

IMS HANDICAPPING

AND

PERFORMANCE CURVE SCORING

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The Australian Yachting Federation (AYF) and the Victorian Yachting Council (VYC) have fully supported the introduction of the International Measurement System (IMS) into Australia. This support is evident by the purchase of precision measurement equipment and associated computer equipment for state measurers and also by the provision of computer programs for the processing of yacht race results using IMS derived handicaps. This support has fostered an IMS fleet of 336 yachts in Australia (as at February 1992) of which 93 yachts are registered at Victorian Clubs.

IMS racing offers yachtsmen and women a great opportunity for competitive sailing amongst fleets of yachts of varying ages and design types. It is a measurement rule devised by yachtsmen, for yachtsmen, and encourages racing in safe, fast yacht designs by providing a sophisticated method of handicapping yachts according to their computer predicted sailing performance. A natural consequence of this level of sophistication is the attendant "baggage of numbers" associated with the multiple handicaps that the IMS uses and this has led to some confusion as to which handicap is used for a particular race and how that race is scored. The aim of this article on IMS Handicapping and Performance Curve Scoring is to dispell any mysteries as to the origins of IMS handicaps and also to demonstrate methods of scoring yacht races using this system.

The article is divided into several sections in an attempt to cater for all interests. For those people contemplating IMS racing, the introductory part of this article is for you. It contains a brief introduction to the IMS and its intended aims and demonstrates the fairness and opportunities for good competitive sailing available to all yachts racing under this handicapping system. Technical aspects of the IMS and race scoring, covered in subsequent sections, can be left for later on when you feel capable of digesting their import.

The second section of the article deals in more detail with the methods used to obtain IMS handicaps from a yachts computer predicted velocities and how they relate to yacht race courses. This section does not require an intimate understanding of computers or computer modelling, but does require an act of faith in believing that computers can play a part in assessing your yachts sailing performance in a range of wind conditions and yacht course configurations. If you feel inadequate in the face of "modern technology" skip this section!

The third section is for those people with a healthy disrespect for Race Officials and their ability to always get the right results. It concerns race scoring and the calculation of corrected times. To follow the examples in this section, arm yourself with a calculator! You don't need anything too sophisticated, one that adds, divides, subtracts and multiplies will be sufficient - something like the calculator you use for your tax return will be more than adequate.

The fourth section will give an insight into the plight of your Race Committee. Have they adopted the correct method of scoring your race? Are the results a true reflection of your endeavours? This section should be of benefit to any person racing in IMS, whether you are an "innocent bystander" or a "full-bottle" aficionado.

Happy reading.

PART 1 THE IMS AND ITS INTENDED AIMS

The intention of the IMS

The IMS is a handicapping system based on computer predicted velocities for a particular yacht in a wide range of wind conditions and points of sail. The yachts predicted speeds are derived from computer models based on fundamental principles of hydro- and aerodynamics and known as the Velocity Prediction Program (VPP). This program uses precise hull, rig, sail, propeller and floatation measurements to predict speeds which are then converted to a table of time on distance handicaps (seconds per mile) for various wind strengths and course configurations. This information is presented in tabular form on a yacht's IMS certificate.

The predicted performance of your yacht and additional information presented on the IMS certificate, may be used to optimize your boat's actual performance. This information is similar to analyses used by competitors in the America's Cup, except that you only pay a fraction of the cost!

The IMS handicapping system, incorporating the design of the hull measurement apparatus and the computer VPP, was developed under the direction of the late Irving J. Pratt of the United States Yacht Racing Union (USYRU) and implemented as the Measurement Handicapping System (MHS) in the US in 1978. In 1985 the MHS was adopted by the Ocean Racing Council (ORC) as an international yacht handicapping system and re-named the International Measurement System.

The IMS is a "measurement" handicapping system devised by yachtsmen and not yacht designers, and as such, its intention is to prevent "design development" or "design obsolescence" which has been the bane of other measurement systems such as the International Offshore Rule (IOR). As well as providing a handicapping system, the IMS actively discourages the use of exotic materials in yacht construction as well as promoting the "comfort level" and cruising capability of a yacht. No longer does your yacht suffer because it has a tree trunk for a mast and is built like a brick out-house for Bass Strait gales, has an enclosed head, comfortable bunks, sail lockers for wet gear, etc. These are features incorporated within the IMS Rules and allowed for in the racing handicaps.

The IMS provides fair handicapping

The IMS provides a fair handicapping system for yacht fleets consisting of a broad range of designs. This fact is evident in the results of recent fleet regattas in Victorian and Tasmanian waters:

1991 Ocean Racing Club of Victoria (ORCV) Winter Series. Top points scorer in IMS division and Overall Winner of the Lord Wardens Trophy.

Shenandoah II (Sparkman & Stephens 34)

1991 ORCV *Bass Strait Triangle* Race.

Morning After (Sparkman & Stephens 34)

1991 TT Line *Abel Tasman* Melbourne-Devonport Ocean Race.

Cotton Blossom II (Farr 55)

1991 Rudder Cup.

Illusion (Davidson 34)

1991 Melbourne-Hobart Ocean Race

Friction (Adams 12)

1991 Sovereign Series.

Recooperator (Buchanan 9.3)

1992 Petersville Regatta. Overall winner IMS.

Jacobina of Shenval (Jutson 9.5)

1992 Australia Day Geelong Regatta. Top points scorer IMS.

Under Capricorn (Borresen BB12)

These winning yachts listed above highlight the advantages of IMS racing:

Shenandoah II and *Morning After* are "old style" racer-cruisers with long histories. Hardly flush-deck playgrounds for athletic young rock-stars, but more like the solid ocean racing designs of the past where you just retire to your bunk when the weather cuts up rough! *Shenandoah* was unbeatable in the past ORCV Winter Series and has recently been re-measured after a keel modification for next season.

Cotton Blossom II and *Under Capricorn* are production cruiser/racers. The current issue of *Australian Sailing* (Jan 1992) reviews Frank Smith's *Under Capricorn* (Borresen BB12); not only a double sink with hot and cold pressure water, but Frank can cook a roast dinner for the crew in the oven! One wonders how many races he would win if he had acquired the racing version of the BB12 - it is two tonnes lighter. *Cotton Blossom* is built and equipped in similar style and has been a consistent winner of both line honours and handicap trophies in recent IMS events.

Illusion and *Jacobina* are at the small end of IMS fleets. *Illusion* is a past Sydney-Hobart winner; a converted IOR racer, and *Jacobina* is a purpose-built IMS boat. Both yachts enjoy good competitive racing and are always in the top half dozen yachts in any company.

As well as these series winning yachts, consistent IMS place getters such as Ron Layton's *Rockstar*, a 50-footer with a double bed with a view of the water; Bruce Moore's *Alibi*, and Alan Collins' *By Order of the Secretary* - both mid-size production yachts; amply demonstrate the ability of the IMS to provide fair handicapping and allow competitive fleet racing for all types and ages of yachts.

Some Features of IMS Handicaps

The IMS is a unique and sophisticated method of handicapping yachts, and as a consequence a number of features become apparent.

First, an IMS yacht does not have a single "rating" as in other measurement systems such the Channel Handicapping System (CHS) or the IOR. Instead, each yacht has its own unique set of handicaps relating to various race course configurations and wind strengths. Also, since the IMS is a measurement rule and not a performance rule, these handicaps are a reflection of the yacht's predicted ability and not the crew's demonstrated performance. In IMS, good sailing in any boat is rewarded by good results.

Secondly, the range of handicaps derived from the Velocity Prediction Program, which attempts to simulate a yacht's performance in a range of sailing conditions, eliminate the "light air" or "heavy air" boat advantages inherent in single rating systems. IMS handicaps are an explicit recognition that a yacht's relative performance will vary in different wind strengths and race course configurations and ensure that a yacht well sailed in 8 knots of wind will win just as often as the same yacht well sailed in 18 knots. It is worthwhile noting that in the 1992 Petersville Regatta, George Gjergja's J44 *Adria* was third in Race 3 - 8.8 nautical miles around the buoys in 8 knots of breeze; third in Race 5 - 30.8 mile passage race to Portsea in 20 knots of wind; and second in Race 6 - 16 mile race in 8 knots of breeze. This is a consistent performance in different wind strengths and over vastly different race courses.

Thirdly, the familiar complaint of - "We didn't get our weather today!" will no longer be valid since poor performance characteristics in particular conditions will be reflected in the yacht's handicap. Frank Smith in *Under Capricorn* certainly has no preference for weather conditions. He has won races in all conditions!

Another feature of the IMS as it operates in Australia is that the AYF maintains and distributes measurement data and race management computer programs for nominal fees. These programs and data are available to all and are helping to standardize the scoring methods and production of results. As well as producing results, computer programs allow the production of **Scratch Sheets** which are listings of each entrant's handicaps. These Scratch Sheets are extremely useful for boat-to-boat comparisons during a race and are encouraging a more active participation in yacht races.

PART 2 VELOCITY PREDICTIONS AND IMS HANDICAPS

An example IMS certificate for the yacht *Paragon of Virtue* is shown in Appendix A. Portions of this certificate are reproduced below.

Velocity Predictions

The IMS certificate has a set of tabulated values under the heading:

SPEED AS A FUNCTION OF SAILING CONDITION.

These values are predicted velocities (in knots) derived from precise measurements of the yacht's hull, rig, sails and propeller, as well as hull floatation characteristics. Several hundred hull measurements are taken (up to 800) and used by a computer program to produce machine measured hull lines. These hull lines are sufficiently complete to enable the computation of accurate values for displacement, sailing length, wetted surface area, vertical centre of gravity, etc. These derived hull characteristics combined with the other measurements of the rig, sails, propeller and floatation, are then used in a computer simulation of the yacht's sailing performance in various wind strengths and points of sail.

This computer simulation model is known as the Velocity Prediction Program.

-----SPEED AS A FUNCTION OF SAILING CONDITION-----									
OPTIMUM BEAT					OPTIMUM RUN				
VTW	BTW	V	VMG	HEEL	BTW	V	VMG		
6	45	4.650	3.248	6	140	4.352	3.378		
8	44	5.637	3.988	13	143	5.343	4.308		
10	43	6.164	4.500	19	147	6.112	5.169		
12	40	6.384	4.823	22	161	6.297	5.967		
14	39	6.517	5.026	25	168	6.770	6.631		
16	38	6.605	5.152	26	172	7.193	7.128		
20	38	6.718	5.270	29	174	7.935	7.897		
		REACH		REACH		REACH		RUN	
VTW		BTW = 45		BTW = 90		BTW = 135		BTW=180	
		V		V HEEL		V HEEL		V	
6		4.593		6.179	7	4.710	2	3.053	
8		5.640		7.061	14	5.949	2	4.008	
10		6.333		7.493	21	6.833	3	4.921	
12		6.689		7.760	28	7.356	4	5.782	
14		6.892		7.939	30	7.774	5	6.550	
16		7.014		8.128	20	8.141	7	7.089	
20		7.154		8.450	27	8.786	12	7.870	

Table 1. Table of Predicted Velocities

Table 1 above shows *Paragon of Virtue's* predicted velocity (V) in knots at various true wind velocities (VTW). BTW is the angle between the true wind direction and the boat's course, VMG is the velocity made good directly to windward or downwind and HEEL is the angle of heel of the yacht. The Optimum Run is sailed downwind with the gybing angles optimized for the best VMG along the course.

These velocity predictions form the basis of IMS handicaps.

- Circular Random,** presuming equal distances sailed in every wind direction as though sailing around a perfectly circular course with a constant wind direction (25% beating);
- Linear Random,** presuming equal periods of time of wind from every direction (16% beating);
- Non-Spinnaker,** a linear random course sailed with no spinnaker, and
- Ocean Racing,** a composite course based on varying percentages of Circular Random and Windward-Leeward courses with wind velocity averaging applied.

These are not the only types of courses allowed. An infinite number of courses can be constructed with particular percentages of beating, reaching and running and handicaps derived for these courses. More about this later.

The General Purpose Handicap

The General Purpose Handicap shown on the IMS certificate is an average of the Circular Random handicaps at 8 and 12 knots. For example

$$\text{General Purpose Handicap} = \frac{709.9 + 563.1}{2} = 636.5 \text{ seconds/mile}$$

The General Purpose Handicap can be used as a "single figure" handicap in the same way as a CHS or IOR handicap, although it should be noted that if the race conditions vary significantly from Circular Random (8-12 knots), unsatisfactory outcomes of races may result.

The General Purpose Handicap provides a useful comparison between yachts and can be used for dividing IMS fleets into divisions.

The Constructed Course

The AYF has made available the *Performance Curve Race Management Program* developed by the ORC. This program, commonly known as the PCS (Performance Curve Scoring) program, together with yacht measurement data supplied on computer disk by the AYF enables the calculation of handicaps for any type of course which can be constructed from a knowledge of the distance and bearing of individual legs of the course and the direction of the wind. Alternatively, the program allows courses to be constructed according to given percentages of beat, reach and run. This facility enables the calculation of handicaps for an unlimited range of yacht racing courses.

IMS Handicaps

The IMS certificate has a set of tabulated values under the heading:

TIME ALLOWANCES IN SECONDS PER MILE.

These time allowances or **handicaps**, 42 in total, are tabulated for six yacht course types and seven wind velocities. Each handicap in the table is an expression of the predicted average time (in seconds) to sail one nautical mile on the given course configuration and in the given average wind velocity. Since none of the six courses listed above are purely one point of sail, all the handicaps in the table are based on an average of the various points of sail which make up the course type and are derived from the predicted speeds shown in the Table of Velocities.

An IMS handicap is in fact a predicted average velocity for a yacht to sail a given course in a particular wind strength.

-- TIME ALLOWANCES IN SECONDS PER MILE -----

GENERAL PURPOSE	TRUE WIND/ WIND LEeward (KTS)	WINDWARD (6-LEG)	OLYMPIC	CIRCULAR RANDOM	LINEAR RANDOM	NON-SPIN-NAKER	OCEAN RACE
636.5 SEC/MI	6	1159.7	1088.6	882.6	844.2	993.1	1010.1
	8	916.8	867.6	709.9	683.3	788.0	786.7
	10	781.4	747.3	617.1	597.5	674.7	660.3
	12	699.3	676.5	563.1	547.7	606.6	582.4
	14	647.1	632.9	529.8	516.6	563.4	531.5
	16	612.7	604.9	508.2	495.7	535.1	496.5
	20	571.5	571.4	481.2	468.3	501.0	450.5

Table 2. Table of Handicaps

The Six Nominated Course Types

Six courses are shown in the Table of Handicaps on an IMS certificate. These courses are representative of the many types of courses used by Yacht Clubs. Each course is "constructed" or made up of various percentages of points of sail and handicaps for each course type are derived from the predicted speeds shown in the Table of Velocities.

The listed courses and their various percentages of beating, reaching and running are:

Windward-Leeward, presumed to have a beat content of 50% and a run content of 50% of the course;

Olympic (6-leg), presuming a 45-degree right angled triangle with three windward legs (55% of the course length), two 135-degree spinnaker reaches (26%) and one downwind leg (19%);

Figure 1 below shows a standard Olympic (6-leg) course and a constructed 8-leg "round-the-sticks" club course together with percentages of Beat, Reach (45, 90 and 135 degree) and Run for each course. The percentages of Beat, Reach and Run have been calculated by the PCS program.

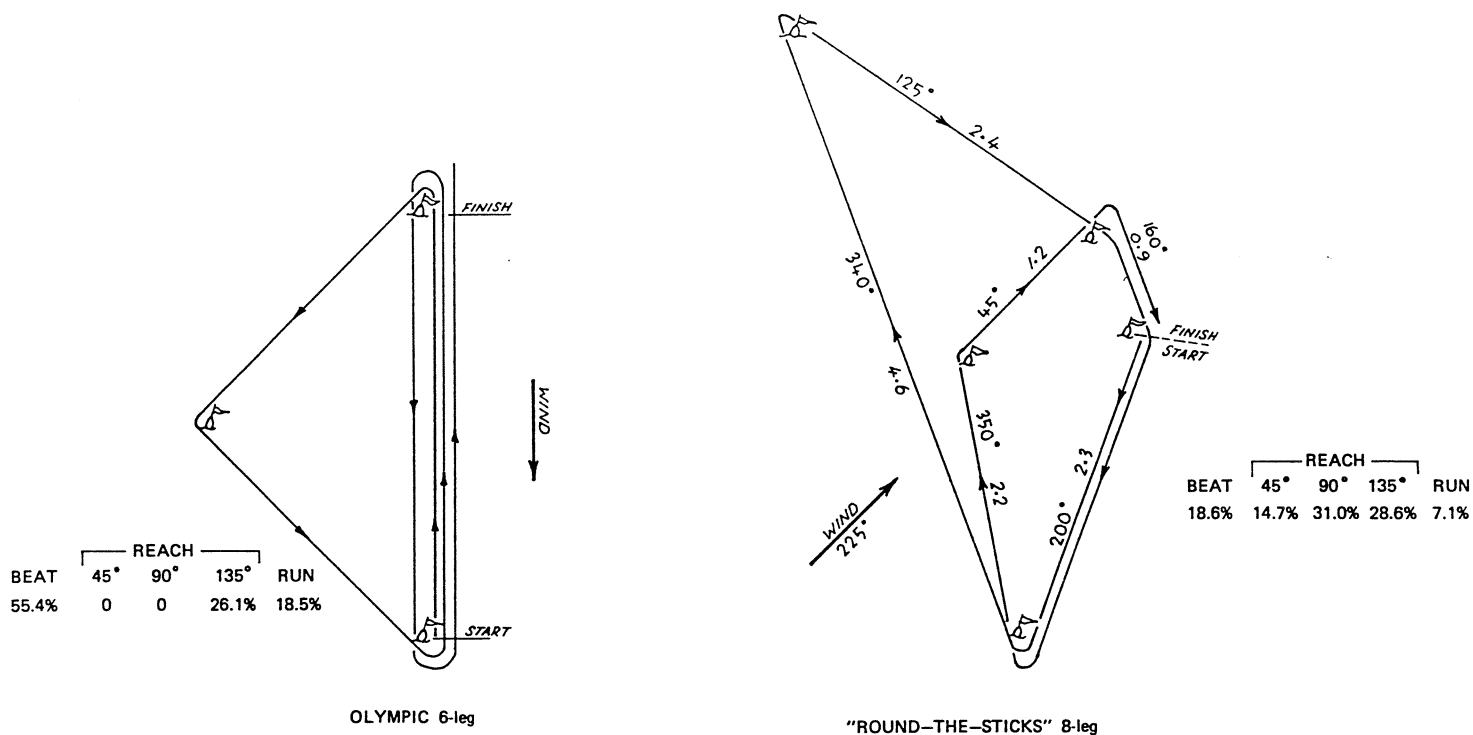


Figure 1 Olympic 6-leg course and 8-leg "round-the-sticks" course

Table 3 shows a table of handicaps for each course derived from *Paragon of Virtues'* IMS certificate. The handicaps for the Olympic course are shown on the certificate, whereas the handicaps for the constructed course have been derived from the Table of Velocities by the PCS program.

Paragon of Virtue

		Beat	Reach			Run	
			45°	90°	135°		
Constructed 8-leg course		18.6%	14.7%	31.0%	28.6%	7.1%	
Wind speed (Knots)	6	8	10	12	14	16	20
Handicap (sec/mile)	871.5	703.1	613.6	562.1	530.8	510.1	483.6
		Beat	Reach			Run	
			45°	90°	135°		
Olympic 6-leg course		55.4%	0	0	26.1%	18.5%	
Wind speed (Knots)	6	8	10	12	14	16	20
Handicap (sec/mile)	1088.6	867.6	747.3	676.5	632.9	604.9	571.4

Table 3. Table of handicaps for Olympic and constructed course

The Performance Curve

The Table of Handicaps, shown on the IMS certificate and in Tables 2 and 3 above, may be interpreted as a series of *Performance Curves*. A Performance Curve is a measure of a yacht's predicted average speed over certain types of courses in varying wind strengths.

Figure 2 below shows *Paragon of Virtue's* Performance Curves for the Olympic 6-leg and the 8-leg "round-the-sticks" courses shown in Figure 1 above. Each curve has been drawn from the handicap data shown in Table 3.

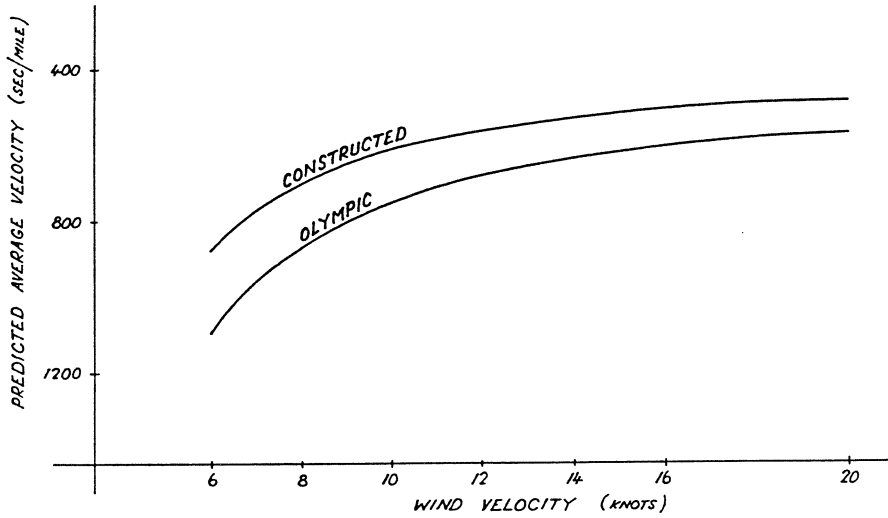


Figure 2. Performance Curves

PART 3 IMS RACE SCORING

IMS race scoring is done in one of two ways:

- (a) selecting a single handicap from a table of handicaps for a particular course configuration and wind speed, usually known as **single wind speed scoring**;

Note that selecting the General Purpose Handicap is exactly the same as single wind speed scoring.

- (b) using the "implied wind" derived from a yacht's performance curve for the particular course, usually known as **performance curve scoring**.

An Example Race

For the purposes of demonstrating the two scoring methods, consider the finish times for a fictitious race using the 8-leg "round the sticks" course (16.8 nautical miles) shown in Figure 1 above.

The finish times of the following yachts are given below in Table 4.

Race: 8-leg "round-the-sticks" - 16.8 nautical miles
Start Time: 1400 hours
Wind Direction: 225 degrees (average)
Wind Speed: 14 knots (average)

Yacht Name	Finish Time	Elapsed Time
	h m s	h m s
<i>Popstar</i>	16 36 39	2 36 39
<i>Under Milkwood</i>	16 51 30	2 51 30
<i>Paragon of Virtue</i>	16 56 32	2 56 32
<i>Rechabite</i>	17 04 09	3 04 09
<i>Perception</i>	17 05 27	3 05 27
<i>Excuse</i>	17 15 35	3 15 35

Table 4. Yachts and race times.

Table 5 below shows an IMS "Scratch Sheet" for the yachts in the fictitious race. A scratch sheet is a table of handicaps at selected windspeeds for yachts in a particular race. The PCS program has the facility to generate scratch sheets for any selected course including a constructed course.

Yacht Name	Reach							
	6kt	8kt	10kt	12kt	14kt	16kt	20kt	
				Beat	45°	90°	135°	Run
				18.6%	14.7%	31.0%	28.6%	7.1%
<i>Popstar</i>	764.2	615.0	534.8	487.7	458.1	437.8	410.5	
<i>Under Milkwood</i>	831.7	674.9	591.6	543.2	512.7	491.7	462.8	
<i>Paragon of Virtue</i>	871.5	703.1	613.6	562.1	530.8	510.1	483.6	
<i>Perception</i>	900.6	728.4	637.4	585.2	553.2	531.8	503.0	
<i>Rechabite</i>	918.5	736.8	639.5	583.0	548.0	524.4	492.4	
<i>Excuse</i>	964.5	773.6	671.5	612.9	577.4	554.6	525.6	

Table 5. IMS Scratch Sheet for a constructed course at selected wind speeds.
(Yachts shown in General Purpose Handicap order)

IMS Scoring - Single Wind Speed

After the Race Committee selects the most appropriate course from those listed on the IMS certificate, or constructs a course as in this example, which most closely approximates the percentages of beat, reach and run in the actual course sailed by the yachts, it only remains to adopt a wind speed. The selected wind speed for the particular course then determines each yachts handicap.

For a wind speed of 14 knots on the 8-leg constructed course for the example race, the handicaps to be used are listed on the Scratch Sheet shown in Table 5 and reproduced below.

Yacht	Handicaps		Time Correction			Corrected Time			
	actual	relative	secs	h	m	s	h	m	s
<i>Popstar</i>	458.1	0.0	0	0	0	0	2	36	39
<i>Under Milkwood</i>	512.7	54.6	917	0	15	17	2	36	13
<i>Paragon of Virtue</i>	530.8	72.7	1221	0	20	21	2	36	11
<i>Rechabite</i>	548.0	89.9	1510	0	25	10	2	38	59
<i>Perception</i>	553.2	95.1	1598	0	26	38	2	38	49
<i>Excuse</i>	577.4	119.3	2004	0	33	24	2	42	11

Table 6. Handicaps and Time Corrections

In Table 6 the yachts are shown in increasing order of handicaps. Note that the order is slightly different from the Scratch Sheet. The yacht with the lowest handicap, usually the largest and fastest boat in the fleet, becomes the "Scratch Boat" and her handicap is subtracted from all others to produce handicaps relative to the Scratch Boat. Each relative handicap (seconds/mile) is multiplied by the course length (miles) to give a Time Correction in seconds. This Time Correction is converted to hours, minutes and seconds and subtracted from each yachts Elapsed Time to give a series of Corrected Times for the race. Lowest Corrected Time is the winner.

Note that the Elapsed and Corrected times for the Scratch Boat will always be the same.

Yacht Name	Finish Time			Elapsed Time			Corrected Time			Place
	h	m	s	h	m	s	h	m	s	
<i>Paragon of Virtue</i>	16	56	32	2	56	32	2	36	11	1
<i>Under Milkwood</i>	16	51	30	2	51	30	2	36	13	2
<i>Popstar</i>	16	36	39	2	36	39	2	36	39	3
<i>Perception</i>	17	05	27	3	05	27	2	38	49	4
<i>Rechabite</i>	17	04	09	3	04	09	2	38	59	5
<i>Excuse</i>	17	15	35	3	15	35	2	42	11	6

Table 7. Race Results - Single Wind Speed
Corrected Time order

IMS Scoring - Performance Curve

With Performance Curve Scoring, the Race Committee need only select the most appropriate course. It is not necessary to select a wind speed. The method of scoring is as follows.

Each yacht's elapsed time (in seconds) is divided by the course length (in miles) to give an average velocity in seconds/mile. This average velocity (or average speed) is exactly the same as a handicap shown on the IMS scratch sheet and represents the average time in seconds to sail one nautical mile on the given course configuration.

Race: 8-leg "round-the-sticks" - 16.8 nautical miles
 Start Time: 1400 hours

Yacht Name	Finish Time			Elapsed Time			Ave.Vel.	Implied Wind	
	h	m	s	h	m	s	sec/mile	knots	
<i>Popstar</i>	16	36	39	2	36	39	9399	559.46	9.382
<i>Under Milkwood</i>	16	51	30	2	51	30	10290	612.50	9.498
<i>Paragon of Virtue</i>	16	56	32	2	56	32	10592	630.48	9.623
<i>Rechabite</i>	17	04	09	3	04	09	11049	657.68	9.626
<i>Perception</i>	17	05	27	3	05	27	11127	662.32	9.452
<i>Excuse</i>	17	15	35	3	15	35	11735	698.51	9.471

Table 8. Table of Handicaps and Implied Winds

Table 8 also has a column headed **Implied Wind**. The Implied Wind can be considered as that wind velocity which would produce a predicted time, using the IMS velocity predictions for the course sailed, which is exactly the same as the actual elapsed time of the yacht. Now since predicted times are derived from handicaps (average velocities) for the particular course, the IMS Scratch Sheet can be used to calculate a yacht's Implied Wind. Remember that a Scratch Sheet merely shows handicaps for a particular course at selected wind speeds.

A portion of the IMS Scratch Sheet for the example race is shown below.

Yacht Name	8kt	10kt
<i>Popstar</i>	615.0	534.8
<i>Under Milkwood</i>	674.9	591.6
<i>Paragon of Virtue</i>	703.1	613.6
<i>Perception</i>	728.4	637.4
<i>Rechabite</i>	736.8	639.5
<i>Excuse</i>	773.6	671.5

Table 9. Portion of the IMS Scratch Sheet

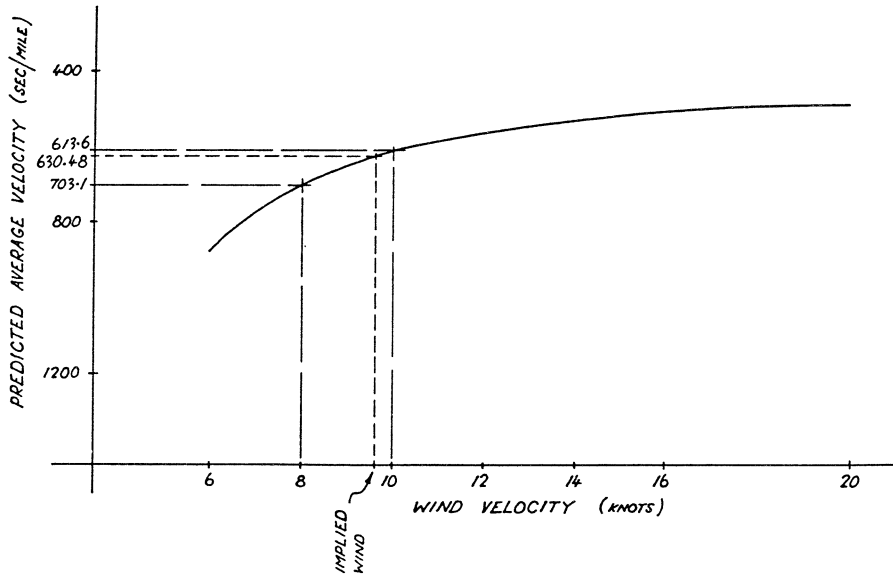


Figure 3. Performance Curve for PARAGON OF VIRTUE
(Constructed course)

By inspection of the Scratch Sheet, the derived handicap for *Paragon of Virtue*, 630.48 sec/mile, lays somewhere between her handicaps for 8 knots (703.1) and 10 knots (613.6) and hence *Paragon's* Implied Wind must be between 8 and 10 knots. To calculate the Implied Wind, a linear interpolation can be used to give:

$$\frac{703.1 - 630.48}{703.1 - 613.6} = \frac{8 - x}{8 - 10} \quad \text{where } x = \text{Implied Wind} = 9.623 \text{ knots}$$

This value of the Implied Wind calculated by this method will not be exactly correct since a linear interpolation assumes that the Performance Curve is a series of straight lines rather than a smooth curve. The PCS program fits a *Spline Curve* through the handicaps to produce a yacht's Performance Curve before determining the Implied Wind (see Fig.3 above) and hence results from the PCS program will vary slightly from this worked example.

This same interpolation technique is used to calculate the Implied Wind for the other yachts shown in Table 8 above.

The yacht with the highest Implied Wind is the winner

Yacht Name	Implied Wind knots	Place
<i>Rechabite</i>	9.626	1
<i>Paragon of Virtue</i>	9.623	2
<i>Under Milkwood</i>	9.498	3
<i>Excuse</i>	9.471	4
<i>Perception</i>	9.452	5
<i>Popstar</i>	9.382	6

Table 10. Performance Curve Scoring - Implied Wind order

Corrected times are a more familiar method of ordering yachts and in Performance Curve Scoring the following method is used to calculate a yacht's corrected time.

The Implied Wind establishes how well you have sailed your own boat around the course and it may be assumed that you would have sailed the Scratch Boat equally as well. Therefore, the Implied Wind for each boat is used with the Performance Curve for the Scratch Boat to find out how long it would have taken you to sail the course in the Scratch Boat. Since everybody is theoretically sailing the same Scratch Boat, all corrected times are directly comparable.

The Corrected Time order will be exactly the same as the Implied Wind order.

In the example race, *Popstar* is the Scratch Boat and using *Rechabites* Implied Wind and *Popstar's* Performance Curve (IMS Scratch Sheet handicaps) the following handicap (average velocity) is obtained as

$$\frac{9.626 - 8}{10 - 8} = \frac{x - 615.0}{534.8 - 615.0} \text{ to give } x = 549.80 \text{ sec/mile}$$

Yacht	Handicaps		Time Correction			Corrected Time			
	calculated	relative	secs	h	m	s	h	m	s
<i>Rechabite</i>	549.80	-9.78	-164	-0	2	44	2	33	55
<i>Paragon of Virtue</i>	549.92	-9.66	-162	-0	2	42	2	33	57
<i>Under Milkwood</i>	554.93	-4.65	-78	-0	1	18	2	35	21
<i>Excuse</i>	556.01	-3.57	-60	-0	1	00	2	35	39
<i>Perception</i>	556.77	-2.81	-47	-0	0	47	2	35	52
<i>Popstar</i>	559.58	0.00	0	0	0	00	2	36	39

Table 11. Performance Curve Scoring - Corrected Times

Using the interpolation method above, a handicap is calculated for each yacht and then reduced to a Table of handicaps relative to the Scratch Boat *Popstar*. Multiplying the relative handicaps (seconds/mile) by the length of the course (miles) gives a Time Correction in seconds which is converted to hours, minutes and seconds. The Time Correction is then applied to the Elapsed Time of the Scratch Boat to give Corrected Times for each yacht.

Yacht Name	Finish Time	Elapsed Time	Corrected Time	Place
	h m s	h m s	h m s	
<i>Rechabite</i>	17 04 09	3 04 09	2 33 55	1
<i>Paragon of Virtue</i>	16 56 32	2 56 32	2 33 57	2
<i>Under Milkwood</i>	16 51 30	2 51 30	2 35 21	3
<i>Excuse</i>	17 15 35	3 15 35	2 35 39	4
<i>Perception</i>	17 05 27	3 05 27	2 35 52	5
<i>Popstar</i>	16 36 39	2 36 39	2 36 39	6

Table 12. Race Results - Performance Curve Scoring
Corrected Time order

Note that the Corrected Time and Elapsed Time for the Scratch Boat are the same.

PART 4 IMS AND THE RACE COMMITTEE

A Race Committee's job is to provide the safest and fairest racing for competing yachts. Providing fair racing entails adopting the most suitable race course for the conditions and then using the most appropriate handicaps and race scoring methods. These principles apply to any organized racing no matter what handicapping system is used; but when using the IMS with its multiple handicaps; extra care should be taken to select the handicaps which most closely approximate the race conditions or the Race Committee may be liable to criticism regarding the fairness of race results.

Selecting the Best Possible Handicap

As shown in Part 2, the IMS has the facility to produce handicaps for an infinite number of yacht racing courses. As well as the six course types shown on the IMS certificate, handicaps may be derived for any course provided the percentages of beat, reach and run are known, or can be calculated. Expressed in a slightly different manner, it could be said that a handicap is a reflection of the percentages of beating, reaching and running in a yacht racing course. A corollary to this statement is that if these percentages are unknown then the situation may occur that the handicaps for that race may not be the best possible.

When might this situation occur? Obviously when nothing is known of the expected conditions, or when conditions are changing or may change. This happens frequently in Ocean Races and quite often in longer "Bay-races".

When might this situation be prevented from occurring? When a course can be layed (and maintained in the prevailing conditions) so that the percentages of beat, reach and run are known and constant, or when the sailing conditions are constant and the relative percentages can be derived from a knowledge of the course sailed.

Looking at these two situations it is clear that race courses fall into two simple types, **predictable** and **unpredictable**. For yachts racing in **unpredictable** conditions, such as an Ocean Race or long Bay-race, handicaps for these races should be selected for a course which is a compromise between the various conditions encountered or expected. Examples of these compromise courses are the Circular and Linear Random and the Ocean Race courses. For yachts racing **predictable** courses, such as an Olympic course, the handicaps can be the best possible. It is the Race Committees job to select the course which most closely agrees with the conditions encountered, or most likely approximates the conditions expected.

Selecting a Scoring Method

Assuming the most appropriate course for the race will be selected, thereby ensuring the best possible handicaps will be used, a decision on the scoring method to be used must be made. Part 3 of this article demonstrates the two methods of scoring IMS races: Single Wind Speed and Performance Curve Scoring (PCS). PCS has a decided advantage over the Single Wind Speed scoring method in so far as it relieves the Race Committee of the problem of declaring a wind speed for the race. The selection of a wind speed is often a contentious issue and the Race Committee must commit resources in the way of additional official boats and wind instruments to correctly estimate the average wind conditions over the course for the duration of the race. Also, incorrectly estimating the wind strength may unfairly prejudice some yachts and advantage others. Bearing these points in mind it would appear that Performance Curve Scoring has some definite advantages over the Single Wind Speed method.

Factors affecting Race Results

There are several factors which affect IMS results and lay within the domain of the Race Committee. Some of these are:

1. Race results should clearly state what type of course is or has been selected and what scoring method is being used. If Single Wind Speed scoring has been used then the selected wind speed should be stated.

2. If a race is held in conditions which favour larger yachts, such as a race sailed in a moderate breeze for the larger yachts but fading to a light breeze for the smaller yachts still on the race course, then any declared wind speed (for Single Wind Speed scoring) will favour one part of the fleet over the other, or in the case of Performance Curve Scoring, the calculated **implied wind** will be biased towards the larger yachts. This problem may be overcome to some extent by dividing the fleet into divisions according to General Purpose Handicap limits and selecting wind speeds for each division if using the Single Wind Speed scoring method.
3. The length of the course is critical since all IMS handicaps are time on distance handicaps. Depending on the closeness of the racing and the length of the course it is possible to change the handicap finish order of a race by changing the length of the course by as little as two or three percent. It is no longer good enough for a Race Committee to have a guess at the course length and where practicable the course length should be determined to an accuracy of 0.1 nautical miles.

The race results should clearly state the course length used in the calculations.

4. In layed courses such as Olympic and America's Cup type courses, care should be taken to set out the correct shapes and maintain the desired percentages of beat reach and run if the wind direction varies. Failure to do so means that the handicaps may not reflect the actual sailing conditions and/or the course may not be the correct length.

CONCLUSION

The IMS is a sophisticated yacht handicapping method employing modern measurement equipment and techniques coupled with computer modelling and analysis to produce a table of predicted velocities. These speed predictions are able to be converted to handicaps for a wide range of sailing conditions which allow fair and equitable handicapping of keelboat yachts of all types and sizes. The fairness inherent in this system is being demonstrated on the water in recent regattas. Old style cruiser/racers are winning again in strong competitive fleets; modern production yachts are winning against purpose built IMS racers; and former IOR yachts suffering from "design obsolescence" have been given a new lease of life.

The numbers of yachts racing in IMS in Victoria is increasing, and no other yacht measurement rule is achieving this same success, in fact IOR and CHS divisions are in decline as far as numbers are concerned. Since new yachts on the water has been relatively few in the past 12 months and fleet sizes have been generally 10% - 20% smaller than in previous years it is obvious that the owners have been voting with their feet and sailing IMS!

ACKNOWLEDGEMENTS

Information for this article has been obtained from a number of sources which are acknowledged. They are, in no particular order

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Note: "American Sailor" is the official journal of the United States Yacht Racing Union (USRYU).

OFFSHORE is the official journal of the Cruising Yacht Club of Australia (CYCA).

APPENDIX A

IMS AMENDED TO JANUARY 1991
 YACHT: PARAGON OF VIRTUE
 SAIL#: US-12345
 CLASS: TARA0

RATING CERTIFICATE# 28509
 BASED ON FULL MEASUREMENT
 NOT VALID AFTER 12/91

I CERTIFY THAT I UNDERSTAND MY
 RESPONSIBILITIES UNDER THE IMS.

40' SLOOP BY SAS
 MASTHEAD RIG, 157% JIB
 FIXED KEEL
 EXPOSED, FOLDING PROP
 LONG BATTENS
 AGE DATE 3/89

OWNER:
 MR. JOHN O. SAILOR
 123 SPINNAKER LANE
 NEWPORT RI 02840

CENTERBOARD		COMMENTS	
KCDA	.000 WCBA	0	
ECM	.000 CBDA	.000	
CBRC	.000 WCBB	0	
CBMC	.000 CBDB	.000	
CBTC	.000		

FREEBOARDS		PROP INSTALLATION	
FAM	4.310 SFFP	2.492 PSA	25.000 PHD
FAM	3.410 SAFF	37.531 PHL	.480 ESL
SG	1.025 LOA	40.230 PSD	.090 PRD
IM	54.477 SPL	15.980 P	48.500 BL1
J	15.910 SL	52.500 E	13.790 BL2
LPG	24.700 SAM	28.800 BAL	.500 BL3
LPI	.000 HBS	.000 BD	.530 BL4
FSP	.240 SPS	13.250 BAS	5.750 BL5
LP	24.940 SFJ	.000 HB	.520 BLP
HBI	3.659 ISP	54.230 MW	.500 MGL
IG	54.100 BATX	.852 GO	.610 MGN

MIZZEN		MAINSAIL		MAST	
IY	.000 PY	.000 BY1	.000 MD1Y	.000 HBY	.000
EB	.000 EY	.000 BY2	.000 MD1Y	.000 HBY	.000
YSD	.000 BAY	.000 BY3	.000 MD1Y	.000 HBY	.000
YSF	.000 BAY	.000 BY4	.000 MD1Y	.000 HBY	.000
YSMG	.000 BAY	.000 BY5	.000 MD1Y	.000 HBY	.000

TIME ALLOWANCES IN SECONDS PER MILE		TRUE WINDWD/ OLYMPIC CIRCULAR LINEAR		WIND LEeward (6-LEG) RANDOM	
GENERAL PURPOSE					
6	1159.7	1088.6	882.6	844.2	993.1
8	916.8	867.6	709.9	683.3	788.0
10	781.4	747.3	617.1	597.5	674.7
12	699.3	676.5	563.1	547.7	606.6
14	647.1	632.9	529.8	516.6	563.4
16	612.7	604.9	508.2	495.7	535.1
20	571.5	571.4	481.2	468.3	501.0

MR MARK H VINBURY
 227 NORTH RD
 PEACE DALE RI 02883
 MEASURED: 2/22/89
 INP RCVD: 2/24/89
 ISSUED: 3/13/91
 FL0TATIN: 2/22/89
 JOHN W. WRIGHT
 USYRU OFFSHORE
 BOX 209
 NEWPORT, RI 02840
 COPYRIGHT 1991

CERT# 28509 SAIL# US-12345
 YACHT: PARAGON OF VIRTUE
 FORMER: HULL:
 OFFSETS: C19509.LP
 RUN DATE: 3/13/91
 INP RCVD: 2/24/89

INCLINING TEST		CALCULATED	
W	PD	GSA	.180 RM2
1) 50.0	44.000 RSA	102.600 RM20	1320.8 POSITIVE
2) 100.0	88.500 PLM	1595.000 RM40	1091.8 STABILITY
3) 150.0	132.000 PL	1592.206 RM60	726.8
4) 200.0	176.000 WD	44.030 RM90	285.3
		RM	1392.2 RMC
			1392.2

MEASUREMENT TRIM (SG=1.025)		RATIO OF STABILITY CURVE AREAS, POSITIVE/NEGATIVE = 2.366	
FF 4.31	FA 3.41		
KEEL DRAFT (DHKO)	7.67	MAXIMUM BEAM (MB)	12.68
ENDPLATE ADJ (KEDA)	.00	2ND MOMENT LGTH (LSMO)	31.90
DISPLACEMENT (DISP)	19608	WETTED SURFACE (WSD)	340.0
SAIL AREA (SA)	775	PROP PROJ AREA (PLPA)	.069

SAILING TRIM (CREW & GEAR ABOARD)		RATED BEAM (B)	
SECT AREA @ MAX (AMS1)	20.99	SINK FORWARD (SKF)	.00
BEAM/DEPTH (BTR)	4.09	SINK AFT (SKA)	.26
KEEL DRAFT (DHKA)	7.79	WETTED SURF (WS)	356.6
CENTERBOARD EXT (CEMA)	.00	DISPLACEMENT (DISP)	21825
EFFECTIVE DRAFT (ED)	6.60	CREW RT'G ARM(CRA)	4.81
EFFECTIVE CB EXT (ECE)	.00		

SPEED AS A FUNCTION OF SAILING CONDITION		OPTIMUM BEAT		OPTIMUM RUN	
VTW	BTW	V	VWG	HEEL	BTW
6	45	4.650	3.248	6	140
8	44	5.637	3.988	13	143
10	43	6.164	4.500	19	147
12	40	6.384	4.823	22	161
14	39	6.517	5.026	25	168
16	38	6.605	5.152	26	172
20	38	6.718	5.270	29	174

MINIMUM DISPLACEMENT IN MEASUREMENT TRIM: 6905 LBS.		RANGE AVAILABLE TO DECLARE A CREW LIMIT: 1075 - 1654 LBS.	
VTW	BTW	V	VWG
6	45	4.650	3.248
8	44	5.637	3.988
10	43	6.164	4.500
12	40	6.384	4.823
14	39	6.517	5.026
16	38	6.605	5.152
20	38	6.718	5.270