Surface Ship Endurance Fuel Calculations

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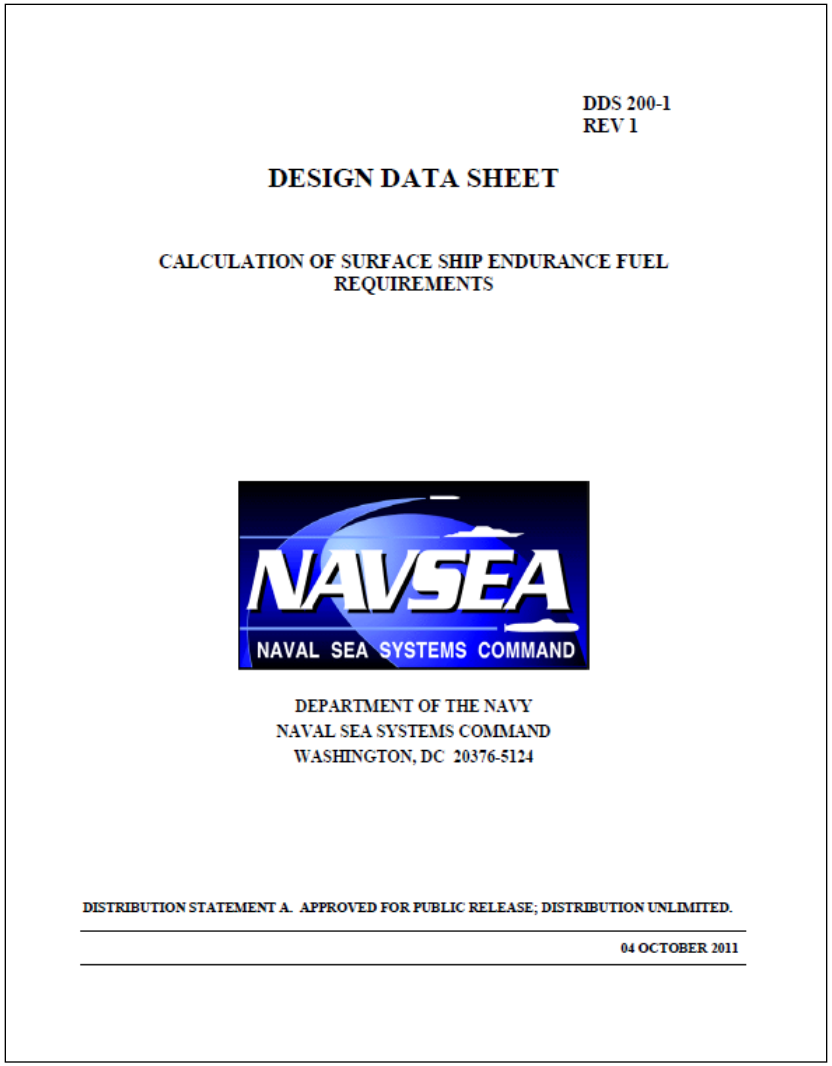
Introduction

- Motivation
- Endurance Conditions
- Calculation Modifications
- Special Cases
- Ship Design Implications
- Design Tools
- Future Work

Endurance Fuel Calculations are used to size the fuel tanks



DDS 200-1
REV 1

DESIGN DATA SHEET

CALCULATION OF SURFACE SHIP ENDURANCE FUEL REQUIREMENTS

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
WASHINGTON, DC 20376-5124

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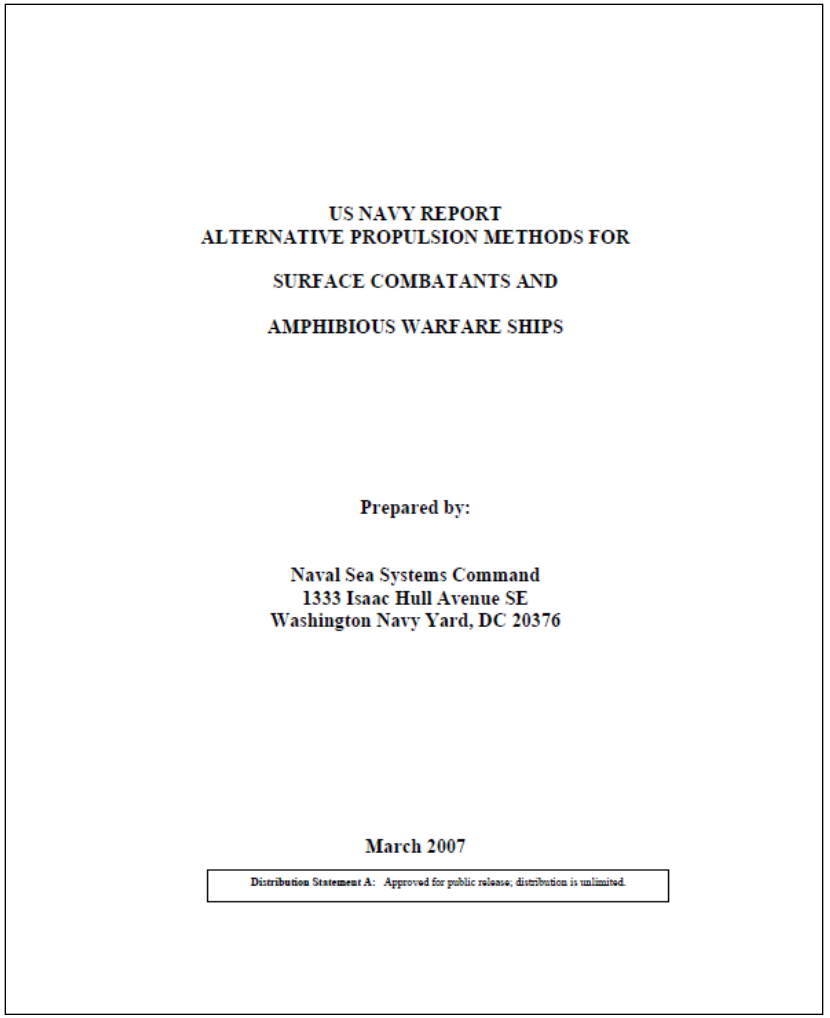
Motivation

- Need to align endurance fuel calculations with operational practice
  - Optimize design in a meaningful way
- Report to Congress on alternate propulsion methods
- Technical Warrant Holder recommendations



US NAVY REPORT
ALTERNATIVE PROPULSION METHODS FOR

SURFACE COMBATANTS AND

AMPHIBIOUS WARFARE SHIPS

Prepared by:

Naval Sea Systems Command
1333 Isaac Hull Avenue SE
Washington Navy Yard, DC 20376

March 2007

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Endurance Conditions

- Surge to Theater
  - Distance at sustained speed
  - Cruise with self defense
- Economical Transit
  - Distance at endurance speed
  - Cruise with self defense
- Operational Presence
  - Time on station with specified speed-time profile
  - Mission

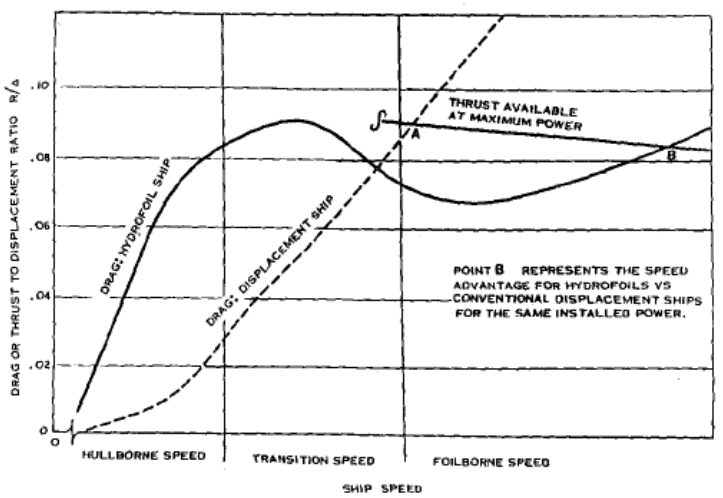
Ship must be able to satisfy all specified endurance conditions

Calculation Modifications

- Sea state and fouling factor
  - Use high end of sea state 4
  - Calculate fouling impact
- Ambient condition profile
  - 25% at 10°F
  - 50% at 59°F
  - 25% at 100°F
- 24 Hour average load
  - DDS 310-1 rev 1 will provide guidance
- Instrumentation inaccuracy correction factor eliminated
- Tank Volume
  - Account for internal structure
  - Do not include fuel for aircraft, boats, other vehicles, and cargo
- Calculation form replaced by two worked examples

Special Cases

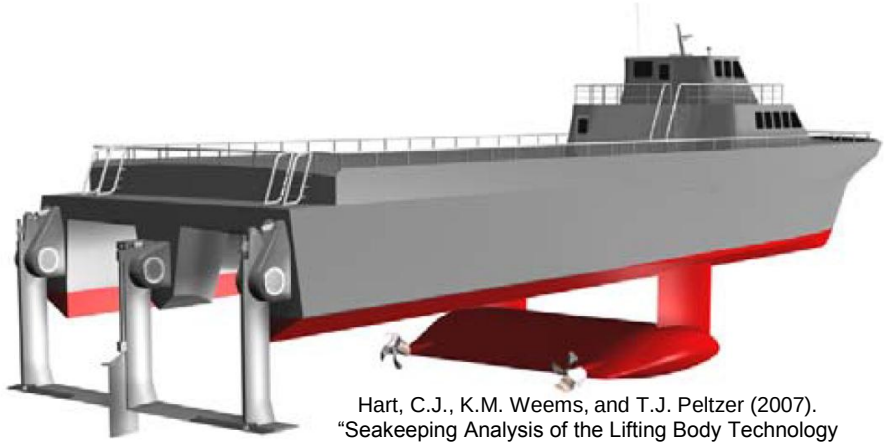
- High Speed Ships
  - Allowed to account for reduction in ship drag as fuel is consumed.
- Economical Transit
  - Allowed to use a speed greater than specified endurance speed if less fuel is used.
  - Allowed to use a speed-time profile with an average speed equal to the endurance speed.



R.J. Johnston, "Hydrofoils," NEJ Feb 1985

Ship Design Implications

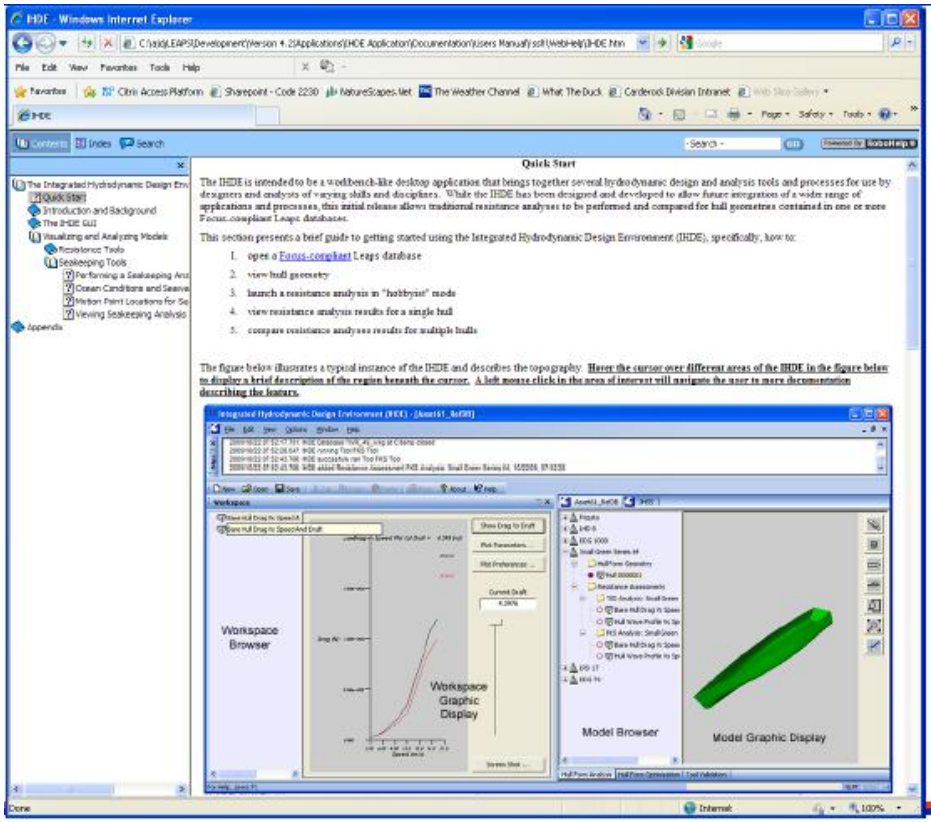
- Power system optimization
  - Attention to part load efficiency
  - Promote
    - Cruise-boost plants
      - Including hybrids
    - Integrated power systems
- Hull resistance optimization in higher sea states



Hart, C.J., K.M. Weems, and T.J. Peltzer (2007). "Seakeeping Analysis of the Lifting Body Technology Demonstrator *Sea Flyer* Using Advanced Time-Domain Hydrodynamics," Proceedings, Ninth International Conference on Fast Sea Transportation, Shanghai, China

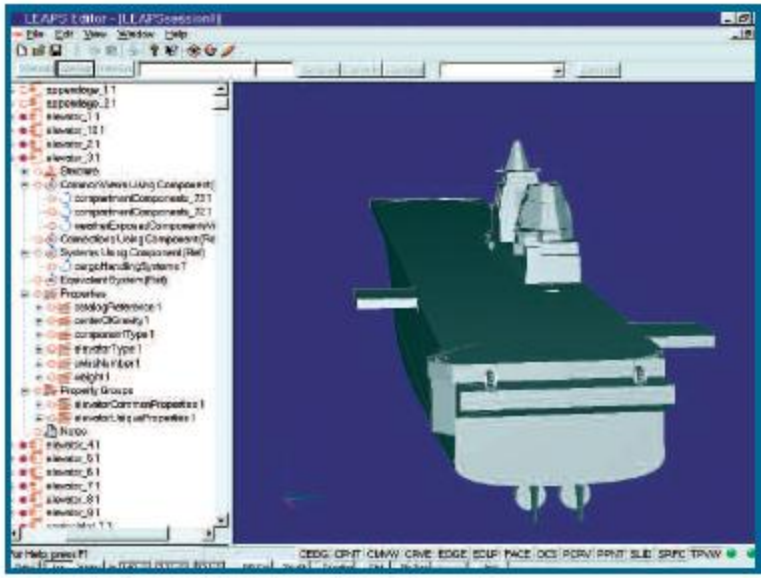
Design Tools

- Advanced Surface Ship and Submarine Evaluation Tool (ASSET)
- Rapid Design and Integration (RDI) environment
- Integrated Hydrodynamics Design Environment (IHDE)
- Leading Edge Architecture for Prototyping Systems (LEAPS)
- Systems Engineering Application for Quick Evaluation of Shipboard Technology (SeaQuest)



Future Work

- Incorporate DDS 200-1 rev 1 into design rules and specifications
- Revise DDS 310-1 to include calculations for 24 hour averages
- Revise the NAVSEA Design Practices and Criteria Manual, Electrical Systems, Chapter 300
- Update ASSET/RDI/LEAPS to include new calculation methods and associated data.



Conclusions

- DDS 200-1 Rev 1 is a significant revision
  - Aligns ship design to fleet operations
  - Will impact future ship design
  - Will impact ship design tools development
- Available online from the Defense Technical Information Center (DTIC)

http://www.dtic.mil/dtic/tr/fulltext/u2/a550279.pdf