

VPP Rating Rules





Jim Teeters

Head, Offshore Office, US Sailing

Brief History of VPP Handicapping in the US

- MIT/Pratt Project – **MHS** Rule
 - US initiative to create a rule that could predict actual boat speed using scientific methods – **Velocity Prediction Program**
 - First use: Newport Bermuda Race 1978
- MHS given to ORC to become **IMS** in 1987
 - International Rule
 - 17 years of growth and development
- 2004: **ORR** replaced IMS (in the US.)
 - ORA management and development
 - US Sailing Offshore Office: daily implementation
 - Sailing Yacht Research Foundation: R&D to support rule development
 - 2015 Introduction of **ORR-Ez**
- Introduction of **ORCi** and **ORC Club**
 - Growing acceptance

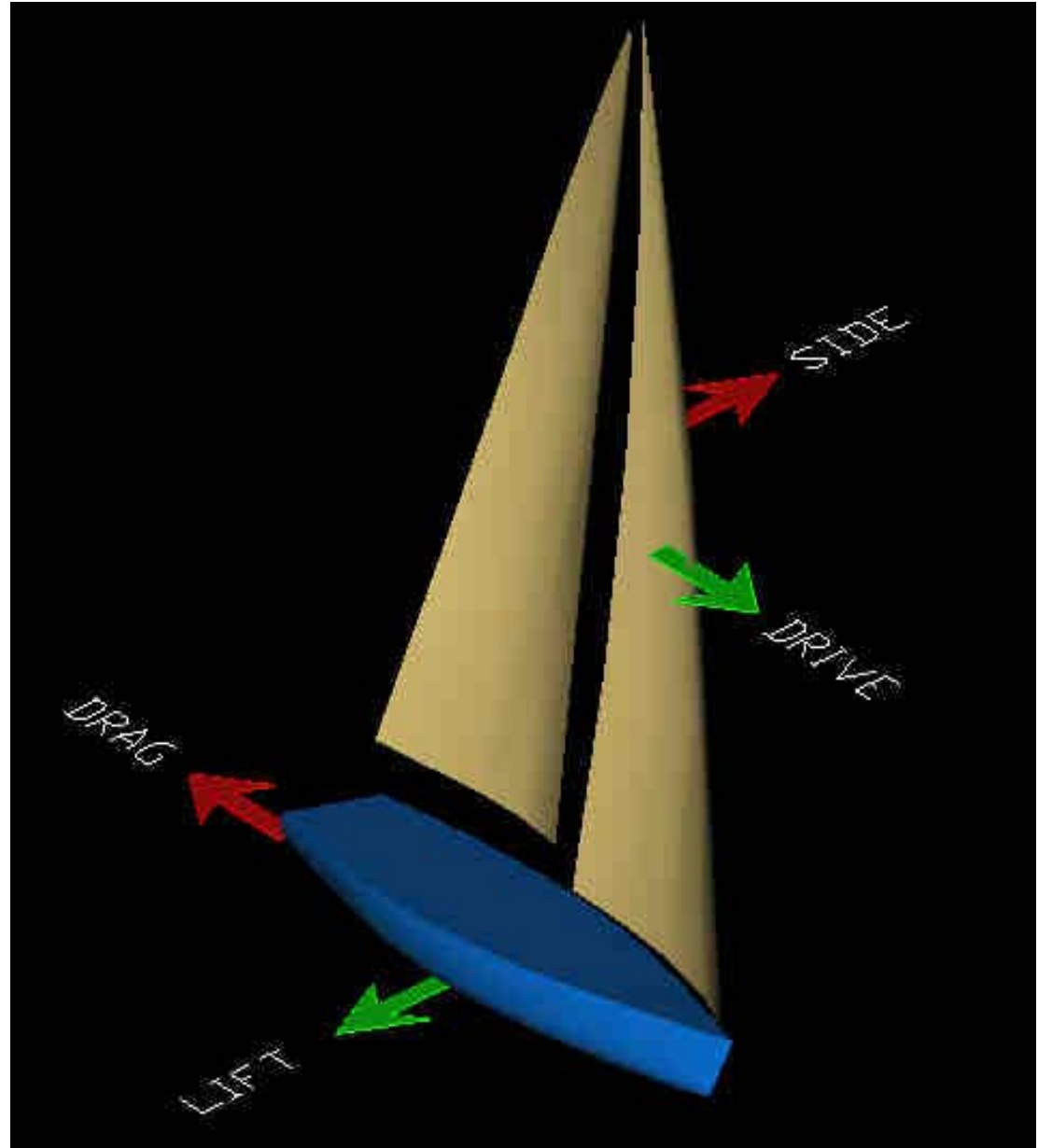


- VPP
 - Balance of Aerodynamic and Hydrodynamic Forces and Moments to find Equilibrium Speed at any Wind Angle and Wind Speed
 - Equations of High School Physics and Calculus
 - Calibrated with Extensive Tow Tank and Wind Tunnel Testing
 - Verified against Real World Sailing



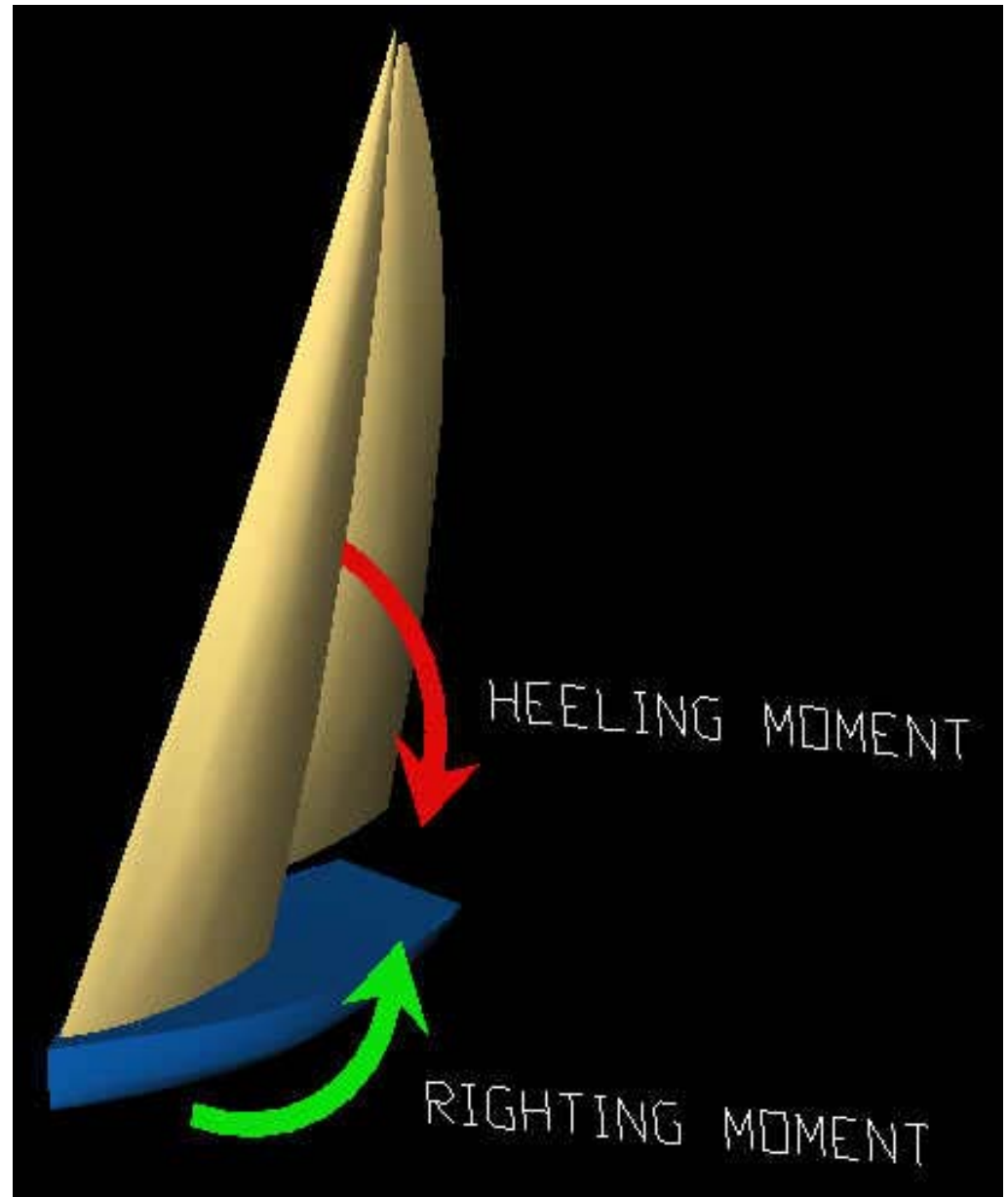
Balance of Forces

- Drive = Drag
- Side = Lift
- Vertical Force Balance:
 - weight + vertical sail pressure = buoyancy + vertical lift



Balance of Moments

- Heeling Moment =
Righting Moment
- Yaw Balance
- Pitch Balance



Data Necessary for VPP

- Hull & Appendages Hydrodynamics
 - Lift, Drag and Stability Characteristics over a Range of Conditions of Speed, Heel, etc.
 - Towing Tank and Computational Fluid Dynamics
- Rig Aerodynamics
 - Lift, Drag and Center of Effort for a Range of Heel, Wind Speed and Angle
 - De-powering Model to Represent the Requirements of Stability-Limited Sailing
 - Wind Tunnel Tests, CFD, Back Engineering
- Environmental Conditions: Wind, Waves



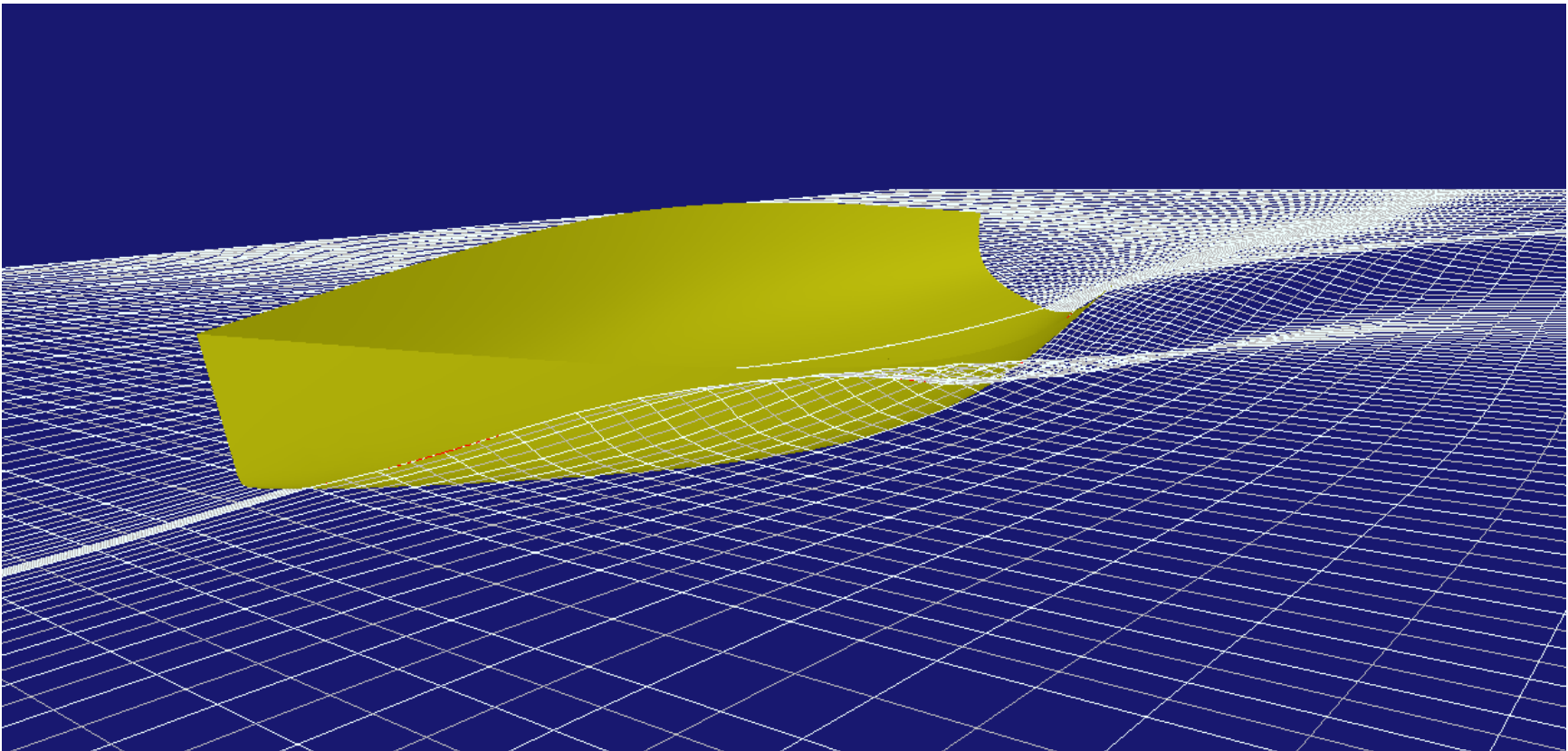
Towing Tank: Hull Hydrodynamics

- Scaled Model Towed down Basin
 - Fixed in Roll, Sway, Yaw and Surge (Speed)
 - Free in Pitch, Heave
- Measure Lift & Drag Forces, Roll & Yaw Moments, Heave & Pitch Deflections



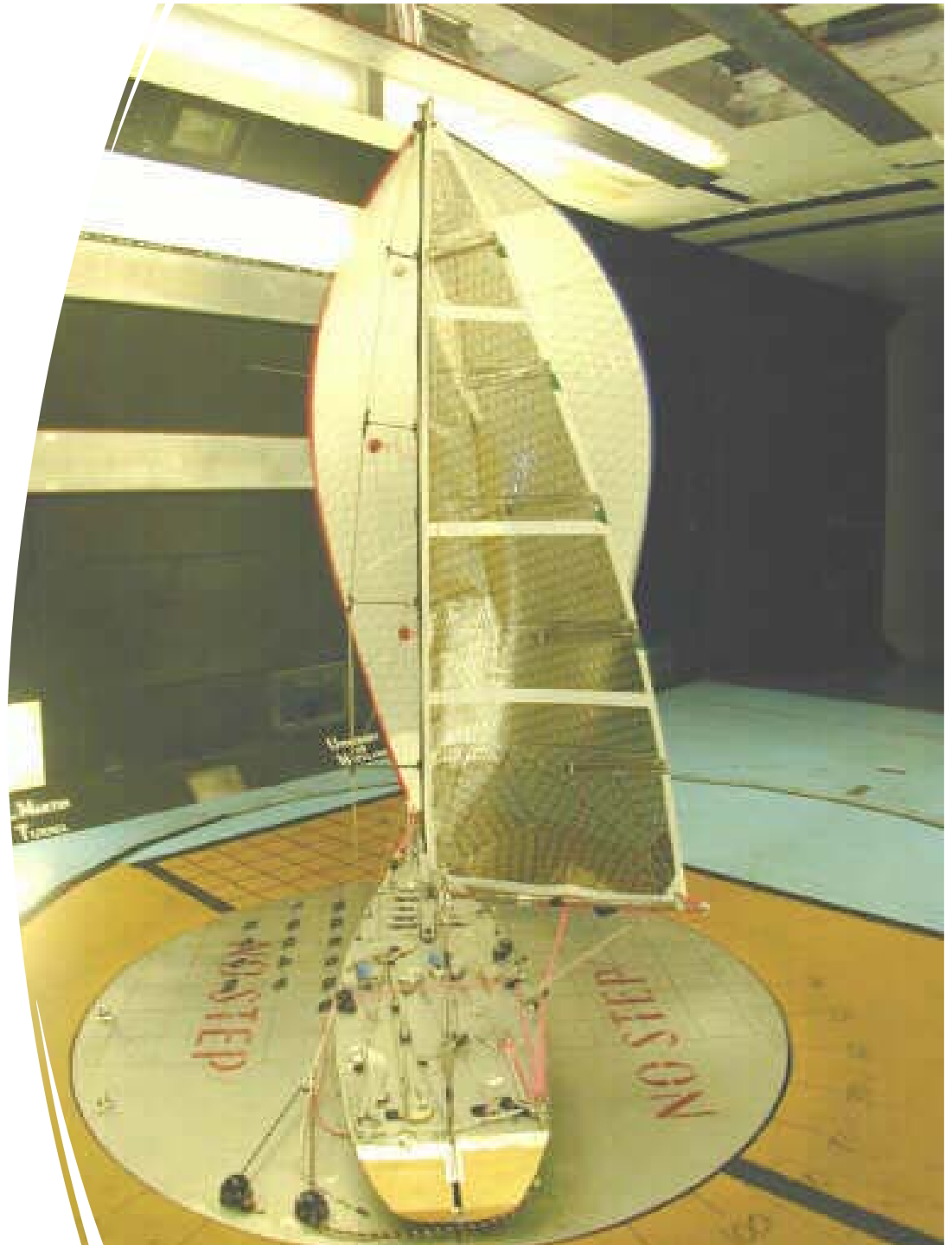
CFD: Hull Hydrodynamics

- Panel Codes: FlowLogic (David Egan)
- Viscous (RANS) Codes



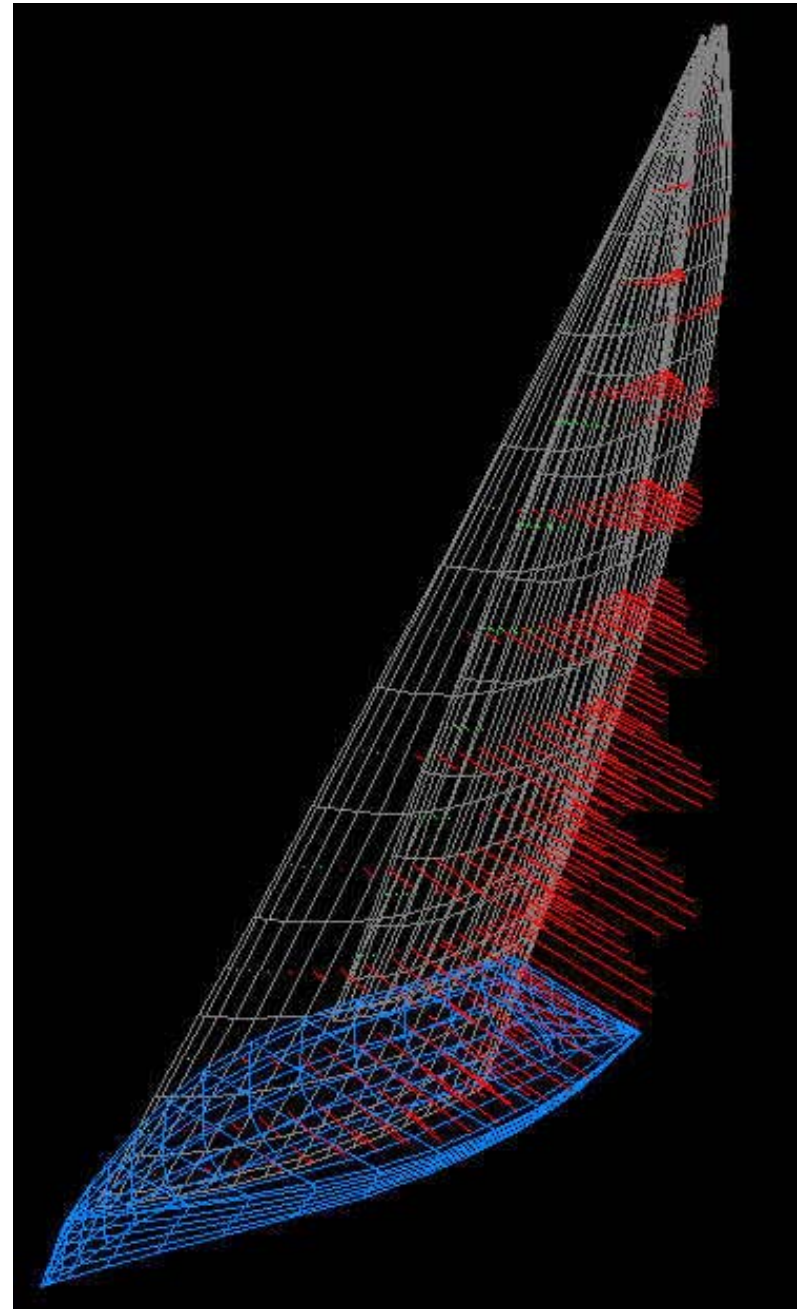
Wind Tunnel: Sail Aerodynamics

- Scaled Model of Rig with Hull Topsides
- Boat Stationary, Air Cycled Through Tunnel
- Rotate Boat for a Range of Apparent Wing Angles
- Measure Total Forces and Moments for Entire Rig and Hull: Combine Various Sails
- Trim Sails to Get Optimal Performance



CFD: Sail Aerodynamics

- Vortex Lattice (S2KV)
- Lifting Line
- Lifting Surface Programs
- RANS



US Sailing: getting rated in ORR/ORC

- Contact Offshore Office (Jim, Chris, Sydney)
- Boat Measurements:
 - **Geometry of Hull/Keel/Rudder** (old: pre-existing, new: designer files/hull scans)
 - **Rig, Sails, Props**
 - In-water measurements: **Freeboard, Inclination**
 - (**Sister ship data** for geometry, disp., stability)
- We will find a measurer in your area
- We process your ORCi, ORC Club and ORR certificates



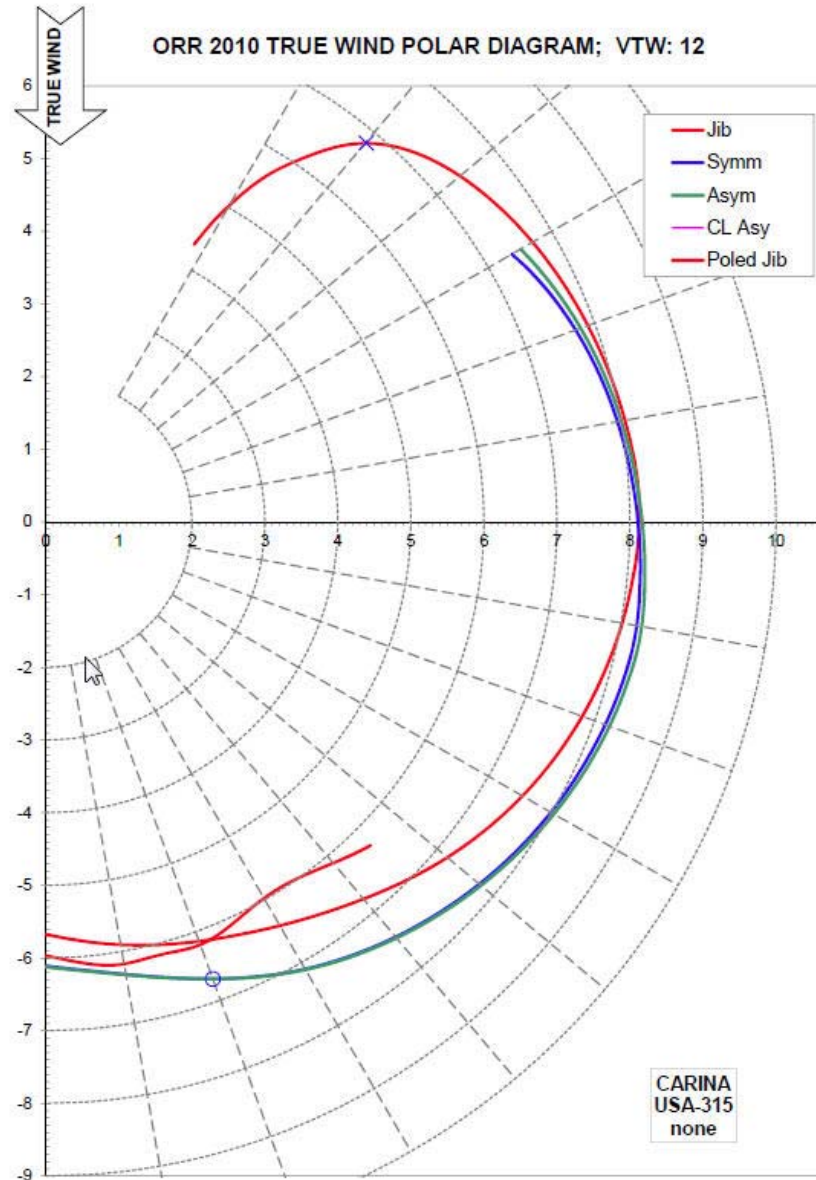
VPP Output

Polar Curves for 1 Wind

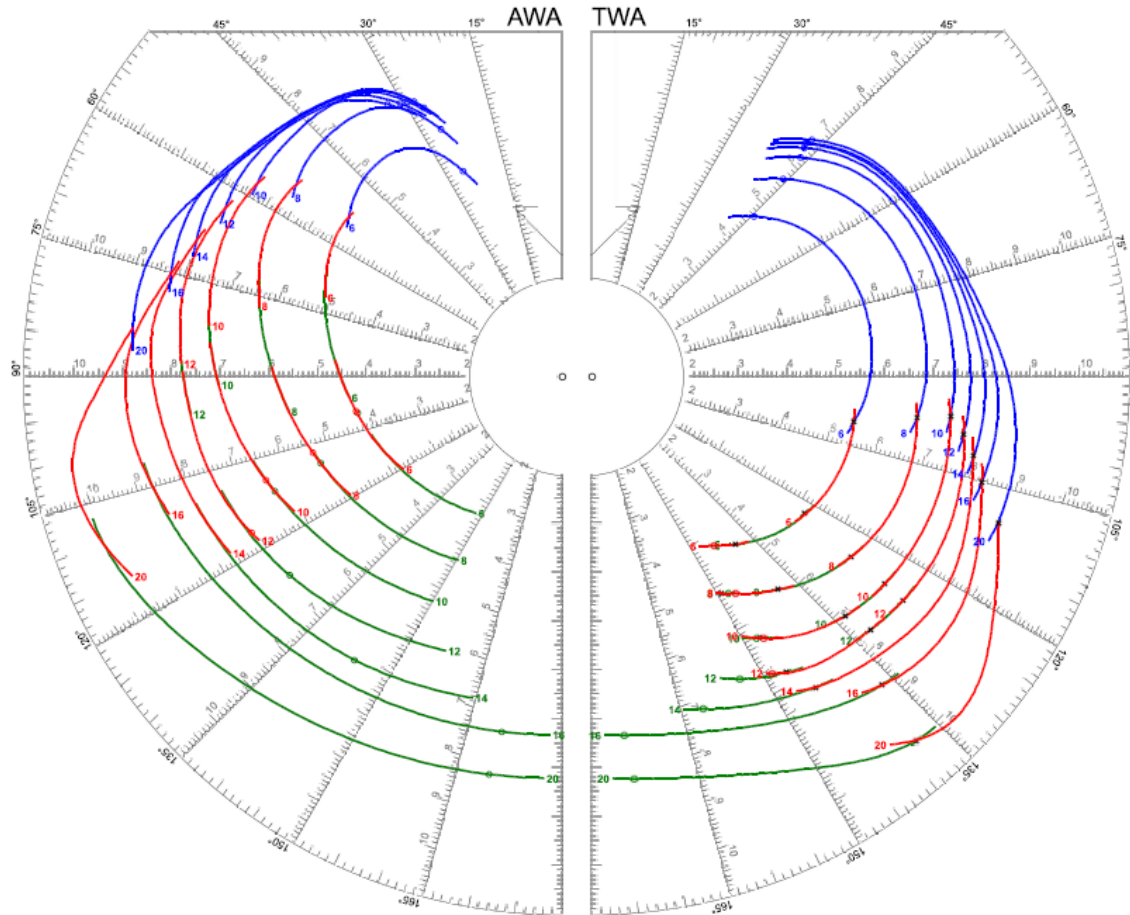
Red: Main+Genoa/Jib

Blue: Main+Symmetric

Green: Main+Asymmetric



ORC Speed Guide

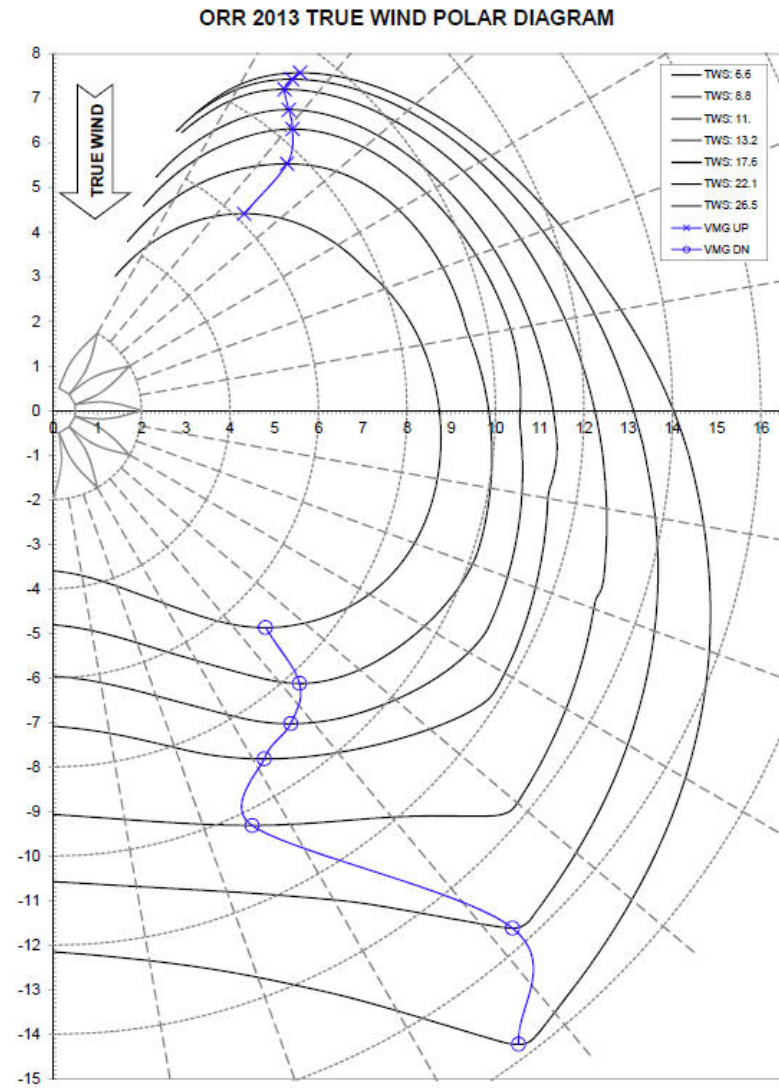
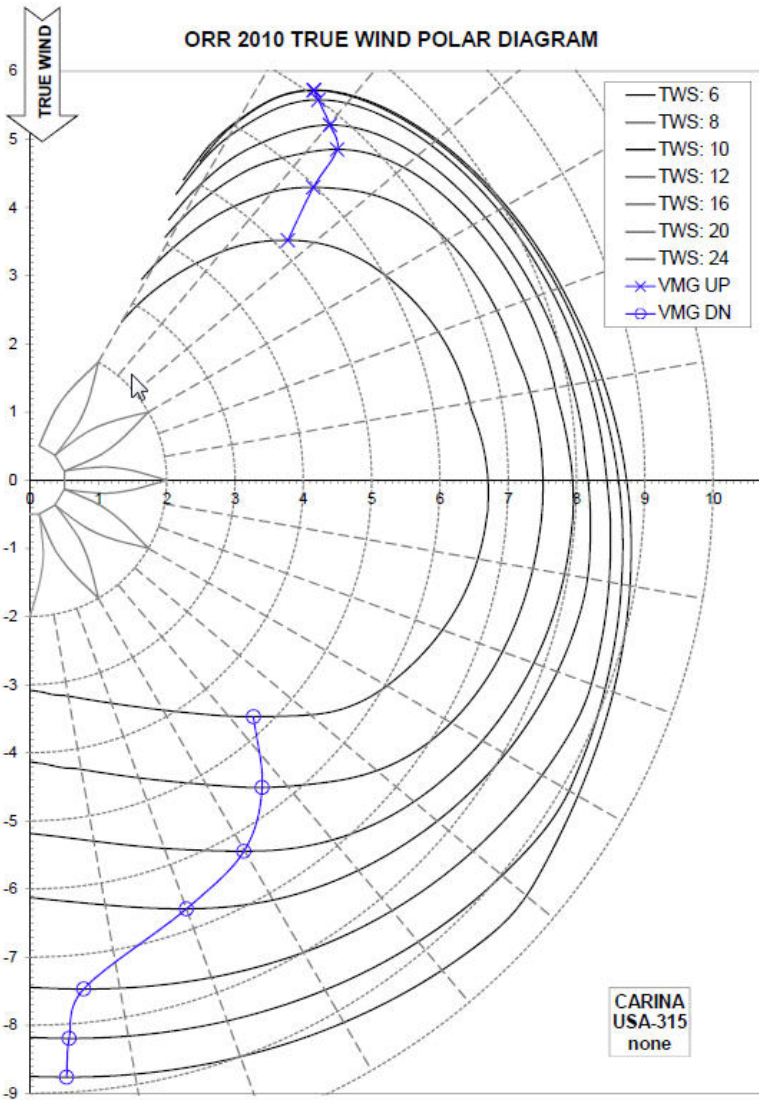


Name **WINDHOVER**
 Sail # **USA 5201**
 Class **Swede 41**
 Designer **Knut Reimer**
 Builder **Fisksatra**
 Ref. # [04560026BA](#)

This page contains the polar curves for all wind speeds. The curves are trimmed to highlight the intersection points between different sails. The legend describes the type of sails, also mentioning the sail area when applicable.

TWS: 6,8,10,12,14,16,20

- Headsail, 37,95 m² (id = Genoa)
- Symmetric, 73,76 m² (id = S2)
- Asymmetric on Centerline, 72,25 m² (id = A-sail)



VPP Output: Tables of Speeds

TABLE OF BOAT SPEED POLARS (knots) (at True Wind Angles)							
Wind Speed (knots)	6 kts	8 kts	10 kts	12 kts	16 kts	20 kts	24 kts
Opt Beat Angle (deg)	46.8 d	43.9 d	43.5 d	41.0 d	38.1 d	37.1 d	37.1 d
Opt Beat	4.66	5.36	6.03	6.24	6.46	6.56	6.60
52 deg	5.05	6.04	6.60	6.89	7.17	7.30	7.34
60 deg	5.46	6.42	6.88	7.15	7.41	7.53	7.58
75 deg	5.93	6.74	7.16	7.46	7.75	7.89	7.96
90 deg	6.00	6.86	7.32	7.63	7.96	8.16	8.26
110 deg	5.81	6.73	7.20	7.56	8.15	8.43	8.57
120 deg	5.46	6.49	7.02	7.41	8.03	8.59	8.82
135 deg	4.52	5.75	6.59	7.06	7.76	8.36	8.94
150 deg	3.74	4.88	5.90	6.63	7.45	8.06	8.63
165 deg	3.35	4.38	5.30	6.13	7.15	7.79	8.35
180 deg	3.24	4.23	5.12	5.92	6.97	7.64	8.19
Opt Run	4.02	4.94	5.70	6.19	7.01	7.66	8.21
Opt Run Angle (deg)	143.6 d	148.8 d	153.9 d	163.0 d	174.2 d	175.8 d	175.8 d



VPP Output: Tables of Handicaps (SPM)

TABLE OF TIME ALLOWANCES (Sec/Mile) (at True Wind Angles)								
Wind Speed (knots)	6 kts	8 kts	10 kts	12 kts	16 kts	20 kts	24 kts	
Opt Beat Angle (deg)	46.8 d	43.9 d	43.5 d	41.0 d	38.1 d	37.1 d	37.1 d	
Beat VMG	1130.1	931.7	822.2	763.8	707.9	687.1	683.8	
52 deg	712.6	596.5	545.3	522.7	501.8	493.2	490.3	
60 deg	659.4	560.9	523.1	503.6	485.8	477.8	474.8	
75 deg	607.6	534.1	502.7	482.3	464.7	456.3	452.2	
90 deg	600.0	524.8	492.1	471.6	452.1	441.3	435.7	
110 deg	619.6	534.9	499.7	476.0	441.5	427.1	420.2	
120 deg	659.2	554.6	512.9	486.1	448.1	419.0	408.2	
135 deg	796.4	626.3	546.7	509.8	464.0	430.8	402.5	
150 deg	963.1	737.4	610.6	543.0	483.4	446.8	417.0	
RunVMG	1112.0	851.5	703.7	608.0	516.3	471.5	439.6	
Opt Run Angle (deg)	143.6 d	148.8 d	153.9 d	163.0 d	174.2 d	175.8 d	175.8 d	

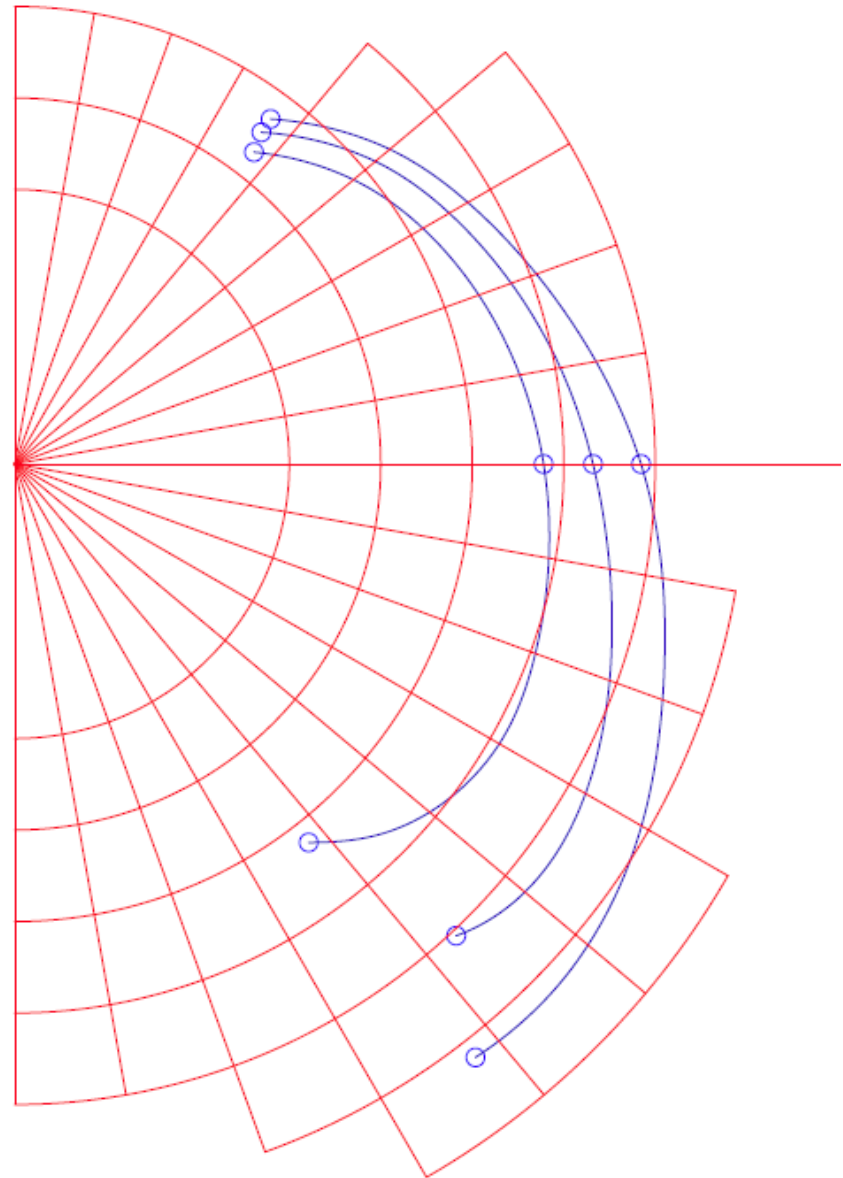


Build a Rating

40% VMG Upwind
30% 90d Reach
30% VMG Downwind

25% 12 knots
50% 16 knots
25% 20 knots

	12	16	20	Sum
VMG Up	10.0%	20.0%	10.0%	40.0%
90d Reach	7.5%	15.0%	7.5%	30.0%
VMG Dn	7.5%	15.0%	7.5%	30.0%
Sum:	25.0%	50.0%	25.0%	100.0%



VPP Output: Tables of Handicaps (SPM)

TABLE OF TIME ALLOWANCES (Sec/Mile) (at True Wind Angles)								
Wind Speed (knots)	6 kts	8 kts	10 kts	12 kts	16 kts	20 kts	24 kts	
Opt Beat Angle (deg)	46.8 d	43.9 d	43.5 d	41.0 d	38.1 d	37.1 d	37.1 d	
Beat VMG	1130.1	931.7	822.2	763.8	707.9	687.1	683.8	
52 deg	712.6	596.5	545.3	522.7	501.8	493.2	490.3	
60 deg	659.4	560.9	523.1	503.6	485.8	477.8	474.8	
75 deg	607.6	534.1	502.7	482.3	464.7	456.3	452.2	
90 deg	600.0	524.8	492.1	471.6	452.1	441.3	435.7	
110 deg	619.6	534.9	499.7	476.0	441.5	427.1	420.2	
120 deg	659.2	554.6	512.9	486.1	448.1	419.0	408.2	
135 deg	796.4	626.3	546.7	509.8	464.0	430.8	402.5	
150 deg	963.1	737.4	610.6	543.0	483.4	446.8	417.0	
RunVMG	1112.0	851.5	703.7	608.0	516.3	471.5	439.6	
Opt Run Angle (deg)	143.6 d	148.8 d	153.9 d	163.0 d	174.2 d	175.8 d	175.8 d	





Go Racing!!

