

Virginia Tech

DD-21 Destroyer Concept

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Mission Needs Statement

- Dominance in independent and joint ops
- Mission and Threat Analysis
- Non Material Alternatives
- Material Alternatives
 - Evaluate the impact of speed on concept design

MNS, cont.

- Constraints
 - Sustained speed of at least 40 knots
 - Optimize effectiveness vs. cost
 - Reduce manpower
 - Minimize production time
 - Maximize survivability
 - Satisfy pollution laws

Required Operational Capabilities

- Amphibious Readiness Group (ARG)
Escort
- Carrier Battle Group (CBG)
- Mine Counter Measures (MCM)
- Non-Combatant Ops / Humanitarian (NCO)

Concept Exploration Model

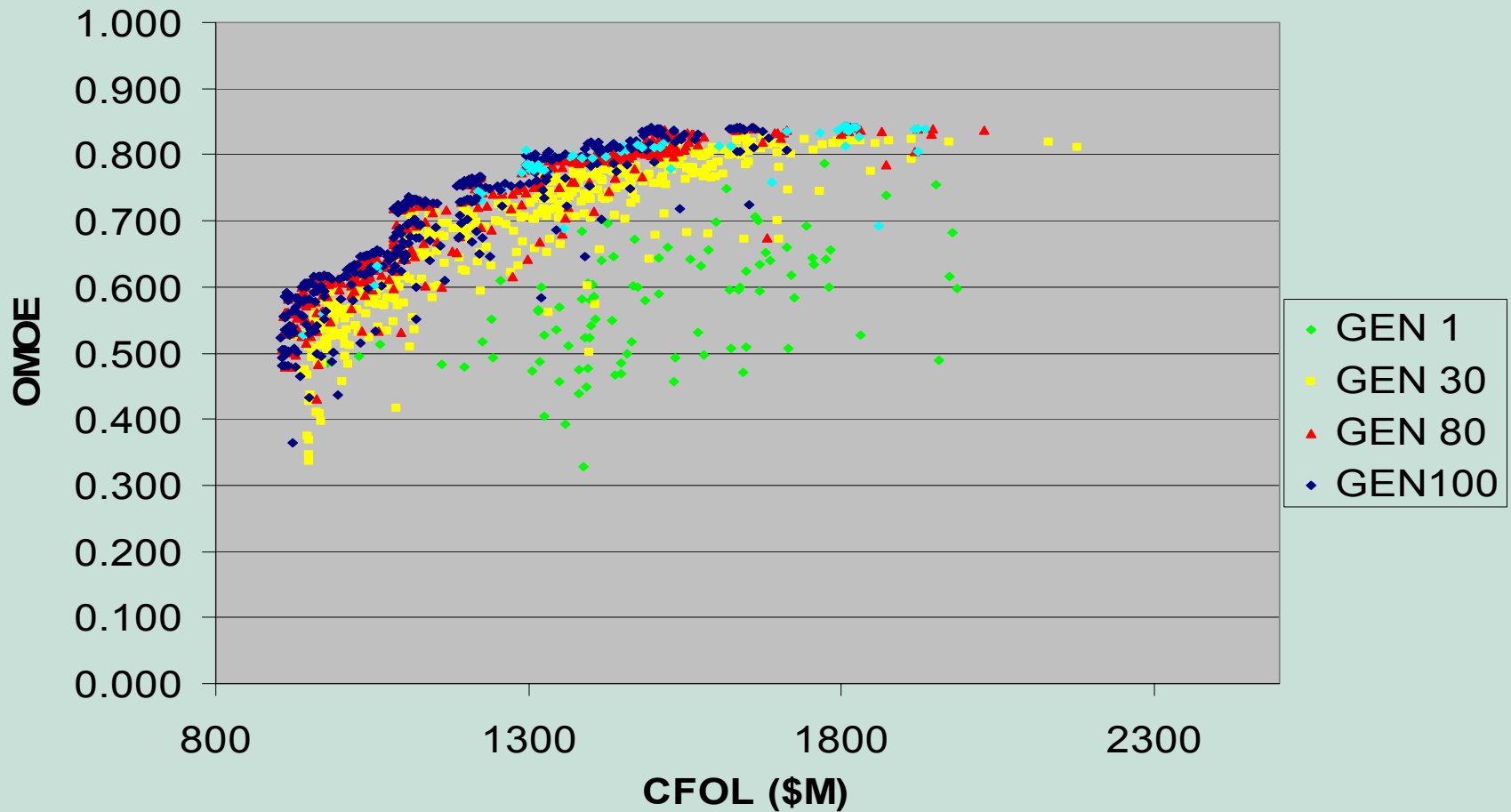
- Three Hulls
 - Transport Factor used in choices
 - Evaluate hull forms in terms of load capacity vs. speed
 - Mercier-Savitsky
 - Regression formulas produced for resistance data
 - FastShip Atlantic
 - Resistance from existing data of model testing
 - SS United States
 - Resistance from existing data of ship

Concept Exploration Model, cont.

- Propulsion Choices
 - Waterjets
 - Surface piercing propeller
 - Conventional propeller
- Weapons and Missions Options

Non-Dominated Frontier

DD21 Non-Dominated Frontier - Feasible



Baseline Concept Design

	HI	BBH	BCD	BBL	LO
LBP [ft]	598.48	537.83	437.4	414.21	404.41
Beam [ft]	103.74	93.22	67.7	64.02	62.51
Draft [ft]	26.33	23.66	19.09	18.23	17.79
D10 [ft]	49.87	44.82	35.02	34.52	35.17
Lightship [LT]	9683.8	7200.8	3841	3577.5	3278
Full load displacement	16164.6	11750.9	5870	5357.8	4998.1
FL Vertical CG [ft]	30.47	27.72	24.68	21.23	20.97
Np	6	4	4	4	4
Ve	35	35	35	35	35
Nhelo	2	2	2	0	0
Range	10000	8000	4000	4000	4000
Manning	128	125	73	66	50
Sustained speed	42.87	40.11	41.96	42.28	42.44
Maximum speed	45.03	42.22	43.8	44.23	44.38
C fola [\$M]	1803.9	1450.4	1297	1057.2	971.8
OMOE	0.842	0.813	0.807	0.631	0.559

Hull Form and Structure

The background features a dark blue gradient with a prominent white curved line starting from the top left and curving towards the right. A bright blue triangle is positioned on the right side, pointing towards the center of the slide.

Concept & Requirements Exploration

Requirements

Hull Geometry

Cost, Risk and Effectiveness

Resistance & Power

Seakeeping & Maneuvering

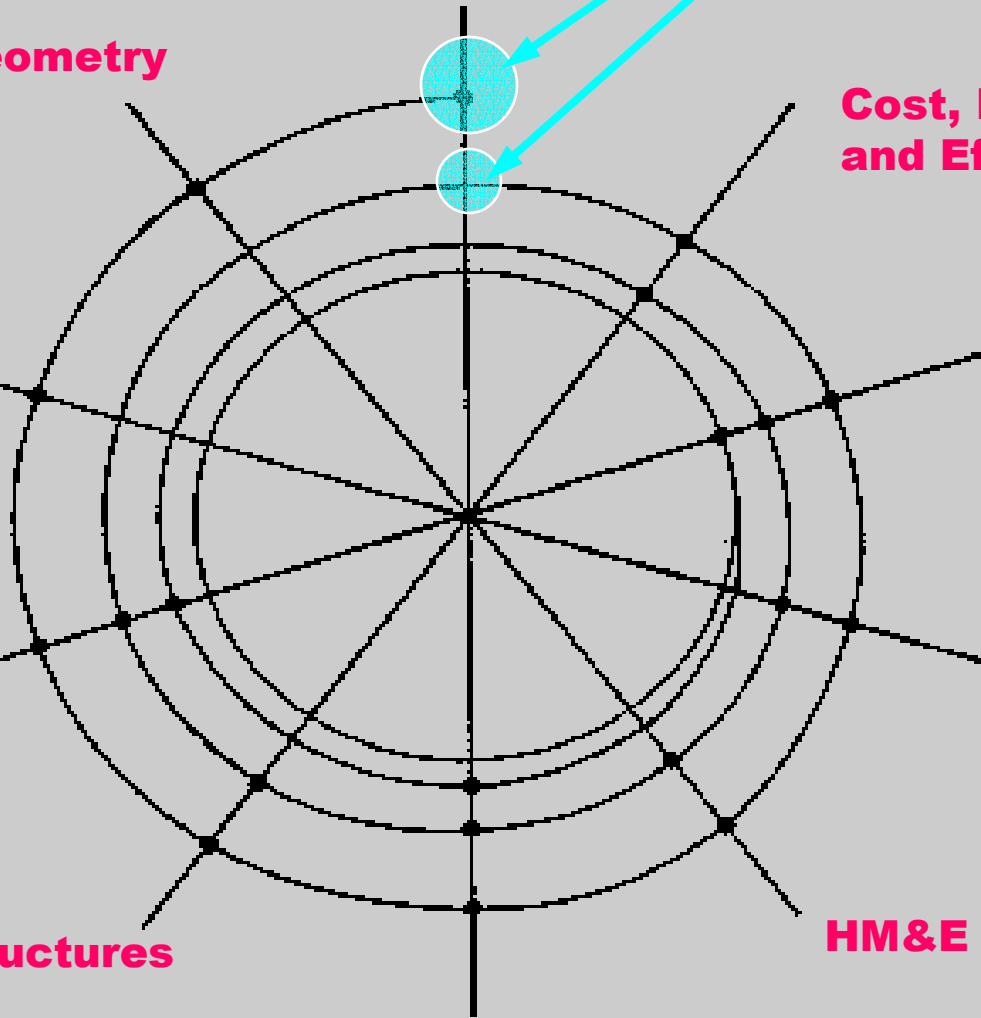
Manning & Automation

Weights and Stability

Structures

HM&E

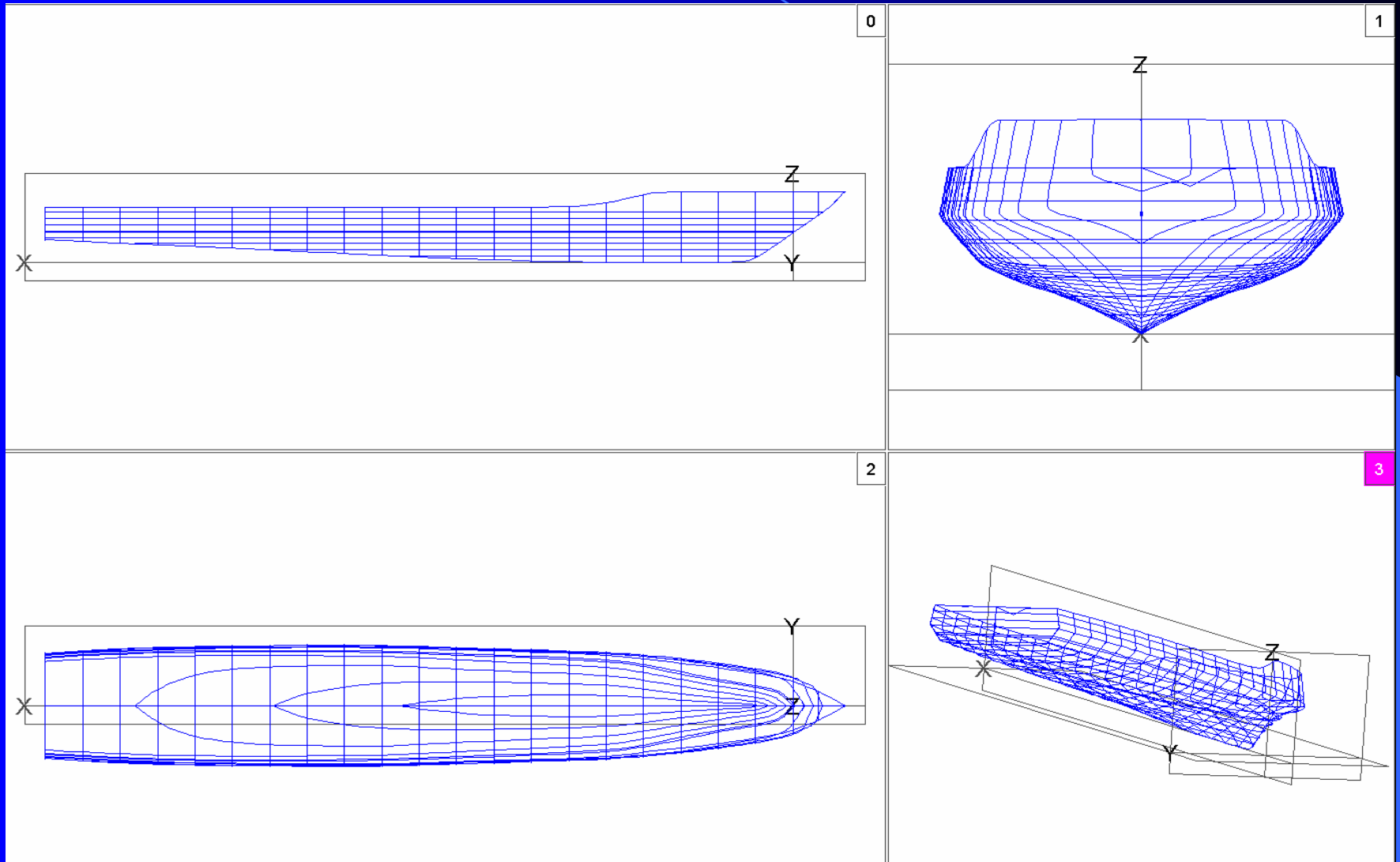
Space & Arrangements



Hull Form Development

- FastShip Atlantic Offsets
- Scaled in HECSALV
- Read offsets into Fastship program
- Surface fit to offsets

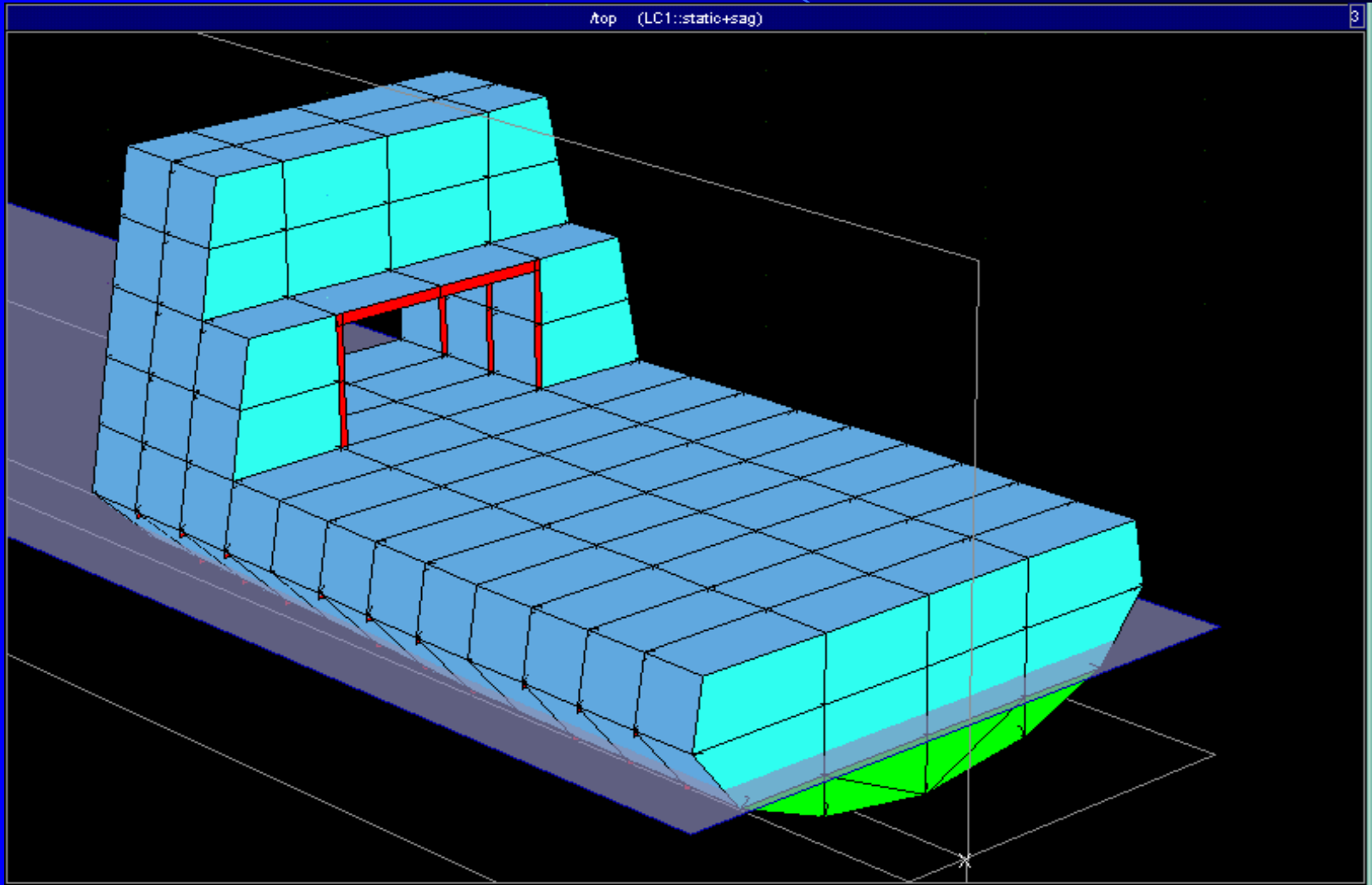
Hull Form



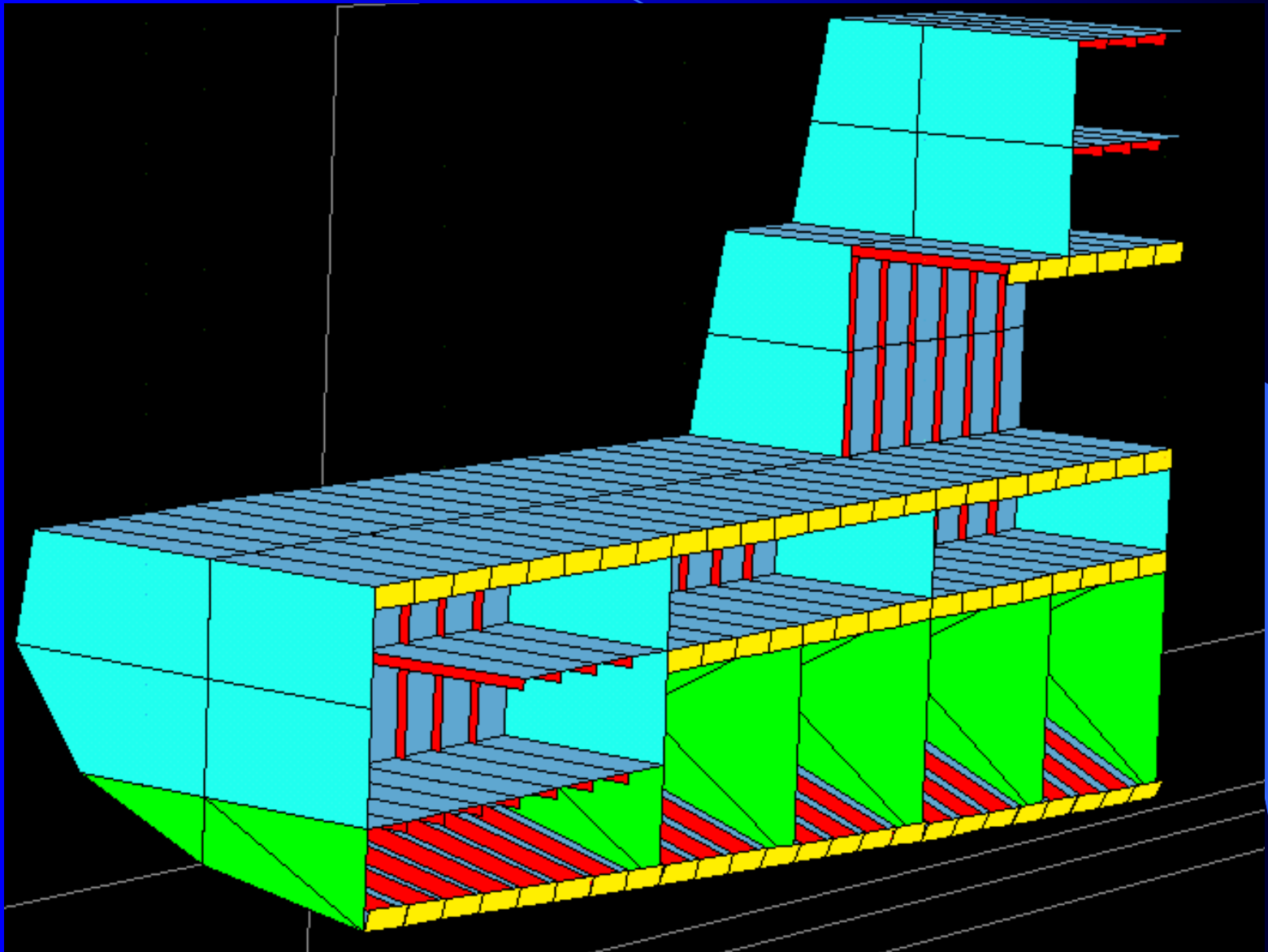
Structural Design and Analysis

- Three watertight sections of the hull
 - One centered at midships
 - One section forward and one aft of midships
- Tested in Maestro
 - Moments and Shear Forces from HECSALV
- Materials
 - Composite deckhouse to reduce weight
 - Standard steel construction for hull

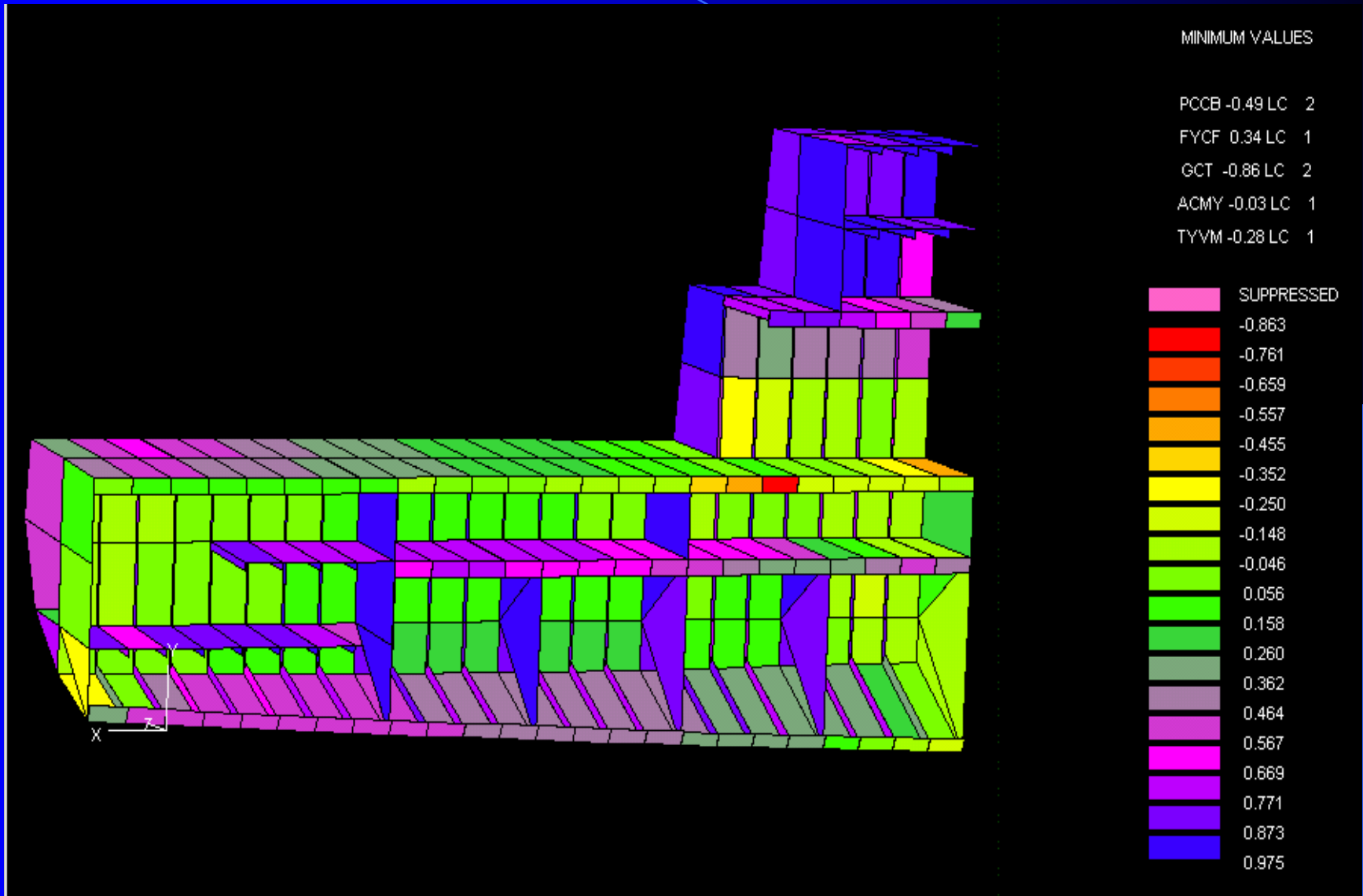
Maestro Model, Stern View



Maestro Model, Internal Structure



Maestro Model, Adequacy Parameter Minimum Values

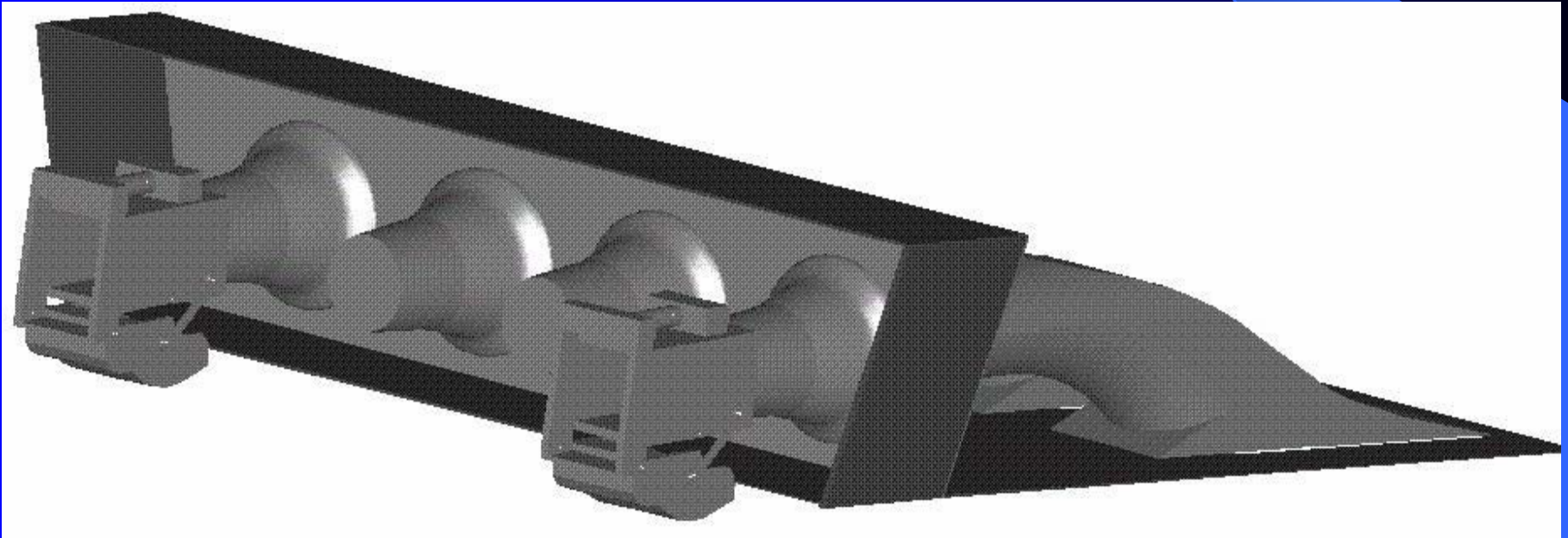


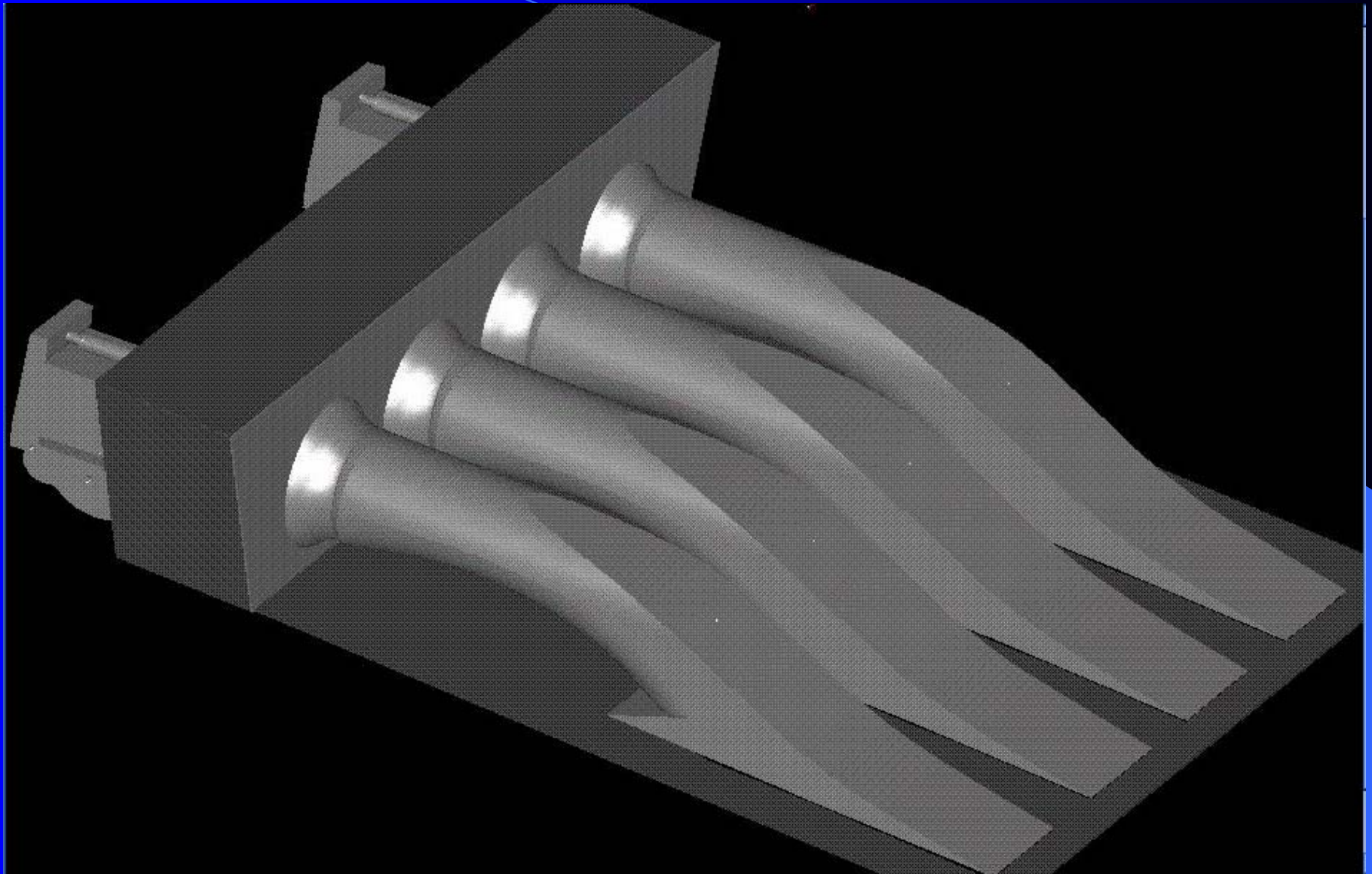
Resistance, Power and Mechanical Arrangements

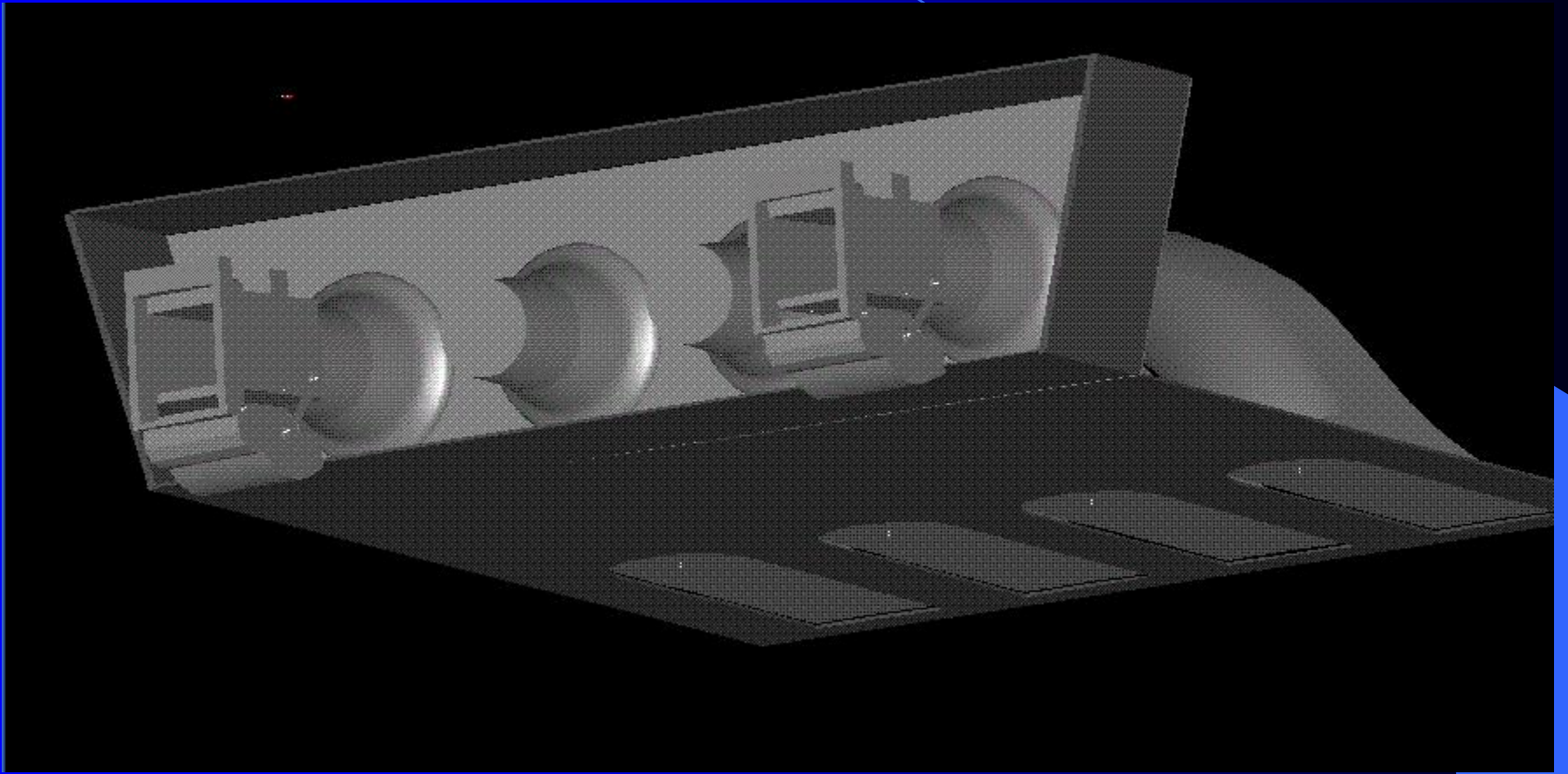
Resistance and Power

- LM-6000
- Waterjets large enough to provide power
 - Not currently available
 - Scaled by inlet diameter vs. kilowatts

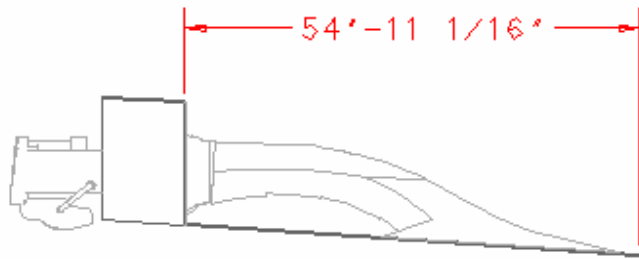
Waterjet Arrangement



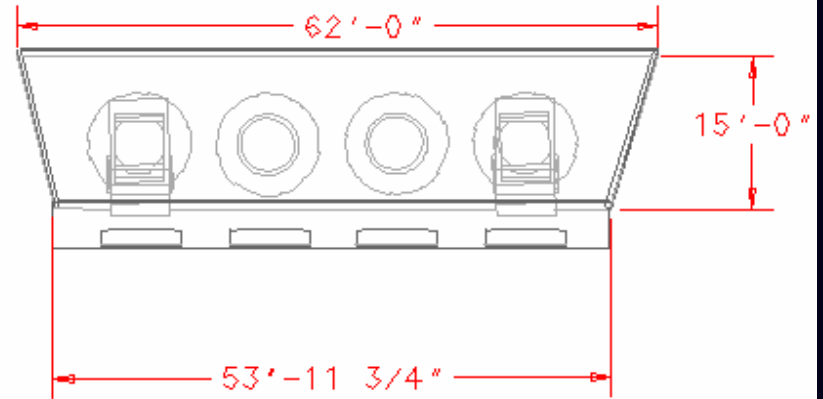




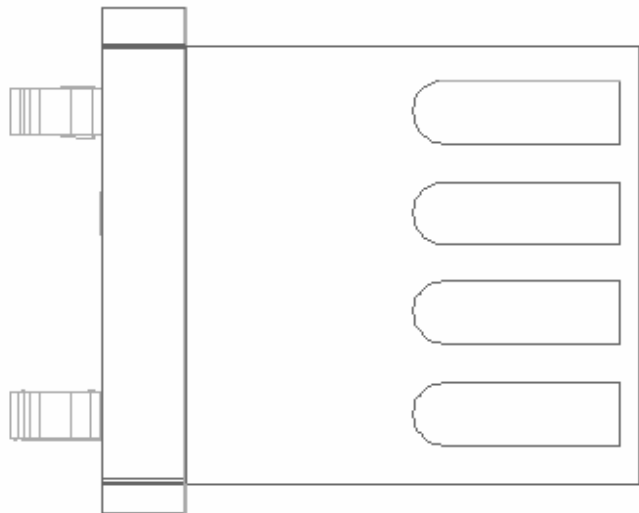
WATERLINE IS
4.9 FEET FROM
TRANSOM BASELINE



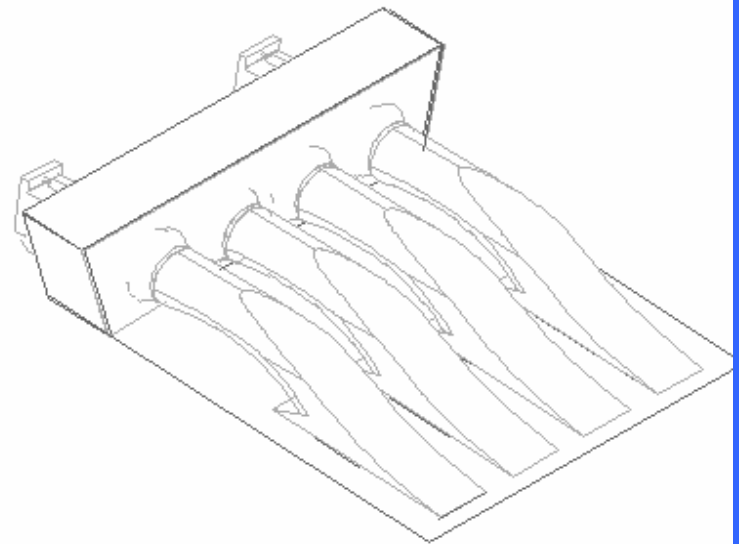
FRONT



LEFT



BOTTOM



ISOMETRIC

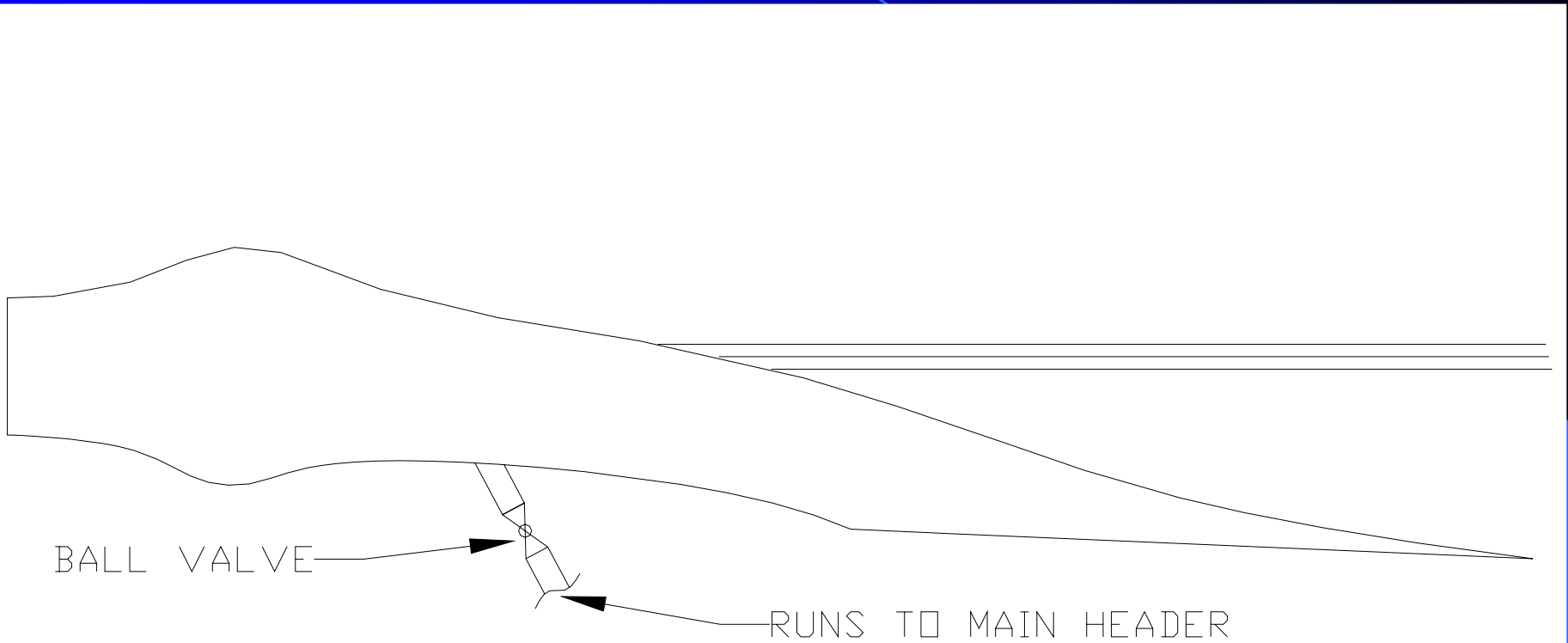
Resistance and Power Requirements

- NAVCAD software used to calculate Resistance, P_E , Fuel Consumption, and Efficiency
- Fuel Consumption at endurance speed of 35knts: 2554.78 gph
- Propulsive Efficiency at 35knts: 69.75%
- P_E at 35knts: 83362.41 hp
- P_E at top speed: 149616.54 hp

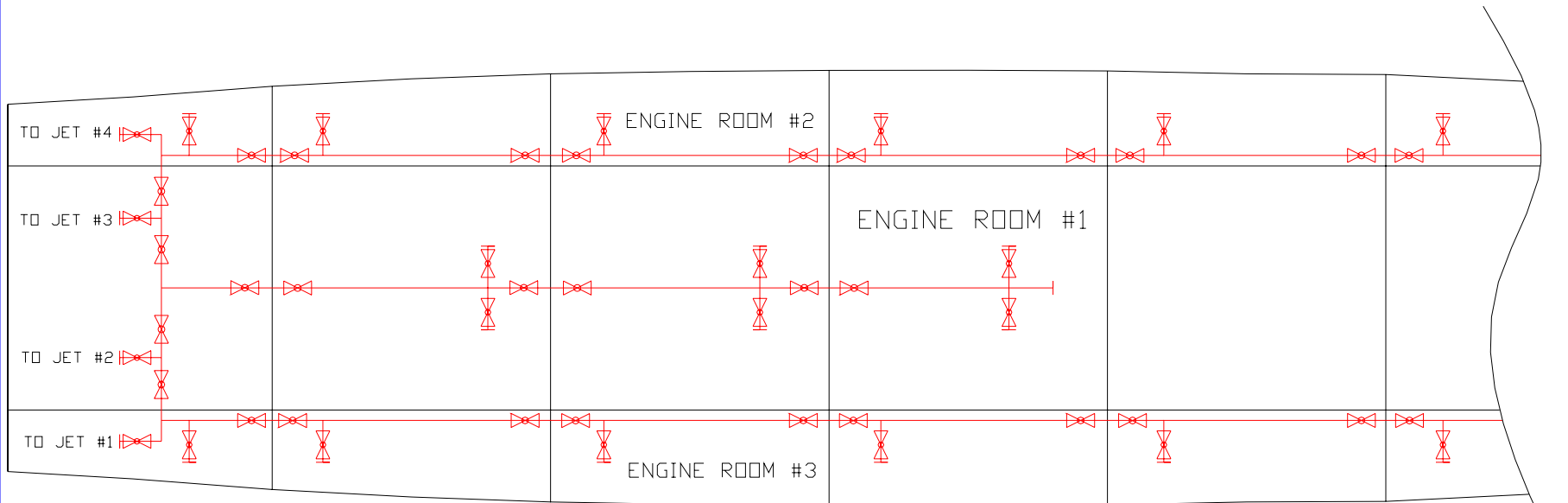
Mechanical and Electrical

- Dewatering systems of waterjets
- Forward Emergency Generator
- PDSS generators
- Smart Ship Technology to enhance survivability

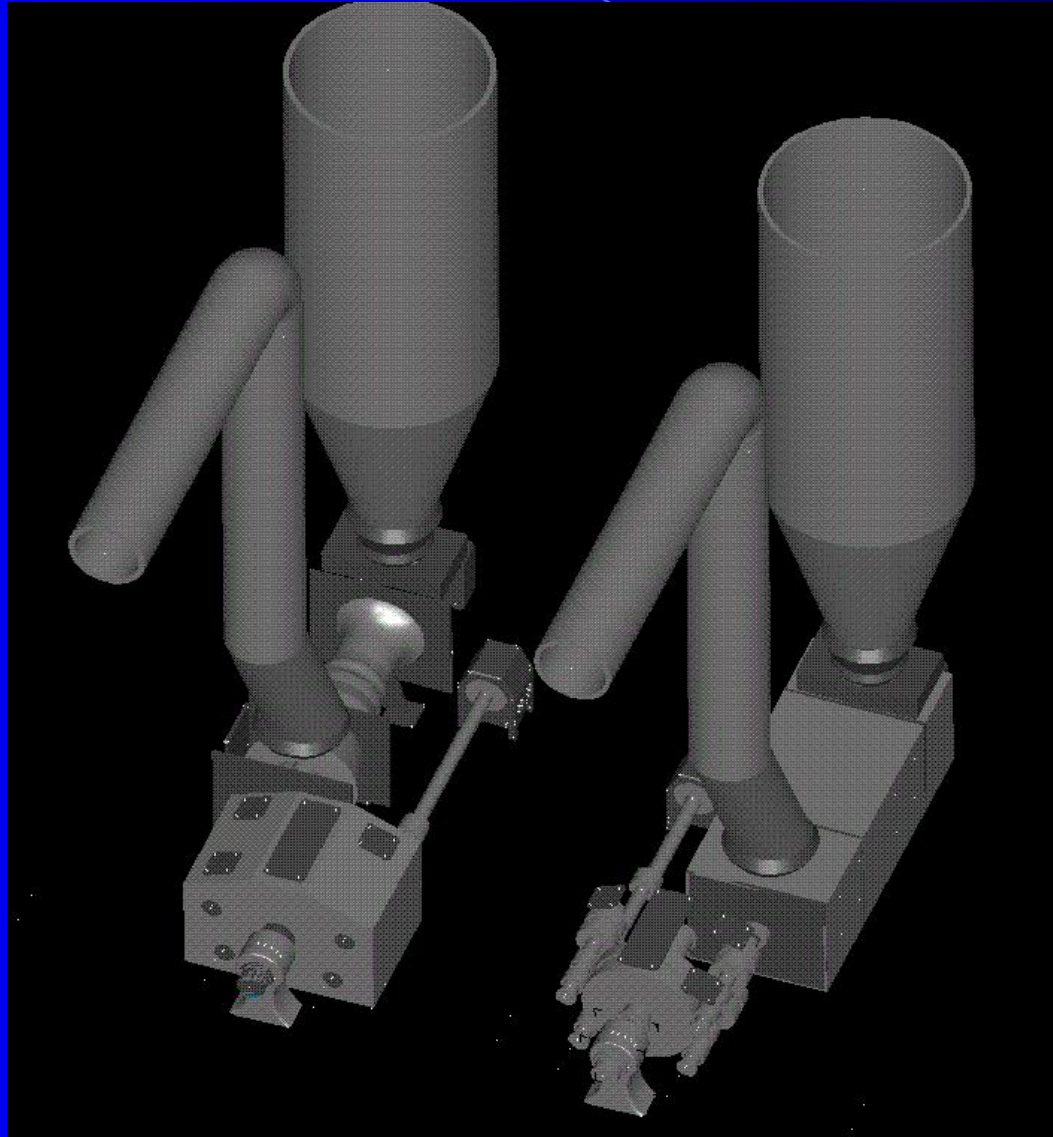
Dewatering Concept Design



Dewatering System



Machinery Room





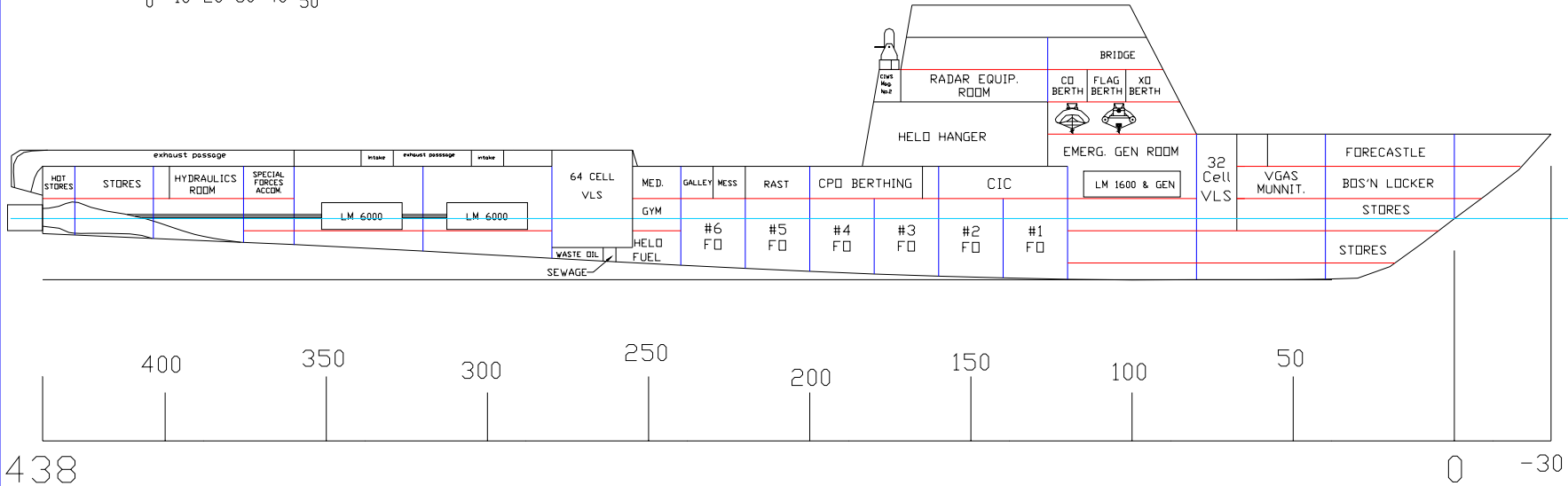
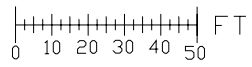
Space, Arrangements and Manning

Space and Arrangements

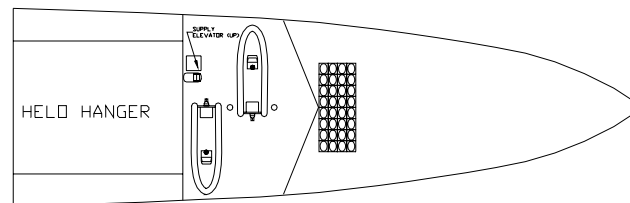
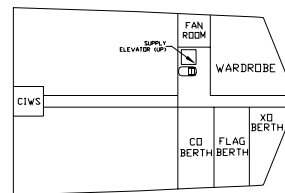
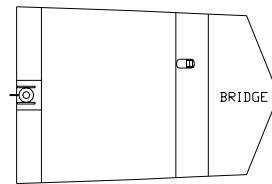
- Radar Cross Section
 - Every surface at 10 degrees
- Heat Signature
 - Exhaust system
- Deckhouse placement
- Helo deck placement
- Internal module arrangements

Arrangements: Profile View

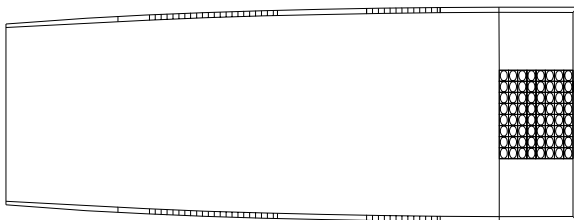
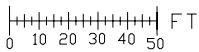
SCALE



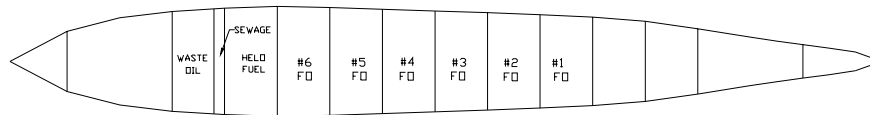
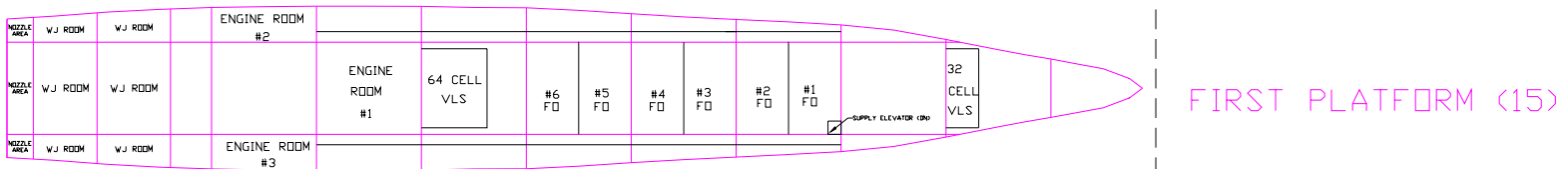
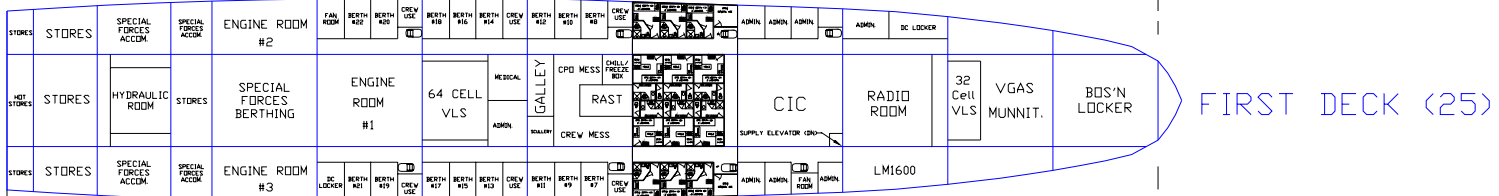
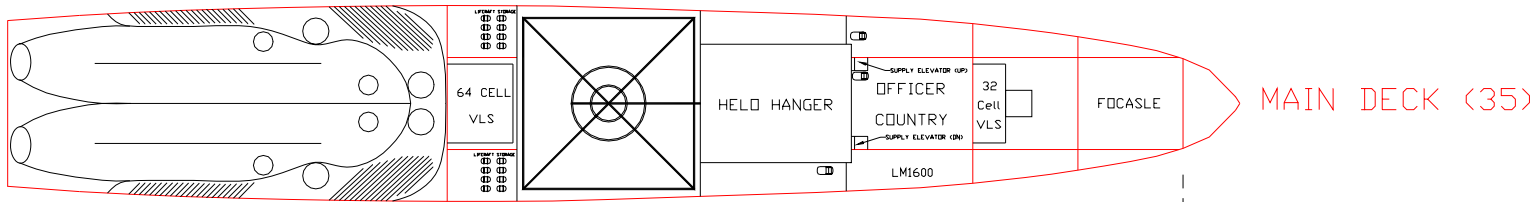
Arrangements: Deckhouse Plan



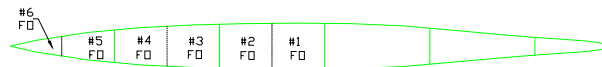
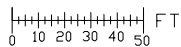
SCALE



Arrangements: Hull Plan

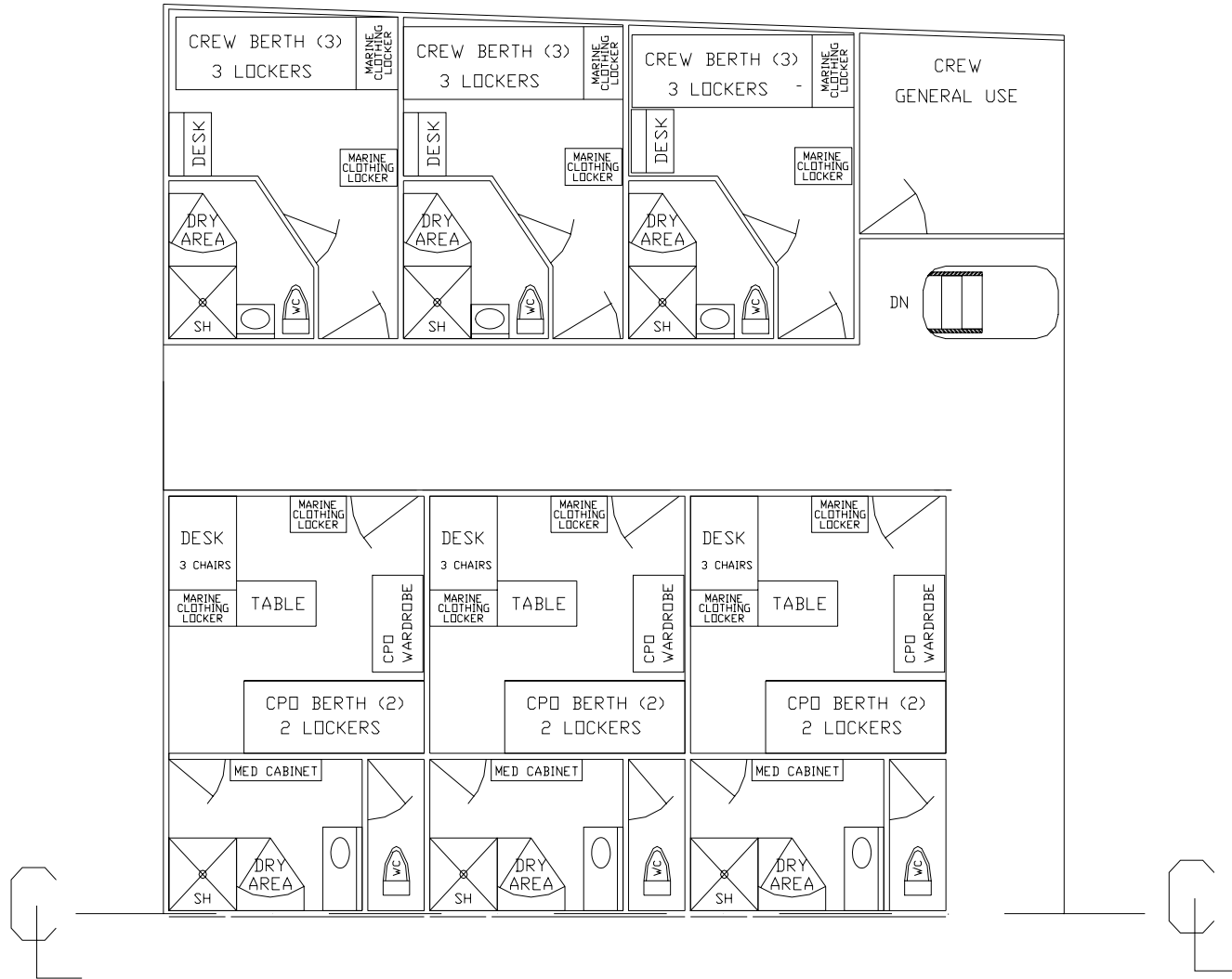


SCALE



INNER BOTTOM (5)

Arrangements: Berthing



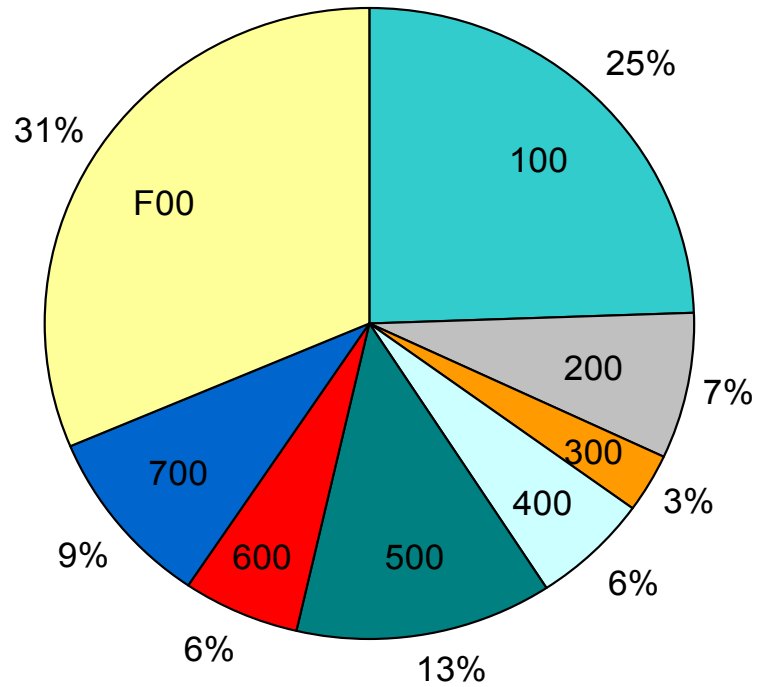
Weights, Centers and Seakeeping Analysis

Loading and Centers

- Total Weight = 6223 LT
- LCG = 215 feet aft of FP
- VCG = 22.1 feet above BL
- TCG = 0.06 feet (Port)

SWBS Report

SWBS Report



Seakeeping Limit Criteria by Subsystem

- Helo
 - Vertical velocity = 6.5 ft/sec at landing spot
 - Roll = 5 degrees
- Personnel
 - Vertical acceleration = 0.4g at bridge
 - Transverse acceleration = 0.2g at bridge
 - Roll = 8 degrees

Seakeeping Limit Criteria, cont.

- VLS
 - Vertical acceleration = 0.6g at launcher outboard corner
 - Transverse acceleration = 0.7g at launcher outboard corner
 - Roll = 17.5 degrees
- All
 - Pitch = 3 degrees

Mission Systems

- Anti-Aircraft Warfare
- Anti-Surface Warfare
- Anti-Sub Surface Warfare
- Advanced C4-I system
- Mine Countermeasures
- Naval Surface Fire Support
- Sensor and Electronic Warfare
- Strike Warfare

Weapons Systems

- VLS Missiles
- Advanced Gun System
- 2 Lamps MK III Helos
- Phalanx CIWS

Advanced Gun System

● NEED

- VOLUME OF FIRES & SUSTAINABILITY
- IMPROVED LETHALITY
- INCREASED RANGE

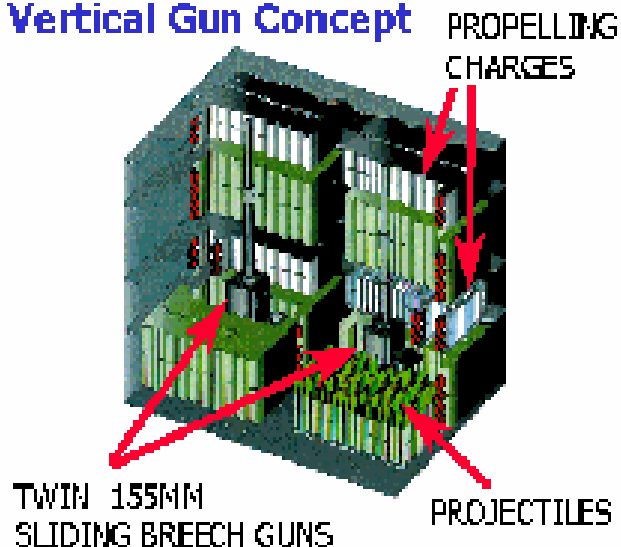
● SOLUTION

- EXPAND ON USA / USMC 155MM
- ADVANCED GUN SYSTEM

● COMPLEMENTARY PROGRAM

- LEVERAGES EXISTING ORDNANCE TECHNOLOGIES
 - 5" ERGM
 - ARMY XM982 155MM PROJECTILE
 - SADARM / UNITARY WARHEADS
 - ARMY CRUSADER Program

Vertical Gun Concept



● Meets DD 21 ORD requirements:

- Twin 155MM guns
- 750 rounds/barrel
- 100NM range
- Advanced Handling System => reduced manning
- Flush deck => reduced signature
- Reduced maintenance

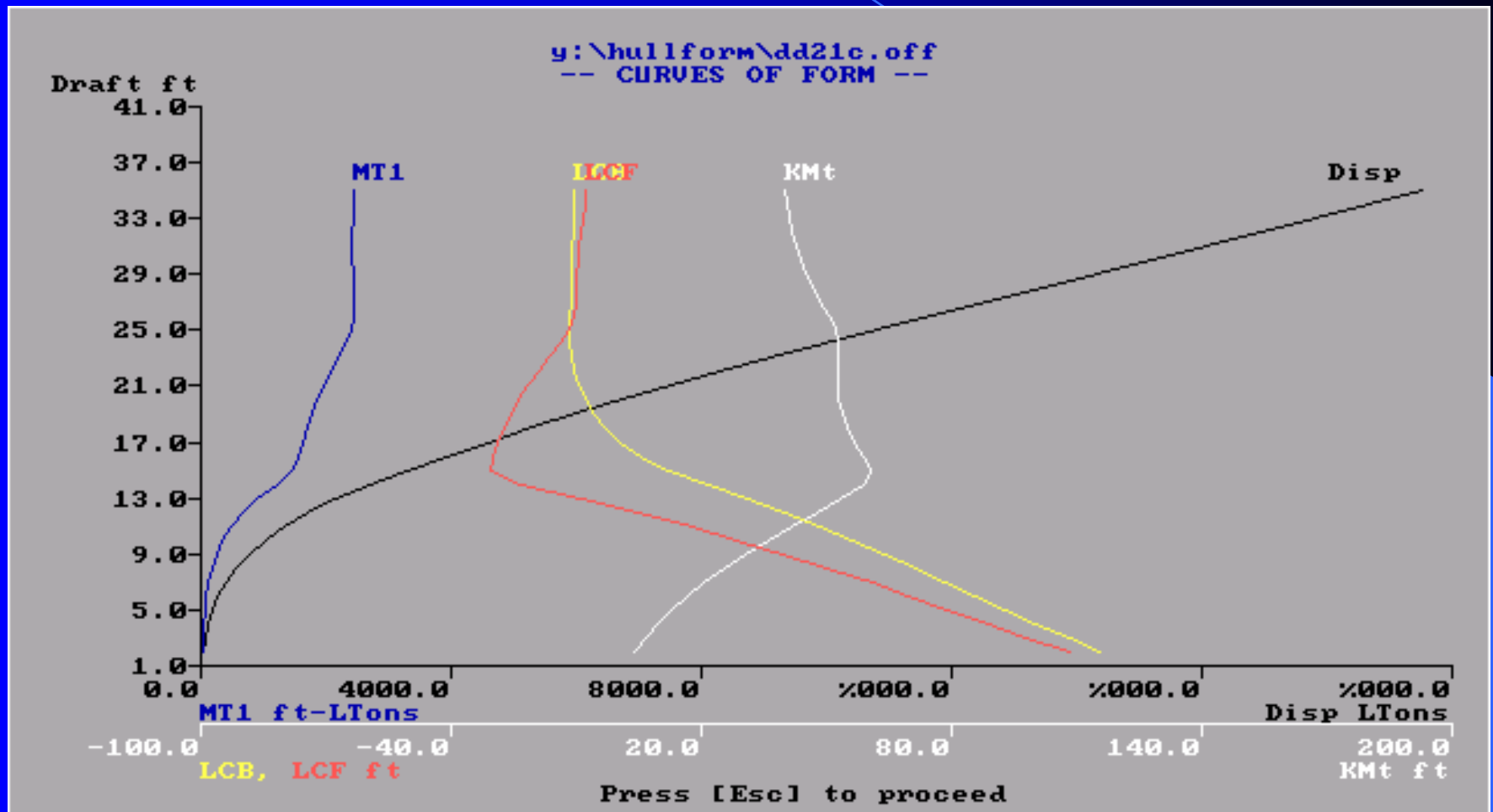
JROC
APPROVED

Hydrostatics, Intact and Damage Stability

Hydrostatics and Stability

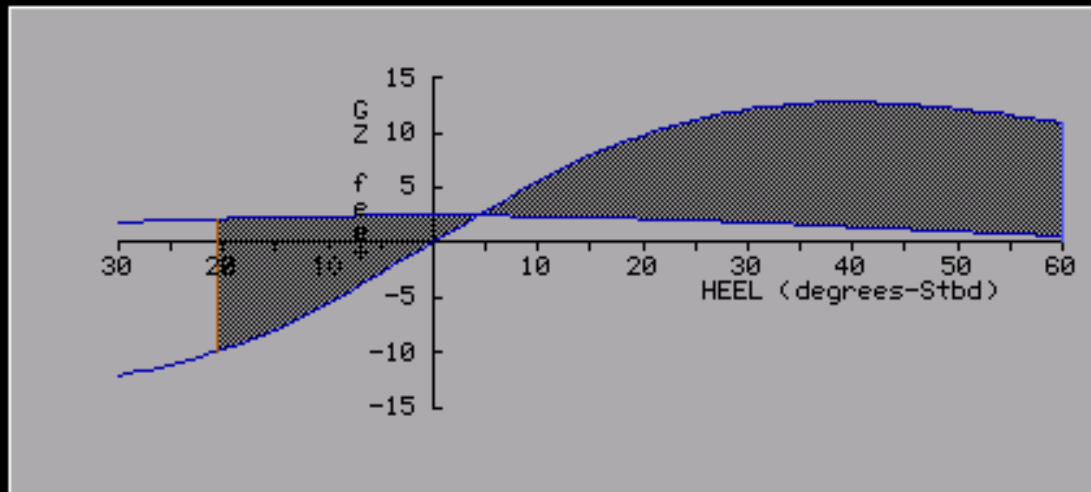
- Intact stability
 - DDS 079-1
 - Two loading cases for each of three stability requirements
 - Beam Seas and Rolling
 - High Speed Turning
 - Topside Icing
- Damage stability
 - DDS 079-1
 - 54.75 foot opening required (12.5% of LBP)

Hydrostatic Curves



Beam Seas and Rolling, Full

BEAM WIND with ROLLING STABILITY EVALUATION
(per U.S. Navy DDS079-1)

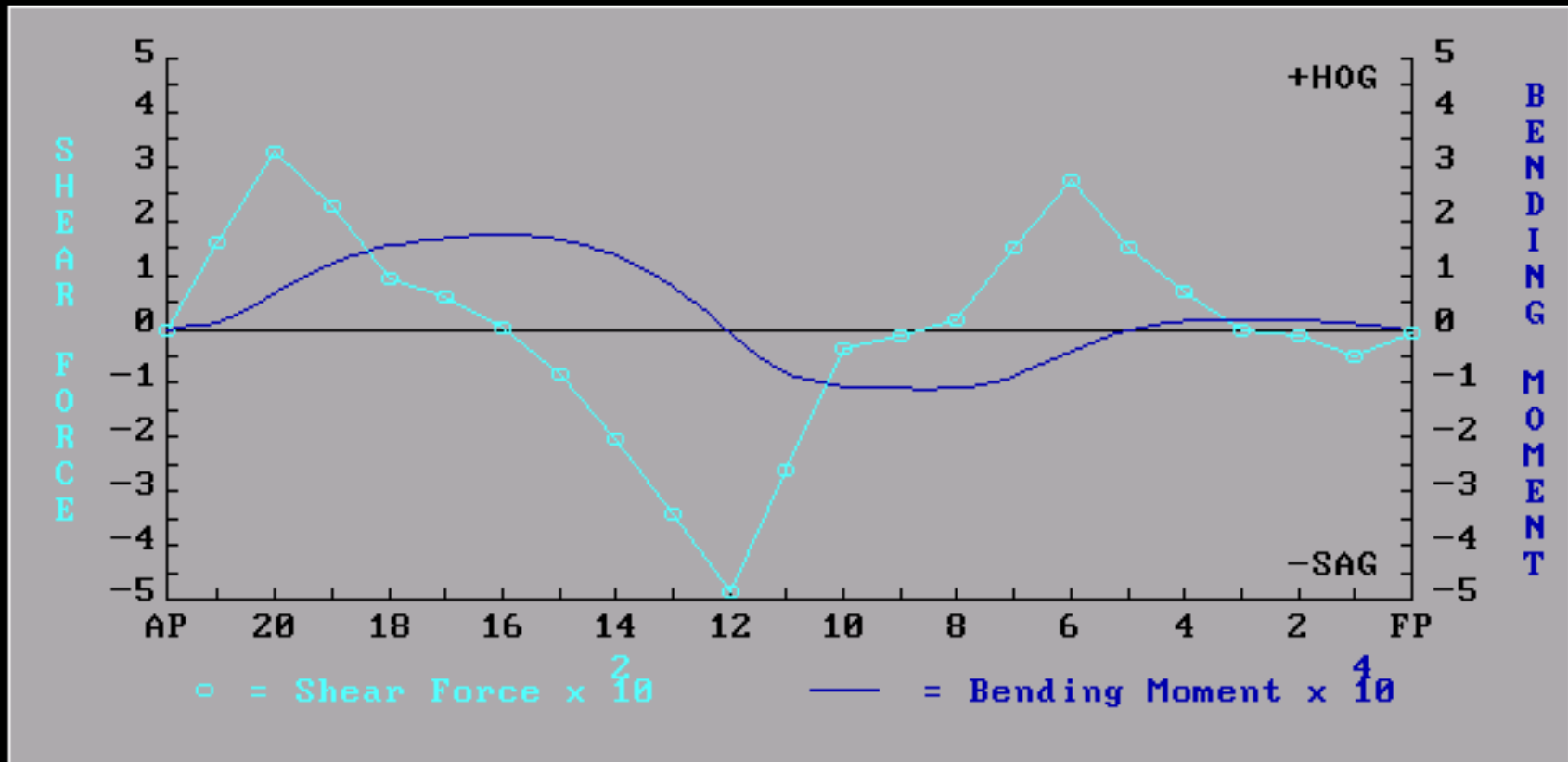


	Available	Required
Wind Heeling Arm L_w	2.458 ft	
Maximum Righting Arm	12.744 ft	4.097 ft
Capsizing Area A_2	165.4 ft-deg	
Righting Area A_1	483.5 ft-deg	231.5 ft-deg

[Tab] for tabular summary; [Esc] when done

Strength Curves, Full Load

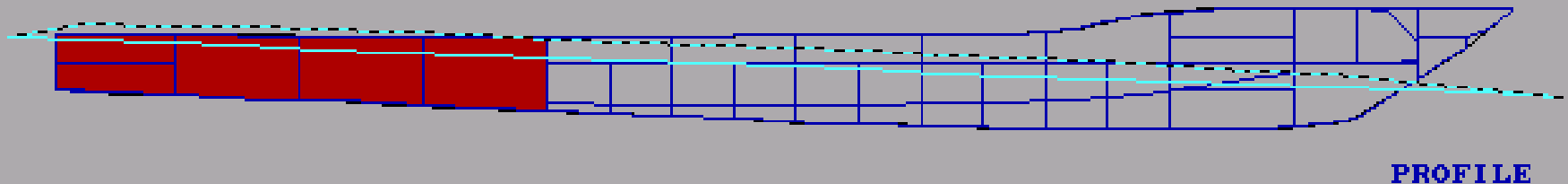
SHEAR FORCE & BENDING MOMENT SUMMARY



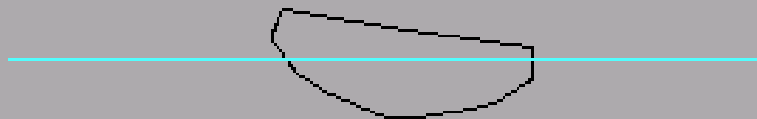
[Tab] for strength table; [Esc] when done

Limiting Case Damage Stability

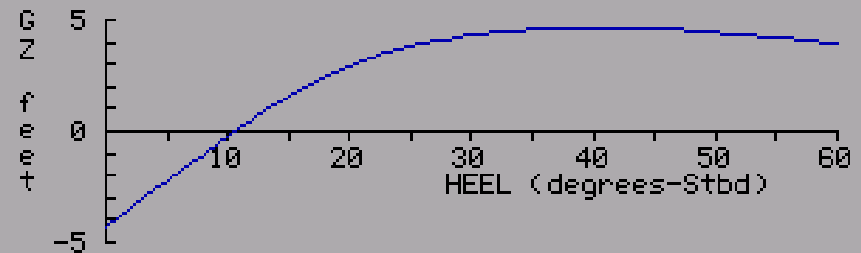
FREE-FLOATING DAMAGED CONDITION



AP 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 FP



SECTION AMIDSHIPS
(Looking Forward)



RIGHTING ARM CURVE

Press [Esc] to proceed

Final Analysis

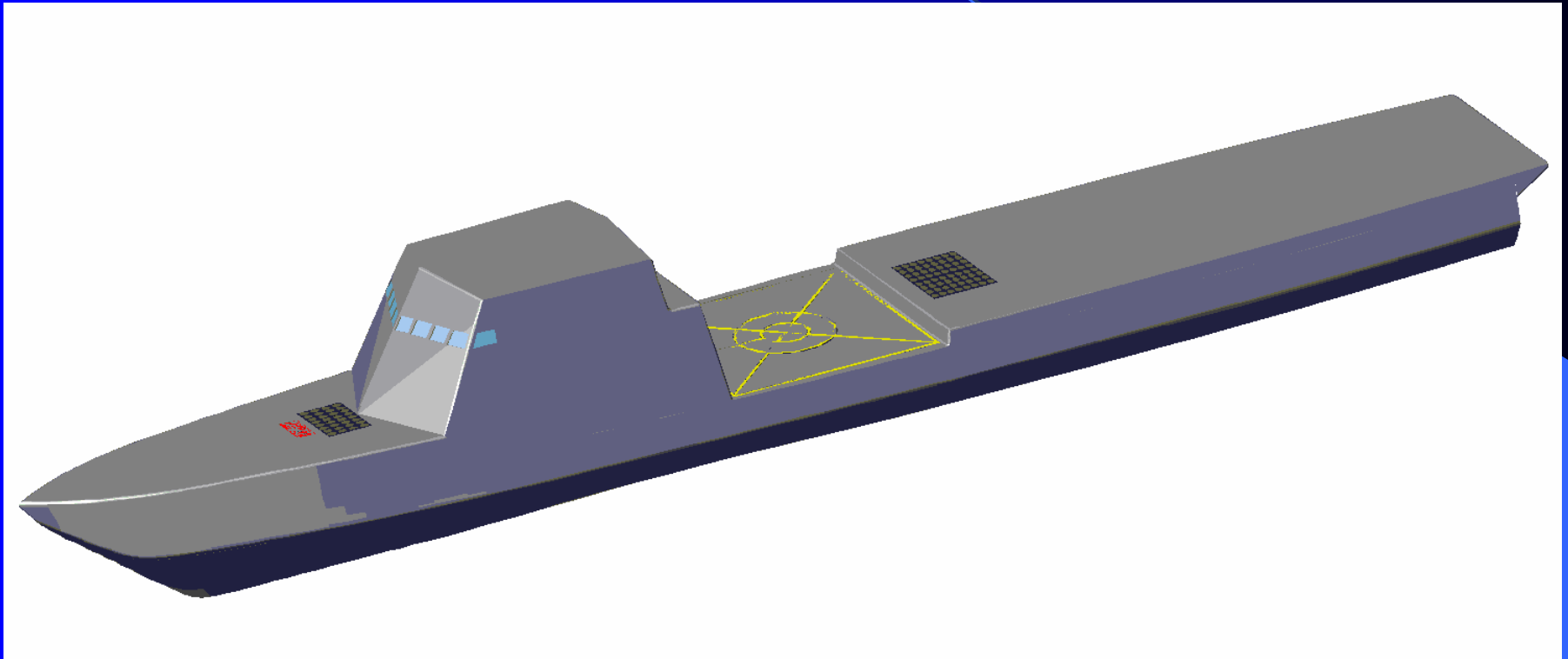
Final Concept Design

- Concept Baseline
 - LBP = 437.4 ft
 - Beam = 67.7 ft
 - Draft = 19.09 ft
 - Disp. = 5870 LT
 - Range = 4000 nm
 - Sustained Speed = 41.96 knots
 - Manning = 73
- Final Concept Design
 - LBP = 438 ft
 - Beam = 67.7 ft
 - Draft = 19.14 ft
 - Disp. = 6223 LT
 - Range = 4000 nm
 - Sustained Speed = 43+ knots
 - Manning = 92
- Cost Estimates
 - Lead Ship = \$1.3 Billion
 - Follow Ship = \$900 Million

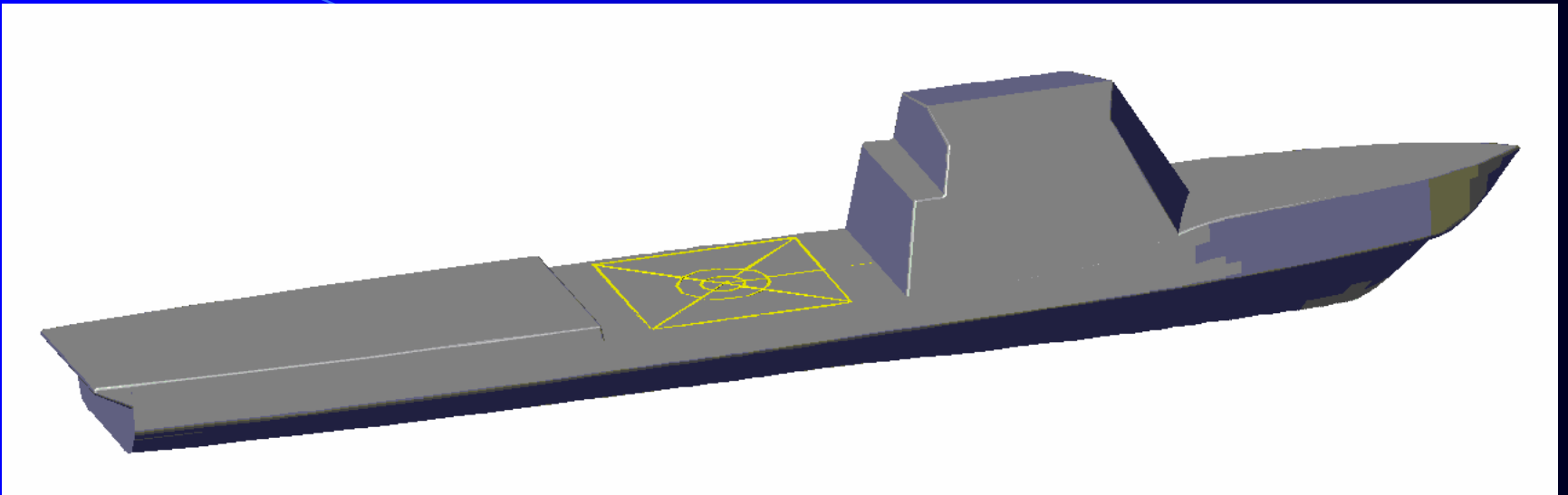
Conclusions and Future Work

- Assessment of DD-21
 - Ship is stable, but stiff
 - Low profile for reduced radar cross-section
 - Can adequately protect the areas assigned
 - Waterjet arrangement will need to be tested
 - Quality of life has been improved
- Recommended improvements
 - Testing of hull type
 - Further research of waterjet technology and improvements
 - Improve weight distribution to improve seakeeping

Final Concept Design



Questions?



Thank you for your time