Passive Ride Control by Means of Hydrofoil Stabilized Catamarans

H A W C

HYDROFOIL ASSISTED WATER CRAFT

HYSUCAT – Malan Conradie – Gordon’ s Bay showing Hysucat Foil system in action – SOFT LANDING – NO SLAMMING

HYSUCAT 8.5 - Racing Edition

LOA: 8.5M
Beam: 2.95M
Dry Weight: 1600kg
Fuel Load: 200L
Engines: 2 x 150 Evinrude E-Tec HO
Top Speed: 56 kt

Top speed: 45.8 kts
Cruising speed: 30kts @4000 rpm

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Brief History of Hydrofoil Development

Kometa

HMCS Bras d' Or (FHE 400)

German VS-8

WM Ellsworth

Boeing Jetfoil

- Hydrofoil Vessels since early 1900's until 1980's – examples here span 1940's to 1970's
- www.hydrofoilworld.org

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HYDROFOIL PRO's and CON's (Old Model)

PRO's

- High Speed Sustainability in waves
  - *with modest payloads*
- High Speed:25kts to 30kts
- Stable Platform in Waves
  - *for passengers and weapons*
- Wake minimization
  - *Sensitive waters*
- High Speed Maneuverability
  - *In Waves*
  - *Chases*

CON's

- Modest Payloads
- Large Protruding Foils Sensitive to Impacts
  - *extended draft*
  - *extended beam*
- Sharp Edges
  - *potential harm to wild life*
- Considered Exotic
  - *Not considered normal*
- Technically Complex
  - *Too few experts*
- Complex Propulsion
  - *Bespoke Design*
- Expensive to build
  - *Large exotic materials*

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Stellenbosch University - SA

Prof. Dr. Ing. Karl Günter Hoppe

- Inventor HYSUCAT / HYSUWAC Foil systems
- World renowned expert in Hydrofoil Hybrid Technology
- Naval Architect
- Propulsion specialist
- *Responsible for Original Hull Shape and foil concepts*

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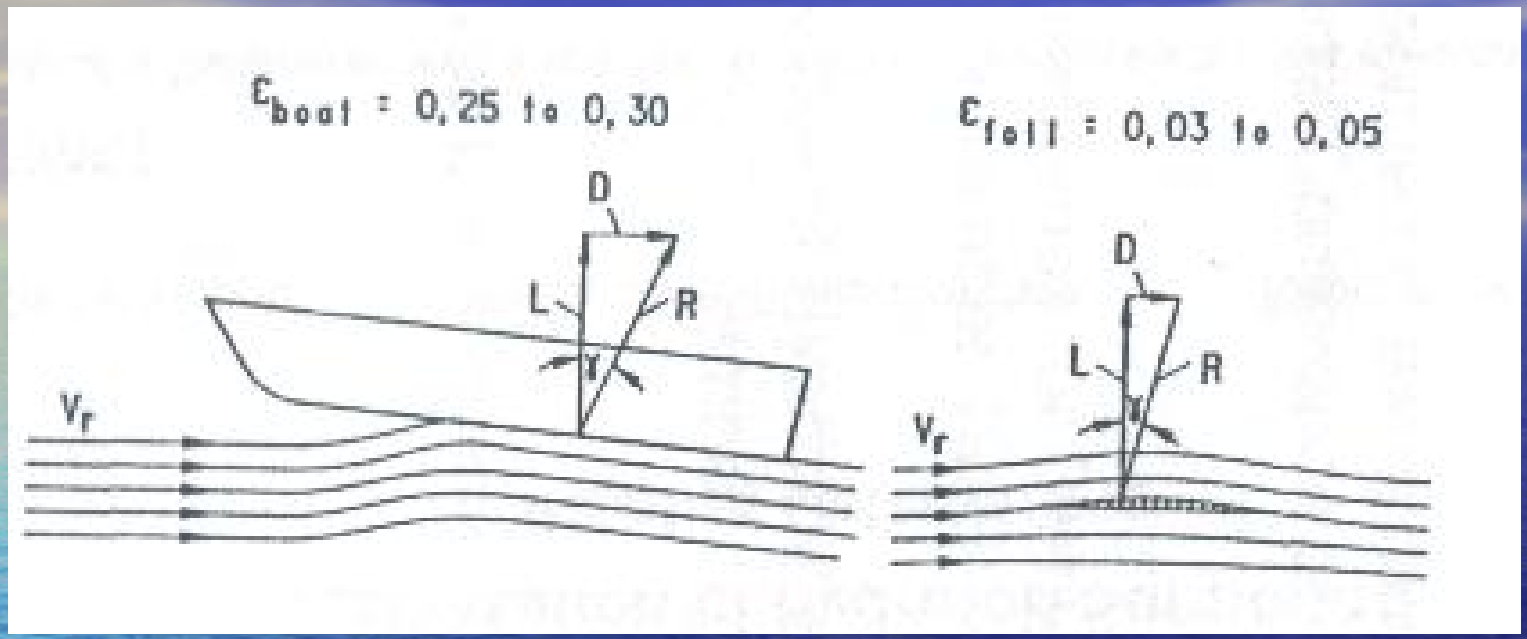
Basic Hydrofoil Principle



Planing Hull Drag to Lift Ratio (ε) is 5x or 10x greater than foil

Drag (D) / Lift (L) = (ε) Foil Efficiency

Planing boat ε = 0.25 – 0.30 ; Foil ε = 0.03 – 0.05

- Also - Foils lift a vessel and reduces the drag of the large wetted surface area of boats - Result – the boat goes faster and requires less power. Hybrids foil systems do not require specially adapted propulsion systems.

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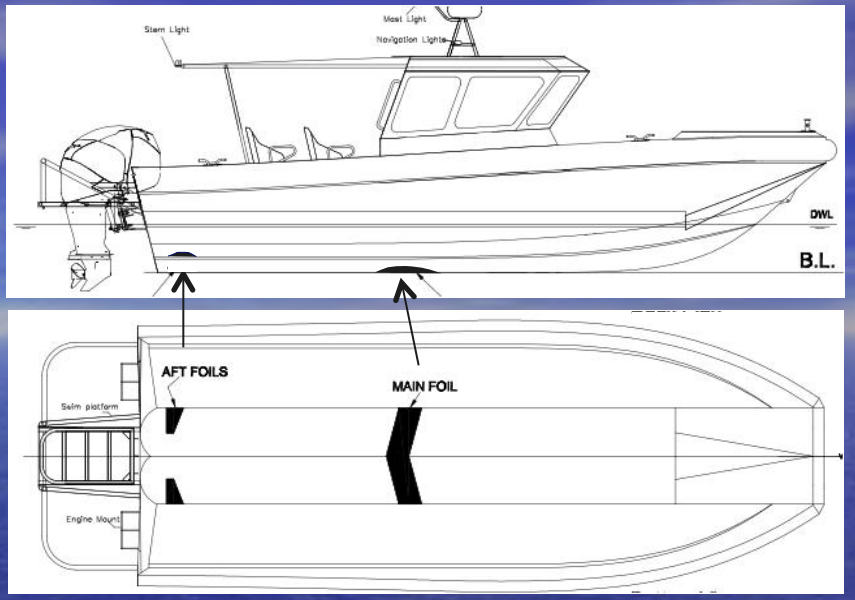
HOW HYSUCAT WORKS

- Foil System Lifts Boat Reducing Drag
- Lift to Drag Ratio on planing Monohull **L/D = 5**
- Lift to Drag Ratio on Foil Assisted Cat **L/D = 20**



Significant Improvement resulting in substantial performance benefits and fuel savings

Using standard unmodified engines and propulsions systems.

Lift below shows a 400mm to 600mm lifting of the hull over its normal floating position resulting in the low drag, hence higher speed capability.

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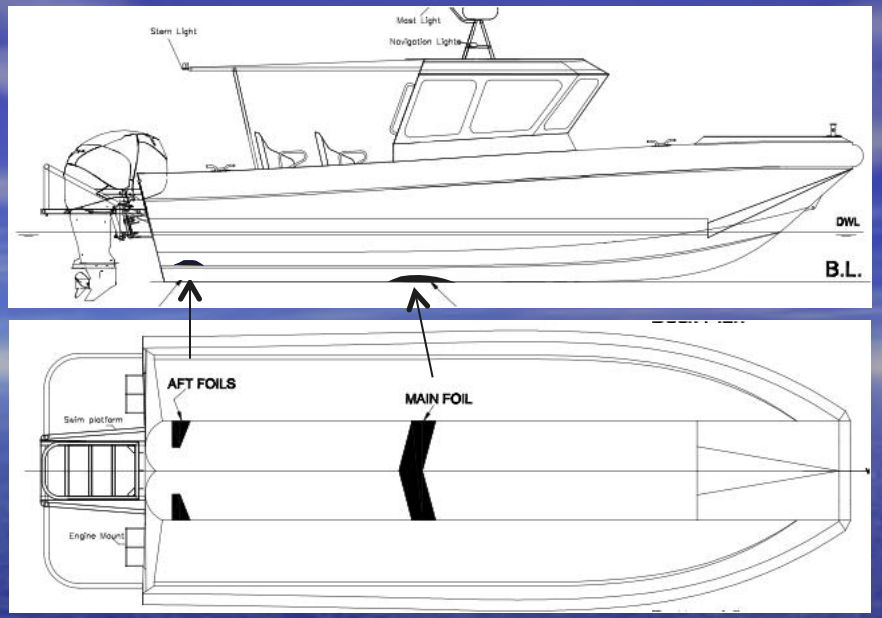
HYSUCAT Technology



Hydrofoil Supported Catamaran

Significant Benefits

1. *Increase Boat Speed without adding to installed power*
2. *Substantial Fuel Savings through increased speed and lower torque requirement from engines*
3. *Carry more weight (130% more than conventional type boat without diminishing performance)*
4. *Much Smoother and faster ride in rough water with limited speed loss in waves – no slamming.*
5. *Very low wakes produced.*
6. **Significant rough water capabilities (passengers do not get sea sick)*
7. **Safe maneuverability at high speeds in rough water.*

** Recent discoveries from operating HAWC 11 and HAWC 12 DWJ regularly in sea states 4, 5 and 6 normally and in demos for HK Govt. units)*

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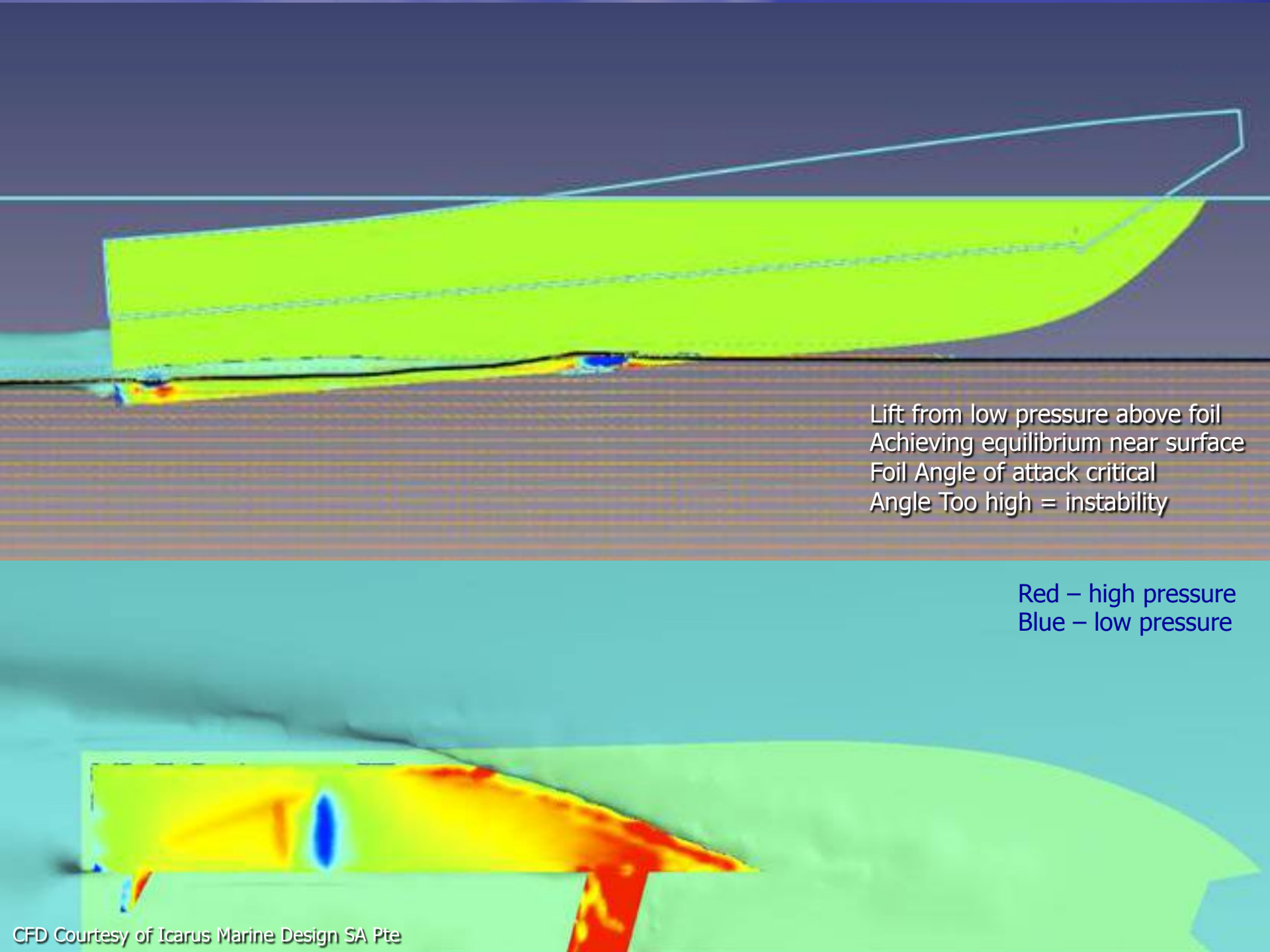
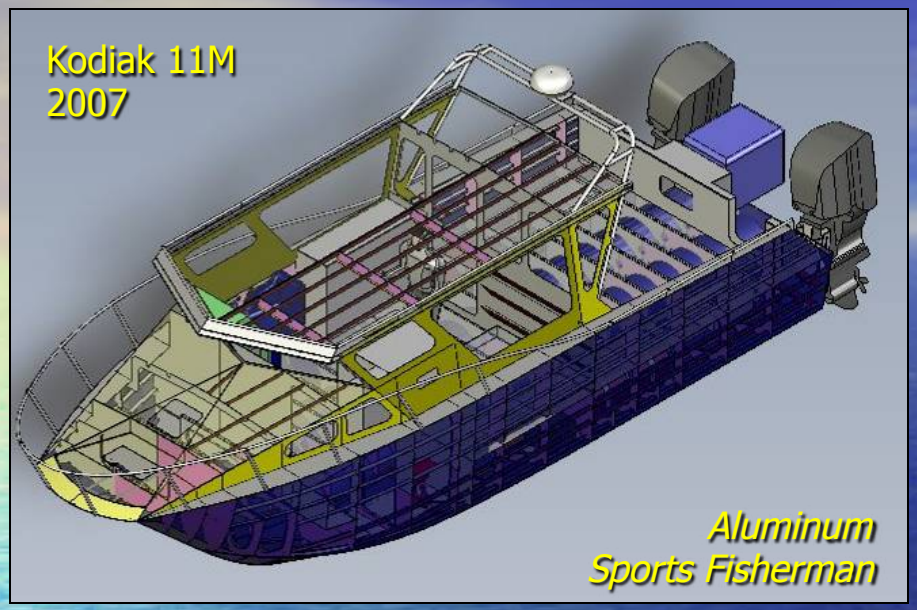
HAWC 12 DWJ
LOA: 12.65M
Beam: 4.2M
Engines: Marine Diesel 2 x VGT400
Propulsion: DOEN 2 x DJ110Z waterjets
Displ.: 13t
Max Speed: 37kts @ 11.5t

CFD Courtesy of Icarus Marine Design SA Pte


Lift from low pressure above foil
Achieving equilibrium near surface
Foil Angle of attack critical
Angle Too high = instability
Red – high pressure
Blue – low pressure
CFD Courtesy of Icarus Marine Design SA Pte

2007 HAWC Hull 1 – Kodiak AK



35ft Sports Fisherman

- Designed and Built 2007
  - *DNV Standards - Sea State 6 (Very rough Seas 15ft – 20ft)*
- 2 miles / gal fuel efficiency
- 52 mph top speed *(46kts)*
- 200 gal fuel tank Range 400 NM
- Fastest, smoothest riding, most efficient boat of this size, power and weight built in 2007
- NO SLAMMING HULL !!
- *Award Won – Connecticut Quality Improvement Award (Silver) - Transportation*

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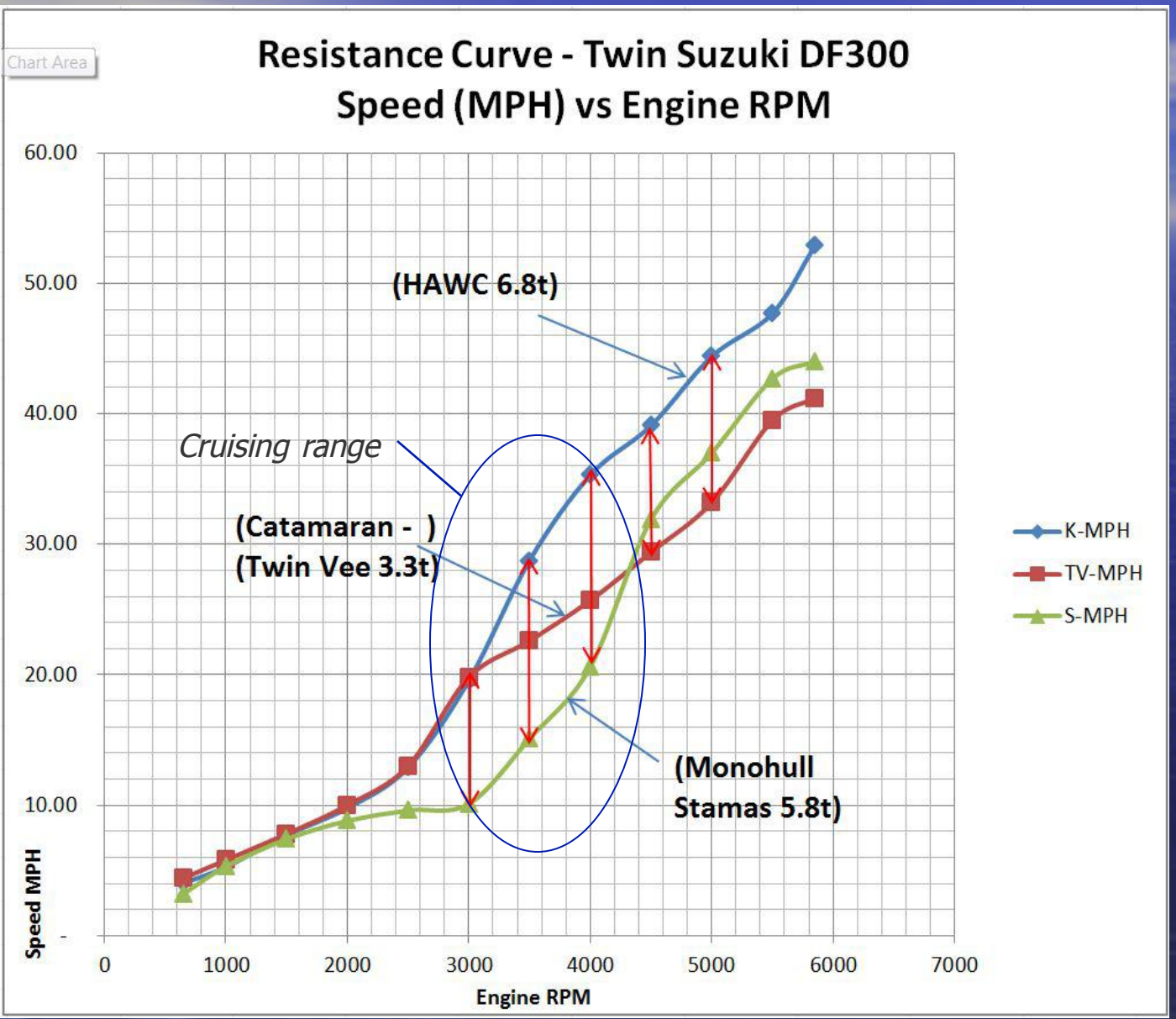
COMPARING Suzuki DF 300



Boat test data:

Monohull:

Stamas 340 Express
LOA 10.4M
Beam 3.66M
Displ. 5717kg

Catamaran

Twin Vee 36S
LOA 10.36M
Beam: 3.40M
Displ. 3267kg

HAWC: Kodiak
LOA: 11.0M
Beam: 3.50M
Displ. 6800kg

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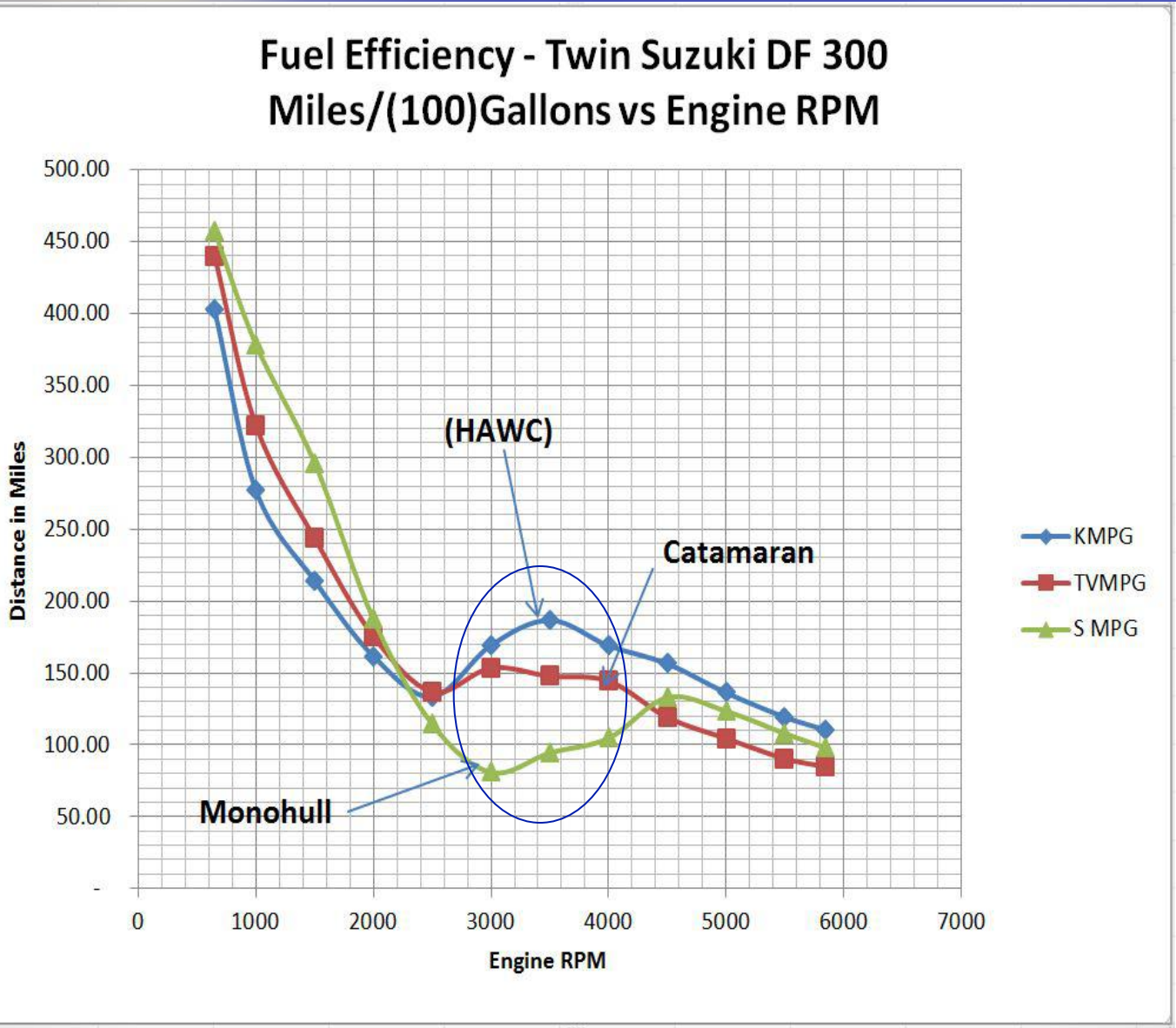
COMPARING Suzuki DF 300



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Hybrid Foils: PRO's and CON's (New Model)

PRO's

- High Speed Sustainability in waves
- High Speed: 25kts to 50+kts
- Stable Platform in Waves
- Wake minimization
- High Speed Maneuverability
- Limited Protrusions
- Standard Propulsion systems
- Lower Power requirements
- Low Fuel Use
  - *40% savings*
- Higher Payloads
- Low Cost
- Safe

CON's

- Considered Exotic
- Technically Complex
  - *Too few experts*

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Sea Trial Invitation
May/June 2014
Hong Kong

HAWC 25 Search & Rescue

Builder: Wang Tak Engineering & Shipbuilding Co. Ltd.
Design: HAWC / Icarus Marine S.A. (Pte) Ltd

HAWC – Workboats, Water Taxis, Ferries
Less Power, Higher Speed, Significant Fuel Savings
Soft Ride in Rough Water, Superior Handling

- 25M x 7.8M
- 79t Displacement
- MTU 12V2000M72 1080 kW x 2
- Gear Box ZF3050
- FPP inclined Shaft
- Top Speed 35kts
- Engtek A50RTE (azimuth) Engtek 12 BTM (Bow thruster)
- Fuel: 1720L x 2
- Water 2000L x 1
- Fixed Tandem Foil System
- Fire Fighting 360m^3/h
- Fire Monitors 140m^3/h
- Tank Tested

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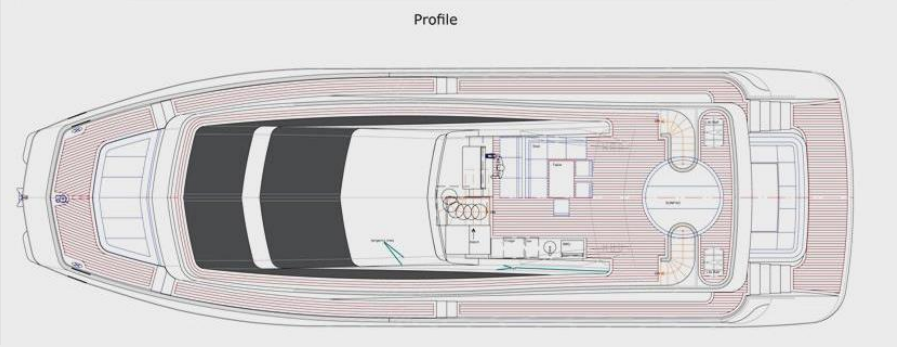
RESCUE
南灣號
NAM VAN


南灣號
NAM VAN


南灣號
NAM VAN


南灣號


56kts Top Speed
35kts Cruising
HYSUCRAFT 80
Luis De Basto Design
KG Hoppe Engineering



81' (24.699m)

Draft	1.226m (4.03')
Displacement	63.802 [t] Full Load
Engines	2 x Caterpillar CAT 32 ACERT 1925 HP @ 2300 rpm (MTU 16V2000M72 - Optional)
Top Speed	56 knots at full load
Cruising Speed	35 knots (most economical speed)
Range at cruising speed	524 nautical miles
Propulsion system	2 x ZF Gearbox with ratio 1.441:1 driving KaMeWa 45A3 Waterjets.
Fuel tank	5355 Kg Diesel Fuel (*Long range version with 7500 Kg fuel possible for range 800 nautical miles*)
Water Tank	1200 litres fresh water

The Hysucraft 80' is a Multi-Hull-Foil-Assisted hybrid with a tandem foil system installed inside the tunnel of the fully asymmetrical planing catamaran.

Exterior and Interior design by Luiz de Basto Designs
Hull design and engineering – Foil Assisted Ship Technologies

Come and Experience
a Transformation in Boating!

Wang Tak Engineering & Shipbuilding Co. Ltd.
www.wangtak.com.hk

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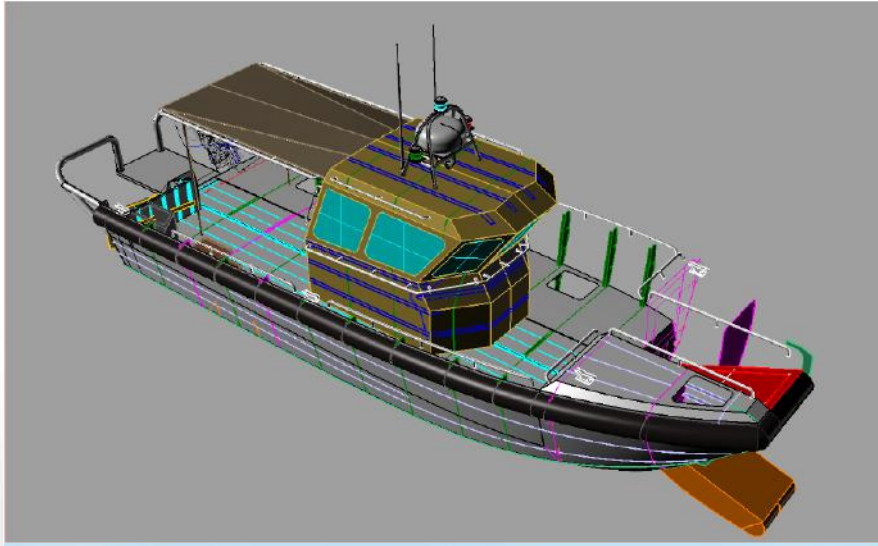
HAWC Technologies Ltd.
www.hawctech.com

HAWC 25 – Macau Airport Rescue



HAWC 25 Technical Particulars:

VESSEL: HAWC 25
(Hydrofoil Assisted Water Craft)
Builder: Wang Tak Engineering & Shipbuilding Co. Ltd
Designer: Icarus Marine S.A. (Pte) Ltd

Length Overall:	25.8M
Breadth Moulded:	7.8M
Depth Moulded:	1.3M
Hydrofoil System:	Tandem Foil
Max Speed:	35 kts
Displacement:	79 t
Engines:	1080kW x 2 (MTU 12V 2000 M72)
Gear Box:	ZF 3050
Propulsion System:	Fixed Pitch Propellers on inclined shaft in Prop tunnels
Genset:	135kW x 2
Thrusters:	Engtek A50RTE (Azimuth) Engtek 12BTM (Bow)
Fire Pump:	360m³/ hr x 1
Fire Monitors:	140m³/ hr x 2

HAWC 11M – 45kts; 2 x 250hp Outboard Engines

HAWC 12 DWJ – 35+kts; 2 x 400hp Diesel; Water jets

HAWC *- Work Boats, Water Taxis, Ferries*
Less Power, Higher Speed, Significant Fuel Savings,
Soft Ride in Rough Water, Superior Handling

Contact:
gkutt@hawctech.com
Tel: +852 9862 6963

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Parameters Determining Foil Optimization

DETAILS – VARIABLES – CALCULATIONS – MODEL TESTING – EXPERIENCE

- Hull form / shape – Asymmetric Hull, high dead-rise angle preferred
- Engine Power – Ratios: HPs/Displacement tons equals 60x to 100x
- Propulsion system – Propellers / blades / pitch / diameter best efficiency
  water jets and surface drives require high RPM
- Foils designed for: a. High Fuel Economy maximize lift to drag (less speed)
  b. High Speed (thinner foil with super-cavitating capabilities)
- Hull displacement: Heavier vessel will require larger foil or tandem foil systems and
  power and propulsion systems matching for optimum performance
- LCG position: Critical for foil placement and vessel balance to ensure
  ride stability (model testing requirement not essential)
- Foil dimensions: Chord length, Dihedral Angle, Sweep angle, Attack Angle,
  Foil thickness, Foil shape (front and rear matching)
- Effect of trim tabs / interceptors / trim of OB engines, stern drives and surface drives.
- Effect of Jack plates – when props become semi surface piercing affects performance and foil angle setting considerations and trim.
- Engine offset from transom – determines maneuverability.
- *All of the above and more affect foil design and all parameters associated with foil optimization.*
- *Complex mathematical formula matrix required lies at heart of all foil systems designed for specific hulls, power and propulsion systems.*

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RELEVANT EXPERIENCE IN FOIL APPLICATIONS

- BRIEF: Operational requirements of client clearly understood and within realistic and deliverable performance goals capabilities, as well as design features, standards and quality control.
- Science and Technology: Accurate performance prediction; Foil calculation, foil design, Hull form design, hull structures, foil placement, foil installation, testing and performance evaluation. Flag, Classification and HSO requirements fully met to operate in designed and declared sea state limits for vessel speed.
- Design – styling, Boat function, weight saving, construction and build knowhow.
- Fabrication – efficiency, cost control, weight control, quality control, construction methodology, procurement, machinery selection, component selection, installation of all of above.
- Operations set up and feedback – Performance in all sea conditions, especially rough water. Handling characteristics include. Vessel trim sensitivity and porpoising limits, weight distribution, list trimming. Propeller selection, Engine RPM range. Reliability testing. (Experience and feedback leads to innovation and improvements)

- Development team: Client, Project manager, Designers, Technologists (hull, foil systems, propulsions systems; Engine specialist and installation; mechanical equipment, electrical, electronic, general procurement and installation; material supplier; naval architect / designer; CAD specialists; Engineering (structure, stability) ; Classification; Fabricator, Construction team, NDT testing; Interior design and interior fit out; trainers; operators; testing and evaluation.

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Optimizing Foil Systems for Vessels up to 15M

- Propulsion Systems
  - Depends upon size of vessel, speed required, and displacement weight.
    Recommended: Outboards, Stern drives, Standard Shaft Props.
    For commercial applications – medium duty minimum. High performance engine utilize at 70% to 82% MCR. Choose engines with longer maintenance cycles.
  - Outboard Engines – *excellent up to 12M, 12t.*
    Good cruising to top speed; 4 bladed props
  - Stern Drives – *excellent up to 14M, 15t.*
    Good cruising to top speed.
  - Standard Shaft Propulsion – *excellent for reasonably high cruising speed;*
    Poor high speed performance; Multi-bladed props.
  - *Surface Drives – Good high speed operation. Requires constant high engine RPM.*
    Best suited for lightweight medium sized boats up to 17M
  - *Waterjets – Same as surface drives. Better suited to larger vessels 15M plus.*
    Upsize waterjet – best option for high speed operations for larger vessels.

- Engines
  - 12M or smaller – Outboard engines considered – ease of installation and cost or small diesels
  - For 12M vessels and above start at 2 x 350hp with stern drives or standard props. 12t
  - For 15M vessels – light weight vessel Diesel up to 600hp with Medium Duty
  - Engine Gap 600 hp to 800 hp – no lightweight medium performing engines available. Most engines in this power range are large and heavy, increases displacement weight.

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COMMITMENT

- HAWC Technologies is committed to saving at least 30% of fuel on all boats converted, produced or built over existing technologies
- HAWC is committed to making boating fast – getting to destinations quickly and safely in sea states up to sea state 6
- HAWC is committed to the development and production of 100 Foil Assisted Vessels in the coming 5 years
- The commitment aims to get as many related persons involved as owners, users, contributors to the design, construction and use of these vessels so the knowledge and knowhow can spreads
- HAWC is committed to talking with anyone who is interested in putting a boat into service for individuals and communities where access to remote locations or services by sea or water transport is a necessity.

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