Polar Curve Scoring: Analysis and Assessment following the NYYC Annual Regatta

Submitted by Eric Johnson and Paul Zabetakis

According to ORC, *"Polar Curve Scoring is the most powerful engine of the ORC rating systems. Its unique feature, making it fundamentally different and much more precise from any other handicap system, is its capacity to give and rate different handicaps for different race conditions because yachts do not have the same performance in different wind strengths and directions."* Following an extensive review of this methodology, the authors believe that ORC is correct.

The key the difference between using **Performance Curve Scoring** (PCS) versus the **5-band Wind Speed** methodology is that PCS takes out of the equation any arbitrary decision about wind speed (TWS) and bases the scoring on actual boat performance.

- **5-Band Methodology:** In this scoring method, the **starting point is an assumed wind speed** (TWS) chosen by the RC to which performance and corrected times are then calculated.
- **Performance Curve Scoring:** In contrast, PCS uses the **actual boats performance**, as measured by elapsed time sailed around a predetermined course, and then by using an "index of performance" (aka "implied wind or scoring wind") calculates corrected times for each boat in the fleet.

It is this use of the term "implied" or "scoring" wind that causes the most confusion. To understand PCS, one must embrace the concept that "scoring wind" is **not an actual measure of wind**. Rather it is an **index of performance**. That is to say, the "scoring wind" is an **index** of all the factors that go into performance: boat preparation, boat handling, sail selection, hiking, picking up wind shifts, avoidance of unnecessary boat-on-boat interactions, quick and clean spinnaker sets and douses, to name a few. **In other words, this "scoring wind" or perhaps better referred to as a "scoring index" is a measure of your boats performance in the race and how fast you complete the course distance.**

Polar Curve Scoring relies on the following key components"

1. **ORC certificates** provide a range of ratings with the time allowances expressed in sec/nautical mile (SPM)
2. **Courses**: the type of course can vary and include:
   a. W/L (50% each of upwind and downwind),
   b. All-Purpose (includes equal distribution of all wind directions)
   c. Constructed: Data from each leg is used: wind direction, length and direction of each leg
3. **Performance Curves:** each boats performance curve is calculated using the type of course and associated time allowances given in the boats ORC certificate:
   a. **Vertical Axis**: represents the ***"Elapsed Time"*** in SPM to complete the race.
   b. **Horizontal Axis**: represents the wind speed in knots.
      i. **NOTE:** once these curves are created the horizontal axis is NO LONGER TWS – RATHER IT IS AN **INDEX OF PERFORMANCE**

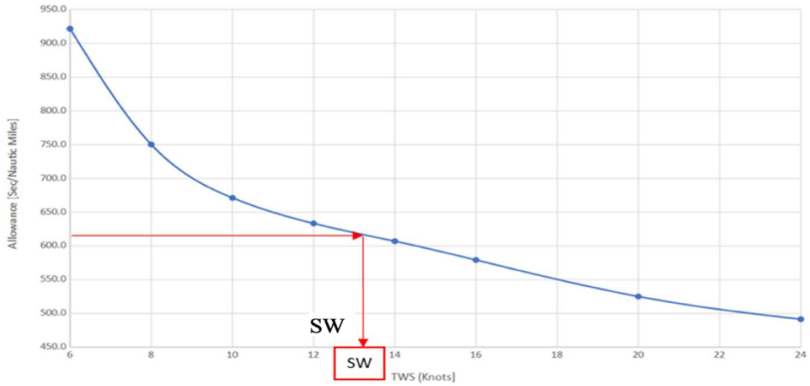


Figure 2: Performance Curve

Once the curves are generated, the horizontal axis is no longer TWS. Rather it is an index of performance referred to as a **"Scoring Wind"** (SW).

As the authors point out, PCS uses the "scoring wind" as an index of performance. The relative values of that index can be used to determine ordinal places in the standings. To express results in a manner which most sailors are used to (viz. Corrected Time) and additional step is taken to derive "Corrected Time" based on "Scoring Wind". This is described below.

Corrected Time Calculation:

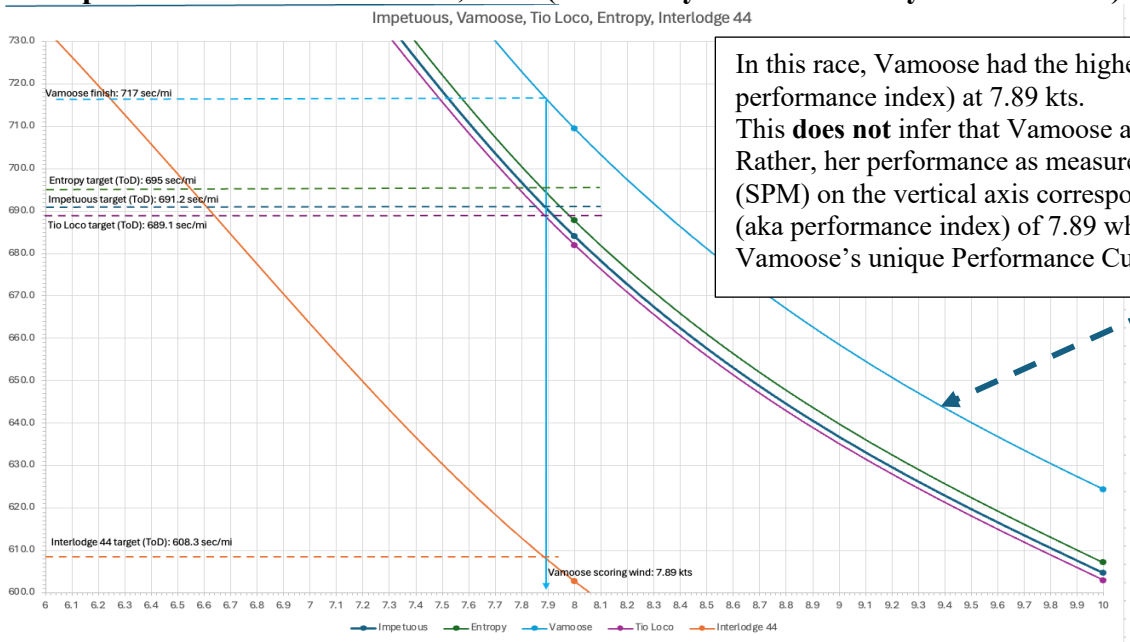
1. **Elapsed Time**: The elapsed time (in SPM) for each boat is plotted on the vertical axis and the corresponding "scoring wind" or "performance index" is shown on the horizontal axis.
2. **"Scoring Wind"**: The "scoring wind" **represents the boat's performance on the course**. The faster the boat has sailed, the higher the "Scoring Wind", which is the primary index for scoring.
3. **Time-on-Distance (ToD):** The ***highest*** "Scoring Wind" (or Performance Index) of any boat in the race is then used as the wind speed for corrected times calculations.
   - Using the **highest "Scoring Wind/Performance Index"** on the horizontal axis, the appropriate time allowances are determined on each boat's individual curve on the vertical axis.
   - Such a time allowance is then used as a single number **Time-on-Distance** coefficient
4. **Corrected Times:** Each boats Corrected Times are then calculated using as a single number Time-on-Distance coefficient:

Corrected time is calculated as follows:

Corrected time = Elapsed time – (ToD Delta * Distance)

Where **ToD Delta** = ToD the boat – ToD the **fastest boat** in the fleet
(NOTE: the corrected time of the boat having the fastest ToD in the fleet will be equal to her elapsed time)

Example: ORC C Race 3 June 16, 2024 (data analysis conducted by Eric Johnson)



In this race, Vamoose had the highest "scoring wind" (aka performance index) at 7.89 kts.
This **does not** infer that Vamoose actual sailed in 7.89 kts. Rather, her performance as measured by **elapsed time** (SPM) on the vertical axis corresponds to a "scoring wind" (aka performance index) of 7.89 when plotted against Vamoose's unique Performance Curve (blue curve)

Scratch (fastest) boat: Interlodge 44 with a ToD = 608.3 sec/mile

Boat	Elapsed (min)	Elapsed (sec)	Elapsed seconds	Sec/mile (actual)	TOD (target)	Corrected time (sec)	Corrected time (mm:ss)
Vamoose	57	22	3442	717.1	717.1	2919.76	48:40
Entropy	55	43	3343	696.5	695.0	2926.84	48:47
Impetuous	55	27	3327	693.1	691.2	2929.08	48:49
Tio Loco	55	28	3328	693.3	689.1	2940.16	49:00
Interlodge 44	50	35	3035	632.3	608.3	3035.00	50:35

NOTE: While the above was plotted to show how the PCS works, there is a computer program that runs the analysis.

NOTES (www.orc.org):

1) With Time-on-Distance (ToD) scoring, the coefficient of time allowance of one boat will not change with wind velocity but will change with length of the course. One boat will always be giving to another the same handicap in SPM, and it is easy to calculate the difference in elapsed time between two boats needed to determine a winner in corrected time.
2) The "Scoring Wind" for the winning boat normally approximates the predominant wind strength for the race. However, in cases where the "Scoring Wind" does not represent fairly the real wind strength during a race, the wind strength may be determined by the Race Committee.
3) All the formulas for course and performance curve construction and interpolations together with relevant code for the scoring software are available from ORC and scorings software may be downloaded at the ORC website (www.orc.org).
4) An alternative to the method described above is that results can be determined by the order from the highest to the lowest "Scoring wind". In such a case corrected times are calculated from the performance curve of each boat by converting her "Scoring wind" to a time allowance that is multiplied by the length of the course. Use of this method shall be specified in the Notice of Race and Sailing Instructions.