Table 2a. Fuel Saving Technology Matrix (1 of 2)

	Technically Applicable/ Feasible	Cost Benefit	Annual Savings ($)	Comments/ Period of Payback	Technically Applicable/ Feasible	Cost Benefit	Annual Savings ($)	Comments/ Period of Payback	Technically Applicable/ Feasible	Cost Benefit	Annual Savings ($)	Comments/ Period of Payback	Technically Applicable/ Feasible	Cost Benefit	Annual Savings ($)	Comments/ Period of Payback	Technically Applicable/ Feasible	Cost Benefit	Annual Savings ($)	Comments/ Period of Payback
Alternatives	RIBs				41'UTB				47'MLB				87'WPB				110'WPB			
HULL																				
Shape	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
systematic model series resistance and self propulsion tests	OK	NG	NG	Too many hullforms	OK	NG	NG	Test Already Performed	OK	NG	NG	Test Already Performed	OK	NG	NG	Test Already Performed	OK	NG	NG	Test Already Performed
weight reduction (composite panels and shafts, aluminum vs. steel)	OK	NG	NG	Minimal Possibilities	OK	NG	NG	Cost will most likely exceed benefits	OK	NG	NG	Cohen/Ghosh/Shepard Paper	OK	NG	NG	Weight was Critical in Original Design	OK			Cost will most likely exceed benefits
asymmetric stem hullforms	NG	-	NG	Not suitable for Planing Hulls	NG	--	NG	Not suitable for Planing Hulls	NG	--	NG	Not suitable for Planing Hulls	NG	--	NG	Not suitable for Planing Hulls	NG	--	NG	Not suitable for Planing
bulbous bow	NG	--	NG	Not suitable for Planing Hulls	NG	--	NG	Not suitable for Planing Hulls	NG	--	NG	Not suitable for Planing Hulls	NG	--	NG	Not suitable for Planing Hulls	NG	--	NG	Not suitable for Planing
bulbous stem	NG	--	NG	Not suitable for Planing Hulls	NG	--	NG	Not suitable for Planing Hulls	NG	--	NG	Not suitable for Planing Hulls	NG	--	NG	Not suitable for Planing Hulls	NG	--	NG	Not suitable for Planing
Trim Control	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
stem flaps	OK	NG	NG	Trim tabs may already be present	OK	NG	NG	Sedat/Purcell/Hervey Paper	OK	NG	NG	Conflicting Results	OK	OK	206,088	1.3 years	OK	OK	653072	4.5 months
ballast and other liquids storage	OK	NG	NG	Possible Relocation of Fuel Tank(s)	OK	OK	54,150	Immediate Benefit	NG	--	NG	Single Fuel Tank-Mission rqmts	NG	--	NG	Athwartships Fuel Tank Locations	OK	NG	NG	Technique Currently Employed
Smoothness	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
surface preparation	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
improved blasting methods (better grits, hydrojets)	OK	NG	NG	Cost far exceeds benefit	OK	NG	NG	Cost far exceeds benefit	OK	NG	NG	Cost far exceeds benefit	OK	NG	NG	Cost far exceeds benefit	OK	NG	NG	Cost far exceeds benefit
blast to higher standards	OK	NG	NG	Cost far exceeds benefit	OK	NG	NG	Cost far exceeds benefit	OK	NG	NG	Cost far exceeds benefit	OK	NG	NG	Cost far exceeds benefit	OK	NG	NG	Cost far exceeds benefit
pit filling	OK	NG	NG	Cost far exceeds benefit	OK	NG	NG	Cost far exceeds benefit	OK	NG	NG	Cost far exceeds benefit	OK	NG	NG	Cost far exceeds benefit	OK	NG	NG	Cost far exceeds benefit
anti-corrosion	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
improved anti-corrosive paints	OK	NG	NG	See Hull Treatments	OK	NG	NG	See Hull Treatments	OK	NG	NG	See Hull treatments	OK	NG	NG	See Hull Treatments	OK	NG	NG	See Hull Treatments
cathodic protection (active vs. passive)	NG	--	NG	Not suitable for Fiberglass Hulls	OK	NG	NG	See hull treatments	OK	NG	NG	See hull treatments	OK	NG	NG	See Hull treatments	OK	NG	NG	Technique Currently Employed
anti-fouling	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ablative paints	OK	NG	NG	See Hull Treatments	OK	NG	NG	See Hull Treatments	OK	NG	NG	See Hull treatments	OK	NG	NG	See Hull treatments	OK	NG	NG	See Hull Treatments
sound or radio waves	NG	--	NG	Unproven technology	NG	--	NG	Unproven technology	NG	--	NG	Unproven technology	NG	--	NG	Unproven technology	NG	--	NG	Unproven technology
CuNi cladding/metallizing	NG	--	NG	Not Applicable to Hull Material	NG	--	NG	Not Applicable to Hull Material	NG	--	NG	Not Applicable to Hull Material	OK	NG	NG	Wt Impact Severe/Better Technologies	OK	NG	NG	Wt Impact Severe/Better Technologies
in-situ cleaning methods	OK	NG	NG	Technology Exist/Cheaper to Trailer	OK	NG	NG	Better Technology Exist	OK	NG	NG	Better Technology Exist	OK	NG	NG	Better Technology Exist	OK	NG	NG	Better Technology Exist
hull treatments	OK	NG	NG	Expensive/Many RIBs out of the water	OK	OK	62,416	11 years	OK	OK	41,848	4.1 years	OK	OK	337,700	1.2 years	OK	OK	597,138	8.5 months
PROPULSOR																				
Types	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
conventional	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
better design (large dia., slow turning, min BAR, wake adapted)	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable
propeller maintenance and inspection	OK	OK	36,384	1.6 years	OK	OK	40,803	7.8 years	OK	OK	19,641	2.7 years	OK	OK	321,174	2.2 years	OK	OK	649,936	2.0 years
in-situ cleaning	OK	NG	NG	Technique Currently Employed	OK	OK	5,105	4.0 years	OK	OK	2,448	1.4 years	OK	OK	40,147	6 months	OK	OK	81,242	5 months
wake equalizing ducts (WED)	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High
Grothues spoilers	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High
streamlined struts and skegs	OK	NG	NG	Technique Currently Employed	OK	NG	NG	Possibly Re-evaluate Flow around Skeg	OK	NG	NG	Possibly Re-evaluate Flow around Skeg	OK	NG	NG	Possibly Re-evaluate Flow around Skeg	OK	NG	NG	Possibly Re-evaluate Flow around Skeg
improved controllable pitch propeller (CCP) pitch schedules	NG	--	NG	Fixed Pitch Props	NG	--	NG	Fixed Pitch Props	NG	--	NG	Fixed Pitch Props	NG	--	NG	FFP, Adequate Room for CPP Gears	NG	--	NG	FFP, Adequate Room for CPP Gears
twin screw: inboard vs. outboard turning	NG	--	NG	Cannot Alter Direction on Outboard	NG	--	NG	Increase gained from Fin - see below	NG	--	NG	Increase gained from Fin - see below	NG	--	NG	Increase gained from Fin-see below	NG	--	NG	Increase gained from Fin-see below
speed dependent	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Kor t nozzles	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High
waterjets	NG	--	NG	Major Hull Modification	NG	--	NG	Major Hull Modification	NG	--	NG	Major Hull Mods/Vessel Speed too Low	NG	--	NG	Maj Hull Mods/Vessel Speed too Low	NG	--	NG	Major Hull Mods/Vessel Speed too Low
hybrid propulsion (waterjets and propellers)	NG	--	NG	Major Hull Modification	NG	--	NG	Major Hull Modification	NG	--	NG	Major Hull Modification	NG	--	NG	Major Hull Modification	NG	--	NG	Major Hull Modification
surface piercing	NG	--	NG	Outboards	NG	--	NG	Vessel Speed too Low	NG	--	NG	Vessel Speed too Low	NG	--	NG	Vessel Speed too Low	NG	--	NG	Vessel Speed too Low
super-cavitating	NG	--	NG	Outboards	NG	--	NG	Vessel Speed too Low	NG	--	NG	Vessel Speed too Low	NG	--	NG	Vessel Speed too Low	NG	--	NG	Vessel Speed too Low
anti-swirl	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
contra-rotating	OK	NG	NG	Outboard Manufacturer Dependent	OK	NG	NG	Complex Shafting	OK	NG	NG	Complex Shafting	OK	NG	NG	Complex Shafting	OK	NG	NG	Complex Shafting
pre- and post-swirl vanes	NG	--	NG	No pre swirl on Outboard	OK	NG	NG	Based onSedat/Purcell/ Hervey	OK	NG	NG	Based on Sedat/Purcell/ Hervey	OK	NG	NG	% at high speed too low	OK	NG	NG	% at high speed too low
propeller boss cap fins (PBCF)	NG	--	NG	No boss cap on outboards	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High
Grim vane wheels	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High
azimuthing drives	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
electric podded drives vs. mechanically driven z-drives	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
"pullers" vs. "pushers"	NG	--	NG	Outboards	NG	--	NG	Major Modification	NG	--	NG	Major Modification	NG	--	NG	Major Modification	NG	--	NG	Major Modification
contra-rotating (e.g. Schottel)	NG	--	NG	Outboards	NG	--	NG	Major Modification	NG	--	NG	Major Modification	NG	--	NG	Major Modification	NG	--	NG	Major Modification
anti-swirl fins	NG	--	NG	Outboards	NG	--	NG	Major Modification	NG	--	NG	Major Modification	NG	--	NG	Major Modification	NG	--	NG	Major Modification
other	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
tandem	OK	NG	NG	Higher Eff using Contra-Rotating	OK	NG	NG	Higher Eff using Contra-Rotating	OK	NG	NG	Higher Eff using Contra-Rotating	OK	NG	NG	Higher Eff using Contra-Rotating	OK	NG	NG	Higher Eff using Contra-Rotating
overlapping twin screws	NG	--	NG	Outboards	NG	--	NG	Shafts Far Apart-Major Mod	NG	--	NG	Shafts Far Apart-Major Mod	NG	--	NG	Shafts Far Apart-Major Mod	NG	--	NG	Shafts Far Apart-Major Mod
CLT, TVF Kappel propeller	NG	--	NG	Unproven in this size	NG	--	NG	Unproven in this size	NG	--	NG	Unproven at this size	OK	OK	321,174	9.4 years	OK	OK	1,273,900	3.9 years
ring propeller	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High	NG	--	NG	Vessel Speed too High
Smoothness	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
in-situ polishing	OK	NG	NG	Technique Currently Employed	OK	NG	NG	Technology Exists	OK	NG	NG	Technology Exist	OK	NG	NG	Technology Exist	OK	NG	NG	Technology Exists
cu-ni metallizing	NG	--	NG	N/A to Prop Material	NG	--	NG	Not Necessary	NG	--	NG	Not Necessary	NG	--	NG	Not Necessary	NG	--	NG	Not Necessary

Table 2b. Fuel Saving Technology Matrix (2 of 2)

	Technically Applicable/Feasible	Cost Benefit	Annual Savings ($)	Comments/Period of Payback	Technically Applicable/Feasible	Cost Benefit	Annual Savings ($)	Comments/Period of Payback	Technically Applicable/Feasible	Cost Benefit	Annual Savings ($)	Comments/Period of Payback	Technically Applicable/Feasible	Cost Benefit	Annual Savings ($)	Comments/Period of Payback	Technically Applicable/Feasible	Cost Benefit	Annual Savings ($)	Comments/Period of Payback
Alternatives	RIBs				41'UTB				47'MLB				87'WPB				110'WPB			
APPENDAGES																				
fin between shafts on twin screws ships	NG	--	NG	Outboards	OK	OK	25527	5..9 years	NG	--	NG	Missin prohibits installation	OK	OK	100350	2.5 years	OK	OK	406210	1.2 years
Rudder	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
rudder-roll stabilization	NG	--	NG	No Rudder on Outboards	NG	--	NG	Non-fuel savings issue	NG	--	NG	Non-fuel savings issue	NG	--	NG	Non-fuel savings issue	OK	NG	NG	Adequate Room – Remove Stab Fins
Wartsila propac rudder	NG	--	NG	No Rudder on Outboards	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable
twisted rudder	NG	--	NG	No rudders on Outboards	NG	--	NG	Marginal Benefits	NG	--	NG	Marginal Benefits	NG	--	NG	Marginal Benefits	NG	--	NG	Marginal Benefits
asymmetric rudders	NG	--	NG	No rudders on Outboards	NG	--	NG	Marginal Benefits	NG	--	NG	Marginal Benefits	NG	--	NG	Marginal Benefits	NG	--	NG	Marginal Benefits
MAIN PROPULSION MACHINERY																				
Main Propulsion Selection	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
diesel vs. turbines vs. steam vs. electric drives	NG	--	NG	Not feasible	OK	NG	NG	GT Feasible, but Not Worth it	OK	NG	NG	GT Feasible, but Not Worth it	OK	NG	NG	GT Feasible, but Not Worth it	OK	NG	NG	GT Feasible, but Not Worth it
Diesels	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
electronic controls	OK	OK	407614	Combined as Advanced Outboard Technology – 6.0 years	OK	OK	102108	Combined as Advanced Diesel Technology – 63 years	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	OK	OK	1624840	Combine Retrofit – 8 years
multi-port injectors									NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	NG	--	NG	Class Dependent
common rain injector systems									NG	--	NG	Marginal Benefits	NG	--	NG	Marginal Benefits	NG	--	NG	Class Dependent
improved cylinder head shapes									NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	OK	OK	1624840	Combined Retrofit 8 years
Increased pressure/temperature ceramics, new alloys)									NG	--	NG	Marginal Benefits	NG	--	NG	Marginal Benefits	OK	OK	1624840	Combined Retrofit 8 years
plant monitoring, tuning and condition-based maintenance									NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed
onboard fuel meters									NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	OK	NG	NG	Minimal Benefit
fuel additives	OK	OK	54348	5 months	OK	OK	51064	5 months	OK	OK	24551	5 months	OK	OK	200735	1.3 years	OK	OK	796186	5 months
lube oil additives	OK	NG	NG	Unproven Technology	OK	NG	NG	Unproven Technology	OK	NG	NG	Unproven Technology	OK	NG	NG	Unproven Technology	OK	NG	NG	Unproven Technology
synthetic lube oils	OK	NG	NG	Unproven Technology	OK	NG	NG	Unproven Technology	OK	NG	NG	Unproven Technology	OK	NG	NG	Unproven Technology	OK	NG	NG	Unproven Technology
alternative fuels (HFO,CNG,LNG, emuisions, duel fuel, Syngas	NG	--	NG	Not Applicable to Outboards	OK	NG	NG	Logistical Issues	OK	NG	NG	Logistical Issues	OK	NG	NG	Logistical Issues	OK	NG	NG	Logistical Issues
turbocharger retrofits	NG	--	NG	Not Applicable to Outboards	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed
Turbines	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ceramics	NG	--	NG	Not Applicable to Outboards	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable
steam bottoming cycle with gas turbine (STAG)	NG	--	NG	Not Applicable to Outboards	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable
intercooled recuperative (ICR)	NG	--	NG	Not Applicable to Outboards	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable
Electric	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
turbo- vs. diesel- vs. fuel cell-electric	NG	--	NG	Not Applicable to Outboards	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable
AC vs. DC	NG	--	NG	Not Applicable to Outboards	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable
superconducting/cryogenics	NG	--	NG	Not Applicable to Outboards	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable
Transmissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
two-speed transmissions	NG	--	NG	Not Applicable to Outboards	NG	--	NG	Major Modifications	NG	--	NG	Major Modifications	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed
AUXILIARY MACHINERY																				
waste heat recovery system	NG	--	NG	Not Applicable to Outboards	OK	NG	NG	Minimal Benefit	OK	NG	NG	Minimal Benefit	OK	NG	NG	Minimal Benefit offset by Retrofit Cost	OK	NG	NG	Minimal Benefit offset by Retrofit Cost
variable speed electric motors	NG	--	NG	Not Applicable to Outboards	NG	--	NG	Not Applicable	OK	NG	NG	Not Applicable	OK	NG	NG	Minimal Benefit	OK	NG	NG	Minimal Benefit
AC vs. DC motors	NG	--	NG	Not Applicable to Outboards	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	OK	NG	NG	Minimal Benefit	OK	NG	NG	Minimal Benefit
energy efficient lighting (halogen, fluorescent, sodium vapor)	NG	--	NG	Not Applicable to Outboards	OK	NG	NG	Minimal Benefit	OK	NG	NG	Minimal Benefit	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed
energy efficient stoves, refrig, heaters, AC, etc.	NG	--	NG	Not Applicable to Outboards	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed
high efficiency pumps	NG	--	NG	Not Applicable to Outboards	OK	NG	NG	Not Applicable	OK	NG	NG	Not Applicable	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed
reverse osmosis vs. evaporators	NG	--	NG	Not Applicable to Outboards	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Reverse Osmosis	NG	--	NG	Reverse Osmosis
central FW/SW cooling systems	NG	--	NG	Not Applicable to Outboards	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed
sludge/waste oil disposal systems	NG	--	NG	Not Applicable to Outboards	OK	OK	51054	19 years	OK	OK	19618	8.8 years	OK	OK	160585	4.7 years	OK	OK	812420	1.2 years
OPERATIONAL & ADMINISTRATIVE																				
reduced speed operations	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed
course keeping autopilot	OK	NG	NG	Mission Specific	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed
optimum transit speed	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed	NG	--	NG	Currently Employed
use of maximum pitch (without excessive engine loading)	NG	--	NG	Not Applicable to Outboards	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable	NG	--	NG	Not Applicable
energy incentive program	OK	NG	NG	Unrealistic	OK	NG	NG	Unrealistic	OK	NG	NG	Unrealistic	OK	NG	NG	Unrealistic	OK	NG	NG	Unrealistic
review of tactics	OK	NG	NG	Not Applicable to RIB Missions	OK	NG	NG	Not Applicable to 41'UTB Missions	OK	NG	NG	Not Applicable to 47'MLB Missions	OK	OK	OK	Operator Survey	OK	OK	OK	Operator Survey
rationalized total cost accounting	OK	OK	OK	Qualitative	OK	OK	OK	Qualitative	OK	OK	OK	Qualitative	OK	OK	OK	Qualitative	OK	OK	OK	Qualitative

= Indicates ROM Cost Benefit was performed