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AN ENERGY STUDY OF SHIP- TRANSPORTATION SYSTEMS

**A PROGRESS BRIEFING BY
BOOZ, ALLEN TRANSPORTATION
CONSULTING DIVISION**

FOR

U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

U.S. MARITIME ADMINISTRATION

U.S. NAVY

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February 2, 1977

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STUDY OBJECTIVES

- 1. DEVELOP A MARINE INDUSTRY PROFILE IN TERMS OF EQUIPMENT, OPERATING CHARACTERISTICS, ENERGY CONSUMPTION, COSTS AND DEVELOP PERFORMANCE MEASUREMENTS IN TERMS OF TON-MILES PER BTU OR OPERATING HOURS PER BTU FOR EACH INDUSTRY SECTOR IDENTIFIED.**
- 2. IDENTIFY THE ROLE OF ALL GOVERNMENT AND QUASI-GOVERNMENT AGENCIES THAT IMPACT THE MARINE INDUSTRY, PROJECTING CHANGES IN THE REGULATORY STRUCTURE. EVALUATE THE ENERGY USE IMPACT OF THESE EXISTING AND PROPOSED REGULATIONS.**
- 3. IDENTIFY EXISTING AND EXPECTED R&D PROGRAMS IN THOSE AREAS THAT IMPACT THE MARINE INDUSTRY AND FUEL CONSUMPTION. EVALUATE THE MARKET FOR NEW TECHNOLOGIES AND THE EXPECTED ENERGY IMPACT OF THE MORE PROMINENT TECHNOLOGIES. ESTIMATE THE COST OF THESE R&D PROGRAMS TOGETHER WITH THE COST OF IMPLEMENTING THE NEW TECHNOLOGY.**
- 4. EVALUATE ALTERNATIVE INDUSTRY FUTURES IN THE OPERATIONAL, REGULATORY AND TECHNOLOGICAL AREAS TO DETERMINE THE OVERALL ENERGY IMPACT OF EACH LIKELY COMBINATION.**

SUMMARY OF THE ENERGY CONSUMED FOR TRANSPORTATION SERVICES

Sector	Energy Consumed (Quads)	Percent of Total Energy Consumed
Highway	12.91	66
Air	1.92	10
Pipeline	1.15	6
Rail	0.57	3
Marine	2.95	15
Total	19.50	100

Source: Marine consumption represents estimates provided by Booz, Allen & Hamilton. All other estimates are provided by the Energy Research and Development Administration.

SUMMARY OF THE ENERGY CONSUMPTION AND PRODUCTIVITY OF THE MARINE TRANSPORTATION INDUSTRY

Sector	Population	Long Tons of Cargo Moved (Millions)	Energy Consumed (quads)	Percent of Total Energy Consumed
Ocean	4,800	654.9	2.360	80.0
Great Lakes	690	175.3	0.052	1.8
Inland Waterways	2,400	535.8	0.009	3.0
Coastal	1,930	213.0	0.112	4.0
Offshore	620	—	0.064	2.2
Pleasure Craft	7,400,000	—	0.241	8.2
Fishing & Misc.	90,300	—	0.032	0.8
Total	7,500,740	1,579	2.950	100.0

SUMMARY OF THE ENERGY REQUIREMENTS OF THE OCEAN SHIPPING SECTOR

Service Type	Energy Requirements (Quads)	Percent of Total
Liner	0.53	22
Tramp	1.08	46
Dry Bulk	0.33	14
Tankers	0.33	14
Passenger	0.08	4
Total	2.36	100

ENERGY CONSUMED IN THE OCEAN SECTOR BY FLAG

Flag	Population	Millions of Tons Carried	Billions of Ton-Miles	Btus in Quads	Btus/ Ton-Mile
U.S.	340	45.0	260.1	.215	827
Foreign	4,434	610.0	3,467.4	2.145	619
Total	4,774	655.0	3,727.5	2.360	633

OCEAN SHIPPING FUEL REQUIREMENTS BY POINT OF PURCHASE *

Vessels	Point of Purchase			
	United States		Overseas	
	Quads	Percentage	Quads	Percentage
U.S.	.090	43%	.125	57%
Foreign Flag	.350	16%	1.795	84%
All Vessels	.440	20%	1.920	80%

* Based on "Bunker Fuels" published U.S. Department of Commerce, Bureau of Census.

MODEL OUTPUTS

- **SINGLE VESSEL PERFORMANCE, ANNUAL BASIS**
 - **FUEL CONSUMPTION PROFILE**
 - **COST CHARACTERISTICS**
- **SINGLE VESSEL LIFE CYCLE COST PERFORMANCE**
- **ANNUAL FUEL CONSUMPTION PROFILES FOR EACH INDUSTRY SECTOR**

LOGIC FLOWCHART

COST ANALYSIS APPROACH

- **SINGLE VOYAGE COSTS**
 - **VESSEL OPERATING COSTS**
 - **FUEL COSTS**
 - **PORT DUES AND CHARGES**
 - **CARGO HANDLING COSTS**
- **CAPITALIZATION SCHEME**
 - **OUTRIGHT PURCHASE**
 - **TITLE 11 FINANCING**
 - **LEASE**

FUEL CONSUMPTION METHODOLOGY

FUEL CONSUMPTION PER VOYAGE BASED ON:

- TYPE OF POWER PLANT
- FUEL RATE AT DESIGN SPEED
- SHAFT HORSEPOWER
- FUEL RATE IN PORT

ADJUSTMENTS TO NOMINAL FUEL CONSUMPTION BASED ON:

- OPERATION AT LESS THAN DESIGN SPEED
- ACTUAL CARGO LOADING
- CHANGE IN SERVICE CHARACTERISTICS

LIFE CYCLE COST METHODOLOGY

TASK II - POTENTIAL CASE STUDIES

	CONSTRUCTION ASPECTS						OPERATIONAL ASPECTS									
	PROPULSION MACHINERY	HULL	HABITABILITY	ENVIRONMENTAL AND SAFETY	MANNING AND LICENSING	FINANCIAL ASSISTANCE	ITINERARY	ENTRY RESTRICTIONS	TARIFF REVIEW AND FILING	MONOPOLY CONTROL	FINANCIAL ASSISTANCE	CARGO ALLOCATION	FUEL PRICES AND AVAILABILITY	TRAFFIC CONTROL	MAINTENANCE AND REPAIR STANDARDS AND FREQUENCIES	ENVIRONMENTAL DISCHARGE ASPECTS PREVENTION, CLEAN UP
1. U.S. COAST GUARD	•	•	•	⊙	•									⊙	•	•
2. FEDERAL ENERGY ADMIN.													⊙			
3. MARITIME ADMINISTRATION	•	•	•	•		•	⊙		•		•	⊙			•	
4. FEDERAL MARITIME COMMISSION							⊙	•	•	⊙						
5. CLASSIFICATION SOCIETIES	•	•	•	•	•										•	
6. ENVIRONMENTAL PROTECTION AGENCY				•												•
7. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION				•												
8. INTERSTATE COMMERCE COMMISSION				•			⊙	•	•	⊙						
9. ST. LAWRENCE SEAWAY DEVELOPMENT CORP.				•										⊙		
10. PANAMA CANAL CORP.		•		•										⊙		
11. DEPT. OF STATE												⊙				
12. DEPT. OF AGRICULTURE												⊙				
13. DEPT. OF DEFENSE	•	•			•							⊙				
14. EX-IM BANK												⊙				
15. STATE GOVERNMENTS				⊙												⊙
16. ARMY CORPS OF ENGINEERS													⊙			

• JURISDICTION EXPIRES WITH INDIVIDUAL ODS
CONTRACTS OVER THE NEXT TWO YEARS

TASK II - CASE STUDIES SELECTED

	CONSTRUCTION ASPECTS						OPERATIONAL ASPECTS							
				ENVIRONMENTAL AND SAFETY			ITINERARY			MONOPOLY CONTROL		FUEL PRICES AND AVAILABILITY	TRAFFIC CONTROL	ENVIRONMENTAL DISCHARGE ASPECTS PREVENTION CLEAN UP
1. U.S. COAST GUARD				●								●		
2. FEDERAL ENERGY ADMIN.							●							
3. MARITIME ADMINISTRATION							●							
4. FEDERAL MARITIME COMMISSION							●		●					
15. STATE GOVERNMENTS				●										●
16. ARMY CORPS OF ENGINEERS												●		

TASK II - CASE STUDIES

	<u>% COMPLETE</u>
● STATE OF WASHINGTON – PUGET SOUND TANKER REGULATIONS	100%
● TRANSPORTATION REQUIREMENT FOR WEST COAST CRUDE OIL SURPLUS	100%
● BACKFITTING OF SEGREGATED BALLAST ON TANKERS	100%
● THE AVAILABILITY OF MINI BRIDGE SERVICES	100%
● CARGO POOLING/LINER SERVICE RATIONALIZATION	100%
● REQUIRED PORT CALLS FOR ODS	80%
● LOCK AND DAM 26 – INLAND WATERWAYS	80%
● INLAND WATERWAY USER CHARGES	80%

TASK II

CASE 1 - STATE OF WASHINGTON—PUGET SOUND TANKER REGULATIONS

	1980	1980
	16,580,000 L.TONS OF CRUDE SHIPPED THROUGH PUGET SOUND PER YEAR W/O NORTHERN TIER PIPELINE	45,928,000 L. TONS OF CRUDE SHIPPED THROUGH PUGET SOUND PER YEAR WITH NORTHERN TIER PIPELINE
INCREASE DUE TO TUG ESCORT	0.037×10^{12} BTUs	0.108×10^{12} BTUs
INCREASE DUE TO TANKER SIZE RESTRICTION	0.250×10^{12} BTUs	1.040×10^{12} BTUs
TOTAL	$.287 \times 10^{12}$ BTUs	1.148×10^{12} BTUs

TASK II
CASE 2 - TRANSPORTATION REQUIREMENTS FOR
WEST COAST CRUDE OIL SURPLUS

OPTION	TRANSPORTATION ENERGY REQUIREMENT
OPTION 1: SHIP SURPLUS CRUDE TO JAPAN IN EXCHANGE FOR ARABIAN GULF CRUDE ON U.S. GULF COAST	0.136 QUADS
OPTION 2: SHIP SURPLUS TO LONG BEACH THEN BY PIPELINE TO GULF COAST	0.057 QUADS
OPTION 3: SHIP SURPLUS TO PUGET SOUND THEN BY PIPELINE TO NORTHERN TIER STATES	0.005 QUADS*
OPTION 4: SHIP SURPLUS TO GULF COAST BY WAY OF PANAMA CANAL	0.070 QUADS

*DESTINATION IS DIFFERENT THAN OTHER OPTIONS

TASK II

CASE 3 - BACKFITTING SEGREGATED BALLAST ON TANKERS

OPERATING POWER LEVEL	OPERATING SPEED	IMPACT ON TANKER ENERGY CONSUMPTION
100%	104%	+20%
90%	101%	+10%
80%	97%	+ 3%
70%	92%	- 5%

TASK II

CASE 4 - THE AVAILABILITY OF MINI-BRIDGE SERVICES

OPTION	MODE	STATUTE MILES	TON-MILE	ENERGY REQUIRED (BTUs X 10 ¹²)	INCREASE OVER MINI-BRIDGE
MINI-BRIDGE	RAIL/WATER	8654	655 (RAIL) 720 (WATER)	4.82	—
ALL WATER (INDIRECT)	WATER	11249	720	6.48	34%
ALL WATER (DIRECT)	WATER	11169	720	6.43	33%

TASK II

CASE 5 - CARGO POOLING/LINER SERVICE RATIONALIZATION

(CONTAINER CARGO)

TRADE ROUTE	NUMBER OF CONTAINERS ON THE TRADE IN 1974	CONTAINER-MILES (MILLIONS)	ESTIMATED SAVINGS %	ESTIMATED SAVINGS (QUADS)
5, 7, 8, 9	463,000	1,852	40%	.0175
29	457,000	3,085	40%	.0291
12	164,000	1,927	40%	.0182
10	144,000	720	10%	.0017
16	65,000	780	10%	.0018
21	61,000	305	10%	.0007
26	67,000	536	10%	.0030
11	47,000	212	10%	.0005
4	43,000	108	10%	.0003
6	24,000	96	10%	.0002
ALL OTHERS	115,000	575	10%	.0013
TOTALS	1,650,000	10,196		.0743

TASK II

CASE 6 - REQUIRED PORT CALLS FOR ODS PARTIAL RESULTS FOR NON-CONTAINER LINER SERVICE

TRADE AREA	FLAG OF OPERATORS	AVERAGE VOYAGE LENGTH (DAYS)	NUMBER OF PORT CALLS
GULF COAST TO EUROPE	U.S. FOREIGN	36 68	7 17
GULF COAST TO MEDITERRANEAN	U.S. FOREIGN	82 85	13 12
GULF COAST TO FAR EAST	U.S. FOREIGN	120 125	12 16

TASK II

CASE 7 - LOCK AND DAM 26 INLAND WATERWAYS

INCREASED TOWBOAT ENERGY CONSUMPTION
DUE TO DELAYS AT LOCK AND DAM 26
IN BTUs ($\times 10^{12}$)

DELAY (HOURS)	ANNUAL VOLUME	
	50 MILLION TONS	60 MILLION TONS
5	.053	.062
10	.107	.124
15	.161	.186
20	.215	.248
25	.268	.310

TASK II

CASE 8 - INLAND WATERWAY USER CHARGES POTENTIAL IMPACTS BY COMMODITY

COMMODITY	IMPACTS
COAL	<ul style="list-style-type: none">- ADVERSE EFFECT ON SOUTHERN ILLINOIS COAL FLOWING TO ILLINOIS, WISCONSIN AND MINNESOTA UTILITIES; POTENTIAL FOR SWITCH IN SOURCE OF SUPPLY TO WESTERN COAL- POTENTIAL FOR MODAL DIVERSION OR ALTERNATIVE SUPPLY SOURCES FOR UTILITIES ON THE WARRIOR RIVER- POTENTIAL IMPACT ON THE RELATIVE COMPETITIVENESS OF GULF VS. EAST COAST COAL EXPORT PORTS
PETROLEUM	<ul style="list-style-type: none">- POTENTIAL FOR MODAL SHIFTS TO PIPELINES
STEEL	<ul style="list-style-type: none">- NO IMPACTS ON STEEL ORIGINATED IN THE PITTSBURGH/MONONGAHELA AREA, OTHER AREAS TO BE INVESTIGATED
GRAINS	<ul style="list-style-type: none">- LIKELY MODAL SHIFT TO RAIL FOR GRAINS ORIGINATING IN UPPER MISSISSIPPI AND UPPER MISSOURI REGION - POSSIBLE DIVERSION OF EXPORTS FROM NEW ORLEANS TO SEATTLE OR OTHER GULF COAST PORTS
FERTILIZER	<ul style="list-style-type: none">- POSSIBLE MODAL DIVERSIONS OF PHOSPHATE TO RAIL AND NITROGEN TO PIPELINE
CONSTRUCTION AGGREGATES	<ul style="list-style-type: none">- POTENTIAL MODAL DIVERSIONS ON THE KENTUCKY RIVER TO TRUCK AND ILLINOIS RIVER TO TRUCK OR RAIL

TASK II

SUMMARY OF IMPACTS

	IMPACT IN BTUs
CASE 1 - STATE OF WASHINGTON, PUGET SOUND TANKER REGULATIONS	+ .287 X 10 ¹²
CASE 2 - TRANSPORTATION ALTERNATIVES FOR WEST COAST CRUDE OIL SURPLUS	+52.0 X 10 ¹²
CASE 3 - BACKFITTING OF SEGREGATED BALLAST ON ALL TANKERS	-0-
CASE 4 - THE AVAILABILITY OF MINIBRIDGE SERVICE	+ 1.61 X 10 ¹²
CASE 5 - CARGO POOLING/LINER SERVICE RATIONALIZATION	+74.3 X 10 ¹²
CASE 6 - REQUIRED PORT CALLS FOR ODS	-0-
CASE 7 - LOCK AND DAM 26 - INLAND WATERWAYS	+ .115 X 10 ¹²
CASE 8 - INLAND WATERWAY USER CHARGE	UNKNOWN

TASK III

APPROACH TO ANALYSIS OF ENERGY CONSERVATION RESEARCH AND DEVELOPMENT

- **WILL COMBINE BOTH QUALITATIVE AND QUANTITATIVE ANALYSIS**
 - **QUANTITATIVE BENEFIT ASSESSMENT**
 - **QUANTITATIVE COST ASSESSMENT**
 - **QUALITATIVE RISK ANALYSIS**
- **METHODOLOGY TO BE USED FOR DATA GATHERING WILL BE HEAVILY WEIGHTED TOWARDS INTERVIEWS**
 - **GOVERNMENTAL AGENCIES**
 - **COMPONENT MANUFACTURER**
 - **CHAIRMAN OF SNAME TECHNICAL COMMITTEES**

TASK III

ITEMS TO BE CONSIDERED IN THE EVALUATION OF CONSERVATION RESEARCH AND DEVELOPMENT

- **POTENTIAL FOR ENERGY SAVINGS**
 - NEAR TERM
 - LONG TERM
- **PROJECT'S CURRENT PRIORITY**
 - LEVEL OF PROJECT MANAGER
 - CONTINUITY OF FUNDING
- **LEVEL OF FUNDING**
 - PRESENT
 - ANTICIPATED VS. REQUIRED
 - COST TO COMPLETE
- **CATEGORY OF RESEARCH**
 - EXPLORATORY
 - DEVELOPMENT
 - PROTOTYPE
 - HARDWARE
- **INVOLVEMENT OF ULTIMATE USER**
 - GOVERNMENTAL AGENCY
 - MANUFACTURER
 - CONSUMER
- **SCHEDULE**
 - LENGTH OF PROJECT
 - PERCENT COMPLETION
 - COMPLETED INTERIM MILESTONES
- **UNSOLVED TECHNICAL PROBLEMS**
 - CRITICALITY OF PROBLEMS
 - NUMBER AND INTERRELATIONSHIPS
- **PROJECT MANAGER'S EVALUATION**
 - RISK
 - POTENTIAL
 - PRIORITY ASSIGNED BY MANAGEMENT

MARITIME MARKET FOR BOTTOM-CYCLE APPLICATIONS

COMMERCIAL FLEET

<div> <div>HORSEPOWER RANGE</div> <div>TYPE</div> </div>	800- 1000	1001- 2000	2001- 3000	3001- 4000	4001- 5000	5001- 6000	6001- 7000	7001- 8000	8001- 9000	9001- 10000	10001 & UP	TOTAL
TOWING VESSELS	631	1074	272	219	116	53	32	5	15		8	2425
OFFSHORE WORKBOATS	152	445	112	35	9	9	2	9			1	774
CARGO VESSELS	21	58	18	15	8	6	3	4	1		9	143
FISHING VESSELS	144	149	31	54	2	2						382
PASS./FERRY	133	162	16	9		3	3	7			1	334
MISC. SERVICE CRAFT	14	19	3									36
YACHTS	401	213	7	1	1							623
TOTAL	1496	2120	459	333	136	73	40	25	16		19	4717

1985 MARITIME MARKET FOR BOTTOM-CYCLE APPLICATIONS

COMMERCIAL FLEET

HORSEPOWER RANGE TYPE	800- 1,000	1,001- 2,000	2,001- 3,000	3,001- 4,000	4,001- 5,000	5,001- 6,000	6,001- 7,000	7,001- 8,000	8,001- 9,000	9,001- 10,000	10,000+	TOTAL
TOWING	593	1,048	320	222	122	57	33	6	16	1	8	2,426
OFFSHORE	292	859	218	68	16	16	4	16			2	1,491
CARGO	21	58	18	16	8	6	3	4	1		27	162
FISHING	144	149	31	54	2	2						382
PASS/FERRY	133	163	18	9		3	3	7			1	337
MISC SERVICE	14	19	4									37
YACHTS	401	213	7	1	1							623
TOTAL	1,598	2,509	616	370	149	84	43	33	17	1	38	5,458

MARITIME MARKET FOR BOTTOM-CYCLE APPLICATIONS **SUMMARY**

<div> <div></div> <div>HORSEPOWER RANGE</div> <div>SECTOR</div> </div>	800-1000	1001-2000	2001-3000	3001-4000	4001-5000	5001-6000	6001-7000	7001-8000	8001-9000	9001-10000	10001+	TOTAL
NOAA	7	5	4	1	2							19
U.S.C.G.	16	100	30		15				1	4	3	169
U.S. NAVY	62	106	71	6		6	17			8	40	316
COMMERCIAL	1496	2120	459	333	136	73	40	25	16	19	19	4717
TOTAL	1581	2331	564	340	153	79	57	25	17	12	62	5221

1985 MARITIME MARKET FOR BOTTOM-CYCLE APPLICATIONS

SUMMARY

<div> <div>HORSEPOWER RANGE</div> <div>SECTOR</div> </div>	800- 1000	1001- 2000	2001- 3000	3001- 4000	4001- 5000	5001- 6000	6001- 7000	7001- 8000	8001- 9000	9001- 10000	+10001	TOTAL
NOAA	7	7	4	1	2							21
USCG	3	100	43				39		1	9	3	198
U.S. NAVY	62	108	61	6	25	6	17			8	42	335
COMMERCIAL	1,598	2,509	616	370	149	84	43	33	17	1	38	5,458
TOTAL	1,670	2,724	724	377	176	90	99	33	18	18	83	6,012

SUMMARY

MARITIME MARKET FOR BOTTOM-CYCLE APPLICATIONS

FULL LOAD FUEL COMSUMPTION CHARACTERISTICS OF MARINE DIESEL ENGINES (800 HP AND ABOVE)

COMPARISON OF DIESEL-MARINE VESSEL OPERATING FACTOR

(CRAFT WITH 800 BHP AND ABOVE)

TYPE OF CRAFT	DUTY CYCLE % POWER	HORSEPOWER (AVG.)	EQUIVALENT NO. OF 8-HR. OPERATING DAYS/YEAR	SPECIFIC OPERATING FACTOR % POWER/YEAR/1,000 HP
"SEALIFT" TANKER	70	14,000	750	7,300
AMPHIBIOUS WARFARE	60	16,000	214	2,060
CARGO SHIP	80	3,100	780	1,930
RIVER PUSH/TOW BOAT	75	2,000	1,032	1,500
OCEAN TUG	75	2,600	625	1,220
OFF-SHORE WORK BOAT	55	1,700	900	842
PASSENGER/CAR FERRY	70	1,500	690	725
FISHING BOAT	50	1,700	610	520
FLEET SUPPORT	70	4,400	166	510
RESEARCH SHIP	40	2,100	200	168
HARBOR TUG	30	1,300	250	97
PLEASURE YACHT	46	1,000	12	5.52

SHIP CHARACTERISTICS

TYPE	CONTAINER	US FLAG
DWT	16500.	LONG TONS
HORSEPOWER	17000.	
TYPE OF POWER	STEAM	
DESIGN SPEED	20.0	KNOTS
FUEL CONSUMPTION		
AT DESIGN SPEED	86.	LTON/DAY
IN PORT	11.	LTON/DAY

SERVICE CHARACTERISTICS

SERVICE	TR 5789 N.ATL/W.EUR+RAL
SPEED, KNOTS	20.0
ROUND TRIP TIME, DAYS	21.7
AT SEA	16.7
IN PORT	5.0
AVERAGE DISTANCE, N MI	8000.
CARGO PER HAUL, LT	14850.

SUMMARY FOR ONE VOYAGE

FUEL CONSUMED, L TONS	
AT SEA	1427.
IN PORT	56.
TOTAL	1483. (61462.369 MRTU)

COST SUMMARY

VESSEL COSTS	200084.	
PORT COSTS	250.	
CARGO COSTS	83160.	
TOTAL DIRECT COST		283494.
GEN + ADMIN	70873.	
TOTAL OPERATING COST		354367.

CAPITALIZATION SCHEME

METHOD

FULL CAPITAL COST 9070000.

INITIAL INVESTMENT 1814000.

DEBT SERVICE/LFASE PMT 739040.

ANNUAL INTEREST RATE .080

CORPORATE TAX RATE .48

TITLE XI

OPERATING COSTS

YEAR	WAGES	SUBSIST	M+R	INSUR	FUEL(SEA)	FUEL(PORT)	PORT DUES	CARGO COST	TOT DIRECT	G+A	DEBT SRV	AN OP COST
1	21099.	6625.	4991.	15516.	1926878.	75538.	3808.	1266591.	3321045.	830261.	739040.	4890346.
2	21521.	6758.	5090.	15826.	1965415.	77048.	3884.	1291923.	3387466.	846867.	739040.	4973372.
3	21952.	6893.	5192.	16143.	2004724.	78589.	3962.	1317761.	3455216.	863804.	739040.	5058059.
4	22391.	7031.	5296.	16466.	2044818.	80161.	4041.	1344116.	3524320.	881080.	739040.	5144440.
5	22839.	7172.	5402.	16795.	2085715.	81764.	4122.	1370999.	3594806.	898702.	739040.	5232548.
6	23295.	7315.	5510.	17131.	2127429.	83400.	4204.	1398419.	3666702.	916676.	739040.	5322418.
7	23761.	7461.	5620.	17474.	2169977.	85068.	4288.	1426387.	3740037.	935009.	739040.	5414085.
8	24237.	7610.	6224.	16553.	2031830.	79654.	4374.	1454915.	3625446.	906362.	739040.	5270848.
9	24721.	7763.	6349.	16384.	2072518.	81247.	4461.	1484013.	3697955.	924489.	739040.	5361484.
10	25216.	7918.	6476.	17222.	2113958.	82872.	4551.	1513693.	3771914.	942979.	739040.	5453977.
11	25720.	8076.	6605.	17566.	2156247.	84529.	4642.	1543967.	3847353.	961838.	739040.	5548231.
12	26234.	8238.	6737.	17917.	2199372.	86220.	4734.	1574846.	3924300.	981075.	739040.	5644414.
13	26759.	8403.	6872.	18276.	2243360.	87944.	4829.	1606343.	4002786.	1000696.	739040.	5742527.
14	27294.	8571.	7009.	18641.	2288227.	89703.	4926.	1638470.	4082842.	1020710.	739040.	5842592.
15	27840.	8742.	7149.	19014.	2333992.	91497.	5024.	1671240.	4164498.	1041125.	739040.	5944663.
16	28397.	8917.	7292.	19394.	2380671.	93327.	5125.	1704664.	4247788.	1061947.	739040.	6048775.
17	28965.	9095.	7438.	19782.	2428285.	95194.	5227.	1738758.	4332744.	1083186.	739040.	6154970.
18	29544.	9277.	7587.	20178.	2476851.	97098.	5332.	1773533.	4419399.	1104850.	739040.	6263288.
19	30135.	9463.	7739.	20581.	2526388.	99040.	5438.	1809004.	4507787.	1126947.	739040.	6373773.
20	30738.	9652.	7894.	20993.	2576915.	101021.	5547.	1845184.	4597943.	1149486.	739040.	6486468.

REQUIRED REVENUES

PRESENT VALUE OF INCOME STREAM

59794958.

AVERAGE/INITIAL ANNUAL REVENUE

4876656.

AVERAGE/INITIAL RFR

22.

ANNUAL CASH FLOW

YEAR	DIR OP COST	DEBT SRVC	TAXES	CAPITAL	CASH OUT	DEPREC	INTEREST	GR REVENUE	RFR NET REVENUE	NPV-NI RV
1	3321045.	739040.	-140143.	1814000.	4742204.	453500.	580480.	4876656.	22.	134452.
2	3387466.	739040.	-135091.	0.	4838282.	453500.	567795.	4974189.	22.	135907.
3	3455216.	739040.	-121412.	0.	4936647.	453500.	554096.	5073673.	22.	137026.
4	3524320.	739040.	-107066.	0.	5037374.	453500.	539300.	5175146.	23.	137773.
5	3594806.	739040.	-92006.	0.	5140541.	453500.	523321.	5278649.	23.	138108.
6	3666702.	739040.	-76185.	0.	5246232.	453500.	506064.	5384222.	24.	137990.
7	3740037.	739040.	-59551.	0.	5354534.	453500.	487425.	5491907.	24.	137372.
8	3625446.	739040.	53126.	500000.	5323973.	491962.	467296.	5601745.	25.	277771.
9	3697955.	739040.	73832.	0.	5435316.	491962.	445557.	5713780.	25.	278464.
10	3771914.	739040.	95579.	0.	5549511.	491962.	422078.	5828055.	26.	278544.
11	3847353.	739040.	118436.	0.	5666667.	491962.	396721.	5944616.	26.	277949.
12	3924300.	739040.	142481.	0.	5786896.	491962.	369336.	6063509.	27.	276613.
13	4002786.	739040.	167796.	0.	5910318.	491962.	339760.	6184779.	27.	274461.
14	4082842.	739040.	194469.	0.	6037061.	491962.	307817.	6308474.	28.	271414.
15	4164498.	739040.	222595.	0.	6167258.	491962.	273319.	6434644.	28.	267386.
16	4247788.	739040.	252277.	0.	6301053.	491962.	236062.	6563337.	29.	262284.
17	4332744.	739040.	283626.	0.	6438596.	491962.	195823.	6694603.	30.	256007.
18	4419399.	739040.	316761.	0.	6580050.	491962.	152366.	6828495.	30.	248446.
19	4507787.	739040.	351810.	0.	6725584.	491962.	105432.	6965065.	31.	239482.
20	4597943.	739040.	388912.	0.	6875380.	491962.	54744.	7104367.	31.	228987.

CAPITALIZATION SCHEME

METHOD

FULL CAPITAL COST
INITIAL INVESTMENT

DEBT SERVICE/LEASE PMT

ANNUAL INTEREST RATE

CORPORATE TAX RATE

LEASE

9070000.

0.

770950.

0.000

.48

OPERATING COSTS

YEAR	WAGES	SUBSIST	M+R	INSUR	FUEL (SEA)	FUEL (PORT)	PORT DUES	CARGO COST	TOT DIRECT	G+A	DEBT SERV	AN OP COST
1	21099.	6625.	4991.	15516.	1926878.	75538.	3808.	1266591.	3321045.	830261.	770950.	4922257.
2	21521.	6758.	5090.	15826.	1965415.	77048.	3884.	1291923.	3387466.	846867.	770950.	5005283.
3	21952.	6893.	5192.	16143.	2004724.	78589.	3962.	1317761.	3455216.	863804.	770950.	5089970.
4	22391.	7031.	5296.	16466.	2044818.	80161.	4041.	1344116.	3524320.	881080.	770950.	5176350.
5	22839.	7172.	5402.	16795.	2085715.	81764.	4122.	1370999.	3594806.	898702.	770950.	5264458.
6	23295.	7315.	5510.	17131.	2127429.	83400.	4204.	1398419.	3666702.	916676.	770950.	5354328.
7	23761.	7461.	5620.	17474.	2169977.	85068.	4288.	1426387.	3740037.	935009.	770950.	5445996.
8	24237.	7610.	6224.	16553.	2031880.	79654.	4374.	1454915.	3625446.	906362.	813450.	5345258.
9	24721.	7763.	6349.	16884.	2072518.	81247.	4461.	1484013.	3697955.	924489.	813450.	5435894.
10	25216.	7918.	6476.	17222.	2113958.	82872.	4551.	1513693.	3771914.	942979.	813450.	5528343.
11	25720.	8076.	6605.	17566.	2156247.	84529.	4642.	1543967.	3847353.	961838.	813450.	5622641.
12	26234.	8238.	6737.	17917.	2199372.	86220.	4734.	1574846.	3924300.	981075.	813450.	5718825.
13	26759.	8403.	6872.	18276.	2243360.	87944.	4829.	1606343.	4002786.	1000696.	813450.	5816932.
14	27294.	8571.	7009.	18541.	2288227.	89703.	4926.	1638470.	4082842.	1020710.	813450.	5917002.
15	27840.	8742.	7149.	19014.	2333992.	91497.	5024.	1671240.	4164498.	1041125.	813450.	6019073.
16	28397.	8917.	7292.	19394.	2380671.	93327.	5125.	1704664.	4247788.	1061947.	813450.	6123185.
17	28965.	9095.	7438.	19782.	2428285.	95194.	5227.	1738758.	4332744.	1083186.	813450.	6229380.
18	29544.	9277.	7587.	20178.	2476851.	97098.	5332.	1773533.	4419399.	1104850.	813450.	6337699.
19	30135.	9463.	7739.	20581.	2526388.	99040.	5438.	1809094.	4507787.	1126947.	813450.	6448184.
20	30738.	9652.	7894.	20993.	2576915.	101021.	5547.	1845184.	4597943.	1149486.	813450.	6560878.

REQUIRED REVENUES

PRESENT VALUE OF INCOME STREAM

63782289.

AVERAGE/INITIAL ANNUAL REVENUE

5201848.

AVERAGE/INITIAL RFR

23.

ANNUAL CASH FLOW

YEAR	DIR OP COST	DEBT SRVC	TAXES	CAPITAL	CASH OUT	DEPREC	INTEREST	GR REVENUE	RFR NET REVENUE	NPV-NI RV
1	3321045.	770950.	-2362683.	0.	2559574.	0.	0.	5201848.	23.	2642274.
2	3387466.	770950.	-2402536.	0.	2602747.	0.	0.	5305885.	23.	2703138.
3	3455216.	770950.	-2443185.	0.	2646784.	0.	0.	5412002.	24.	2765218.
4	3524320.	770950.	-2484648.	0.	2691702.	0.	0.	5520242.	24.	2828541.
5	3594806.	770950.	-2526940.	0.	2737518.	0.	0.	5630647.	25.	2893129.
6	3666702.	770950.	-2570077.	0.	2784251.	0.	0.	5743260.	25.	2959010.
7	3740037.	770950.	-2614078.	0.	2831918.	0.	0.	5858125.	26.	3026208.
8	3625446.	813450.	-2565724.	500000.	2779534.	0.	0.	5975288.	26.	3195754.
9	3697955.	813450.	-2609229.	0.	2826665.	0.	0.	6094794.	27.	3268129.
10	3771914.	813450.	-2653605.	0.	2874738.	0.	0.	6216690.	27.	3341951.
11	3847353.	813450.	-2698868.	0.	2923773.	0.	0.	6341023.	28.	3417250.
12	3924300.	813450.	-2745036.	0.	2973789.	0.	0.	6467844.	29.	3494055.
13	4002786.	813450.	-2792127.	0.	3024805.	0.	0.	6597201.	29.	3572396.
14	4082842.	813450.	-2840161.	0.	3076841.	0.	0.	6729145.	30.	3652304.
15	4164498.	813450.	-2889155.	0.	3129918.	0.	0.	6863728.	30.	3733810.
16	4247788.	813450.	-2939129.	0.	3184056.	0.	0.	7001002.	31.	3816946.
17	4332744.	813450.	-2990102.	0.	3239278.	0.	0.	7141022.	32.	3901745.
18	4419399.	813450.	-3042095.	0.	3295603.	0.	0.	7283843.	32.	3988239.
19	4507787.	813450.	-3095128.	0.	3353056.	0.	0.	7429520.	33.	4076464.
20	4597943.	813450.	-3149222.	0.	3411657.	0.	0.	7578110.	34.	4166453.

CAPITALIZATION SCHEME

METHOD

FULL CAPITAL COST

INITIAL INVESTMENT

DEBT SERVICE/LEASE PMT

ANNUAL INTEREST RATE

CORPORATE TAX RATE

FULL INVST

9070000.

9070000.

0.

0.000

.48

OPERATING COSTS

YEAR	WAGES	SUBSIST	M+R	INSUR	FUEL (SEA)	FUEL (PORT)	PORT DUES	CARGO COST	TOT DIRECT	G+A	DEBT SRVC	AN OP COST
1	21099.	6625.	4991.	15516.	1926878.	75538.	3808.	1266591.	3321045.	830261.	0.	4151307.
2	21521.	6758.	5090.	15626.	1965415.	77048.	3884.	1291923.	3387466.	846867.	0.	4234333.
3	21952.	6893.	5192.	16143.	2004724.	78589.	3962.	1317761.	3455216.	863804.	0.	4319020.
4	22391.	7031.	5296.	16666.	2044818.	80161.	4041.	1344116.	3524320.	881080.	0.	4405400.
5	22839.	7172.	5402.	16795.	2085715.	81764.	4122.	1370999.	3594806.	898702.	0.	4493508.
6	23295.	7315.	5510.	17131.	2127429.	83400.	4204.	1398419.	3666702.	916676.	0.	4583378.
7	23761.	7461.	5620.	17474.	2169977.	85068.	4288.	1426387.	3740037.	935009.	0.	4675046.
8	24237.	7610.	6224.	16553.	2031880.	79654.	4374.	1454915.	3625446.	906362.	0.	4531808.
9	24721.	7763.	6349.	16884.	2072518.	81247.	4461.	1484013.	3697955.	924489.	0.	4622444.
10	25216.	7918.	6476.	17222.	2113968.	82872.	4551.	1513693.	3771914.	942979.	0.	4714893.
11	25720.	8076.	6605.	17566.	2156247.	84529.	4642.	1543967.	3847353.	961838.	0.	4809191.
12	26234.	8238.	6737.	17917.	2199372.	86220.	4734.	1574846.	3924300.	981075.	0.	4905375.
13	26759.	8403.	6872.	18276.	2243350.	87944.	4829.	1606343.	4002786.	1000696.	0.	5003482.
14	27294.	8571.	7009.	18561.	2288227.	89703.	4926.	1638470.	4082842.	1020710.	0.	5103552.
15	27840.	8742.	7149.	19014.	2333992.	91497.	5024.	1671240.	4164498.	1041125.	0.	5205623.
16	28397.	8917.	7292.	19394.	2380671.	93327.	5125.	1704664.	4247788.	1061947.	0.	5309735.
17	28965.	9095.	7438.	19782.	2428285.	95194.	5227.	1738758.	4332744.	1083186.	0.	5415930.
18	29544.	9277.	7587.	20178.	2476851.	97098.	5332.	1773533.	4419399.	1104850.	0.	5524249.
19	30135.	9463.	7739.	20581.	2526388.	99040.	5438.	1809004.	4507787.	1126947.	0.	5634734.
20	30738.	9652.	7894.	20993.	2576915.	101021.	5547.	1845184.	4597943.	1149486.	0.	5747428.

REQUIRED REVENUES

PRESENT VALUE OF INCOME STREAM

62985070.

AVERAGE/INITIAL ANNUAL REVENUE

5136830.

AVERAGE/INITIAL RFR

23.

ANNUAL CASH FLOW

YEAR	DIR OP COST	DEBT SRVC	TAXES	CAPITAL	CASH OUT	DEPREC	INTEREST	GR REVENUE	RFR NET REVENUE	NPV-NI RV
1	3321045.	0.	255371.	9070000.	4406678.	453500.	0.	5136830.	23.	730152.
2	3387466.	0.	264832.	0.	4499165.	453500.	0.	5239566.	23.	740401.
3	3455216.	0.	274482.	0.	4593502.	453500.	0.	5344357.	24.	750856.
4	3524320.	0.	284325.	0.	4689725.	453500.	0.	5451245.	24.	761519.
5	3594806.	0.	294366.	0.	4787873.	453500.	0.	5560269.	25.	772396.
6	3666702.	0.	304606.	0.	4887985.	453500.	0.	5671475.	25.	783490.
7	3740037.	0.	315052.	0.	4990098.	453500.	0.	5784904.	26.	794807.
8	3625446.	0.	420880.	500000.	4952688.	491962.	0.	5900602.	26.	947915.
9	3697955.	0.	434020.	0.	5056464.	491962.	0.	6018615.	27.	962150.
10	3771914.	0.	447423.	0.	5162317.	491962.	0.	6138987.	27.	976670.
11	3847353.	0.	461095.	0.	5270286.	491962.	0.	6261767.	28.	991481.
12	3924300.	0.	475039.	0.	5380414.	491962.	0.	6387002.	28.	1006588.
13	4002786.	0.	489263.	0.	5492745.	491962.	0.	6514742.	29.	1021997.
14	4082842.	0.	503771.	0.	5607323.	491962.	0.	6645037.	29.	1037714.
15	4164498.	0.	518569.	0.	5724192.	491962.	0.	6777937.	30.	1053745.
16	4247788.	0.	533664.	0.	5843399.	491962.	0.	6913496.	31.	1070097.
17	4332744.	0.	549060.	0.	5964990.	491962.	0.	7051766.	31.	1086776.
18	4419399.	0.	564764.	0.	6089013.	491962.	0.	7192801.	32.	1103789.
19	4507787.	0.	580782.	0.	6215516.	491962.	0.	7336658.	32.	1121142.
20	4597943.	0.	597120.	0.	6344549.	491962.	0.	7483391.	33.	1138842.

LT BUNKER LT DIESEL TRIL BTU VESSEL POP TONS MOVED

					LT BUNKER	LT DIESEL	TRIL BTU	VESSEL POP	TONS MOVED
OCEAN	LINER	CONTAINER	TOTAL US	FF	758232.	0.	31.	28.	3130.
					1370493.	0.	57.	49.	4954.
		RO/RO	TOTAL US	FF	250315.	0.	10.	10.	494.
					1110784.	0.	46.	42.	3031.
		BWG CARR	TOTAL US	FF	497502.	0.	21.	11.	1498.
					184133.	0.	8.	4.	567.
		BREAK BULK	TOTAL US	FF	2337320.	0.	97.	166.	4125.
					0.	5661160.	244.	483.	12198.
		TOTAL US			3843369.	0.	159.	215.	9246.
		FF			2665410.	5661160.	355.	578.	20751.
	NON-LINER	TRAMP	TOTAL US	FF	437229.	0.	18.	75.	1102.
					0.	23636140.	1020.	4981.	70844.
		DRY BULK	TOTAL US	FF	118507.	0.	5.	8.	1978.
					0.	7399727.	319.	611.	145841.
		TANKER	TOTAL US	FF	618389.	0.	26.	32.	18245.
					0.	6845486.	295.	474.	251253.
		TOTAL US			1174126.	0.	49.	115.	21324.
		FF			0.	37881353.	1634.	6066.	467938.
	TOTAL US				5017495.	0.	208.	330.	30571.
	FF				2665410.	43542514.	1989.	6643.	488688.