Dynamic Positioning Committee

Marine Technology Society

Thrusters

Use of Main Drive Waterjets as Azimuth Thrusters

Dick Borrett
Andy Birkinshaw

CWF Hamilton

October 9-10, 2007

Return to Session Directory

Use of Main Drive Waterjets as Azimuth Thrusters

Dick Borrett and
Andrew Birkinshaw

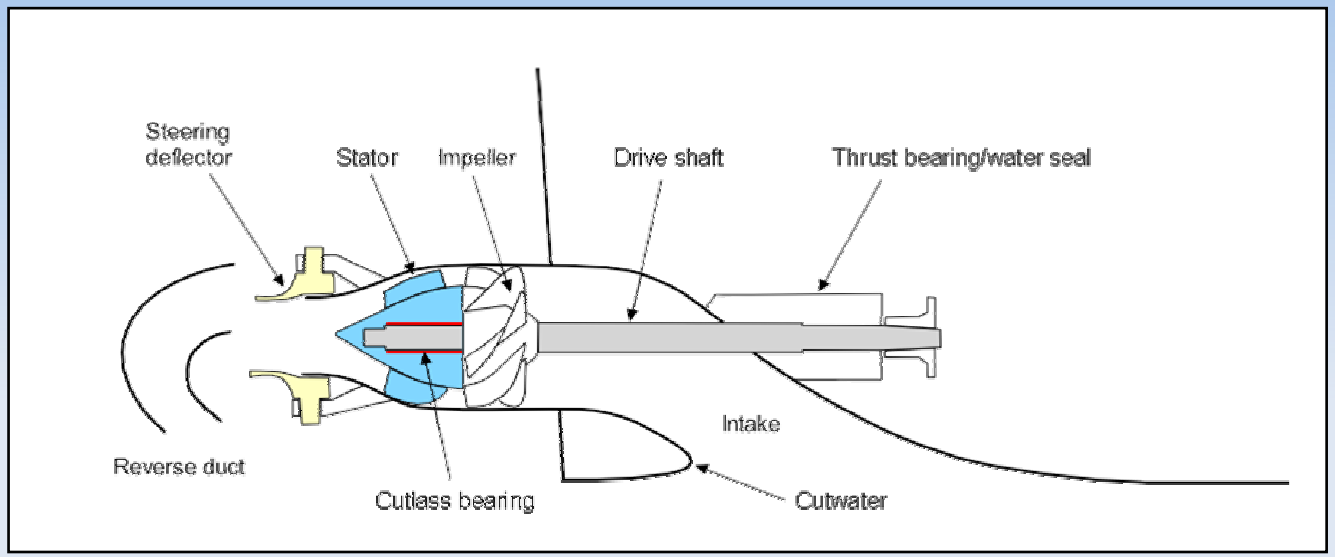
HamiltonJet
Christchurch,
New Zealand

Overview

- Waterjet Basic Principles
- Advantages of Waterjet Propulsion in Crew Boats
- Thrust characteristics for Transit and Dynamic Positioning
- How Thrust is Controlled
- Control System and DP interface
- Transverse Thrust Methods.

Return to Session Directory

Waterjet Basics



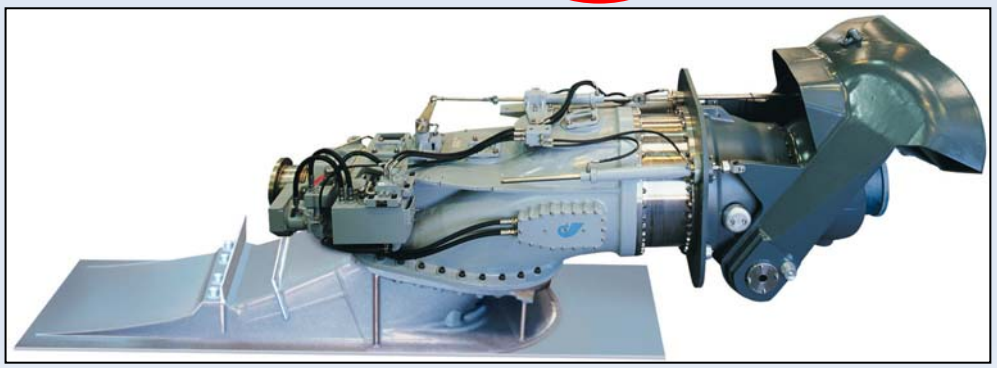
- A waterjet is a pump
- Thrust is created by a reaction force
- Thrust controlled by:
  - engine RPM
  - steering deflector (nozzle) and reverse duct positions.

Return to Session Directory

Waterjet Crew Boats

Length Overall	53.8m	177 ft
Length BP	48.01m	157.5 ft
Beam	9.14m	30.0 ft
Depth	4.11m	13.5 ft
Light Displacement	205 MT	202 LT
Loaded Displacement	508 MT	500 LT
Main Engines	4 x Cummins KTA50 M2 Diesels	
Power	4 x 1800 BHP @ 1900 RPM	
Waterjets	4 x Hamilton HM811	
Bow Thrusters	1 x 200 hp Tunnel (docking only) 1 x 200 hp drop-down azimuth	
Speed at 450 LT	18.5 knots	
Speed at 210 LT	31 knots	

Jet Model	Max. Cruise Power (sHP)	Max. DP Power (sHP)	Max. DP Thrust (tons)
HM571	1877	664	3.5
HM651	2414	837	4.5
HM721	2950	1060	5.6
HM811	3755	1340	7.1



Return to Session Directory

Waterjet Advantages in Crew Boats

- Higher transit speeds at light loads
- High bollard pull
- Fast and accurate thrust control
- ‘Azimuth thruster' characteristics
    - Shallow draft
    - Reduced underwater damage
    - No engine overload
    - Gearbox always engaged
    - Simple installation and interfacing.

Return to Session Directory

Waterjet Transit Performance

Fixed Pitch Props

- Prop RPM and vessel speed closely related
- Prop ‘pitched’ for required speed at full load
- When light, speed limited by governor

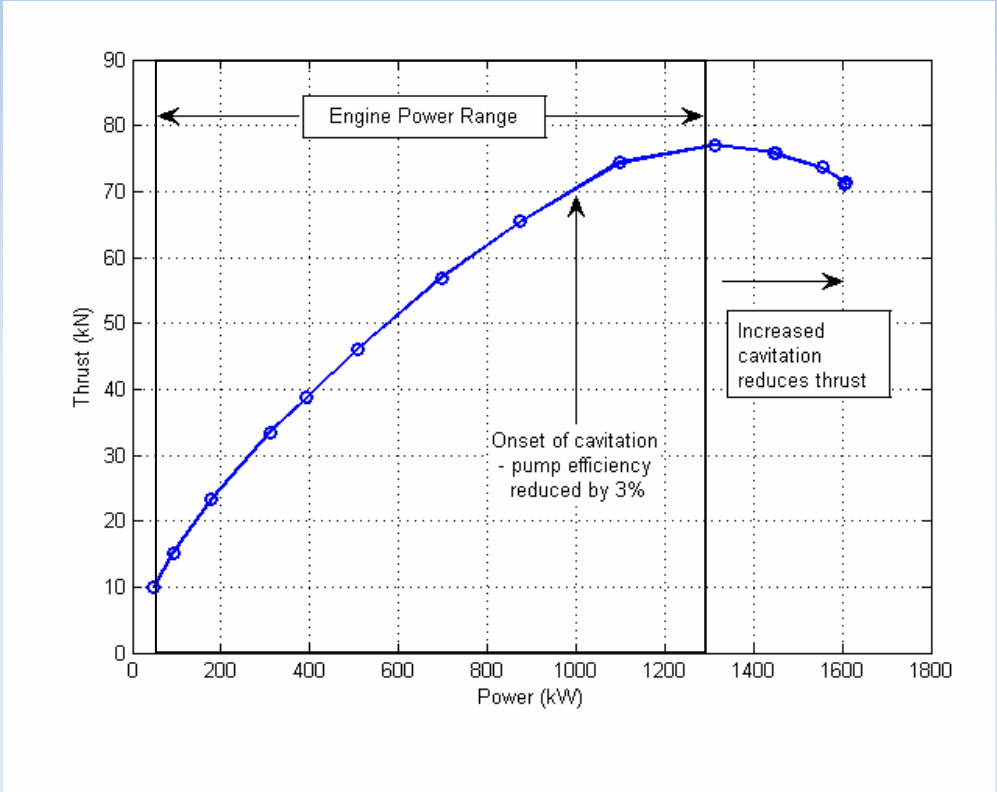
Waterjets

- RPM and vessel speed not directly related
- Full engine power absorbed at all speeds
- When light, higher speed achieved.

Return to Session Directory

Bollard Pull Thrust

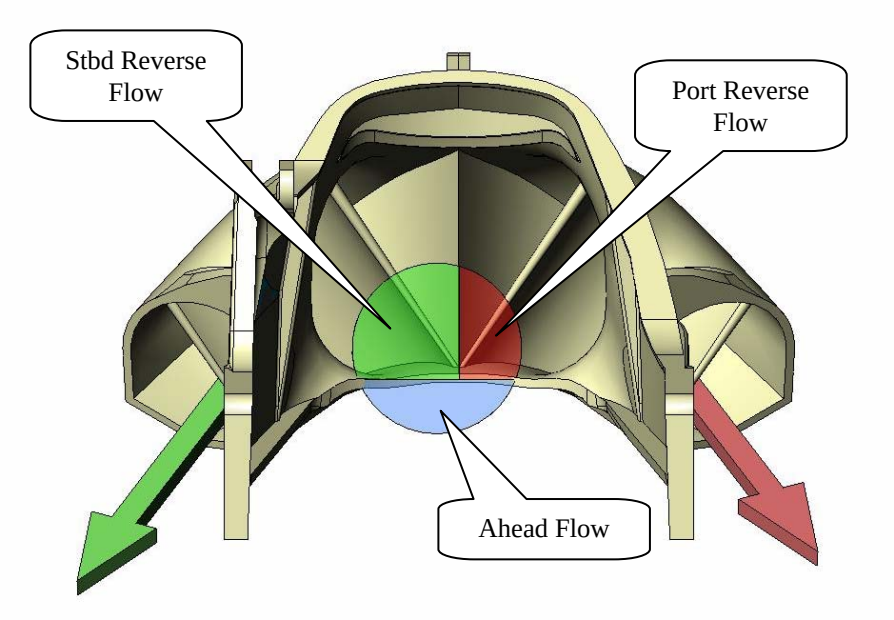
- Thrust limit determined by cavitation resistance
- This depends on NIR and intake geometry
- Maximum bollard pull specified at '-3%' point
- Engine power matched to max thrust
- Intermittent thrust OK at higher power

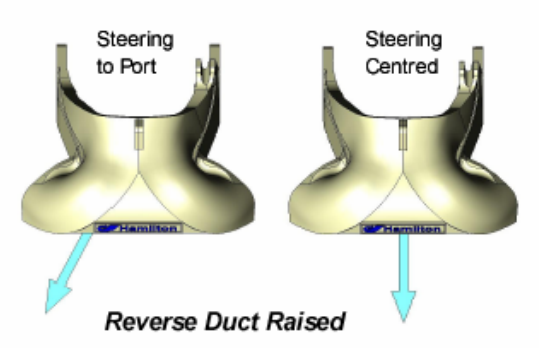


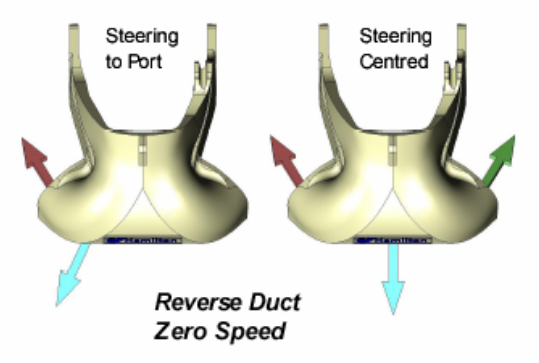
- Design optimised for performance at all speeds
- Larger jet sizing maximises bollard pull for given engine power.

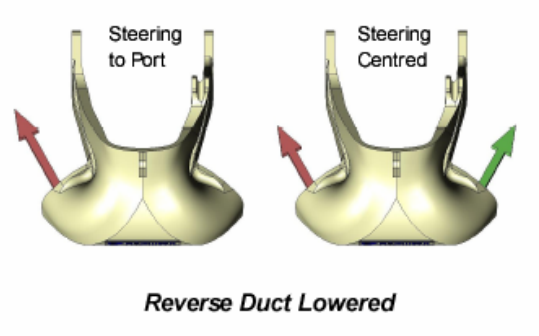
Return to Session Directory

Thrust Control







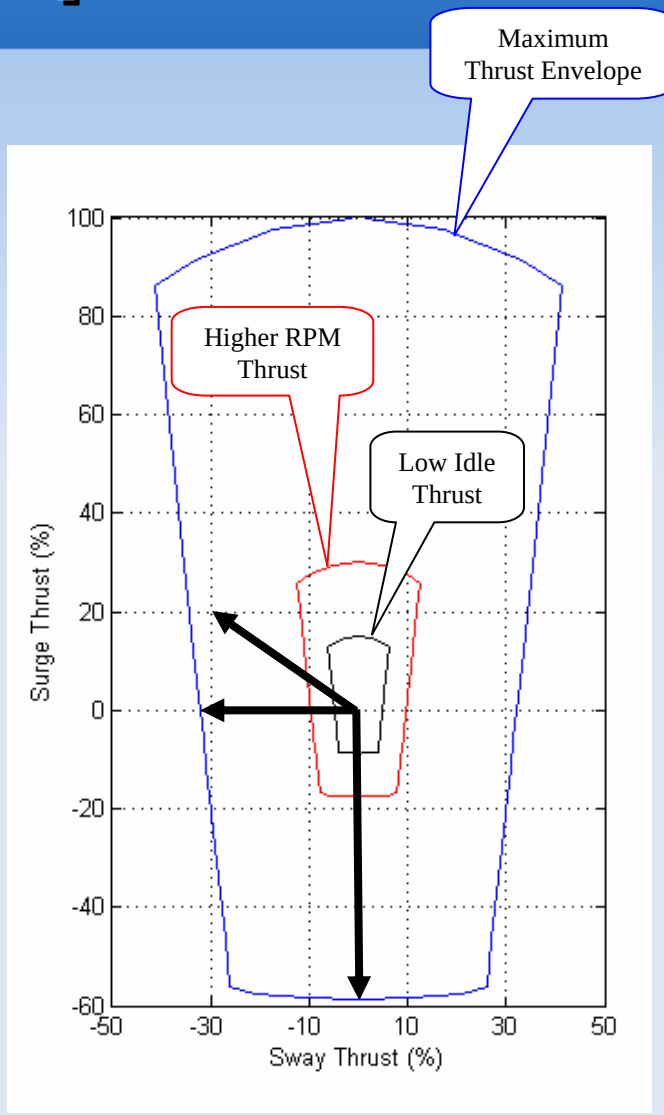


- Thrust controlled by splitting the flow
- Ahead flow controlled by steering
- Reverse flow components controlled by steering and reverse

Return to Session Directory

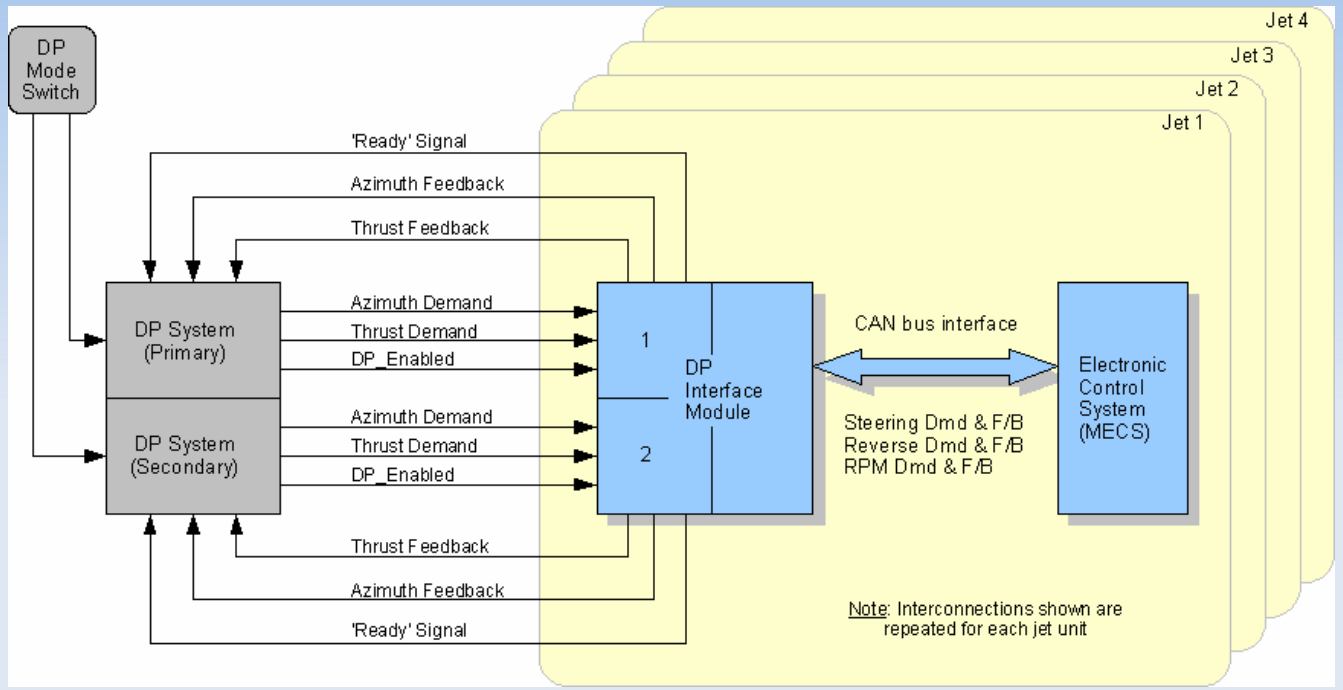
Thrust Envelopes

- Sway thrust – steering
- Surge thrust – reverse
- Envelope is scaled with RPM
- Reverse thrust ~ 58%
- Side thrust ~ 32%
- Any thrust vector can be defined within the outer envelope
- Steering, reverse and RPM must be determined.



Return to Session Directory

System Interfacing



- DP system sends thrust and azimuth demands to DPI Module
- DPI calculates steering, reverse and RPM demands
- DPI returns thrust and azimuth feedback
- Dual interfaces for DP2 capability
- Quick and easy setup
- High level of redundancy.

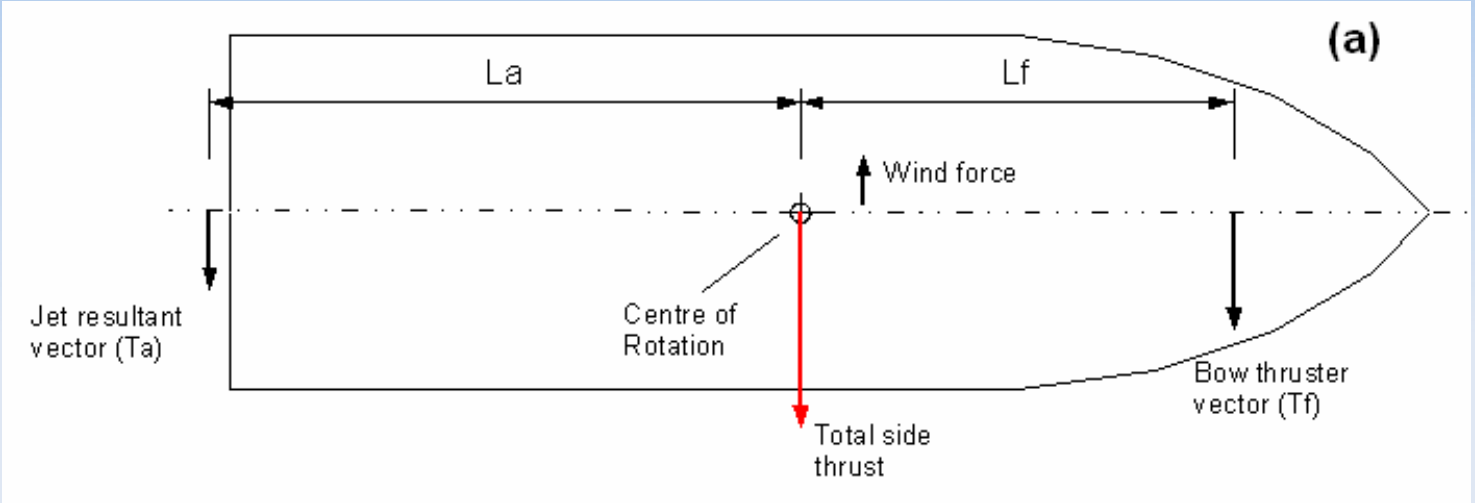
Return to Session Directory

Transverse Thrust Methods

- Crew boats limited in side thrust ability
- 3 different thrust methods analysed
- Assumptions:-
  - Not a full DP capability analysis
  - Calculations based on ‘Joyce McCall’
  - Current and wave forces act at COR
  - Wind forces centred 3m ahead of COR
  - Wind speed 10 knots.

Return to Session Directory

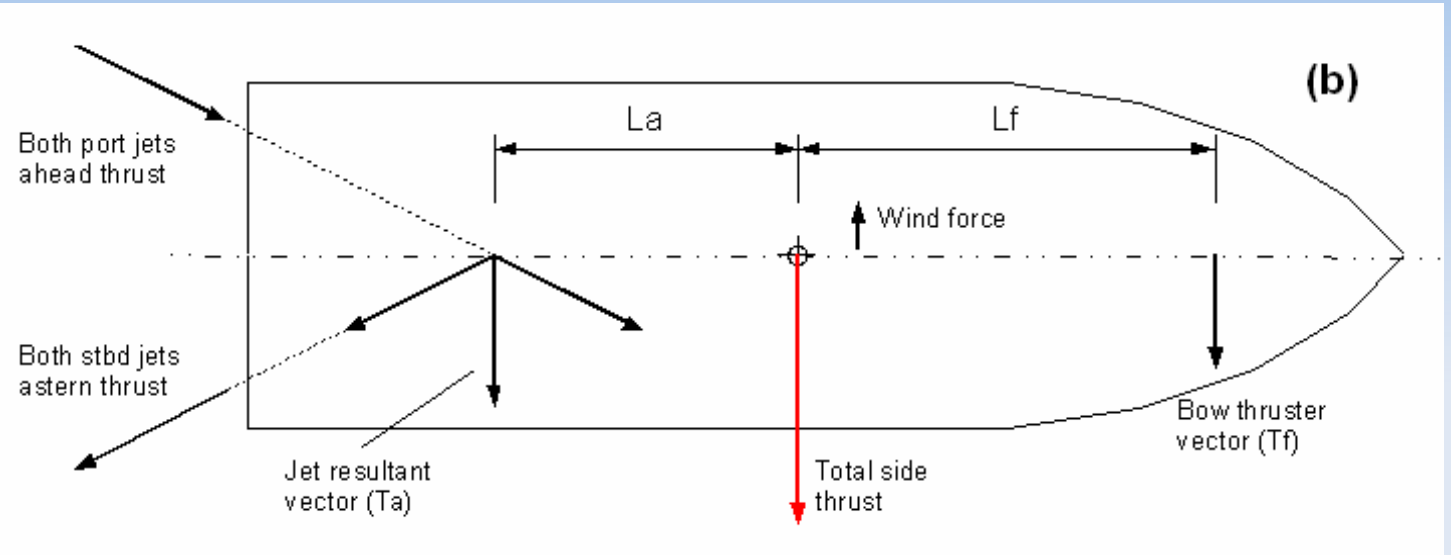
Transverse Thrust Method 1



- Jets thrust sideways with bow thruster
- All jets thrust the same
- Jet thrust ~ 15% of available side thrust
- Low power levels
- ‘Bow thruster limited’.

Return to Session Directory

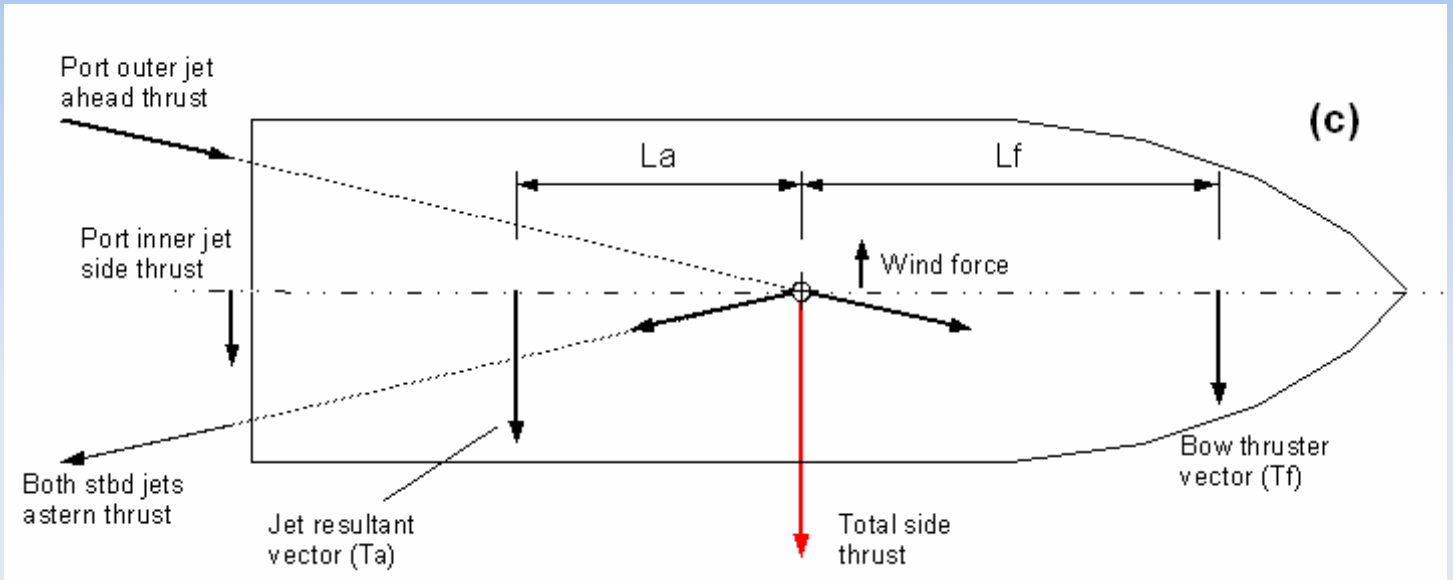
Transverse Thrust Method 2



- Jet longitudinal thrust reflected sideways
- Optimum when:-
  - Lf . Tf = La . Ta + wind moment
  - Ta maximised
- Thrust increase ~ 35% over method 1
- High power levels.

Return to Session Directory

Transverse Thrust Method 3



- One jet thrusts sideways
- Remaining jets reflect side force at COR
- Thrust increase ~ 37% over method 1
- High power levels.

Return to Session Directory

Summary

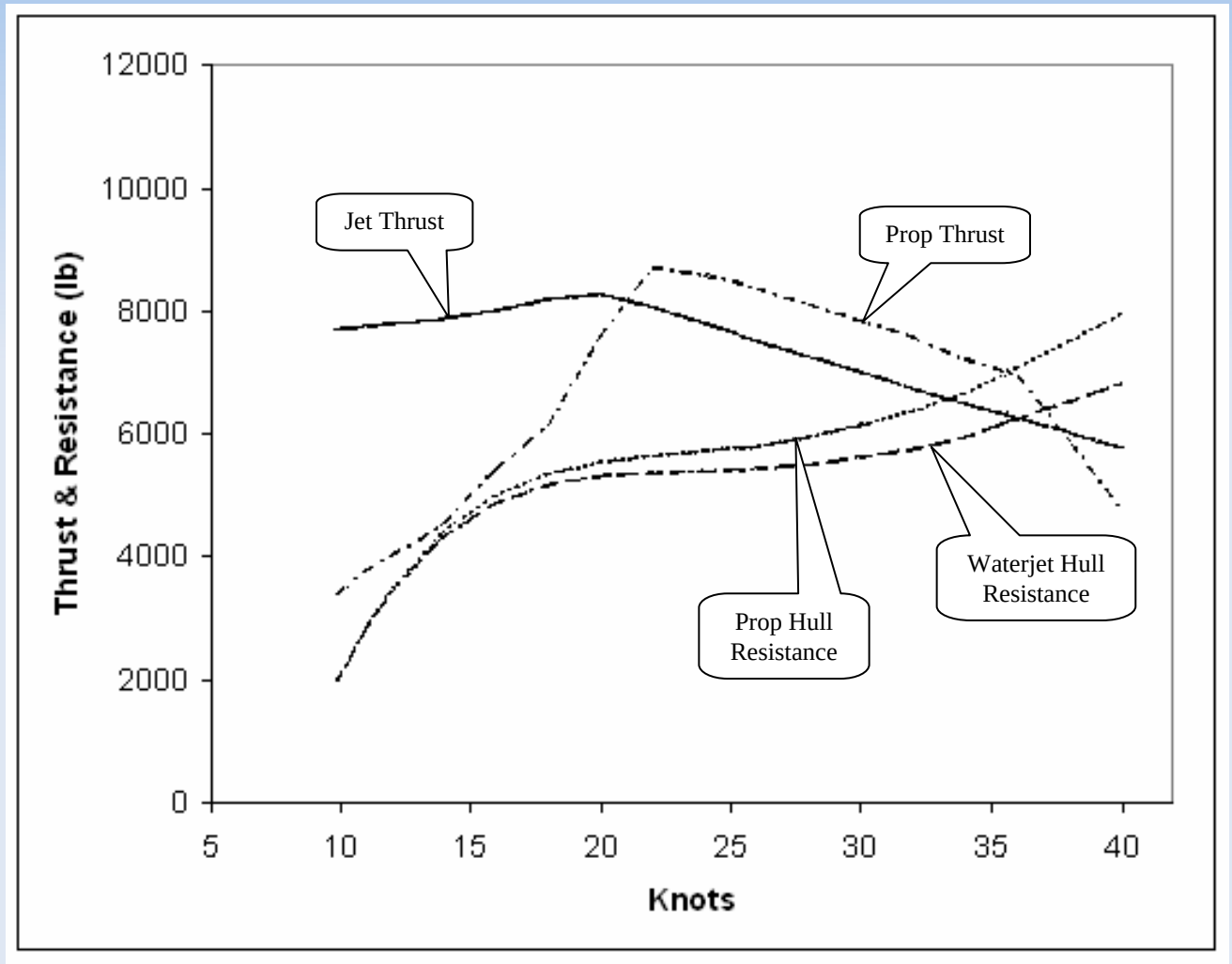
- Waterjets are a good solution for vessels that operate in widely different modes
- Allow higher speeds when running light
- High bollard-pull thrust
- Effectively emulate azimuth thrusters
- Quick and accurate thrust response
- DP interfacing
- Improved capability may be achieved by using different transverse thrust strategies.

Return to Session Directory

Questions?

Return to Session Directory

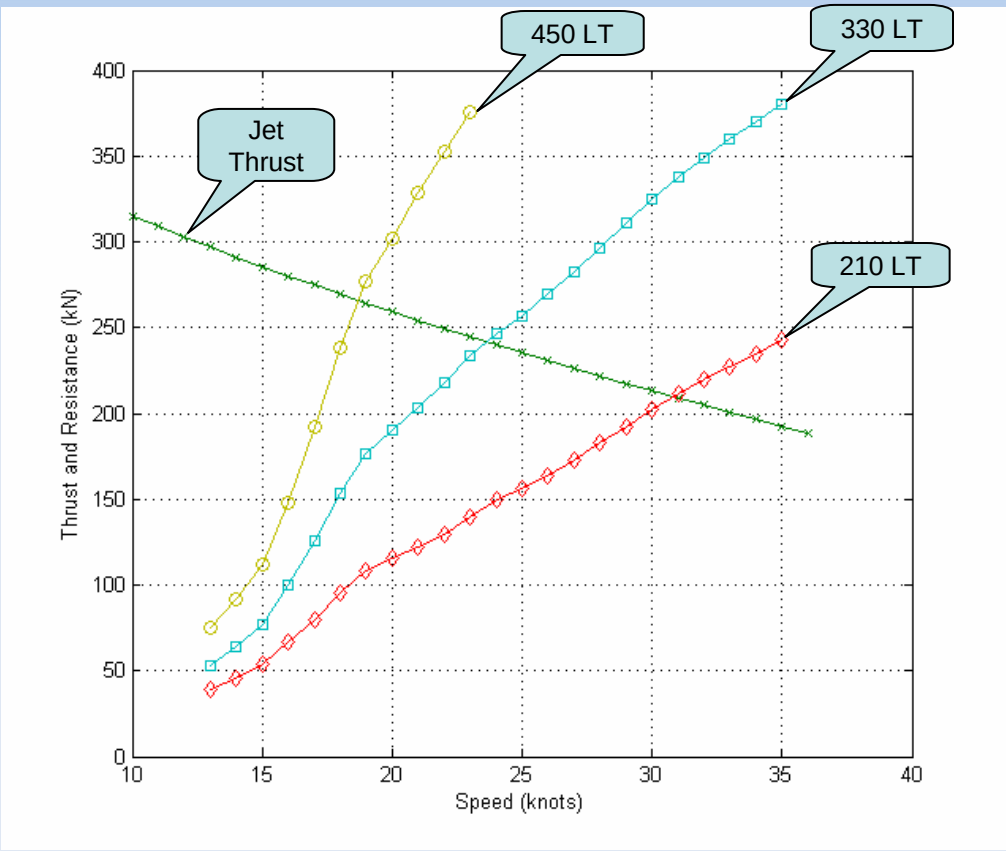
How Waterjets Differ to Props



Return to Session Directory

Transit Performance

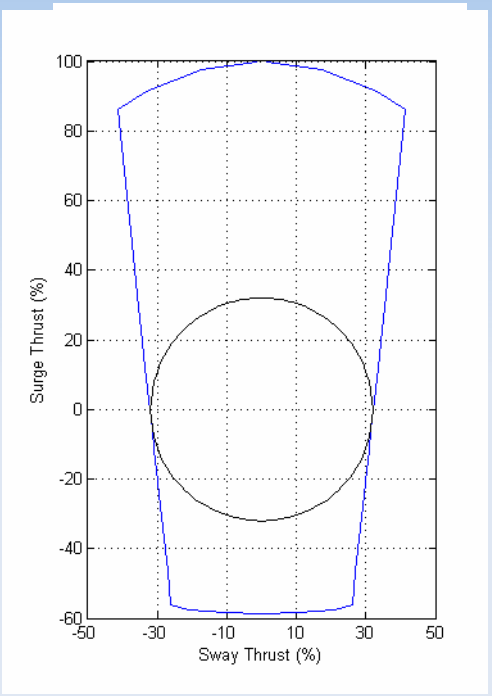
- Crew boat resistance varies widely with displacement
- Waterjets use full engine power at all loading conditions



Return to Session Directory

Differences to Azimuth Thrusters

- Non uniform thrust envelope
- Restrict to circular region
- Restricted azimuth zones largely avoided
- Rapid response for thrust reversal
- Push-pull thruster pairing not needed
- Virtually infinite thrust resolution
- No unwanted vectors while changing azimuth



Return to Session Directory