America's Marine Highways
Dual-Use Vessel Development Program

Service Requirements
& Concepts Designs

SNAME Northern California Section
November 14, 2012

Dual-Use Vessel Development Program

- Create an economically viable marine alternative to the long haul freight truck to relieve congestion and wear on the interstates.
- Focus on high traffic Corridors along the East & West Coasts for voyages over 500 miles
- Develop easy to build, flexible ship designs suitable for series production
- Provide military dual use capability to meet future sealift requirements using economical commercial ships.

Overview of the Projects

- **MARAD Project**: Develop a Portfolio of Concept Level Vessel Designs for American Marine Highways
  - Vessel types best suited to take trailers off the highways
  - Focus on ocean-going vessels for longer range services
  - Vessels should be suitable for military dual-use for sealift
- Vessel Designs: Eleven Different Designs
  - Vessels range across a wide spectrum of sizes, types & speeds
- Market Assessment and RFR Analysis of Potential Routes and Vessels
- RFR Analysis results prepared by Dr. Tedesco
- **CCDoTT Projects**: Two projects to further develop AMH designs
  - Further Develop 3 most viable Designs with related Economic Analyses
  - Develop requirements for LNG Propulsion and add to one of the AMH Designs

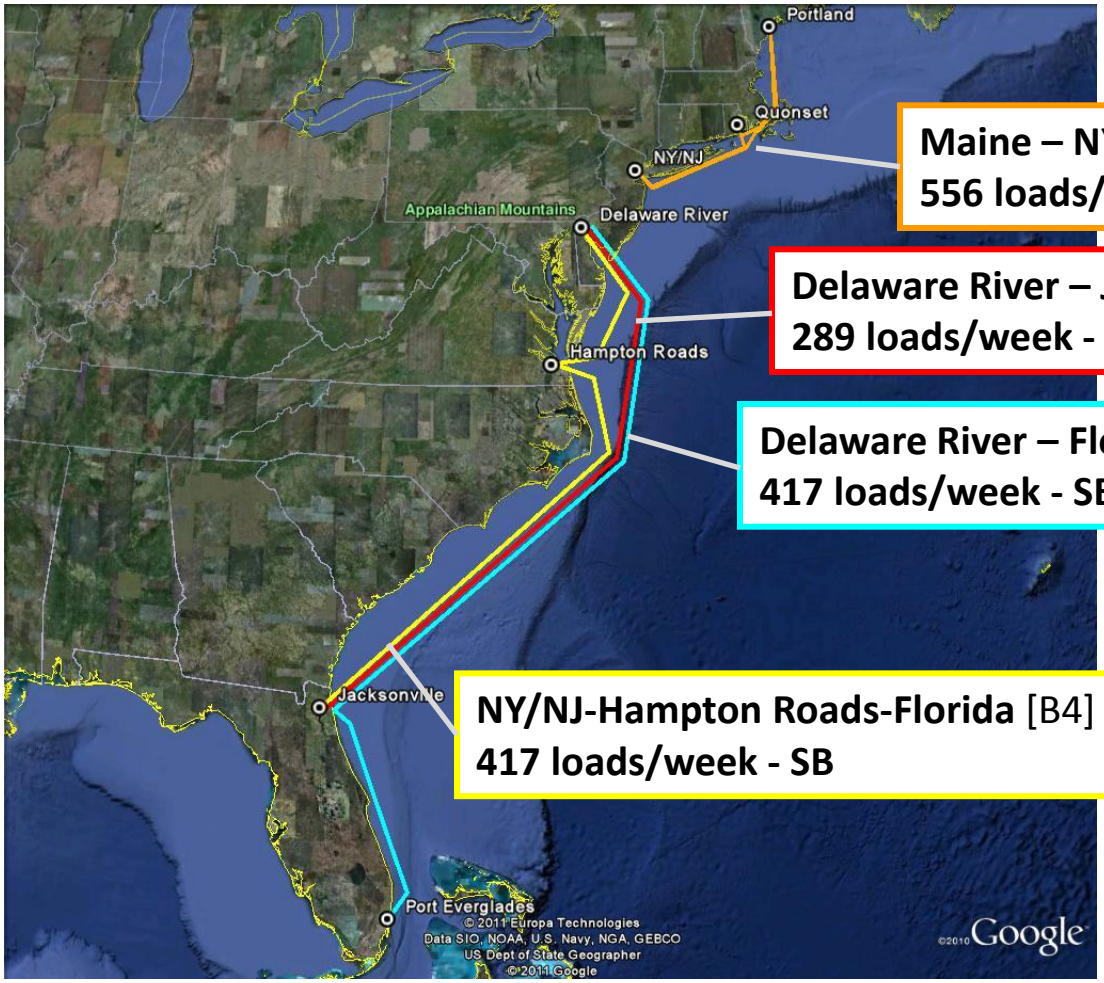
Stakeholder Inputs

- Interviewed 25 Trucking Cos. on both coasts as part of MARAD project – done by Mercator International
- TRANSEARCH database purchased for key regions
- Interviewed 8 ship operators, 5 ports, several advocacy groups
  - Existing Jones Act ship operators
  - Several AMH potential ship operators
  - Major & regional ports
- Literature search carried out
- Input from US Navy on military dual use requirements
- Input from OPNAV N-42 and MARAD on potential government support initiatives for an AMH project

AMH Basic Service Requirements

- Principal Particulars –mostly based on dual-use
  - Beam suitable for US ports and shipyards (less than 120 ft)
  - Minimum speed of 15 knots for dual-use
  - Design speed is 1.5 to 2 knots over schedule speed
  - Draft less than 34 ft for dual-use
- Port calls per week and number of ships
  - Recommend minimum of 2 port calls per week
  - 3 or more is preferable
  - Schedule should be morning arrival, evening departure
- Capacity
  - Design based on estimated 2014 Loads/Week + 25% surge
  - Trailers predominate, but containers growing

AMH Likely Routes & Cargo Volumes – East Coast



Maine – NY/NJ – SE New England [B1]
556 loads/week - SB

Delaware River – Jacksonville [B2]
289 loads/week - SB

Delaware River – Florida (3 Ports) [B3]
417 loads/week - SB

NY/NJ-Hampton Roads-Florida [B4]
417 loads/week - SB

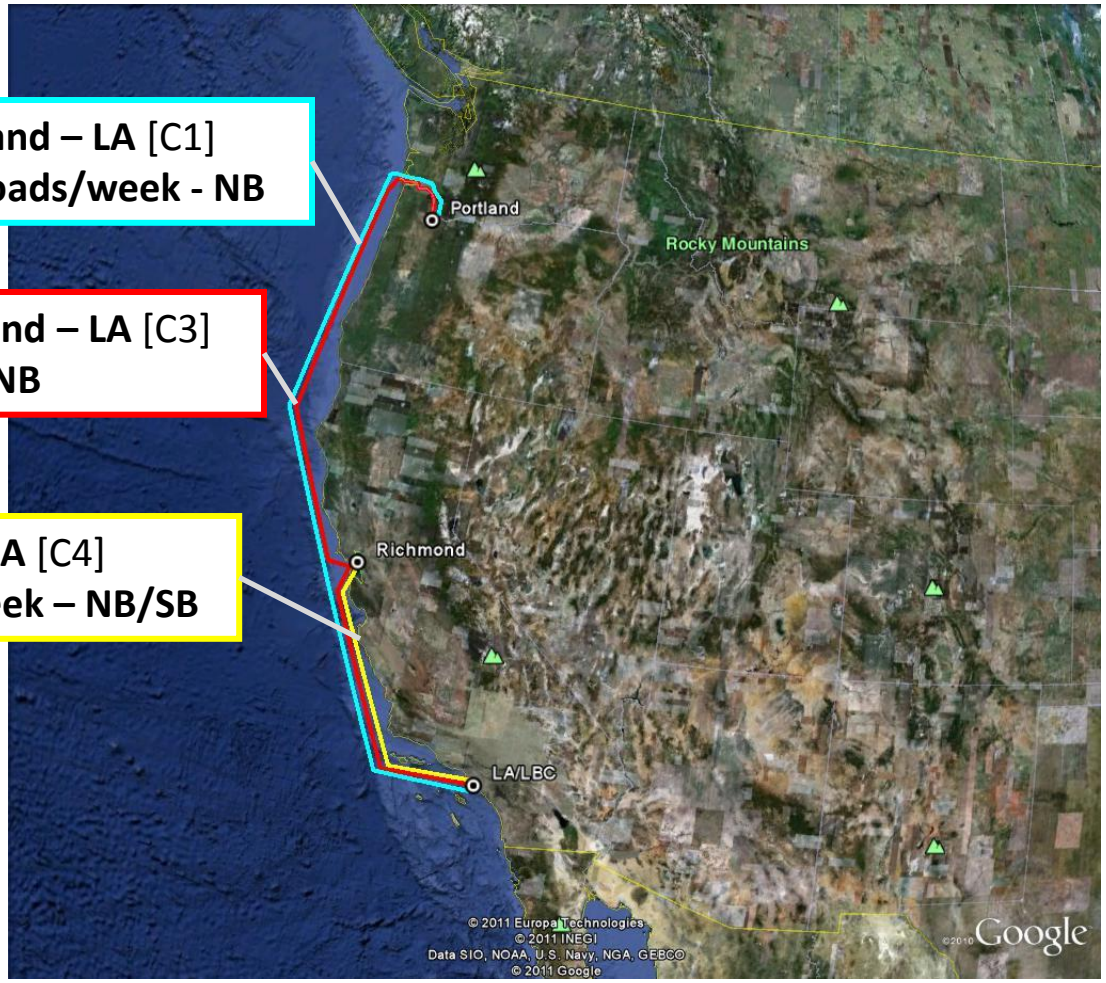
1. Volumes are estimated 2014 head haul direction loads.
2. Volumes are based on about 5% to 10% diversion rate of potential cargo to the AMH Service

AMH Likely Routes & Cargo Volumes – West Coast

Portland – LA [C1]
667 loads/week - NB

Portland – Richmond – LA [C3]
746 loads/week - NB

Richmond – LA [C4]
258 loads/week – NB/SB



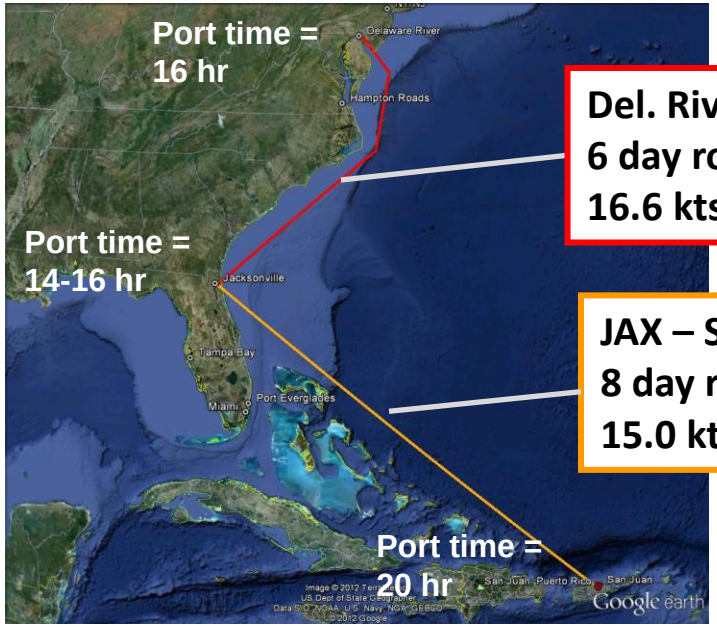
1. Volumes are estimated 2014 head haul direction loads.
2. Volumes are based on about 10% to 15% diversion rate of potential cargo to the AMH Service

East Coast/Puerto Rico - 2 Week RT Combined Service

2 ships – one call per week in each port –combined service

4 ships – two calls per week in each port- combined service. With 4 ships on 8 & 6 day RT – do not have two ships in JAX on same day

6 ships – two calls per week in each port with direct services between ports



Del. River – JAX 765 nm
6 day roundtrip
16.6 kts (avg)

JAX – SJU 1121 nm
8 day roundtrip
15.0 kts (avg)

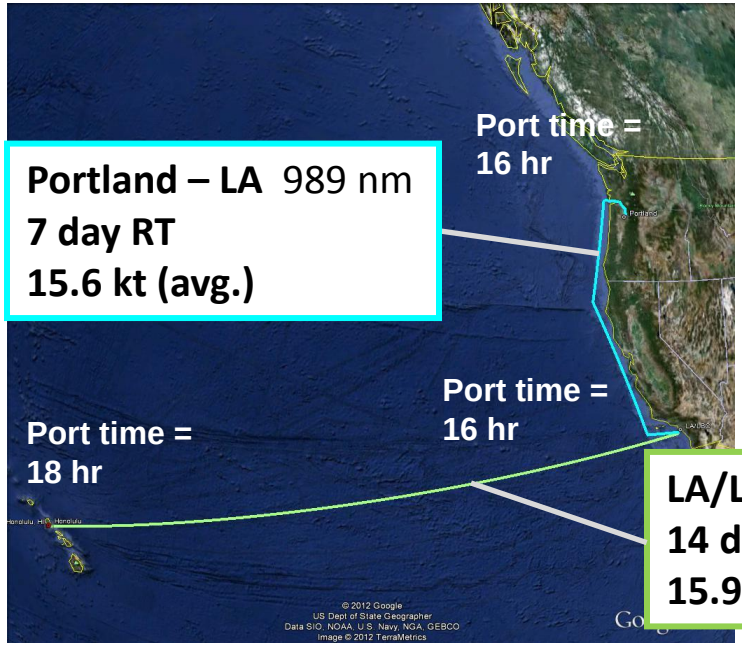
Port	Arrive Pilot		Pilot	Arrive Dock		Port	Leave Dock		Pilot	Leave Pilot		Sea Dist	Sea Time	Speed
	Day	(Time)	(Hrs)	(Day)	(Time)	(Hrs)	(Day)	(Time)	(Hrs)	(Day)	(Time)	(NM)	(Hrs)	(Knots)
Jacksonville	0	3:00	2.0	0	5:00	14.0	0	19:00	2.0	0	21:00	1121	78.0	14.4
San Juan, PR	4	3:00	2.0	4	5:00	20.0	5	1:00	2.0	5	3:00	1121	72.0	15.6
Jacksonville	8	3:00	2.0	8	5:00	16.0	8	21:00	2.0	8	23:00	765	46.0	16.6
Philadelphia	10	21:00	8.0	11	5:00	16.0	11	21:00	8.0	12	5:00	765	46.0	16.6
Jacksonville	14	3:00												
	Hours Totals		14.0			66.0			14.0				242.0	

West Coast/Honolulu - 3 Week RT Combined Service

3 ships – one call per week in each port – combined service

6 ships – two calls per week in each port – combined service

10 ships – two calls per week in each port with direct services between ports



Port	Arrive Pilot		Pilot	Arrive Dock		Port	Leave Dock		Pilot	Leave Pilot		Sea Dist	Sea Time	Speed
	Day	(Time)	(Hrs)	(Day)	(Time)	(Hrs)	(Day)	(Time)	(Hrs)	(Day)	(Time)	(NM)	(Hrs)	(Knots)
Portland/Vancouver	0	20:00	9.0	1	5:00	16.0	1	21:00	9.0	2	6:00	989	62.0	16.0
LA/LB	4	20:00	2.0	4	22:00	16.0	5	14:00	2.0	5	16:00	2233	140.0	16.0
Honolulu	11	12:00	2.0	11	14:00	18.0	12	8:00	2.0	12	10:00	2233	141.0	15.8
LA/LB	18	7:00	2.0	18	9:00	16.0	19	1:00	2.0	19	3:00	989	65.0	15.2
Portland/Vancouver	21	20:00												
	Hours Totals		15.0			66.0			15.0				408.0	

Commercial Cargo Requirements

- Trailers
  - Mostly 53’
  - Average weight about 22 metric tons (48,500 lbs)
- Containers
  - Mix of International Freight and Domestic Intermodal types
  - International are 40’ or 45’ long x 8’ wide x 8.5’ or 9.5’ high
  - Domestic Intermodal are 53’ long x 8.5’ wide x 9.5’ high
  - Average wt 20 mt (45,000 lbs)
- Expected mix is 80% x 53’ Trailer/Container, 15% x 40’/45’ Container, 5% special/oversize
- RoRo vessels predominately Trailers, Rocon is more Containers
- Transport of containers can grow over time so flexibility of stowage needed

Other Requirements

- Deck strengths - require 250 to 350 psf for **dual-use**
- Minimum RoRo area 96,000 ft^2 for **dual-use**
- Containers on RoRo vessels stowed two-high on Cassettes
- Special provisions needed for over size, reefer and hazardous cargo
- Detailed requirements developed for Ramp design
- LoLo Container stowage similar to Containerships
- Clear Height: min 14'-9" RoRo (meets **dual-use** requirements), 23'-9" for two high container Cassettes
- Range: minimum 10,000 nm for **dual-use**

Two High Container Cassette

Container Cassette can sit without special fittings on ground or deck

Cassette for multi-length containers (40'/45') on special trailer

Portfolio of Eleven AMH Vessel Designs for MARAD

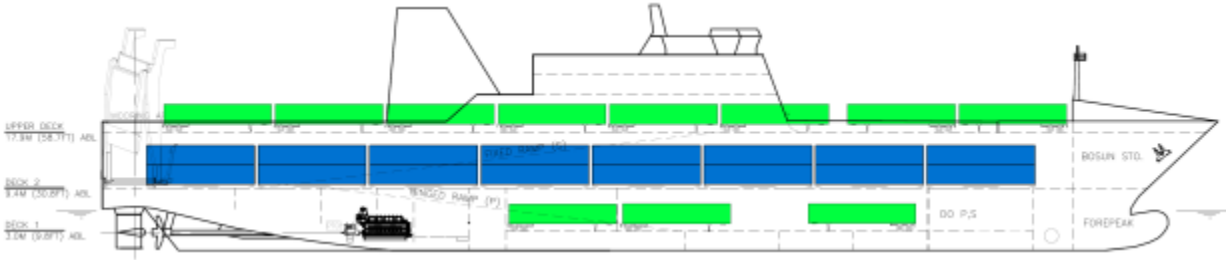
- Vessel type definitions
  - RoRo – all cargo is driven on or off
  - Rocon – combination RoRo & dedicated container (loaded by cranes)
  - Small – less than 500 TEU
  - Medium – 500 TEU to under 1,000 TEU
  - Large – 1,000 TEU or larger
  - TEU sizes – 53’ Trailer/Container- 2.8 TEU, 40’ Container- 2.0 TEU
  - Speed – Design speed (at normal engine rating with 15% sea margin)
- Covers wide range of possible AMH Vessels - Vessel concept datasheets available on MARAD website
- Designs selected for further development on basis of viability for multiple AMH Routes and Military Dual-Use Capability
  - Design 03 – RoRo Medium 23 knots
  - Design 04 – RoRo Medium 20 knots
  - Design 13 – Rocon Large 22 knots

Vessel Designs - RoRo

53' Trailer | 53' Container
40' Trailer | 40' Container

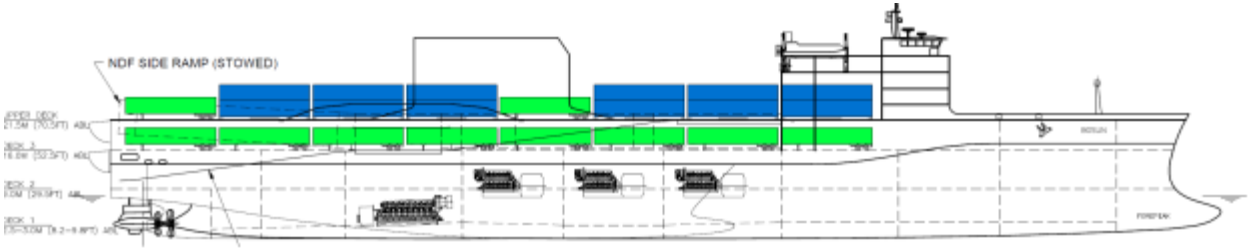
01-RoRo Small 18 kt

550'x89'x 58.7' (168x27x17.9m)
Draft 19.8' (6.0m)
71 Trailers, 80 Containers
RoRo 74,400 ft^2
10,000 kW, Twin Screw w/ CPP



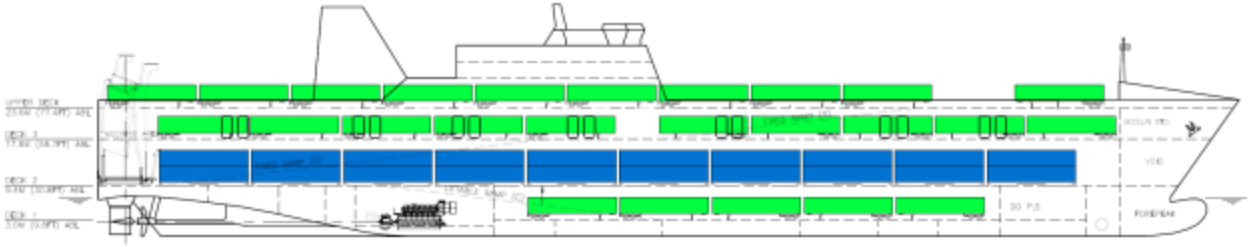
02-RoRo Trimaran 29 kt

673'x 133'x70.6' (205x41x21.5m)
Draft 26.9' (8.2m)
115 Trailer, 138 Containers
RoRo 106,023 ft^2
76,500 kW, CPP, Pod, 2xWater Jet
Developed jointly with CSC



03-RoRo Medium 23 kt

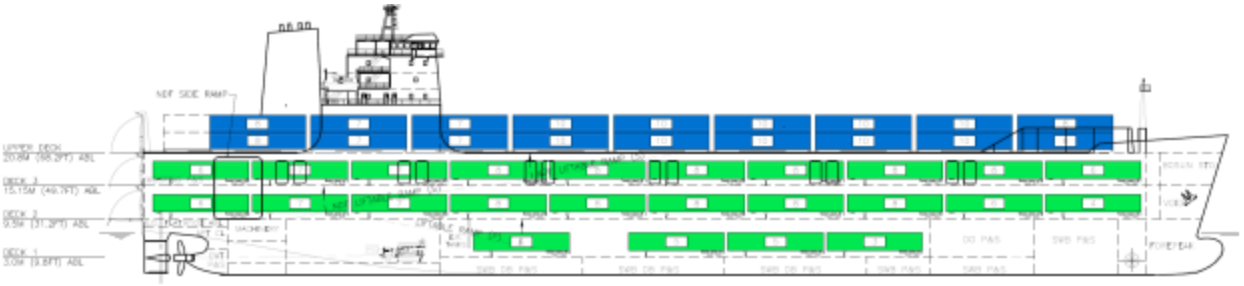
682'x95'x77.4'(208x28.5x23.6m)
Draft 23.3' (7.0m)
151 Trailers, 104 Containers
RoRo 130,820 ft^2
28,000 kW, Twin Screw w/ CPP



Vessel Designs - RoRo

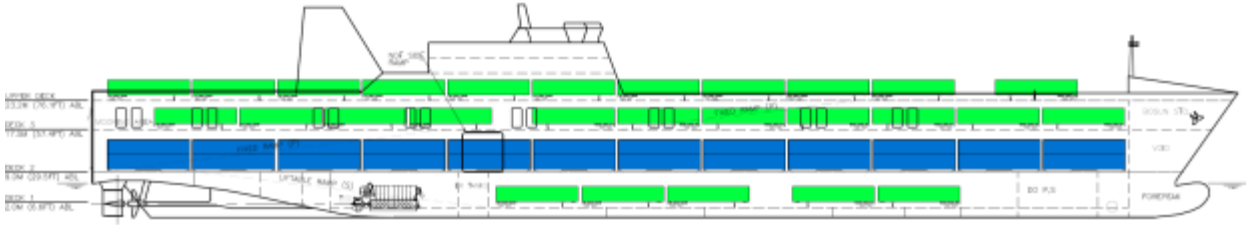
04-RoRo Medium 20 kt

602’x95’x68.2’ (184x29x20.8m)
Draft 23.3’ (7.1m)
154 Trailers, 160 Containers
RoRo 144,500 ft^2
17,000 kW, Twin Screw w/ CPP



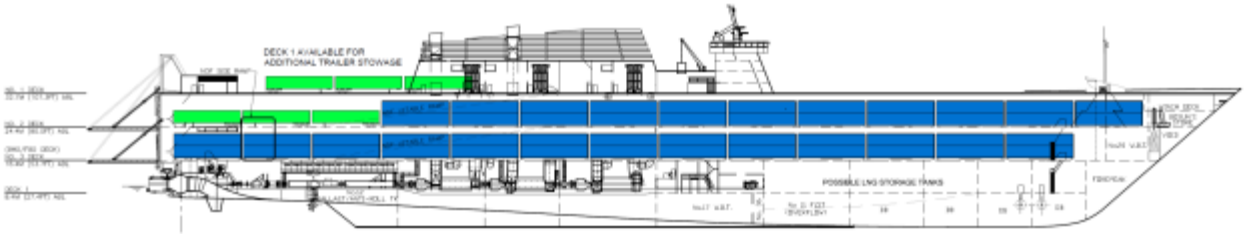
05-RoRo Large 21 kt

740’x97’x76.1’ (226x29.5x23.2m)
Draft 22.3’ (6.8m)
203 Trailers, 140 Containers
RoRo 166,116 ft^2
18,000 kW, Twin Screw w/ CPP



06-RoRo Fastship 30 kt

869’x131’x107’ (265x40x32.7m)
Draft 32.8’ (10.0m)
60 Trailers, 440 Containers
RoRo 192,550 ft^2
118,000 kW, 3 x Waterjets



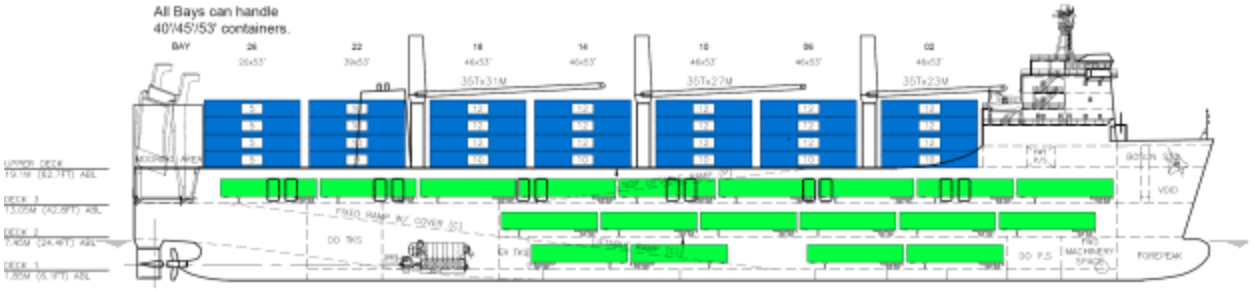
Vessel Designs - Rocon

11-Rocon ATB Medium 14 kt

708'x106'x45.3' (216x32.2x13.8m)
Draft 14.1' (4.3m)
50 Trailers, 376 Containers
RoRo 87,627 ft^2
9,000 kW, Twin Screw w/ CPP

12-Rocon Large 18 kt

596'x106'x60.7' (182x32.2x18.5m)
Draft 22.4' (6.8m)
125 Trailers, 289 Containers
RoRo 128,454 ft^2
14,000 kW, Twin Screw w/ CPP



13-Rocon Large 22 kt

660'x106'x61.0' (201x32.2x18.6m)
Draft 24.9' (7.6m)
101 Trailers, 363 Containers
RoRo 110,145 ft^2
21,000 kW, Single Screw w/ FPP

Vessel Designs - Other

21-Container Feeder 18 kt

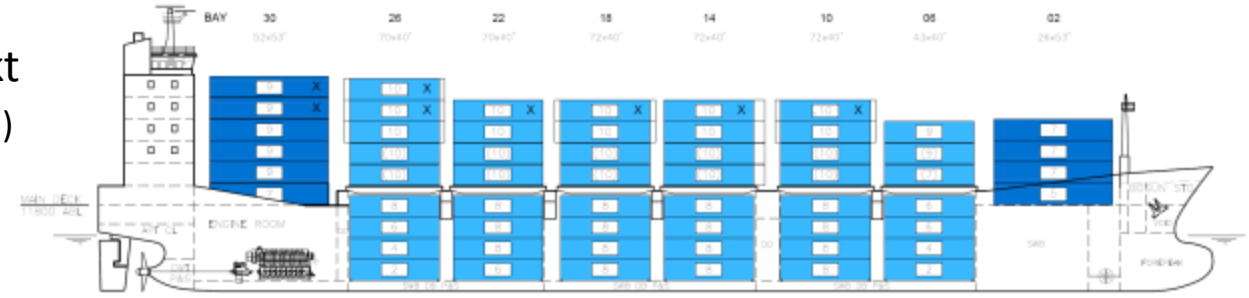
498'x81'x38.7' (152x24.8x11.8m)

Draft 24.9' (7.6m)

392 Containers

RoRo None

9,600 kW, Single Screw w/ FPP



22-Ropax Medium 22 kt

707'x97'x73.2' (216x29.5x22.3m)

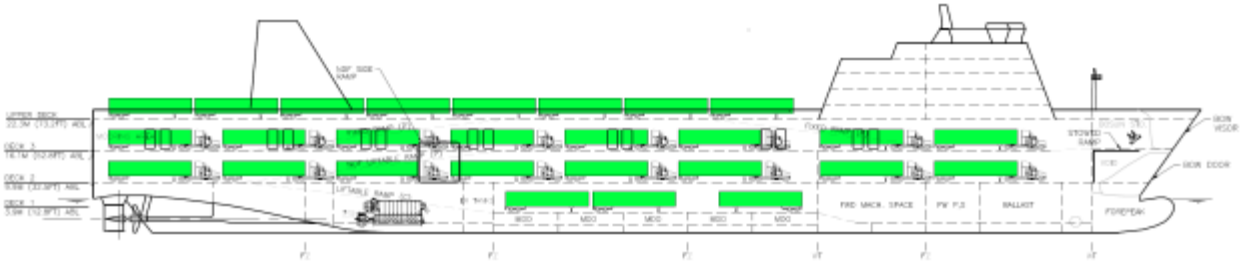
Draft 22.0' (6.7m)

77 Trailers, 105 Tractor/Trailer

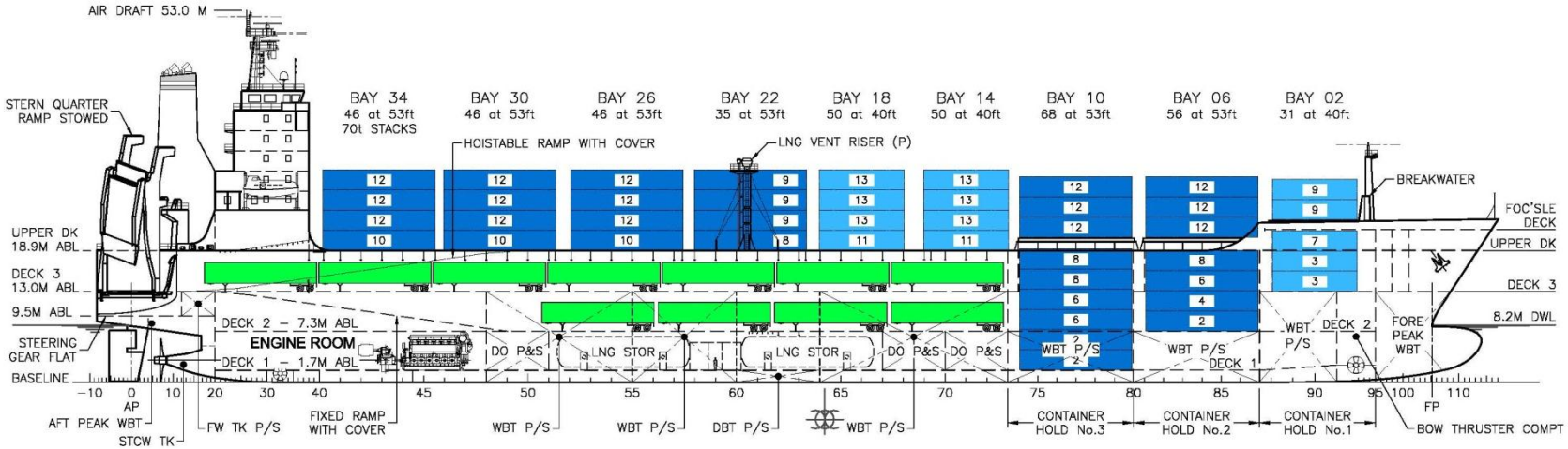
105 Passenger

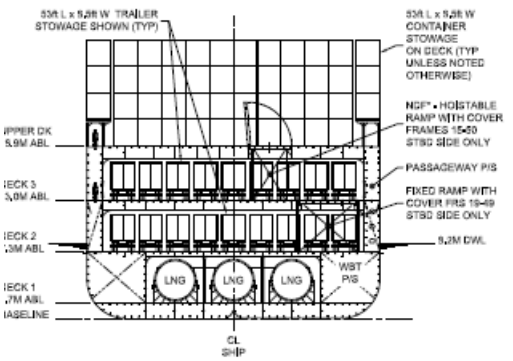
RoRo 148,762 ft^2

20,000 kW, Twin Screw w/ CPP

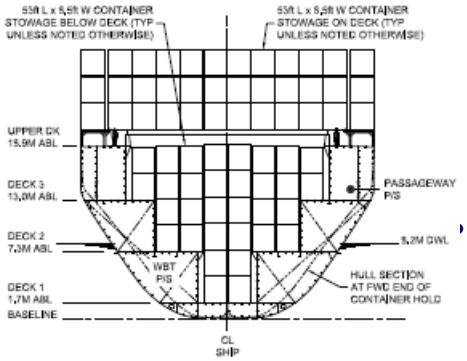


Design 13 –Arrg't for LNG Propulsion (from CCDoTT Project)





SECTION AMIDSHIPS - FRAME 55 LOOKING FWD



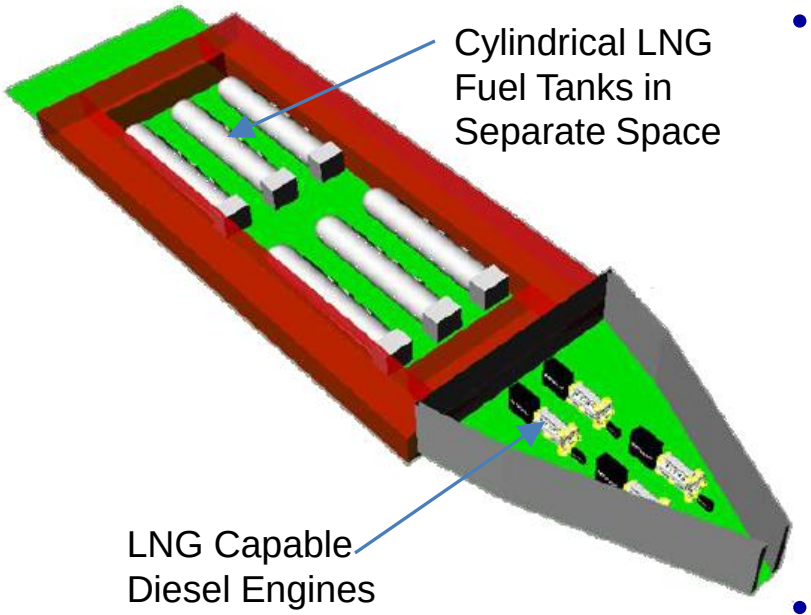
CONTAINER HOLD No.3 - FRAME 75 LOOKING FWD

- Suitable for Combined Service including both AMH and offshore Jones Act services
  - Large container capacity suitable for offshore services
  - Provides good base load from offshore service to keep vessels full and cover costs
- LNG Propulsion
  - LNG Storage Tanks on Lower Deck
  - Dual Fuel Medium Speed Engines – LNG or Diesel Fuel
  - LNG Range about 2,500 nm (1 round trip)

Design 13 - Principal Particulars

Length Overall	201.3 m (660.4 ft)
Length Between Perp.	187.0 m (603.5 ft)
Beam	32.2 m (105.6 ft)
Design Draft	8.2 m (26.9 ft)
Design Speed	22.0 knots
Crew Size	15 to 18 persons
TEU Capacity	1355 TEU
Max Trailer Capacity	89 Trailers (53') & 6 Trailers (40')
Typical Full Load Container & Trailer Capacity	414 Containers (mix of sizes) 95 Trailers (53'&40') – 1314 TEU
RoRo Deck Area for AMH	5,750 m^2 (62,000 ft^2)
Max RoRo Deck Area (in military service)	8,850 m^2 (95,000 ft^2)
Type of Ramp	1 x Stern Quarter Ramp
Required Propulsion Power (without electric load)	21,050 kW for 22 kts, 15% sea margin
Installed Propulsion Power (with power for shaft generator)	23,400 kW
Daily At Sea LNG Fuel Cons. (includes electric load)	167.7 m^3/day (75.5 mt/day) at Design Speed plus 0.5 mt/day of MGO pilot fuel
Fuel type	LNG
LNG Effective Storage Volume (with 6 Tanks)	1,000 m^3
Range with LNG Fuel	2,800 nm
Range Diesel Fuel	12,000 nm

LNG Propulsion



LNG Tank Illustration from ONR CISD

- LNG as a ship fuel has great potential as fuel of choice for the future
  - Clean burning – meets all current and future emission standards
  - Existing Technology: Dual fuel engines in use on LNG carriers and coastal vessels/ferries in Europe
  - LNG Fuel is Lower cost - about 30% lower than gas oil fuel (MGO)
  - Vessel regulatory issues manageable
  - LNG can be stored in internal tanks, CNG cannot
  - Variable Range Possible - Short Range on LNG (2,500 mi), Long Range with diesel fuel (dual-use)
- Major roadblocks
  - Lack of availability of bunkering system
  - Higher cost for engines and fuel tanks
  - Mostly unfounded fear of LNG by some
  - Loss of area on lower cargo decks on RoRo vessels to make space for LNG Tanks

Environmental Enhancements- Make AMH Greener

- Class Notations – ABS Enviro+ & Green Passport or equivalent
  - Avoid use of hazardous substances in construction and in operation
  - Design for scrapping with reduced generation of hazardous waste
- Reduced Discharges to the Air
  - Exclusive use of low sulphur fuel (will be required to operate in the ECA 2015) or LNG
  - Cold ironing in port, where available
  - Reduced use of incinerator and disposal of sludge ashore
- Reduced Discharges to the Sea
  - Ballast Water Treatment system installed
  - Design for minimal ballast water intake and discharge – retain and shift ballast onboard
  - Deck Drain water retained onboard in port
  - Gray water and sewage retained onboard in port
  - No overboard discharge of garbage except food waste after grinding. Recycle to shore
  - Biocide free antifouling
  - Biodegradable stern tube oil or water lubricated stern tube

Energy Efficiency – Reduced Fuel Costs

- Hull Optimization
  - Use parametric estimation program such as HEC SEP to optimize hull parameters such as length, beam, draft, block coefficient to achieve lowest fuel consumption per trailer-mile
  - Use CFD and multi-stage model test program to refine hull lines
  - Hull efficiency improvements where cost effective – rudder bulbs, post swirl devices, etc
- Service Speed Optimization
  - Optimize schedule and speed on basis of speed vs fuel consumption per trailer-mile considering transit time parameters & reduce port times for slower steaming
- Machinery Technology
  - Latest electronically controlled diesel engines
  - Performance monitoring equipment – KW meters, FO meters, Real time engine monitors
  - Waste Heat Recovery systems in larger engine plants
- Reduced Energy Consumption from Ship Service Loads
  - Reduced HVAC loads - better house insulation, window tinting, efficient lighting
  - Variable speed motors, fans, pumps
- Solar Power – possible for some electric power generation

Vessel Construction Costs

- US Construction Costs basis - large or mid-tier shipyards currently building commercial vessels using best available technology (technical support from overseas shipyards)
- Costs have Uncertainty so range given – non standard designs have higher uncertainty on up side
- Indicated Costs ($ M) for 3 Ship Series - average cost per vessel with LNG capable engines for all vessels except 02, 06 & 11 & diesel only version of 13
- The costs are estimated final negotiated contract prices and not initial asking prices by shipyards, which are likely to be higher.

	01-RoRo Small 18kt	02-RoRo Trimaran 29kt	03-RoRo Med 23kt	04-RoRo Med 20kt	05-RoRo Large 21 kt	06-RoRo Fastship 30kt
Ship Price - Each	**$122**	**$301**	**$197**	**$163**	**$182**	**$357**
Lower bound estimate	$110	$271	$177	$147	$164	$321
Upper bound estimate	$134	$347	$217	$180	$200	$410
Uncertainty	-10%/+10%	-10%/+15%	-10%/+10%	-10%/+10%	-10%/+10%	-10%/+15%
	11-ATB Rocon 14kt	**12-Rocon Large 18kt**	**13-Rocon Large 22kt**	**13 - Rocon with LNG Fuel**	**21-Container Feeder 18 kt**	**22-Ropax Med 22kt**
Ship Price - Each	**$114**	**$164**	**$160**	**$190**	**$84**	**$211**
Lower bound estimate	$103	$148	$144	$171	$77	$190
Upper bound estimate	$126	$180	$176	$213	$90	$242
Uncertainty	-10%/+10%	-10%/+10%	-10%/+10%	-10%/+12%	-8%/+8%	-10%/+15%

Conclusions

- AMH vessel designs cover a wide range of possible routes, pier facilities, ports, and cargo mixes
- Designs with greatest potential for economically viable operation
  - RoRo Designs 03, 04 & 05 – 250 to 350 Trailers & Containers - for AMH Services
  - Rocon Designs 12 & 13 – 100 to 125 Trailers, 300 to 400 Containers – for high volume AMH Services and combined AMH/offshore Jones Act Services
  - ATB Design 11 – 50 to 100 Trailers, or 300 containers – for shorter Services
- Military dual-use capability can be incorporated into the designs without major impact on cost or commercial operation
- Performance Requirements - Useful guidance for designers of AMH vessels
- Specific AMH Routes have been proposed - RFR Analyses made by Dr. Matt Tedesco that follow show some Routes can be profitable
- America's Marine Highways concept can meet multiple national goals - reduced truck traffic, reduced pollution, new sealift support vessels

Advancing AMH

- Reach out to potential AMH Operators to tailor designs to specific services
  - Combined AMH/offshore Jones Act Services potentially profitable, but existing operators will resist any direct incentives to operators in existing Jones Act Services
- Better define potential AMH Cargo Volumes and Routes to build confidence in AMH viability by potential investors
- Develop government incentive programs to attract operators and shippers
  - Low cost, long term vessel financing & startup financial support for qualified operators
  - Reward shippers for using AMH – useful for combined AMH/offshore Jones Act Services
  - Resistance from competing modes of transport – intermodal rail and existing operators is a major roadblock
- Promote use of LNG propulsion to lower fuel cost & reduce environmental impact – make AMH the greener freight transport alternative
- Reduce costs
  - Develop improved, cost effective methods of cargo handling
  - Operate with reduced manning levels because of coastwise service