
LEAKALYZER USE 101
LEAKALYZER™
understanding and interpreting your Water Loss Sensor
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What the Leakalyzer Does

- Precisely measures water level changes to the 10,000 of an inch plotting these changes on a graph over a period of several minutes.

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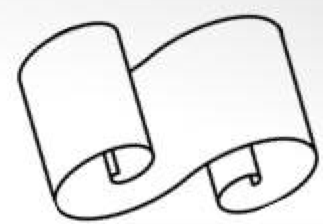
10,000th of an inch is 10 times smaller than the eye can see!

- The thickness of a red blood cell

- 1/10th the diameter of a strand of silk

- 1/100th the thickness of a piece of paper



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What You Do

- Interpret this collected and displayed data to diagnose a variety of pool conditions including: leak rate, evaporation rate, general leak location, and other related pool conditions.

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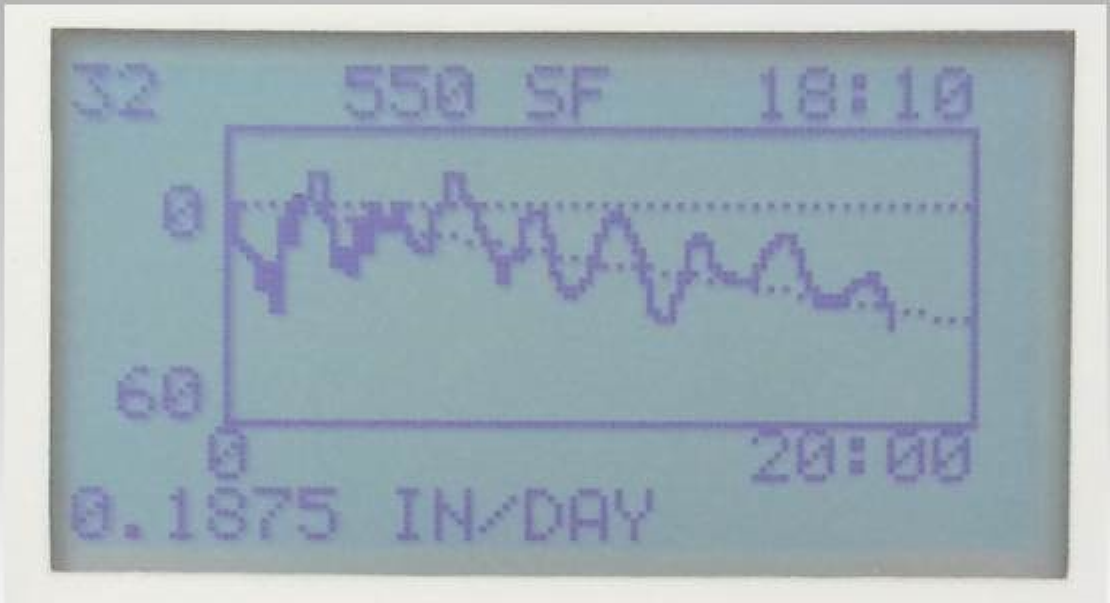
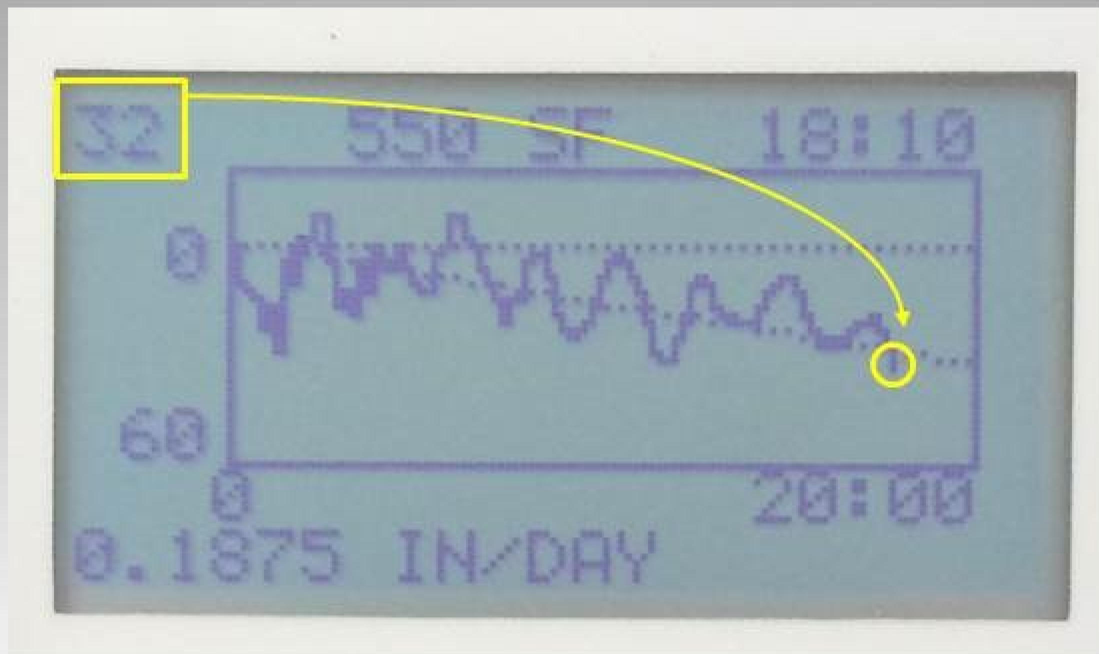
Understanding the Leakalyzer graph is key to interpreting results



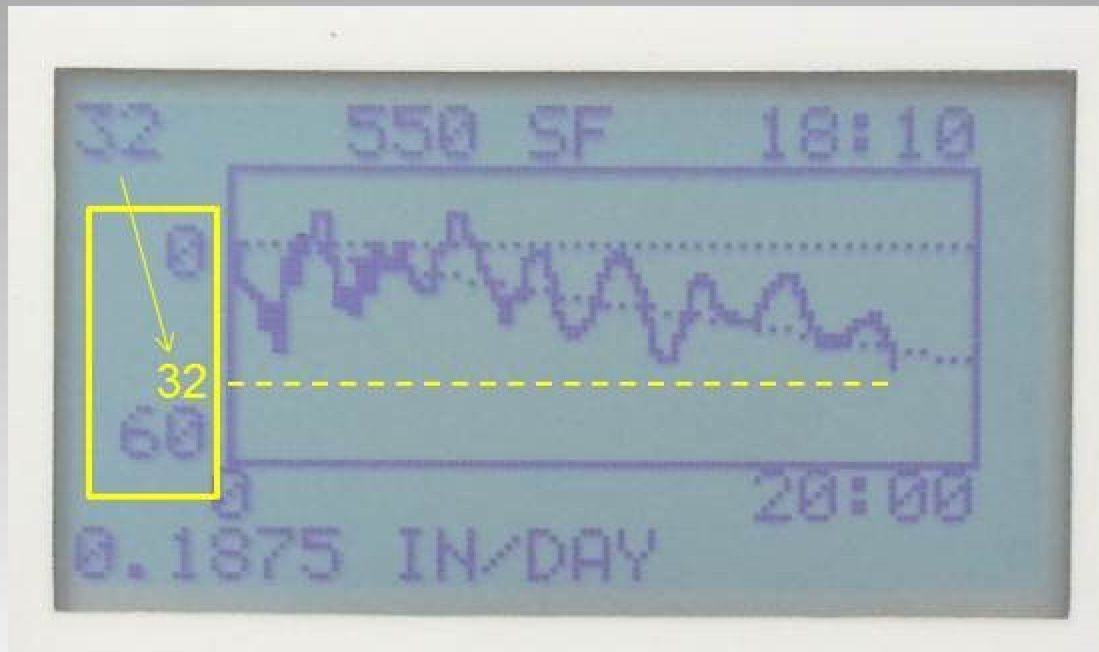
Here is a typical graph from a test you might do with your Leakalyzer. Once you understand how to interpret the results you will appreciate that what we are seeing here tells us if the pool is leaking, how much, and even what part of the pool the leak is in. In a few slides we'll examine how that information can be derived from the graph alone, but for now, let's look at the components of the graph and what they mean.

Graph Screen Components



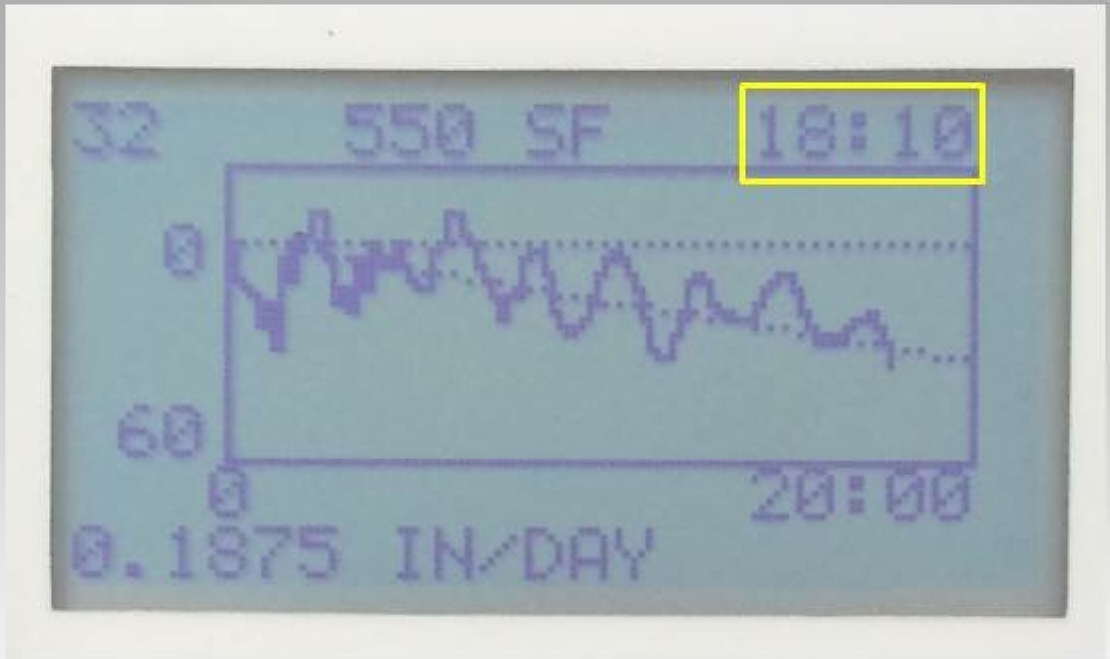
The number in the upper left corner shows how many 10,000ths of an inch the water level has dropped since the start of the test. The number corresponds to the most recent (furthest right) point plotted on the graph. Positive numbers represent a drop in water level, negative numbers represent a gain in water level. This number will change every several seconds, and a new point will be plotted on the graph as the test progresses.

Graph Screen Components



The numbers to the direct left of the graph show the vertical axis scale in 10,000ths of an inch. As you can see from this example, the last point on the plotted line (32/10,000thsof an inch) corresponds to a point on the vertical axis that is about half way between the 0 and the 60.

Graph Screen Components



The number in the upper right represents the time elapsed since the start of the test. This graph is showing an elapsed time of 18 minutes and 10 seconds since the start of the test.

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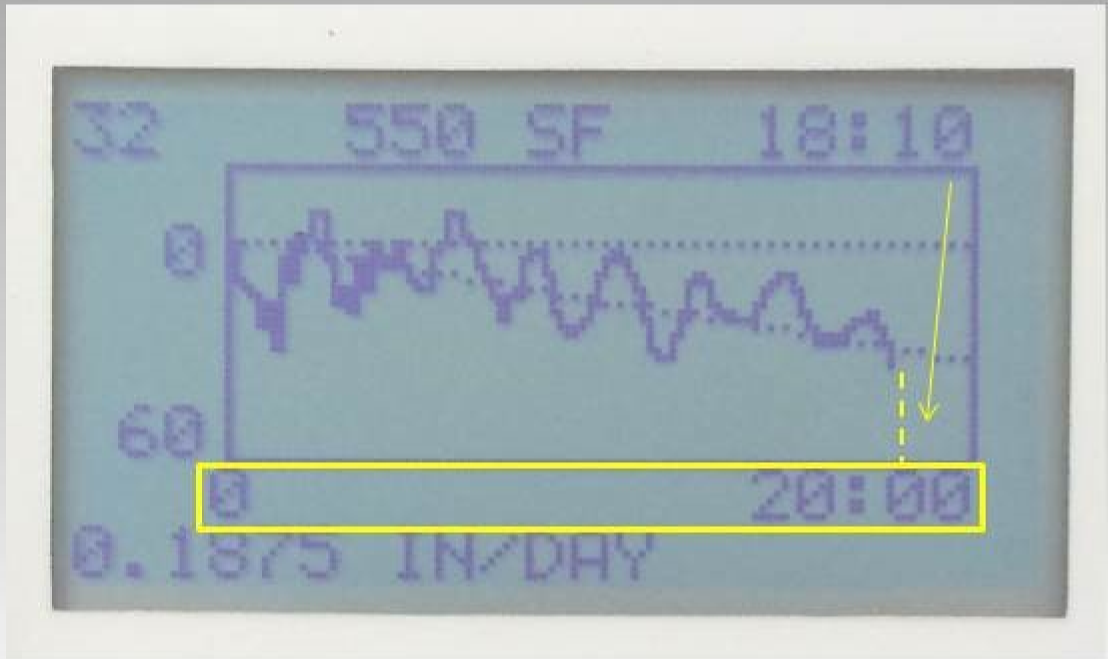
Graph Screen Components



The numbers at the direct bottom of the graph show the scale of the horizontal axis in minutes and seconds. The last point is plotted at a horizontal position that corresponds to 18 minutes and 10 seconds along this scale. Tests can be run for up to 2 hours and the scale of the graph will automatically adjust so that data for the entire test can be seen on one graph.

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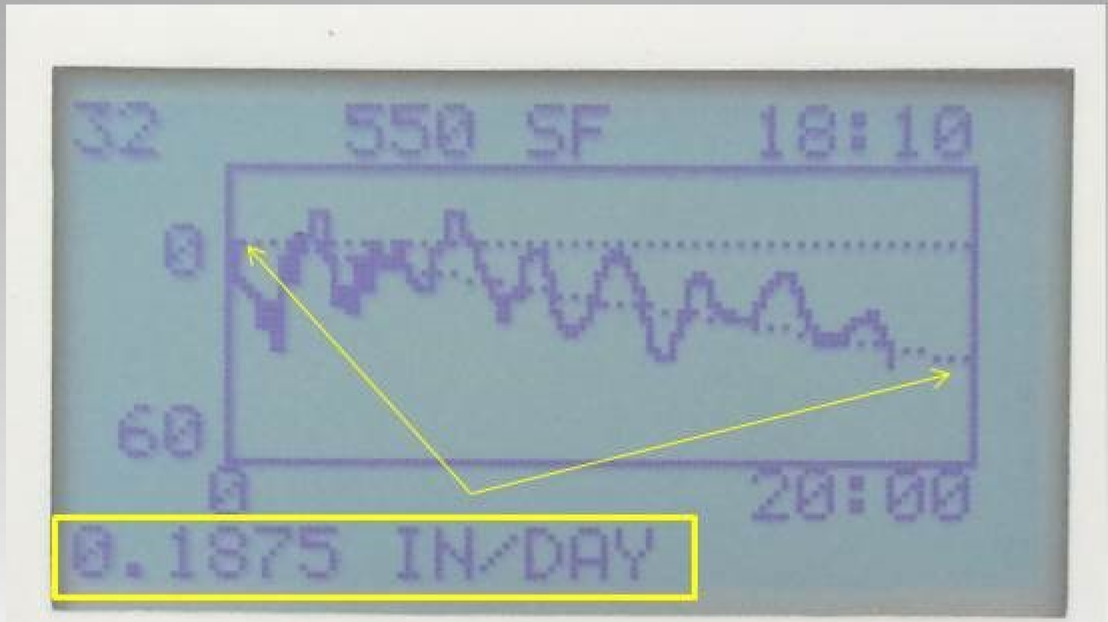
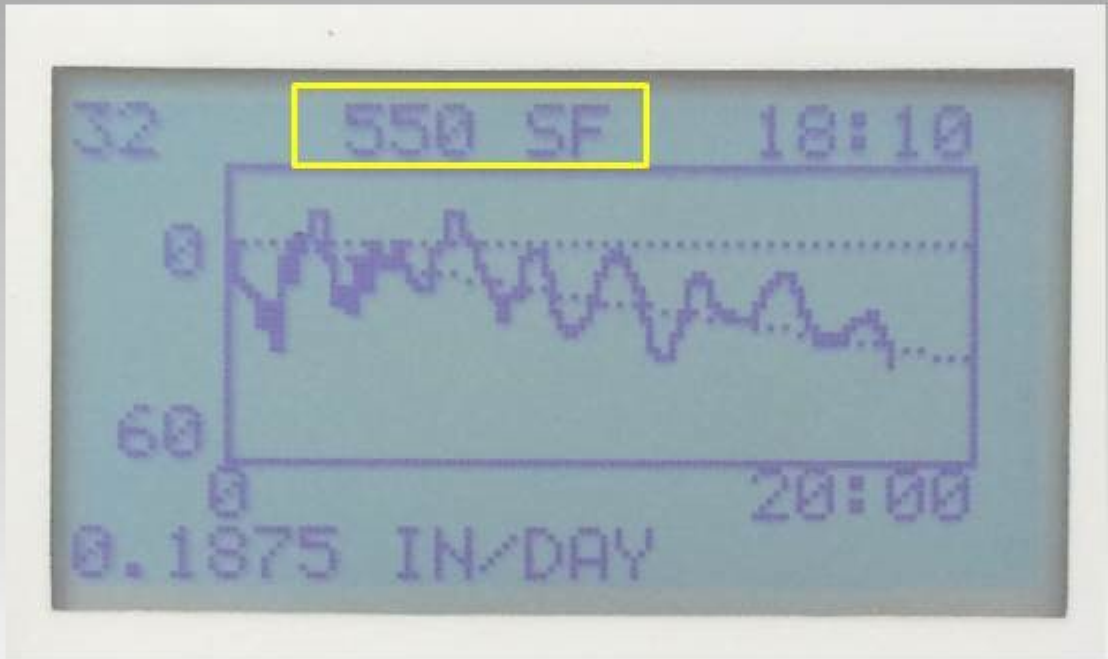
Graph Screen Components



The number at the very bottom of the screen displays the Estimated Evaporation Rate that was selected during the test set up stage. A dashed line representing what a constant water loss at this rate would look like is displayed on the graph as a downwardly sloping straight line. You will compare the slope of the plotted line to this reference line. The horizontal dashed line represents what no change would look like. In a little bit we'll look at how you derive and enter this Evaporation Estimate.

Graph Screen Components



The last number, at the very top of the screen, is another number that represents data input at the beginning of the test. It is the square footage of the swimming pool and actually will have no impact on anything displayed on the graph. We will discuss this number in more detail later when we look at the "Detail" screen. It is used there to calculate an estimate of gallons of water lost per day or hour.

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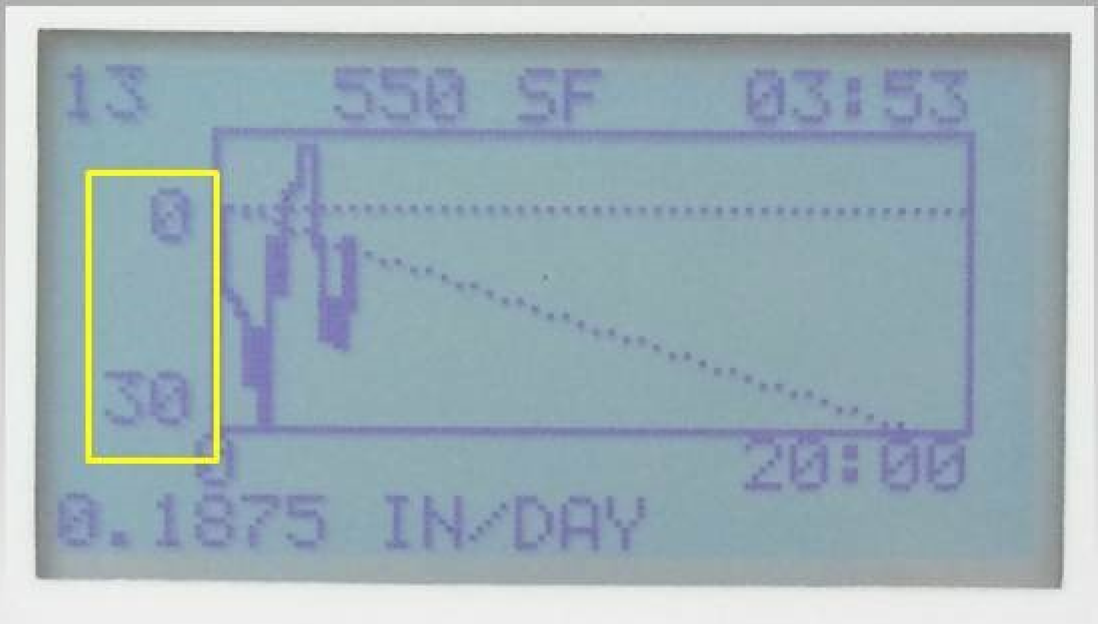
Scale effects graph appearance

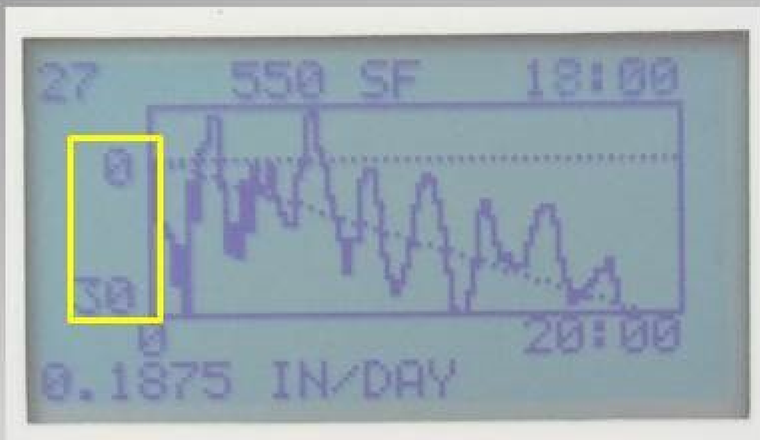


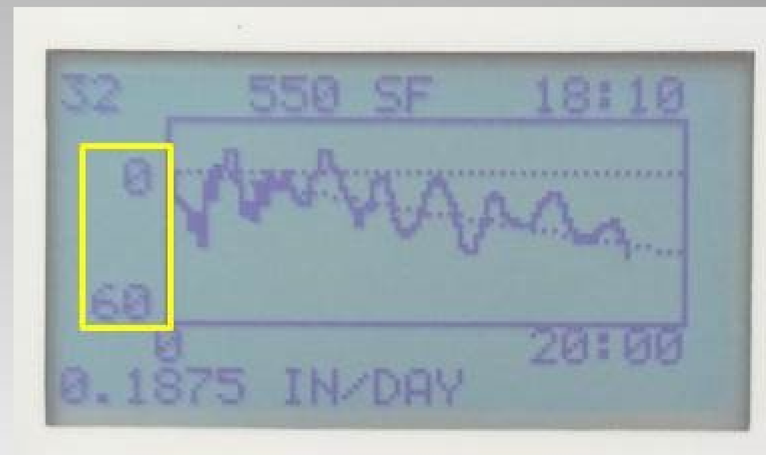
Here is what the graph of the test we have been looking at looked like at 3:53 into the test. When the test first starts up the graph scale will be at it's most sensitive setting of 0 to 30/10000ths. Because of this sensitivity the slightest water movement (remember we're measuring changes the thickness of 1/100thof a piece of paper) will appear as major changes on the graph.

Scale effects graph appearance

As the test progresses you will begin to see a pattern appear. The screen on the right shows how the test has progressed after 18 minutes. The ups and downs still look pretty steep because the graph is still on its most sensitive scale but we are starting to see that the peaks and valleys are progressively lower demonstrating an overall trend.

Scale effects graph appearance

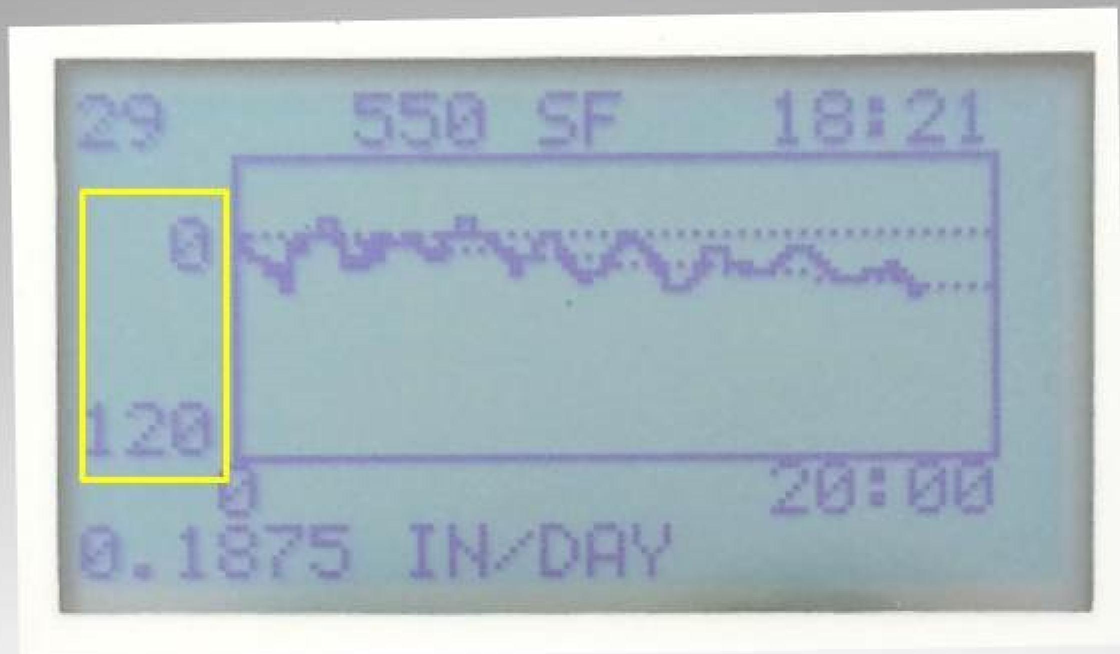




Vertical scale changes to 0-60 once a number is recorded that no longer fits on 0-30 scale.

As the test progresses even more the vertical scale of the graph will automatically change when a value is measured that will no longer fit on the graph. It can also be changed by pressing the up or down arrows while the graph is displayed. Note how the graph of the test we have been looking at becomes less severe as the vertical scale of the graph changes to 0-60/10000ths.

Scale effects graph appearance



Here is the same test at 18:21 elapsed time. We have pushed the "up" arrow to increase the scale of the graph so it displays 0-120 units on the vertical axis.

Scale effects graph appearance

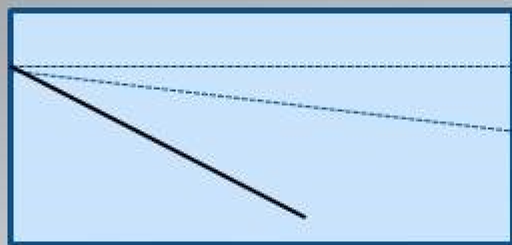
0-30 scale at 18:00

0-60 scale at 18:10

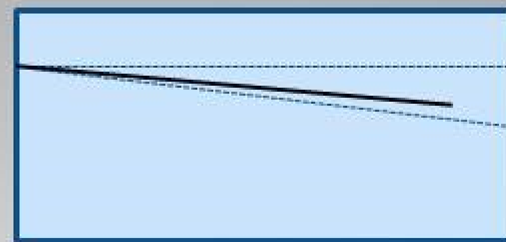
0-120 scale at 18:21

Notice again how the same test results look very different depending on the scale of the graph. Also notice how the "steepness" of both the plotted line and the evaporation estimate line become less severe as the scale increases. As we interpret the graphs we shouldn't get too concerned with their absolute steepness or jaggedness. Instead we are looking for **patterns in the graph** and how the **overall slope** compares to the "evaporation estimate " reference line.

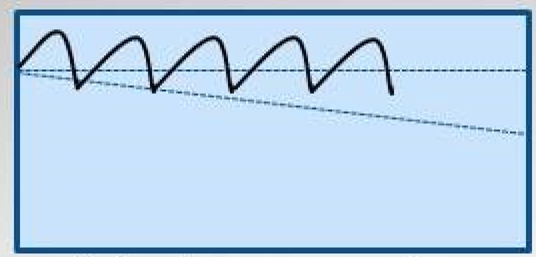
Diagnostic Graph Patterns



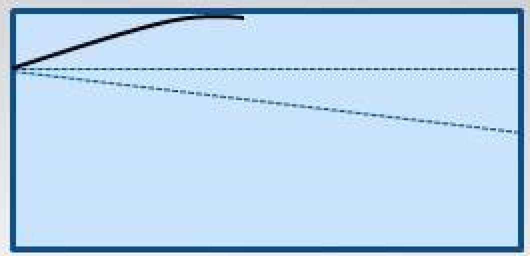
Water Leak



Evaporation



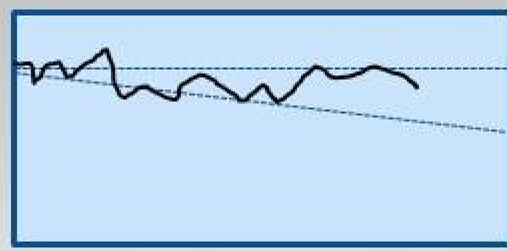
Air Leak - pump running



Air Leak - pump off

Leak problems at the pool are characterized by the distinctive patterns they create on the Leakalyzer graph screen. The above diagrams show the types of patterns we would expect from different leak problems. We will explain the physical reason for these patterns in a moment but first we have to acknowledge that your actual graphs at the pool will not always perfectly fit these patterns.

Random pool movement creates "noise"



Unfortunately, unless you are testing a perfectly still pool with no wind, you are likely to pick up water level changes that result from waves and turbulence in the pool. We call this random background motion "noise."

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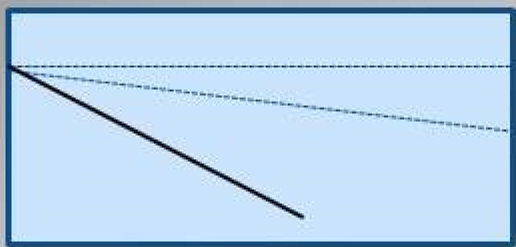
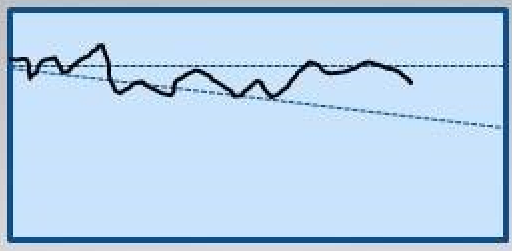
Random pool movement creates “noise”



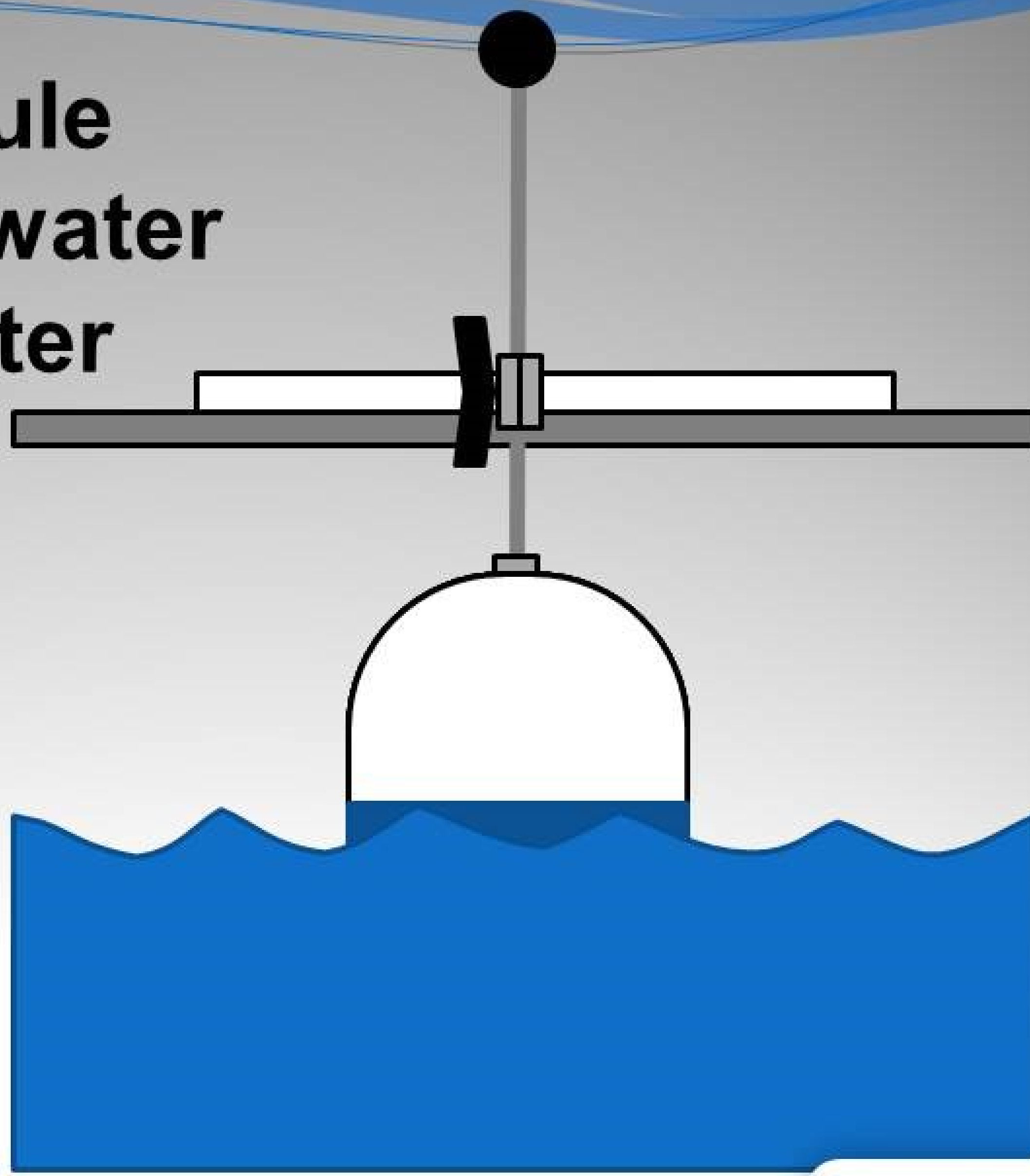


Water Loss Pattern + Random Motion = Actual Graph

Virtually any outdoor pool you test will be susceptible to “noise” that will mask or degrade the underlying leak pattern. After using the Leakalyzer you will become good at mentally disregarding these ups and downs and seeing the patterns through the noise. However, to make it easier, the Leakalyzer provides both mechanical and digital tools that will enable you to minimize the appearance of distracting background “noise.”

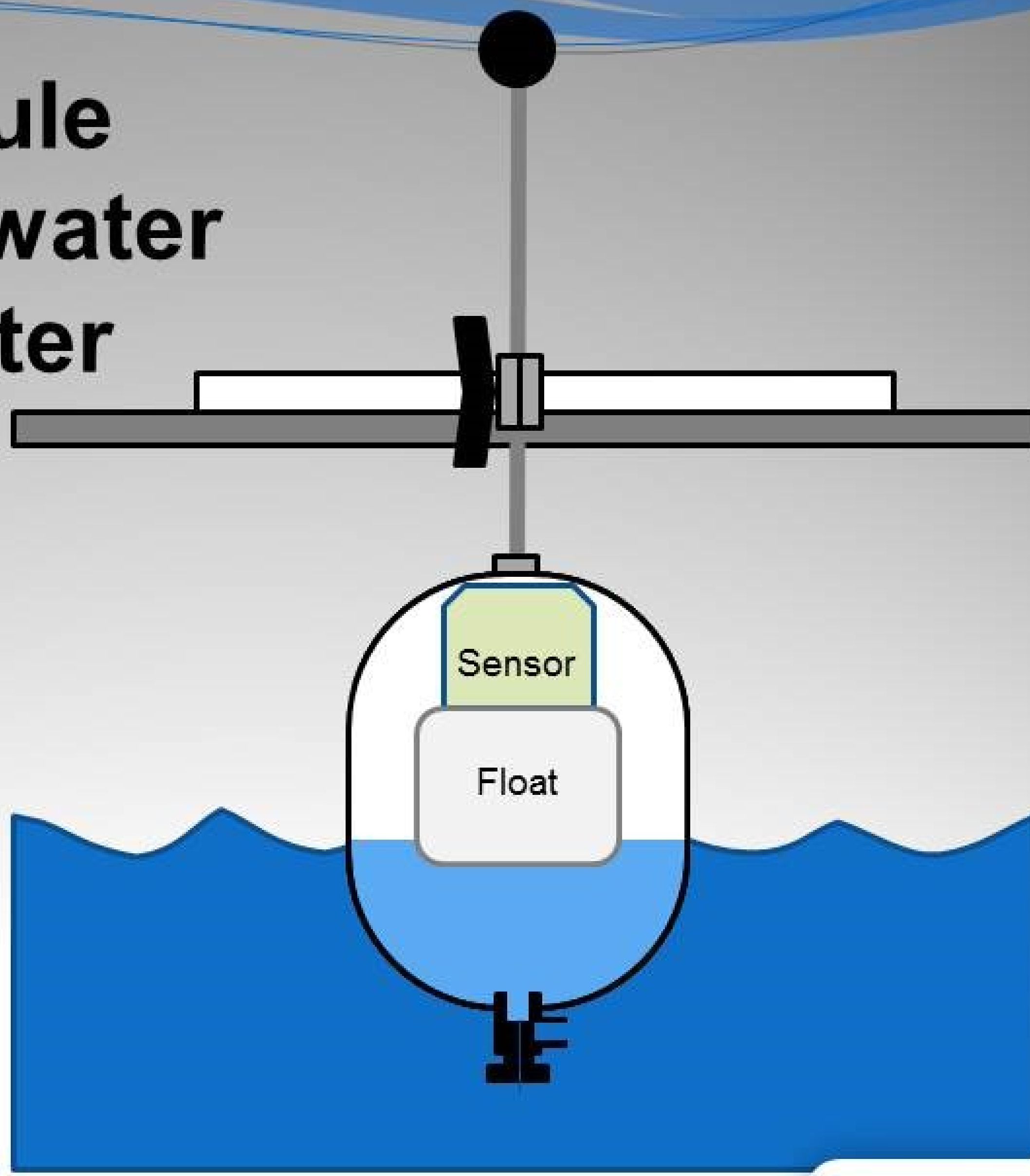
Sensor Capsule isolates test water from pool water

Where it not for the design of the sensor capsule which protects the float and sensor from surface waves in the pool the graph would look much more “noisy than it already does.



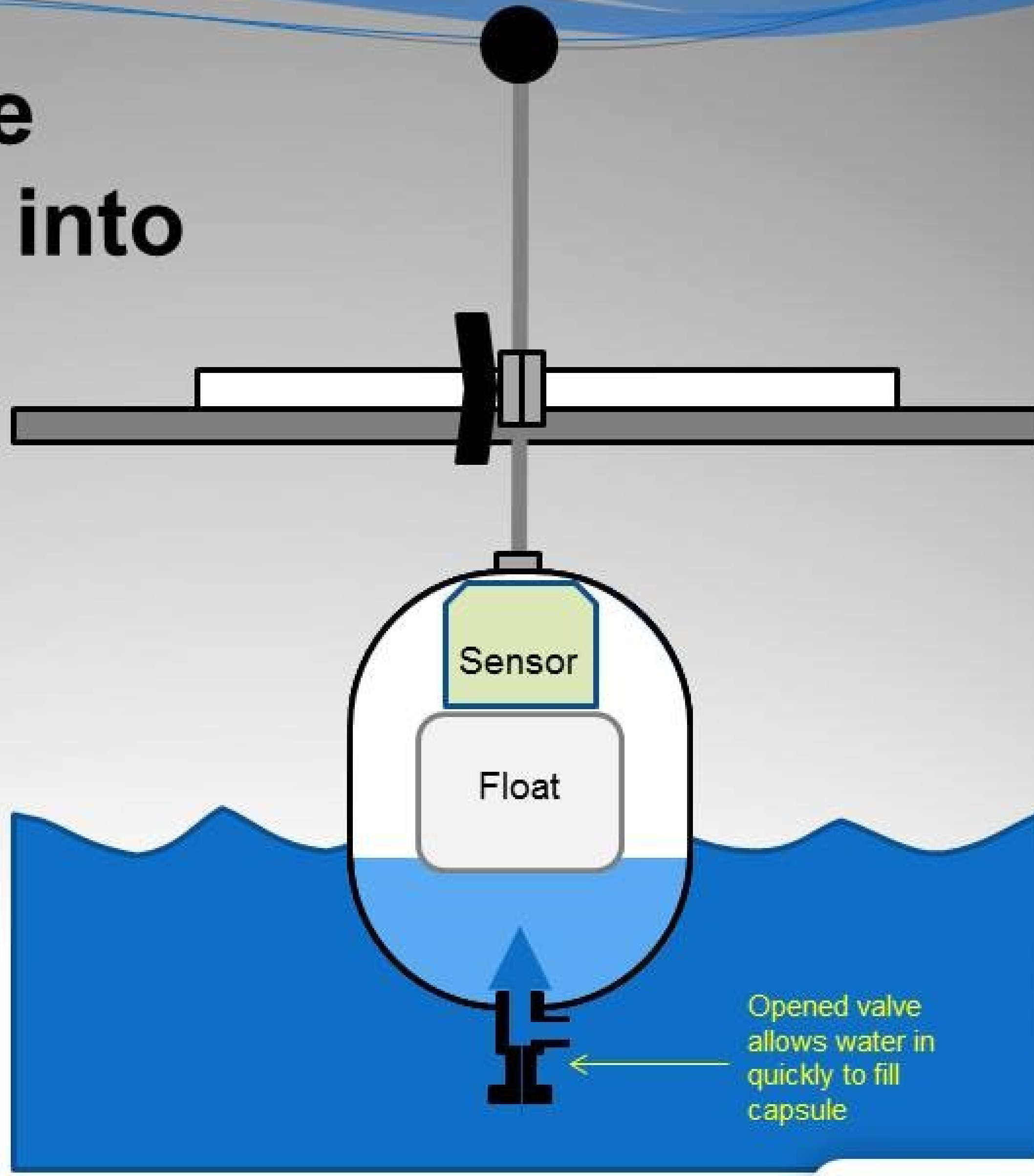
Sensor Capsule isolates test water from pool water

Inside the capsule a float rests on the isolated water and engages a sensor mechanism. Water inside the capsule is at the same level as that in the pool but is protected from the surface motion.



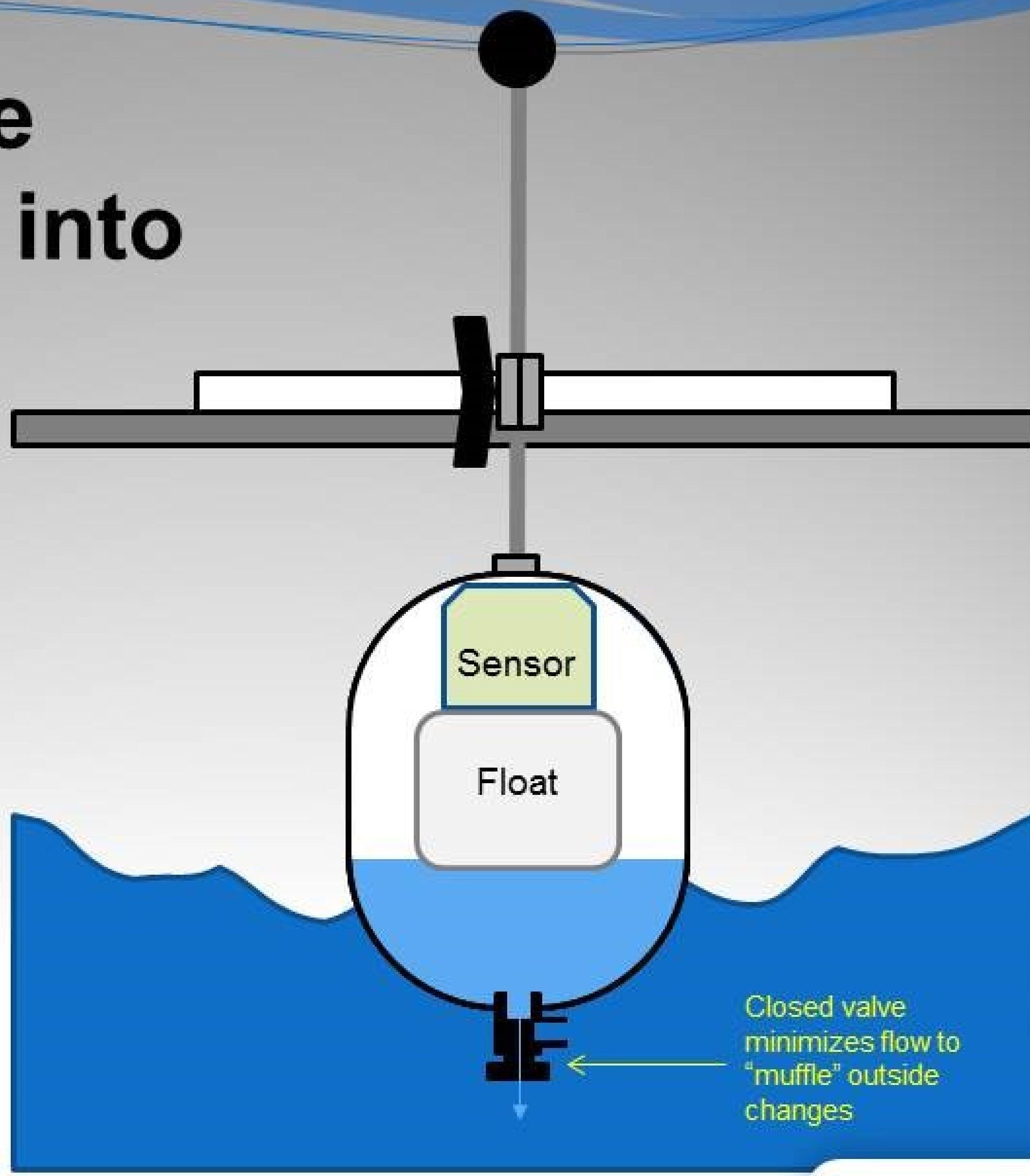
Capsule Valve controls flow into capsule

When the Capsule is first put into the pool open the valve at the bottom to allow water to quickly fill the capsule.



Capsule Valve controls flow into capsule

Once the capsule is filled (upper right corner of your handheld screen will read "READY") you can close the valve to further reduce the effect of larger water level disturbances. The valve cap has a small hole in it that will allow water flow even when the valve is completely closed.



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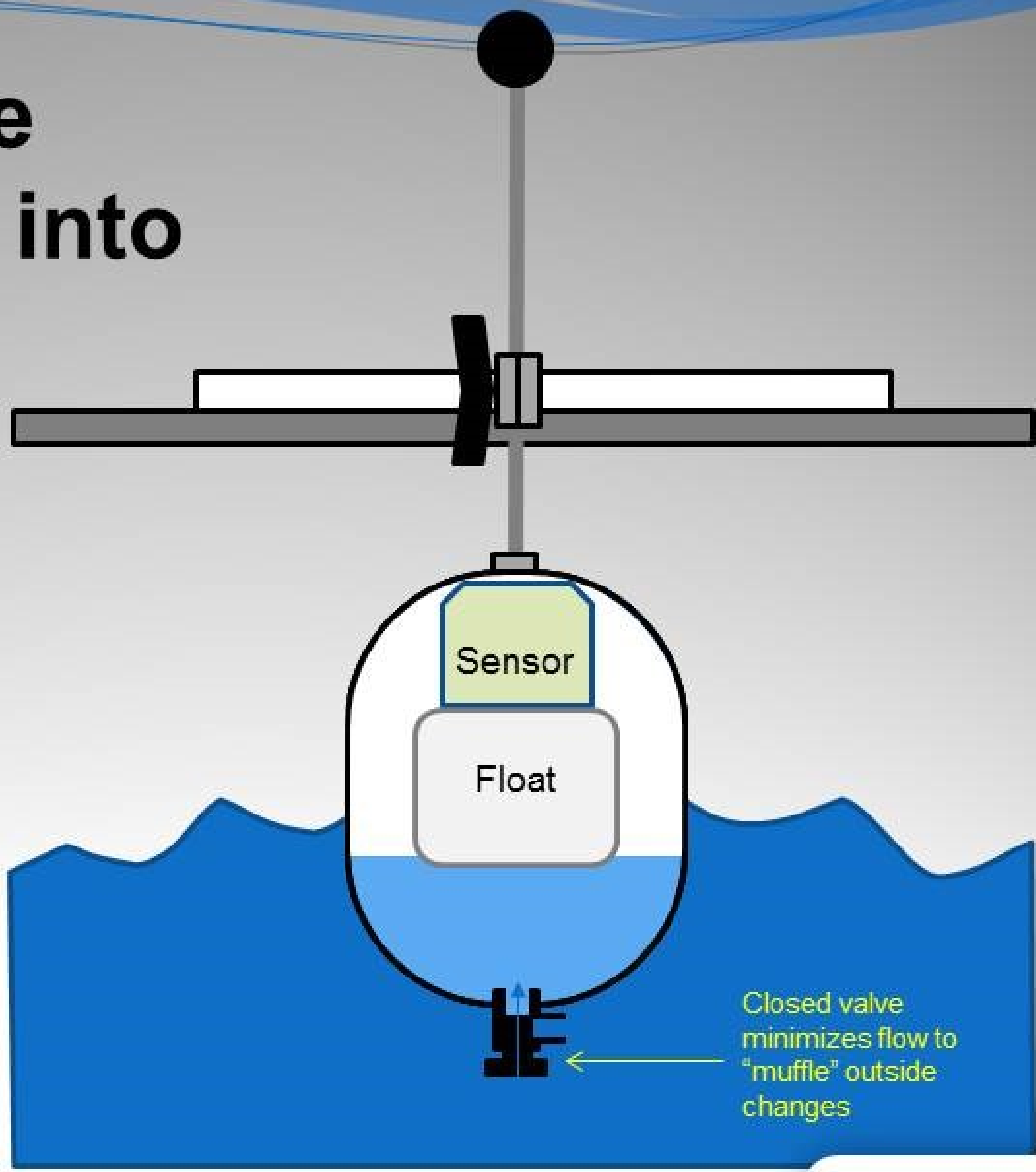
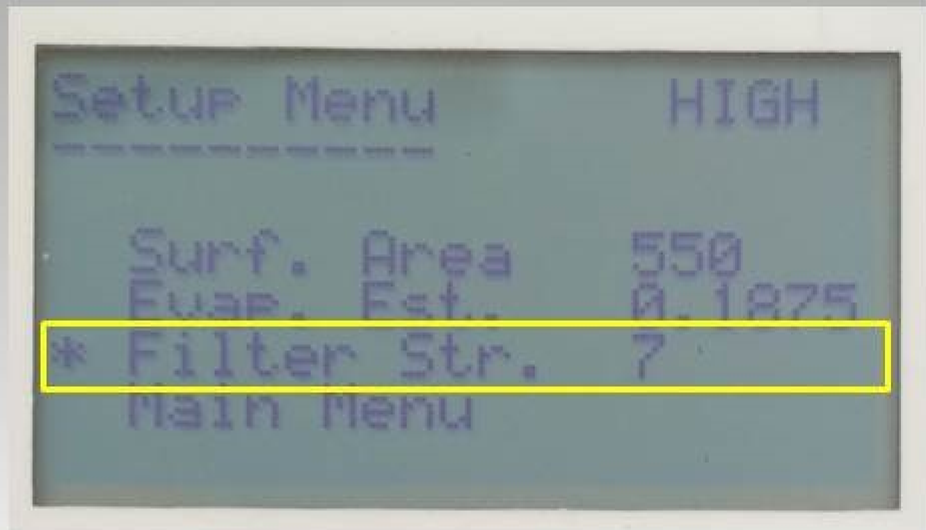
Capsule Valve controls flow into capsule

Closing this valve, especially on windy days will have the effect of smoothing the graph. Make sure however to open the valve when you are done with the test in order to fully drain the capsule before storage.



Minimizing “noise” with Filter at set-up



The Leakalyzer also has an adjustable filter built into the software of the system that can “smooth-out” the graph for easier viewing. Instead of muffling the flow of water to the sensor, the filter uses mathematical algorithms to control the way collected data is displayed. In order to understand the way this works we first have to understand how the Leakalyzer establishes the number it displays on the graph.

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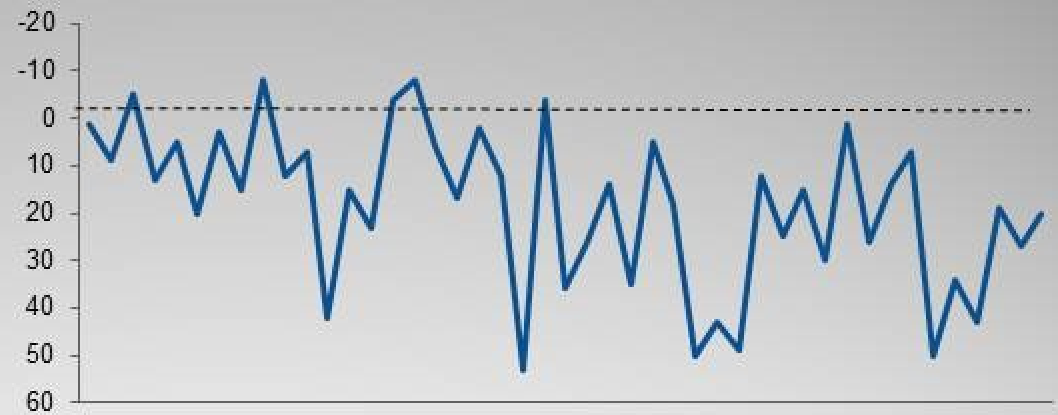
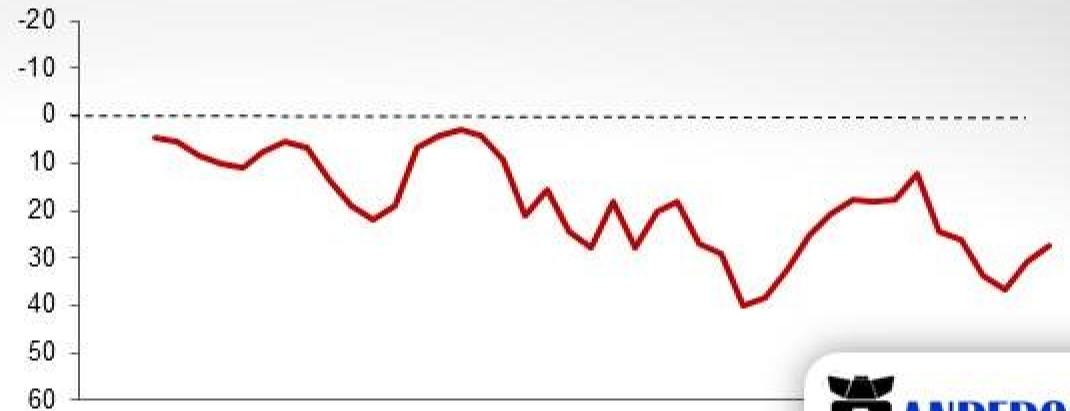
Effect of Filter on graph

The float and the sensor are actually under constant motion, and the Leakalyzer is collecting all of this data. To make the graph more readable however, each point recorded on the graph is actually an average of data collected over a period of time.

Raw Data

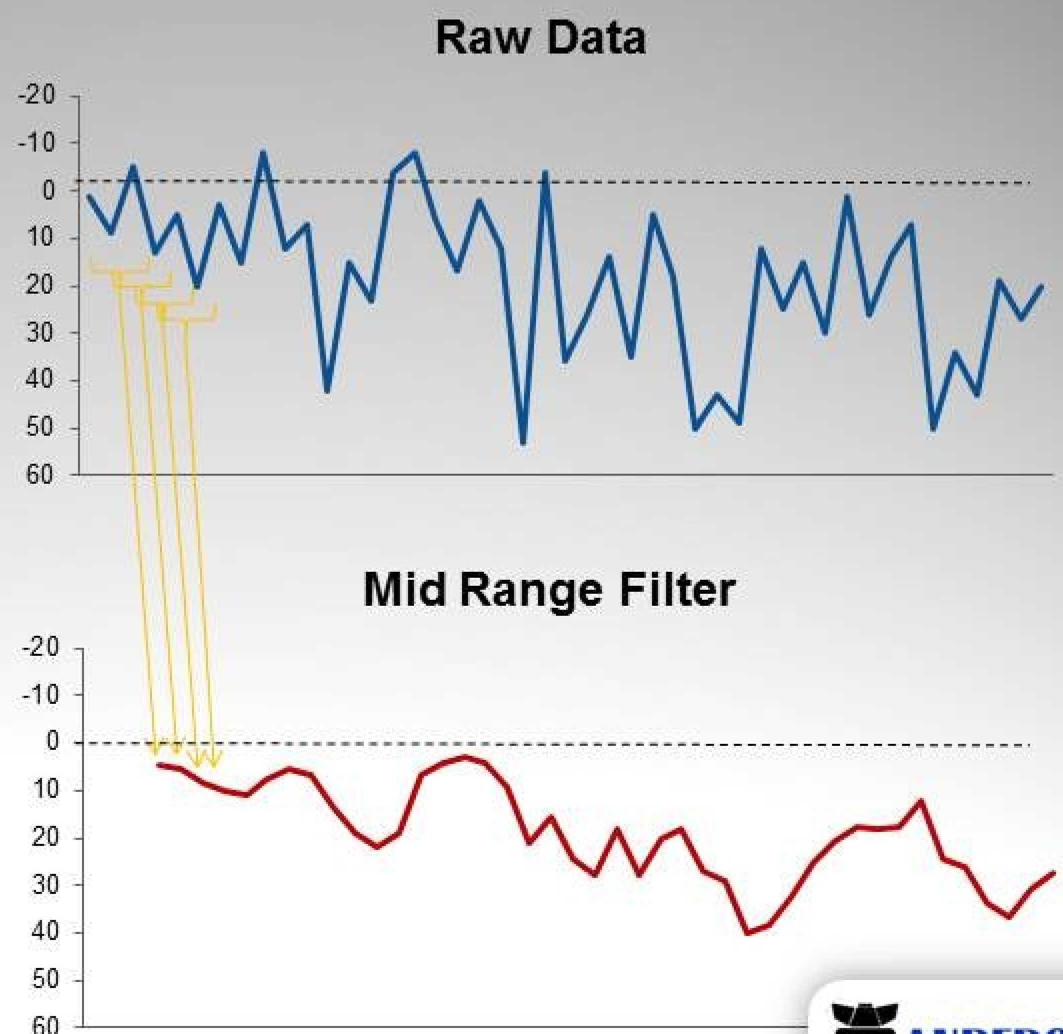


As Displayed



Effect of Filter on graph

In this example, data from four readings are averaged in order to generate each displayed point. As each point is recorded on the graph older data is dropped from this average and newer data is added. The mathematical process of analyzing data in this way is referred to as applying a "moving average."



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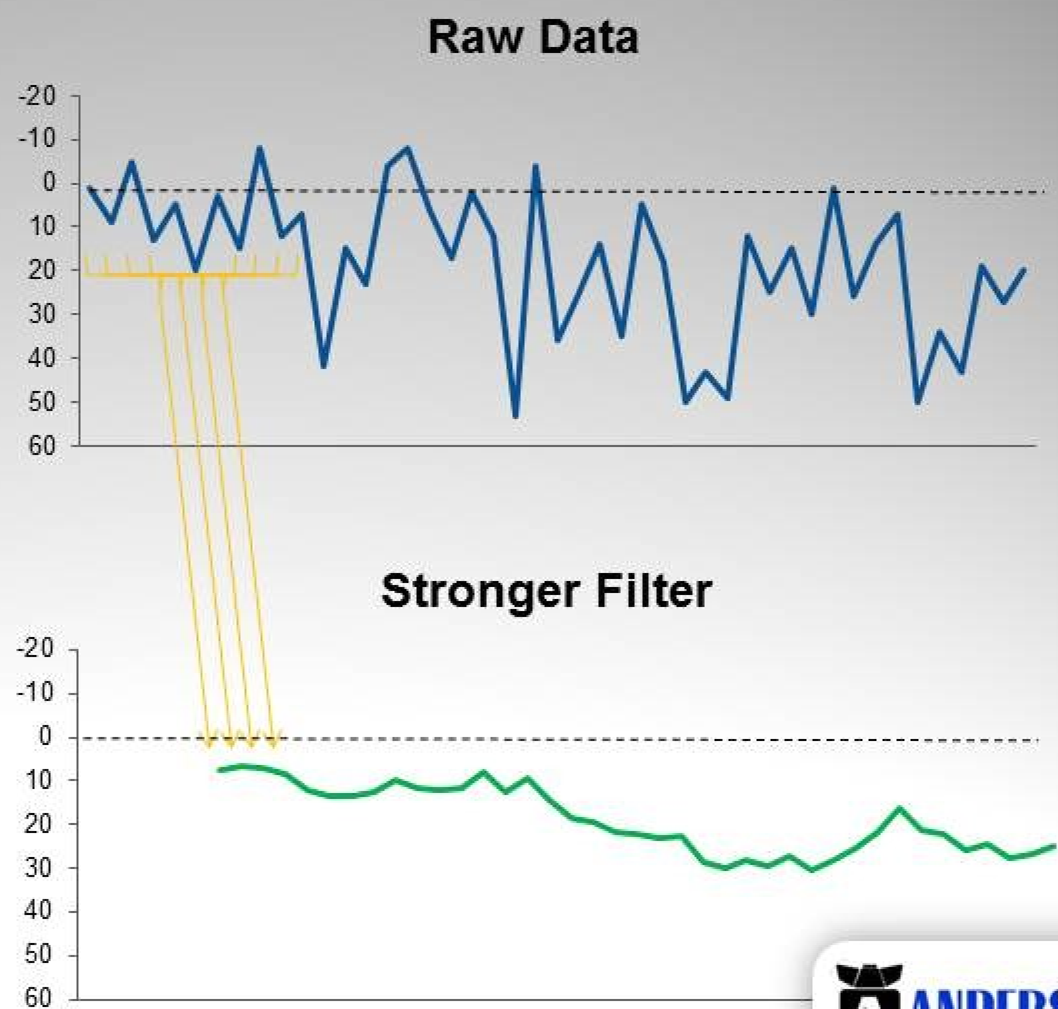
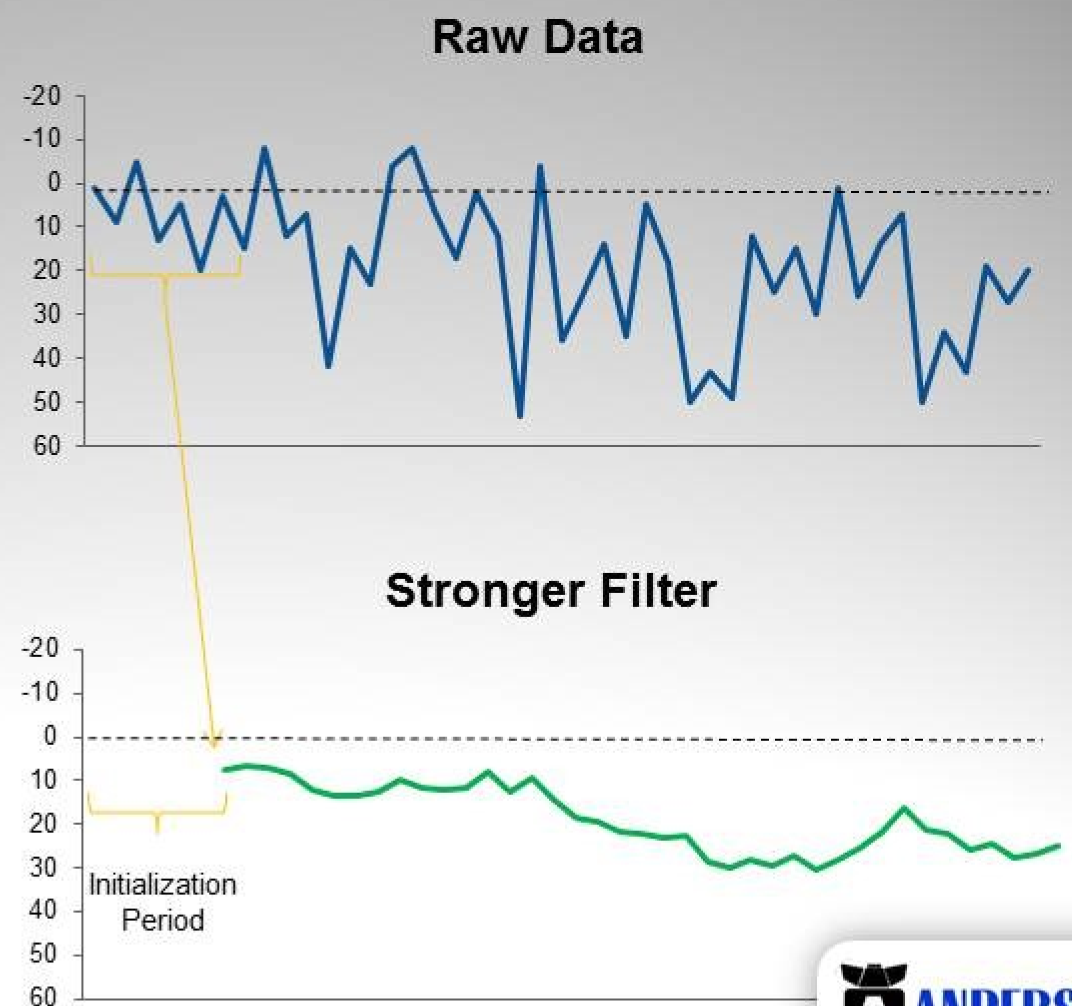
Effect of Filter on graph

By adjusting the filter strength the period from which this data is averaged can be made shorter or longer. The higher the filter strength, and thus the longer the period from which data is averaged, the smoother your line will be.

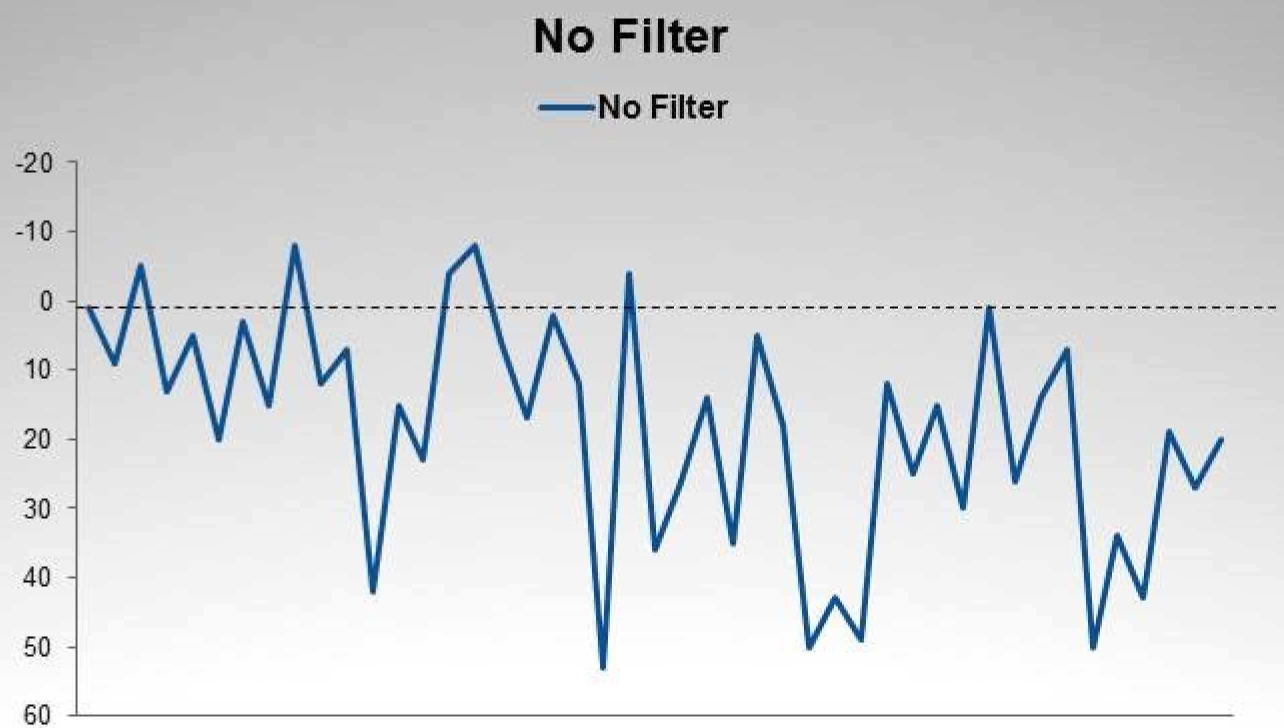


Effect of Filter on graph

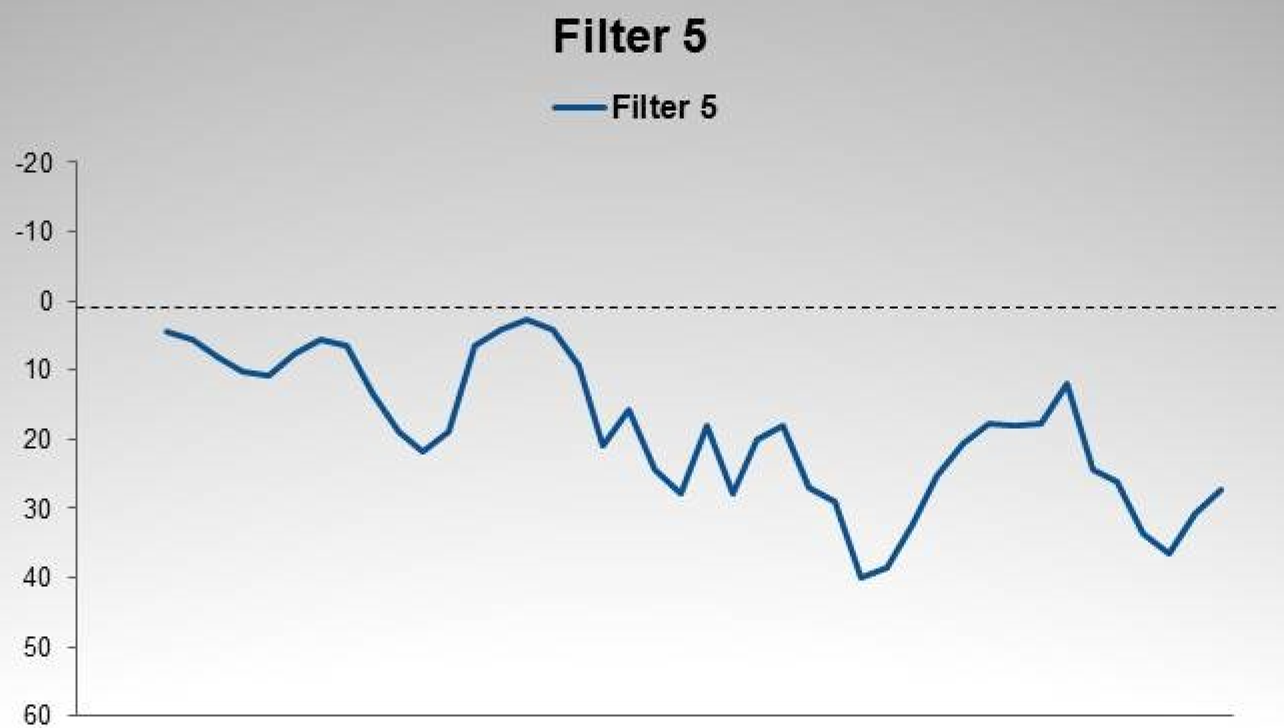
The filter strength settings for your Leakalyzer allow you to adjust the moving average period from 24 seconds (filter 5) to 3 minutes (filter 20). You will be able to tell how long the period is by noting how long the "initialization period" is at the start of the test. During this time the Leakalyzer is collecting enough data to generate the first point on the graph.



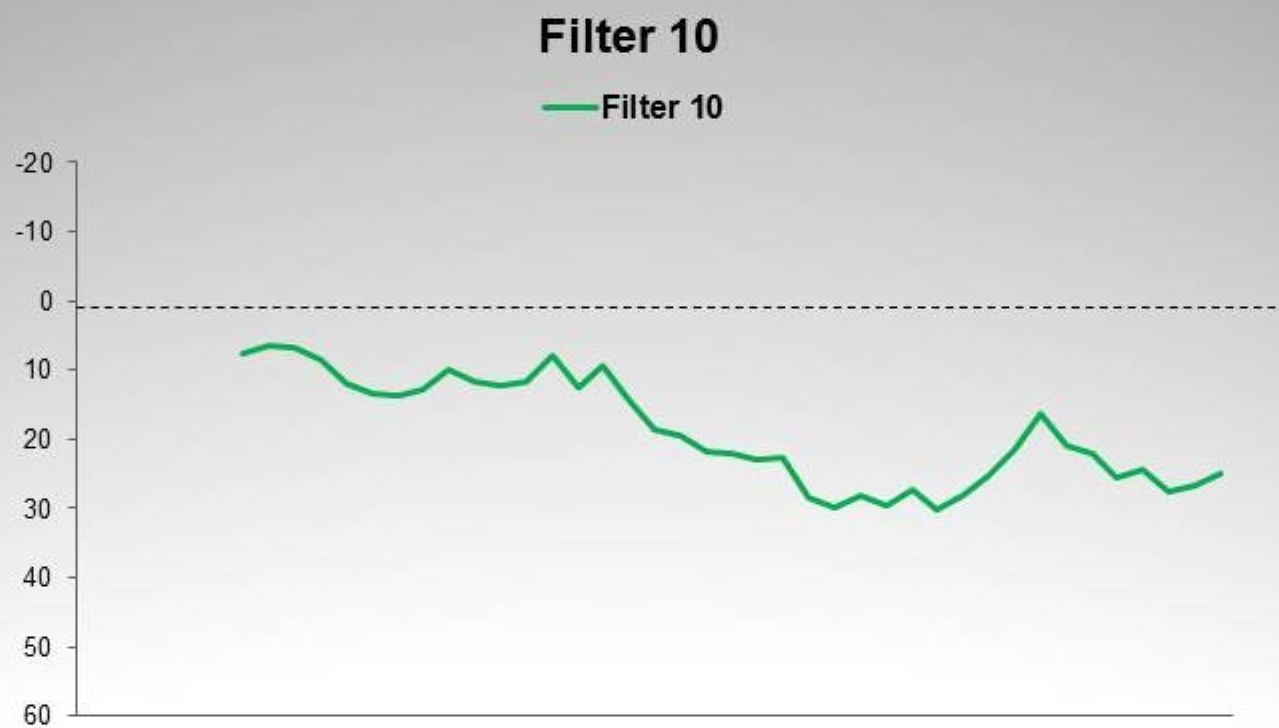
Effect of Filter on graph



Effect of Filter on graph



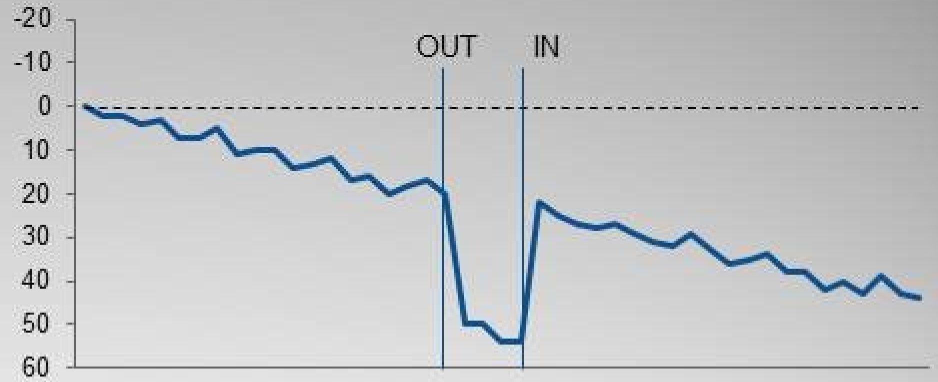
Effect of Filter on graph



Increasing Filter Strength Reduces Responsiveness

While increasing the filter strength will have the positive benefit of smoothing out the line, it will also make the graph less responsive to events happening at the pool. Sometimes it is beneficial to clearly display the effects of these events. Here for instance are the graphs that result from taking a gallon of water out of the pool and then putting it back in.

Low Range Filter



Mid Range Filter

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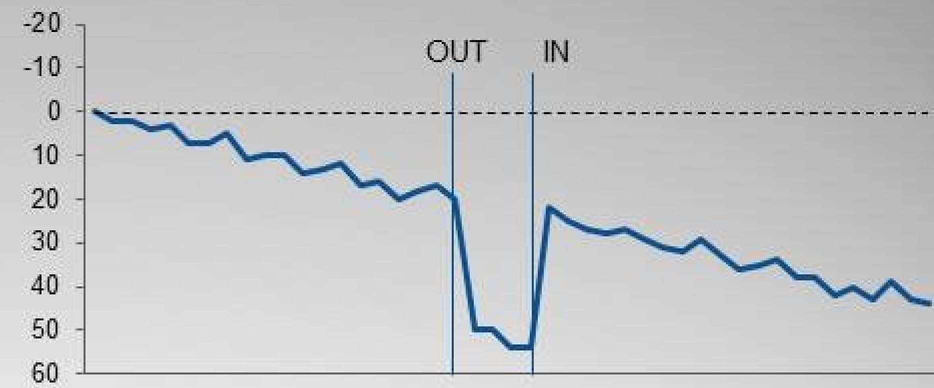
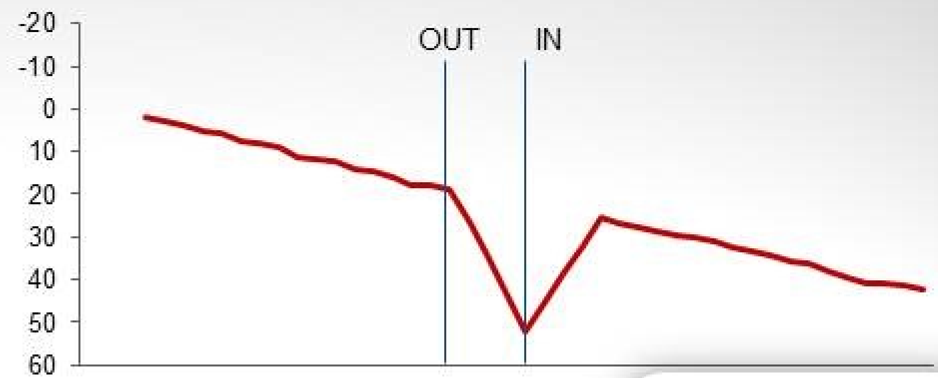
Increasing Filter Strength Reduces Responsiveness

We have marked the point at which water was taken out and then when it was put back in. As you can see, when the filter is set at a stronger setting it takes more time to see the full effect of the event and for the graph to "recover" to the regular pattern.

Low Range Filter



Mid Range Filter



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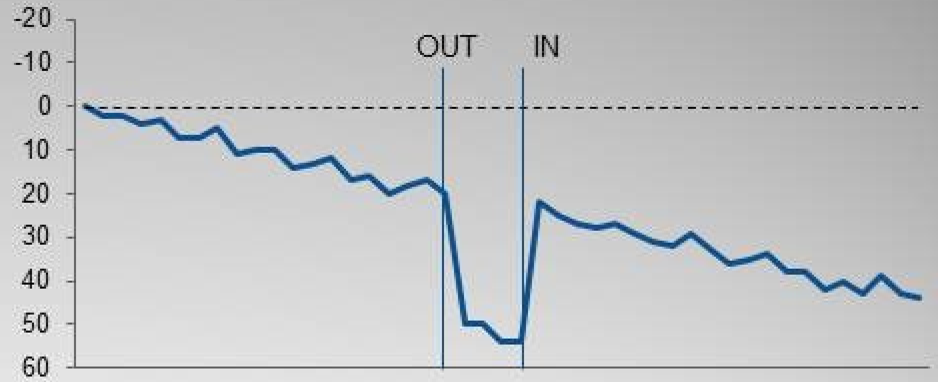
Increasing Filter Strength Reduces Responsiveness

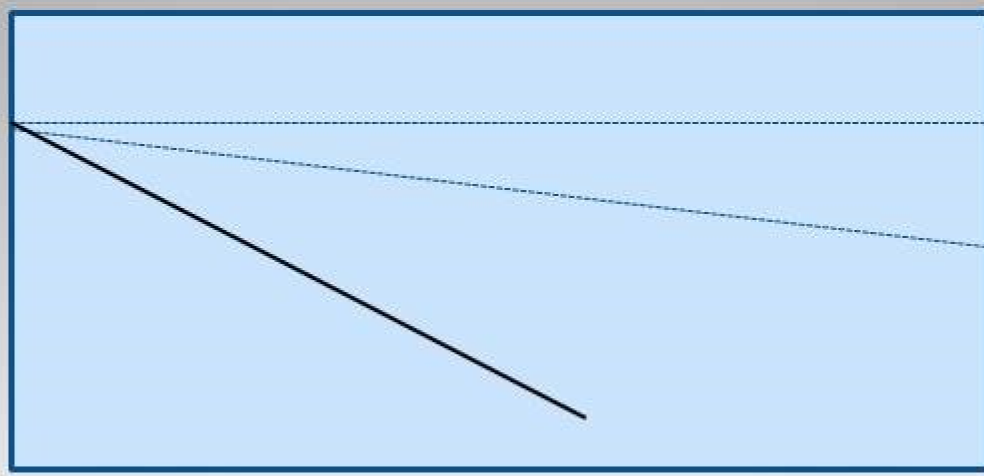
When the filter is set at a stronger setting the event may not even register as something distinct from the normal pattern. Therefore, especially for shorter tests where you are observing the pool while testing, we suggest using lower filter strengths and your own observation to "flatten" the "noise" while still being conscious of events that contribute to graph effects.

Low Range Filter



Strong Range Filter

Water loss to leaks and evaporation



Water leaks and evaporation effect the water level change at a constant rate when the pool is operated under consistent conditions. Assuming an absence of "noise" water loss due to leaks and evaporation will produce a straight, downwardly sloped line. The steepness of this line, or the degree of slope, will indicate the rate of water loss. The steeper the drop . . . the bigger the problem.

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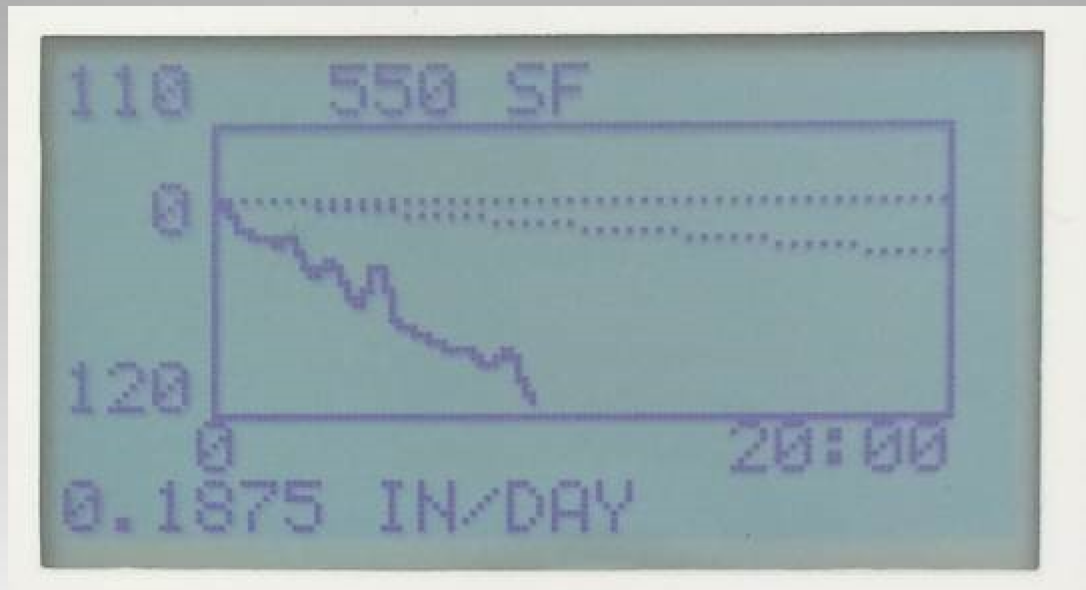
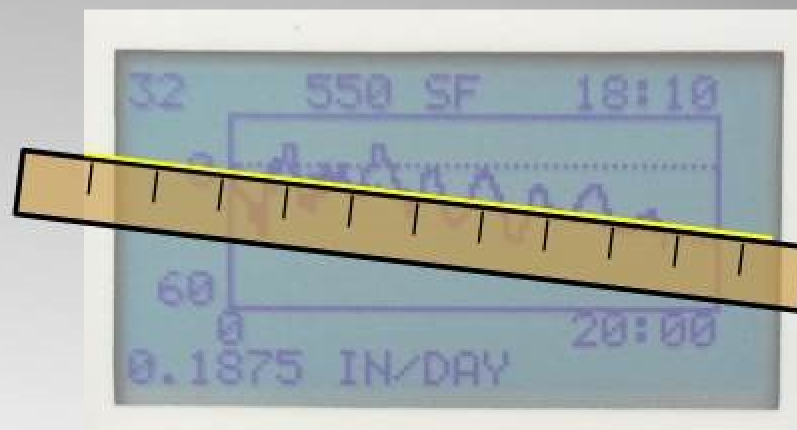
Identifying constant loss



Although the sensor capsule and the digital filter will reduce the effects of most turbulence. there will almost always be some "noise" recorded on the graph. Identifying the constant water loss due to leaks and evaporation requires us to imagine the "best fit" straight line that represents the data we're collecting.

What is a “best fit” line?



Like the term “moving average” we discussed earlier “best fit” is another mathematical concept that is used to help analyze graphed data. Basically it describes a **straight line** that has the least divergence from every point on the graph. Think about using a ruler to draw a line through a graph of points. The “best fit” line will be the one that is *on average* closest to all of the points.

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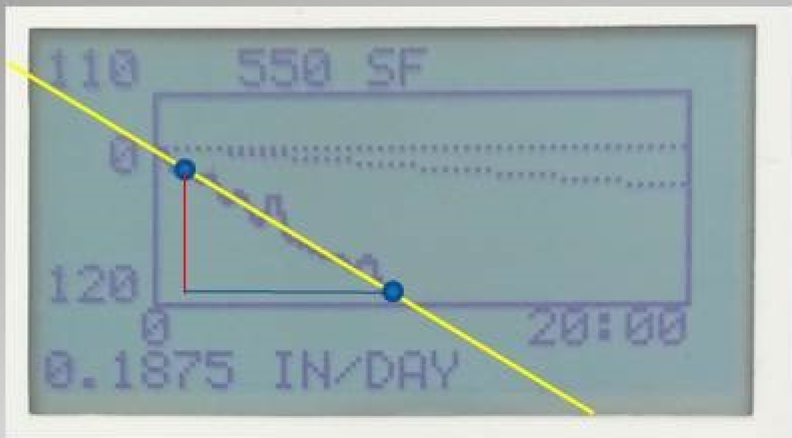
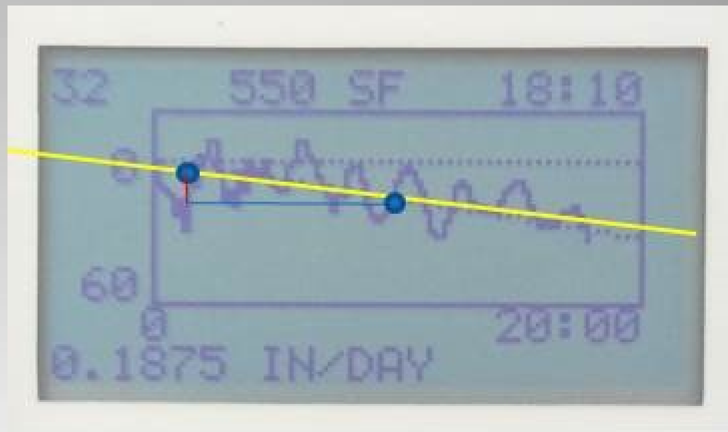
It's all about the slope of this best fit line

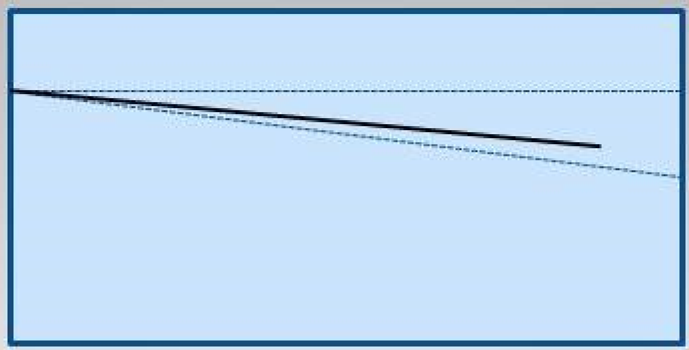




Slope is determined by comparing two points on aa straight line and comparing the change in x values vs. the change in y values.

It really doesn't matter where the last point in the graph is or whether the line is above or below the zero line. The most important thing to us is the slope of this best fit line (change in x units vs. change in y units). On a Leakalyzer graph the slope corresponds to water level change per period of time. The steeper the line the more severe the water loss.

Evaporation



Evaporation happens in virtually any uncovered pool and like a leak, will produce a consistently sloped downward straight line under consistent conditions. The Leakalyzer cannot distinguish between evaporation and a leak. However, because we can generally predict the evaporation rate, it is possible to compare the slope of our graph to what an expected line for evaporation would be. Any graph producing a more steeply sloped line than what would be expected for evaporation indicates a leak.

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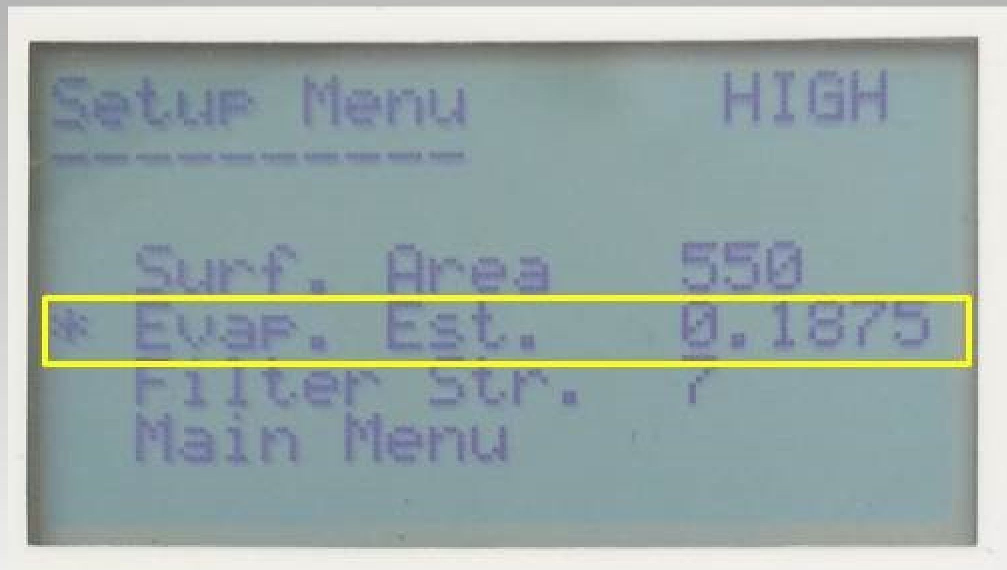
Evaporation



In order to establish a reference line on the graph to which we can compare our actual water loss an "Estimated Evaporation Rate" is entered into the Leakalyzer during the test set up. Normal evaporation rates vary due to environmental conditions but generally range between 1/8" – ½" per day.

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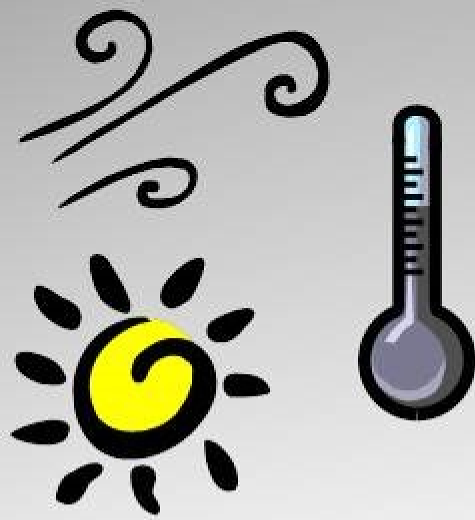
Evaporation rates are variable



Water Temperature

Wind

Air Temperature

Humidity

Water Movement

Evaporation is dependent on environmental conditions that can change from day to day and pool to pool. Wind is the biggest contributor to evaporation. On a windy day you can expect a higher evaporation rate. The online Evaporation Index Calculator at leaktools.com shows how current weather conditions in your area will effect the evaporation rate. As you use your Leakalyzer you will become more attuned to the conditions that contribute to evaporation and therefor more accurate in your estimates.

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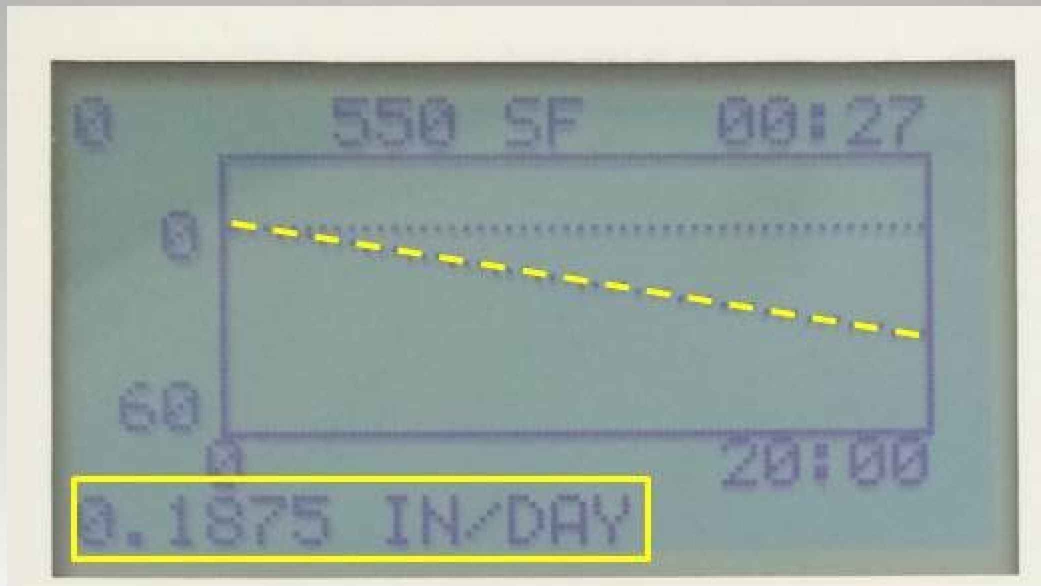
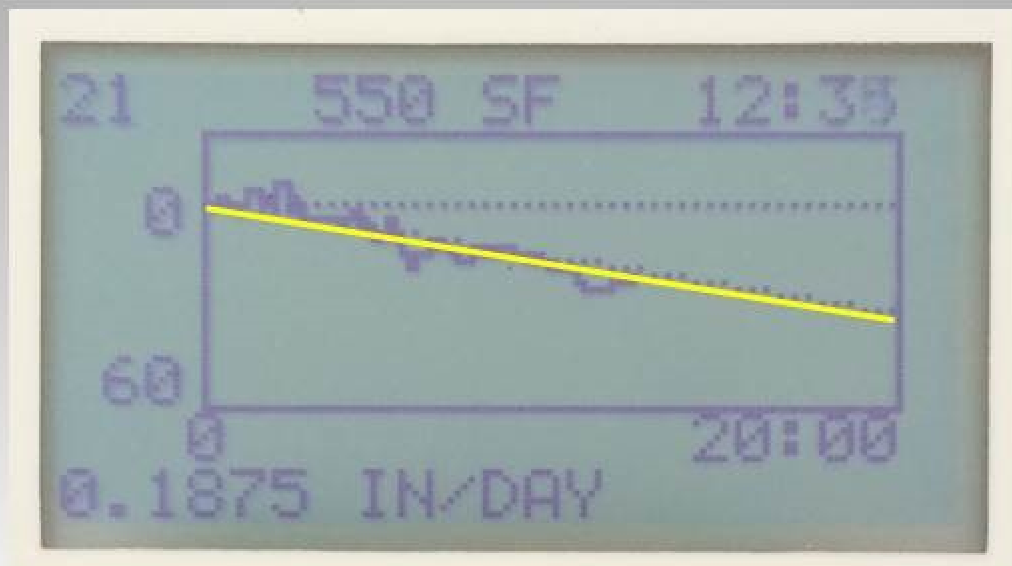
Evaporation estimate reference line



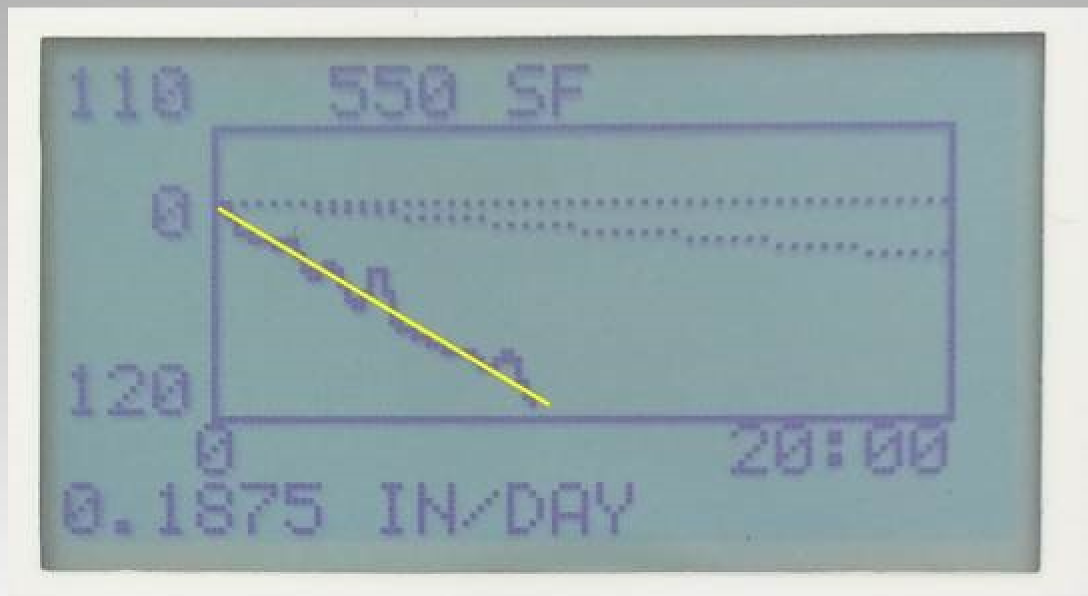
Once the graph screen is displayed the number entered as an evaporation estimate will appear at the bottom of the screen and a dashed reference line will appear on the graph.

Compare actual data to reference line



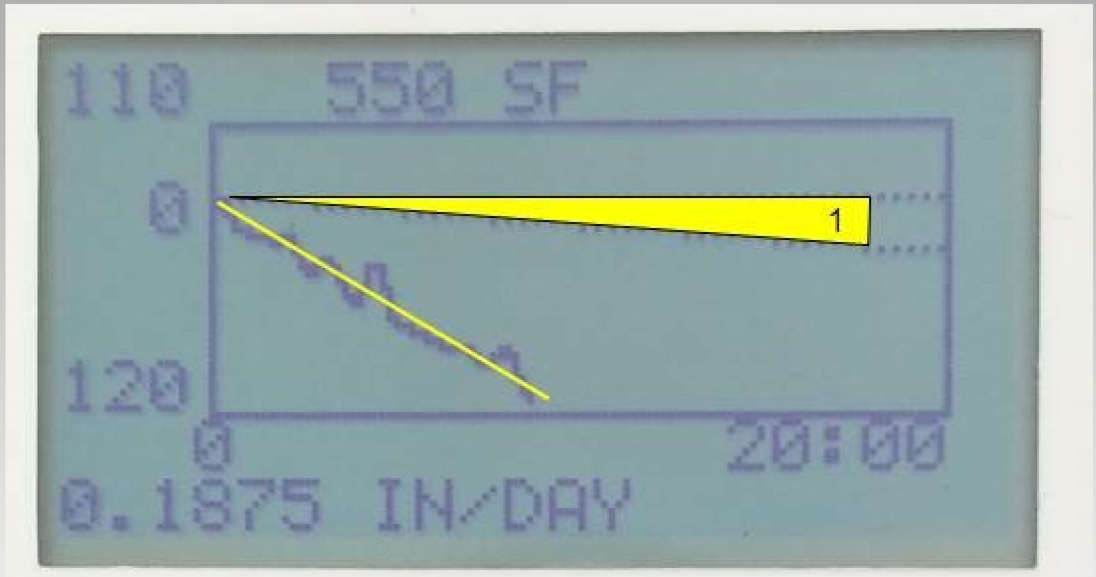
If the slope of the "best fit" straight line that representing the plotted graph is flatter or more shallow than the reference line we can assume that the water loss is within a range you considered to be normal evaporation. The graph above shows the measured water loss to be very close to what was expected for evaporation. Assuming our evaporation estimate was accurate it is likely that this pool does not have a leak.

Water Leaks



When a pool is leaking at a faster rate than evaporation the plotted line will be at a much steeper slope than the evaporation estimate line. Once we have run the test long enough that we can discern a constant slope (a representative "best fit" line) we can estimate the rate of water loss two ways.

Estimating leak rate



The first is by simply looking at the graph and visually comparing the slope of the plotted line to the known slope of the evaporation index. We know the rate of water loss of the evaporation line (.1875"/day). If we consider the area between the 0 line and the evaporation line as a "piece of pie," and then figure out how many pie wedges would fit between the 0 line and our plotted line, we can multiply this rate by the number of wedges to estimate the total water loss at the pool.

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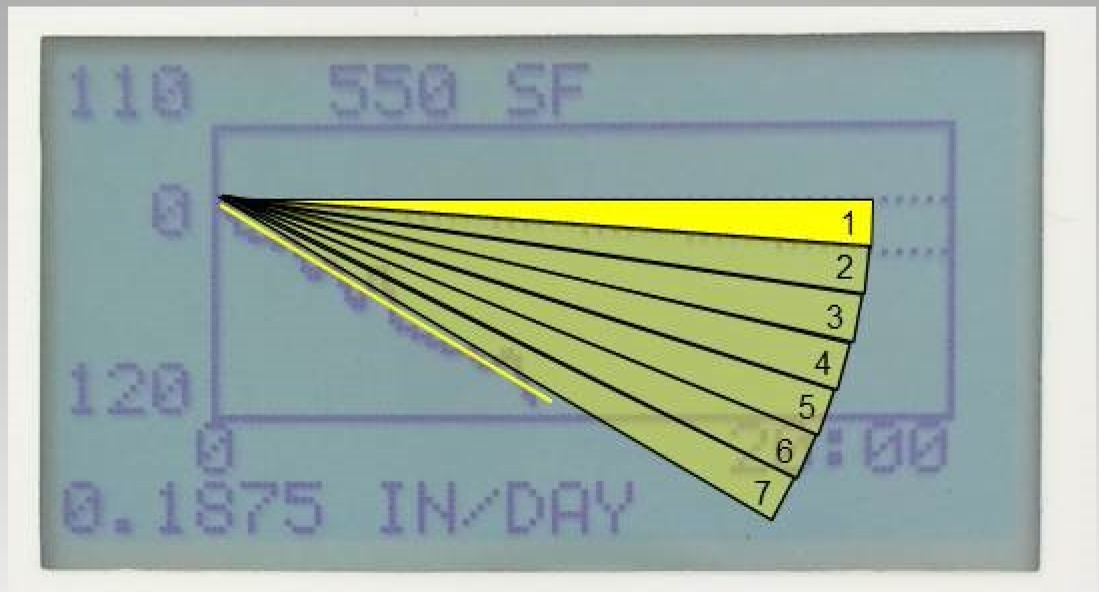
Estimating leak rate



In this case, we can fit a little more than 7 pie wedges (each of them equivalent to .1875" per day) between the 0 line and an imaginary "best fit" line of our graphed data. As a result we would estimate that we are loosing at a rate of a little more than 1.3 inches per day.

.1875" x 7 = 1.3125"

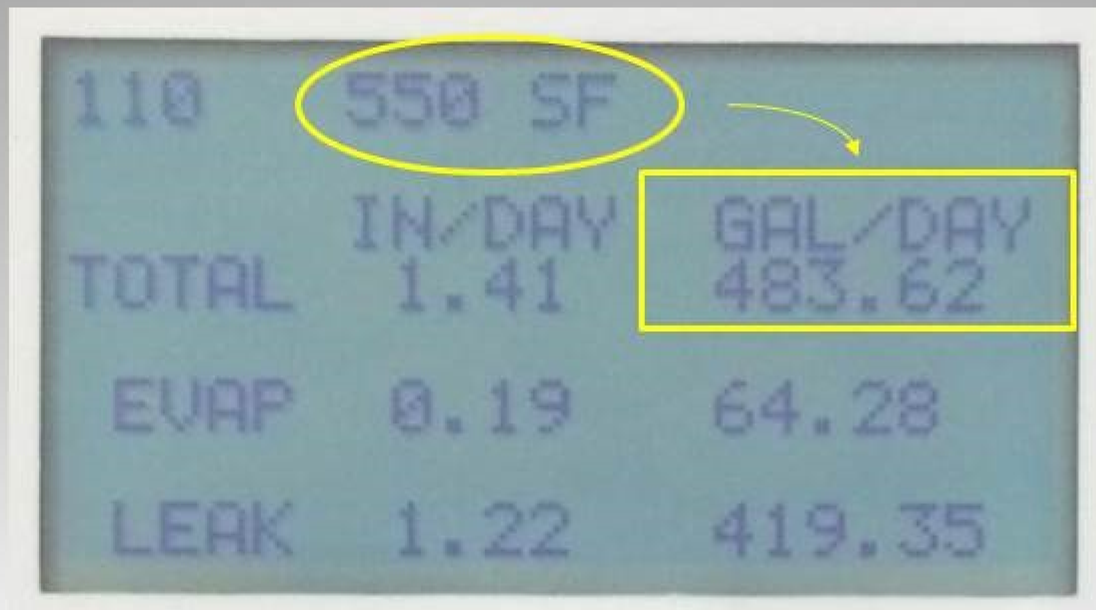
Estimating leak rate

Use the up or down arrows to toggle between values shown in per **day** or per **hour** units

The other method of determining water loss is to let the Leakalyzer calculate it for us. By pressing the "Detail" button during your test you will be shown what the Leakalyzer "thinks" the pool is losing. As you can see the Leakalyzer has calculated a rate of loss very close to what we calculated by looking at the graph.

Estimated from graph: a little more than 1.31"/day
Detail Screen calculation: 1.41"/day

Estimating leak rate



In addition to calculating the loss in inches the Leakalyzer will also use the surface area value you input at the set-up stage to calculate the loss in gallons..

1.41" water loss x 550 square feet x .62 gallons per inch per square foot = 483.62 gallons

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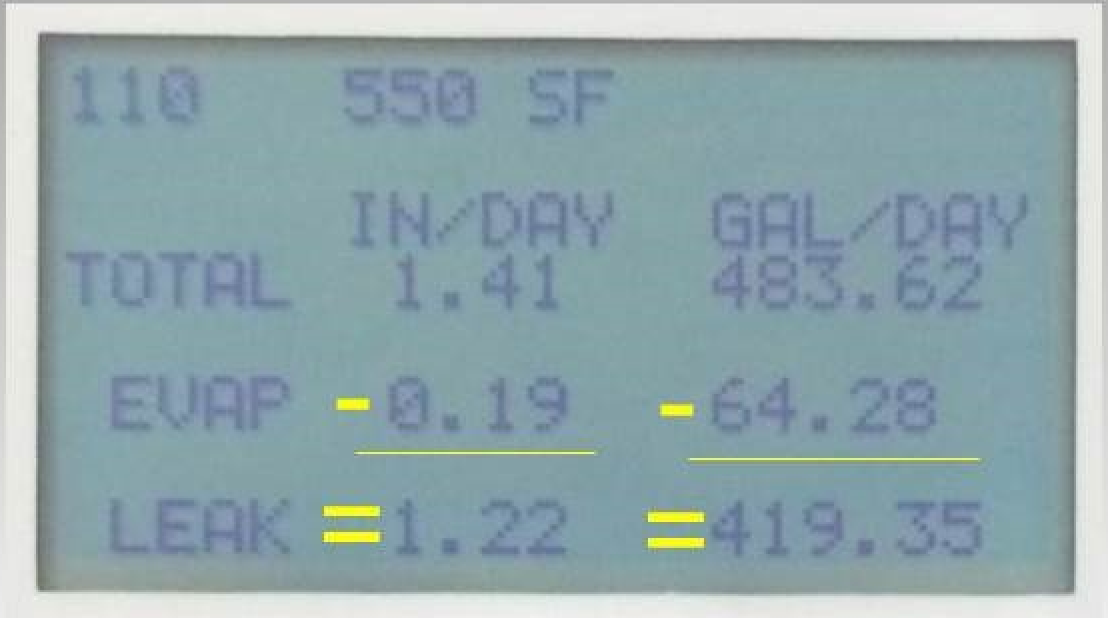
Estimating leak rate



The second and third lines help us account for evaporation. The second line shows the evaporation estimate you entered at test set-up. The bottom line labeled "LEAK" is what is left of the total loss after the evaporation amount has been subtracted. You can press the "Detail" button again to return to the graph screen.

How the Leakalyzer calculates water loss from collected data

The Leakalyzer uses a mathematical algorithm to determine the slope of a best fit line that represents all data since the start of the test. The devices processor can mathematically calculate this number very efficiently but it cannot determine if the data collected is representative of the problem at the pool. This is where your ability to factor in other observations and experience will come into play.

Before depending on results shown on the detail screen it is important for you to assure that the collected data seems representative of what is happening at the pool and will produce a good best fit line. Generally this means running the test long enough to be sure that the trend is not just noise, and assuring that all of the data aligns with a consistent pattern.

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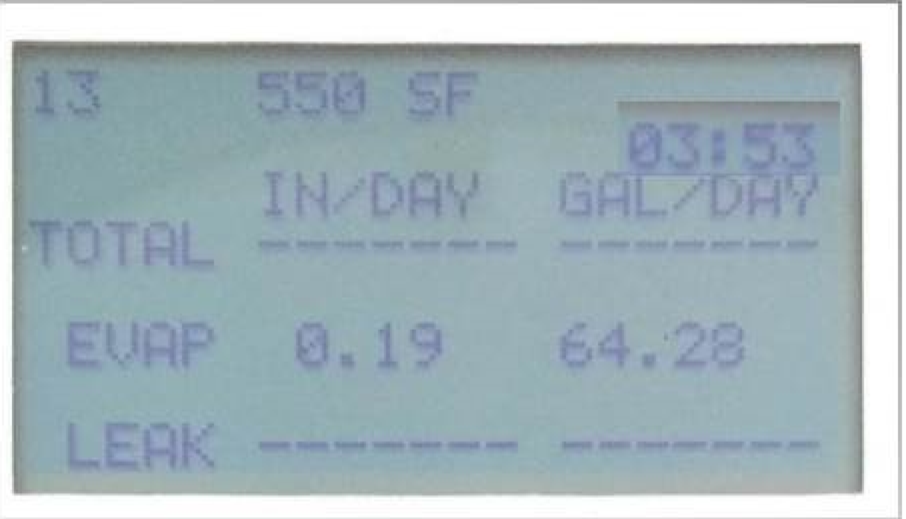
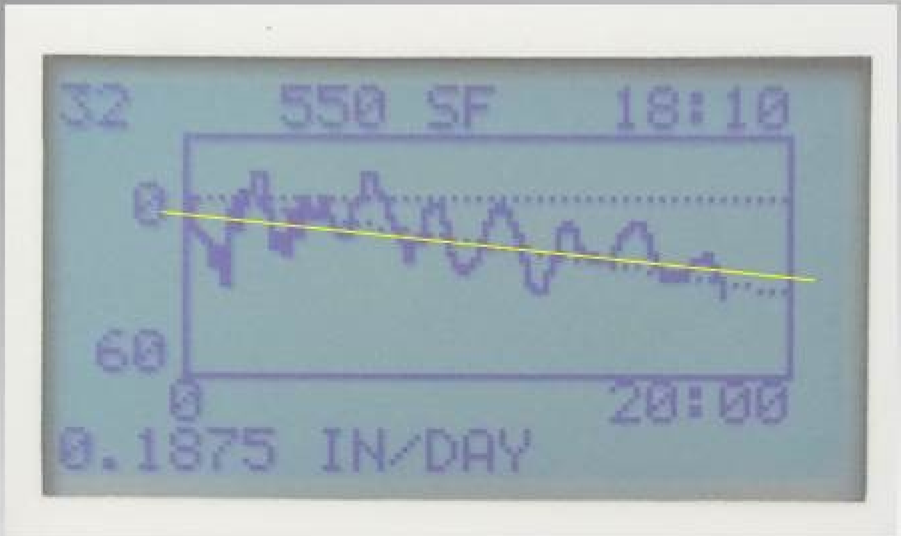
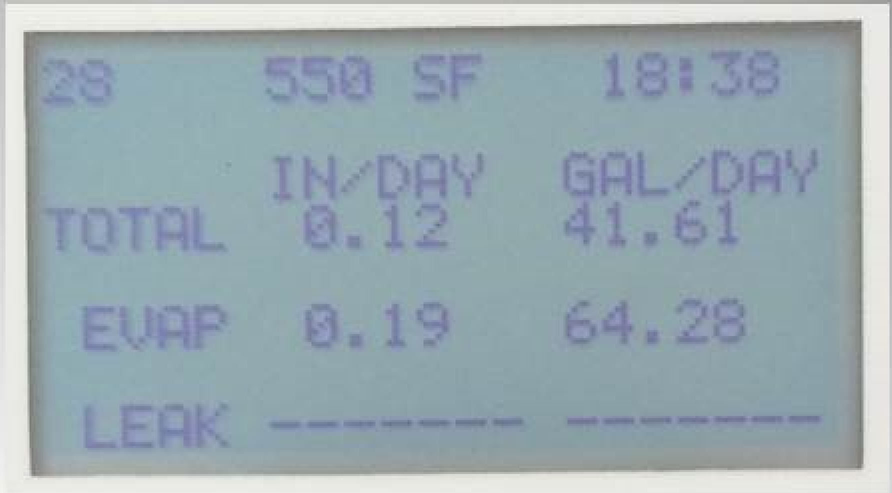
Early estimates may not be accurate



The best fit line used to produce results on the detail screen will not be accurate during the first several minutes of the test because of unavoidable "noise" and other events. Remember what the graph looked like at the beginning of the test we first looked at? If we were to press the detail button at this point in the test the Leakalyzer would conclude that the pool was gaining water (upwardly sloping best fit line).

Detail calculations will be accurate when a trend becomes discernable





Once a recognizable trend has developed, and you can be pretty sure that future points on the graph will fall within that trend, pressing the detail button should give accurate results. In this case the best fit line calculates water loss that is less than what we thought evaporation would be. So it is telling us that we are not losing water to a leak. This graph however is showing a pattern that indicates another common problem . . . .

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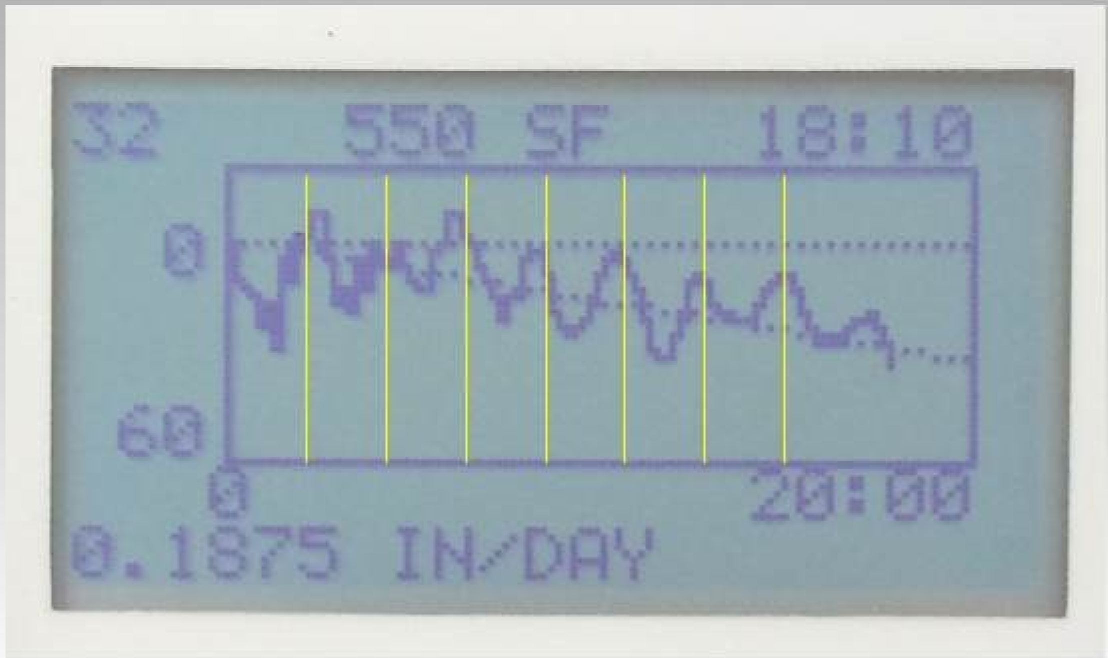
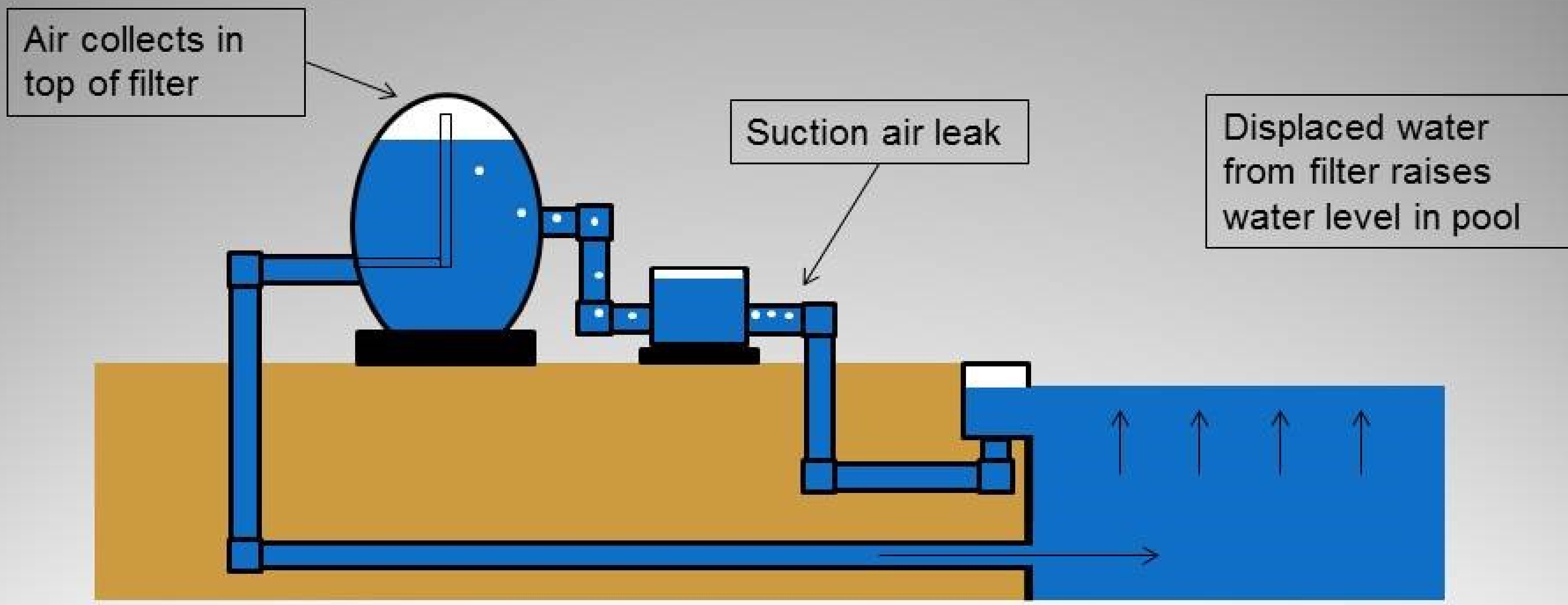
Regular pattern of peaks may indicate suction leak



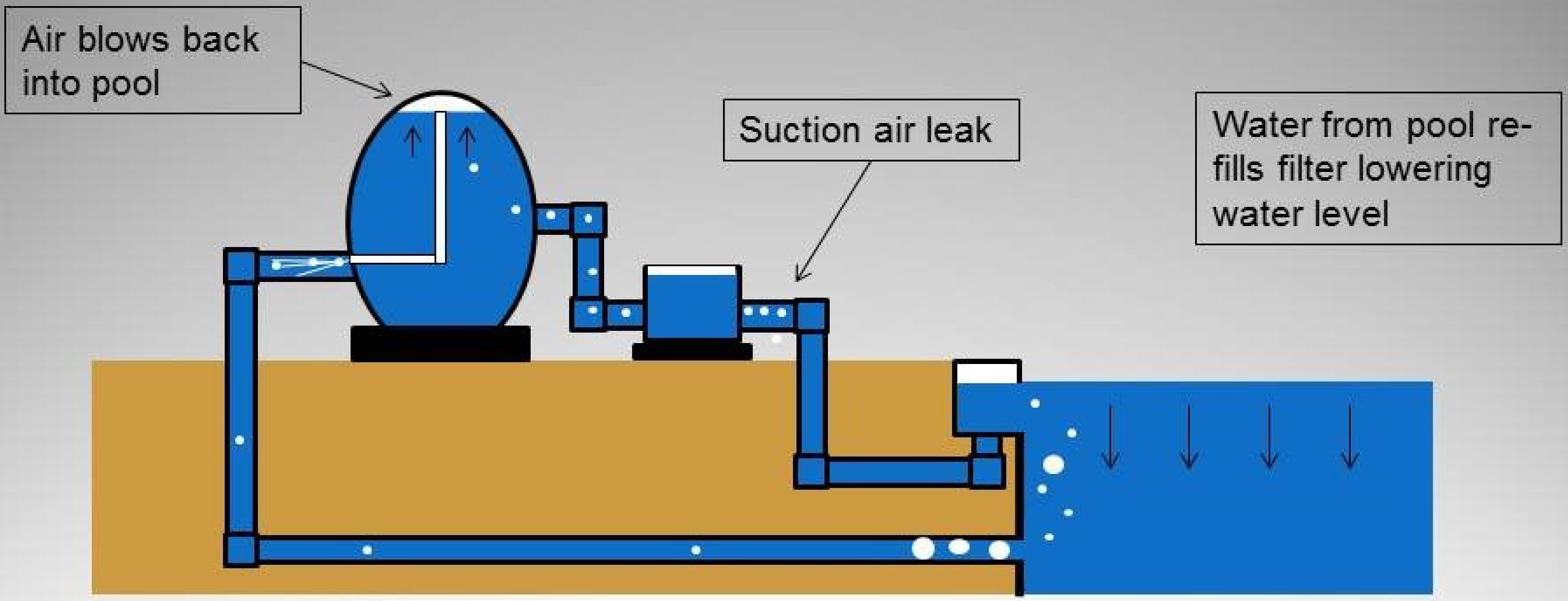
Note how the peaks and valleys of this graph occur at regular intervals. Although there is also some “noise” seen in this graph, this regular pattern is created by something other than noise. Generally this regular “peak and valley” pattern happens when the pool is operating and there are suction side air leaks.

Effect of suction side air leaks



Air is pulled into the plumbing system through leaks in the suctions side plumbing and accumulates in the filter and pump – displacing water that goes into the pool.

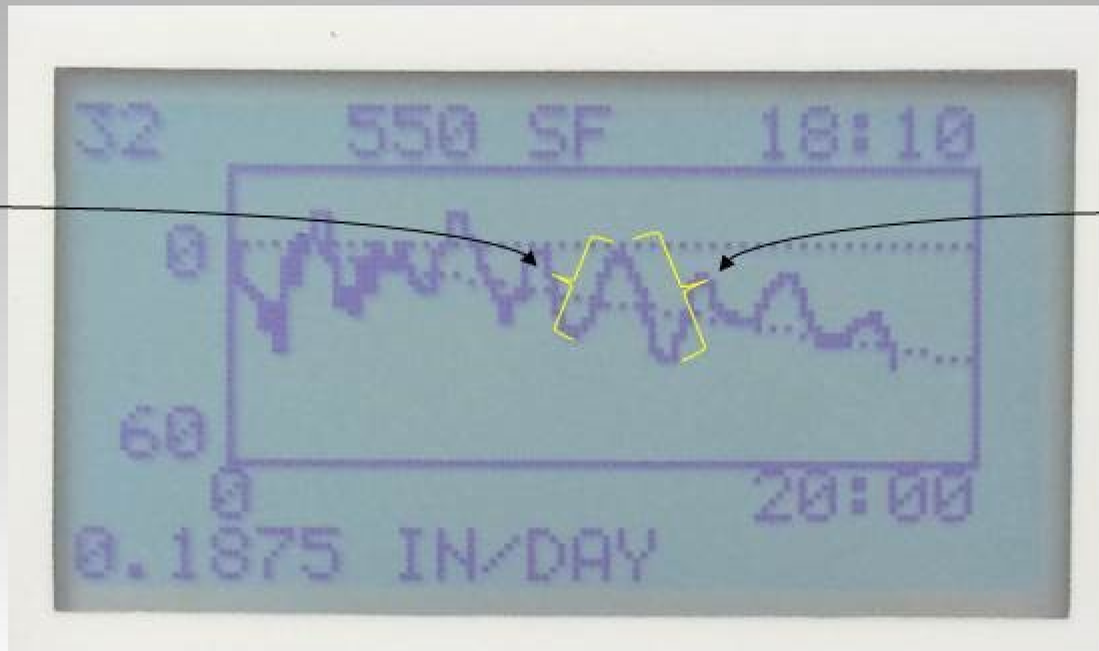
Effect of suction side air leaks



When too much air is collected in the filter the air is eventually expelled through the filter's air relief tube back into the atmosphere through the pool. As this happens pool water fills the filter back up thus lowering the water level in the pool.

Regular pattern of peaks may indicate suction leak

Pool level rises as air is pulled through leak and fills filter causing displaced water to enter pool.



Pool level drops as air is expelled through returns and water re-fills filter and pump.

The Leakalyzer records this phenomena. As air is pulled into the plumbing system and collects in the filter water is displaced into the pool causing the graph to rise. When the air is eventually expelled as bubbles through the returns the displaced water returns to the filter from the pool causing the graph to drop and the process to start all over again.

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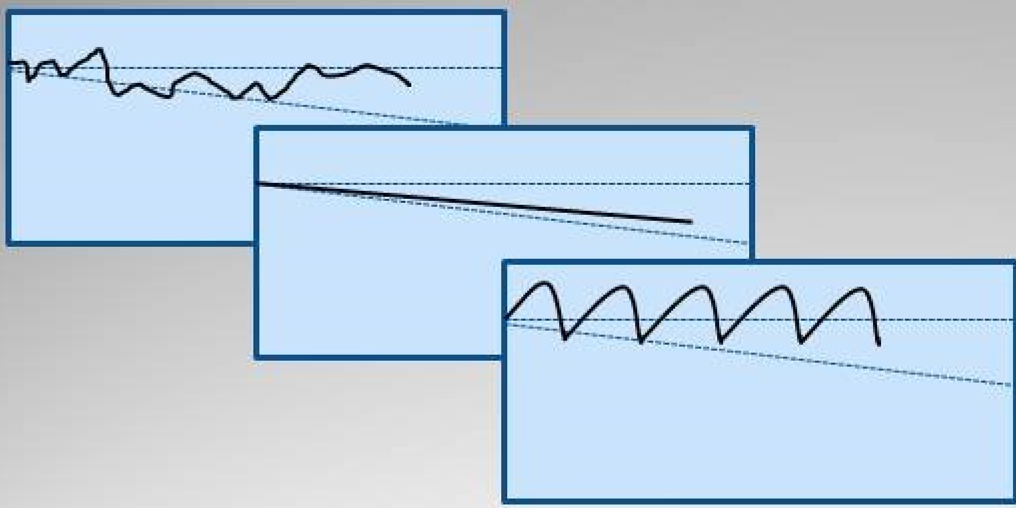
Multiple patterns = lots of info



Noise + *Evaporation* + *Air Leak* = *Information Rich Graph*

So this graph is telling us that under the conditions tested (pump running) the pool is losing some water but not more than what we thought evaporation would be and that it likely has a suction side leak air leak. Confirmation of this of course would be possible through observation of the pool.

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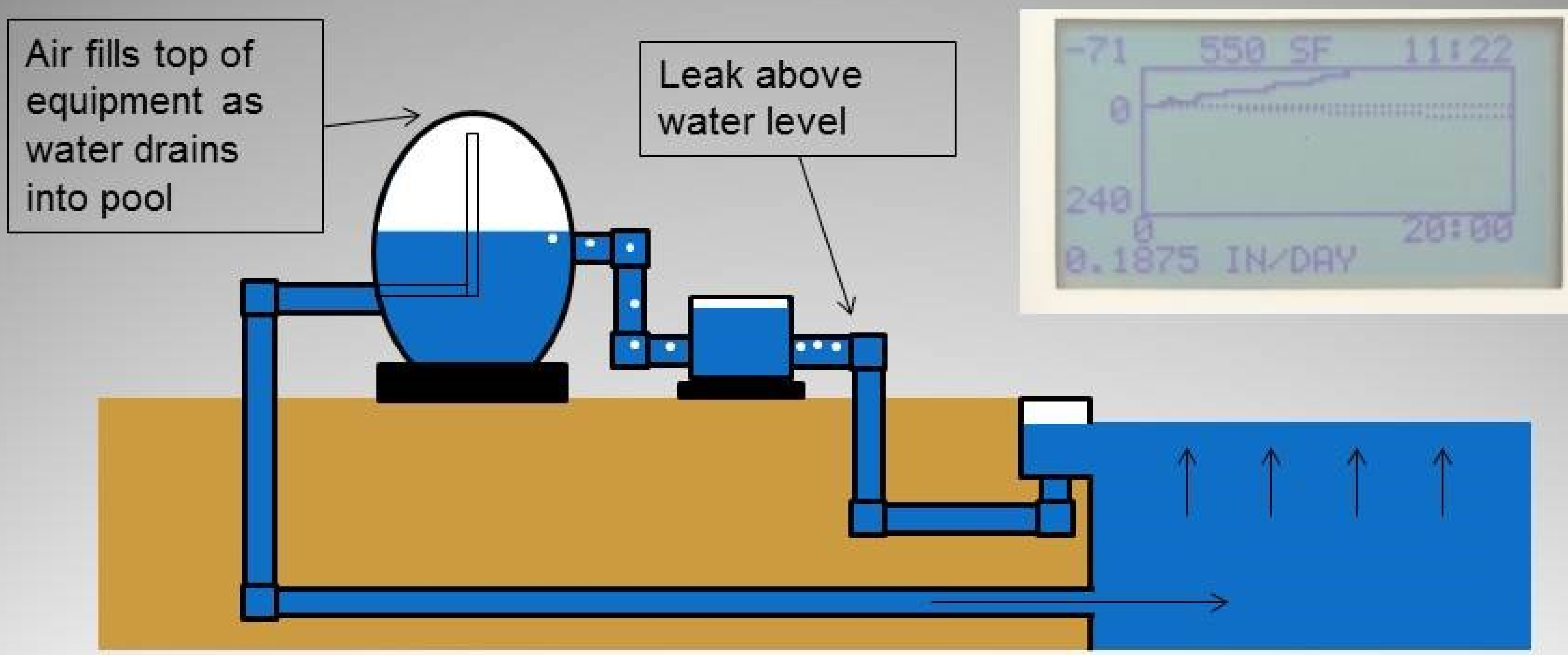
Water draining into pool



Further analysis can be done by doing a Leakalyzer test right after the pool equipment has been turned off. Water trapped in the above water level plumbing and equipment actually experiences a suction force as gravity pulls the water back to the pool. Any leak in the plumbing or equipment above pool water level will allow air into the system enabling water to actually drain into the pool. The draining water increases the water level in the pool at a constant rate.

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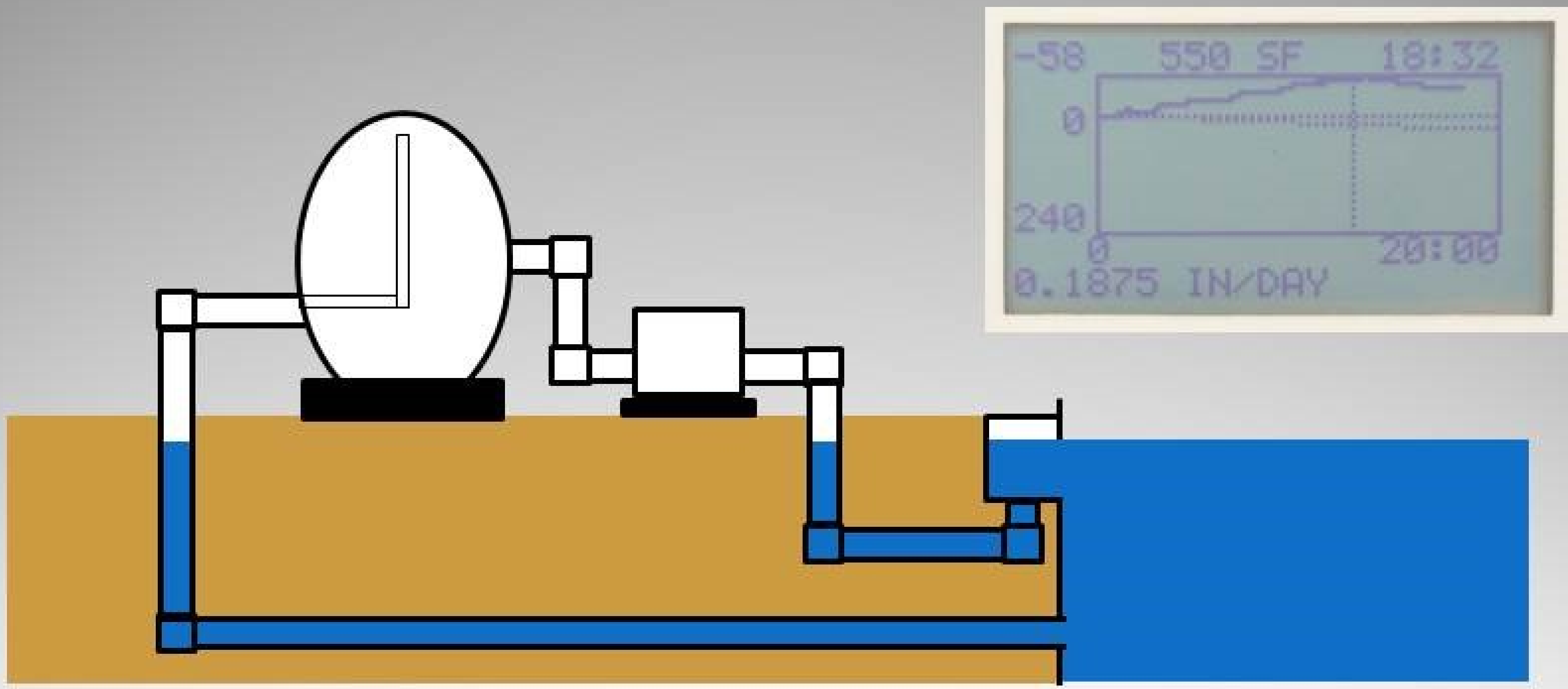
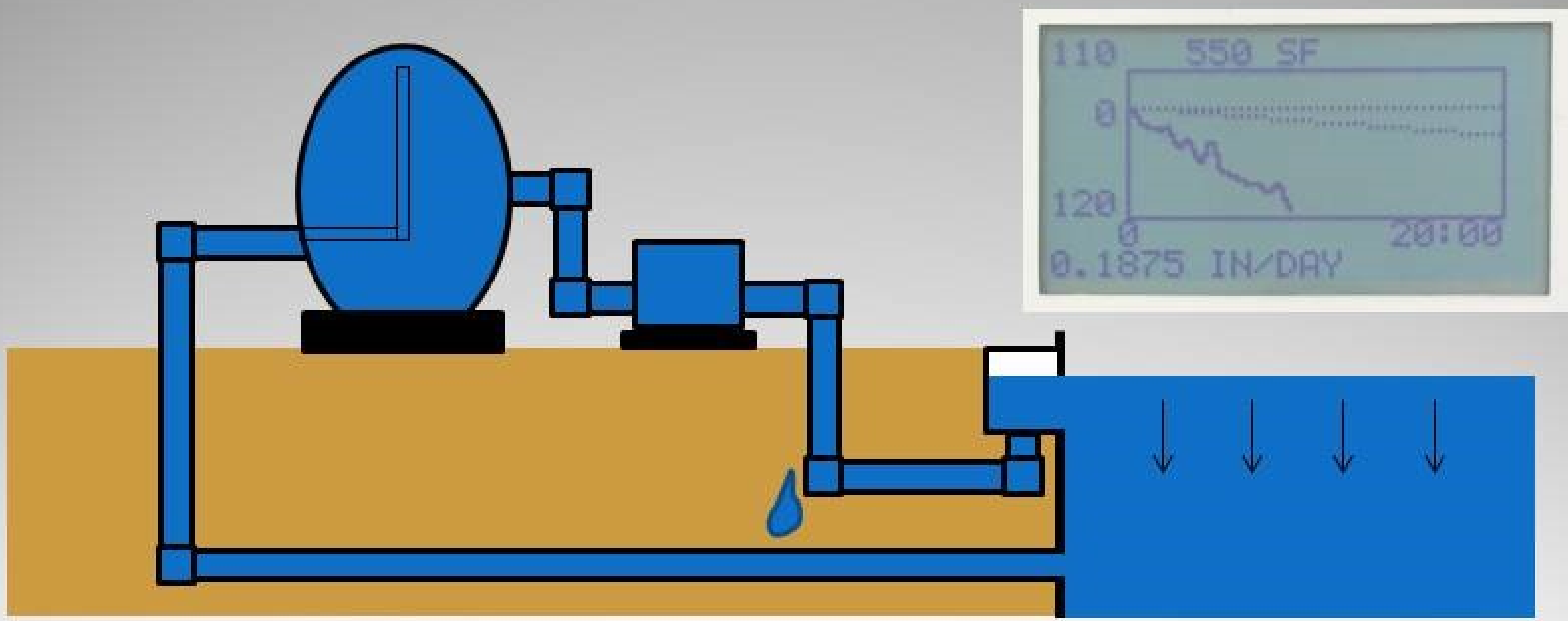
Water draining into pool



Water will drain into the pool until all water above pool level has entered the pool. At this point the water in the pool will stabilize or begin dropping due to underlying evaporation or additional below water level leaks.

Water loss after pump turned off



A leak in below water level plumbing or pool, but without any air leak in the above water level plumbing, will result in water level drop even directly after the pump has been turned off. This is because all water in the above water level plumbing will stay in the pipes if there is no way for air to enter the system allowing that water to enter the pool.

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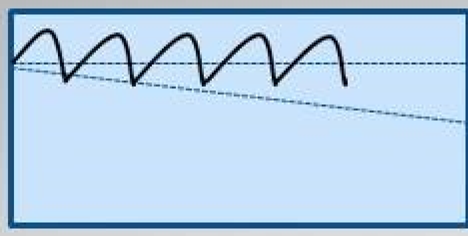
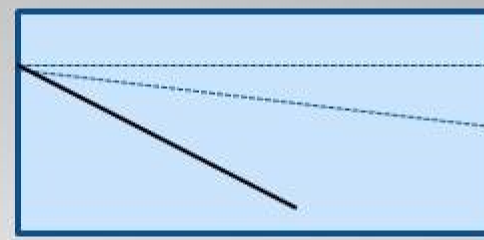
Location suspicions based on readings before and after pump is turned off

If a pump-running test looks like this:

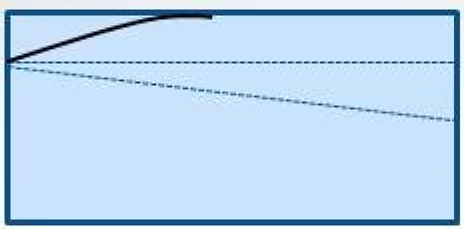


Suspect a
suction side leak

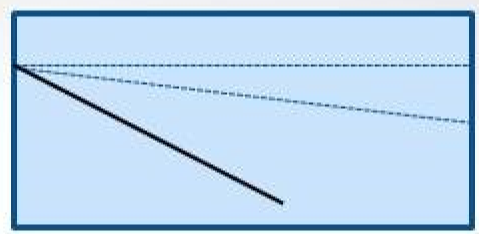


Suspect a
pressure side or structural leak

If the test then looks like this right after the pump is turned off:

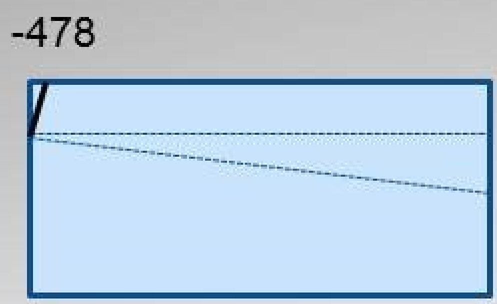


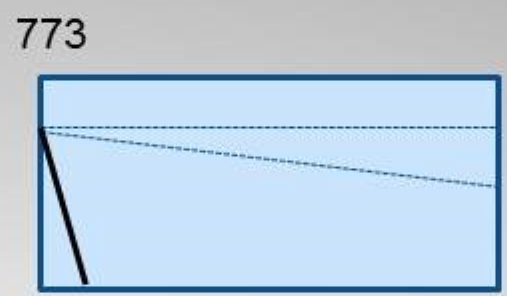
Suspect that leak to be
above pool water level



Suspect that leak to be
below pool water level

Confusing results unrelated to pool level changes





Sometimes when you first start a test the line will quickly extend off of the top or the bottom of the graph. This situation will be accompanied with numbers in the upper left that are well outside of the largest graph scale of -80 to 240. While this could be the result of excessive water change in the pool, it is more likely because of water level changing inside the capsule after the device has been set up or moved. Make sure to open the valve at the bottom of the capsule when first installing the capsule so it can quickly fill. You need for your data to be visible on the graph so the best thing to do in this situation is to "RESTART" the test.

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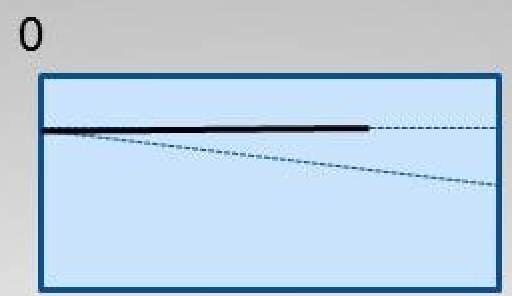
Confusing results unrelated to pool level changes



Sometimes you may notice that the line never leaves the absolute zero position. One possible reason for this is that the capsule is too high and/or water has not entered the capsule enough to engage the float. Make sure the valve in the bottom of the capsule has been opened to allow water into the capsule and make sure that the water level of the pool is within the blue line of the capsule. The other reason for this may be more serious mechanical problems inside the capsule that may require factory attention.

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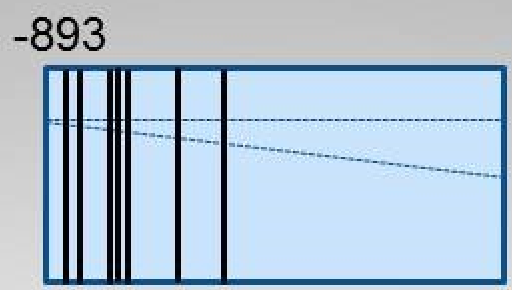
Confusing results unrelated to pool level changes



When the Leakalyzer is properly measuring "noise" in the pool it will result in changes that cause the number in the upper left to change by single digits or possibly lower double digits each reading. However, if you notice this number changing by triple digits each time a new number is recorded this indicates a problem. Your graph may look like the one above. This is generally a result of moisture affecting the electronics of the unit most likely at the 5 pin connector that goes between the capsule and the handheld device. Dry these connectors in front of a hair dryer or car heater to bake out any moisture that may be causing problems and try it again.

For best results when interpreting your Leakalyzer data:

- Understand how the scale of the graph can effect graph appearance
- Let the test run long enough to recognize a pattern in the line
- Disregard "noise" created by random pool motion
- Practice identifying the slope of the "best fit" line to determine rate of loss
- Consider the effect that changes to pool operation may have on pool level
- Recognize that there is a reason for most every change to the graph

Contact us if you have any questions: 800-348-1316

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