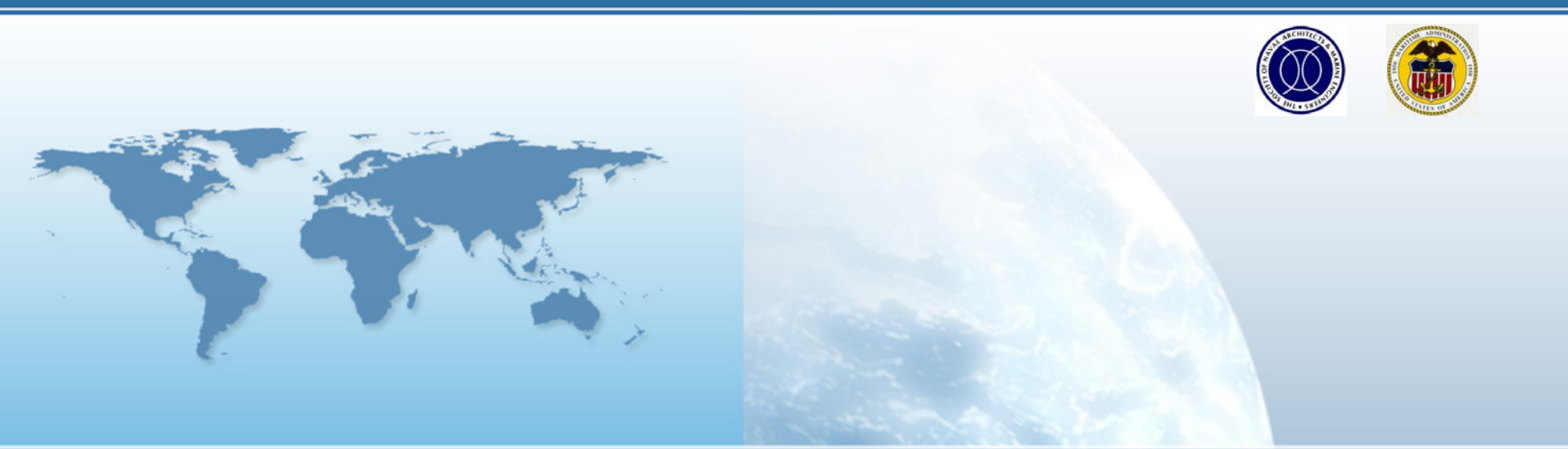


SNAME/MARAD International Student Design Competition

Ultra Green Arctic Shipping System

Stevens Insitutute of Technology

John Dolny

Frank Sorrentino

Caryn Connolly

Chris Ford

STEVENS Institute of Technology

U.S. Maritime Administration Arctic Transportation Conference

June 5, 2008
Washington, DC

Project Objective

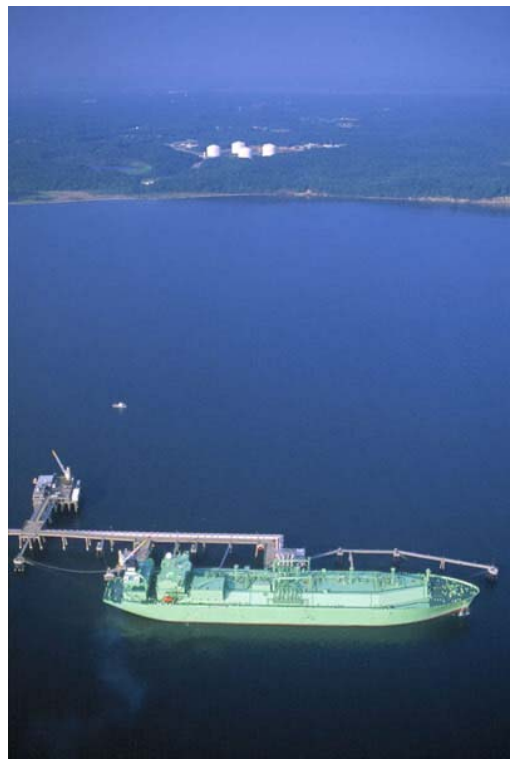
- Design an Ultra Green Arctic LNG Transport System
- Transport LNG between Kara & Barents Seas to Northeast US Ports
- Be economically competitive and environmentally friendly

Presentation Outline

- US ports
- Arctic region of concern
- LNG transportation route
- Arctic LNG carrier design

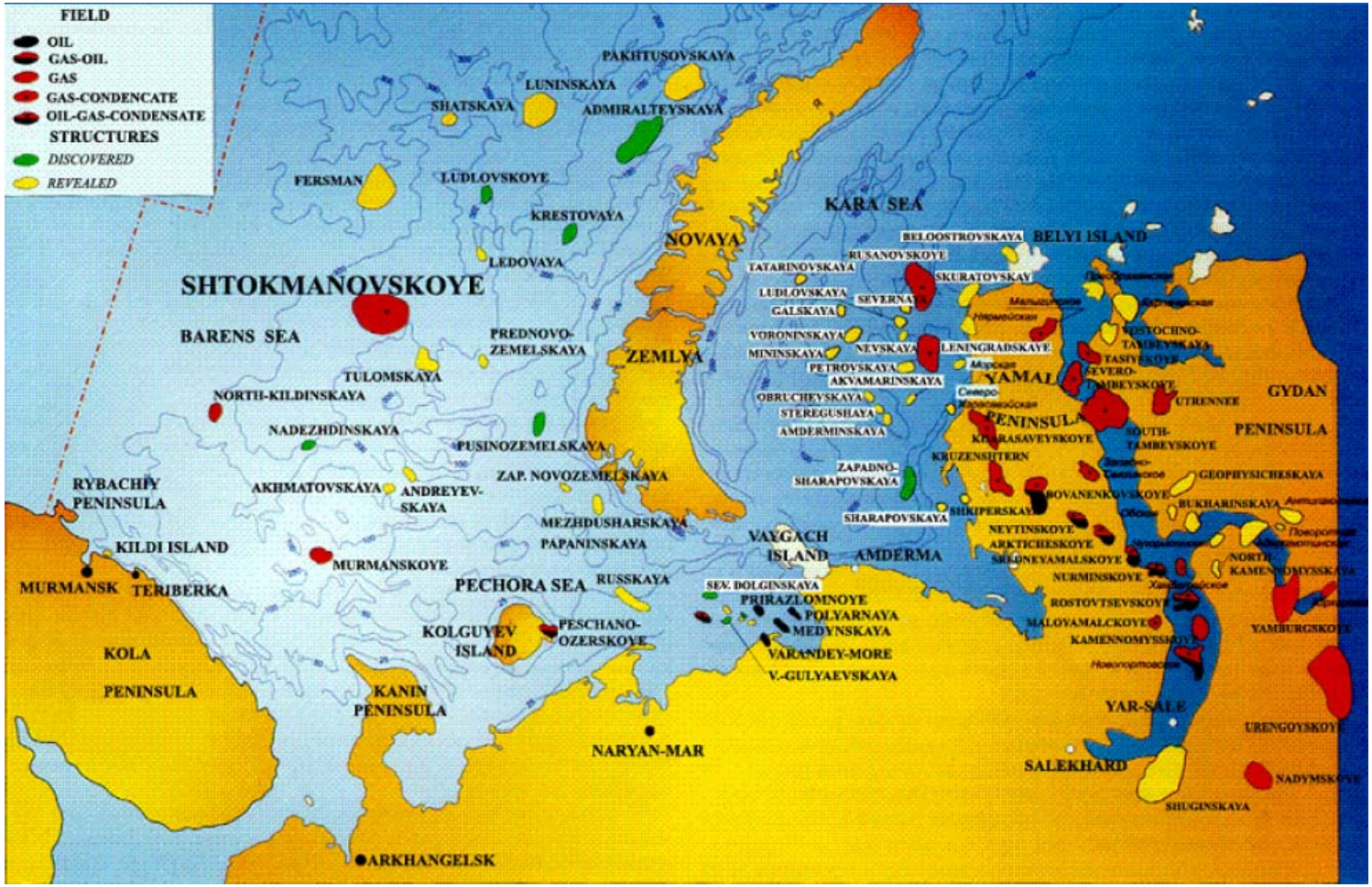
Northeast US Port

- Cove Point, MD
  - Storage Capacity: 221,000,000 m^3
  - Daily Throughput Capacity: 28,316,000 m^3
  - Offshore loading terminal
  - Gas is distributed along the eastern seaboard via pipeline

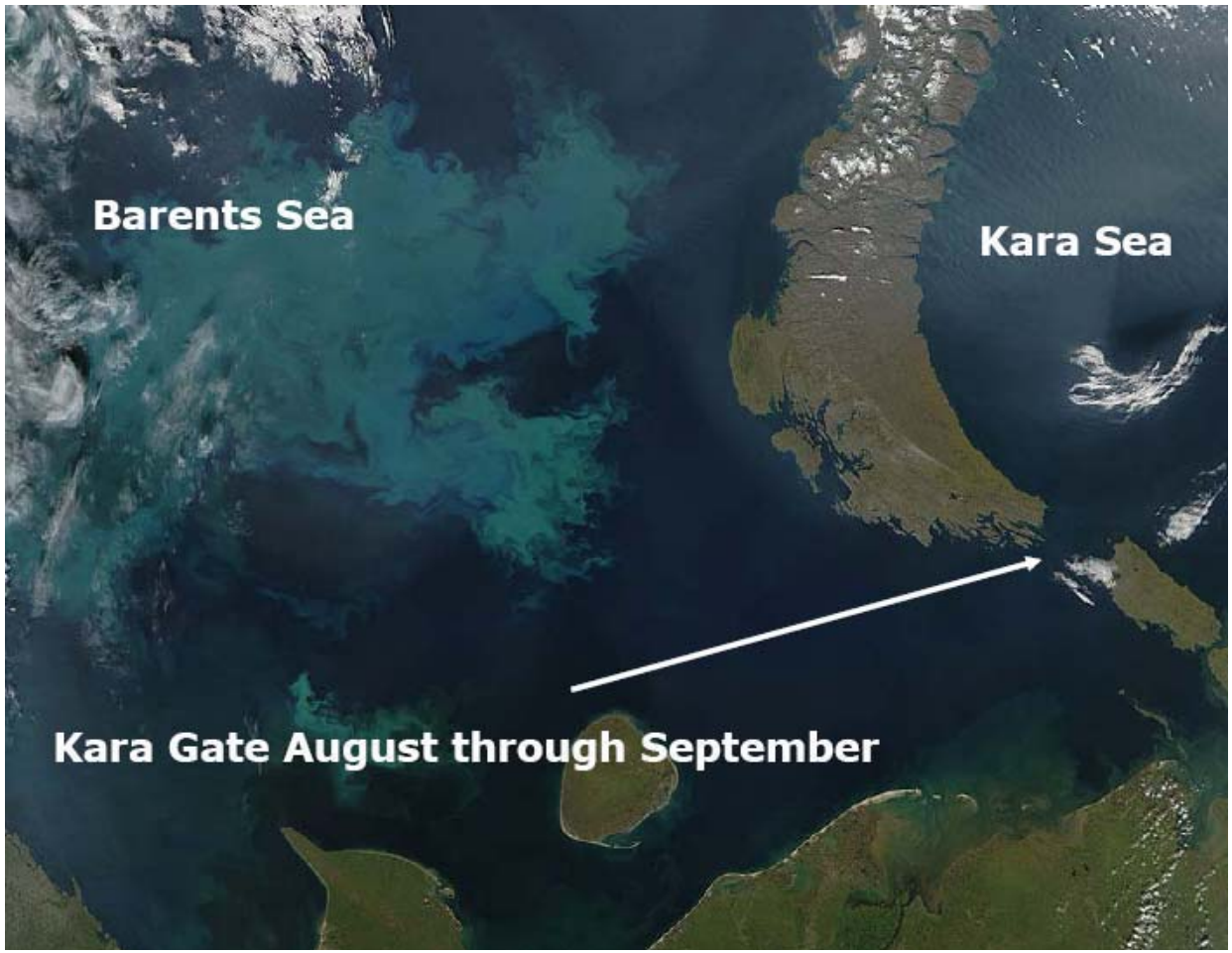


LNG Transportation Route

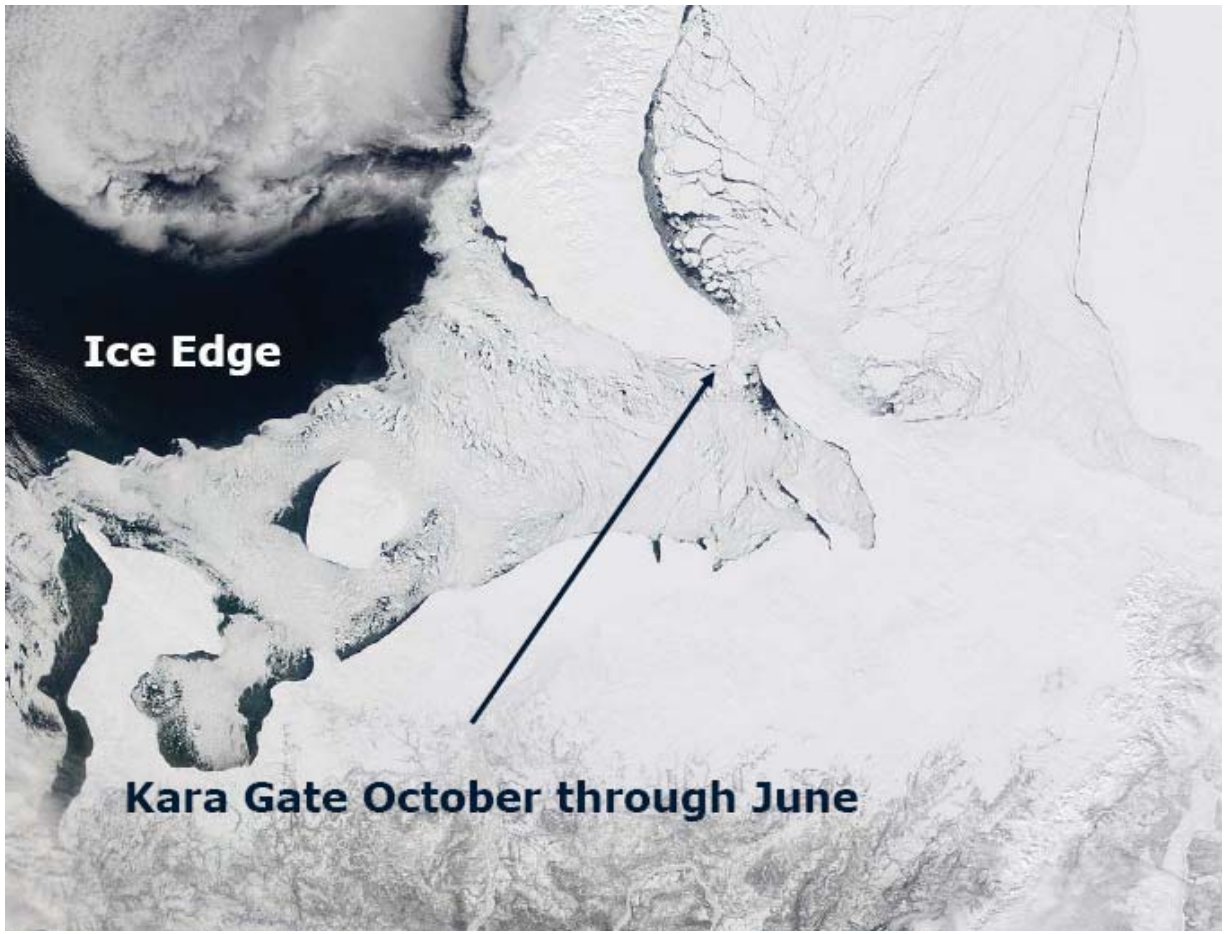
Natural Gas Supply



Kara & Barents Seas – Aug through Sept



Kara & Barents Seas – Oct through June



LNG Transportation Route

- Gas pumped via pipeline to Varandey
  - Storage and liquefaction plant
- LNG pumped to offshore pumping station

Ice Breaking Capabilities

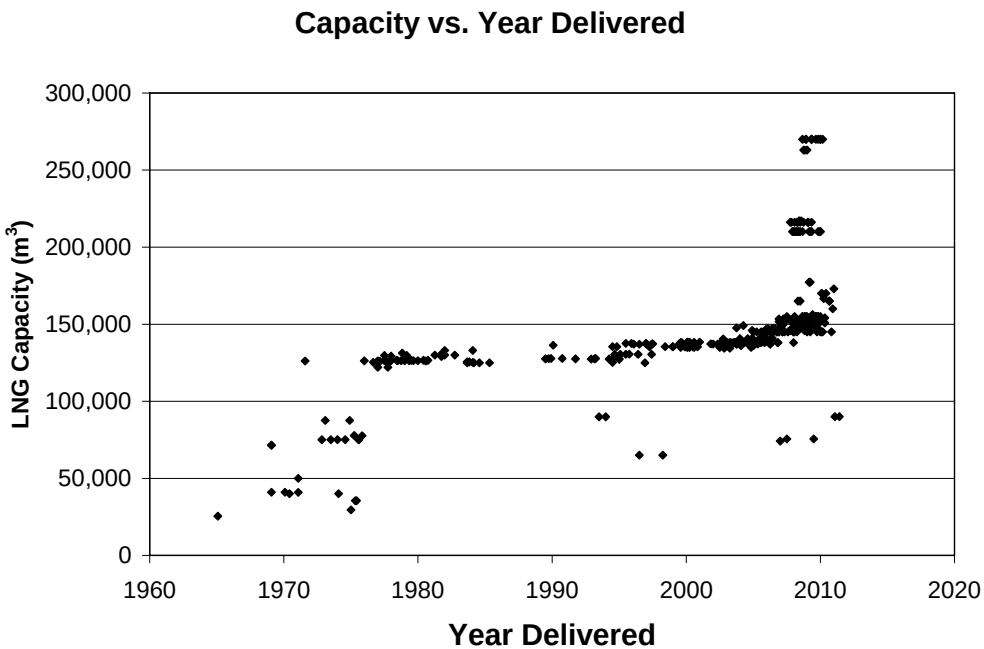
- Offshore pumping station location
  - First-year ice 0.7 to 1.3 meters
  - Advances & recedes annually
- Double Acting Principle
  - Astern in ice
    - Improved ice-breaking performance
  - Ahead in open water
    - Allows for bulbous bow

Azipod Propulsors

- Optimal solution for double acting ships
  - 360° Podded rotation ability
  - Run at full torque ahead or astern
- Other benefits
  - Maneuverability
  - Reduced exhaust emissions
  - Eliminates shaft lines, struts & rudders
  - Redundancy

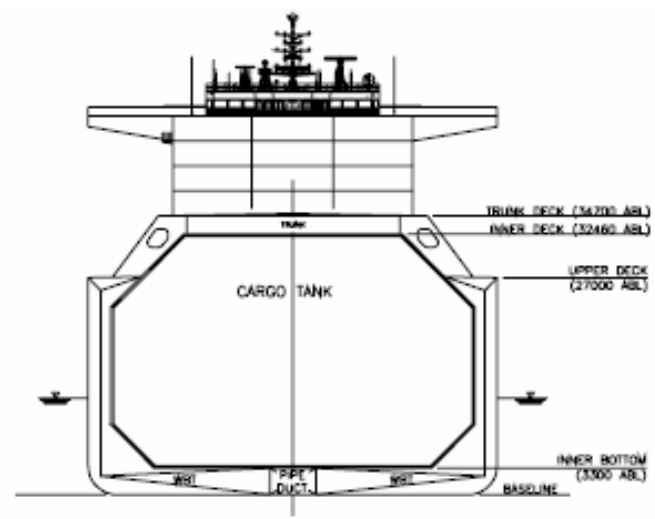
Size Selection

- Driven by capacity & economies of scale
- Parametric Analysis
  - *The World Fleet of LNG Carriers*
  - *The Orderbook of LNG Carriers*
  - *ABS Record for Gas Carriers*
- Principle Dimensions
  - Cargo Capacity: 200,000 m3
  - Length: 295 m
  - Beam: 48 m
  - Draft: 12.6 m
  - Depth: 27 m

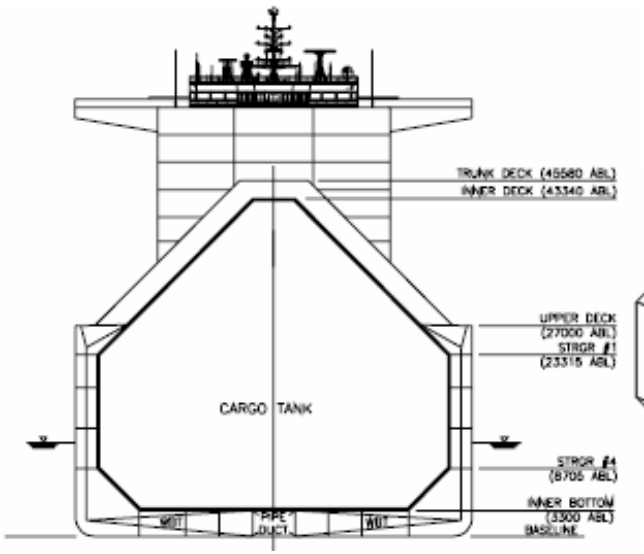


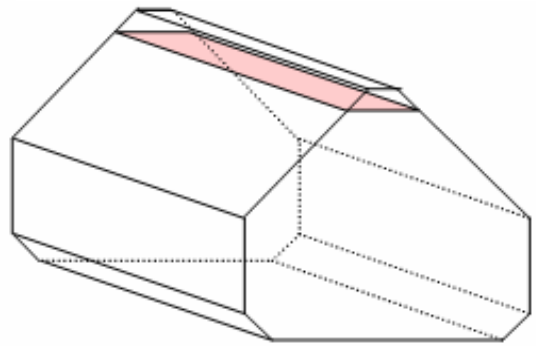
Prism Tank Design Concept

- Developed by ConocoPhillips
- Raised upper hoppers increases tank capacity
- Decreased liquid free surface reduces sloshing impact loads



Traditional Membrane Tank

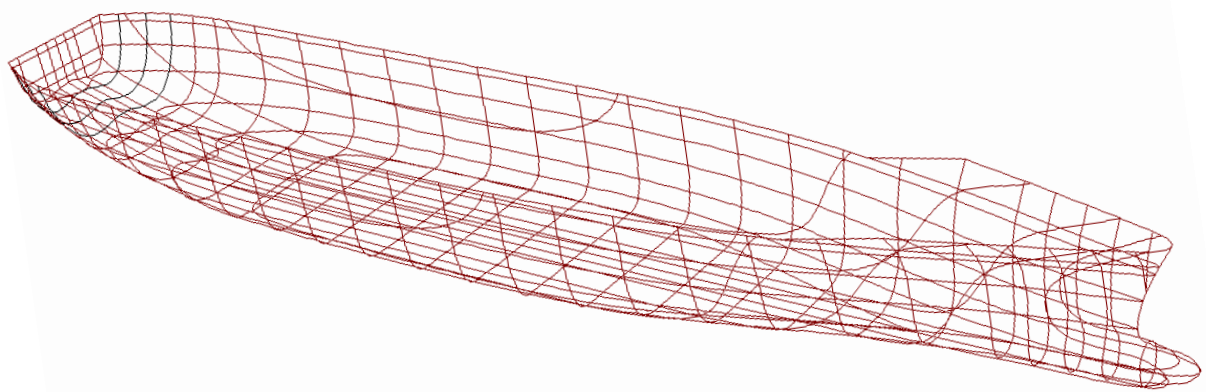




Prism Tank

Hull Form

- Series 60 parent hull form
- Modified ice breaking stern
- Bulbous bow
  - Designed using the *1978 Kracht Method for the Design of Bulbous Bows*



Resistance & Propulsion

- Resistance estimated using *Holtrop & Mennen's 1978 Statistical Powering Prediction*
- Propeller selected and optimized using *Principles of Naval Architecture "Propeller Design"*
- *Particulars*
  - EHP: 13385 kW (18000 HP)
  - BHP: 18860 kW (25000 HP)
  - MCR: 24100 kW (32300 HP)
  - Prop Diameter: 5.0 m
  - Design Speed: 19 knots

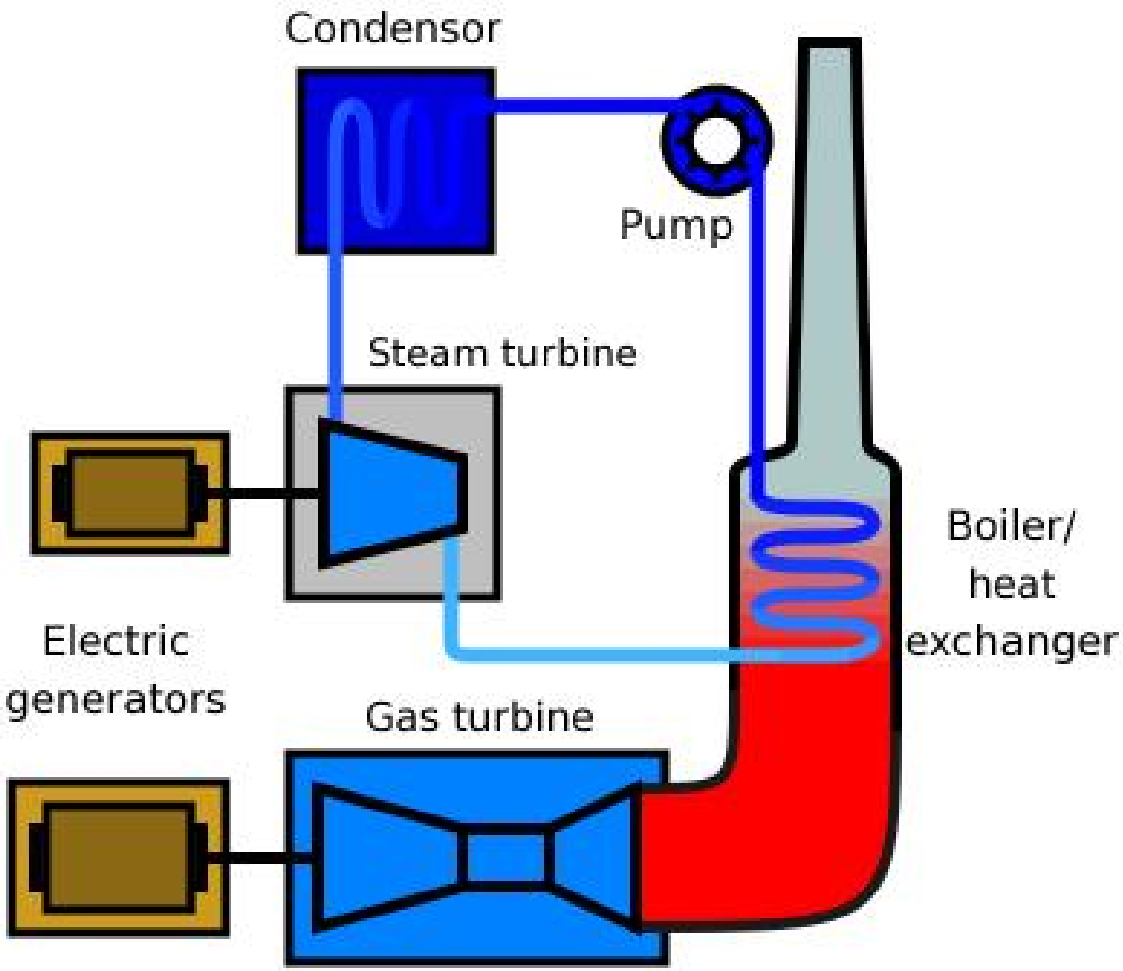
Propulsion System

- LNG ships traditionally steam powered using the boil-off gas as fuel
  - Typically the cleanest of all merchant ships
  - Low fuel efficiency
  - Lack of steam experienced crew
- Increased interest in alternate propulsion solutions
  - Low-speed diesel w/ reliquefaction (DRL)
  - Duel fuel diesel engines (DFDE)
  - **Combined gas and steam turbine system (COGAS)**

COGAS Propulsion System

- Combined Gas and Steam Turbine System
  - Presented by Professor Edwin Wiggins (Webb Institute) at the NY Metro SNAME Chapter meeting on Sept. 11, 2007
  - Boil-off gas burned in gas turbine at ~7800 lb/hr
  - Exhaust gas creates steam in a waste heat boiler and drives a steam turbine
  - Gas Turbine: 17000 kW (23000 HP)
  - Steam Turbine: 7200 kW (9700 HP)
- Each turbine is directly connected to a generator

COGAS System

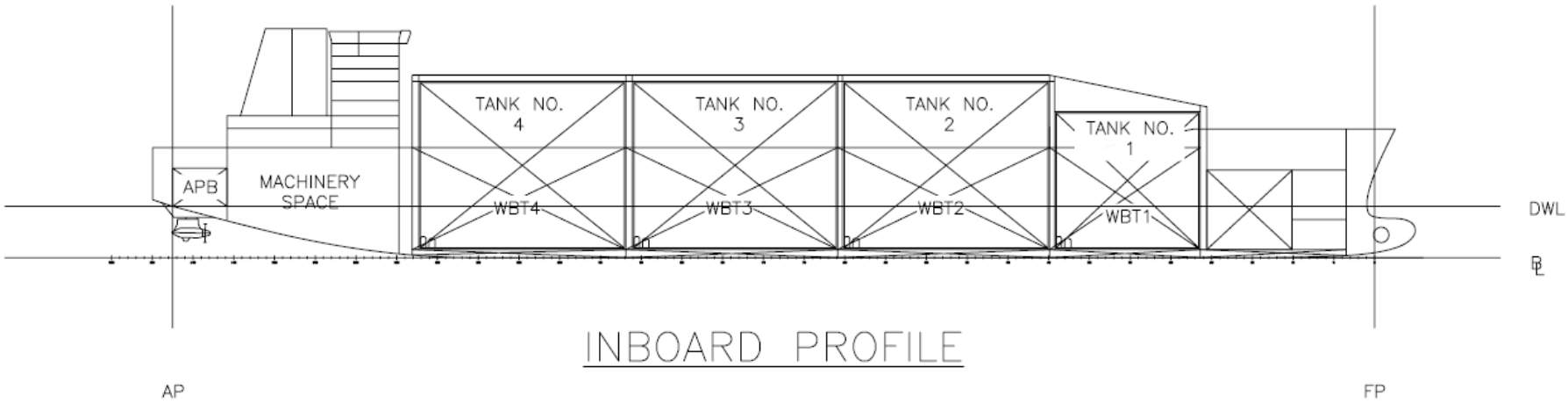


Benefits of COGAS System

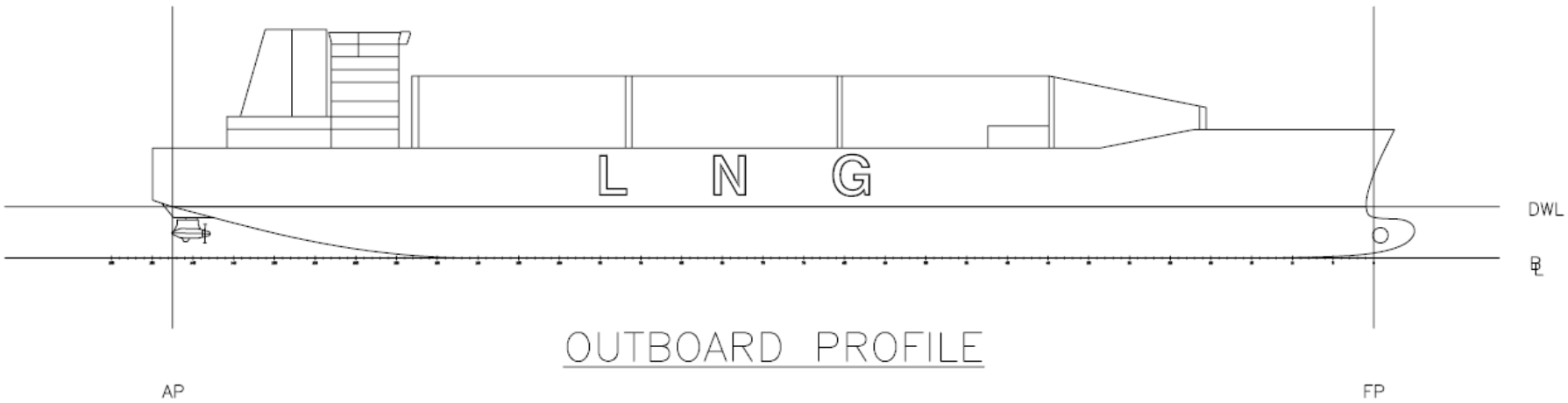
- No SO_x Emissions
- Reduced CO_2 Emissions
- Improved cycle efficiencies over tradition steam systems
- Natural Gas is cheaper per MMBTU

	IFO 380	MDO	Natural Gas
$/tonne	$600.00	$1,200.00	-
BTU/lb	18500	18500	-
$/MMBTU	*$14.71*	*$29.42*	*$11.60*

General Arrangement

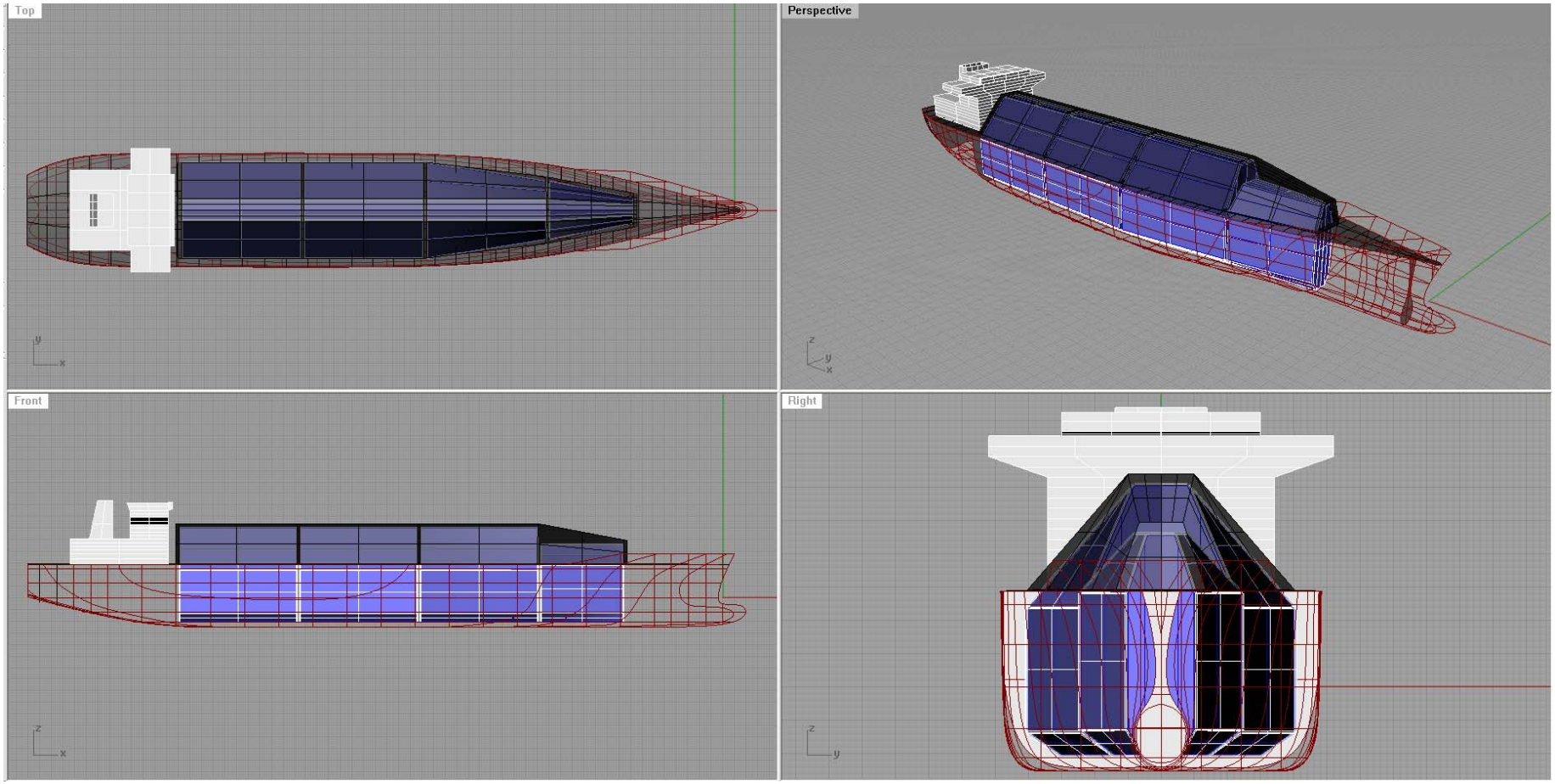


INBOARD PROFILE



OUTBOARD PROFILE

3D Model



Thank You

Questions?

STEVENS
Institute of Technology