

“Fair racing between different types of boats on handicapping systems in sail racing”

Chapter 4

4 Calculation of corrected time

The calculation of corrected time from elapsed time and handicapping number can be done in several ways. All the major handicapping systems use either "time-on-time" or "time on-distance", with certain variations. The shortcomings of all these systems will be dealt with in the next chapter.

4.1 Time-on-time

In a time-on-time calculation you simply multiply the time correction factor (TCF), which is a speed figure proportional to knots, with the elapsed time (ET) to get the corrected time (CT):

$$CT = TCF * ET. \quad \text{Eq 4.1}$$

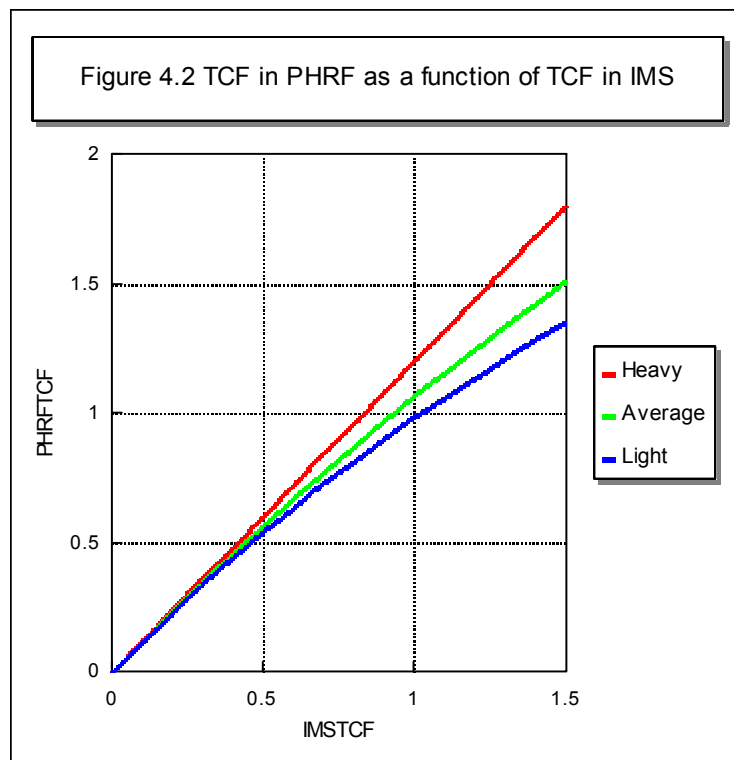
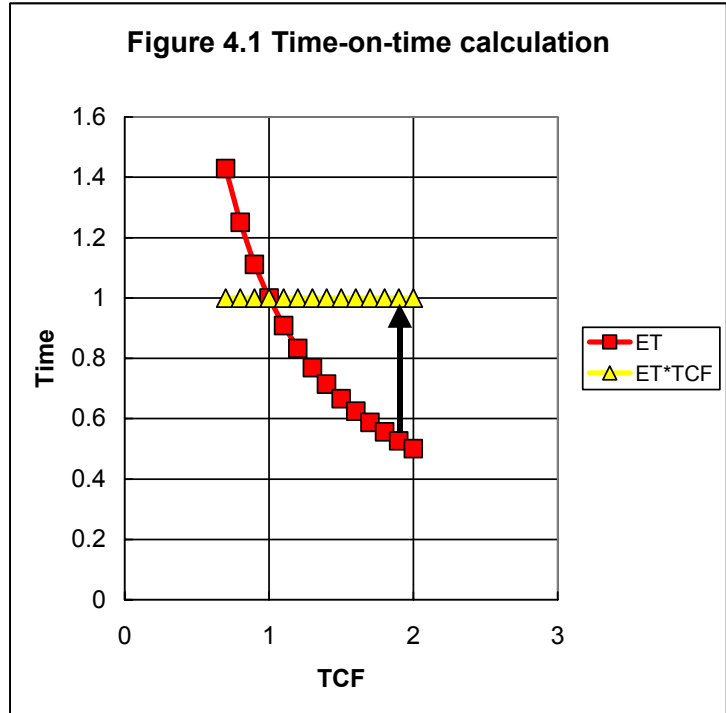
The major idea is that you refer all boats to TCF = 1. A boat with TCF = 1 will get no correction, but all other TCF's lead to corrections. It is assumed, ideally, that if all boats sailed equally well, the elapsed times would fall on the hyperbola (the red curve in Figure 4.1)

$$ET = 1/TCF \quad \text{Eq 4.2}$$

and all corrected times would then become

$$CT = TCF * 1/TCF = 1 \quad \text{Eq 4.3}$$

Eq 4.3 is the yellow line in Figure 4.1. LYS numbers are TCF's, and



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may be used directly in time-on-time calculations, while a PHRF or an IMS number is a time allowance in sec/mile used primarily for time-on-distance calculations. PHRF numbers may be transformed to TCF's as

$$\text{TCF} = 650 / (480 + \text{PHRF}) \text{ Heavy air or all off the wind} \quad \text{Eq 4.4}$$

$$\text{TCF} = 650 / (550 + \text{PHRF}) \text{ Average conditions} \quad \text{Eq 4.5}$$

$$\text{TCF} = 650 / (600 + \text{PHRF}) \text{ Very light air or all windward work} \quad \text{Eq 4.6}$$

The reason why you have to add a number of 480-600 to PHRF in the denominators above, is that PHRF is about 535 sec/mile lower than the actual speed of the boat in sec/mile, as compared to IMSGPH. PHRF = 0 roughly corresponds to IMSGPH = 535, while PHRF = 150 roughly corresponds to IMSGPH = 700.

IMS numbers may be transformed to TCF's as

$$\text{TCF} = 600 / \text{IMS} \quad \text{Eq 4.7}$$

where IMS is a sec/mile number from the certificate.

By using the conversion formulas in chapter 8, we can find the relationship between TCF's from PHRF and IMS.

$$\text{PHRFTCF} = 650 / (540 / \text{IMSTCF} + B - 480) \quad \text{Eq 4.8}$$

where B is the constant in the denominators of Eqs 4.4 - 4.6. In heavy wind B = 480 gives

$$\text{PHRFTCF} = 1.20 * \text{IMSTCF} \quad \text{Eq 4.9}$$

So for heavy winds the two TCF's are proportional. In lighter winds, however, PHRF is increasingly favouring the larger boats as compared to IMS. See Figure 4.2.

The shortcomings of time-on-time calculations are dealt with in Chapter 5.

4.2 Time-on-distance

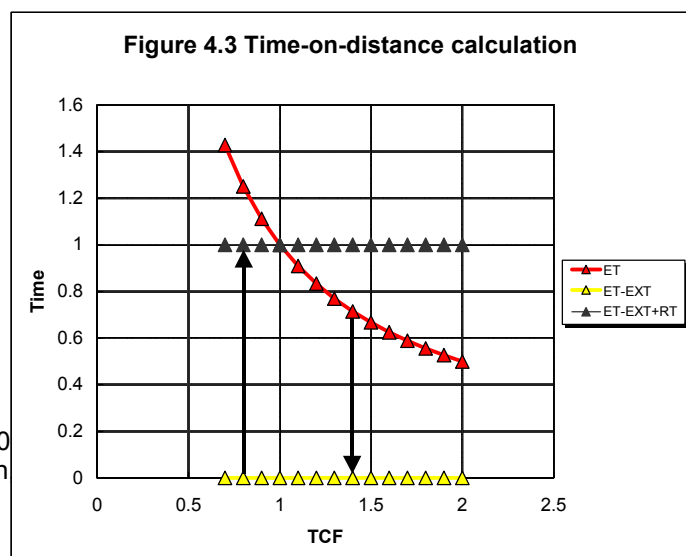
When you use time-on-distance, you subtract the time allowance TA from the elapsed time:

$$\text{CT} = \text{ET} - \text{TA} + \text{RT} \quad \text{Eq 4.10}$$

where

$$\text{TA} = \text{SMH} * \text{NM}. \quad \text{Eq 4.11}$$

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SMH is a seconds/mile handicap number, like IMS or DH, and NM is the course distance sailed from start to finish in nautical miles. The idea is to compare the elapsed time (the red curve in Figure 3.3) with the time the boat is expected to use at the actual distance. For a system like IMS the corrected time will then be around zero, and therefore a reference time RT, like the elapsed time of the smallest or largest boat in the race may be added in order to obtain more understandable and useful values of the corrected times.

The shortcomings of time-on-distance calculations are dealt with in chapter 5.

4.3 Performance Curve Scoring in IMS

IMS numbers are in sec/NM, and may be used for time-on-distance calculations, but the preferred method of scoring in IMS is called Performance Curve Scoring. A performance curve is a sec/NM number as a function of wind speed, and may be found on the IMS certificate for a given wind angle or a given course type like windward/leeward. You may also construct a performance curve for the actual course from the performance curves for different wind directions found on the certificate. The race management software will do this for you when you enter the distances and directions of the different legs of the racecourse.

Boat	Distance	Hours	Minutes	ET in secs	sec/NM	Implied wind speed
X-119	8 NM	1	20	4800	600	11.5 knots
X-95	8 NM	1	24	5040	630	9.8 knots

Table 4.1 and Figure 4.4 show an example of Performance Curve Scoring for two boats: an X-119 with red performance curve, and an X-95 with green performance curve. We assume that they sail a racecourse of 8 NM. The X-119 finishes at 1 hour and 20 minutes, which equals 4800 seconds, while the X-95 finishes at 1 hour and 24 minutes, which equals 5040 seconds. This gives an elapsed time of 600 sec/NM for the X-119 and 630 sec/NM for the X-95. The implied wind speed is about 11.5 knots for the X-95 (green arrow) and 9.8 knots for the X-119. This means that the X-95 has sailed better, since it apparently has sailed in a higher wind speed than the

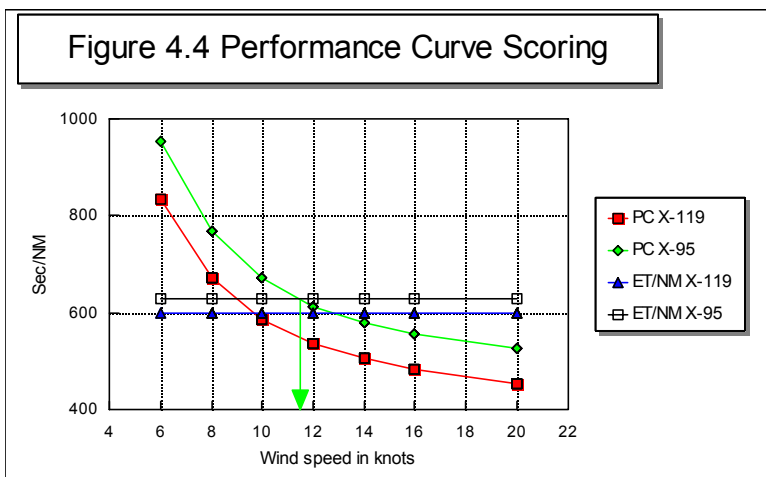


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X-119. In performance curve scoring the scoring is such that the boat with the highest implied wind speed wins, and the other boats are ranked according to the implied wind speeds.

4.4 Performance Line Scoring in ORC Club

ORC Club is a simplified system based on the same VPP as IMS. The scoring may be Performance Line Scoring, time-on-distance scoring or time-on-time scoring based on a TCF = 600/IMSGPH. In Performance Line Scoring the Performance Curve is represented by two numbers: Performance Line Time (PLT) and Performance Line Distance (PLD). Corrected times are calculated as

$$CT = PLT \cdot ET - PLD \cdot NM. \quad \text{Eq 4.12}$$

For example if we use the Performance Line Scoring numbers from Appendix 2, elapsed time 4800 seconds and distance 8 NM we get:

$$CT = 0.772 \cdot 4800 - 63.04 \cdot 8 = 3201.28 \text{ seconds.}$$

The advantage of using two numbers is that the system gives a better scoring of light weather boats as compared to heavy weather boats in different wind speeds. See also chapter 10 for a more detailed discussion of two handicapping numbers as compared to one number.