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MASTER

AN ENERGY STUDY OF SHIP-TRANSPORTATION SYSTEMS

DOE/CS/51175--T12

A PROGRESS MEETING AT BOOZ, ALLEN APPLIED RESEARCH

Bethesda, Maryland

FOR

U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

U.S. MARITIME ADMINISTRATION

U.S. NAVY

On September 16, 1976

DISCLAIMER

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STUDY OBJECTIVES

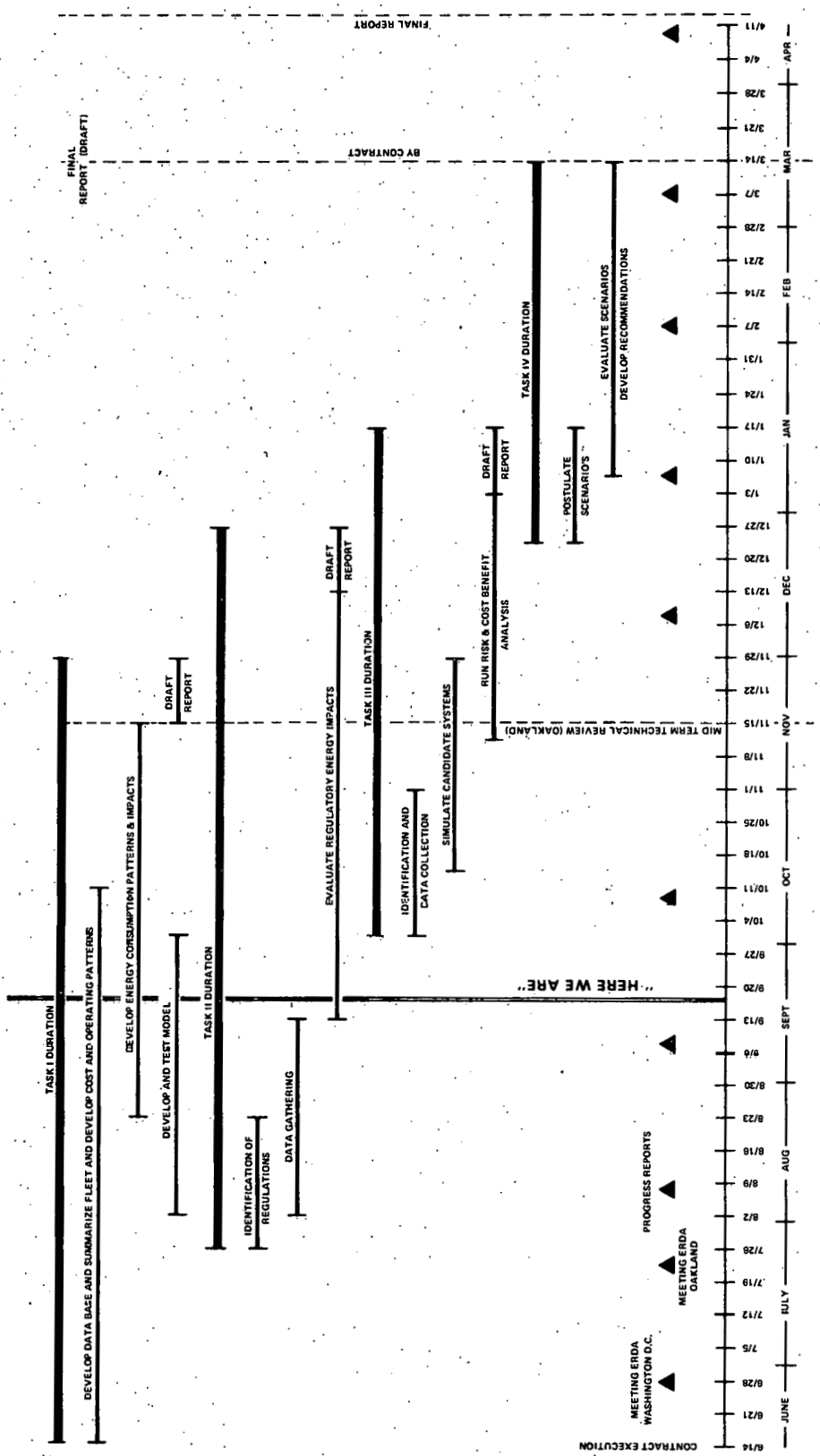
1. Develop a marine industry profile in terms of equipment, operating characteristics, energy consumption, costs and develop performance measurements in terms of ton-miles per BTU or operating hours per BTU for each industry sector identified.

2. Identify the role of all government and quasi-government agencies that impact the Marine Industry, porjecting 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.

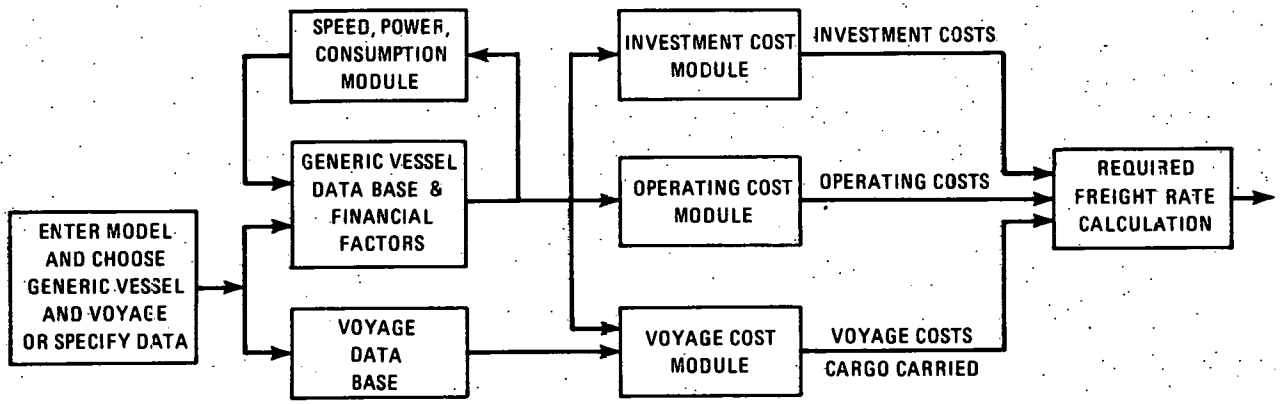
Project Schedule



PRELIMINARY VESSEL PROFILES

Vessel Type		Population	Total Horsepower (In Millions)	Productivity (Millions of L.T.)	Energy Use (Millions of L.T./Yr)
1. Ocean					
. Liner	U.S.	270	60.3	14.93	28
	F.F.	900	-	34.87	
. Nonliner	U.S.	3	.2	.2	
	F.F.	-	-	98.5	
. Passenger	U.S.	2	.03	-	
	F.F.	84	-	-	
. Dry Bulk	U.S.	17	1.7	4.0	45.5
	F.F.	500	5.0	160.9	
. Liquid Bulk	U.S.	50	3.3	306.1	59.5
	F.F.	470	7.0		
2. Great Lakes (Foreign Trade)					
. Liner	U.S.	3	-	.03	Included In Ocean Shipping Consumption
	F.F.	131	-	.91	
. Nonliner	U.S.	-	-	4.3	
	F.F.	-	-	43.7	
3. Great Lakes (Domestic Trade)					
. General Cargo	U.S.	20	.009		
	Canada	8	.03		
. Dry Bulk	U.S.	172	.7		
	Canada	128	.65		
. Tanker	U.S.	16	.025	130.4	.34
	Canada	43	.14		
. Ferry	U.S.	39	.07		
	Canada	12	.008		
. Tug	U.S.	79	.05		
	Canada	51	.09		
4. Inland Waterway					
. Tow Boats/Tugs		3,965	5.0	535.8	1.9
5. Coastwise					
. General Cargo		29	-	209	1.8
. Dry Bulk			-		
. Tanker		173	29.2		
6. Offshore Fleet					
. Crew Boats		149	.3		Included in Categories 8 & 9
. Tugs		217	.4		
. Tug/Supply		149	.7		
. Supply		105	.3		
. Geophysical		30	.03		
7. Pleasure Craft		6.3 Million	8.3	186 Hrs/Boat/Yr	1.5 Billion Gallons (48% Gas, 52% Diesel)
8. Fishing Craft					.03
9. Miscellaneous					
TOTAL		9,135 Commercial 6.3 Million (Pleasure Boat)	115.2 8.3	1.5 Billion L.T. 186 Hrs/Boat/Yr	137 1.5 Billion Gallons

This is a preliminary listing and caution should be employed in use other than the context of this meeting.



OUTPUT (Continued):

- VESSEL TYPE AND PARTICULARS
- ROUTE PARTICULARS
- INVESTMENT COSTS
  - REQUIRED RATE OF RETURN
  - FINANCING PARTICULARS
- OPERATING COSTS AND ESCALATION FACTORS
  - DEPRECIATION
  - INSURANCE
  - M&R
  - STORES
  - OVERHEAD, FOOD AND WAGES
- VOYAGE COSTS AND ESCALATION FACTORS
  - FUEL
  - LUBE OIL
  - PORT CHARGES
  - CANAL CHARGES
  - MILES
  - DAYS AT SEA
  - DAYS IN PORT
- FUEL CONSUMPTION
  - SFC AT SEA AND IN PORT
  - TONS PER DAY AT SEA AND IN PORT
  - BBL'S PER DAY AT SEA AND IN PORT.

Task 1
Model Logic Flow

GENERIC VESSEL DATA BASE ELEMENTS

- Type of Vessel
- Operating Year
- DWT
- LBP
- Draft
- Depth
- Beam
- HP
- Speed
- Specific Fuel Consumption
  - At Sea
  - In POrt
- Light Ship Weight
- Capital Costs
  - Hull and Outfit
  - Machinery
- Crew Number
- Financial Factors
  - Required Rate of Return
  - Depreciation Scheme
  - Economic Life
  - Cost Escalation Factors
    - M&R
    - Stores
    - Overhead, Food, Wages
    - Fuel
    - Port Charges
  - Assumed Tax Rate

VOYAGE DATA BASE ELEMENTS

- Ports of Call
- Length in N.M.
- Port Charges
- Canal Charges if any
- Time in Port

Task 2
ERDA Maritime Energy Study
Agency/Jurisdiction Matrix

	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

● JURISDICTION

◉ JURISDICTION WITH PERCEIVED ENERGY USE IMPACT

TASK 3

TECHNOLOGY AREA OF INTEREST	PRESENT DAY	ADVANCED TECHNOLOGY
HULL COATINGS	1-2 YEARS	> 3 YEARS
HULL FORMS	HIGH DEADRISE VLCC'S TUNNEL STERN HIGH BEAM/DRAFT RATIO FLOWS	SURFACE EFFECT SHIP AIR CUSHION VEHICLE CATAMARAN HULL FORMS
PROPULSION AND TRANSMISSION	SHROUDED PROP'S PLANETARY GEARS NUCLEAR IMPROVED EFFICIENCY	CLOSED CYCLE G.T. IMPROVED EFFICIENCY
FUELS	METHANOL	HYDROGEN COAL BASED

THE MARITIME MARKET FOR BOTTOM CYCLE APPLICATIONS

SECTOR	NO. OF LARGE SHIPS	NO. OF SMALLER CRAFT	TOTAL VESSELS
N.O.A.A.	20	0	20
U.S. COAST GUARD	100	175	275
U.S. NAVY	150	400	550
COMMERCIAL	20	5,200*	5,220
TOTAL	290	5,575	6,065

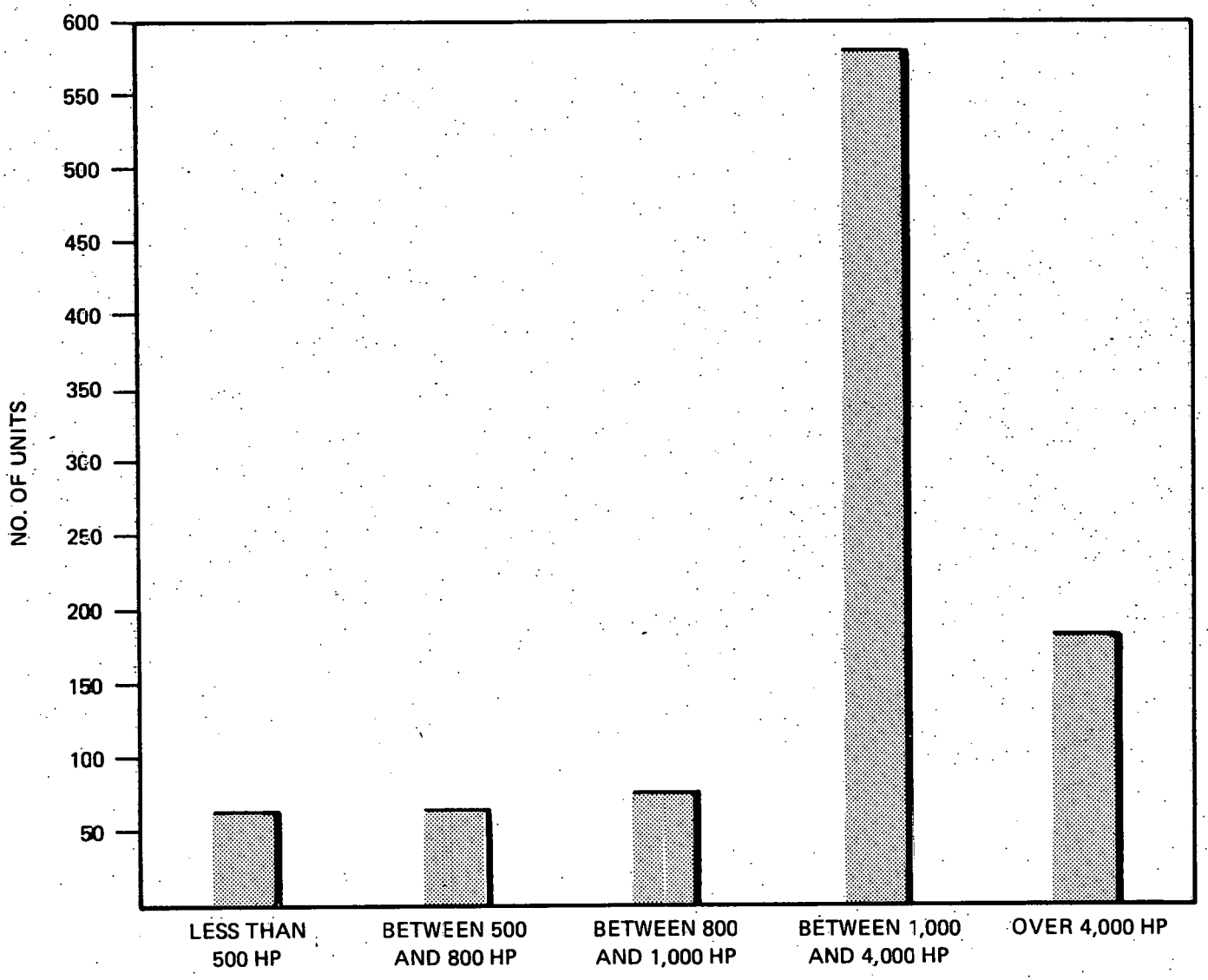
* Excludes fishing vessels

COMPARISON OF MARINE AND TERRESTRIAL APPLICATIONS AND POTENTIAL FUEL SAVINGS (1976/77)

	NUMBER OF UNITS	ENERGY SAVINGS WITH 100% USE OF H.R.S. (BBLS/DAY)	ENERGY SAVINGS WITH 10% USE OF H.R.S. (BBLS/DAY)
TERRESTRIAL	59,600*	280,000	28,000
MARINE	3,300+	12,800	1,280

* 2,000 hp >

\+ 700 hp >



Distribution of Diesel Engine Horsepowers in the Offshore Supply Industry

TASK 1
MODEL STRUCTURE AND LOGIC FLOW

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MODEL STRUCTURE AND LOGIC FLOW

The structure of the model will be organized around three modules:

- Investment — will cover construction costs (U.S.) for various generic vessel types
- Operational — will cover the fixed operational costs associated with operation for the various generic vessel types
- Voyage — addresses parameters and costs that are peculiar to the operating scenario.

The output of the model will be a basic required freight rate calculation expressed as a cost per service measure. For cargo vessels, the service measure will be an expression of the annual tons delivered, for offshore supply vessels, tug boats, fishing vessels and pleasure craft the service measure will be operating hours. Other data to be presented at the end of a run are:

- Vessel type and particulars
- Route particulars
- Investment costs
  - Required rate of return
  - Financing particulars
- Operating costs and escalation factors
  - Depreciation
  - Insurance
  - M&R
  - Stores
  - Overhead, food and wages
- Voyage costs and escalation factors
  - Fuel
  - Lube oil
  - Port charges
  - Canal charges
  - Miles
  - Days at sea
  - Days in port

. Fuel consumption

- SFC at sea and in port
- Tons per day at sea and in port
- Bbl's per day at sea and in port.

1. CALCULATIONS

The model user will be able to choose a generic vessel type applied to a specific trade route, or specify a particular vessel and apply it to a particular voyage. In the event that a vessel and voyage pattern other than those contained in the model are desired to be evaluated, then the model user will have to supply all the necessary data.

The basis for the RFR calculation is the expression:

$$\text{Capital Cost} = \sum_{i=0}^{n-1} \left[\frac{RFR}{(1+r)^i} - \frac{(\text{Operating Cost})_i}{(1+r)^i} \right] (1-t)$$

EACH INDIVIDUAL operating cost will be discounted to a persent value through the formula:

$$\text{Present Value} = \left(\begin{matrix} \text{Cost Item} \\ \text{at Year 0} \end{matrix} \right) \left(\frac{1 - \left(\frac{1}{1+r}\right)^n}{1 - \left(\frac{1}{1+r}\right)} \right)$$

where r is the discount rate.

If the cost item is to be escalated at an inflation rate g then the expression is:

$$\text{Present Value} = \left(\begin{matrix} \text{Cost Item} \\ \text{at Year 0} \end{matrix} \right) \left[\frac{1 - \left(\frac{1+g}{1+r}\right)^n}{1 - \left(\frac{1+g}{1+r}\right)} \right]$$

except for the case where $r = g$ then the expression is:

$$\text{Present Value} = N \left(\begin{matrix} \text{Cost Item} \\ \text{at Year 0} \end{matrix} \right)$$

At all times the following limits must be satisfied:

$$-1 < \frac{1+g}{1+r} < 1$$

After the present value of all future operating costs are calculated they are added to the capital costs and multiplied by the following expression to get the average annual cost (AAC):

$$AAC = (\text{Present Value of All Costs}) \left(\frac{r(1+r)^n}{(1+r)^n - 1} \right)$$

where r is the discount rate.

The average annual cost is then divided by the annual throughput to arrive at the cost per ton laid down.

2. ALTERNATE FORMULA

Whenever the discount expression given in Section 1 above for the escalation case cannot satisfy the limits then a loop has to be employed to calculate the present value using the expression:

$$\text{Present Value} = \sum_{i=0}^{n-1} \left(\begin{matrix} \text{Cost Item} \\ \text{at Year 0} \end{matrix} \right) \left(\frac{1+g}{1+r} \right)^i$$

where n is the economic life in years

r is the discount rate/year

g is the escalation rate/year.