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COMALCO ALUMINIUM

COMALCO INDUSTRIES PTY. LIMITED • 168 KENT STREET SYDNEY • TELEPHONE 27 8821 • GPO BOX 527

TO MEMBERS OF THE ROYAL INSTITUTION OF NAVAL ARCHITECTS

Australian Branch

Gentlemen,

The attached report on design criteria and economic study for an all-aluminium trawler was prepared for the Aluminum Association of the U.S.A. and obtained through Kaiser Aluminum, one of Comalco's owning partners, from the Association for dispersal to you, upon a request from your Institution's secretary, Mr. Eric Trivett.

The resultant design, sponsored by the Aluminum Association, is for a vessel which, it is felt, will be more profitable to its owner due to the inherent advantages of aluminium over comparable steel or wooden vessels. It has greater speed, longer range and larger carrying capacity due to its aluminium construction. The aluminium will need considerably less maintenance and the design allows for a minimum crew.

Initial costs are estimated at approximately 11.5% over costs for a steel vessel but it is anticipated this extra initial cost would be paid back in less than one year due to higher nett income from the aluminium designed vessel.

Details of the design are now available for a sum of U.S.$250 per boat which is considered very nominal as there is U.S.$15000 actual work in the total design work.

As the boat has been designed as a multi purpose type which can be used as a purse seiner, stern trawler, long liner, double rigged trawler or mother ship and by extending the forecastle or deck house can accommodate processing equipment for canning, it is felt a future exists for it in the Australian fishing industry.

The aluminium raw materials required to build this type of vessel have been available from Comalco for some years and there is no doubt this vessel can be built by competent Australian fabricators.

I trust the information will be of some assistance to you and will continue the trend towards a more efficient Australian fishing industry. If further information is required, please contact me at the above address.

P. G. HOWARD
Manager - Transport Markets.

INCORPORATED IN VICTORIA

DESIGN CRITERIA AND ECONOMIC STUDY

ALL-ALUMINUM TRAWLER

Prepared for

THE ALUMINUM ASSOCIATION

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Pascagoula, Miss.

May 12, 1966.

DESIGN CRITERIA AND ECONOMIC STUDY
FOR A SUBSIDIZED
ALL-ALUMINUM TRAWLER

FORWARD

This study and preliminary design, Drawing 330-3, was prepared under the sponsorship of The Aluminum Association to determine the possible economic advantages of a fishing vessel constructed of aluminum alloy. This vessel was to be of a popular size and with thoroughly modern fishing gear, and with versatility a paramount consideration to permit the vessel to engage in several types of fishing with none or minimum modifications.

Full advantage was taken of collaboration with the Pascagoula Base of the Bureau of Commercial Fisheries of the U. S. Department of the Interior, whose vast experience and files of cost data provide a degree of authenticity to the study that would otherwise not have been possible.

INTRODUCTION

It is evident that U. S. fishermen are becoming keenly aware that to remain competitive, their vessels must be highly efficient, inexpensive to operate and maintain, fast enough to reach distant fishing grounds, big enough to carry a profitable load safely, remain at sea for prolonged periods, and be capable of operating with a degree of flexibility impossible with existing fishing vessels.

These trawlers have been of more or less conventional design and no appreciable gain appears to have been made in effecting economies or fishing efficienty other than by increasing vessel size and power.

The increased investment represented by these larger vessels is mainly based on the belief that return on investment will improve with greater carrying capacity and fishing efficiency. This belief is founded on the knowledge that as vessel size increases the cost of construction per ton of capacity decreases, as do many of the operating costs when based on capacity tonnage alone. (Green and Broadhead 1965) However, these advantages, inherent in the larger vessel, do not necessarily increase the profitability of the vessel. This is because the factors which contribute to gross income and operational costs are quite complex and varying in nature.

The two basic factors that determine vessel net earnings are (1) the gross income and (2) the cost of maintenance and operation. Gross income is dependent upon a vessel's efficiency and the proficiency of its crew, thus it is irrevocably tied to catching efficiency and the number of days spent fishing. One of the inherent advantages of larger vessels is their ability to stay at sea for long periods of time, thereby reducing running time, and the ability to continue fishing under more severe conditions of wind and sea. It must be borne in mind, however, that the dollar earnings for crew and owner vary considerably with vessel size and design; therefore the optimum vessel size and design must be owner-oriented, since it is the owners who must realize a reasonable return on investment if advanced design fishing vessels are to be constructed. Operational and maintenance costs which are deducted from gross income include such items as fuel, comestibles, gear replacement, crew's wages, hull and machinery maintenance and repair, insurance, taxes, depreciation, etc. Therefore, the profit margin of a given vessel is determined not only by the gross income, but to a large extent by the cost of maintenance and operation. Thus any reduction in operational and maintenance costs also results in increased profit.

In an effort to start a trend toward reduced costs and increased efficiency in the shrimp industry it is suggested that the use of all-aluminum vessels would effect significant economies and increase production and enable these vessels to operate at a profit margin considerably in excess of that realized by conventional vessels constructed from wood or steel.

There are two basic reasons why the use of aluminum will result in greater earnings for both owners and crewmen: (1) the low weight of aluminum as compared with other structural materials, and (2) aluminum's high resistance to corrosion in the marine environment. Lower structural weight means that a larger cargo can be carried for the same displacement at the same power and speed, or the same cargo at increased speed with lower displacement resulting in more fishing days, or at the same speed with less power which results in a savings in fuel costs.

Aluminum's high resistance to corrosion in sea water and the marine atmosphere will result in a significant reduction in hull maintenance and repair costs and will probably increase the economical life expectancy of the vessel two-fold.

DESIGN CONSIDERATIONS

The intent and goal of the design effort for the vessel described herein has been to produce a vessel which complies in all respects with the requirements and limitations of the Subsidy Act and at the same time will result in a fishing vessel with improved earning capacity and reduced maintenance and operating costs.

The following analyses describes the designed capabilities of the vessel and compares and illustrates the increased earning capacity and economies that will result from an all-aluminum structure when compared to a similar vessel constructed from wood or steel.

ADVANCED DESIGN

The design will permit the vessel to function as a double rigged shrimp trawler, a stern fish-trawler, a tuna longliner, or a purse seiner without further structural modification or alteration.

By extending the forecastle aft (or the deckhouse), processing equipment such as heading and fileting machines or shrimp peeling and canning equipment could be accommodated, thus resulting in a pocket-size factory ship operation.

Hull design incorporates a fine entrance for speed and driving, double chine hull form for easy motion, deep draft and ample beam for stability and seaworthiness and raised forecastle for dry decks and protection of personnel in heavy weather fishing. An all-hydraulic centralized gear handling complex, watertight divisional bulkheads for increased safety, stern ramp, and shroudless A-frame mast are other notable features.

ABILITY TO OPERATE IN EXPANDED AREAS

A special feature of the design is the capability for long-range operation. Normal fuel capacity is 26,000 gallons which will permit 80 to 90 day trips to fishing grounds 1000 to 1400 miles from port. For extended trips of up to 136 days to fishing grounds as far distant as 4800 miles from port, an additional 22,000 gallons of fuel can be carried in the aft freezer tank.

Potable water tank capacity is 4000 gallons. A waste heat sea water distiller with a capacity of 100 gallons per day insures adequate potable water for extended trips. While the aluminum and steel boat have equal fuel and fish hold volumes, the aluminum boat has 38 tons greater "lift" capacity.

EQUIPPED WITH NEWLY DEVELOPED GEAR

The vessel will be equipped with complete processing and freezing facilities for shrimp and will be able to alternately or simultaneously preserve industrial fish in refrigerated brine or sea water. The design incorporates three unique features in this respect: (1) shrimp can be graded in four sizes, quick-frozen in 5-pound containers in the main deck plate freezer, and stored below at -10°F. Capacity is 200 pounds of shrimp tails per hour, which can be increased to meet demand of mothership operation, with storage capacity for 90 tons; (2) freezer storage hold can be flooded and industrial fish stored in refrigerated sea water (135 tons for aluminum vessel, 97 for steel vessel); or (3) freezer storage hold can be divided and 40 tons of industrial fish stored in refrigerated sea water in the aft hold. This last feature is included to permit shrimp trawlers fishing grounds close to industrial plants to utilize the industrial fish catch incidentally caught while shrimp trawling.

It is reported by Wolff (1963) and Miles (1951) that for every pound of shrimp caught (whole weight) about 8¼ pounds of industrial fish are taken in the trawl and discarded. Roithmayr (1965), in calculating the industrial fish catch discarded by shrimpers, placed this figure at about 52,000 tons in 1959. Vessels fishing the Gulf of Mexico catch between 60,000 and 90,000 pounds of shrimp tails per year per vessel. Whole weight would be approximately 100,000 to 150,000 pounds (40% weight for head). Using a catch ratio of 1:8 and an average price to vessel of $27/ton ($35/ton for pet food, $20/ton for reduction), it is clearly evident that the gross income for shrimp trawlers operating near industrial fish processing plants will be increased considerably by this feature.

The ability to fish or shrimp in the rough seas common to the Gulf, Caribbean Sea, and Atlantic Ocean is made possible by the hull design and incorporation of a stern ramp, a feature that has revolutionized fishing concepts throughout the world. The ability to purse seine with a minimum crew by the simple addition of a power block is possible by incorporation of a parallel shaft, combination purse-seine-trawl winch, hydraulic sacking and hoist winches, and adequate clear deck space aft.

The stern trawling arrangement also makes possible the use of midwater trawls, such as the Cobb pelagic trawl, for exploiting presently unutilized midwater stocks of industrial fish that have been reported in commercial quantity in the Gulf of Mexico by the Burea of Commercial Fisheries. Adequate power, seaworthiness and winch capacity provides the capabilities for exploiting the deep water Royal Red shrimp resource.

CONTRIBUTE IN HELPING THE DOMESTIC INDUSTRY MEET FOREIGN COMPETITION

An aluminum vessel will reduce maintenance and operating costs, increase production, and by its long-range capabilities will better enable the domestic industry to take and market its share of the resources of the world ocean.

SUITABILITY FOR MILITARY PURPOSES IN TIME OF WAR OR NATIONAL EMERGENCY

Due to its speed, long-range capabilities, freedom from routine maintenance, and the increased carrying capacity resulting from the use of aluminum, the vessel is ideally suited to patrol, reconnaissance, or supply duties in remote areas of the world. Centralization of cargo-handling facilities and main propulsion control, and reserve AC ship's electrical service will permit operation with a minimum of officers and crew and readily accommodate the additional electronic equipment required by the military. Removal of the main deck processing equipment will provide berthing facilities for additional personnel with a minimum of conversion expense.

LIMITATIONS

The added capability for long-range operation resulting from the low weight of the aluminum structure will permit the vessel to operate in distant waters and still be able to land its catch in a U. S. port.

Centralization of the gear-handling complex and semi-automated processing equipment will permit efficient operation with a maximum of 5 crewmen. It is mandatory that potential crew's earnings be attractive to U. S. fishermen if they are to participate in a distant water fishery. An all-aluminum vessel's crew can obviously be expected to enjoy increased wages.

The requirement, that the vessel will not operate in a fishery if such operation would cause economic hardship to efficient vessel operators already operating in that fishery, makes it highly desirable, if not mandatory, that the vessel be designed and equipped as a multi-purpose vessel. This feature provides the flexibility required to insure that the vessel is not economically handicapped if ruled ineligible to participate in a given fishery.

VESSEL DATA

Hull Dimensions	Aluminum	Steel	Wood
Length Overall	86'6"	86'6"	86'6"
Length on Water Line	80'	80'	80'
Beam	24'	24'	24'
Depth	12'6"	12'6"	12'6"
Maximum Draft	9'6"	9'6"	9'6"
Machinery Particulars			
Main Propulsion	450 HP	450 HP	450 HP
Fuel Consumption (steaming)	650 gal/day	650 gal/day	650 gal/day
Capacities			
Fuel (normal) gal.	26,000	26,000	10,000
Fuel (maximum) gal.	48,000	48,000	10,000
Potable water, gal.	4,000	4,000	1,200
Fish hold (cu.ft.) aft.	2,800	2,800	2,200
fwd.	2,000	2,000	1,760
Total hold capacity	4,800 cu.ft.	4,800 cu.ft.	3,960 cu.ft.
Weights Long Tons			
Structure	33	71	80
Machinery	10	10	10
Outfit	28	28	28
Light Shipweight	71	109	118
Displacement (maximum)	264	264	264
Deadweight capacity	193	155	146
Lightweight of vessel	71	109	118
Cargo	(91)	(53)	109*
Fuel (normal)	84	84	32
Water	15	15	2
Crew and stores	3	3	3
Max. displacement @ 9'6" draft	264	264	264
Diff. in carrying capacity	+38	--	--
Displacement at departure	170	208	--
Diff. in displacement at dept.	-38	--	--
Displacement ready to fish (distant waters)	160	195	--
Diff. in displacement ready to fish	-35	--	--

*Wooden vessel would have insufficient fuel remaining for fishing and return to port since approximately half of fuel is consumed in passage to distant fishing grounds. If fuel capacity is increased to meet demand of distant water fishing practically all available internal space would be taken up with fuel tanks, leaving insufficient space for catch. This is because the shell cannot be utilized for tanks as with steel or aluminum construction. It is considered that this deficiency alone precludes further consideration of a wooden vessel.

Speed	Aluminum	Steel
Outward bound	12.25 knots * (170 LT displacement)	10.9 knots (208 LT displacement)
Diff. in speed outward bound	+1.35 knots	
Homeward bound (23-ton catch)	12.25 knots (112 tons disp.)	11.25 knots (150 tons disp.)
Diff. in speed homeward bound (23-ton catch)	+ 1 knot	
Homeward bound (80-ton catch)	12.25 knots (170 tons disp.)	10.9 knots (208 ton disp.)
Diff. in speed homeward bound (80-ton catch)	+1.35 knots	
Loaded to 9'6" draft	11.6 knots (264 LT)	11.6 knots (264 LT)**

**NOTE: At maximum displacement (264 LT) vessels have same speed being of identical design. Aluminum vessel, however, is carrying 38 tons more fish. *Aluminum vessel's speed limited to 12.25 knots by speed/length ratio.

Range (total nautical miles)		
Normal (10% margin fuel) (10% allowance weather)	9526	8476
Diff. in range (normal)	+1050 n.m.	
Extended (10% margin fuel) (10% allowance weather)	17,464	15,539
Diff. in range (extended)	+1925 n.m.	

COMPARATIVE MAINTENANCE COSTS

Hull maintenance costs for aluminum boats will be lower than those for comparable vessels of steel or wood. The cost of maintenance depends upon a number of variables. These include vessel age, individual practices, size of vessel and the nature of the fishing operation. Many owners will habitually postpone upkeep until extensive repairs are necessary, especially in times of poor fishing. This fact, combined with poor maintenance accounting records, makes it extremely difficult to acquire accurate data concerning maintenance costs for fishing vessels.

As a result it was possible to obtain accurate cost data on hull maintenance for only two vessels, one a 70-foot wooden shrimp trawler and the other a 90-foot steel trawler. This data is included below and shows that nominal maintenance costs exist for steel and wooden vessels for a few consecutive years and are then offset by significant above-average costs as a result of extensive repairs and/or protective painting.

Green and Broadhead (1965) in computing annual repair costs for tuna fishing vessels, places this figure at approximately $15,000 for vessels in the 100-ton capacity class. Hull repairs, painting, and drydocking normally account for 30% to 40% of the total annual repair cost, thus would average between $4,500 and $6,000, which agrees quite closely with the hull cost figures obtained for the 90-foot steel trawler.

HULL MAINTENANCE COST DATA

	70-ft.wood vessel Built 1956	90-ft.steel vessel Built 1946
1952		$ 5193.03 hull 1441.92 paint
1953		7892.94 hull 807.96 paint
1954		4010.84 hull 771.72 paint
1955		5368.02 hull 1113.84 paint
1956		10,947.45 hull 1169.28 paint
1957		22,152.07 hull 1071.47 paint
1958		523.62 hull 1044.92 paint
1959	$ 1294.94 hull 320.45 paint	3812.90 hull 2193.11 paint
1960	749.00 hull 689.46 paint	2526.29 hull 1612.40 paint
1961	1850.77 hull & paint	2976.23 hull & Pnt.
1962	2365.21 hull & paint	2653.13 hull & Pnt.
1963	7026.77 hull 695.41 paint	632.22 hull 2701.36 paint
1964	3547.20 hull 65.92 paint	1561.90 hull 614.19 paint
1965	6015.60 hull 856.08 paint	4592.79 hull 1901.43 paint
AVERAGE Adj. Average	$ 3653.83 ($1817.00)	$ 6520.50 ($4662.00)

The high hull maintenance costs shown for the years 1963 through 1965 for the wooden vessel and 1956-57 for the steel vessel are apparently not representative of average yearly maintenance costs, being the result of extensive repairs to the respective hulls for replacement of dry rotted timber and wasted steel structure. Eliminating these years results in the average annual maintenance cost of $1817 for the wooden hull and $4662 for the steel hull.

It must be born in mind, however, that these exceptionally high maintenance cost years, although not representative of normal hull maintenance, are to be expected in a steel or wooden ship structure.

Aluminum has a decided advantage in this respect, for maintenance of an aluminum hull will be considerably lower than that of steel and should remain fairly constant throughout the life cycle of the vessel. Hull maintenance should be limited to haul-out and bottom painting only, and should not exceed $1500 per year. The estimated savings in the maintenance cost of an aluminum vessel is convervatively estimated at $3000 per year. Lack of sufficient data on a comparable size wooden vessel precludes an accurate estimate of yearly maintenance costs. On the basis of the data presented above, however, it may be hypothesized that a wooden vessel would enjoy equally low maintenance cost for the first few years of operation but that these costs would increase substantially with vessel age.

COST ANALYSIS (estimated)

Item	Aluminum		Steel	
	Labor	Material	Labor	Material
Shipyard Engineering	$3,000.00	$1,000.00	$3,000.00	$1,000.00
Structural(hull)	30,000.00	36,960.00 $1120/ton	30,000.00	14,342.00 @ $202/ton
Main propulsion	5,000.00	18,000.00	5,000.00	18,000.00
Shafting & propellers	2,000.00	2,800.00	2,000.00	2,800.00
Generators	2,500.00	10,000.00	2,500.00	10,000.00
Wiring	2,000.00	2,000.00	2,000.00	2,000.00
Piping	2,000.00	2,500.00	2,000.00	2,500.00
Outfit	7,000.00	15,000.00	7,000.00	15,000.00
Refrigeration	13,000.00	12,000.00	13,000.00	12,000.00
Insulation	3,000.00	2,000.00	3,000.00	2,000.00
	$69,500.00	$102,260.00	$69,500.00	$79,642.00

Cost Summary	Aluminum	Steel
Material & equipment	$102,260.00	$79,642.00
Labor	69,500.00	69,500.00
Overhead (70% of labor)	48,650.00	48,650.00
Subtotal	$220,410.00	$197,792.00
Profit (10%)	22,041.00	19,779.00
Total cost	$242,451.00	$217,571.00
Aluminum cost over steel	$24,880.00 (11.5)	

This estimate of the cost differential between aluminum and steel is within the range of estimates prepared by Benson and Kossa (1959) and the Harbor Boatbuilding Co., of San Diego, California, who in estimating the difference in cost between steel and aluminum construction for tuna clippers arrived at a cost differential of 11.5 and 17.6% respectively.

ESTIMATED EARNINGS DATA AND PAYOUT

In this section a method of computing annual gross income as a function of days fished and average expected daily catch is used. The sample earnings data is derived from a series of selected existing fisheries for which average catch data is available.

U. S. Ports Grounds	San Juan	Miami	Tampa	Browns- ville	N. Gulf
S. America (Guianas)	1,200	2,100	2,000	2,600	2,500
W. Africa (Gold Coast)	4,000	4,800	5,050	5,280	5,400
Caribbean (Honduras)	1,200	720	750	960	900
Mexico (Campeche)	1,550	700	700	480	660

Table NO.1: Distance table (one way) to major distant water shrimp grounds from U. S. ports (approximate nautical miles).

Aluminum vessel's extended range is 17,464 nautical miles which provides the capability to fish any of these major production areas from any of the leading U. S. shrimp ports.

Tables 1 and 2 provide a means for estimating gross income for a given shrimp fishery. The following examples are based upon average reported catch rates for a selected

U. S. Ports	On Board	Rd.Trip	MIAMI		SAN JUAN		TAMPA		BROWNSVILLE		NO. GULF	
Geog. Location	Fuel	Cycle	Alum.	Steel	Alum.	Steel	Alum.	Steel	Alum.	Steel	Alum.	Steel
S. America (Guianas)	Normal 26,000 gal.	Days/Passage	14	16	8	9	13.5	15	18	20	17	19
		Days/Fishing	65	60	80	78	66	62	55	50	57	52
	Maximum 48,000 gal.	Days/Passage	14	16	8	9	13.5	15	18	20	17	19
		Days/Fishing	153	148	168	166	154	150	142	137	145	140
West Africa (Gold Coast)	Normal	Days/Passage	33	36	27	32	35	38	36	40	37	41
		Days/Fishing	16	8	31	18	10	3	8	0	5	0
	Maximum	Days/Passage	33	36	27	32	35	38	36	40	37	41
		Days/Fishing	103	96	119	106	98	91	96	85	93	83
Caribbean Sea (Honduras)	Normal	Days/Passage	5	6	8	9	5	6	6	7	6	7
		Days/Fishing	90	86	80	78	90	86	86	83	86	83
	Maximum	Days/Passage	5	6	8	9	5	6	6	7	6	7
		Days/Fishing	176	174	168	166	176	174	174	170	174	174
Mexico (Campeche)	Normal	Days/Passage	5	5	10	12	5	5	3.5	3.7	4.5	5
		Days/Fishing	88	88	75	73	88	88	92	91	90	88
	Maximum	Days/Passage	5	5	10	12	5	5	3.5	3.7	4.5	5
		Days/Fishing	176	176	163	160	176	176	180	180	178	176

TABLE 2: Comparsion of days used up for passage versus fishing for aluminum versus steel vessel to a given area from a given port. Departure speed used = 12.25 aluminum, 10.9 steel. Fuel consumption, 650 gal/day passage; 250 gal/day fishing; 1 day fuel reserve.

area and the assumption that the aluminum and steel vessel will have equal catch rates.

1. South America from Miami; trip cycle, 4200 nautical miles, fuel 26,000 gal.

Trip data	Aluminum	Steel
Days for passage	14	16
Days fished	65	60
Average daily catch	700 lb.	700 lb.
Catch per trip	45,500 lb.	42,000 lb.
Trip value @ $1/lb.	$45,500.00	$42,000.00
Annual gross income (Trip value x 4)	$182,000.00	$168,000.00
Diff. in gross income	+$14,000.00 for aluminum	

Pay Out

Increased earnings to owner (60% of $14,000)	$8,400.00
Decreased maintenance costs (painting, drydocking, etc.)	3,000.00
Increased annual earnings to Owner	11,400.00
Extra cost aluminum construction	24,880.00

Pay Out $= \frac{\$24,880.00}{11,400.00} = 2.2$ years

2. West Africa from Miami; trip cycle, 9600 nautical miles, fuel 48,000 gal.

Trip data	Aluminum	Steel
Days for passage	33	36
Days fished	103	96
Average daily catch	1,200 lb.	1,200 lb. *
Catch per trip	123,600 lb.	115,200 lb.
Trip value @ $1/lb.	$123,600.00	$115,200.00
Annual gross income (trip value x 2)	247,200.00	230,400.00
Diff. in gross income	+$16,800.00 for aluminum	

Pay Out

Increased earnings to owner (60% of $16,800	$10,080.00
Decreased maintenance costs	3,000.00
Increased annual earnings to owner	$13,080.00
Extra cost aluminum construction	24,880.00

Pay out $= \frac{\$24,880.00}{13,080.00} = 1.9$ years

*Shrimp catch, West Africa grounds reported at 1 to 2 metric tons per night per boat; 1,200 lbs. a conservative estimate.

3. Honduras from Miami; trip cycle, 1440 nautical miles, fuel, 26,000 gal.

Trip data	Aluminum	Steel
Days for passage	5	6
Days fishing	90	86
Average daily catch	600 lb.	600 lb.
Catch per trip	54,000 lb.	51,600 lb.
Trip value @ $1/lb.	$54,000.00	$51,600.00
Annual gross income (trip value x 3)	$162,000.00	$154,800.00
Diff. in gross income	+$7,200.00 for aluminum	

Pay Out	
Increased earnings to owner (60% of $7,200.00)	$4,320.00
Decreased maintenance costs	3,000.00
Increased annual earnings to owner	$7,320.00
Extra cost of aluminum construction	$24,880.00

Pay out $= \frac{\$24,880.00}{7,320} = 3.4$ years

4. Industrial fishery (North Gulf of Mexico):

The aluminum vessel's inherent ability to carry a larger payload, at designed displacement, than a comparable-sized vessel constructed of steel, due to its lower weight of structure, shows a greater increased earning potential in this fishery. This is because earnings in this fishery are more dependent upon load carrying capacity than upon speed or range of operation. Comparative earnings potential based upon an average of 40 trips per year and an average price of $27* per ton for the catch is as follows:

Weights (long tons at departure)	Aluminum	Steel
Fuel	40	40
Water	15	15
Stores	3	3
Light shipweight	71	109
Displacement at departure	129	167
Fish	135	97
Displacement (loaded)	264	264
Increased fish load	+38 tons for alum.	

38 long tons = 42.5 short tons
Increased annual earnings = 40 x 42.5 x $27 = $45,900.00

Pay out

Increased earnings to owner (60% of $45,900)	$27,440.00
Decreased maintenance costs	3,000.00
Increased annual earnings to owner	$30,440.00
Extra cost of aluminum construction	24,880.00

Pay out $= \frac{\$24,880.00}{30,440} = .82$ years or 10 months

*Based on current price of $35/ton for pet food and $20/ton for reduction to fish meal.

SAMPLE ANNUAL ACCOUNTING SCHEDULE
(Based on projected earnings for two extended trips to West African shrimp grounds from Miami, Fla.

	Aluminum	Steel
Gross Income	$247,200.00	$230,400.00
Owners share (60% of gross)	148,320.00	138,240.00
Owners Expense		
Fuel @ 15¢ gal.	14,250.00	14,250.00
Lube oil	400.00	400.00
Maintenance hull	1,500.00	4,500.00
Maintenance machinery	6,500.00	6,500.00
Gear replacement & repair	6,000.00	6,000.00
Insurance	12,000.00	12,000.00
Social Security	870.00	870.00
*Depreciation	7,247.00	10,779.00
Interest on loan (ave.5%)	5,435.00	4,850.00
Miscellaneous expenses	10,000.00	10,000.00
	$64,202.00	$70,149.00
Owners share	$148,320.00	$138,240.00
Less Operating Costs	64,202.00	70,149.00
Profit before taxes	$84,118.00	$68,091.00

*Computed on basis of 40% subsidy being deleted and straight-line depreciation 20 years for aluminum and 12 years for steel.

SUMMARY

This paper has presented evidence which substantially supports the use of aluminum as a media for fishing vessel construction in preference to conventional structural materials such as steel and wood.

We have further shown that aluminum construction will (1) increase a vessel's earning power, (2) will reduce operating and maintenance costs, and (3) that the increased initial cost of aluminum construction can be recovered in a reasonable time.

Finally, that on balance, aluminum construction is completely feasible and may well be the answer to the U. S. fishing industry's search for increased efficiency and profits.

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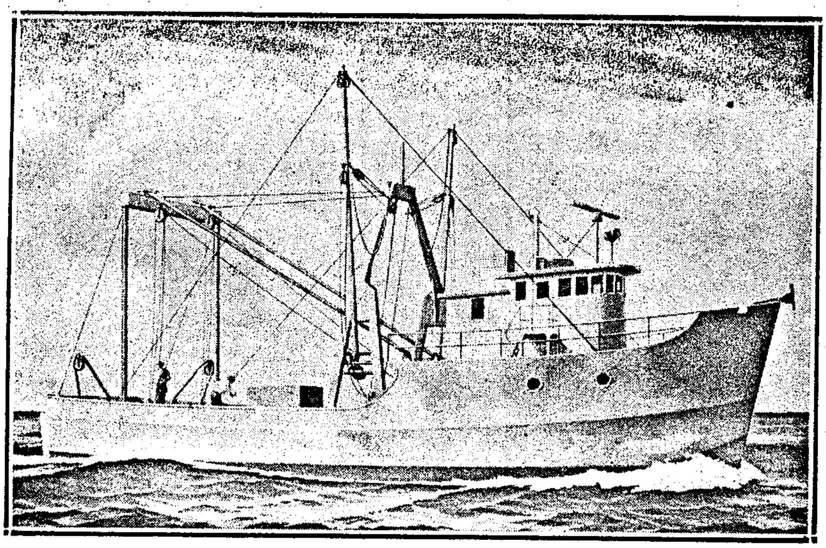
FISHING GAZETTE

AUGUST 1966

The Recognized Authority of the Commercial Fishing Industry
Published Continuously Since 1879

AN ALUMINUM TRAWLER CONVERTIBLE TO FIVE USES!



- A DOUBLE-RIGGED SHRIMP TRAWLER
- A STERN FISHING TRAWLER
- A TUNA LONG-LINER
- A PURSE SEINER
- A POCKET-SIZE FACTORY SHIP

AN 86-FOOT ALL-PURPOSE ALUMINUM FISHING VESSEL MAY WELL BE THE ANSWER TO THE U. S. FISHING INDUSTRY'S NEED TO IMPROVE EFFICIENCY AND INCREASE PROFITS TO GAIN A MORE FAVORABLE COMPETITIVE POSITION AMONG THE FISHING FLEETS OF THE WORLD, SAYS THE ALUMINUM ASSOCIATION.

The Association recognized the importance of effecting economies and efficiency in the commercial fishing industry when its Commercial Marine Subcommittee commissioned Naval Architect Robert H. Macy, of Pascagoula, Miss., to design an all-aluminum fishing vessel with the most modern features for economical operation. He was also commissioned to conduct an economic study of such a vessel compared to vessels of similar size built of other materials.

Macy has designed a vessel capable of functioning as a double-rigged shrimp trawler, a stern fishing trawler, a tuna long-liner, and a purse seiner, without further structural modification or alteration. The design criteria, it is pointed out, meet all requirements of the Fishing Vessel Construction Differential Subsidy Act and incorporate features recommended by personnel at the Pascagoula base of the Bureau of Commercial Fisheries and by local fishermen.

Simply by extending the forecastle or deckhouse aft, Designer Macy explains, processing equipment such as heading and filleting machines or shrimp peeling or canning equipment can be accommodated, resulting in a pocket-size factory ship operation.

The hull design incorporates a fine entrance for speed and driving, double chine hull form for easy motion, deep draft and ample beam for stability and seaworthiness, and raised forecastle for dry decks and protection of personnel in heavy weather fishing, according to Macy. An all-hydraulic centralized gear handling the winches, watertight divisional bulkheads for increased safety, stern ramp, and shroudless A-frame mast are other features. Interior bulkheads are the new sandwich construction which permit savings in labor cost.

Macy emphasizes a special feature of the design—the capability for long-range operation. Normal fuel capacity is 26,000 gallons which will permit 80- to 90-day trips to fishing grounds 1000 to 1400 miles from port. For extended trips of up to 136 days to fishing grounds as far distant as 4800 miles from port, an additional 22,000 gallons of fuel can be carried in the aft freezer tank.

Potable water tank capacity is 4000 gallons. A waste heat sea water distiller with a capacity of 100 gallons per day insures adequate fresh water for extended trips.

The vessel will be equipped with complete processing and freezing facilities for shrimp and will be able to alternately or simultaneously preserve industrial fish in refrigerated brine or seawater.

The shrimp, Macy says, can be graded in four sizes, quick-frozen in 5-lb. containers in the plate freezer on the main deck, and stored below at —10°F. Capacity is 200 lb. of shrimp per hour, which can be increased to meet demands of the factory-ship whose storage capacity is 90 tons.

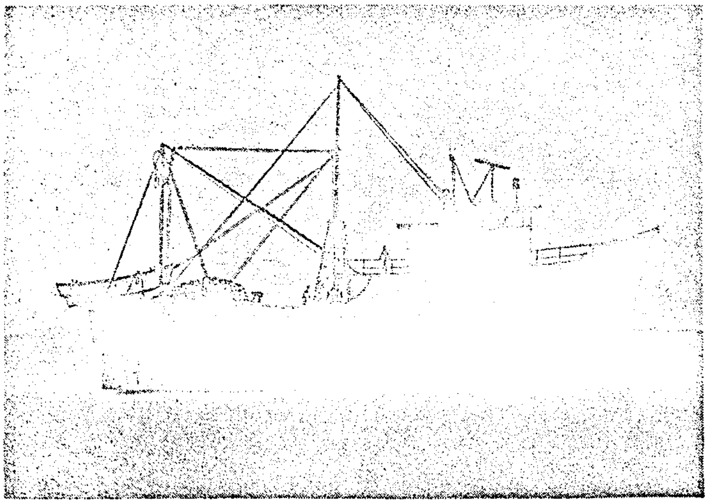
For industrial fishing, the vessel's freezer storage hold can be flooded and the catch stored in refrigerated seawater. To permit shrimp trawlers operating close to industrial plants to utilize the industrial fish incidentally caught while shrimp trawling, the freezer storage hold can be divided and 40 tons of industrial fish stored in the aft hold.

In providing this feature, designer Macy had in mind studies which showed that for every pound of shrimp caught (whole), about 8¼ lb. of industrial fish are taken in the trawl and discarded. The industrial fish catch discarded by shrimpers was placed at about 52,000 tons in a 1959 study.

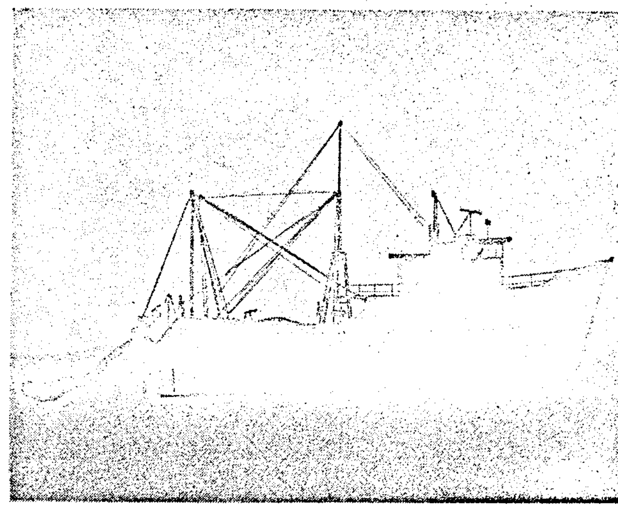
Vessels fishing the Gulf of Mexico catch between 60,000 and 90,000 lb. of shrimp per year per vessel. The whole weight would be approximately 100,000 to 150,000 lb. Using a catch ratio of 1:8 and an average price to vessel of $27 per ton ($35 per ton for pet food, $20 per ton for reduction), "it is clearly evident that the gross income for shrimp trawlers operating near industrial fish processing plants will be increased considerably by this feature," Macy said.

The ability to shrimp or fish in the rough seas common to the Gulf, Caribbean Sea, and Atlantic Ocean is made possible by the hull design and incorporation of a stern ramp, a feature that has revolutionized fishing concepts throughout the world, the designer states. The ability to purse seine with a minimum crew by the simple addition of a power block is possible by incorporation of a parallel shaft, a combination purse-seine-trawl winch,

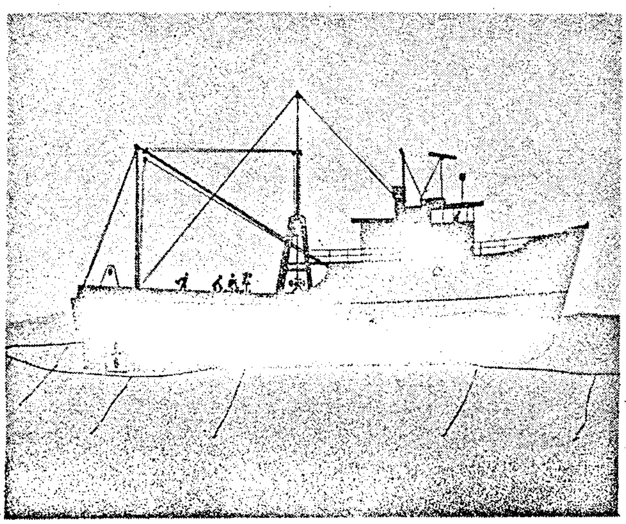
(Continued on Back Cover)



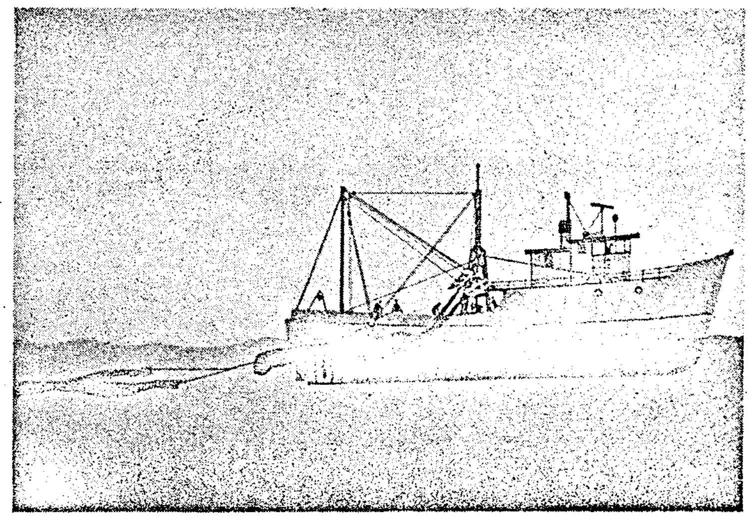
As purse seiner



As stern trawler

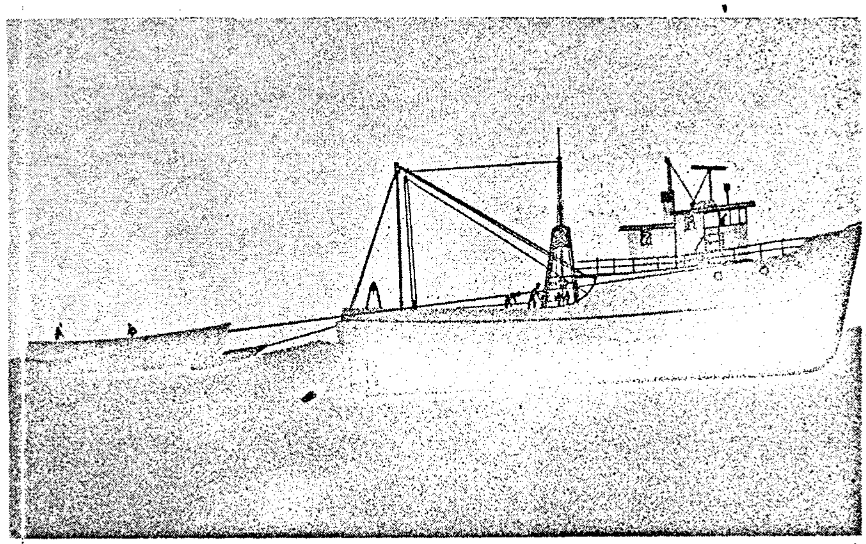


As long-liner



As double-rigged trawler

Complete drawings of the 86-foot aluminum multi-purpose fishing vessel, consisting of lines and offsets, construction profile and plan, construction sections, engine installation plans, arrangement plan and profile and complete specifications, as commissioned by The Aluminum Association, can be obtained from Robert H. Macy, P. O. Box 758, Pascagoula, Miss. 39567, for a charge of $250. This fee entitles the purchaser to build only one boat. A similar fee is required for each additional boat built. A brochure with details, illustrations and economic studies is available free from Ross Peterson, The Aluminum Association, 420 Lexington Avenue, New York, N. Y. 10017.



As mother-ship

hydraulic sacking and hoist winches, and adequate clear deck space aft.

Macy explains that the stern trawling arrangement also permits the use of midwater trawls—such as the Cobb pelagic trawls—for exploiting presently unutilized midwater industrial fish that have been reported in commercial quantity in the Gulf by the Bureau of Commerical Fisheries. Adequate power, seaworthiness and winch capacity provides the capabilities for exploiting the deep water royal red shrimp resource, he said.

The Subsidy Act requirement, stating that the subsidized vessel will not operate in a fishery if such operation would cause economic hardship to efficient vessel operators already serving that fishery, makes it "desirable if not mandatory," says Macy, "that the subsidized craft be designed and equipped as a multi-purpose vessel." This feature, permitted by the Subsidy Act, provides the flexibility needed to insure that the new vessel is not economically handicapped if it is ruled ineligible to participate in a given fishery.

Shrimp trawlers and other fishing vessels for which construction differential subsidies have been granted have, up to now, been of more or less conventional design, notes Macy. "No appreciable gain appears to have been made in effecting economies or fishing efficiency other than by increasing vessel size and power."

However, Macy explains, "The increased investment represented by these larger vessels is mainly based on the belief that return on investment will improve with greater carrying capacity and fishing efficiency. This belief is founded on the knowledge that as vessel size increases, the cost of construction per ton of capacity decreases, as do many of the operating costs when based on capacity tonnage alone. However, these advantages, inherent in the larger vessel, do not necessarily increase the profitability of the vessel. This is because the factors which contribute to gross income and operational costs are quite complex and vary in nature.

"The two basic factors that determine vessel net earnings are (1) the gross income and (2) the cost of maintenance and operation. Gross income is dependent upon a vessel's efficiency and the proficiency of its crew. Thus, it is irrevocably tied to catching efficiency and the number of days spent fishing. One of the inherent advantages of larger vessels is their ability to stay at sea for long periods of time, thereby reducing running time, and the ability to continue fishing under more severe conditions of wind and sea. It must be borne in mind, however, that the dollar earnings for crew and owner vary considerably with vessel size and design."

A vessel's profit margin, Macy points out, also varies with the amount of operational and maintenance costs which include such items as fuel, food supplies, gear replacement, crew wages, hull and machinery maintenance and repair, insurance, taxes, depreciation, etc.—all deducted from gross income. Thus, any reduction in operational and maintenance costs also produces increased profit.

"In an effort to start a trend toward reduced costs and increased efficiency in the shrimp industry," Macy suggests, "the use of all-aluminum vessels effect significant economies, increase production and enable these vessels to operate at a profit margin considerably better than that realized by conventional fishing vessels constructed from wood or steel."

He lists two basic reasons "why the use of aluminum will produce greater earnings for both owners and crewmen: (1) the low weight of aluminum as compared with other structural materials, and (2) aluminum's high resistance to corrosion in the marine environment.

"Lower structural weight means that a larger cargo can be carried with the same total displacement at the same power and speed, or the same cargo at increased speed with lower displacement resulting in more fishing days, or at the same speed with less power which results in a savings in fuel costs."

Summing up, Macy points out that an aluminum fishing vessel "will reduce maintenance and operating costs, increase production, and by its long-range capabilities will better enable the domestic industry to take and market its share of the resources of the world oceans." The added capability for long-range operation made possible by the low weight of the aluminum structure will permit the new 86-footer to operate in distant waters and still be able to land its catch competitively in a U.S. port, he concluded.

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420 Lexington Ave., New York, N. Y. 10017

"DESIGN CRITERIA AND ECONOMIC STUDY ALL-ALUMINIUM TRAWLER"

Prepared for The Aluminium Association

By Robert H. Macy,
Naval Architect & Marine Engineer,
Pascagoula, Miss.
12th May, 1966.

Made available by COMALCO INDUSTRIES PTY. LTD.

CHAIRMAN: MR. ALLAN PAYNE

DISCUSSION

Captain Bell: (Royal Australian Navy)

The form of our meeting this evening is something of a new innovation in that we have sent you all a copy of a paper which had been previously presented in the United States. It was prepared for the Aluminium Association by Mr. Macy who is a Naval Architect and Marine Engineer and through the good offices of Comalco they have made it available to us. It has been assumed that you will have read the paper and therefore we think the most profitable way of using our time is to immediately start the discussion. Your council felt that this particular paper fitted in very well after our two previous sessions in giving us another insight into the possible methods of construction of fishing vessels and equally a certain insight into the economics of this.

Mr. Allan Payne has offered to lead our discussion this evening. I don't believe that there are any more significant remarks I can make at this stage, and it would be appropriate to hand over the meeting to Mr. Payne.

Mr. Allan Payne:

I think I could best begin by reading a little note on Mr. Macy himself, and this has not been circulated. Mr. Macy received his degree in Naval Architecture and Marine Engineering at the Massachusetts Institute of Technology in 1933; he was with the Newport News Shipbuilding six (6) years, and then the Naval Weapons Research Establishment, then Naval Architect for the Coastguard two (2) years. He was Assistant to the President of Inglis Shipbuilding for thirteen (13) years in design and sales matters; for two (2) years he was adviser to the Minister for Public Works, Argentina on shipbuilding. He has been an independent consultant for the last ten (10) years and he has made 348 designs of vessels, mostly fishing boats, barges and off-shore drilling rigs. Since we did ask Mr. Macy some questions and he did reply, I think perhaps we should start with those. ("We" being Comalco and myself). We thought the claimed weight savings would be better understood if there was a midship section available for the steel, wood and aluminium boats. We did mention that another way of looking at the comparison of these steel, wood and aluminium ships was what you could get for the same money and then we noticed there were certain discrepancies in the speeds and displacements for a fixed horsepower and we asked about this. The explanation of how weight saving was made, which might come back in the form of a midship section, came back in a brief answer that weight saving applies throughout the hull on all items. What is the basis of comparison of the steel and aluminium ships is that the steel ship is to a certain classification society rules or to a certain minimum requirement; in other words, is it the lightest steel ship that it can be and is the aluminium vessel built to the same sort of requirements and the answer to that was pretty brief again.

Scantlings equal or exceed American Bureau - this probably is meant to apply to both the steel ship and the aluminium ship. I will come back to that in a minute. There is no data on what you get for an equal investment of money. This approach to the question has not been made. We come then to this business of speeds against displacements and I think the best way to disarm any criticism here is to talk about it from this side. Now, as the paper was produced, you would understand first, that the ships were of the same shape because on Page 8 you find the maximum displacement at 9' 6" draft is quoted as 264 tons for each ship (the aluminium ship, the steel ship and the wooden ship), so this suggests that they are all the same shape; and going on to Page 9, the lightest displacement is 112 tons, the aluminium ship does 12¼ knots; at the next displacement 150 tons, the steel ship does 11¼ knots; at the next displacement 170 tons, the aluminium ship (perhaps due to the higher polish) does 12¼ knots; at 208 tons displacement, the steel ship does 10.9 knots; at 264 tons (which is a greater displacement of course), the aluminium ship does 11.6 knots and so does the steel ship. You will find that sometimes the ship is getting heavier and getting faster which is good if you can achieve this.

Mr. Boden:

Am I right in saying that the displacement for the last condition, 9' 6", is heavy for the steel ship? Is that the intention?

Mr. Payne:

Yes, that is right. For the purposes of our discussion, if we had Mr. Macy here perhaps he could have given us a better explanation of the figures. The answers would have held together better.

A very interesting subject is aluminium vessels versus steel and wood vessels. Mr. Macy's paper applies to a ship which would be quite unusual in our experience. This is a ship which, although 80 feet waterline, voyages from the Gulf of Mexico to such places as North Africa, South America, to fish. It is an unusual or different fishing condition to anything we have in Australian waters. Now I will ask whoever raises his hand first to contribute something to this discussion.

Mr. Bryant: (Garden Island Dockyard)

Mr. Chairman, the first thing I notice is the tremendous difference in both fuel and water carrying capacity of the wooden vessel against either the steel or aluminium, and even allowing for the fact that the "Pollyanna" and this ship have got a skin 3" thick maximum and 6" frames, I think that you ought to fit something like, 3/4 anyway, of the fuel and water capacity of these steel and aluminium ships in the wooden ship.

Mr. Payne:

I think that is reasonable too. I am not here, of course, to defend Mr. Macy, but it does seem he has lost an awful lot of volume there in the wooden ship. As a matter of fact, on my own interest in the paper, I have concentrated on the comparison between steel and aluminium, what is the ratio between the tank capacities roughly.

Mr. Bryant:

On these, 26,000 against 10,000 which is 2½ to 1.

Captain Bell:

In fact the maximum is even worse. It is 48 against 10 - 4.8 to 1.

Mr. Payne:

In New Mexico, Texas, Louisianna thereabouts, a wooden ship is built out of soft woods with lots of great big members.

Mr. Bryant:

It would probably be built of hardwood framing and softwood planking. It would be Oregon planking. They would use either Mesquite or Oak for the framing and the framing should, in fact, in scantlings, be reasonably light because it is a very, very strong timber and I doubt whether the framing would be more than about 4" or 5" sizes.

Mr. Payne:

I did say to Comalco it is a great shame we don't have some drawings of the ship but time did not allow this. If the steel and aluminium ships rely on the double bottom type tanks, you could believe that the wooden ship would come off very badly by comparison.

Mr. Bryant:

Not necessarily, because if you wish to build double bottom tanks into the wooden ship, you can still use them.

Mr. Payne:

Suppose you have transverse floors sticking up?

Mr. L. Hedges:

Floors at every frame would make it almost impossible to go down to the shell.

Mr. Payne:

About the saving in weight - I believe that is reasonable, and I may perhaps ask Comalco to comment on that. I think it is quite normal that an aluminium structure of equal strength and stiffness to a steel structure weighs about half what the steel structure does, and if you allow a little less stiffness, you can still keep equal strength and get down to quite a little bit less than half of the steel.

Mr. Bryant:

They did not say anything about the specification of the aluminium in the trawler?

Mr. Payne:

No. Aluminium shipbuilding alloys are so well understood nowadays that it is hardly necessary to go into that side of the question. Would somebody from Comalco like to comment about comparative structure weights?

Mr. J. Hunt: (Comalco)

I think your figures are correct. A copy of a steel structure, in aluminium, would be of equal strength, equal stiffness - about 2 to 1. A re-design to take advantage of an exclusive extrusion design for the ribs and stiffeners make it even more favourable for aluminium. The alloys used for the ribs and stiffeners 6061; for the sheathing probably the 4% magnesium alloy 5083.

Mr. Payne:

5083. These are alloys that are very, very commonly mentioned in all the American literature on aluminium ship building.

Mr. Bryant:

Excepting 6061. This is a bit high in copper for what we are prepared to accept.

Mr. Payne:

Do you think so for internal framing?

Mr. J. Hunt:

The copper specification is 0.15 to 0.40%. In the American alloy you add chromium 0.15 to 0.35 and the complex alloy that you form locks away the copper so that it isn't in fact a corrosive influence and there is no free copper in that context. I would say that the corrosion resistance of this alloy in sea water is equal to the corrosion resistance of 4% magnesium alloy. In other words, in a high copper alloy you are worried about surface corrosion and ex-poliation which may occur, in that the skin starts to peel off like the leaves of a book. In high magnesium alloys you are more worried about the stress corrosion which allows a point or centre weakness which will split the whole material - a fatigue type crack which occurs in the stressed grain. The corrosion difference between these two alloys, 6061 and 5083, is insignificant and except where poor design occurs these alloys are free of corrosion problems.

Mr. Bryant:

We have had experience here at Garden Island with 6061 on radar antennae. In fact they were practically self-destructive and the expoliation was severe to the point where quite a number of members had to be renewed in place and these had to be metal sprayed or coated with zinc rich paint.

Mr. J. Hunt:

I checked the analysis on those for Barry Parkes. They were supposed to be 6061 but they were, in fact, 4% copper which is one of the 2,000 series.

Mr. Bryant:

Your 6061 has 1½% to 4% in the top range.

Mr. J. Hunt:

No. This is 0.15 to 0.40 of 1% in 6061. The problem of the antenna was the supplier's error. They claimed it was a 6061 type alloy but it wasn't. It was a structural aircraft type alloy with 4%.

Mr. Payne:

I would have thought it was pretty well established that the recommended marine alloy standard, by themselves, at least stand up remarkably well in sea water. They, for all practical purposes, don't corrode?

Mr. Hunt:

For all practical purposes they do not corrode. We have had a test at Bell Bay running for six years - tied in on a pylon at the wharf. It is a control sample to see what happens when ships are tied up and when ships are not tied up. 6061 alloy has not been affected at all. You scrape the barnacles off and you can polish it again.

Mr. A. Hunter: (H.M.A.S. "Nirimba")

It surprised me that he compared the cost saving without commenting as to whether this was a one off type for each wood, steel or aluminium. Obviously it is much cheaper to build many off so that the cost saving would be different for the three types, if you were only building one as compared to building perhaps 20 of each type. The other point he did not compare, as you mentioned, was the structural characteristics used in each case. In other words, the shape of the wooden boat internally could quite well have been different to that of the aluminium boat, brought about by the fact that the extrusions used as stiffeners could possibly have been of a very short cross-section as compared to a larger, wide wooden section.

Mr. Payne:

Yes, to give the maximum internal space.

Mr. Boden:

There is not that much difference in the fish hold capacity that doesn't measure up with the difference in the fuel capacity.

Mr. Payne:

Once again, it is a pity that we did not have drawings. There may be some explanation of this. It may be that the layout in the steel and aluminium ships is something that just can't be done in a wooden ship.

Captain Bell:

He has made it fairly clear in the note that the wooden vessel has insufficient fuel remaining for fishing and return as approximately half of the fuel is consumed in passage to distant fishing grounds. If fuel capacity is increased to meet demand of distant water fishing, practically all available internal space would be taken up with fuel tanks leaving insufficient space for the catch. This is because the shell can not be utilised for tanks as with steel or aluminium construction. It is considered that this deficiency alone precludes further consideration of a wooden vessel - (top of page 9). I personally think that is a gross exaggeration. His framing of the steel and aluminium must be exceptionally deep if it is going to provide the sort of fuel tank capacities he is talking about.

Mr. Payne:

Yes. I think to put it forward without drawings to support it is a bit hard.

Mr. J. Hunt:

Although if you consider some of these newer designs in rail tankers of aluminium and compare the same being in steel, you can build tanks by correct design of welding so that the tanks in themselves become stiffeners. In this case you are using actually the smooth bottom for the tank.

Mr. Payne:

We are allowing for this, that in the steel and aluminium ships all the walls of the tanks are made to be useful parts of the structure of the ship. These ships are quite unusual in their way of working, aren't they, with their 20 days on passage, even 40 days on passage in one case. A steel ship 41 days going from the North Gulf, west to the Gold Coast of West Africa.- normal days fishing, it says here, would be zero. In other words, that is normally, she would get out and back and that is all (this on page 13). The maximum days fishing she would have would be 83 days fishing on the Gold Coast. You can believe that in a situation like this a light weight ship that could get there faster or with less fuel or whatever, would really be of great advantage.

Mr. Bryant:

I think that there is a slight exaggeration in all these figures on Page 8, in the first two columns being identical for steel and aluminium. This is not so because aluminium, for the same strength, is much thicker than steel, so there must be some difference in capacities. I know it is slight but it should appear.

Mr. Payne:

Yes, this is so. I wonder if it is insignificant when you consider that a lot of the capacities the last two figures are zeros (0). I wonder if it would move past the last two figures; it might not.

Mr. Bryant:

I found with the minesweepers here that there was considerable loss of capacity in aluminium tanks due to stiffening as compared with the steel stiffening and I feel it would be significant even for the last three figures.

Mr. Payne:

Could this have been a tank which you know you sometimes get in a ship which, because of the structure requirements in that area, contains a lot of steel work or aluminium work and in a case like that it could be significant, whereas, perhaps in general, throughout a ship it might not amount to so much. I agree that if with these figures here, instead of zeros in the last two figures, you had a figure, then they certainly would be different.

Lieut. Fazio: (H.M.A.S. "Nirimba")

I am interested on account that at no stage can I see where any detailed construction with aluminium rivetting or welding has been used for construction on these boats. I have been charged with producing an aluminium vessel at H.M.A.S. "Nirimba" at a future date. I find that I am going to be very much up hill producing an all welded job. Would anyone in the discussion group care to enlighten me on which is the best or most suitable method of constructing a vessel, say about 40 feet in length?

Mr. Payne:

Could we refer to Mr. Macy's paper for a moment. I think he felt that it was not necessary for the purpose of his comparisons to go into the details of the construction, and depending on how long we stay strictly with Mr. Macy's paper we might refer back to that later on because Comalco's technical department would be delighted to help you.

Mr. Bryant:

I think we must assume both these vessels are welded.

Mr. Payne:

Yes, I should think so on an 80 footer in this day and age.

Mr. D. Dixon: (Maritime Services Board)

There are about three things I would like to elaborate on. Firstly, he makes a statement to the effect that due to the speed length ratio there is a limitation of speed. I would say from the photo that she is definitely a transom stern and if you will look at the waterline length of 80 feet on a speed of 12¼ knots I think you will find it is approximately 1.35. I would say with that type of a stern she should be able to go faster than 1.34 ratio.

Mr. Payne:

I thought that was quite remarkable too. On the face of it, it seems remarkable. Let us suppose that we believe that as from 112 tons displacement to 170 tons for the same horsepower, the ship doesn't change her speed at all, that she is doing 12.25 knots, and is fully extended. You could imagine a ship of such a shape with a pointed stern making a tremendous wave of a nasty shape but it is remarkable, from the economy point of view, that a ship that goes all this long way is the ideal ship. You read the early parts of the paper where the design is offered to operators for various purposes. You will see if you compare these things here that you can go from 112 tons to 208 tons displacement with hardly any change of speed which is surprising. If you go to Page 9 of the speeds and displacements there is a little note beside it that the ship's speed is limited to 12¼ knots by speed length ratio and as Mr. Dixon says, with their shape, surely she will do better at 112.

Mr. Dixon:

Further, I would say that she is definitely a multichine or a developed surface hull. I would say possibly penalising yourself on shape as compared to say, a tender vessel, would be conventional round bilge and this would be a reasonable assumption.

Mr. Payne:

There again we have not enough data, Mr. Dixon. Looking at this boat over here, a multichine job, I think could go faster than this - I can't see the ratio of 1.34 stopping it. I agree, on the other hand, don't you think that if the ship is at this bad point where the resistance is rising very rapidly with a small increase in speed, the change of resistance due from double chine to round bilge would hardly show up, assuming that she was a ship of that kind, that she was on the steep part of the resistance curve?

Mr. Dixon:

But I don't think it is that steep yet with that type of hull.

Mr. Payne:

I agree with you it should not be, but on the other hand when you see the quoted speeds and displacements it suggests that she is.

Mr. Dixon:

We add more fuel here. On your steel and labour and material costs I think you will find that the all up for steel is 71 tons fabricated for material costs is $202 per ton. Now the labour cost on that works out at $423 per ton. So the total cost of this in erected steel is $625 per ton. I would say that the Americans must be way back in the shipbuilding market at that price.

Mr. Payne:

I can not say anything on that. Perhaps someone else would.

Captain Bell:

The cost structure in the industry is such that this is not unreasonable.

Mr. Dixon:

But even if multichine, it would be very good to get that price. Barge work, yes, you would have straight work. You can produce barges and square work and get $540 to $600 per ton in this state. Now, we know America is much dearer cost wise, otherwise they would be building ships against the Japanese. It seems very tight at $626 per ton, i.e., labour and material.

Mr. Payne:

Are you quoting for the steel ship?

Mr. Dixon:

Steel only.

Mr. Payne:

Well, that is making Mr. Macy's paper more impressive. Perhaps you have something to say about the aluminium costs as well.

Mr. Dixon:

On the aluminium there is $932 per ton labour, that is based on 33.2 tons of aluminium, so virtually all he has done is just about doubled his steel labour costs. I feel it is reasonable to assume that he is using twice as much aluminium per ton so that the labour cost is nearly twice on this one.

Mr. Payne:

Per ton I am not sure. Any comment from Comalco on costs of fabrication per ton in these heavy sizes? Of course, we will refer it back to America.

Mr. J. Hunt:

I think you would have to accept their costing there; it is only the question now that if we were to make these boats here would the labour of manufacturing the steel boat versus manufacturing the aluminium boat be about the same?

Mr. Payne:

In effect he does do this. I have read a good many other statements that they say the same thing with people that are used to handling steel and with people that are used to handling aluminium in these sort of thicknesses and sizes the labour costs for the final structure work out to be much the same.

Mr. L. Hedges:

The yard which built Vic. Carter's "Tina" in Holland is quoting within 5% for yacht hulls in steel or aluminium and that is on curved work.

Mr. Payne:

This is a boat about 40 feet long out of about 3 mm. steel or 5 mm. aluminium.

Mr. Dixon:

That confirms these figures more or less.

Mr. Payne:

I think we can assume this is right.

Mr. Bryant:

As a matter of fact, the labour costs are very similar for steel or aluminium because what you save in the light weight of aluminium for handling it costs you for laying down bigger welds.

Mr. Payne:

More expensive welding but quicker, isn't that right?

Mr. Bryant:

Yes. In any case it works out about the same for labour, the material cost is very different and I don't know how the Dutch people can quote within 5% steel or aluminium for labour and material. There should be about a 25% difference in this.

Mr. Payne:

This is a yacht with a good deal of shape in it and it is possible that the forming is a lot quicker and easier in aluminium.

Mr. Dixon:

I think you will find on this article that the costs are not the same. You have 32 tons of aluminium at $30,000.00 labour which is $932 per ton; taken out in steel it is 71 tons at $30,000.00 works out at $423 per ton, so it is twice the cost.

Mr. Payne:

The cost per ton is twice but the cost for the finished article is the same. In fact, it is stated on Page 11, that the cost analysis estimate of structural hull item, that is the second item from the top, and then you have labour aluminium, labour steel and it is $30,000.00 in both cases. He has taken this standard assumption that labour is the same.

Mr. Dixon:

The third point I would like to mention is this lack of maintenance or comparative maintenance cost of aluminium. He brushes it off quite nicely by saying that the hull maintenance cost of aluminium boats will be lower than those for a comparable vessel of steel or wood. It is alright to say this but you have to support it.

Mr. Bryant:

There are a number of vessels around the harbour which refute his statement.

Mr. Dixon:

There are aluminium boats around the harbour that refute it too. The hydrofoil of the Port Jackson & Manly Co., has operated for two years and they are in trouble.

Mr. J. Hunt:

That is the method of treatment.

Mr. Nichol:

Compare the two. This boat we are speaking of is completely all aluminium. What about the one you are speaking of?

Mr. Dixon:

The hydrofoil is all aluminium. This is not the problem. It is inside the bilge water that is giving them trouble around the rivets. They are getting a jelly.

Mr. Bryant:

Because you have a potential there, you have two different types of material even if they were the same material to start with, once you knock the rivet back you have two different materials and galvanic corrosion.

Mr. Dixon:

Fair enough, and this is why I doubt this statement on maintenance costs. Admittedly, they have steel hydrofoils. They have a bronze propellor and a stainless steel shaft. I do not think this is so much the problem. They are having trouble keeping the paint on the hull. They have sand blasted the hull & put coal tar epoxy on and they still don't think they are in front. But, inside the rivets, in the bilges, are corroding. Now, I would say ordinary sea water should not corrode but when you get organic acids coming out of fish, I think there must be something in this. How will the aluminium stand up to this?

Mr. Bryant:

Any two slightly different aluminiums will corrode but the answer to this is to blast them and spray them with pure aluminium and this will stop it. You will, in fact, clad all these varying aluminium compositions. I have tried this and it works quite well. This is putting a skin over the top, in fact, you are cladding it with pure aluminium.

Mr. Boden:

Is it not a fact that where rivetting is used, the rivets should be dipped in some type of composition to prevent direct contact between the rivet and the surrounding aluminium?

Mr. Bryant:

This is a good idea.

Mr. Payne:

Virtually we are careful with rivet alloys and we are careful with the state of hardness of the rivets. For the applications that we provide boats, we have had no trouble. I think, getting back to Mr. Macy's ground, that he is talking about a welded aluminium ship and I think there is sufficient body of evidence in the past that these ships do stand up very well. I know of a yacht built in the United States called "Director". The builder has built a lot of aluminium yachts and he had an aluminium work boat which was completely unpainted and uncared for and he had to admit that the more he knocked it about the better it lasted. So this was one case where there was no trouble and I am sure there are many other cases such as this.

Mr. Hunt:

The individual case where you find there are some problems, you have to track that down and find out exactly why. The normal fish hold, made out of aluminium, has been going for so long and is acceptable. It is bright and clean and accepted by the Health Departments throughout the world as being a suitable material and it does not corrode and damage the food product.

Mr. Payne:

If the fish cargo is such that it is attacking the aluminium hold you will not be able to sell it.

Mr. Hunt:

He does comment but he doesn't say that the maintenance is nil. What he does say is that the maintenance of the hull for aluminium would cost about $1,500.00 that is compared to $4,500.00 for steel. This is the sample accounting sheet on Page 16.

Mr. Dixon:

Before that he says hull maintenance should be limited to hauling out and bottom painting only. That is rather odd isn't it?

Mr. Payne:

Do you think so? Supposing everything goes according to plan, that is exactly what you would expect.

Mr. Dixon:

The Port Jackson & Manly Co. would like to do this.

Mr. Payne:

But really Mr. Dixon this is not the same thing is it? This could well be a straight out mistake by the builders of the boat.

Mr. Dixon:

This is an aluminium boat working in the harbour here. We have something to talk about.

Mr. Bryant:

Of course, it is a question of whether they are using saucepan material or structural aluminium.

Mr. Dixon:

Lloyd's of London have assured the Manly Co. that the aluminium used in this vessel is the best available for marine uses. They are very worried about it and they have had these analyses taken out.

Mr. Hunt:

Lloyd's or Port Jackson?

Mr. Dixon:

Manly Co. have approached Lloyds and Lloyds had them out and this was the answer they received "that the materials used were the best available for this particular application". I am not here to down aluminium but I know of a vessel that they are having trouble with and this is why I like to mention it to give you food for thought.

Mr. P. Howard: (Comalco)

Mr. Chairman, if I may. We have statistics which we don't have here but can be obtained on fishing fleets operating in Alaskan waters. They have been operating for some years and it is actually a cross section of the fleet performance related to performance of vessels of other materials that they had in use before and this indicates that the low maintenance is in fact true. As Mr. J. Hunt said although Lloyds might say that the materials themselves are quite satisfactory, maybe some other weakness has crept into the design or structure that has not been tracked down and I suspect this is what has happened.

Mr. J. Hunt:

I think it is up to Comalco to have a look at this.

Mr. Howard:

We have not been asked to.

Mr. Payne:

It's all Supermar design and Supermar have now built about 78 of these hydrofoils and surely if they had had all this trouble all over the world they still would not be building the way they are. This is my basic thought on it.

Mr. Howard:

This is an overseas built vessel.

Mr. Dixon:

The first one was built in Japan and the new one has been built in Italy by Rodriguez.

Mr. Hunt:

Are they having any trouble with the new one?

Mr. Dixon:

It only arrived two weeks ago.

Mr. Bryant:

There is a lot of misconception about this because you get a lot of aluminium hydroxide and it blows up and blows the paint off. People tend to think the whole thing has failed but in fact you have lost very little metal. Very often, and if you did not bother to paint it, you would get a much better performance than if you try and put something on it to make it look pretty.

Mr. L. Hedges:

Only if you get a hard scale oxide, not if you get a powder.

Mr. Dixon:

It is definitely the jell they are getting and they cannot keep the paint on the vessel.

Mr. J. Hunt:

This is a hydrofoil and the fact that it does lie idle a certain period every day they have to keep the anti-fouling on it but in fact, the anti-fouling washed off so they then repainted the whole boat. This was done at a dockyard in Sydney. The method of doing it was to take the boat and just sand blast it. This you cannot do because you blast in any old paint and what you have done, immediately is to produce a series of electrolytic cells everywhere you have a bit of paint or a piece of sand blasted into the surface and you are creating problems in the surface. It occurs with steel but it is worse with aluminium so this is the first problem. The second is occurring in the bilges. I am not too sure because on that boat, the part where the blisters occurred after the first sand blasting and repainting was in fact in the area of the rivet heads. Now there is something wrong there. Maybe the rivets are loose or maybe they are loose when the boat is actually under strain when it crashes back down. The strain is sufficient to cause the rivets to move. If this occurs you are getting water in between the two surfaces of the rivet and aluminium and then you are sealing it off where air cannot get to it and this is the only reason you can get a jell. Where you cannot get air to the actual point of corrosion on the aluminium you must get a jell but if you can get air there it is impossible to form this jell.

Mr. Bryant:

I'll refute this. Obviously the reason it is corroding is because the composition of the rivets either from working or initial composition is different to other parent plating so that you have galvanic corrosion. You have a potential difference between the two materials. Now the only other thing to do with air, is one of differential aeration and this you will get. There is no question about this. If you have a space between the head of the rivet and the plate, but if they are loose to this point, then they are going to leak and if they are not leaking then they are not loose.

Mr. Hunt:

All they have is that the rivets corroded on the outside and are now corroding on the inside.

Mr. Bryant:

These are two different problems. One is due to the high copper content in the anti-fouling paint without a sufficient barricade and the other is due to the different composition of the rivets inside.

Mr. Hunt:

The second anti-fouling was not a copper anti-fouling at all. It could derive from the residue.

Mr. Bryant:

What was the second if it was not copper? What was the toxic agent?

Mr. Hunt:

An organic tin composition. After the first trouble they were worried enough to write to Japan and ask their exact recommendations. The first coat they put on was material supplied with the boat which they were completely unsure of the type of product as it was in unbranded tins.

Mr. Bryant:

There are two quite different problems inside and outside, and the problem inside is one which is common in all rivetted aluminium structures and boats. I have never seen a rivetted boat yet which didn't have this problem. I am not talking about dinghies and that type of rivetted boat.

Mr. L. Hedges:

Now to get onto general terms. There is a difference between maintenance on rivetted and welded steel ships because of a bit of working at plate joints and with floors. I think you will find there is a difference between welded aluminium and rivetted aluminium in large structures too.

Mr. Payne:

I think everybody is agreed on that.

Captain Bell:

If we are considering the maintenance cost we need to know something about how the steel vessel was treated. Was it just a standard steel structure which was allowed to rust then painted over with a primer and so on, or are they assuming the sorts of preservation which would normally be applied now to a new steel vessel? This, I expect, is pertinent and it depends if you put a little more into the initial capital cost of the steel vessel and protect it adequately but not as much as you are putting into the aluminium vessel. I think you could reduce the maintenance of the steel vessel to something of the same order as the aluminium vessel.

Mr. Payne:

I personally think that this is a really good argument. This is where we want to know some facts; the facts that all people who are considering building ships like this would really want to know. We well know that the upper works of a P. & O. liner just don't corrode or suffer in any way. No great amount of effort is expended on painting it really, but it gets regularly painted each time and it is just the same 30 years after as it was when it was built. With modern paints a fishing operator who made careful allowance for the maintenance requirements of steel might not have to pay out very much money at all. I think Mr. Macy makes a suitable disclaimer. He says here "the cost of maintenance depends on a number of variables. These include vessel age, individual practices, size of vessel and the nature of the fishing operation. Many owners will habitually postpone upkeep until extensive repairs are necessary, especially in times of poor fishing". All this sort of thing makes it very very difficult to make these sort of comparisons. I think that one point that would be put forward for aluminium is that with neglect you are just about as well off as you are with care, whereas with steel you have to have care. I remember reading of a wonderful system used by a Dutch fishing boat owner operating steel boats with a crew who were apparently frightened to the point that if they observed any damage to the paintwork they dabbed it with black coal tar. They were not allowed to use any paint, they had to use this black coal tar and when the ship was sufficiently spotted and at a suitable time the ship went into dock, for a carefully allowed time, for re-painting, and it was not given one brush of anti-corrosive paint and a final coat. The paintwork was renewed properly and these ships had no corrosion problems whatever. Now this is the best that you can do and with modern paints it is probably very good. In the present day when we are more scientific and better organised than we were years ago, this is one of the questions for somebody comparing aluminium and steel vessels. Mr. Macy makes the proper disclaimer. He does not help us very much and we would like to know the answer.

Mr. R. Holmes: (Cockatoo Dockyard)

Would you say that Mr. Macy figures on painting the bottom hull and leaving the superstructures and topsides just bare aluminium with no maintenance costs on the parts just left bare?

Mr. Payne:

He does not say so.

Mr. J. Hunt:

The cost of aluminium versus steel - everything is the same except the material which is basically the price of the steel versus the cost of aluminium.

Mr. Bryant:

This would be very sensible as there has been a ship steaming around the ocean for some years with the whole of her upper works unpainted and there has been very little corrosion.

Mr. Payne:

Steel or aluminium?

Mr. Bryant:

Aluminium.

Mr. Payne:

I think it might be a good idea to paint a large part of it fluorescent orange or something like that but otherwise leave it bare.

Lieut. Fazio: (H.M.A.S. "Nirimba")

Mr. Chairman. The aluminium trawler crayfishing boat in Western Australia, the "Lady Fatima", which is, I understand, unpainted from the waterline up, has been in operation for something like four or five years with no problems at all to date.

Mr. Payne:

Most people here will accept that an aluminium fishing boat could be operated with very little protective paint, probably nothing much more than the anti-fouling. I have asked questions about the effect of fuel oil acids when stored in fuel tanks but have not been able to find out very much.

Mr. Bryant:

The only problem is if you have a diesel and you have diesel fuel you will get cladosporium. This is a bacteria which is a sulphur abusic mixture which does dig holes in the aluminium but the actual fuel does not cause any trouble.

Mr. Payne:

No, it is the sulphuric acid that these things form, isn't it, that causes the trouble? I do not know how much of a problem this is with ordinary usage.

Mr. Bryant:

This is a serious problem in aircraft and it is a serious problem with fresh water tanks in some of our ships here.

Mr. Hunt:

This is a growth that occurs in tanks in specialised periods. Quite a lot of research is going on to discover how to cover the tank to prevent this.

Mr. Payne:

Perhaps there will be some additive developed for use in the fuel that will eliminate this.

Mr. Bryant:

They have not found one yet. In fact, this takes place at the water fuel interface because most fuel tanks have water in them and it initiates there and eventually goes right through the fuel but it takes some time. In a ship it is not such a serious problem as you are not going to fall out of the sky as with an aircraft. It is extremely serious if you have integral tanks in the structure.

Mr. Payne:

Aircraft tanks are coated with something to protect against this.

Mr. Bryant:

Yes, but it goes through them as well. Epoxy has been the best coating so far. It is a question of life expectancy with this too.

Mr. Dixon:

Have you any idea of the time factor there? Is this what they call straw that grows in the tank.

Mr. Bryant:

It does, it clogs all your filters. It is like an algae. After a while it looks like straw but it is not, it is an actual bacteria. Yes, normally about 18 months is the time at which the onset of this becomes known and it can do serious damage in the next two years.

Mr. Hunt:

In two years flying time of planes, fuel tank changes are recommended in the States. This is even for civilian aircraft with linings made of aluminium.

Mr. Payne:

So that somebody operating a fishing boat could probably afford to clean their tanks out completely once a year. Is this difficult? Is it expensive?

Mr. Bryant:

To clean it out - no - but they would do much better to coat their tanks, in fact, with an epoxy.

Mr. Payne:

This would be cheaper in the long run. Does the epoxy coating last for a long while?

Mr. Bryant:

Yes, it does last about four years and it may last longer.

Mr. Payne:

At the end of four years, do you have to try to get it off before you renew the coat?

Mr. Bryant:

No. At the end of four years you can treat it with an acid etch and just touch it up.

Mr. Payne:

It does not sound too bad.

Mr. Dixon:

Does it work quite well with aluminium?

Mr. Bryant:

Yes, if you etch the aluminium and get it back to a clean surface.

Mr. Payne:

Perhaps a fisherman who built an expensive aluminium ship, more expensive than steel, might be inclined to arrange to pump the residue of his tanks into some holder.

Mr. Bryant:

Once it is contaminated, he might as well pump it overboard.

Mr. Payne:

I understand there is no way of reclaiming contaminated fuel in which case it would be better to use the coating.

Captain Bell:

There is a factor in the sample maintenance schedule which, I believe, is worthy of looking into. In the figure for depreciation it stated that it is based on a straight line depreciation over a period of 20 years for aluminium and 12 years for steel. It seems to me that if you are looking in the high cost of maintenance for steel that you should get a better life than 12 years out of a fishing trawler and that this is a double allowance for the same thing.

Mr. Payne:

Yes, this is certainly a point to consider.

Mr. H. Owen: (Navy)

On the chart for maintenance, the steel vessel has been going for 20 years you will notice. It was built in 1946 and its last figure is 1965.

Mr. Payne:

Yes, I think when you start to write a paper about the maintenance of two fishing boats, one aluminium and one steel, you are a very brave man; you have a very contentious problem.

Mr. Hunt:

Now, how much cheaper do you think this aluminium boat would be to operate than a steel one, and if you were looking at it from that concept you would probably look for the boat that would confirm this. I think everybody would be thinking of a different boat, a type of steel boat of a different section.

Mr. Payne:

As an ex consultant, I could almost put it this way. Perhaps Mr. Macy was paid to do the design and then he was asked to do this as a sort of extra and this is a pretty hard job.

Mr. Bryant:

It is also a very dangerous pastime to get other people's opinions when they know what you are trying to find out. Everything becomes rose-coloured.

Mr. Howard:

Mr. Chairman, we are going to endeavour to try and obtain answers to all the questions if this is possible, from Mr. Macy, and we have arranged to pass all these questions to him. In fact, they are very interested that you gentlemen are holding a meeting on this paper and I think they would be very interested in all these curly (and otherwise) questions. He will do his best to answer all questions.

Mr. Payne:

Perhaps if Mr. Macy had known or had intended his paper for this sort of group he would have given us more information about speeds and powers, perhaps also given us some idea of the shape of the ship and so on, making quite a difference to our discussion.

Mr. Howard:

It may be slanted more towards fishing boat owners and operators.

Mr. Boden:

Is the discussion intended to apply to Mr. Macy's concept of the aluminium vessel in America or the concept of the aluminium vessel in Sydney or the Australian coast?

Mr. Payne:

I gather Mr. Macy's concept is of an aluminium vessel in America.

Mr. Boden:

Would it be pertinent to have some discussion as to how such a vessel would work out here under our conditions.

Captain Bell:

Yes. After all we are reading this knowing his assumptions relate to the U.S.A. but we are interested in what could be done in Australia, as to whether this paper gives us a valid point and already so many questions have been asked without answers, and we all would be very wary of applying this and building a similar aluminium boat in Australia.

However, any points that you could raise, Mr. Boden, would be most valuable.

Mr. Boden:

Number one point is that should a vessel run into trouble or difficulty, what are the present facilities for initial repairs. Presumably the work on the aluminium vessel does require some special capital costs. I gathered in discussions today that to purchase a T.I.G. set is worth about $600 while an M.I.G. set runs into something in the order of $2,000 and whether this kind of equipment and any other equipment that might be necessary for handling aluminium is readily available in Port Lincoln or in Eden or somewhere else where such vessels as we are talking about generally habitate is a real problem at this moment. It is a fact that you cannot very well interest people in building aluminium vessels until someone is prepared to go a little bit further ahead and set up the necessary plant and equipment for servicing aluminium vessels.

Mr. Payne:

I will refer this to Comalco but I think if someone produces the best material in the world for a certain purpose than you must go through this stage in starting to use it. Is there any comment from Comalco on the spread throughout Australia of fabricating equipment for aluminium?

Mr. Howard:

This is a problem today in the recognised boat building yard where they have not used aluminium construction before. If the vessel was built in aluminium by a recognised boat building yard then they would have the equipment initially and the necessary training and knowhow applied to their operators. Therefore, in that specific area the problem would be overcome but if something occurs where a plate has to be welded in a distance from the source of the equipment there is a problem, but there are some people in Australia today who are very good aluminium fabricators and are prepared to travel on a maintenance and repair project to do this sort of work. It certainly would obviously be more expensive to do this initially before the equipment is in the right place than it would be to repair a wooden vessel.

Mr. Hunt:

I ask the question as to what sort of damage you would really want to attempt to repair in, say, Port Lincoln, on any type of craft, particularly fishing trawlers.

Mr. Bryant:

One with a hole in it. A marker buoy coming through the side would make a reasonable sort of gash. I would point out that in a place like Ulladulla, even now, they generally resort to the local garage to weld up a steel vessel.

Mr. Hunt:

Is this the final repair job or does it get completed elsewhere?

Mr. Boden:

Yes, it is acceptable by the average owner as final. A repair of this type gets by and as long as the M.S.B. will accept it and as long as the vessel is seaworthy and there is no risk to personnel I don't think the M.S.B. would turn it down. I don't think they are looking for gild-edged repairs as long as it is a functioning vessel but whether the local garage could do the job with your aluminium vessel is another matter.

Lieut. V. Fazio:

I would say highly improbable in my case at H.M.A.S. "Nirimba". There are very few places in Australia that are as well or better equipped than we are to undertake welding of any major proportions and we find that with the Argonarc and Argonaut processes we have, we must shut the front door of the welding shop otherwise the wind will blow the gases away. I don't see how the local garages are going to cope.

Mr. Payne:

As against this, there is this structural damage to a fishing boat that would be pretty rare. It happens, but it is not very frequent and I think you could put up with the idea that you would have to get someone to load up a truck with gear and drive to a particular point. It might be easier, depending on the nature of the damage, to have the ship steam round to a point where the work could be done.

Mr. Bryant:

I think the ship would finish up with rivetted patches on it.

Mr. Hunt:

I think the rivetting would be given away and probably you would go for an epoxy cement.

Mr. Payne:

Yes, so that she could go round to some place where the job could be done.

Mr. Dixon: (M.S.B.)

In point of interest, at the Quay just recently, two Japanese trawlers came in and naturally they are not fitted with brakes and one rammed clean into the stern of the other. This happened in the morning. We walked over in the lunch hour and they had their own welding set on board. They had cut the plate out, (it had even broken up one of the fairleads on the stern) and they had even fabricated a bit of that up and by nightfall one of the crewman had fixed the whole vessel and they had painted it and went to sea that night. This chap had obviously served his time in a shipyard and he was one of the crew of the vessel, obviously an engineer - I suppose as a marine engineer.

Mr. Payne:

Is this practical with aluminium ships carrying your own welding gear on board?

Captain Bell:

I don't think you would put it in a fishing trawler even of this size.

Mr. Bryant:

You would if you were in a fleet as a mother ship.

Mr. Dixon:

These were small trawlers that had the welding sets.

Mr. Hedges:

I have been on a steel yacht at sea with a 32 volt Lincoln.

Mr. Payne:

I would not be surprised if there are steel fishing boats that have welding sets on board.

Mr. Dixon:

I think the day will come when we will see the aluminium fishing boats with sets in them too.

Mr. Payne:

Yes. These questions might have been asked five or six years ago when steel fishing boats were rare but now it is getting to be the other way around.

Mr. Boden:

There is still an antipathy towards steel on a lot of fishing fleets.

Mr. Bryant:

I did a survey on this not long ago and I found that the greatest objection that fishermen had to steel fishing vessels was that they burnt their feet in the summer and this is a real discomfort.

Mr. Boden:

There is another objection that has been raised, especially in connection with tuna fishing, that a steel vessel transmits noise - engine noises and others - far more than corresponding wooden vessels and for this reason it is thought that the steel vessel does not fish as well. I am not supporting this but this is a genuine statement made by quite a number of people who prefer a wooden vessel.

Mr. Trivett: (Garden Island Dockyard)

This was covered in the discussion of Mr. Cormack's paper.

Mr. Dixon:

I would agree with that because this is very true. We have steel vessels and we have wooden vessels and we have taken sound readings out on both and the noisiest vessel we have is the diesel-electric dredge, up to 107 decibels in the engine room. Our wooden vessels were relatively quiet. Even in the "Captain Phillip", we mounted the engines on Silentbloc mountings (even in a timber vessel) to get rid of the structural noises and with some success we have got rid of quite a lot of other noises, airborne too.

Mr. Payne:

It is claimed that aluminium structures are a little better than steel in this respect.

Mr. Hunt:

It has something to do with the frequencies of the noise. At certain frequencies you can get a lot of trouble with aluminium, but with other frequencies you get the same type of trouble with steel.

Mr. Hedges:

I don't think the owners of steel vessels worry very much and I think that is an owner's excuse when they don't catch fish.

Mr. Payne:

In the discussion the last time, the top boat in South Australia was a steel boat but, of course, she was also a new boat so it would be impossible to readily determine what the factor really was. Probably the best captain, fishermen, and crew went to sea in her because she was new. It may not have had anything to do with the ship at all. At least the fact that she was steel did not stop her from being the best boat.

Mr. Howard:

I understand the "Lady Fatima" in Western Australia is the best boat in the area.

Mr. Payne:

Yes, she certainly was, at least for a time.

Mr. Dixon:

Have you any information on the "Lady Fatima" you could give us?

Mr. Howard:

We have some information on aluminium fishing craft, actual operating experience, which I could provide. It does not have much detail about the "Lady Fatima" as it is only about two paragraphs but it is included in a world-wide survey of aluminium fishing vessels that have been operating since about 1950 or 1955.

Mr. Dixon:

There was a write up in one of the welding journals.

Mr. Howard:

I think probably the Department of Primary Industries, Fisheries Division, would give you more information on that than anyone else.

Mr. Hunt:

What sort of details were you thinking of?

Mr. Dixon:

The whole set-up based on this paper. If they could give us something specific on the maintenance this would clarify my views on it.

Mr. Hunt:

Virtually, it has been maintenance free. In other words they have spent nothing on it. Outside of the lazy times when not doing anything specific, someone does some maintenance, but so far as maintenance costs, when I was there about June or July, at that time the operators said "we have had no problems at all". They had run in and damaged a wharf but had not damaged the boat at all. The deflection characteristics were such that the aluminium deflected, then went back but with steel the damage would remain.

Mr. Dixon:

Have they got cathodic protection around the propeller or how do they overcome this problem?

Mr. Hunt:

Yes, they have got cathodic protection around the propeller.

Captain Bell:

Of what form - sacrificial aluminium anode?

Mr. Hunt:

A zinc anode. One of those heavy metal things.

Mr. Bryant:

Actually, if they used rubber bearings and a flexible rubber coupling they probably would not need any protection from the propeller, would they? That is insulating the propeller, in fact, from the hull.

Mr. L. Hedges:

Quite a number would like to know the answer to that question.

Captain Bell:

This is fine, provided you maintain your insulation.

Mr. Hunt:

You have to go all the way back to the engine, right through all the piping and leads.

Mr. Bryant:

No, you have to go back to the stern tube. You would have a flexible coupling mounted in rubber bearings and fill your stern tube with water to lubricate the bearings and you have complete insulation.

Mr. Payne:

This is done in some aluminium fishing boats I know.

Mr. Hunt:

Except that you still have the problem of differential electric potential on the boat versus the propeller.

Mr. Payne:

Certainly not. They are insulated and it can be done.

Mr. Bryant:

If you insulate you have no circuit.

Mr. Hunt:

You have the propeller at one potential, the boat at another and you have salt water in between.

Mr. Payne:

But you have no return to close the circuit. If anyone is trying this I think it would be advisable to vent the stern tube so that there was a constant stream of water through it otherwise you would have different water inside to outside and you would have a closed circuit.

Captain Bell:

You need to provide a flow of water to prevent overheating in any case.

Mr. Payne:

Yes, you would need that exchange of water anyway. You might mention the classification societies as aluminium versus steel because I know how you can build a steel fishing boat to Lloyd's requirements but I don't know how you go about building it in aluminium.

Mr. Bryant:

They make you build in scantlings above what you need. Usually that is a penalty.

Mr. Payne:

They should allow you the effect of the corrosion allowance that you don't with aluminium, ostensibly, but that is arguable. They might allow you that and then there is the question of what deflection they would allow you, whether they would want you to have the same deflection as the steel ship or the same stress.

Mr. Hunt:

What Mr. Leveau says in his paper is generally accepted that this greater deflection under load is permissable, and Lloyds Register, for instance, will allow deflection of up to 1/500 for the deck beams.

Mr. Payne:

This apparently is a greater deflection than that used on steel.

Mr. Hunt:

There is a handbook on this. This is Muckle's book from Britain. We have copies at Comalco; it is one that has been accepted by Lloyds. I have not read it deeply enough to be able to comment on what seems to be the difference.

Mr. Payne:

It refers to the design of aluminium ship structures by Muckle and you have copies of that also at Comalco.

Mr. Hunt:

Yes we have.

Mr. Payne:

No doubt that refers to talking to the Classification Societies because they would be the key to this wouldn't they? It would have to be something they would accept.

Mr. Bryant:

At one stage, Lloyds based their deflections on the characteristics of the weld zone rather than the parent plate and this was quite a case for aluminium and whether they have overcome this I don't know.

Mr. Boden:

As a rule, what would be the effect of building an aluminium vessel to the same scantlings as a steel vessel?

Mr. Bryant:

It would be one third as strong.

Mr. Hedges:

One third the weight and about half the strength is more correct.

Mr. Hunt:

The comparisons that I can make at this stage are the American steel alloys and the ship steel A.S.T.M.A. 131, the relationship between that and the two types of aluminium alloy used, the plate and the extrusions which replace rolled joists. 230 strength to weight ratio, 230 for the steel, 460 for the extrusion and 480 for the plate, so it is just about 2 to 1, so that the aluminium is half as strong as the steel but one third the weight.

Mr. Bryant:

On the other hand, your connections are not nearly as strong as the plate and this normally reduces your whole structure to about one third the strength of the cell.

Mr. Hunt:

Are you talking of a butt weld or a weld between sections?

Mr. Bryant:

Seam welds or any welds, it does not matter.

Mr. Hunt:

The strength that is accepted on that is the yield strength of the aluminium itself. The yield strength of 6061-T6 is 40,000 lbs/sq. in. while standard ship steel is 33,000 lbs/sq. in.

Mr. Bryant:

Yes, but yield strength does not apply to 6061 in the weld zone.

Mr. Hunt:

Yes.

Mr. Payne:

That is as laid down in the weld, that is what the yield strength would be, deposited.

Mr. Hunt:

No, the yield strength, the ultimate strength for that is around about 48,000 lbs/sq. in. for alloy 5083, and it drops to 40,000 lbs/sq. in. in the welded area whereas the steel at 66,000 lbs/sq. in. when welded drops down to 33,000 lbs/sq. in.

Mr. Boden:

You mean that in each case the aluminium retains a higher yield value than the equivalent steel?

Mr. Hunt:

In the welded areas, yes.

Mr. Nichol: (Sydney Technical College)

Are you quoting a high tensile steel or a high yield steel?

Mr. Hunt:

No, standard ship's plate.

Mr. Payne:

Then this comparison would be valid if thicknesses were the same from one material to the other, wouldn't it?

Mr. Hunt:

Yes.

Mr. Boden:

Where does the half strength come in? If I understood you rightly before, you said the weight was about one third but the strength is half.

Mr. Hunt:

This is taking a piece of material versus a piece of aluminium versus a piece of steel of the same section. If we consider a welded structure you look to find your weakest zone and it obviously is the welded area. In the aluminium area it isn't quite annealed but in the steel area it must be annealed so that your design characteristics will vary.

Mr. Boden:

Perhaps I misunderstood you. The yield value that you gave us for aluminium alloy 6061 was something of the order of 40,000 lbs/sq. in. and in steel 33,000 lbs/sq. in. and yet in the structure as a whole, the aluminium structure is not as good as the steel structure for the same size, same condition.

Mr. Hunt:

No, this is replacing one for one.

Mr. Dixon:

The facts being that if you try to duplicate that condition you would have to use a different welding arrangement. You put your welds in a different place. You don't normally use straight butt joints. Trying to get equivalent strength right through you would have to use a lap.

Mr. Bryant:

Use of a lap is a very bad welded joint.

Mr. Payne:

This is very bad.

Mr. Payne:

Suppose we had a simple tension member which was subject to some sort of fluctuating load but always in tension. Probably a shipbuilding yard would just make a plain butt joint and would not try any fancy reinforcements or diamond plates or anything like that - just a plain butt joint in steel and I suppose you would do the same thing in aluminium. The interesting strength in each case is the yield strength of the steel, if the welded butt material would behave in that way. It is the 0.1% proof stress in the aluminium if its material would behave that way in the weld and I think it would. I gather that section for section the aluminium joint would actually be stronger.

Mr. Hunt:

Yes, in the direction of the weld and in tension only.

Mr. Boden:

If I may follow on your thoughts, let us go away from the weld now, to the same piece of plate that has been joined - how does the basic aluminium material compare with the basic steel material?

Mr. Hunt:

It would probably be easier to put it on the board.

	Ship Steel	5083	6061-T6
Weight per cubic inch	0.129	0.096	0.098
Ultimate Tensile	66	45	45
Yield Strength	33	32	40

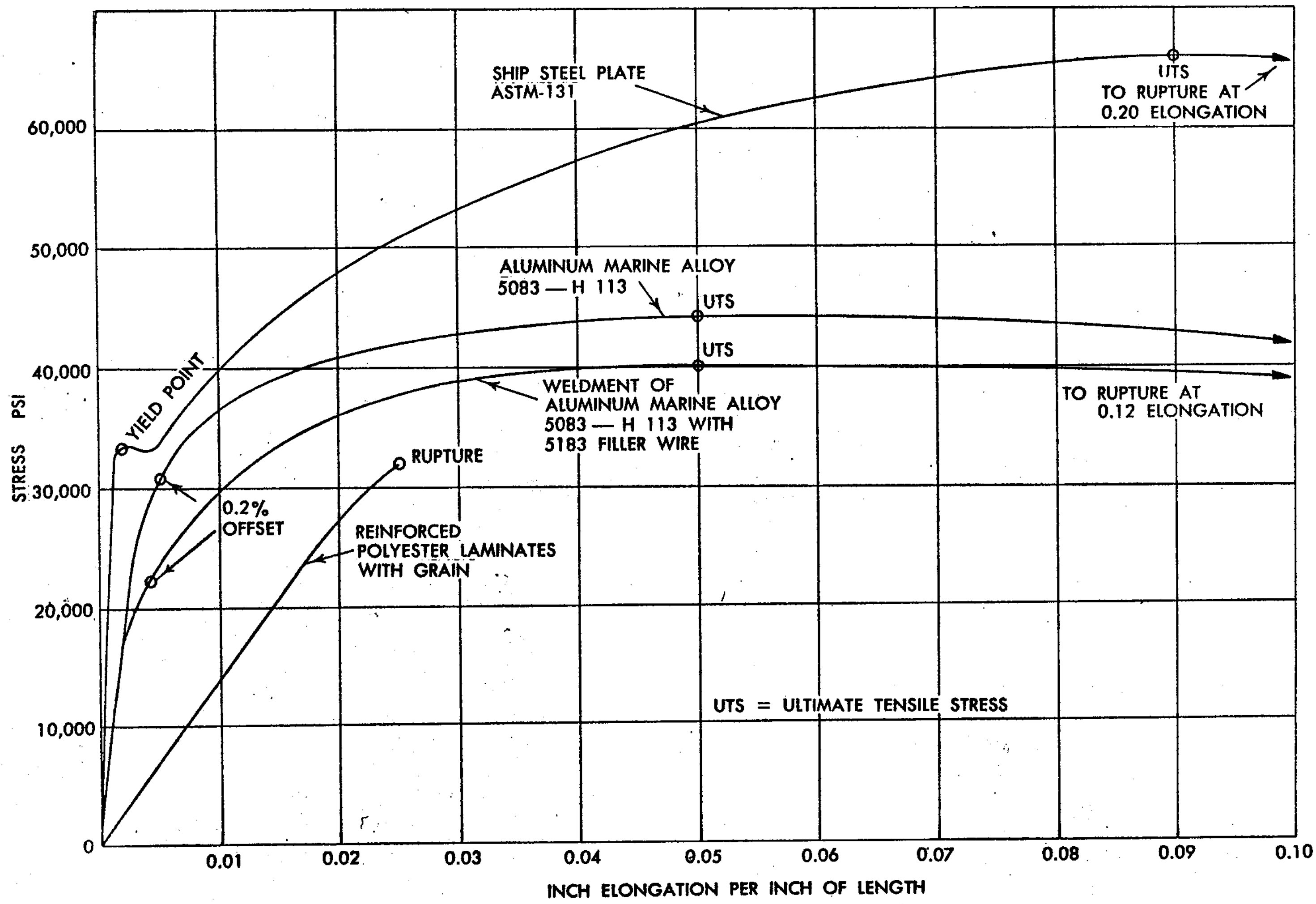

Fig. 1 — Typical stress-strain diagrams for hull materials.

If we take the tensile strength related to this we get a certain figure and here to this a different one, so that ratio in this case, using the ultimate it is 480, 460, 230,200.

Now, that is the unwelded condition of materials if we weld the figures that I can remember, of this alloy, the design strength which is the U.T.S. on this drops to 20,000 lbs, and the design strength on M.S. drops to 20,000 lbs. So, in any welded joint you can forget whether you are using aluminium or steel because, in fact, the co-relationship of the weld metal, this is taking that. If it is a butt joint you have left the metal present, whether steel or aluminium, the total area which is annealed partly in perhaps this small area either side, this is stronger than the plate either side and this is back to normal plate.

Mr. Bryant:

So you don't gain anything in weight by using aluminium.

Mr. Payne:

Yes, but this is on a sectional basis.

Mr. Bryant:

I understood they were on a weight basis.

Mr. Payne:

This is on a sectional area basis all the time.

Mr. E. T. Bell: (Navy)

I think the yield strengths would drop in about the same relationship.

Mr. Hedges:

The big problem in practical cases, as I see it, is that you can produce fairly good quality welds in steel with a reasonable tradesman and you need a good tradesman for good quality welds in aluminium and there is a big difference.

Mr. Boden:

Following your question - is it any more difficult to weld uphand in aluminium than it is to weld steel uphand?

Mr. Howard:

I am not a welding expert unfortunately. Our welding man is not here tonight. In our experience, and we have done a lot of training of aluminium welders, men who have been experienced in steel and men who have not actually had very much welding experience at all, and with the training that we have been able to give them we have good structural results. I would like to comment on the various horizontal, vertical, downhand, uphand types, but I think that in most cases we have found it is a little easier.

Mr. Hunt:

It depends on the operator, but the one I am thinking of does, on 3/16" thick sheet, 15" a minute on an uphand, vertical.

Mr. Boden:

There is a very critical temperature with welding aluminium. It does not take very much to reach the point where you lose the whole bead.

Mr. Hedges:

It depends on the operator.

Mr. Hunt:

It is the type of machine you use. If you use one with a drooping current, that means as you move away from the work the arc will close off rather than increase the potential to make the arc longer, this is then automatically compensated by feeding the wire faster through this type of machine. M.I.G. is probably the best type of machine, one with which you cannot splatter.

Mr. Boden:

Would this apply mainly to all the M.I.G. types?

Mr. Hunt:

That is the M.I.G. I think on most of this work that we are talking about. Here it would be all M.I.G.

Mr. Howard:

Which is a consumable electrode type machine.

Mr. Hunt:

We haven't the best equipment in this country as yet, that is the equipment they are using in the States. In other words, what is used in an ordinary common shipyard in the States isn't available in Australia to be used by anybody at this moment, but it is coming. The demand, I think, has been three orders placed in the last fortnight for welding machines from the States, on machines which we had to write the specification out for the local company to import from overseas, from the States and one from France.

Mr. Dixon:

In the test result on the weld, say a tension test, does it break outside the weld in the metal adjacent to the weld, similar to a steel break?

Mr. Hunt:

Yes, it is within ¼" of the edge of the weld bead.

Mr. Dixon:

Is it anywhere near the strength of the parent metal or is it a reduced strength?

Mr. Hunt:

It is on those figures (given above) about 20,000 lbs ultimate as against about 47,000 lbs (indicate on blackboard) for 6061-T6 alloy. This is yield in lbs/sq. inch in thousands and for 5083 plate, the yield drops from 32000 p.s.i. to 24000 p.s.i.

Capt. Bell:

Well gentlemen, we have had a very good discussion on this Paper. I see time is marching on and I would personally like to say that we are very grateful to Mr. Howard for providing us with the Paper. Frankly, there are some advantages in having a few unanswered questions as we have derived more intellectual exercise, and I think, satisfaction out of the Paper than if perhaps it had been a polished product with all the questions fully answered. With these remarks, perhaps you gentlemen would like to express our appreciation to Comalco for making this Paper available.

CARRIED BY ACCLAMATION.

THE USE OF THE MAGNESIUM ALLOYS OF ALUMINIUM IN MARINE APPLICATIONS

Three major problems are involved in selecting a material for marine construction -

1. Strength
2. Corrosion resistance
3. Resistance to stress corrosion

Other factors examined in conjunction with these are material cost, fabrication costs, weight, fire resistance and impact resistance. The superiority of aluminium with respect to the latter four of these factors is well established.

The alloys of magnesium in aluminium have been used for marine applications for over 40 years and in an effort to increase the strength of these alloys the magnesium content was increased 3 to 6 per cent. Some stress corrosion problems occurred so that a complete research programme was carried out to determine the highest strength alloy suitable for marine use. Kaiser introduced the alloys 5086 and 5083 and the results of 10 year tests on these alloys at the U.S. Navy Marine Engineering Laboratory at Annapolis were recently published in the U.S. Journal "Corrosion" March, 1966, indicating their suitability.

SEA WATER CORROSION:

The results obtained after 7 years 4 months on the 5005 (¾% mg), 5050 (1% mg), 5357 (1% mg), 5052 (2¼% mg), 5086 (4% mg) and 5083 (4½% mg) showed that although the area covered by salt water had fouled with marine growth only superficial surface marking was present and the tensile tests showed no loss in yield strength or elongation of the material. Tests were made on samples totally immersed in sea water, partly immersed in sea water and suspended in air above the sea and all results obtained were satisfactory.

STRESS CORROSION:

The stress selected was equivalent to 75% of the yield strength of the material and both welded and unwelded samples were tested. The alloy 5083 was found to contain the highest amount of magnesium and therefore the highest strength after welding which showed little corrosion and no stress corrosion cracks after 10 years' exposure in marine conditions.

The deepest corrosion effect on any of these alloys after five years' exposure was only five thousandths of an inch.

The results of these tests confirm the excellent corrosion behaviour of the Aluminium Magnesium alloy in marine environments and the selection of these alloys for welded structures will ensure a long low maintenance life of the vessel both large or small. The use of the casting alloys 135, 160Q or 320 will ensure a similar long-life for the fittings.

JAMES R. HUNT