown Time” refers to the time in seconds that the meter will remain on after the last button has been pressed. Following this time, the meter will automatically shutdown.
- The “Backlight” option refers to the time in seconds during which the backlight will remain on after any button has been pressed.
- Select the option you wish to change, using the up and down arrows, and then press “ENTER”.





- The TRACKER will prompt you to enter the desired time in seconds. The time can be changed (increments of 30 seconds only) using the up and down arrows.
- To accept the changes, press “ENTER”. This will return you to the “OPTIONS” screen.

NOTE: The “Shutdown Time” option will only be in effect when the meter is NOT logging (see DATALOGGING). This is to allow for continuous logging data (for as long as there is adequate power). The meter will also not shutdown if it is in charging mode (i.e. charger cable is connected.)

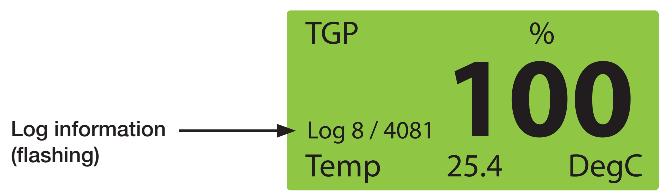
1.8 DATALOGGING

The datalogging option allows the user to store data in the meter and then transfer the data to a computer or laptop. The user can select which parameters will be datalogged and the time between each reading.

1.9 MANUAL DATALOGGING

It is possible to manually record a reading with the Tracker, without the datalogging feature being on. To do so, simply press the “ENTER” button (while on the Main Screen) when a reading should be logged. Each time a reading is logged, the main display screen will show the log number and the total possible logs (according to the settings established by the user).

Example: On this screen, the meter has logged reading number 8 out of a possible total of 4081 logged readings.

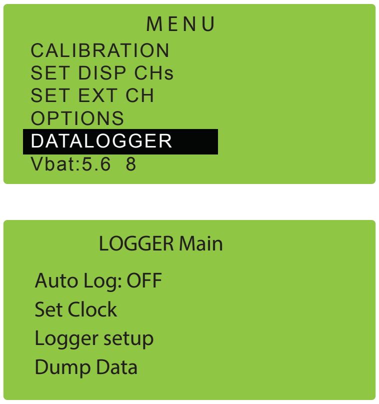


NOTE: the meter will log the information for the parameters selected under “Logger Setup”.

1.0 OVERVIEW

For all other datalogging options, follow these directions:

• Press “MENU” and use the arrows to select “DATALOGGER”. Press “ENTER”.

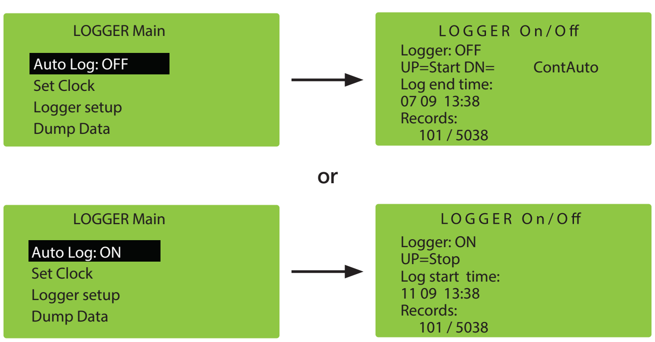


• 4 choices will appear on screen: “Auto Log”, “Set Clock”, “Logger setup”, and “Dump Data”.

1.10 AUTO LOG

Auto log displays the status of the auto log function, i.e. on or off. When off, the meter is no longer recording any readings. When on, the meter is recording readings according to the rate that was selected by the user.

• Use the arrow keys and press “ENTER” to select “Auto Log”.



The “LOGGER On/Off” menu provides the following information:

1. Logger: OFF: the meter is not presently recording any readings

ON: the meter is presently recording readings

2. UP=Start or DN=ContAuto or UP=Stop

According to the present datalogging mode (i.e. on or off), these provide the user with information as to the function for the up and down arrows.

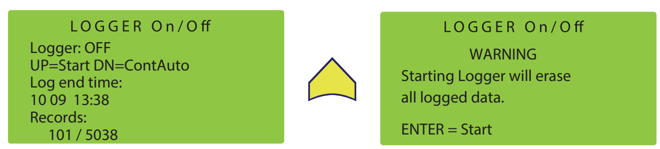
For example:

Pressing the “UP Arrow”: if logger off: starts the datalogging mode from the beginning thereby erasing all previous data if logger on: stops the datalogging mode, but does not erase any recorded readings

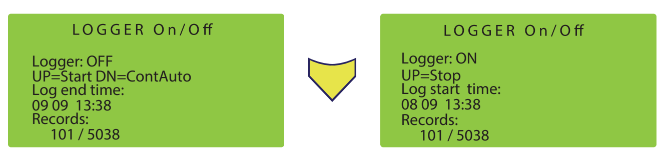
Pressing the “DOWN Arrow”: if logger off: continues datalogging following the last recorded reading (no recorded readings are lost). If logger on: has no effect.

NOTE: To delete recorded readings: The only method for erasing all readings stored in the Tracker is to use the “UP” arrow in the “LOGGER On/Off” menu while the logger is “OFF”.

If the logger was off, and readings had been recorded, pressing the “UP” arrow will result in a **WARNING** screen being displayed: “Starting Logger will erase all logged data”.



To accept (and lose all previously recorded readings), press “ENTER”. To refuse (and keep all previously recorded readings), press “ESC” and press the “DOWN” arrow to continue readings from stop point.



3. Log end time or Log start time:

Log end time (displays when Logger is off):

Displays the day, month and time (hr:min) of the last recorded reading.

Note that this is synchronized according to the settings in “Set Clock” (see next page: SET CLOCK).

Log start time (displays when Logger is on):

1.0 OVERVIEW

Displays the day, month and time (hr:min) of the first recorded reading.

Note that this is synchronized according to the settings in “Set Clock” (see next page: SET CLOCK).

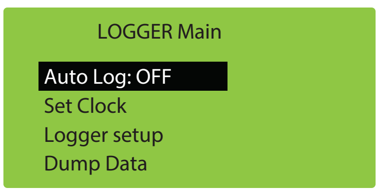
4. Records:

Displays the number of records logged over the maximum number of records that can be logged according to the present settings.

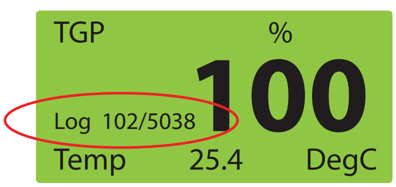
For example: 100 / 5038: 100 records logged with a maximum of 5038 records that can be logged. The

Maximum number of records varies based on the selected parameters to record.

- To return to the “LOGGER Main” menu, press “ESC” once.



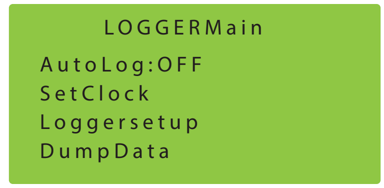
- To return to the “Main Display Screen” directly, press “MENU” once.

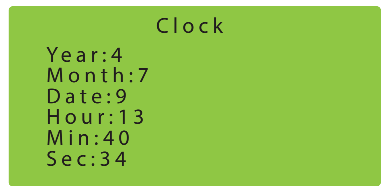


The “Log 102/5038” message fl ashes and counts up each time a reading is recorded using the datalogging function.

1.11 SET CLOCK

This option allows the user to set the meter’s clock according to their time zone (or any other desired time). The selected time is then used by the meter to display when the first and last readings were recorded, as well as the time each record was made.



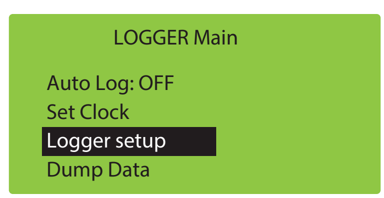


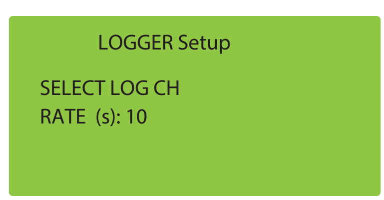
- Use the “UP” and “DOWN” arrows to increase or decrease a value highlighted by the cursor. “LEFT” and “RIGHT” arrows can be used to move the cursor left or right.
- When the value has been corrected, press “ENTER” to accept the value and move the cursor to the next row.
- The last “ENTER” will return you to the “Logger Main menu”.

1.12 LOGGER SETUP

This function allows you to select which parameters will be recorded and at which interval (number of seconds between each recorded reading).

- Use the “UP” and “DOWN” arrows to select “Logger setup”. Press “ENTER”.





1.0 OVERVIEW

Two options will appear: SELECT LOG CH: allows you to select the parameters that will be recorded using the datalogging feature.

RATE (s): XX: allows you to select the interval in seconds between each reading.

1. Select log channel:

- Use the “UP” and “DOWN” arrows to select “SELECT LOG CH” and press “ENTER”.

LOGGER On/Off

Logger: OFF
UP=Start DN=ContAuto
Log end time:
09 09 13:38
Records:
101 / 5038

LOGGER Sel Ch

LTGP mmHg
LTemp DegC
LBP mmHg
LTGP %
LdP mmHg

To select a parameter that will be recorded:

- Use the “UP” and “DOWN” arrows to highlight the desired parameter.
- Press the “RIGHT” or “LEFT” arrow to select the parameter. The letter “L” will appear next to the parameter.

To remove a parameter from the list of recorded readings:

- Use the “UP” and “DOWN” arrows to highlight the desired parameter.
- Press the “RIGHT” or “LEFT” arrow to remove the parameter. There should be no letter “L” next to the removed parameter.

To return to “LOGGER Setup”: Press the “ESC” button.

To return to the Main Display Screen: Press the “MENU” button.

2. Set recording rate: Use the “UP” and “DOWN” arrows to select “RATE (s): XX” and press “ENTER”.

LOGGER Main

Auto Log: OFF
Set Clock
Logger setup
Dump Data

LOGGERSetup

SELECT LOGCH
RATE (s):10

Use “UP” and “DOWN” arrows to increase or decrease the value that is highlighted by the cursor, and use the “LEFT”and “RIGHT” arrows to move the cursor to the appropriate position.

The value displayed is in seconds.

LOGSetup Rate

Enter Lograte
(10secminimum)
1 0

The maximum time allowed is 9999 seconds (or 2 hours, 46 minutes and 39 seconds).

- Press “ENTER” to accept the new value. (This will return you to the “LOGGER Setup” menu).
- Press “ESC” to return to the “LOGGER Main” menu.
- Press “ESC” again to return to the “MAIN” menu.

1.13 DUMP DATA

Instructions for using Hyper Terminal to dump data from PT4 Tracker to Windows (32 or 64-bit)

1.0 OVERVIEW

1.14 INSTALLING HYPER TERMINAL

HyperTerminal is only included on Windows machines that are running Windows XP and is no longer available In Vista, 7, or any later version.

If you need HyperTerminal in one of these later versions of Windows you can actually extract two files from your XP installation and copy them over to your Windows installation.

The two files you will need are hypertrm.dll and hypertrm.exe.

You should be able to find hypertrm.exe in C:\Program Files\Windows NT and hypertrm.dll in C:\ Windows\System32.

If you have the Windows XP CD, you should be able to find both of these files in the i386 directory on the CD.

Step 1: On the Windows 7 PC create a new folder under C:\Program Files\HyperTerminal for 32-bit. For 64-bit PC, create a new folder C:\ Program Files (x86)\HyperTerminal

Step 2: Copy both files to that folder (**hypertrm.exe and hypertrm.dll**)

Step 3: Now you can run the program by clicking on "hypertrm.exe".

Step 4: If you want to have HyperTerminal on your Start Menu just create a shortcut to hypertrm.exe and put it in C:\ProgramData\Microsoft\Windows\Start Menu\Programs and when you go to All Programs under the Start

Menu Hyper Terminal will be there (you might have to rename the shortcut).

If you do not have access to the original HyperTerminal or an XP installation you can still use alternative programs.

The most common alternative is HyperTerminal Private Edition which is a commercial emulation program that can be found online with a free trial. This successor to the original HyperTerminal functions the same way and can use the same instructions as outlined for HyperTerminal.

A free alternative to the Original HyperTerminal is Putty, which can also be found online, this program has a different look and feel to HyperTerminal and may require different set of steps in order to achieve the same results. Use the steps listed in this manual as an overall guideline to what is required to connect to the Tracker, but refer to the Putty manual specifically to achieve the desired result.

1.15 INSTALLING DRIVER

Step 1: Plug the USB to Serial Converter into you PC.

Step 2: Windows will automatically search for the appropriate drivers.

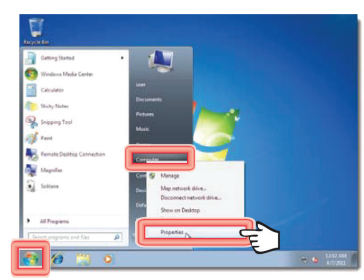
Note that you may need to be connected to the internet for this process to complete.

1.16 CONFIGURING COM PORT SETTING

Step 1: Connect USB data cable to your PC. **Do not connect it to the Tracker yet**

Step 2: Press the [START] button.

Step 3: Right click [Computer] and select [Properties].



Step 2 & 3

Step 4: From the Properties window select

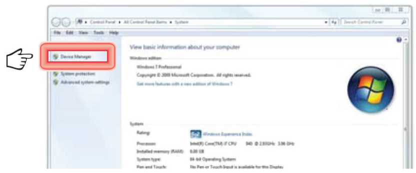
[Device Manager].

In the Device Manager locate

[Port (COM & LPT)].

1.0 OVERVIEW

Click the arrow on the left to expand the list to see all of the items connected to the PC.



Step 4

Step 5: Right click [USB Serial Port (COM_)] and select [Properties].

Step 5

Step 6: Select the [Port Setting] Tab.

Step 7: Configure the Port Setting to Read: [9600]

[8]

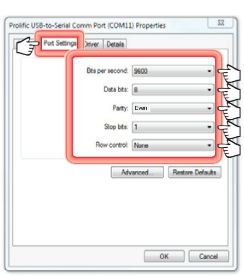
[Even]

[1]

[None]

Remember the Com Port # associated with “Prolific

USB to Serial Comm Port”.



Step 6 & 7

Step 8: Close Program and launch Hyper Terminal.

1.17 SETTING UP THE HYPER TERMINAL

Step 1: For XP Machines

Open the Hyper Terminal Folder:

Click [START]

Select [ALL Programs]

Select [ACCESSORIES]

Select [COMMUNICATIONS]

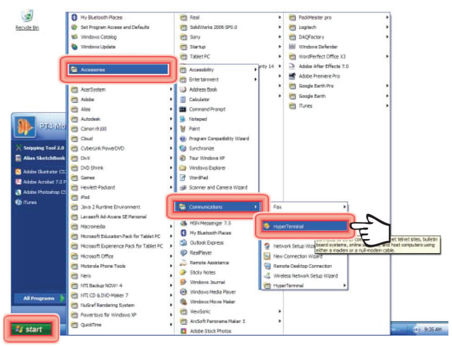
Click [HYPER TERMINAL]

For Windows 7 (if a shortcut was created as per instructions on page 13)

Click [START]

Select [ALL Programs]

Click [HYPER TERMINAL]

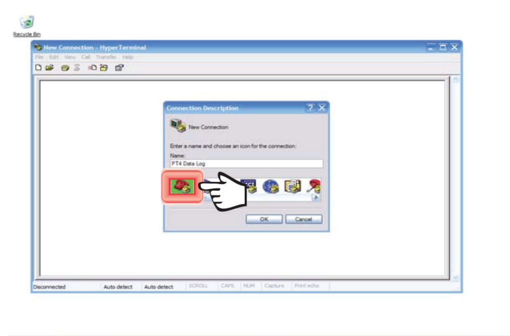


Step 2: When Connection Description box appears: ENTER NAME (e.g.. PT4 Data Log)

SELECT the [TELEPHONE ICON] for the connection.

Your communication settings will reside in this file.

Click [OK].



1.0 OVERVIEW

Step 3: When the Phone Number box appears, select the correct [COM PORT] that is connected to the PT4 Tracker as found in the device manager (previous page).

Click [OK].

This [COM PORT] now represents the RS232 9 pin connected to the PT4 Tracker.

Step 4:

Under [COM "#"] Properties Window

Select the following values:

BITS PER SECOND OPTION to [9600]

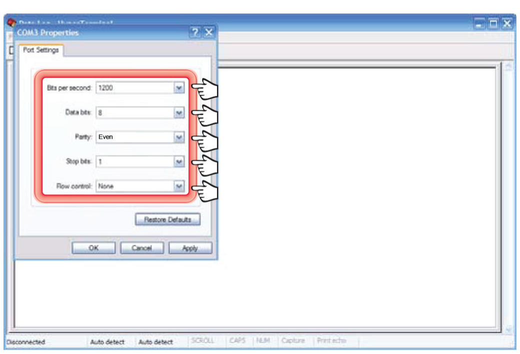
DATA BITS to [8]

PARITY to [EVEN]

STOP BITS to [1]

Select [NONE] for FLOW CONTROL

Click [OK]



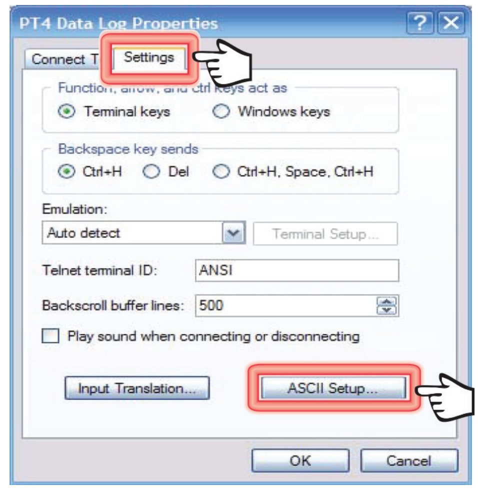
Step 5:

Under the [FILE] MENU.

Select [PROPERTIES].

Click [SETTINGS].

Click the [ASCII SETUP] BUTTON.



Step 6:

Under the [ASCII SETUP] MENU check off:

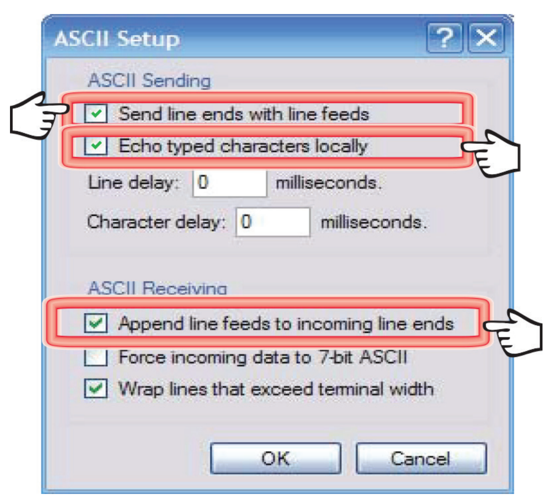
[APPEND LINE FEEDS TO INCOMING LINE ENDS].

[Send line ends with line feeds].

[Echo typed characters locally].

All other settings remain the same (default).

Click [OK].

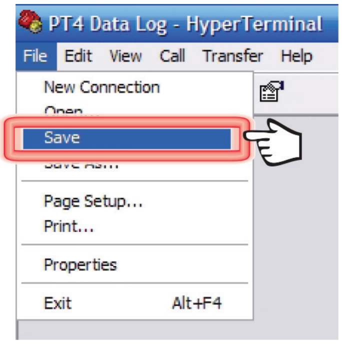


1.0 OVERVIEW

Step 7:

Save this connection by selecting [FILE] from the main pull down menu.

Select [SAVE].



The above settings are retained when the [SAVE] option is executed.

This completes the setup procedure.

When launching Hyperterminal for future use:

For XP:

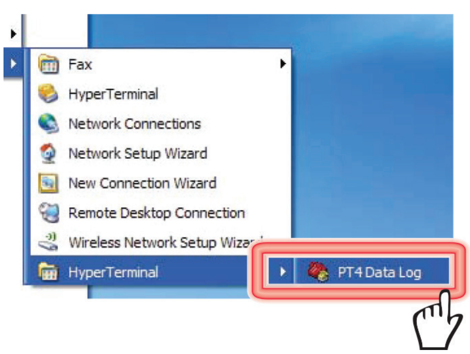
This saved connection configuration fi le will now be present beside the Hyperterminal launch button.

For Windows 7:

Launch Hyperterminal

Select [File] [Open]

Click on the file name created in **Step 2** (the file extension for hyperterminal is ".ht")

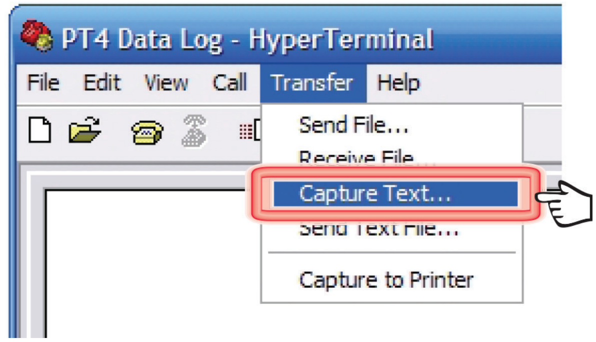


Step 8:

Capturing Data under Hyper Terminal.

Click the [TRANSFERS] MENU.

Select [CAPTURE TEXT FILE].

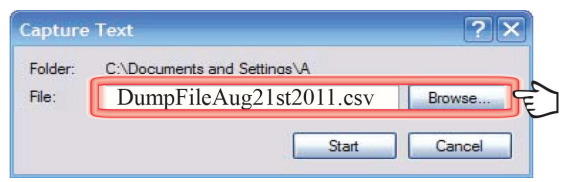


Step 9

Click [BROWSE]

Name the file to be saved with the file extension ".csv"

Click [START].



Step 10:

Turn on PT4 Tracker, by pressing the PWR button wait to initialize.

***The probe should still be attached at this point.**

Step 11:

To enter DATALOGGING Program:

Press and hold MENU.

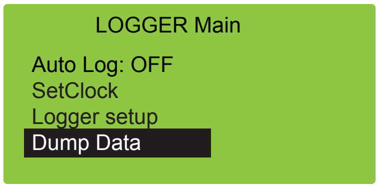
Select DATALOGGER and press ENTER.

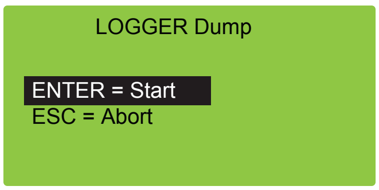
Use the "UP" and "DOWN" arrows to highlight "Dump Data" and press "ENTER".

1.0 OVERVIEW

Remove probe from meter and attach the data transfer cable (USB adaptor or RS485 adaptor) to the right 6-pin connector.

Press the “ENTER” button on the meter.



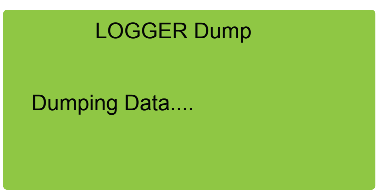


Step 12:

From the DATALOGGER menu select Dump Data and press ENTER.

Press ENTER to start Data Dump Procedure.

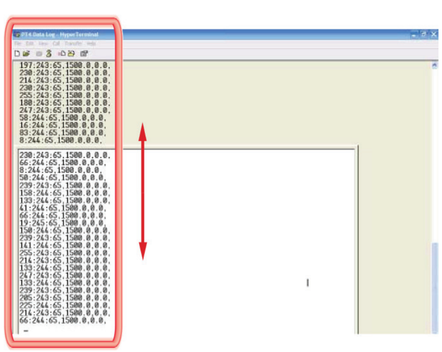
Press ESC to abort Data Dump process.



Step 13:

Your logged data should appear in the Hyper Terminal Window.

When logger is finished, close the Hyper Terminal Window.



Step 14:

To Close the Hyper Terminal Folder:

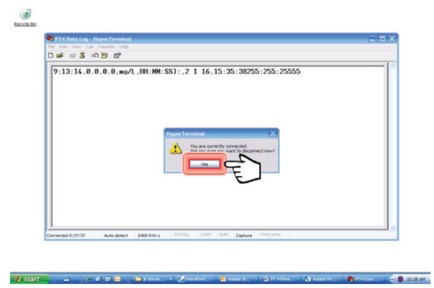
Select [FILE] from the main pull down menu.

Select [SAVE].

Select [Exit] from the [File] menu.

When prompted “Do you want disconnect now?”

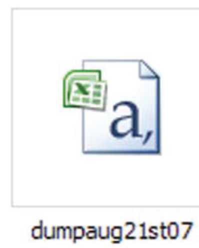
Select “Yes” in the Disconnection Box.



Step 15:

To View Logged Data:

Open the captured text file from the Hyper Terminal as saved in a specific location on your computer (see Step 9).

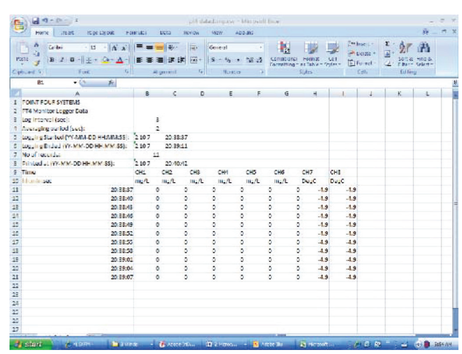


DumpFileAug21st2011.csv

Step 16:

The data will open in a Microsoft EXCEL Spreadsheet.

Adjust the columns width of the spreadsheet to align the data properly.



Note: If your system is not equipped with Microsoft Excel, a trial version can be downloaded at: http://office.microsoft.com/en-us/excel/

2.0 SERVICE & MAINTENANCE

2.1 NORMAL PERIODIC USE

After each measurement session:

- Remove the probe from the water, rinse clean straight away before any form of fouling dries on the membrane tubing.
- Slide off the protective tubing shield.
- Rinse off the membrane tubing with clean fresh water and gently shake the probe dry.
- Allow up to 4 hours for the probe to dry out (*more time might be required in cold damp environments).
- Store dry at room temperature.
- **If time is of the essence, have a spare cartridge available, and swap out the cartridges.**

Probe being rinsed under water.

Unscrewing protective screen from the probe body.

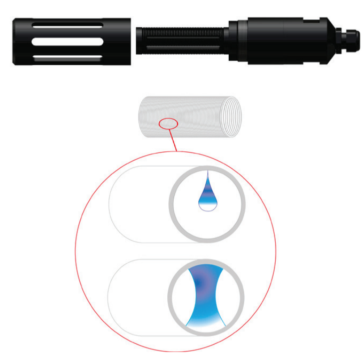
Rinsing membrane cartridge (still connected to probe) under running water.

Allowing probe to dry and store.

2.2 CONTINUOUS USE

In some applications the TGP probe is left continuously submerged in water. Under such circumstances, eventually water condenses as small droplets on the internal walls of the tubing. As these droplets grow in size, they will eventually coalesce resulting in "cross-bridging". The pressure detected by the sensor will produce a difficult-to-define average of the actual TGP. Cross-bridging can lead to excess water accumulation inside the tubing.

Excess water in the tubing can damage the pressure transducer if actual contact is made with the pressure sensitive wafer.



The time taken for such a condition to arise is inversely proportional to water temperature. i.e: the higher the water temperature, the faster the bridging will occur.

In summary, the frequency of probe maintenance is site and condition specific.

AS A GUIDELINE, THE PROBE SHOULD BE REMOVED FROM THE WATER ON A ROUTINE BASIS EVERY THREE WEEKS FOR CLEANING. (based on water temp of 15Deg C)

*Refer to section NORMAL PERIODIC USE for maintenance procedures.

2.0 SERVICE & MAINTENANCE

2.3 A SIMPLE CHECK FOR A DAMAGED OR BROKEN MEMBRANE TUBE

If the membrane tube is compromised in any way, TGP readings will be wrong. A simple way to check the integrity of the tubing is to observe the TGP readings as the probe is steadily immersed in water. A fast increase (several mmHg per second) in displayed values indicates a damaged or broken membrane tube. Replace the cartridge and recalibrate.

The recommended method to check for a faulty membrane cartridge is to use the syringe test as shown on the following page.

- Inspect the tubing for any visible signs of damage. If damaged or broken, replace the cartridge. Otherwise leave the probe in air until there is no sign of water present in the tubing.
- Re-calibrate if necessary.

Note: A need for an unusual degree of calibration correction could mean that the pressure sensor has been damaged by the bulk water.

2.4 CHANGING THE MEMBRANE CARTRIDGE

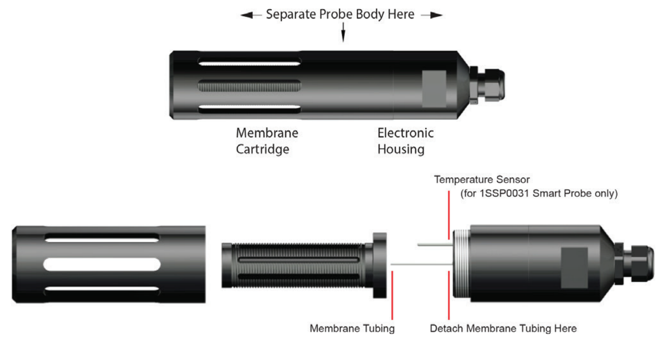
Occasion may arise where the membrane tubing becomes damaged resulting in erroneous readings. This is typically displayed as a sharp increase in TGP when the probe is in water with values that remain high over time.

To fix this issue, the membrane cartridge must be replaced, or returned to Point Four Systems for reconditioning. It is crucial that the probe not remain in water as this can damage the sensor and electronics within.

Use the following steps to change the membrane cartridge:

Step 1:

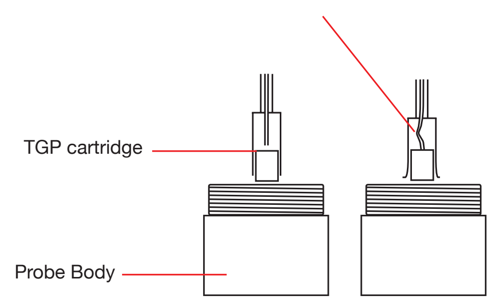
CAREFULLY unscrew the membrane cartridge from the probe body. Be careful not to damage or stress the fine membrane tube, which connects to the pressure sensor in the electronics housing.



Step 2:

Pinch the head of the membrane tube; carefully separate the membrane tubing from the sensor port and set the now completely detached membrane assembly aside.

NOTE: ENSURE THAT INNER SILASTIC TUBE HAS NOT COLLAPSED! SEE IMAGE BELOW.



2.0 SERVICE & MAINTENANCE

Step 3:

Take the new membrane cartridge, and reassemble the TGP probe in the reverse order of disassembly.

NOTE: IF POSSIBLE, APPLY SILICONE GREASE ON THE MEMBRANE CARTRIDGE THREADS TO AVOID THE PLASTIC BODY FROM SEIZING IN FUTURE DISASSEMBLY.

WHEN ASSEMBLED, CHECK DOWN THE INSIDE OF THE MEMBRANE CARTRIDGE TO ENSURE THAT THE TUBING IS NOT KINKED.

2.5 THE TGP SYRINGE TEST

The TGP Syringe Test is a simple and effective test to determine:

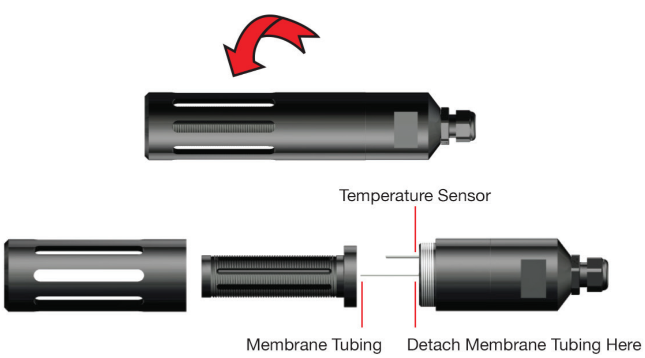
If the Silastic tubing within the TGP cartridge is damaged and needs to be replaced.

It can also be used to routinely check the functionality of the TGP probe.

2.6 TESTING THE CARTRIDGE

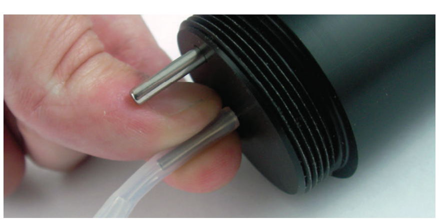
Step 1:

Unscrew the cartridge from the TGP probe.



Step 2:

Disconnect the Silastic tubing from the probe sensor by pinching the end of the tubing and gently sliding it off.

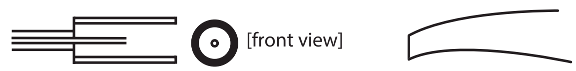


Step 3:

Draw the plunger of the syringe half way back and then attach the cartridge tubing to the end of the syringe. Note: Do not slide the tubing more then cartridge opening.

Step 4:

Attach the cartridge tubing to the end of the syringe.



Note: Do not slide the tubing more then cartridge opening.

5. Place the cartridge in a container of water and GENTLY apply pressure to the plunger.

If resistance is felt in the syringe when pressed and no bubbles appear from the cartridge when placed underwater, there are no holes in the Silastic tubing.

This indicates that the unit is good.

If bubbles appear from the cartridge when placed underwater, there are holes in the Silastic tubing.

This indicates that the unit needs to be replaced.

Contact supplier for a replacement TGP Cartridge.

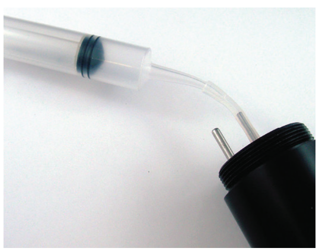
2.0 SERVICE & MAINTENANCE

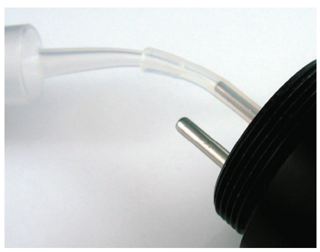
NOTE: IF POSSIBLE, APPLY SILICONE GREASE ON THE MEMBRANE CARTRIDGE THREADS TO AVOID THE PLASTIC BODY FROM SEIZING IN FUTURE DISASSEMBLY.

WHEN ASSEMBLED, CHECK DOWN THE INSIDE OF THE MEMBRANE CARTRIDGE TO ENSURE THAT THE TUBING IS NOT KINKED.

2.7 TESTING THE TGP PROBE

1. Remove TGP Cartridge from the TGP probe. Make sure TGP Probe is still connected to the monitoring device.
2. Draw the plunger of the syringe half way back.
3. Attach syringe to sensor port in the TGP probe using the silicon tube that was supplied with the syringe.





4. Apply pressure (push the plunger) or vacuum (pull the plunger) with the syringe, and check the displayed values. The reading should respond accordingly. (I.E. When Applying pressure, the TGP readings will increase and when applying a vacuum, the TGP readings will decrease).

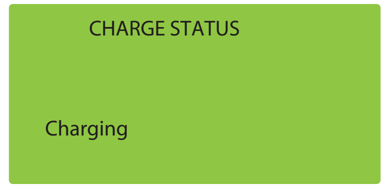
When test has been concluded, remove syringe, re-install cartridge, and recommission probe.

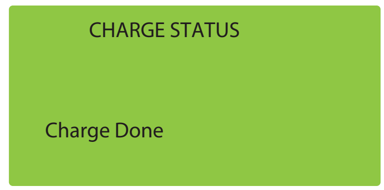
2.8 BATTERIES

The PT4 Tracker is powered by a rechargeable Ni-MH battery, that supplies unit power for up to 70 hours per charge.

To recharge the battery, attach the charger cable (LEFT SIDE 4-PIN CONNECTOR) to the meter, and insure that the correct wall plug connector is placed on the charger (refer to section “Components”). The meter will remain on while it is charging (fl ashing the message “No Probes Detected”).

To confirm that charging is complete, attach the probe (right 6-pin connector). With the charger plugged in, press the “RIGHT ARROW” button twice. The following screen will be displayed:

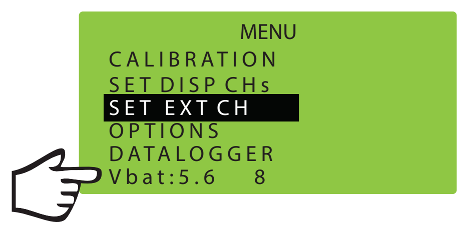


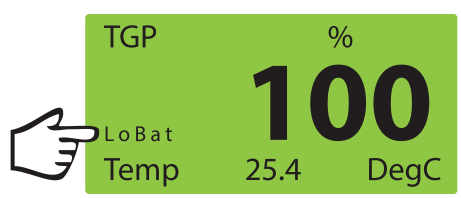


The screen will display the message “Charging” until the battery is fully charged, at which point the message will change to “Charge Done”. Total charge time is approximately 2 hours (for a full charge).

To avoid discharging the battery, it is advisable to keep the Tracker connected to the charger when it is not in use, as Ni-MH batteries have a fairly high discharge rate while in storage and will be fully discharged in about 3 months if the Tracker is not used.

The Tracker can be connected to the AC charger at any time regardless of the amount of battery life remaining, this will not compromise the performance of the battery, as the Ni-MH battery within the Tracker does not suffer from the memory effect.





2.0 SERVICE & MAINTENANCE

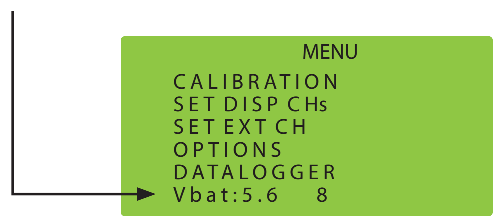
*Note:

- Although the meter has been charged prior to shipping, it is recommended that you fully charge your meter prior to its first use.
- Battery life of the Tracker is reduced depending on the use of the backlight as well as when it is used in extremely high or low temperatures (-5°C / +30°C).
- Store the Tracker in a cool, dry and well ventilated place out of direct sunlight. The ambient temperature should be kept below 30°C for long-term storage.
- Prevent charging or using batteries in extremely high or low temperatures (-5°C / +30°C).
- The Data Logging capacity of the Tracker significantly exceeds the battery life of the installed battery (normally 70 hour battery life). For logging periods over 100 hours connect the Tracker to the supplied power supply or a supplementary battery pack.
- A low battery will be indicated either by the Vbat reading 4.0V or less (in the MENU display), or by the main display showing the message “LoBat”.

3.0 TROUBLESHOOTING

3.1 NORMAL PERIODIC USE

1. Display remains blank after pressing PWR.
    a. Verify that the batteries are charged by plugging in the Charger Adapter.
    b. Hold the PWR down for a longer period of time.
2. “ERROR NO PROBES DETECTED” appears on the screen after pressing PWR.
    a. Press PWR again to turn meter off.
    b. Detach probe.
    c. Verify that all four prongs on the connector are intact and that no dirt is present.
        i. If the prongs are damaged, contact Pentair Technical Support.
        ii. If dirt is present, clean with distilled water and allow to dry prior to reattaching the probe.
    d. Firmly reattach probe to the meter.
    e. Press PWR to turn meter on.
    f. If message persists, contact Pentair Technical Support.
3. Readings appear to be erroneous.
    a. Insure that the probe is clean and not caked with dirt or biofouling.
    b. Verify that the battery has sufficient power (“Vbat“ should be at least 4.00).



    c. If readings persist, compare them with expected values.
        i. For temperature, verify value by placing probe in an ice water bath.
        ii. For TGP and BP, compare value with weather office readings.
    d. If a large, unexplained difference exists, the meter may no longer be calibrated.
    e. If the meter has been left in water (or exposed to regular rain), the humidity may have penetrated the tubing (this is inherent to all existing TGP probes). Remove the probe from the water and place in a dry area for 24 hours. Then follow the calibration instructions.
    f. If readings persist, contact Pentair Technical Support.

4.0 SPECIFICATIONS

General: Provides digital output of TGP probe measurements.

MEASURED	MEASUREMENT RANGE	RESOLUTION
Total Gas Pressure [TGP]	0–1550 mmHg	1 mmHg
Barometric Pressure [BP]	0–1550 mmHg	1 mmHg
Temperature [°C]	0.0–40 °C	0.2 °C

DERIVED		
Total Gas Pressure [TGP]	0 - 200%	1%
ΔP [TGP - BP]	1550 - 1550 mmHg	1 mmHg

PROBE DIMENSIONS	LENGTH	WIDTH	HEIGHT	DIAMETER
Probe	19 cm (7.4 in)	—	—	4.2 cm (1.6 in)
Handheld	16 cm (5.1 in)	8.5 cm (3.3 in)	3.2 cm (1.3 in)	—

STORAGE	
Temperature	-10 °C to +60 °C, in factory container
Relative Humidity	5% to 85% RH at up to +40 °C 5% to 40% RH above +40 °C up to +60 °C
Altitude	Up to 3,000 meters (10,000 feet)

OPERATION	
Temperature	0 °C to 50 °C
Relative Humidity	5% to 85% RH at up to +40 °C 5% to 40% RH above +40 °C up to +60 °C
Altitude	Up to 3,000 meters (10,000 feet)

PROPERTIES	
Response Time	Typical: 5 minutes (90%) Response time is improved by insuring there is water flow past the probe. However, this is a passive measurement and therefore can require up to 1 hour for accurate measurements.
Power	4xAA NiMH rechargeable batteries/ 20 mA (backlight off), 30 mA (backlight on). Includes battery charger and adapter.
Battery Life (backlight off) (backlight on)	NiMH cells: 70 hours 45 hours
Connector (Left Side Connector) (Right Side Connector)	6 pin –IP68 rated connector (for probe and data transfer cable) 4 pin –IP68 rated connector (for charger cable)
Probe Cable	Std. 5 m (16.4 ft) four conductor, polyurethane jacketed, with custom lengths available on request.
Charger Cable	Std. 1.5 m (5 ft)
A/C Charger Adapter	100-240 VAC / 47-63Hz / 12 VDC, 0.85 Amp

6.0 APPENDIX

6.1 ABOUT TGP

A Brief Discussion of Gas Bubble Disease, Dissolved Gases and Techniques for Measurement

Brian G. D'Aoust
Common Sensing Inc.
Clark Fork ID, USA

Although Gas Bubble Disease was rather well described by Marsh & Gorham the problem was not well known to fish culturists and was often "rediscovered" as facilities were expanded, built in new locations, or otherwise altered through man made or natural causes. More recently, increases in "accelerated aquaculture" involving pumped water, extra aeration and hyper oxygenation has also led to severe outbreaks in numerous cases. Recognition in the late 1960's that the entire Columbia River in the Northwest USA was supersaturated to levels lethal to downstream migrant salmon focused an unprecedented amount of attention on the recognition, pathology, analysis and avoidance of this condition. In like manner the current interest in supplemental oxygen addition for purposes of restoring water quality and/or increased production of fish per volume of water has prompted development of reliable and consistent techniques for monitoring all relevant parameters.

The chief hazard in all systems for enhancing oxygen concentration is that the total gas pressure, (TGP) may exceed the sum of atmospheric and hydrostatic pressure (due to the depth of the water column) because of a lack of provision for removing enough nitrogen in the water source to make up for the extra oxygen added. In many situations, therefore, it is desirable to monitor both oxygen and TGP (PT) or percent saturation relative to atmospheric pressure.

6.2 UNDERSTANDING THE MEASUREMENT

To provide a basis for understanding the measurement a summary of the relevant physics of gases follows. Figures 1 to 5 present conceptual guides to understanding the relationship between Total Dissolved Gas Pressure (TGP), hydrostatic pressure, gas solubility and gas partial pressure.

6.3 DEFINITIONS

These are definitions used in discussing dissolved gas saturation in Aquaculture and Fisheries. The symbol "β" (Beta) represents the solubility coefficient of a gas at temperature "T". The following example indicates the differences in actual gas content, i.e. the number of molecules (expressed either as a weight or volume) contained in a given weight or volume of water at equilibrium at two different temperatures, 0.0ºC and 20.0ºC.

Total Dissolved Gas Pressure (TGP) = Barometric Pressure + ΔP

$$\Delta P = TGP - BP$$

or

$$[O_2] = pO_2 \times \beta \text{ OXYGEN, TEMP}$$

Where: β OXYGEN, TEMP is the solubility of oxygen at temperature "T"

β OXYGEN, 0ºC = 49.1 ml/L

β OXYGEN, 20ºC = 31.05 ml/L

Where: β OXYGEN, TEMP is the solubility of oxygen at temperature "T"

β OXYGEN, 0ºC = 49.1 ml/L

β OXYGEN, 20ºC = 31.05 ml/L

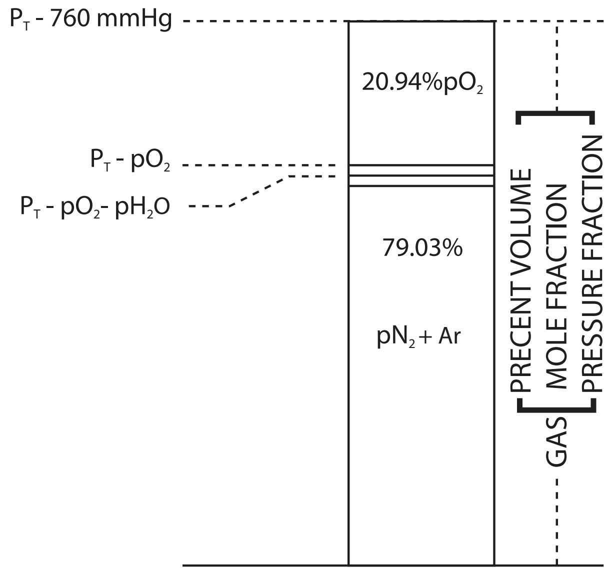
The example serves to illustrate the convenience of using pressure as a measure of saturation state rather than content or concentration, which then requires the use of solubility coefficients.

The habit of using content or concentration to describe the amount of any particular constituent in water, while intuitive, does not lend itself as readily to understanding cases that involve gas supersaturation.

On the other hand, as is shown in Figure 1, the % concentration of each gas in air expressed as either pressure, volume or mole – fraction has direct equivalency to pressure measurement and therefore provides simpler calculations and clearer understanding of what is being measured.

6.0 APPENDIX

Figure 1: % by volume, mole and pressure fraction of constituents of air.



The percent by volume, mole fraction and pressure fraction of the constituents of air shown as a bar graph. On the left of the graph the successive subtraction of oxygen, then oxygen and water vapor from the total pressure, PT shows the relative accuracy that can be realized by simultaneous measurement of total gas pressure and oxygen. Nitrogen and argon are treated as one inert gas, since argon bears a constant ratio to nitrogen and is approximately 0.94% in dry air. The pressure of C02 varies in air but is negligible for our purposes (about 0.031%).

6.4 COMPENSATION DEPTH

A simple way to assess the impact on your fish of a given level of supersaturation is to think in terms of the compensation depth, which is the depth (i.e. hydrostatic pressure) below which bubbles cannot form. This is illustrated in Figure 2. The compensation depth is easily calculated by dividing the ΔP by the pressure-per-depth factor (22.4 mmHg/foot of fresh water or 73.8 mmHg/meter of fresh water).

For example in Figure 2, 120% saturation (at sea level) means a ΔP of 152.0 mmHg. Dividing this number by 22.4 mmHg/ft gives a compensation depth of 6.8ft or approximately 2 meters. If fish are always kept below this limit, they will not be susceptible to Gas Bubble Disease, because bubbles cannot form below this depth.

In converting the %Sat to ΔP – the difference between the TGP or PT and BP (Barometric Pressure), it is convenient to think in terms of 1.0% saturation increments. For example, when at a higher altitude where the Barometric pressure is, say, 700 mmHg at about 2000 ft (615 m) Above Mean Sea Level (AMSL) each 1.0% saturation would be represented by 7.00 mmHg,

Figure 2: Relation of equilibrium, percent saturation and depth

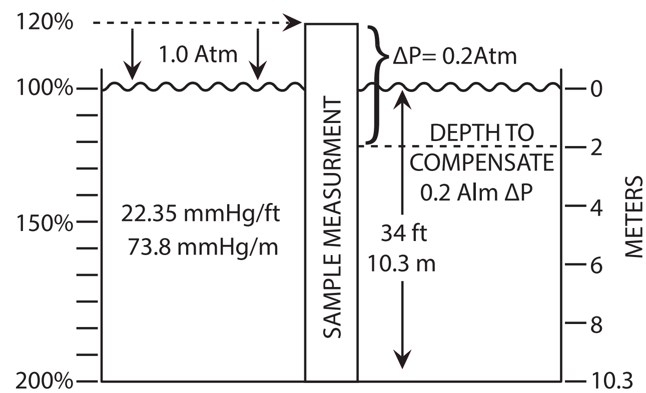


Figure 2 shows the relationship of equilibrium percent saturation and depth. The bar graph shows a hypothetical measurement of 120 %sat, and the ΔP that this represents. The depth at which this ΔP would be balanced by the hydrostatic pressure is shown as approximately two meters in fresh water. On the left, the increasing total dissolved gas pressure (shown on the ordinate as “Percent Saturation”) is allowed by an increase in depth. Depth increments are 22.35 mmHg/foot (73.8 mmHg/meter) of fresh water.

6.0 APPENDIX

Reference to Table 1 indicates the standard Barometric pressure at different altitudes; for intermediate altitudes not listed in Table 3, taking an average between the two nearest altitudes will be sufficiently accurate. To continue the example then, a reading of, say 115% Sat at 2000 ft (615 m) AMSL would represent a ΔP of approximately 15 x 7.066 mm = 106 mmHg. This estimate can be further used then, to check what expected oxygen partial pressure would be encountered in the water by reference to Figure 1, which indicates the percentage of O2 in the atmosphere as 20.94% or a fraction of 0.2094. In other words assuming that the water is in equilibrium with air (but supersaturated) the proportion of the "DELTA-P" due to oxygen can be estimated as: 106 mmHg TGP x .2094 = 22.2 mmHg. Reference to Table 1 will then allow estimating the oxygen content in ppm or mg/L.

TABLE 1: Standard Atmospheric Pressure Values

Feet (Meters) AMSL	Pressure		Temp (°C)
	inchHg	mmHg	
16,000 (4,923)	16.21	411.7	-17
14,000 (4,308)	17.57	446.3	-13
12,000 (3,692)	19.03	483.4	-9
10,000 (3,077)	20.58	522.7	-5
8,000 (2,462)	22.22	564.4	-1
6,000 (1,846)	23.98	609.1	3
4,000 (1,231)	25.84	656.3	7
2,000 (615)	27.81	706.6	11
1,000 (308)	28.86	733.0	13
SEA LEVEL	29.92	760.0	15

For example in Figure 2, 120% saturation (at sea level) means a ΔP of 152.0 mmHg. Dividing Partial Pressure to ppm

To make the conversion from partial pressure to ppm, the following equation from Weiss, 1970 can be used to calculate the desired result. The equation evaluates the natural log (ln) of the Bunsen solubility coefficient, "β3" (alpha3) in some texts or β in Weiss (1970), as a function of temperature and salinity using three constants for temperature and three for salinity:

In β = AI + A2(I00/T) + A3 In(T/I00) + S%. [BI + B2(T/I00) +]B3(T/IOO)2]

where A's and B's are constants, T is the absolute temperature in Kelvin (°C + 273.15)

S%. is salinity in per mil.

The value of the constants for oxygen are:

AI = -58.3877 BI = -0.034892

A2 = 85.8079 B2 = 0.015568

A3 = 23.8439 B3 = -0.0019387

Thus

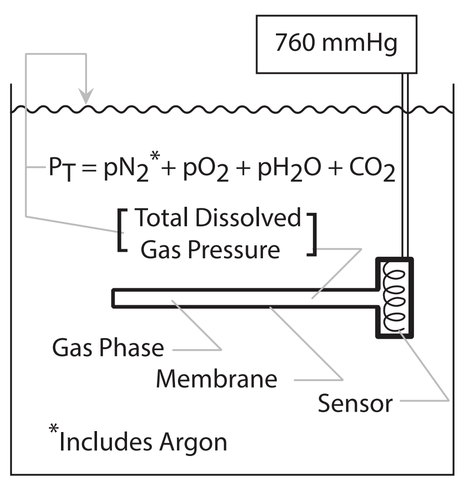
In β = -58.3877+85.8079(I00/T)+23.8439 In(T/I00)+S%[-0.034892+0.015568(T/I00)-B3(T/I00)2]

Multiplying the value of β, which is in units of Litters gas STP/Litter water, by the partial pressure in mm Hg x 1000/760 gives the volume of dissolved gas in ml/Litter STP; a further correction for molecular weight and molar volume gives the concentration of oxygen in mg atoms or parts per million (ppm)

Thus, [02] ppm. = p02 (mmHg) x β x 31.9988 x 1000/ 760 x 22.414

Without an oxygen reading, this approach allows a good estimate of the oxygen content, however, there are many situations where air equilibrium will not hold, such as well water which is often essentially anaerobic, or pumped storage water where air may have been trapped for some time. It is important to keep in mind what is being measured by the TDG meter. The schematized illustration in Figure 3 shows the tubing connected to a pressure sensor, which "sees" a pressure inside the tubing, which is the result of the sum of the partial pressures of all gases present as shown in Figure 1. Only if one can assume air equilibrium, or that air is the only gas mixture present, can you make any conclusions about the constituent gases in the manner done above.

Figure 3: Schematic diagram of the direct measurement of TGP



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In figure 3, the surface of the water is subjected to the partial pressures of all atmospheric gases, which add up to PT or 1.0 Atmosphere (760 mm Hg, 14.7 psi, 29.92 inches of mercury etc). An artificial gas phase shown as the long tubing in cross section is connected to a pressure sensor, which can read out in any units desired.

Keep in mind also that each time the sensor is moved to another location, or removed and put back in the same location, you are “starting over” on the process of equilibration of the volume in the tubing shown schematically in Figure 3. This process of equilibration in the probe is shown in Figure 4. The small “x’s” illustrate the equilibration with the fastest tubing. The effect of temperature is illustrated with the curves taken on the same probe at 38.0 and 8.0ºC.

When using the TGP meter to check various water systems it is important to secure samples at a number of locations in the system to get an idea of the processes of increasing and decreasing saturation that are occurring. An illustration of an intensive aquaculture set up –where oxygen is being added is shown in Figure 5. The labels “M” show different points in this hypothetical system where minimal sampling is advisable.

Figure 4:

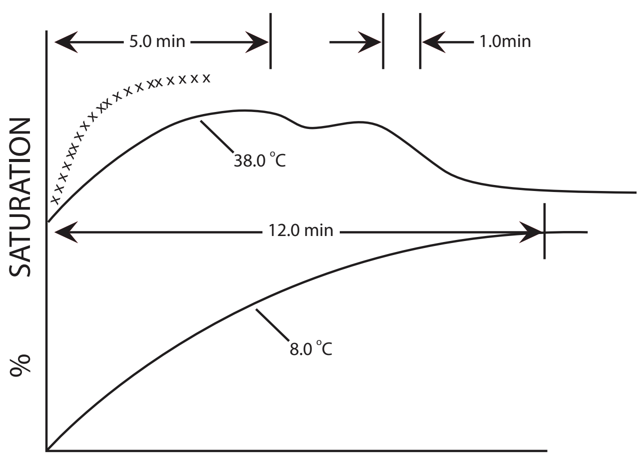

Figure 5:

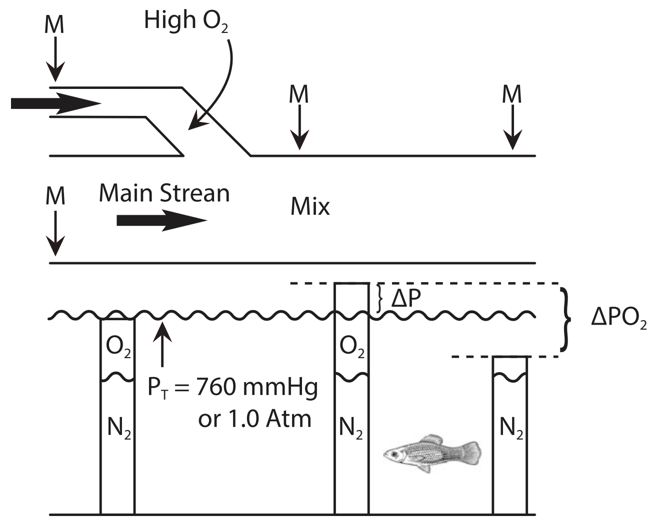

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TABLE 2: PCO_2 values for pH and carbonate alkalinity (fresh water, 10ºC)

	CARBONATE AKALINITY							
pH	600	500	400	300	200	150	75	25
6.0	61.4	51.4	41.1	30.8	20.6	15.4	7.7	2.6
6.1	57.6	48.0	38.4	28.8	19.2	14.4	7.2	2.4
6.2	53.2	44.3	35.5	26.6	17.7	13.3	6.7	2.2
6.3	48.5	40.4	32.4	24.3	16.2	12.1	6.1	2.0
6.4	43.7	36.4	29.1	21.9	14.6	10.9	5.5	1.8
6.5	38.0	32.3	25.9	19.4	12.9	9.7	4.8	1.6
6.6	34.0	28.4	22.7	17.0	11.3	8.5	4.2	1.4
6.7	29.5	24.6	19.7	14.8	9.8	7.4	3.7	1.2
6.8	25.2	21.0	16.8	12.6	8.5	6.3	3.2	1.1
6.9	21.3	17.8	14.2	10.7	7.1	5.3	2.7	0.9
7.0	17.9	70.5	11.9	8.9	5.9	4.5	2.2	0.7
7.1	14.8	12.3	9.9	7.4	4.9	3.7	1.9	0.6
7.2	12.3	10.2	8.2	6.1	4.1	3.1	1.5	0.5
7.3	10.0	8.3	6.7	5.0	3.3	2.5	1.3	0.4
7.4	8.2	6.8	5.4	4.1	2.7	2.0	1.0	0.3
7.5	6.6	5.5	4.4	3.3	2.2	1.6	0.8	0.3
7.6	5.3	4.5	3.6	2.7	1.8	1.3	0.7	0.2
7.7	4.3	3.6	2.9	2.1	1.4	1.1	0.5	0.2
7.8	3.5	2.9	2.3	1.7	1.2	0.9	0.4	0.1
7.9	2.7	2.3	1.8	1.4	0.9	0.7	0.3	0.1
8.0	2.2	1.8	1.5	1.1	0.7	0.6	0.3	0.1

***This assumes a CO_2 solubility value (CO_2) of 1.194 1/L and a pK' for $H2CO_3$ of 6.428 at 10ºC.**

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TABLE 3: Pressure Conversions

DESIGNATION	PSI	KPA	KG/CM²	CM OF H_2O	FEET OF H_2O	INCHES OF HG	MM OF HG	INCHES OF H_2O	OUNCES PER SQUARE INCH	ATMOSPHERES	BAR	MBAR	MPA
psi	1	6.89476	0.07031	70.30693	2.306723	2.03602	51.71486	27.68068	16	0.06805	0.06895	68.948	0.00689
kPa	0.14504	1	0.01020	10.19745	0.334562	0.29530	7.50061	4.01472	2.32060	0.00967	0.01	10	0.001
kg/cm2	14.22334	98.06694	1	1000.026	32.80931	28.95901	735.5588	393.71181	227.5735	0.96784	0.98066	1013.3	0.09806
cm of H2O	0.01422	0.09806	0.00100	1	0.032808	0.02896	0.735537	0.3937	0.22757	0.00097	0.00098	0.9806	0.00098
feet of H2O	0.43352	2.96896	0.03048	30.48	1	0.88265	22.4192	12	6.93624	0.02950	0.02969	29.689	0.00298
inches of Hg	0.49115	3.38639	0.03453	34.53253	1.132957	1	25.4	13.59548	7.85847	0.03342	0.03386	33.864	0.00386
mm of Hg	0.01934	0.13332	0.00136	1.35955	0.04460	0.03937	1	0.53526	0.30939	0.00132	0.00133	1.3332	0.00013
inches of H2O	0.03613	0.24908	0.00254	2.54	0.08333	0.07355	1.86827	1	0.57802	0.00246	0.00249	2.4909	0.00025
ounces per square inch	0.0625	0.43092	0.00439	4.394308	0.14417	0.12725	3.23218	1.73004	1	0.00425	0.00431	4.309	0.000431
atmospheres	14.696	101.3254	1.03323	1033.263	33.8995	29.9213	760	406.794	235.136	1	1.01325	1013.3	0.1013
bar	14.5038	100	1.01972	1019.747	33.4833	29.53	750.0626	401.8596	232.0608	0.98692	1	1000	0.1
mbar	0.0145	0.1	0.00102	1.019	0.003456	0.02953	0.75006	0.40146	0.23206	0.00099	0.001	1	0.0001
MPa	145.038	1000	10.197	10197.45	334.56	295.299	7500.61	4014.74	0.23206	9.669	10	1000	1

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6.5 TOTAL GAS PRESSURE INFORMATION SHEET

GAS BUBBLE TRAUMA

Figure 1: Bulging eyes due to bubble formation caused by supersaturation.

"Gas Bubble Trauma" can result when the water is supersaturated with gas (bottom of a waterfall or overactive aquarium aerator).

Both oxygen and nitrogen enter the fish via the gills, where it is rapidly distributed via the bloodstream to the tissues. At this juncture, supersaturated gases come out of solution and form gas bubbles, thus leading to the condition known as "gas bubble trauma."

Supersaturation by nitrogen is generally the culprit, but oxygen alone (i.e., in systems using oxygen injection) may cause GBD. With zebra fish research systems, the cause is often a leaky pipe on the suction side of the pump, which causes air injection.

Unfortunately, many cases of GDB do not present specific clinical or pathological changes—i.e., fish die without visible bubbles in the tissues.

The main symptoms are:

- Bubbles (emboli) visible in the lateral line, gill filaments, gill covers and fins
- Exophthalmia (bulging eyes)
- No visible signs

Results in:

- Damage to blood capillaries
- Impaired organ development and function, particularly in relation to the gills
- An increased susceptibility to disease
- Behavioral effects (more vulnerable to predation)

6.6 DEFINITIONS

a) Barometric Pressure:

The "weight" of the air above the water surface.

b) Hydrostatic Pressure:

The "weight" of the water.

1 atm = 760 mmHg = 34 ft freshwater = 33 ft saltwater

c) Total Dissolved Gas Pressure:

The sum of the pressures exerted by the dissolved gases in the water.

6.7 TGP CALCULATIONS

$PTG = pO_2 + pN_2 + pCO_2 + pH_2O + p\ldots$

Or $PTG(\%) = (PTG / PBP) \times 100$

Where:

pO_2 = partial pressure of oxygen

pN_2 = partial pressure of nitrogen

pCO_2 = partial pressure of carbon dioxide

pH_2O = partial pressure of water vapor

p… = all other partial pressures present (from dissolved gases)

PTG(%) = TGP expressed as percent saturation

PBP = Barometric Pressure at water surface

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Therefore:

If the water is in equilibrium with air:

TGP = BP and % sat = 100%

If the water is supersaturated:

TGP > BP and % sat ≥100%

TGP can also be expressed as Δ P:

Δ P = TGP – BP

6.8 HOW TO CALCULATE N_2

If we assume that the dissolved CO_2 and Ar are negligible, then we can use the measure of TGP and Dissolved Oxygen to determine the value of dissolved N_2.

TGP = $pO_2 + pN_2$

where

pO_2 is the partial pressure of Oxygen

pN_2 is the partial pressure of Nitrogen

To facilitate the equation, both the TGP and DO measurement should be expressed as a percentage.

TGP (%sat) = [DO (%sat) x 0.2095] +
[N2 (%sat) x 0.7808)]

Solve for N_2:

N2

(%sat) = [TGP - (0.2095xDO)] / 0.7808

6.9 COMPENSATION DEPTH

When TDGP is at 110% at the surface of a water body, the TDGP saturation one meter (3 feet) below the surface is 100%. For each meter you go down in the water, because the water pressure goes up (hydrostatic pressure), the TDGP saturation actually experienced by the fish drops by 10%. Therefore, when the surface TDGP is 120%, a fish two meters down is exposed to a TDGP level of only 100%.

Fish sense high gas pressures, and will go deeper in the tank to compress the gases and thereby preventing bubble formation in the blood stream and tissue. When water is at 102% gas saturation (figure 2), for example, the compensation depth (or depth at which bubbles will not form) is 20 cm (8 inches).

As a guide, for every 1% increase in gas pressure, the fish have to swim 10 cm (4 inches) deeper in the water to equilibrate. If the total gas pressure increases to 110% and the depth of the tank is only 50 cm (20 inches), the fish cannot escape and the consequences will be 100% mortality in about 30 minutes (figure 3).

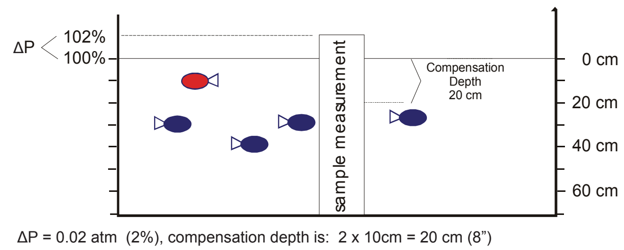

Figure 6: Compensation depth with proper tank depth

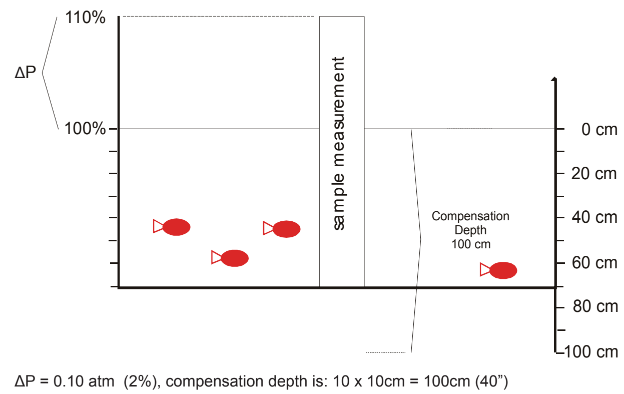

Figure 7: Compensation depth with tank not allowing for minimum depth required.

6.10 CURRENT GUIDELINES

British Columbia Ministry of Environment Guidelines:

Freshwater & Marine Aquatic Life

Max. ΔP ≤ 76 mmHg (or 110% at sea level)

6.11 HATCHERY ENVIRONMENTS

Max. ΔP = 24 mmHg (or 103% at sea level)

ΔP = 0 mmHg when pO_2 is ≤ 100 mmHg

Visit http://www.env.gov.bc.ca/wat/wq/BCguidelines/tgp/ for more details.

NOTES

NOTES

AQUATIC ECO-SYSTEMS

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