



Self Defense Test Ship- Replacement (SDTS-R)

Analysis of Alternatives

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Design Objective

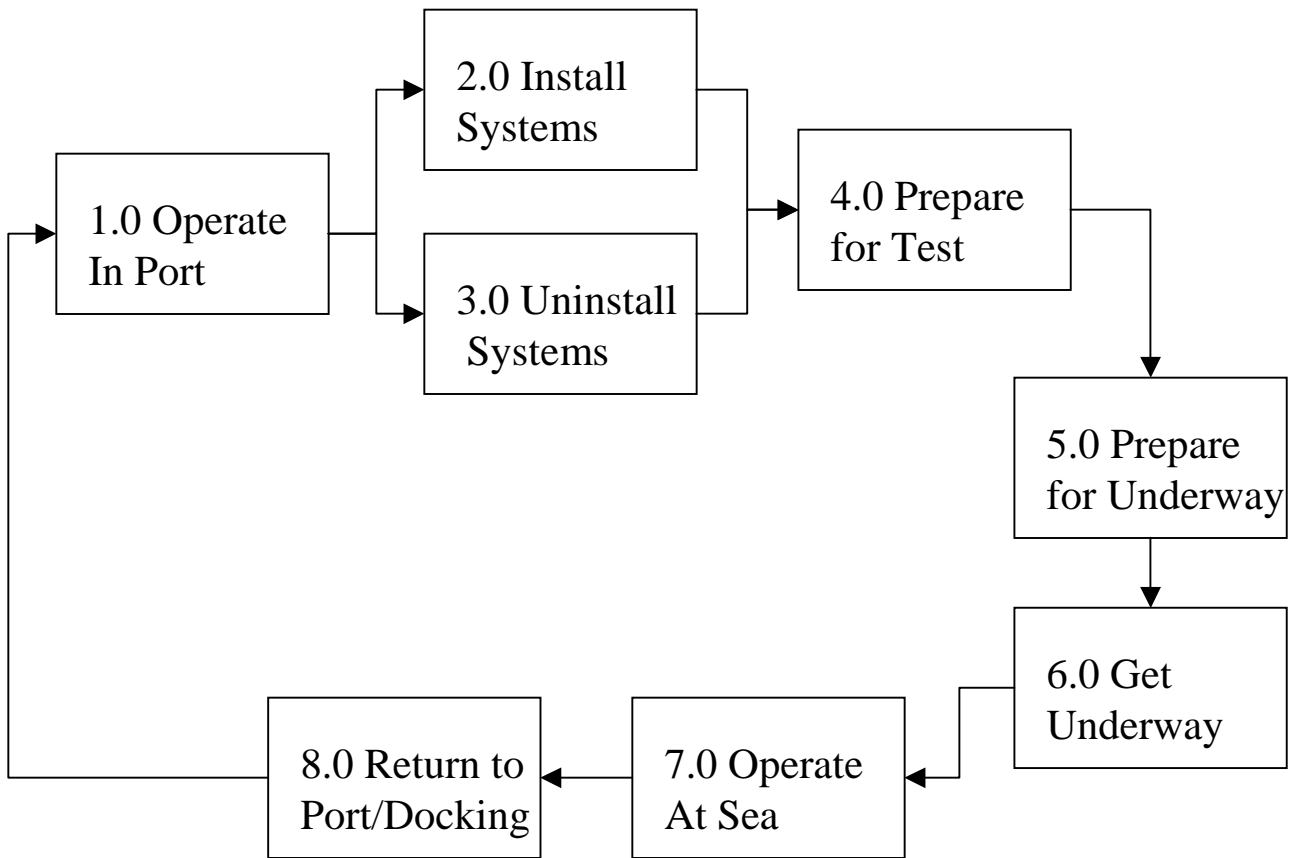
Convert a SPRUANCE-class
destroyer into the
Self Defense Test Ship-
Replacement (SDTS-R)
to conduct at sea evaluation of
ship self defense weapons
and sensors.

SYSTEMS ENGINEERING PROCESS

- PROCESS INPUT
 - CUSTOMER NEEDS - PORT HUENEME MISSION NEEDS
- REQUIREMENTS ANALYSIS
 - TEAM/FACULTY DEVELOPED ORD
- FUNCTIONAL ANALYSIS
 - FUNCTIONAL FLOW DIAGRAM
- SYNTHESIS
 - DEFINITION OF:
 - BASE LINE CS SUITE
 - SSDS Mk II, LPD-17 Version
 - BASELINE ENGINEERING CONFIGURATION
 - PERSONNEL ACCOMMODATIONS
 - ARRANGEMENT ALTERNATIVES

Functional Flow Diagrams

Top Level



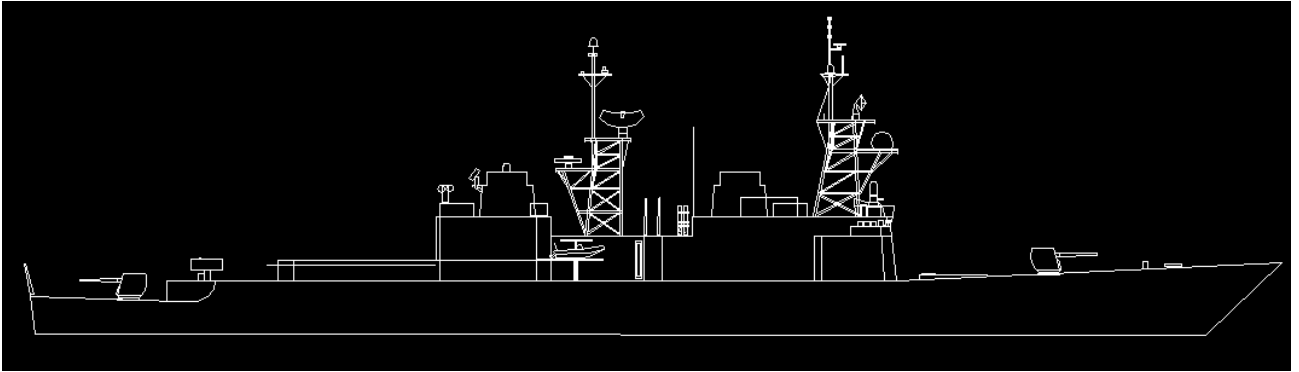
SDTS-R Required Components

- SSDS Mk 2 (LPD-17)
 - SPS-48, SPS-73, SPQ-9, SLQ-32
 - RNSSM, CIWS, RAM
- SPS-49
- Camera Mount
- Flight Deck
- 5 in/54 cal Gun
- HM&E Test Engineroom
- Accommodation for:
 - Crew of 150 including 12 women
 - 12 Day Endurance
- All Electric Services
- Tow Barge
- Remote Control System and Monitoring



Analysis of Alternatives

Design “Givens”

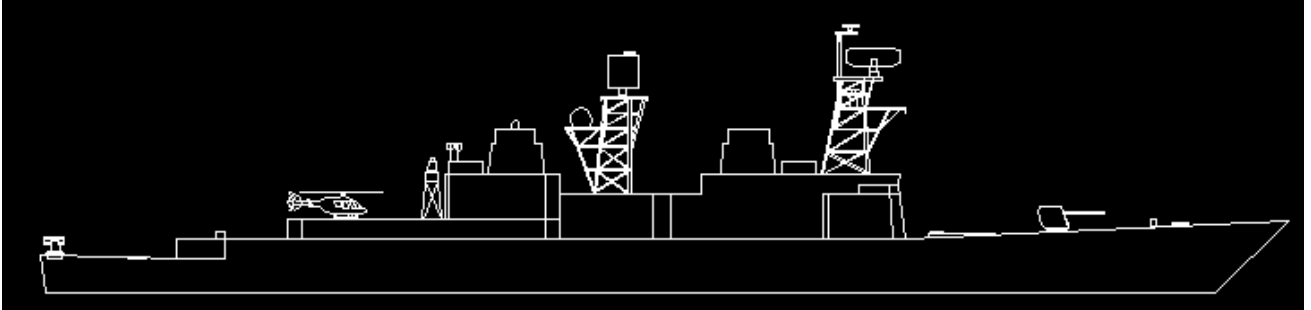


- USS O'BRIEN (DD 975) is prospective hull.
- Plenty of space for the required systems.
- Excess electrical power and services.
- Same for all alternatives:
 - Engineering Plant
 - Remote Control System
 - Messing and Berthing Arrangements

Alternatives Preview

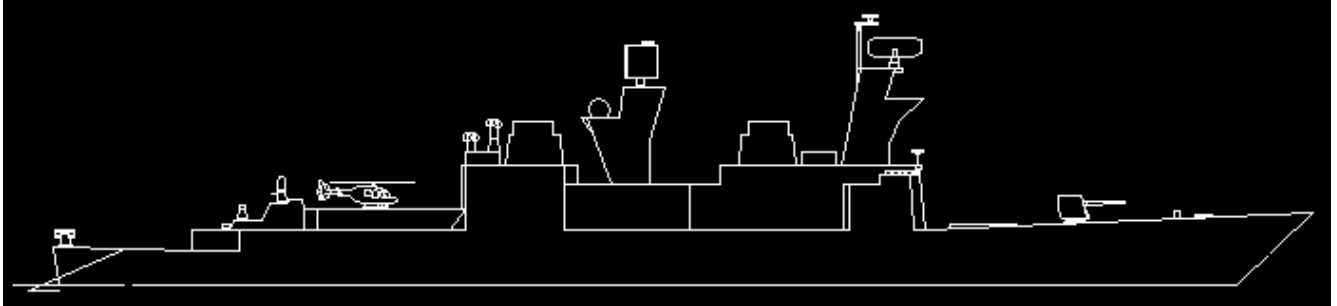
- **A: Minimum Change**
 - Least cost
 - Port hemisphere engagement only
- **B: Improved**
 - Aft hemisphere engagement (Objective)
 - Lower RCS
 - Small room for future growth
- **C: Optimized**
 - Aft hemisphere engagement
 - Even lower RCS
 - Forward flight deck
 - More room for future growth
- **D: Ideal**
 - Minimal RCS and IR signature
 - Highest cost

Alternative A: Minimum Change



- ADVANTAGES
 - Least expense
 - Uses existing weapon and sensor foundations
 - Keeps flight deck aft and relatively free of clutter
 - Leaves missile deck and fantail open
- DISADVANTAGES
 - Large RCS
 - Barge ops requires tugs
 - Limited to port side engagements

Alternative B: Improved Version



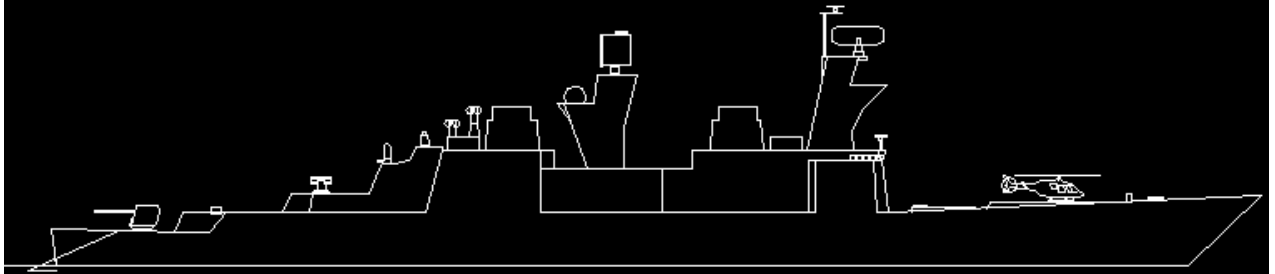
- ADVANTAGES

- Reduced RCS
- 180 degree Field of View
- Barge Ramp
- French doors
- Full use of hangar and flight deck
- MT 52 deck space available
- Low cost

- DISADVANTAGES

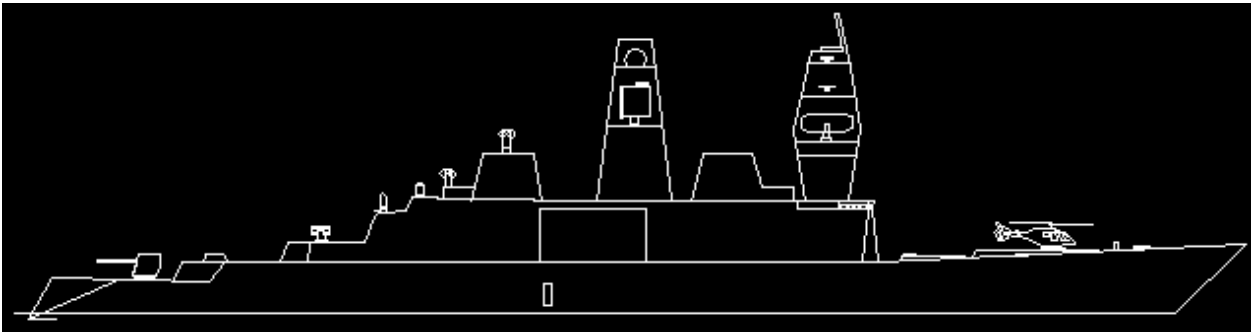
- Limited Camera FOV
- Missile Deck occupied
- Restricted angle of approach for helo
- Reducing range for CIWS
- Still 83% of RCS of Decatur

Alternative C: Optimized Version



- ADVANTAGES
 - Greatly reduced RCS
 - Barge Ramp
 - French Doors
 - Forward Flight Deck
- DISADVANTAGES
 - Expense, Structural Modifications

Alternative D: Ideal Version



- ADVANTAGES

- Best RCS:

- AEM/S (LPD-17 version and Radford version)
- Advanced stacks (IR reduction)
- Reduced bridge wings

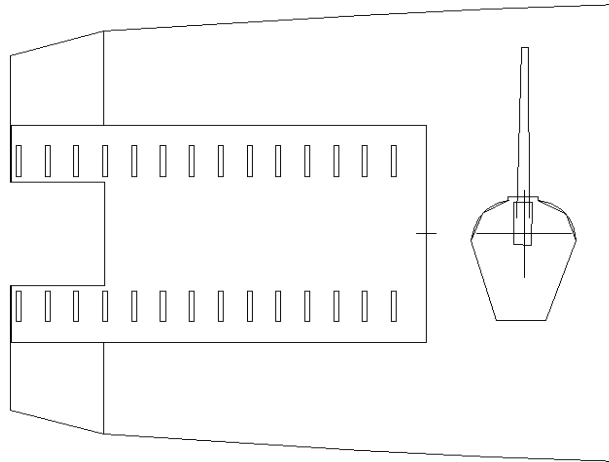
- DISADVANTAGES

- Greatest expense

Two Time and Cost Saving Features

- Barge Ramp
- Enclosed Accommodation Ladders

Barge Ramp



- Eliminates tug services
- Savings of \$18,000 (min) per live fire test
- Barge is easily transportable to any range

Enclosed

Accommodation Ladder

“the French Doors”

Objective:

- Improve safety and ease of personnel transfers to/from small boats such as range craft, pilot boats and tugs.
- Reduce RCS.

Modification:

- Two 10'x10' cofferdams are constructed aft of Fr 382, one port and one stbd.
- Cofferdam extends from the main deck down to the second platform. (WL is 3' above 2nd Platform deck)
- Merchant-type, hull conformal WT doors are fitted for each platform, the lower at 3' above the waterline, the upper platform at 8' above the waterline.
- Note: This configuration is currently in use on the new French Navy Lafayette-class frigates, primarily as a RCS reduction element.

Comparison of Alternatives

Weapons and Sensors

	Alternative A	Alternative B	Alternative C	Alternative D
Weapons and Sensors				
CIWS	CIWS not moved. Located 04 Level Port Side. Missiles must come from Port Side	CIWS Located on Missile Deck Centerline. Helicopter must approach at an angle. (typical)	CIWS on steps.	CIWS on steps.
Camera Mount	Camera mount Forward Port Corner of Flight Deck. Raised Platform. FOV to Port only. Blocks 5' of hanger door.	Camera mounted on missile deck aft and below CIWS.	Camera mount on step forward and above CIWS.	Camera mount on step forward and above CIWS.
Flight Deck	Flight Deck Aft. Keep MT 51	Flight Deck Aft. Keep MT 51.	Flight Deck Forward. Keep MT 52.	Flight Deck Forward. Keep MT 52.
Mk 91 Directors	Mk 91 Director Mounted Port Side of Fwd Mast. FOV to Port Only.	Mk 91 Directors in tandem at aft intakes.	Mk 91 Directors in tandem at aft intakes.	Mk 91 Directors in tandem at aft intakes.
RAM	RAM on Aft Port Corner of Fantail. Known installation location.	RAM on Fantail in MT 52 site.	RAM on Flight deck aft of steps.	RAM on Flight deck aft of steps.
VLS	Maintain one VLS module	Maintain one VLS Module	Maintain two VLS Modules	Maintain two VLS Modules
Missile Deck	Missile Deck available for future growth.	Missile Deck unavailable for future growth.	Missile Deck available for future growth.	Missile Deck available for future growth.

Comparison of Alternatives

Radar Cross Section

	Alternative A	Alternative B	Alternative C	Alternative D
Radar Cross Section				
Mast	Minimized mast.	Minimized Mast. RAM Paneling	Minimized Mast. RAM Paneling	RAM/S
Clutter Reduction	Remove Clutter Aft Aspect and Port Aspects only.	Remove Clutter on Aft Aspects.	Remove Clutter on Aft Aspects.	Remove Clutter on Aft Aspects.
RAM	No RAM coating	RAM Coating on Superstructure	RAM Coating on Superstructure	RAM Coating on Superstructure
Harpoon	No screening	No screening	RAM screen Harpoon Deck	RAM screen Harpoon Deck
Maindeck RCS Reduction			Anechoic Coating 10' below maindeck entire length of ship.	Anechoic Coating 10' below maindeck entire length of ship.
Super- structure		False sloped superstructure forward of midships break	False sloped superstructure forward of midships break	Reduced Bridge Wings. Sloped forward superstructure
Below Hangar on Deck		Main deck weatherdeck below flight deck paneled	Main deck weatherdeck below flight deck paneled	Hangar narrowed and sloped.
Boat Deck RCS Reduction	Port boat deck streamlined. Use SIBD boat deck only.	RAM Blanket over Boat's Crate	Boat Deck Awning	Boat Deck Awning
NSML	Remove Mk 29 NSML.	Remove Mk 29 NSML.	Remove Mk 29 NSML.	Remove Mk 29 NSML.
MT 52	MT 52 removed	MT 52 removed	MT 52 retained	MT 52 retained

Comparison of Alternatives

Personnel and Habitability

	Alternative A	Alternative B	Alternative C	Alternative D
Personnel and Habitability				
Boat	Boat Davit maintained on Starboard Side	Boat Davit has awning	Boat Davit behind Garage Door	Boat Davit behind Garage Door
Personnel Transfer	Permanent Ladder on Starboard Side.	Personnel egress via French Door	Personnel egress via French Door	Personnel egress via French Door
Barge	Standard Tow means.	Barge Ramp	Barge Ramp	Barge Ramp

Requirements Summary

Requirements	Alt. A	Alt. B	Alt. C	Alt. D
15 years life	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
15 kts sust.speed	T	T	T	T
12 days endurance	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Operational @ S.S. 4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Objective S.S. 6	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Remote Operability				
3 hours	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
8 hours	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
COLREGS	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Installed video recorders for:				
S & W	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
navigation	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Instelled data recorders for:				
S & W	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
navigation	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Area & volume for temporary combat systems & sensors	T	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	O
Area & volume for temporary computer/electronics equipment	T	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	O
Support for:				
AIEWS	T	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
BGIO/BGI	T	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
MFR	T	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
RAM HAS	T	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
ESSM/VLS	T	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
AN/SPQ-9B	T	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
IRST	T	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
ATWCS	T	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
NSFS	T	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
LASM	T	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
SATCOM	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DD 21 Tech Projects	T	T	<input checked="" type="checkbox"/>	O
LPD 17 Systems	T	T	T	T

Requirements Summary

Continued

Support for SSDS Mk II (LPD-17 plus SPS-49)	T			
Provide gyro & stable element				
Utility/range boat access	T			
Ability to launch & recover Jet Ranger & Long Ranger Helo		T	T	T
Rescue boat launching				
Towing capability for barge	T			
RCS of SDTS-R*	113%	83%	69%	56%
Support for 150 personnel for 12 days				
Berthing for 12 females				
Crew members (HM&E) (CS)	T	T	T	T
COTS facilities	T	T		O
DC systems & equipment	T			O
Remote monitoring of fire sensitive areas with fire suppression systems				
Remotely power secure ability				O
Ship stability within DD963 limits				
Corrosion suppression under Navy standards				O
Battle group interoperability	T	T		O
Adequate draft for NCBC of Port Huaneme				
All electric ship				
One engineroom for HM&E tests				
Environmental friendly				
Cost	O			T

Remarks: T achieving threshold
 exceeding threshold
O achieving objective

Field of View

Sensor	FOV	Alt. A	Alt. B	Alt. C	Alt. D
RAM	Depress to Min Range	Y	Y	Y	Y
	Elevate 75	Y	Y	Y	Y
	090R to 270R	Y	Y	Y	Y
CIWS	Depress to Min Range	Y	Y	Y	Y
	Elevate 75	Y	Y	Y	Y
	090R to 270R	NO	Y	Y	Y
Camera	Depress to Min Range	Y	NO	Y	Y
	Elevate 75	Y	Y	Y	Y
	090R to 270R	Y	NO	Y	Y
Mk 91 #1	Depress to Min Range	Y	Y	Y	Y
	Elevate 75	Y	Y	Y	Y
	090R to 270R	NO	Y	Y	Y
Mk 91 #2	Depress to Min Range	Y	Y	Y	Y
	Elevate 75	Y	Y	Y	Y
	090R to 270R	Y	Y	Y	Y
SPS 48	Depress to Min Range	Y	Y	Y	Y
	Elevate 75	Y	Y	Y	Y
	090R to 270R	Y	Y	Y	Y
SPS 49	Depress to Min Range	Y	Y	Y	Y
	Elevate 75	Y	Y	Y	Y
	090R to 270R	Y	Y	Y	Y
SPQ 9	Depress to Min Range	Y	Y	Y	Y
	Elevate 75	Y	Y	Y	Y
	090R to 270R	Y	Y	Y	Y

Radar Cross Section

- Soviet Frigate “Kola”
 - Displacement 1900 LT
 - RCS approx. 12000 m²
- ex-Decatur
 - Displacement 4100 LT
 - Surface Area 900 m²
 - RCS approx. 24000 m²
- 50% of RCS from Hull/Superstructure.
 - 12000 m²
 - Directivity Index for Hull and Superstructure is approximately 10.

RCS (Con't)

- Soviet Destroyer
 - Displacement 7000 LT
 - RCS approx 30000 m²
- SPRUANCE Class Destroyer
 - Displacement 7400 LT
 - Surface Area 1500 m²
 - RCS approx 30000 m²
- 50% of RCS from Hull/Superstructure.
 - 15000 m²
- 50% from:
 - Weapons: 5000 m². Directivity=100
 - Sensors: 5000 m². Directivity=100
 - Masts: 5000 m²

RCS Calculations:

Alternative C

Hull and Superstructure Shaping

15000 Geometric			
1	Construction of Steps		Surface Area=42 sq meters. Smooth surfaces= no Directivity Factor. sloped approx 10 degrees, assume sidelobe is 1% of mainbeam reflection
-210	Steps hide Hangar Surfaces		42 sq meters x 10 Directivity Factor. X.5 for Avg Projected Area
-750	Remove clutter from skin of ship		Multitude of tiny di/tri-hedrals: 5% of total
-400	Install RAM Screen over Harpoon deck.		8'x50'=400sq ft=40 sq meter. X10 directivity factor.
-750	Install awning over boat deck		16'x50'=800sq ft=75sq meter. x10 directivity factor. RAM Blanket 80% effective.
-4000	RAM coating (PCMS) on superstructure		Superstructure is 1/3 of total surface=5000 sq meters of RCS. PCMS is eliminates 80% of reflection.
-198	False, sloped forward superstructure		Area=100 square meters, PCMS so RCS=200 sq meters sloped approx 10 degrees, assume sidelobe is 1% of mainbeam reflection
-3840	Anechoic Panelling below maindeck		10'x520'=5200sq ft=480 sq meter. x10 directivity factor. 80% effective.
-400	Weax deck p-way below hangar enclosed.		Area=40 square meters, x10 for Directivity Factor.
120	Barge Ramp Addition		8mx3m waterline in wet deck=24 sq meter. X10 Directivity Factor. x.5 Projected Average Area.
-10218	Net Change		4782 As Modified Geometric Contribution

RCS Calculations: Alternative C

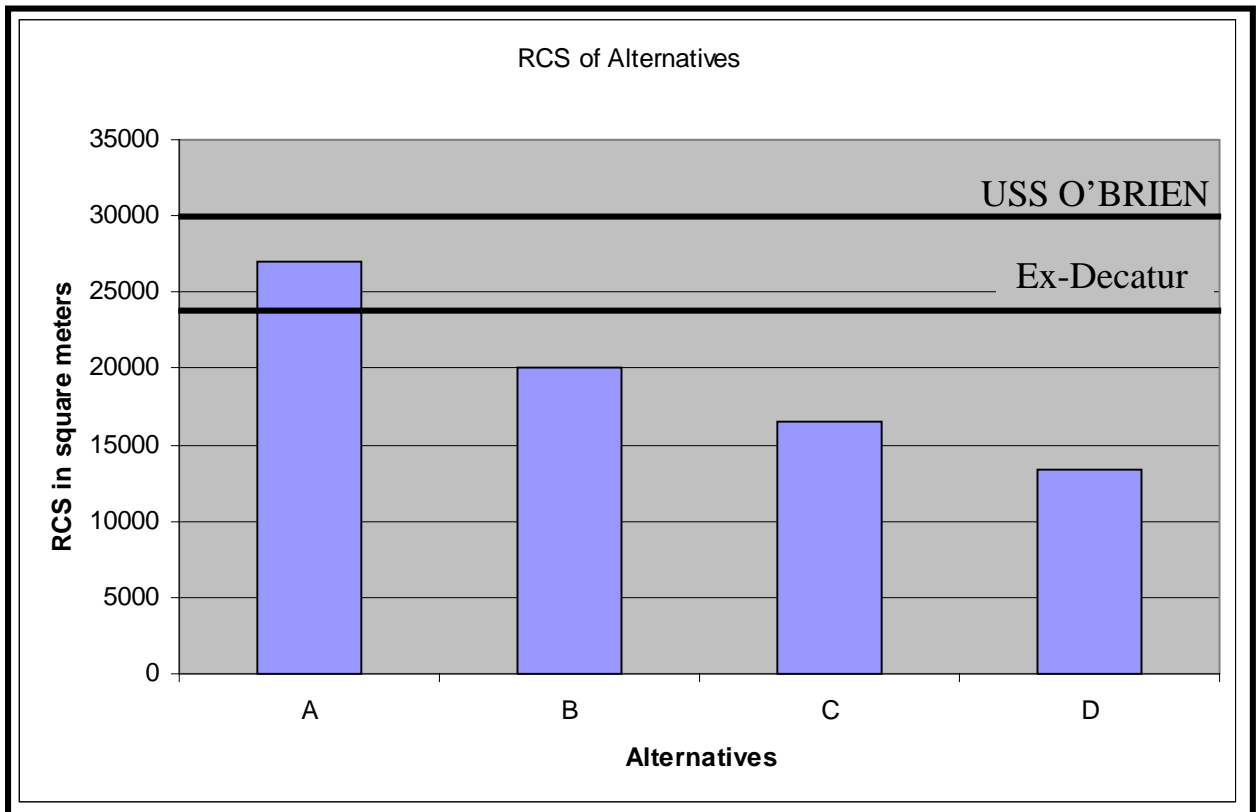
Weapons/Sensors/Mast Shaping

15000	S/MW									
	0	CIWS Moved but same RCS Contribution								
	40	Addition of Camera Mount			Mount is 6x6ft. Area is 4 sq meters x10 for dihedral effects.					
	100	Addition of Camera			Camera area =1. X100 for Sensor Directivity					
	-1250	Remove Excess mast			Entire mast is 1/3 of S/MW=5000 sq meters. Remove about 1/4 of volume					
	-3000	RAM Panel Mast			3750 sq meter of mast remain. RAM Panelling eliminated 80% of reflection					
	600	Addition of RAM			7x10ft launcher and pedestal. Area is 6 sq meters. X100 for Directivity.					
	-600	Remove TAS and SPS-40			TAS area=2 sq m. 40 area=4 sq m. x100 for reflective shaping.					
	2200	Addition of SPS-48 and 49			SPS-48 area=10 sq m. 49 area=12 sq m. x100 for reflective shaping.					
	-1600	Remove Mk 29 NSSML			16 sq m. X100 for Directivity Factor					
	300	Addition of Mk91 Director			Approx 1 sq meter size+ pedestal, smooth surfaces, x100 Directivity Factor					
-3210	Net Change				11790	As Modified S/M/W Contribution				

11790	S/M/W Contribution			
16572	Buick Alternative Estimated Total RCS			
55.24	Percent of O'BRIEN Original RCS			
69.05	Percent of ex-Decatur RCS			

Radar Cross Section Summary

Alternative	A	B	C	D
RCS	27066	20000	16572	13381
% O'BRIEN	90.2	66.7	55.2	44.6
% ex-Decatur	112.8	83.3	69.1	55.8



Stability

- Utilized asset model (figures 1 and 2)
- ASSUMPTIONS - Baseline ship is DD-963 with following modifications:
 - 1) SPS-48 RADAR
 - 2) CIWS camera mount
 - 3) Reduced RCS Panels on masts (GRP panels)
 - 4) Flt Dk weapons platforms (steel frame with GRP panels)
 - 5) RAM launcher aft
 - 6) Reduced RCS enhancements (RAM screens/GRP)
 - 7) No VLS weapons
 - 8) No fwd CIWS
- RESULTS
 - 0.18 ft increase in KG
 - slight decrease in righting arm at large heel angles
- CONCLUSION - DD-963 hull has ample stability for SDTS-R conversion.

Summary

- Four Alternatives presented
 - Range of Signature Reduction
 - Weapons and Sensors Placement
 - Flight Deck Position
- Barge Ramp and French Doors
- Worst Case Stability Analysis

- Cost not specifically evaluated