# **BTE Publication Summary**

# **Fuel Efficiency of Ships and Aircraft**

## **Working Paper**

This Working Paper examines past trends in the fuel efficiency of ships and aircraft, and looks at technical developments and economic factors which could yield further improvements. The periodto 2005 has received attention because of the Australian Government's 1990 decision to adopt the Toronto target, as an interim planning measure. This target involved a reduction in emissions of greenhouse gases not controlled by the Montreal Protocol to 20 per cent below 1988 levels, by 2005.





Bureau of Transport and Communications Economics

## **WORKING PAPER 4**

# FUEL EFFICIENCY OF SHIPS AND AIRCRAFT

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#### FOREWORD

This Working Paper was compiled as part of the Bureau's ongoing research examining greenhouse gas emissions from Australian transport, the initial output of which was BTCE Working Paper 1 Greenhouse Gas Emissions in Australian Transport. The current study on the fuel efficiency of ships and aircraft was initiated by a request from the Australian Bureau of Agricultural and Resource Economics (ABARE) for information to assist in projecting energy usage in various sectors of the Australian economy.

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Bureau of Transport and Communications Economics Canberra November 1992

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#### ABSTRACT

This working paper examines past trends in the fuel efficiency of ships and aircraft, and looks at technical developments and economic factors which could yield further improvements. The period to 2005 has received attention because of the Australian Government's 1990 decision to adopt the Toronto target, as an interim planning measure. This target involved a reduction in emissions of greenhouse gases not controlled by the Montreal Protocol to 20 per cent below 1988 levels, by 2005.

A simple spreadsheet model is used to estimate future fuel usage by the Australian fleets of ships and aircraft, in both domestic and international transport. The model takes account of the current composition and possible replacement patterns of the Australian fleets, the likely rates of improvement in fuel efficiency, and forecasts of the various transport tasks. Possible effects of economic factors bearing on fuel use are considered. Finally the paper presents tentative estimates of future changes in emissions of carbon dioxide from Australian fleets of ships and aircraft, considering the predicted improvements in fuel efficiency and some tentative projected increases in task growth.

#### SUMMARY

This paper forms part of the Bureau's ongoing research on greenhouse gas emissions, the initial results of which are contained in BTCE Working Paper 1 Greenhouse Gas Emissions in Australian Transport. The original impetus for the paper was a request from the Australian Bureau of Agricultural and Resource Economics (ABARE) for information regarding trends in fuel consumption rates for ships and aircraft to assist in formulating projections of Australian energy usage.

The paper considers the potential for improvements in ship and aircraft fuel economy, and the fuel economy and total fuel consumption of the Australian fleets through to 2005, given projected growth patterns. Possible consequences for emissions of  $CO_2$  from the Australian fleets of ships and aircraft are indicated.

Coastal shipping is estimated to be responsible for less than 4 per cent of Australia's emissions of greenhouse gases, and aviation about 6 per cent. While international shipping and aviation generate large amounts of emissions due to the distances involved (BTCE 1991), currently, Australian international fleets carry only a small percentage of our international trade task and less than half our international travel task.

#### SHIPPING

Over the past 20 years there has been a considerable improvement in the fuel efficiency of shipping. An International Energy Agency (IEA) index of the energy intensity of world shipping from 1973 to 1984 shows a reduction in intensity of over 35 per cent, with a high rate of improvement in the mid-1970s and in the later part of the period covered. Data from the Australian National Maritime Association show improvements in fuel efficiency for Australian coastal ships from 1975 to 1987 of 19 per cent for general cargo vessels, 50 per cent for bulk carriers and 29 per cent for tankers.

Recent replacements of Australian ships with more fuel efficient (and smaller crewed) vessels have been encouraged by the Ships Capital Grants scheme (1987) and the Maritime Industry Development Committee (MIDC) scheme. By 1997 almost all ships in the major trading fleet built before 1982 are expected to have been replaced or have had replacements ordered.

For the future, no great improvements in overall engine efficiencies are foreseen for larger marine diesel engines, efficiency are but increases in propulsion system still possible. Higher thermal efficiencies are still theoretically turbocharging and turbo-compounding, possible from from ceramic coated engine components, automated engine monitoring systems and from technologies which management will and improve part-load fuel economy, such as variable exhaust closing and variable injection timing. Efficiency gains are also possible from hull appendages aimed at wake vortex smoothing and from new propeller designs. From scrutiny of the technology and of fleet replacement patterns, the average efficiency of the Australian-flag fleet might be expected to rise by 20 to 25 per cent between 1988 and 2005.

Estimates of future fuel consumption were made with the use of spreadsheet model which listed each ship, and its fuel a consumption per day, in the Australian coastal major trading fleet (over 2000 deadweight tonnes), and in the Australianfleet. It was assumed, unless flag international more information was available, that ships would definite be replaced at age 15 years (or 1992 if this age had aready been reached by that year), by a ship built in the year prior to replacement. Fuel consumption of the replacement vessels was estimated by regression equations developed from data on existing ships.

The model suggests that, should replacement vessels be of the same size and operate at the same speed as the ships they replace, the average rate of fuel consumption for the Australian-flag international fleet could drop by about 20 per cent between 1988 and 2005. This represents the trend rate of improvement in the fuel consumption of existing diesel ships of various vintages when applied to the replacement pattern of the fleet. It is probably close to an upper bound of possible reductions because of the improvements over the past couple of decades, but technical considerations suggest that it is achievable. Additional gains of about 8 percentage points could be achieved if the each ship were replaced by a vessel of 10 per cent larger deadweight tonnage which was operated at a 10 per cent lower speed to achieve the same carrying capacity.

For the coastal major trading fleet there is an additional factor to be considered. This is the existence of four large coal burning ships which could be replaced by motor ships burning a fraction of the tonnage of carbon-containing fuel. Just over half of the improvement projected by the model is from the assumed replacement of these four coal burning ships with fuel oil-burning motor ships. The model suggests that for the coastal major trading fleet as a whole, the average rate of fuel consumption could fall by about 40 per cent between 1988 and 2005. About 90 per cent of the projected fuel efficiency improvement could be achieved by replacing existing ships, when they fall due for replacement, with vessels having levels of fuel efficiency already achieved by modern diesel ships. When a ship life of 20 years was assumed, these improvements in fleet average fuel efficiency by 2005 were reduced somewhat.

#### AVIATION

The energy intensity of aviation (in terms of fuel burned per seat-kilometre) in OECD countries declined by over 35 per cent from 1973 to 1983, according to the IEA. One airliner manufacturer expects the overall fuel-efficiency of the global jet fleet to continue to improve, with an increase of 34 per cent from 1989 to 2005. The narrow-body segment is expected to increase its fuel-efficiency by about 42 per cent from 1989 to 2005 as larger aircraft are introduced and chapter 2 aircraft are replaced by the quieter chapter 3 aircraft. The latter feature high by-pass engines, which besides being quieter, are typically 30 to 40 per cent more fuel efficient than chapter 2 equivalents. These efficiency improvements may moderate the increase in emissions which might be expected from the large projected increases in the numbers of aircraft. Boeing foresee an increase of two-thirds in the world jet fleet between 1988 and 2005.

Future fuel economy gains will come from increasing aircraft size, improved aerodynamics, reduced weight from advanced materials and from progress in engine design, with the rate of progress likely to be influenced by future fuel price levels. However, because of the lifespan of modern airliners, especially wide-bodied planes, many already in service are expected to be still operating in 2000. Every wide-bodied plane built to date would still be structurally capable of flying in 2000, many with still 10 years of useful life. Many of the newer wide-bodied models, such as 767s and A310s, should still be in production, as it takes at least 10 years' production to generate a profit.

Another spreadsheet model was developed to estimate changes in aircraft fleet average fuel efficiency from base year 1988. The model lists each passenger aircraft in the Australian domestic airline (not including commuter airlines) and its fuel consumption per seatinternational fleets and kilometre. It was assumed for the base case, unless more definite information was available, that each aircraft would be replaced at age 15 years. This short economic life reflects an assumption of increasing real fuel costs in the future and also ongoing improvements in aircraft fuel economy.

The model indicates, for the base case, trend domestic fleet average fuel economy improving by some 33 per cent between 1988 and 2005. If the existing size mix of aircraft in the domestic fleet were to be maintained, then the amount of fuel

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used would grow by about 35 to 40 per cent over 1988 levels by the year 2005, at projected traffic growth rates (FAC 1991). When an aircraft life of 20 or 25 years is assumed, improvements in fuel efficiency are reduced.

The model was also used to examine a scenario where it was assumed that all existing aircraft in the domestic fleet were replaced by the most fuel-efficient large and small aircraft in the current fleet: A300-600Rs and F50s, instead of with aircraft having efficiencies estimated by regressions on existing aircraft of different vintages. This scenario resulted in a 96 per cent increase in fleet average fuel efficiency between 1988 and 2005. Clearly, the improvements in fuel efficiency which would be possible if economies of aircraft size could be achieved throughout the fleet greatly outweigh the likely improvements from technical advances in aircraft and engine design.

For the Australian international fleet, the base case improvement in fuel efficiency was about 28 per cent.

#### CHAPTER 1 INTRODUCTION

This paper explores the potential for improvements in the fuel economy of Australia's fleets of ships and aircraft. The work developed from an initial requirement for data for the Bureau's ongoing research on emissions of greenhouse gases from the transport sector, and a request from the Australian Bureau of Agricultural and Resource Economics (ABARE) for information regarding trends in fuel consumption rates for ships and aircraft to assist it in formulating its projections of Australian energy usage.

The Bureau has reported the initial results of its research on greenhouse gas emissions from various modes of transport, and on ways of reducing these emissions, in BTCE Working Paper 1 Gas Australian Transport. Emissions in Greenhouse Improvements in fuel economy of vehicles and vehicle fleets are of major significance in considering the likelihood of achieving either the Federal Government's interim planning target to reduce greenhouse gas emissions not controlled by the Montreal Protocol to 20 per cent below 1988 levels by the year 2005, or even the lesser demand arising from the UN Rio Conference framework convention, which asks that developed countries aim to return emissions to 1990 levels by 2000.

The great bulk (about 98 per cent) of Australian greenhouse gas emissions from domestic transport is comprised of carbon dioxide  $(CO_2)$  and carbon monoxide (CO), which eventually oxidises to  $CO_2$ . For aviation and shipping the percentages are 92 and 99 per cent respectively. Much of commercial aircraft emissions is generated at considerable altitudes and may be more damaging than emissions generated at ground level. This applies especially to oxides of nitrogen  $(NO_x)$ , which may have stronger greenhouse effects when emitted from aircraft engines than from, say, motor vehicles. The  $NO_x$  leads to an increase in tropospheric ozone, which is an active greenhouse gas at these altitudes. The proportion of  $NO_x$  in total emissions is likely to increase with increasing engine fuel efficiency, and the higher engine combustion temperatures this implies.

Chapter 2 describes recent trends in the fuel efficiency of ships and likely advances in the period of interest, that is to 2005. Chapter 3 presents the results of spreadsheet models of the potential fuel efficiency gains to 2005 for the Australian fleets of coastal and international ships. Chapter 4 examines recent trends and likely future developments in the fuel efficiency of commercial airliners. Potential fleet fuel efficiency gains to 2005 for the Australian fleets of domestic and international aircraft are assessed in chapter 5. Chapter 6 presents the conclusions of the paper concerning fleet fuel consumption and emissions. Appendix I shows printouts for the ship fleet models, while appendix II shows those for the aircraft fleets. Appendix III presents some tentative estimates of the effects of fuel economy changes on emissions of CO<sub>2</sub>, the major greenhouse gas.

#### CHAPTER 2 TRENDS IN THE FUEL EFFICIENCY OF SHIPS

This chapter examines past and likely future trends in the rate of fuel consumption of ships arising from technical developments and changes in ship size and operating speeds.

#### RECENT TRENDS IN SHIP FUEL EFFICIENCY

Over the past 20 years there has been a considerable improvement in the fuel efficiency of shipping. Figure 2.1 shows a graph of an index of the energy intensity (based on world bunker oil demand divided by laden tonne-miles) of world shipping from 1973 to 1984 (IEA 1987) which shows a reduction of over 35 per cent, with a high rate of improvement in the mid-1970s and in the later part of the period covered, after the oil price 'shocks' of 1973.

Table 2.1 shows data for the average fuel efficiency of those vessels of the Australian-flag fleet wholly or partly engaged in the coastal trade, presented by the Australian National Maritime Association (ANMA) to the IAC inquiry into coastal These data show improvements in fuel shipping (IAC 1988). efficiency of 19 per cent for general cargo vessels, 50 per cent for bulk carriers and 29 per cent for tankers. ANMA attributed these improvements in fuel economy to increasing ship size, to lower design speeds, more energy efficient improved hull designs and engine technologies, surface finishes (eg. self-polishing antifouling paints).

A Department of Transport and Communications (DoTC) source considered that the big improvements in fleet fuel efficiency have been made, as the ships built when fuel was not such a large cost factor have largely been replaced. Table 2.2 shows some Australian examples of fuel efficiency gains for various types of ships, both coastal and overseas trading vessels.

The move from steam turbines and gas turbines to diesels after the oil price shocks of the 1970s gave a large fuel efficiency increase (see table 2.3), which is unlikely to be repeated. Figure 2.2 shows the past rate of improvement in the fuel efficiency of marine diesel engines (Verhelst 1990). Increased efficiency is claimed for new larger bore, slower running diesel engines. The low speed diesel had 73 per cent of the overall market on a brake horsepower (bhp)-installed basis in 1989, and it is considered that the diesel will remain the dominant prime mover for merchant ships in the foreseeable future (Seatrade Business Review 1989a).

TABLE 2.1 AUSTRALIAN FLAG COASTAL FLEET FUEL EFFICIENCY 1975 TO 1987 (TONNES/DAY/000DWT)

	1975	1980	1985	1987
General cargo	3.68	4.13	3.22	2.97
Dry bulk	1.04	0.92	0.74	0.52
Tankers	1.23	1.14	0.86	0.75

Source IAC (1988) - ANMA submission no.38, pp18-22.

## TABLE 2.2EXAMPLES OF FUEL CONSUMPTION OF REPLACEMENT SHIPS IN THEAUSTRALIAN-FLAG FLEET

Size (DWT)	Speed (knots)	Fuel consumption (per day)		
1981 bulk 141 000 replaced by	14	60 tonnes fuel oil + 1.5 tonnes diesel		
1985 bulk 148 000	14	45 tonnes fuel oil + nil diesel		
1968 tanker 19 000 replaced by	14	36 tonnes fuel oil		
1989 tanker 32 000	13	19 tonnes fuel oil		
1974 bulk 27 000 replaced by	15	36 tonnes fuel oil + 2 tonnes diesel		
1984 bulk 37 000	15	25 tonnes fuel oil + nil diesel		

Source Department of Transport and Communications.







S = slow speed engines

M = medium speed engines

bhp = brake horsepower

Source: Verhelst (1990)

FIGURE 2.2 TREND IN THE RATE OF FUEL CONSUMPTION OF MARINE DIESEL ENGINES

	Years	(grams of fuel / horsepower/hour)
Gas turbine	1950s	230-350
4 stroke medium speed diesel	1967	153-162
	1988	126-129
2 stroke low speed diesel	1963	155
. –	1968	155
	1976	144
	1979	133
	1982	116

TABLE 2.3 EXAMPLES OF INCREASES IN MARINE ENGINE EFFICIENCY

Note In 1980 there was a 20 per cent thermal efficiency gap between diesel and steam turbines, which Harrold considers would be larger today and unlikely to be closed.

Source Harrold (1989)

#### FUTURE PROGRESS IN SHIP FUEL EFFICIENCY

With the high level of thermodynamic efficiency now reached by many engine designs, the pace of development could be said to have slowed down (The Motor Ship 1989a). Earlier, 'a huge amount of engine research and development possibilities' had been referred to, although presumably with diminishing returns in terms of gains in efficiency (The Motor Ship 1988b). For larger engines, no great improvements were foreseen in overall engine efficiencies, but increases were possible in propulsion system efficiency. Higher thermal efficiency is theoretically possible from turbocharging and turbo-compounding, as well as from technologies which will improve part-load fuel economy, such as variable exhaust closing (VEC), effective between 80 100 per cent continuous power rating, and variable and injection timing (VIT), effective between 65 and 80 per cent continuous power rating (Shipping World and Shipbuilder 1991).

For smaller ships, the efficiency of the latest four stroke medium speed diesels has created an active re-engining market. For one major manufacturer, the percentage of its output going to re-enginings has risen from about 10 per cent in 1970 to about 40 per cent in 1987-89 (The Motor Ship 1989b). As well, the comparatively low-speed direct-coupled two stroke diesel is becoming available for medium and small sized ships. For a 4000 DWT ship, a specific fuel consumption advantage of 3 to 8 per cent over four stroke alternatives is claimed (Anderson and Grone 1989).

Ceramic coating of engine components such as piston crowns, cylinder heads and valves has been demonstrated to improve fuel efficiency by up to 5 per cent (Corvino 1989), by reducing heat losses and improving the efficiency of combustion. In the longer term, the development of the adiabatic (zero heat loss) diesel engine, utilising ceramic components, may offer further gains.

New engine layouts, such as 'father and son' combinations (The Motor Ship 1988a) offer the possibility of considerable vessels efficiency gains in which have several common operating speeds, such as cruise ships. Diesel-electric propulsion may become more widespread, especially in vessels with varying power requirements, such as ferries and cruise vessels, as an alternative to geared diesel units. Fuel savings of 3 per cent have been claimed for ferries, together with reductions of up to 24 per cent in NOx emissions, because of the ability to run the diesel engine at a constant speed while optimising the power delivered (Lloyd's Ship Manager 1992b).

Gas turbine engines have recently been claimed (Brady 1991) to offer cruise ships, with their high requirements for nonpropulsive power and heat, a level of fuel economy equal to or greater than that of a modern diesel plant, when auxiliary boiler fuel is included. Auxiliary engines are also an area in which fuel efficiency can be improved. For example, generating sets powered by a turbine driven by a combination of surplus exhaust gas by-passed from the main engine's turbocharger, for the most part, and to a lesser extent by a diesel engine, are claimed to offer savings of up to 50 percent in the cost of generating electricity on board ship (Seatrade Business Review 1988a).

Industry publications are reporting efficiency gains from new hull appendages aimed at wake vortex smoothing, from new propeller arrangements, and from wider use of less-refined fuels, as well as continuing gains from new engine technology, and more automated including ceramic coatings, engine monitoring and management systems. For example, recent advances in engine design, hull forms and propeller layout are claimed to deliver fuel-economy gains of 20 per cent for Very Large Crude Carrier (VLCC) tankers over those delivered two years previously, and some 50 per cent lower overall fuel earlier generations of VLCCs consumption than (Seatrade Business Review 1989b).

Regarding hull appendages, the Schneekluth wake equalising duct, fitted or retro-fitted to the stern of a vessel just forward of the propeller, is said to give fuel savings which repay the cost of installation in as little as one year (Seatrade Business Review 1990). The designer claimed a 6 per cent average increase in propeller efficiency. By mid 1991 some 500 vessels had been fitted with such ducts (The Motor Ship 1991). However Patience (1990, p.110) claims that while it is 'generally accepted that this type of device can improve an inferior hull', it is 'unlikely to prove very effective for a properly designed hull and aft end combination'.

For propellers, features as simple as ribs on the blades of a conventional propeller have been claimed to offer propulsive efficiency gains of 20 to 30 per cent, by converting to useful work the energy usually lost as turbulence (Seatrade Business Review 1989b). Contra-rotating propeller systems are claimed to yield energy savings of up to 16 per cent (Seatrade Business Review 1990), and wider application was then awaiting higher bunker prices to provide more attractive payback times. The Grim vane wheel (a free-running propeller aft of the main propeller) is claimed to offer propulsive efficiency gains of up to 7 per cent for VLCCs (Seatrade Business Review 1989b).

While experimentation is proceeding on other forms of propelling ships, such as electromagnetic propulsion (The Motor Ship 1988c) and foil propulsion aimed at harnessing the power of ocean waves, a recent review concluded that future

ship propulsion would be similar to today's, utilising diesel engines and propellers (*Seatrade* 1991).

Emulsified fuels, wherein water is mixed with fuel oil at concentrations of 16 per cent or so, have been claimed to give savings of 4 per cent in fuel consumption through the catalytic effect of the water vapour released in the cylinder, which helps to atomise the fuel and intensify the fuel/air mixing process. Reductions in exhaust emissions of oxides of nitrogen of up to 30 per cent (Marintek 1991) and carbon monoxide are claimed, together with reduced carbon deposits and exhaust gas temperatures, which reduce maintenance. Ten bulk carriers of a USSR shipping line had been fitted with this system by 1989 (The Motor Ship 1989c).

Concern with the exhaust emissions of ships has led the International Maritime Organisation to introduce restrictions aimed at reducing NOx emissions to 70 per cent of current levels, and emissions of oxides of sulphur (SOx) to 50 per cent of current levels, by 2000 (Lloyd's Ship Manager 1992b). Actions to reduce NOx could have an adverse effect on fuel economy (Marintek 1991). Actions to reduce SOx would inhibit the use of some heavy fuel oils in diesel engines. Any move towards better quality fuels could be expected to yield fuel economy benefits, although Australia has generally low sulphur crudes, and the benefits may be less than elsewhere.

Computerised engine monitoring and diagnostic systems are being developed by engine manufacturers, which continuously monitor the combustion process to ensure that engine settings are always maintained at their optimum levels. These systems could have an important contribution to make to efficient operation (The Motor Ship 1989d). A related area is precision voyage control systems or adaptive autopilots, such as the ETA-pilot, which uses an on-board microcomputer to monitor and control voyage parameters such as speed (either a set speed or maintain schedule), calculated to the optimal а speed combination of revolutions and propeller pitch, and rate of fuel consumption, for various conditions of draught and trim (Fahlgren 1987). One ship performance monitor system yielded a 19 percent improvement in the fuel economy of tankers in

ballast through optimising the trim of the vessels, although the savings for other types of ships were expected to be smaller: around 5 per cent (Seatrade Business Review 1988b).

However, while there have been recent trends towards greater fuel efficiency in conventional shipping, some recent and projected developments could act in the opposite direction. One example is the wave-piercing catamaran, such as the Sea Cat Tasmania, a high speed passenger/car ferry. Another is the SWATH (small waterplane-area twin-hull) 50 knot cargo catamaran with hydrojet propulsion, projected for the year 2000 by Japanese shipbuilders. It is also conceivable that substantial rises in the price of oil could cause a switch towards coal burning ships which burn much larger tonnages of containing a much fuel, higher amount of carbon. than comparable diesel ships.

#### EFFECTS OF SHIP SIZE AND OPERATING SPEED ON FUEL EFFICIENCY

Apart from progress in the design of hulls, engines and propulsion systems, major determinants of the rate of fuel consumption of conventional shipping will be the size of ships and operating speeds, with speeds of particular ships varying with the state of the freight market and the cost of substitutable inputs such as capital and bunker fuel.

#### Ship size

significant There economies of in are size the fuel consumption of conventional shipping<sup>1</sup>. For example, an

1 Evans and Marlowe (1990) give the following equation for the fuel consumption of bulk carrier motor ships of varying size, operating at the same speed:

 $C1 = C2 * (W1/W2)^{0.75}$ 

where

C1 = fuel consumption (tonnes/day) of bulk carrier of deadweight
 tonnage W1
C2 = fuel consumption (tonnes/day) of bulk carrier of deadweight
 tonnage W2

Australian-flag bulk carrier of over 230 000 deadweight tonnes consumes 62 tonnes of heavy fuel oil per day at 14 knots, while others in the same fleet, each with less than one-tenth the carrying capacity, consume nearly half as much fuel each at the same speed.

Ship size could be influenced by the nature of the trade, as well as its volume, by the capacity of ports and their facilities, and by the scope for varying the number of services. Lower frequency of service and the use of larger ships could be a response to changes in the price of capital relative to other inputs or to a preference for cheaper freight costs over more frequent service. The purchase of efficient ships would and more fuel allow new larger technology to be incorporated, where the larger replacement ship is a new ship, and yield further improvements in efficiency.

#### Operating speeds

Increasing the operating speed of vessels may be a short term response to a shortage of shipping capacity, a medium term alternative to re-commissioning laid-up vessels, or a longer term substitution of energy for capital, either to cope with lags involved in building new ships or to avoid the necessity for additional vessels. Similarly, a reduction in speed, together with the use of more or larger ships or both, may be a response to an increase in fuel prices.

#### Freight market

Changes in demand for freight may be satisfied by changing the level of capital employed or the amount of fuel used or both. Stopford (1988) discusses the trade-off that a shipowner faces, in optimising a ship's operating speed, between income and costs: between lower (higher) income from a smaller (larger) cargo-carrying task performed at lower (higher) speeds and the lower (higher) costs from lower (higher) operating speeds. The cost to income of reduced operating speed will depend on the state of the freight market, with

higher optimum speeds in high freight markets and short shipping markets. Stopford notes that the VLCC fleet operated at around 10 knots in early 1986, but when freight rates rose in mid-year, speeds rose to about 12 knots. Especially in times of high interest rates shippers with high value cargoes may be willing to pay for fast transit times, and ship operators confronted with high capital costs may find it economic to run vessels at higher speeds when shipping markets are short.

The extent of increased costs from increased operating speeds will vary with the type of ship, the type of engine and the size of the variation from the normal operating speed<sup>2</sup>. As an example of the way in which the rate of fuel consumption rises

2 BTE (1980) estimated regression equations for the power required to propel various types of ships. The equations were of the form:  $HP = a * (DWT)^{b} * (V)^{c} * e$ 

where HP is the required horsepower, DWT the deadweight tonnage in thousands of tonnes (a measure of carrying capacity), V is speed in knots, a, b, and c are regression coefficients, and e is an error term. The values for the exponent 'c' for the vessel speed variable in the equation for horsepower were estimated to be:

•	
Container ship	2.66
Ro-ro ship	2.80
Bulk carrier	1.43
Ore carrier	1.74
Tanker	2.10
General cargo ship	2.17
Passenger ship	3.55

It is evident that the exponent 'c' increases as the typical design speed of the type of ship increases. For any given engine, the fuel consumption will be directly related to the horsepower output, but the relationship will not be linear, as the propulsion system efficiency will vary with engine revolutions.

Stopford (1988) gives the following equation for the fuel consumption in tonnes per day (F), at the vessel's actual operating speed:  $F = F' * (S/S')^{c}$ 

where

- F' = fuel consumption rate at design speed
- S' = design speed
- S = actual operating speed

c = exponent, about 3 for diesel engined ships,

about 2 for steam turbine engined vessels.

This equation is valid for small variations around the design speed. However, for sizeable variations, say for slow steaming, Laurence (1984) gives an equation of the form:  $F = F' * (A * V^3 - B * V^2 + c * V)$ 

Based on Stopford's equation for minor speed variations, given that steaming time will vary inversely with speed, the quantity of fuel used on a voyage will vary approximately with the square of speed for diesel engined ships.

more than proportionally with an increase in operating speed, the 230 000 DWT bulk carrier mentioned above, which consumes 62 tonnes of heavy fuel oil per day at 14 knots, uses only 38 tonnes of fuel per day at 11 knots, a reduction of almost 40 per cent for a 22 per cent reduction in speed.

#### Changes in input prices

The cost of bunker fuel will also influence the speed at which ship-owners choose to operate their vessels in order to maximise their profits. Evans and Marlow (1990) derive equations for the optimum speed of ships in different types of trades (charter and industrial carrier): as would be expected the higher the price of fuel oil, the lower the optimal operating speed<sup>3</sup>.

Significant changes in input prices which are perceived as being long-term or permanent, such as the oil shocks of the 1970s, will also have lagged effects on ship design (including on design speed) and choice of propulsion unit for new ships, as discussed earlier in this chapter.

Although liner ships operate to schedules, reduced speeds could nevertheless be a viable option, in that reliability is

3 For vessels on voyage charter (or trip charter for the same time period), the optimum speed, s, is given by:

 $s^{2} = (WR-D)/k(R+p)(3d+2st)$ 

- where: W = deadweight tonnage available for cargo
  - R = freight rate
  - D = total disbursements in port
  - d = total voyage distance
  - p = price of fuel (\$US/tonne)
  - t = time in port
  - k = ships fuel constant (tonnes/day at design speed divided by the cube of the design speed in knots).

For vessels which operate as carriers for the firm which owns them:

 $s^3 = (CC+CR)/2pk$ 

where: CC = capital cost per day CR = running costs per day p = price of fuel (\$US/tonne) k = ships fuel constant

generally more important to shippers than transit time. One factor militating against this option however, is the significant cost of capital tied up in containers. In any case, Stopford (1988) notes that liner operators generally pass forward any unexpected increases in bunker prices through a 'bunker adjustment factor (baf)' added to invoices.

One of the scenarios examined in chapter 3 models the effect on Australian coastal and international fleet average fuel efficiencies of increasing all ships in size by 10 per cent; another models the effect of reducing all Australian coastal fleet ship operating speeds by 10 per cent and maintaining capacity by increasing the size of ships by 10 per cent (a more fuel efficient and cost-effective response than using larger numbers of ships to maintain capacity at lower speeds).

### CHAPTER 3 AUSTRALIAN COASTAL AND INTERNATIONAL SHIPS: POTENTIAL FLEET FUEL EFFICIENCY GAINS TO 2005

#### OVERVIEW

Recent Australian ship replacements with more fuel efficient (and smaller crewed) vessels have been a result of the Ships and the Maritime Industry (1987)Capital Grants scheme Up to 1992, the original Development Committee (MIDC) scheme. cut-off for the Ships Capital Grants scheme, 27 vessels had been ordered, of which 23 are already in service. Some new vessels (such as LNG carriers) are for new trades rather than replacements for existing vessels. The scheme has been extended to 1997, and a few more ships have already been A DoTC source expected that by 1997 just about all ordered. other ships built before 1982 in the major trading fleet (which excludes small vessels such as landing barges, and which in 1991 totalled 74 ships) will have been replaced or have had replacements ordered.

to 70 per cent of the existing about 60 result, As а Australian-flag major trading fleet would probably be replaced by 2005, with vessels which could typically be some 15 to 25 more fuel efficient if today's technology is cent per By the time many of these vessels do come to be utilised. replaced, efficiency gains of another 10 to 15 per cent could well be available. On this basis, and ignoring for the time being the presence in the fleet of several coal burning ships, the average efficiency of the motor ships in the Australianflag fleet could therefore rise by some 20 to 25 per cent on a fuel consumption per thousand deadweight tonnes per 1000 nautical miles basis by 2005.

#### MODELLING FUEL EFFICIENCY TRENDS AND FLEET FUEL CONSUMPTION

A spreadsheet model was developed which lists each ship (over 2000 DWT) of the Australian coastal and international fleets and its actual fuel consumption per day. It has been assumed, unless more definite information was available, that each ship would be replaced at age 15 years (or 1992 if this age were reached prior to 1992), by a ship built in the year prior to replacement. The effect of assuming a ship life of 20 years before replacement has also been investigated.

The fuel consumption of each replacement vessel has been estimated from regression equations for particular types of vessels derived from data for vessels in the existing Australian-flag fleets. A log-log regression was done for each major vessel type, with the log of fuel consumption in tonnes per day (including that for auxiliaries) regressed against the logs of deadweight tonnage, year built (minus 1965) and operating speed in knots.

For each of the coastal and international fleets, a fleet average specific fuel consumption (SFC, in tonnes of fuel oil per 1000 deadweight tonnes per 1000 nautical miles) was then calculated for each year up to 2005. These values were used to calculate indices of fleet fuel efficiency. These indices of fleet task were then applied to likely growth rates for the respective shipping tasks, to estimate the changes in fleet fuel consumptions in 2005.

The regression equations were of the form:

 $\ln(\text{fuel consumption per day}) = \text{constant} + a * \ln(\text{DWT}/1000) + b * \ln(\text{year built} - 1965) + c * \ln(\text{speed in knots})$ 

where DWT is deadweight tonnage, a measure of the freight carrying capacity of a ship.

Ship class	Constant	a	Ь	с	R <sup>2</sup>
Bulk	-2.21	0.40 (22.6)	- 0.37 (-5.3)	1.99 (11.5)	0.94
General cargo	-2.95	0.44 (3.4)	-0.08 (-0.5)	1.95 (2.7)	0.91
Container	-1.90	0.29 (1.02)	-0.77 (-4.1)	2.48 (1.8)	0.95
ro-ro	-5.77	0.51 (8.0)	-0.09 (-0.6)	3.08 (6.4)	0.90
Product tanker	1.54	0.64 (7.8)	-0.23 (-3.8)	0.13 (0.2)	0.88
Crude tanker (main engines only)	-2.82	0.69 (3.6)	-0.61 (-3.6)	1.96 (2.6)	0.87

#### TABLE 3.1 REGRESSION EQUATIONS FOR FUEL CONSUMPTION OF REPLACEMENT SHIPS

Note Numbers in brackets are t-statistics

Source BTCE estimates from regressions on data for existing Australian ships.

Table 3.1 shows the coefficients for the variables of the various regression equations, together with coefficients of determination and t statistics (in brackets under the coefficients). These equations under-estimated the actual total fuel consumption of the existing fleets of ships by just under 2.5 per cent.

Date built (adjusted by subtracting 1965 in order to increase the ratio of range to mean value for computational reasons) appeared not to be a statistically significant explanatory variable for general cargo vessels or ro-ro ships. However, the equations were used to estimate fuel consumption for the replacement vessels for these types as the results appeared reasonable considering the rate of technical progress. This formulation of the date-built variable gave a lower rate of improvement in the rate of fuel consumption over time than a suggested alternative treatment, whereby date-built was subtracted from 2006. While the latter gave slightly better t-statistics for the date-built variable, scrutiny of the projections for particular ships suggested that this treatment may have given overly optimistic results, considering the underlying rate of technical change. The more conservative formulation was used to estimate the rate of fuel consumption of replacement ships.

The model indicates that the fleet average fuel consumption rates currently are about 4.0 tonnes of fuel per 1000 deadweight tonnes per 1000 nautical miles for the major trading coastal fleet, or about 0.1 megajoules per DWTkilometre, and 1.8 tonnes of fuel per 1000 deadweight tonnes per 1000 nautical miles for the Australian-flag international fleet, or about 0.04 megajoules per DWT-kilometre.

The fuel used by the coal burning and natural gas-burning ships in the coastal fleet was converted to a fuel oil equivalent on a  $CO_2$  emissions equivalent basis, rather than an energy equivalent basis, in order to be able to estimate changes in  $CO_2$  emissions from the results. This was done by using energy content values from ABARE (1991) and emission rates per unit of energy from OECD (1989 cited in BTCE 1991). For example, 1 tonne of steaming coal contains 27.0 GJ per tonne, compared to 44.1 GJ per tonne for low sulphur fuel oil. Burning coal emits 94.2 kilogrammes of  $CO_2$  per GJ, while burning 1 tonne of fuel oil emits 78.0 kilogrammes per GJ. Thus burning 1 tonne of coal emits (27 \* 94.2)/(44.1 \* 78) =0.74 times as much  $CO_2$  as burning 1 tonne of fuel oil.

The large tonnages of coal burned per day in the four coal burning ships were reduced accordingly when expressed in tonnes of oil equivalent in the spreadsheets. Had the adjustment to oil equivalents of natural gas and coal been done on an energy basis, the improvements in fuel economy stated below on an emissions basis would have to be reduced by about 2.5 to 3.5 percentage points.

As a base case it was assumed that replacement vessels were of the same size and speed as the ships they replaced (the increased ship size and reduced speeds are effects of discussed below). The model suggests "trend" coastal fleet average fuel consumption falling from 4.2 tonnes of fuel per 1000 DWT per 1000 nautical miles in 1988 to 2.5 in 2005, a drop of 41 per cent on an emissions basis. However, just over half (about 21 percentage points) of this improvement is due to the assumed replacement of the four coal burning ships with On an energy basis, the fuel oil burning motor ships. For the Australian-flag improvement is about 38 per cent. international fleet, the trend decrease was from 1.9 tonnes of fuel per 1000 DWT per 1000 nautical miles in 1988 to 1.5 in 2005, a drop of almost 22 per cent. Allowing for the effect of the coal burning ships, these results are consistent with broad-brush estimates made earlier in this chapter from a consideration of the technology.

When a ship life of 20 years was assumed, these improvements in fuel efficiency by 2005 were reduced somewhat. For both coastal ships and the international fleet the improvement in fleet average fuel efficiency was about 4 percentage points less than with a ship life of 15 years.

The "trend" values for fleet average fuel consumption rates reflect the significant progress made over the past twenty years or so in improving the fuel efficiency of ships. While, discussed in chapter 2, further improvements may be as expected, it is not clear that the rate of progress will be as As well, some existing rapid as over the past twenty years. vessels may be replaced with second-hand vessels rather than new vessels. In order to estimate the effects of a complete penetration of already achieved levels of fuel economy, a version of the model was run with replacement vessels assumed to have 1990 levels of fuel economy, as estimated by the regression equations. It was also assumed that these vessels would be of the same size and operate at the same speed as those they replaced.

This version of the model suggests somewhat lower fleet average improvements in fuel efficiency from 1988 levels by
2005: for the coastal major trading fleet, about 37 per cent (emissions basis) or 34 per cent (energy basis), and for the international fleet, 15 per cent. This suggests that, for coastal shipping, about 90 per cent of the fuel efficiency improvement by 2005 in the base case is due to the replacement of vessels (especially the four coal burning ships) with ships having levels of fuel efficiency already achieved by modern vessels. For Australian-flag international shipping the comparable figure is about 70 per cent.

Figure 3.1 presents results from the spreadsheet model for Australia's coastal and international ships. The sharp drop in average specific fuel consumption for the coastal fleet between 1997 and 1999 is due to the assumed replacement at that time of four coal burning ships (each using almost 200 tonnes of coal per day) with diesel engined vessels each using 30 to 40 tonnes of fuel oil per day.

The model was also used to estimate the potential fuel efficiency gains from replacing existing vessels with larger vessels by entering a larger deadweight tonnage into the regression equations. For replacement vessels 10 per cent in deadweight tonnage, the model shows larger a fuel efficiency improvement of the coastal fleet of some 3 percentage points higher (by 2005) than if vessels were For the international replaced by vessels of the same size. fleet, the model shows fleet fuel efficiency improving by about 2 percentage points more (by 2005) than if ships were replaced by vessels of the same size. The equation of Evans and Marlowe (1990), cited in chapter 2, would suggest a 2.4 per cent improvement in fuel economy for a 10 per cent increase in size.

It is by no means certain, however, that the modal task for the coastal fleet will grow in size, facilitating the use of larger ships. During the period 1975 to 1988, the number of tonne-kilometres of coastal sea freight appears to have declined slightly (BTCE *Transport and Communications Indicators* database). The future level of coastal shipping activity depends not only on the size of the task, but also on the number of single voyage permits issued and the possibility of



FIGURE 3.1 TRENDS IN THE FUEL EFFICIENCY OF AUSTRALIAN SHIPPING

continuous voyage permits for foreign-owned ships, a review of cabotage arrangements, and developments in international shipping, particularly relating to economies of scale.

A further version of the model was run which assumed that existing ships were replaced by larger, slower vessels which performed the same shipping task. If coastal vessels were replaced by ships 10 per cent larger in deadweight tonnage, but also 10 per cent slower, then the model shows fleet average fuel consumption in 2005 falling by some 8 percentage points more than if vessels were replaced by new ships of the same size.

Table 3.2 summarises results from the model. The improvements (excluding effects of replacing the coal burning ships) are about what might have been expected from an assessment of the technology involved (as discussed in chapter 2) and the rate at which older ships are likely to be replaced, as discussed at the beginning of this chapter. An underlying improvement of about 20 per cent might be expected in motor ships, which comprise the vast bulk of the Australian fleets.

If it is assumed that technical progress yields no further fuel efficiency gains from 1990 levels, this 20 per cent improvement is reduced (by about one-fifth for the coastal fleet, but by about one-third for the international fleet, which at an average age of 10 years in 1991 was about 2 years older on average than the coastal fleet at that time) to perhaps 15 or 16 percent for motor ships. That is, embodying the sum of the technological progress achieved over the past two decades into new replacement vessels would yield about 70 to 80 per cent of the fuel efficiency gains projected for diesel motor ships in the base case. Delaying the replacement of each vessel until the age of 20 years would appear to give a similar reduction in the size of the projected improvement in fuel efficiency for the coastal fleet, but would have a smaller effect on the international fleet.

The effect of ship size alone can be gauged from the projected increase in fleet fuel economy from replacing each ship with a vessel 10 per cent larger: about 9 per cent for the

	Coasta	1.	
	Emissions Basis	Energy Basis	International
Base case: replacement at 15 years with vessels			
of same size and speed	41	38	22
Replacement at 20 years	37	33	19
Replacement vessels with 1990 levels of fuel efficiency <sup>b</sup>	37	34	15
Replacement vessels 10 per cent larger <sup>b</sup>	44	41	24
Replacement vessels 10 per cent larger and 10 per cent slower <sup>b</sup>	49	na	

#### TABLE 3.2 AUSTRALIAN SHIPS: PERCENTAGE REDUCTIONS IN FLEET AVERAGE TONNES OF FUEL PER 1000 NAUTICAL MILES PER 1000DWT FROM 1988 TO 2005

a Much of the improvement in the coastal fleet is due to the assumed replacement of coal burning ships with motor ships. In the base case, the amount is 21 per cent.

b replacement at 15 years

na not available

Source BTCE estimates

international fleet and about 15 per cent (excluding the coal burners) for the smaller-on-average coastal ships. However, the combination of an increase in ship size and a cut in operating speed is much more marked. Again excluding the coal burning ships, a 10 per cent increase in ship size together with a 10 per cent cut in operating speeds boosts the projected increase in average motor ship fuel economy from about 20 per cent to about 28 per cent between 1988 and 2005, an increase of 40 per cent.

It should be emphasised that the above results are derived by regression from data on existing ships, and incorporate the

effects of assumptions regarding the timing of replacements and the size and speed of the new vessels. Past trends in fuel consumption rates will have been influenced by past prices for capital (ships) and fuel. It is likely that the pattern of future relative prices for ships and fuel will influence the future rate of technical progress and the rate at which it penetrates shipping fleets. For example, if fuel prices were to rise steeply, capital could be substituted for fuel by increasing ship numbers at reduced speeds, thus maintaining capacity. This could result in increased average fuel efficiency from incorporation of new technology in the additional ships, as well as by the reduced speeds.

The improvements in fuel efficiency dicussed above have been used to make some projections, based on very tentative assumptions, of the implications of improvements in fuel efficiency for CO<sub>2</sub> emissions from shipping (see appendix III).

#### CHAPTER 4 TRENDS IN THE FUEL EFFICIENCY OF AIRCRAFT

This chapter examines recent progress and likely future developments in the rate of fuel consumption of aircraft. The future rate of improvement in fleet average fuel efficiency will depend both on the rate of technical progress and the rate at which new aircraft embodying improved technology penetrate the fleet. Economic factors, especially fuel prices, will be important influences on both these sources of increased fuel efficency in aircraft fleets.

#### RECENT TRENDS IN AIRCRAFT FUEL EFFICIENCY

The improving trend in the energy intensity of aviation in OECD countries from 1973 to 1983 is shown in figure 4.1 (IEA 1987). The overall index of energy intensity for the aircraft fleets fell by some 40 per cent over the decade following the oil price shocks of 1973, although with a slowing of the rate of improvement in the later part of the period covered.

A study of world jet fuel consumption by the US Department of the Environment concluded that increasing fuel efficiency allowed a doubling in passenger-miles between 1972 and 1986 with an increase of only 28 per cent in fuel used. The study apportioned the savings to: improvements in engines and operating procedures (19 per cent); increases in aircraft size (24 per cent); better load factors (19 per cent); and mix shift (38 per cent), that is, the retirement of old fuelinefficient aircraft and entry of new, fuel-efficient aircraft (Avmark Aviation Economist 1989a). The rising trend in fuel efficiency (in seat-miles per US gallon) for some examples of airliners is shown in figure 4.2 (Sweetman 1984). These airliners range from models of the 1940s up to the Boeing 767-200, with a projection to 2010 and a 1200 passenger jumbo.







FIGURE 4.2 TREND IN AIRLINER FUEL EFFICIENCY

### FUTURE PROGRESS IN AIRCRAFT FUEL EFFICIENCY

#### Technical progress

Future fuel economy gains will be available from increasing aircraft size, improved aerodynamics, reduced weight from advanced materials, progress in engine design and, possibly, from the use of alternative fuels. These technological factors are discussed in more detail later in the chapter. The viability of use of non-conventional alternative air transport (such as airships) is beyond the scope of this paper.

Sweetman (1984) had considered the present airliner configuration to be efficient, and had noted that very little detailed study of radical configurations was being undertaken, except in the area of engines. In 1990 no radical designs, configurations or technology were foreseen, even among possible, rather than probable, developments: only one all-new design was in prospect: the Boeing 777 (Avmark Aviation Economist 1990a).

Hensher, in a consultancy report for the BTCE (Hensher 1991), reviewed the likely technical advances and the improvement in seat-miles per gallon which might be expected in airliners. Hensher considered that new commercial aircraft would offer 65 to 80 seat-miles per US gallon in the early 1990s, compared to 50 to 79 seat-miles per US gallon in 1989 (Hensher 1991). However Hensher noted that many potential new developments are unlikely to be on-stream until after 2000, so that a movement to larger, technically more efficient existing aircraft types will become the most important means of improving fuel efficiency.

# Penetration of fuel-efficient technology in the fleet

The rate of penetration of fuel-efficient technology will depend on rate of growth of the fleet and the rate at which old fuel-inefficient aircraft are retired. Sweetman (1984) noted that because of the lifespan of modern airliners, especially wide-bodied planes, many of the aeroplanes which would be operating in 2000 were already in service in 1984. [However, these aircraft are likely to be in the more fuel efficient segment of the existing fleet.] Sweetman noted that every wide-bodied plane built to date (1984) would still be structurally capable of flying in 2000, many with still 10 years of useful life. Also, many of the newer wide-bodied models, such as 767s and A310s should still be in production, as it takes at least 10 years' production to show a profit (Sweetman 1984).

However, despite the long life of aircraft and long lead times in aircraft manufacture, the expected growth of the fleet to 2005 is such that there remains considerable scope for improving fleet fuel efficiency through the introduction of additional new and technically superior aircraft. Boeing in 1989 forecast that the world jet fleet would increase by twothirds between 1988 and 2005, with the number of new aircraft entering service in the period exceeding the total number in the 1988 fleet. Boeing predicted that almost half the 1988 world jet fleet would be retired in the period to 2005 (Avmark Aviation Economist 1989b).

While there has been a trend towards greater fuel efficiency in conventional subsonic passenger aircraft in recent years, some future developments could act in the opposite direction. For example, congestion, whether involving aircraft having to maintain holding patterns before landing, or waiting with engines idling on the airport taxiways, has the potential to increase the fuel required to undertake any given level of The effect is both direct, from the extra time the task. engines are running, and indirect, due to the extra fuel burned, especially at takeoff, in carrying the additional fuel load necessary. Regulatory change domestically or internationally, on the other hand, may offset these factors if it results in a more efficient utilisation of existing aircraft capacity. For example, the carriage of domestic passengers by Qantas between Australian airports is likely to retard the growth of aircraft operating purely domestic routes.

#### Economic factors

#### Oil prices

Fleet growth and retirements will be affected by future levels of input prices. Avmark Aviation Economist (1990f) documents six oil shocks which occurred between 1967 and 1990: five of these shocks were sharp increases in prices, ranging from a 32 per cent increase in the price of jet fuel in 1970 to a 274 per cent increase in 1973; a 55 per cent decrease occurred in the first half of 1986. From 1980 to 1988, the average US price for jet fuel fell from \$US36.45 per barrel (about 86 cents per US gallon) to US\$21.50 per barrel or about 51 cents per US gallon (Avmark Aviation Economist 1989c). Short term fluctuations in the spot market for jet fuel can be very sharp: spot prices rose from US\$0.635 per US gallon at the start of August 1990 to US\$1.394 per US gallon by the second week in October 1990 Avmark Aviation Economist (1990e), as a result of the Gulf war.

The pressure for improvements in fuel efficiency will increase with the share of fuel costs in total aircraft operating costs, modified by the ability of operators to pass on cost increases to passengers. The ability to do so will depend on the level of competition in aviation markets. It seems unlikely that operators would be able to pass forward fully any such fuel cost increases.

In mid-1991, fuel, oil and taxes comprised between 26 per cent and 43 per cent of total aircraft operating expenses for the widebodied aircraft, and between 20 per cent and 38 per cent for the narrowbodied aircraft represented in *Avmark Aviation Economist* (1991). Fuel tends to be a lower proportion of total operating costs of newer aircraft both because of better fuel efficiency and because of the higher share formed by capital costs. For example fuel, oil and taxes comprised 40 per cent of total costs for a 747-200, but only 34 per cent for a 747-400 in mid 1991.

Capital costs may also vary with the level of oil prices, as the price of second-hand aircraft may be affected by fuel For example, in October Avmark Aviation Economist prices. (1990d) published a revised schedule of second-hand aircraft prices to replace that published only two months before, because of price changes as a result of the sharp increases in jet fuel prices as a result of the Gulf war. The prices of widebodied aircraft, and to a lesser degree those of newer narrowbodied aircraft increased, while others, especially the prices of older narrowbodies, decreased. For example, the price of a Boeing 747-200B rose from US\$40.0 million to US\$44.0 million: the price of a Boeing 727-100 dropped from US\$2.5 million to US\$2.1 million.

The commercial success of the Boeing 747 jumbo and the cessation of production of the Concorde suggest that fuel economy is more important than lower transit times in the mass travel market of today. Any second generation supersonic passenger aircraft, while likely to be more fuel efficient than Concorde, would still require a trade-off of fuel efficiency for the increased speed for traffic won from subsonic jumbo jets<sup>4</sup>.

### Discussion of technological factors

#### Aircraft size

It is unclear to what extent the increase in the average size of aircraft, which Boeing estimated had contributed 24 per cent to the increase in fuel efficiency between 1972 and 1986, is the result of past increases in oil prices. For example, the Boeing 747 jumbo (capable of seating up to 500 passengers in a high density configuration, more usually about 400), had

4 The BTCE estimates that Concorde is about 5 times less fuel efficient than a 747 jumbo jet, based on the Aerocost model for the 747 and Leney and Burney (1990) for the fuel burned by Concorde on a London-New York flight. Barrett (1991) gives figures which yield ratios of 4.5 on a seat-kilometre basis, and 5.5 on a passenger-kilometre basis. its genesis prior to the first of the oil shocks mentioned above, with the Boeing board agreeing in 1966 to development and production. The rapid growth of the passenger market in the early 1960s had caused US aircraft manufacturers to consider aircraft much larger than previous models, as a way to provide the necessary capacity. US Airforce requirements for heavy transport aircraft were an additional stimulus to the development of much larger passenger aircraft (Australian Aviation 1988).

Boeing's Commercial Airplane Group President considers that much of the traffic now carried by 140-150 passenger aircraft would in future be moved by bigger aircraft. He foresaw a still-larger derivative of Boeing's wide-bodied jets by about the end of the century (O'Lone 1990), for which Boeing expects operating costs to be 25 per cent below those of the 747. Stretched versions of the Boeing 747 carrying up to 500 passengers could be available by the mid-1990s and a doubledeck version of the 747 could be available by the turn of the century, according to Qantas (Blackburn 1991).

Airbus Industrie recently brought forward by 5 years the planning for a 650 seat competitor for the Boeing 747, foreseeing first service use by around 2000. It is examining several prototype Ultra High Capacity Aeroplane configurations for up to 800 passengers. Large 'infrastructure friendly' aircraft with up to 1000 seats (long haul) were foreshadowed (1990b). The projected Economist Aviation Avmark in McDonnell-Douglas MD12 will be initially designed as a 500 seat aircraft, with later stretched versions having a oneclass capacity of 800 to 1000.

Boeing forecast an increase in average (mean) jet size from 181 seats in 1988 to 238 seats in 2005, with additions to the fleet averaging 254 seats in the period to 2005. Avmark's own forecast was for the average seat capacity to rise to 296 in 2005, with additional aircraft averaging 409 seats (Avmark Aviation Economist 1989b). In any case it seems clear that the jet fleet will undergo a considerable increase in average seat capacity by 2005.

Ultra-large cargo aircraft (possibly including flying boats), which probably would be more fuel efficient than existing cargo aircraft, could increase overall freight-related consumption of fuel if they were able to win cargoes from conventional shipping.

#### Aerodynamics

Schmitt (1990), predicting gradual evolutionary progress in design over the next decades, foresaw a potential for overall aerodynamic drag reduction of over 20 per cent. Riblets, microscopically grooved plastic film applied to the fuselage, tail and engine casings of new or existing aircraft was then a subject of current research.

Green et al. (1987) state that one current development aim is to eliminate drag-inducing items such as wing fences, vortillons and vortex generators. Schmitt (1990) also noted the role to be played by weight reduction, using composite materials such as Arall (fibre-coated alloy) or Kevlar, and lighter alloys such as aluminium-lithium.

However, improvements in aerodynamics may not be universal. It has been argued (Avmark Aviation Economist 1990c) that large 'infrastructure friendly' aircraft may not, for reasons of space at airport terminals, be able to adopt the highaspect-ratio (long and narrow) wings which have been an important factor in improving fuel efficiency of modern jet airliners.

#### Engines

Major changes in engine design would be needed to repeat the efficiency gains made with the initial introduction of the high bypass ratio turbofan engine. One such, at least for small and medium airliners, could be the prop-fan engine, using 8 or 10 thin, sweptback blades of smaller diameter than

a conventional fan. This type of ultra high bypass<sup>5</sup> ratio (UHBR) engine could be either an unducted fan (UDF), with bypass ratio of about 35:1 or, in larger engines for reasons of noise, vibration and safety, a shrouded fan with bypass ratios of 15:1 to 25:1 (Green *et al.* 1987).

UDF engines could offer 25 to 28 per cent fuel savings, while shrouded prop-fans could offer 19-21 per cent lower fuel consumption than conventional fan engines (Aviation Week & Space Technology, April 13, 1987). Lynn (1987) stated that the 100-150 passenger class would be the first main use, but problems of gearbox design still had to be overcome for large The UDF had by 1989, units. in an MD-80 demonstrator, fulfilled its technical promise (Donoghue 1989). However, Donoghue (1989) reported that a major engine producer had decided that the market would not require this type of engine until 1997, and had put back plans to introduce its UDF Development had been shelved pending the appearance engine. of a market for the engine. It would appear that some problems of vibration and in-flight noise remain to be solved for this engine. About 4 years would be required for the certification of this particular engine should a market Other engine sizes would require an additional number emerge. of years for technical development. Woolsey (1990) referred to the UDF engine as 'dormant' in Air Transport World's November 1990 Large Engine Update. However, development is continuing with the Russian Yakovlev Yak-42E-LL propfan, which flew for the first time in 1991. When fitted to a 150 seat airliner, a one-third reduction in fuel burn per seatkilometre, compared to a modern turbofan, is expected (Flight International 1991).

Although US airline manufacturers have apparently decided not to adopt UHBR engines (Avmark Aviation Economist September 1990), General Electric is predicting that its GE90 family of large higher by-pass engines, with by-pass ratios of 9 to 10,

<sup>5</sup> The bypass ratio of an engine is the ratio of the external mass of air accelerated by the engine to the mass of air passing through the core or combustion section of the engine. The ratio varies from zero for a turbojet (as fitted to Concorde), through 5:1 or 6:1 for recent turbofans, 70:1 to 100:1 for turboprops, to as high as 200:1 for propeller aircraft.

will have a 9 per cent improvement in specific fuel consumption over its predecessor.

Refined versions of existing big-fan engines, with highefficiency compressors, wide-chord fan blades and fully electronic controls, still offer useful improvements in fuel consumption, and will be standard on most engines by the Ford (1989) notes that the Rolls Royce RB211-534E4 1990s. wide chord fan engine gives specific fuel consumption (SFC) improvements of 4 per cent at maximum cruise speed and 4.75 per cent at maximum climb, compared to its predecessor narrow [Ford noted fuel efficiency improvements chord fan engine. cumulating to an improvement of 16.6 per cent for the Rolls Royce RB211-524 engine from its introduction in 1977 up to the latest version expected to be certified in 1992.] The newer engines also allow the relationship between the core and the by-pass systems to be varied according to the thrust required, slowing the fan at high thrusts, thus increasing efficiency.

Ford (1989) considered that future engine development would probably involve ultra-high by-pass ratio (UHBR) engines, required for still larger subsonic passenger aircraft. An example could be the contra-fan engine developed by Rolls Royce, which could offer SFC some 15 per cent better than the RB211-524G engine already in service.

Second generation supersonic business-class passenger aircraft could feature tandem-fan or dual-cycle engines, which would have a high by-pass turbofan for sub-sonic flight and a highthrust fan for supersonic use (Ford 1989).

The use of ceramics and other non-metallic materials will have a significant impact on thermal efficiency, and hence on specific fuel consumption, in the foreseeable future. Special purpose composite materials, with compositions formulated in conjunction with the design of particular engine components, should allow higher power outputs and lower weights for given engine sizes (Green *et al.* 1987).

#### Alternative fuels

In the longer term, liquid hydrogen may become an alternative to iet fuel. Price (1991) notes engine manufacturers' estimates of a 5 to 10 per cent gain in specific fuel consumption, in terms of the energy content of the fuel Price states that there burned. appear to be no insurmountable technical problems, although tank size, safety and price are issues. Price (1991) gives the cost of hydrogen produced by cheap hydroelectric power at about 4.2 times that of jetfuel on an energy equivalent basis, or 12.7 times that of jet fuel per unit weight.

Hydrogen has almost three times the energy content of the same weight of aviation turbine fuel (avtur), giving a two-thirds reduction in take-off fuel load for equal range (41 000 kg for Boeing 747 compared to 121 600 kg of jet fuel). а The consequent higher cruising altitude possible (36 000 feet compared to 31 000 feet) reduces fuel consumption at a given Length of runway on takeoff would be reduced, as would speed. wing loadings (or wings could be made smaller). Price considers that engine life would be longer, with reduced maintenance and lower engine noise levels. However, fuel tank capacity would need to be almost four times as large, as the density of hydrogen in liquid form is only about one-eleventh of that of avtur (Price 1991).

With hydrogen fuel there would be no carbon dioxide or carbon monoxide emissions and oxides of nitrogen would be reduced, although the amount of water vapour produced would be more than doubled. This water vapour may, above about 9000 metres, form ice-crystal clouds which, while allowing sunlight to pass through, reflect heat back to the earth. The ice crystals can also act as sites for chemical reactions which attack ozone (Barrett 1991).

A Canberra bomber with one engine converted for liquid hydrogen fuel flew in 1956. In the former Soviet Union, a testbed Tupolev 154 passenger aircraft, redesignated as a TU 155, has had one engine converted to operate on either liquid methane (LNG) or liquid hydrogen, as well as on jet fuel. LNG has a higher specific energy than jetfuel, although only about half the specific energy of liquid hydrogen (Automotive Engineering 1991). Thus LNG could confer a portion of the benefits of a lighter fuel load on takeoff promised by liquid hydrogen fuel. LNG has an energy density some three times that of liquid hydrogen, but less than that of jetfuel. About 50 per cent greater storage volume would be required for LNG than for jetfuel, compared to four times the storage volume required for liquid hydrogen.

#### Summary

The expected growth in the size of the world jet fleet, together with the retirement of about half the existing aircraft by 2005, gives considerable scope for improving fleet fuel economy. A leading manufacturer expects the overall fuel-efficiency of the global jet fleet to continue to improve, with an increase of just over 40 per cent from 1989 to 2009 (34 per cent to 2005). The narrow-body segment is expected to increase its fuel-efficiency by about 55 per cent from 1989 to 2009 (42 per cent to 2005), as older aircraft are replaced and larger ones are introduced (Airbus Industrie 1991).

The size of improvements in the fuel efficiency of Australia's fleets of domestic and international aircraft will be influenced by the age structure of these fleets and the replacement policies of aircraft operators, as well as by the rate of technical progress.

# CHAPTER 5 AUSTRALIAN DOMESTIC AND INTERNATIONAL AIRCRAFT: POTENTIAL FUEL EFFICIENCY GAINS TO 2005

#### OVERVIEW

In October 1989, an international agreement was reached at the International Civil Aviation Organisation (ICAO) to phase out all chapter 2 (jet) aircraft by 2002, in favour of the quieter chapter 3 aircraft (the chapters refer to chapters in Volume 1 of the annexe to the ICAO agreement). Chapter 3 aircraft (those certified since October 1977) feature high by-pass, higher fuel efficiency engines, which besides being quieter, are typically 30 to 40 per cent more fuel efficient than their chapter 2 equivalents, which generally have low by-pass engines.

However, this 30 to 40 per cent margin could not be applied overall to the 36 per cent of the Australian aircraft fleet which (as at 31 December 1990) was chapter 2, as some of the aircraft are only marginally in the chapter 2 category. , This level of saving might only apply to some 20 to 25 per cent of the current fleet. The Australian chapter 2 aircraft involved were mainly 727s, F28s, a 707 and a couple of DC9s, together with some of the early 747s, which have high by-pass engines with good efficiency. For wide-bodied non-chapter 3 aircraft and any non-chapter 3 aircraft with high bypass engines, the cut-off date is 31 March 2002. For other non-chapter 3 narrow bodied aircraft, the ICAO cut-off is 25 years of age. The Commonwealth Government has decided on a phase out period commencing 1 April 1995, with the proviso that all subsonic jets added to the register after 1 January 1991 must meet chapter 3 noise standards to be allowed to operate.

Gains in the average fuel efficiency of the Australian domestic and international airliner fleets over the next 15 years will flow from the replacement of existing chapter 2

aircraft with chapter 3 aircraft and from ongoing technical progress in the design of existing high-bypass engine types fitted to replacement aircraft in the period to 2005. As well, gains may be made from re-engining existing chapter 3 aircraft with later engines. However, new technology may be required if the past trend is to be maintained. Ultra-high bypass engines, some models of which may or may not become available later in the 1990s, could offer fuel efficiency gains over 1980s generation engines estimated at between 10 to 30 per cent (Hensher 1991).

## MODELLING FUEL EFFICIENCY TRENDS AND FLEET FUEL CONSUMPTION

A spreadsheet model, similar to that for the Australian fleets of ships, was developed to estimate changes in fleet average fuel efficiency from 1988 as the base year. The model lists each passenger aircraft in the Australian domestic airline and (not including domestic commuter international fleets airlines), and its fuel consumption per seat-kilometre. It definite for the base case, unless more was assumed information was available, either that each aircraft had an economic life of 15 years (from new) in the Australian fleet, or where an aircraft reached the age of 15 years before 1992, that it would be replaced in 1992.

This short economic life reflects an assumption of increasing relative fuel costs in the future, likely if greenhouse mitigation actions, such as a carbon tax, were to be adopted, and also of ongoing technical progress in improving aircraft fuel economy. The effect of assuming an aircraft life of 20 and 25 years was also investigated. If an economic life of 30 years were assumed, the low average age of Australia's domestic fleet (only 6.7 years as at 5 July 1991) means that only about 11 aircraft (727s and F28s) out of 112 planes in the 1991 domestic fleet would be replaced by 2005.

The fuel consumption of replacement aircraft for each existing aircraft type was estimated from regression equations for particular size classes of aircraft, derived from data for

aircraft types in the existing Australian fleets. A log-log regression was done for three size classes (up to and including 50 seats, 51 to 200 seats, and over 200 seats), with the log of fuel efficiency, in seat-kilometres per litre, regressed against the log of the year in which the type/series was first introduced (minus 1955), the log of the number of seats, and the log of long range cruising speed in kilometres per hour.

It was assumed for the base case that the existing size mix of the fleets would be maintained. Each aircraft would be replaced with another of the same number of seats and speed, or with the same number of seats and speed as the latest series of the type now available. In some cases this meant that the number of seats or the speed would be different for the replacement aircraft. The model handled this bv calculating the fuel which would be used when the replacement aircraft performed the task (in seat-kilometres per year for domestic aircraft or seat-kilometres per hour for international aircraft) of the existing aircraft. is This tantamount to assuming that additional aircraft would be used when the capacity (the product of seat numbers and speed) was lower for the replacement than for the existing aircraft. When the replacement aircraft had a larger capacity (product of seats and speed) than the existing aircraft, this amounted to assuming that fewer aircraft were used to perform the existing task. Problems of 'lumpiness' were not considered, as growth in passenger task (discussed in appendix III) seems likely to obviate the risk that the same numbers of higher capacity replacements would instead operate at lower load factors.

The model is in fact quite sensitive to changes in the number of seats for aircraft models. This caveat must be borne in mind when considering the results of this study. The number of seats in aircraft operated by Australian carriers appears to have become more variable of late, with deregulation and increasing international tourist numbers. For example, 737-300s had an average of 109 seats at August 1990 (DoTC 1990). In September 1991, due to a marketing strategy involving the non-filling of a proportion of business class seats, 737-300s operated by one carrier were flying with 96 effective seats. In this case, the original number of 109 seats was used for calculating seat-kilometres per litre and for the regressions, being considered more typical over time. Again, in 1988, Qantas' 747SPs had 220 seats: in 1991, these aircraft had 313 seats. Here, the higher seat numbers were adopted for use in the model, being closer to the number of seats in Qantas's other 747s (from 386 to 406).

For each of the domestic and international fleets, a fleet average fuel efficiency (in seat-kilometres per litre) was then calculated for each year up to 2005. These values were used to calculate indices of fleet fuel efficiency. These indices of fleet task were then applied to forecast growths for the respective tasks, to estimate the changes in fleet fuel consumptions and  $CO_2$  emissions to 2005 (see appendix III).

The regression equations were of the form:

Table 5.1 shows the coefficients for the variables of the various regression equations, together with coefficients of determination, t-statistics (in brackets).

The model indicates, for the base case, trend domestic fleet average fuel efficiency rising from 24.8 seat-kilometres per litre in 1988 (1.5 megajoules per seat-kilometre or 1.9 megajoules per passenger-kilometre) to 32.8 in 2005, a rise of some 32 per cent. For the Australian international fleet, the trend increase was from 27.4 seat-kilometres per litre to 35.1 in 2005, a rise of about 28 per cent. The fleet averages in 1991 are 27.0 (domestic) and 29.1 (international).

When an aircraft life of 20 years was assumed, these improvements in fuel efficiency by 2005 were reduced somewhat. For domestic aircraft the improvement in fleet average fuel efficiency was 22 per cent, about 10 percentage points smaller than with an aircraft life of 15 years. For international aircraft the improvement was about 17 per cent, 11 percentage points less than with a 15 year life. When an economic life of 25 years was assumed, the improvement in the domestic fleet's average fuel efficiency (14 per cent), was less than half that for an economic life of 15 years. The improvement in fleet average fuel efficiency with a 25 year economic life for the Australian international fleet (16 per cent), was under 60 per cent of that with an economic life of 15 years.

The trend values for fleet average fuel consumption rates reflect the significant progress made over the past twenty years or so in improving the fuel efficiency of aircraft. While, as discussed earlier, further improvements may be expected, it is not clear that the rate of progress will be as rapid as over the past twenty years. As well, some existing aircraft may be replaced with second-hand aircraft rather than new aircraft. In order to estimate the effects of a complete penetration of already achieved levels of fuel economy into the existing fleet model mix, a version of the model was run with replacement aircraft having the fuel economy of the latest series of the same type which was available in 1990 and, for the domestic fleet, 727s replaced by 737-400s.

Aircraft class	Constant	a	Ь	с	R²
Large (over 200 seats)	83.172	0.422 (1.5)	1.566 (2.3)	-13.286 (-2.4)	0.689
Medium (70 to 200 seats)	9.985	0.121 (4.0)	0.606 (9.4)	-1.488 (-5.2)	0.998
Small (under 70 seats)	14.180	0.121 (6.4)	0.762 (5.7)	-2.287 (-11.8)	0.996

TABLE 5.1 REGRESSION EQUATIONS FOR FUEL CONSUMPTION OF REPLACEMENT AIRCRAFT

Note Numbers in brackets are t-statistics

Source BTCE estimates based on data from the BTCE's Aerocost model for existing Australian aircraft types.

This version of the model suggests fleet average improvements in fuel efficiency from 1988 levels of about 29 per cent (domestic) and 13 per cent (international) by 2005. This suggests that, for the domestic fleet, almost 90 per cent of the fuel efficiency improvement in the base case (by 2005) is due to the replacement of aircraft with aircraft having levels of fuel efficiency that have already been achieved. For the Australian international fleet this figure is under 50 per cent.

Figure 5.1 shows results from the spreadsheet model for Australia's domestic and international fleets of aircraft, for both trend and 1990 levels of fuel economy, assuming the existing size mix is maintained and a 15 year economic life in the Australian fleet. For the domestic fleet, the high percentage of the base case fuel economy gains which are available with 1990 technology reflects both the assumption 727s would be replaced by 737-400s that and also the availability of later series aircraft having substantially more seats than those of preceding series, while using little extra fuel. For example, the Australian Boeing 737-300 had 109 seats on average in 1990, while 737-400s had 146. The 737-400 uses 4.42 litres per kilometre (according to the BTCE's Aerocost model) and produces 33 seat-kilometres per while the 737-300 uses 4.05 litres per kilometre litre, (Aerocost model) and produces only 27 seat-kilometres per It is assumed that growth in passenger traffic would litre. allow this pattern of replacement without a decrease in load factors.

Finally, the model was used to examine a scenario in which the existing size and model mix is abandoned, so that all existing aircraft are replaced by the most fuel-efficient aircraft in the current fleet. All medium and large aircraft were assumed to be replaced with wide-bodied, 288 seat A300-600Rs which, the BTCE's Aerocost model indicates, give 56 seat-kilometres per litre, compared to about 33 seat-kilometres from a 146 seat 737-400. Small aircraft having less than 90 seats were assumed to be replaced with F50s producing about 37 seatkilometres per litre. This resulted in a 96 per cent increase in fleet average fuel efficiency between 1988 and 2005.



Source BTCE estimates

FIGURE 5.1 TRENDS IN THE FUEL EFFICIENCY OF AUSTRALIAN COMMERCIAL AVIATION

Clearly, the improvements in fuel efficiency which would be possible if economies of aircraft size could be achieved throughout the fleet would greatly outweigh the likely improvements from technical advances in aircraft and engine design.

Table 5.2 summarises the results from the model for various scenarios. Projections of the implications of the estimated improvements in fuel efficiency for  $CO_2$  emissions from aircraft are to be found in appendix III.

# TABLE 5.2AUSTRALIAN AIRCRAFT: PERCENTAGE INCREASES IN FLEET AVERAGESEAT-KILOMETRES PER LITRE OF FUEL FROM 1988 TO 2005

	Domestic	International
Base case		
replacement at 15 years	33	28
Replacement at 20 years	22	17
Replacement at 25 years	14	16
Replacement aircraft with 1990 level of fuel efficiency <sup>1</sup>	29	13
Replacement of all existing medium and large aircraft with wide-bodied A300-600Rs, and all small aircraft		
(<90 seats) with F50s.	96	na

1 Actual seat-kilometres/litre for latest series of the type available in 1990, and 727s assumed replaced by 737-400s.

na not applicable

Source BTCE estimates

#### CHAPTER 6 CONCLUSION

For the Australian coastal (major trading) and international fleets of ships, there appears to be the potential to realise steady incremental fuel efficiency gains over the next 15 years, from replacement of existing vessels and from ongoing technical progress in engine, hull and propeller design. In addition there are, for the coastal fleet, substantial fuel efficiency gains to be made by replacing the 4 coal burning ships with diesel-engined vessels.

Fuel used by the coastal major trading fleet could fall by about 40 per cent from 1988 levels by the year 2005 if the coastal shipping task were to remain static. This estimate is predicated on the assumption that ships are replaced at about 15 years of age, and that the fuel economy of new ships continues to improve. About half of this improvement would come from replacing the 4 coal burning bulk carriers.

Carbon dioxide emissions from coastal shipping were only about 4 per cent of the emissions (69 megatonnes) from Australian domestic transport in 1988. On the assumption of a constant task, coastal shipping could make a small contribution to the mitigation of greenhouse gas emissions: about 1 megatonne in 2005, or about 1 per cent of the projected 100 megatonnes of  $CO_2$  from Australian domestic transport in 2005 (see appendix III).

For international shipping to and from Australia continuance of past growth rates is unlikely, especially if global greenhouse mitigation efforts involve a reduction in coal usage. Bureau of Mineral Resources forecasts for Australia's mineral exports to the year 2000 published in 1987 implied an expected value of the growth rate of Australian mineral export tonnages of 2.9 per cent per year. At this rate of growth, mineral exports would increase by over 60 per cent by 2005. A similar rate of growth might also be assumed for Australia's much smaller tonnages of imports: Australia's average rate of GDP growth over the ten years to 1990-91 was also 2.9 per cent (*Treasury* 1991).

At this rate of growth the task of Australian-flag ships engaged in international trade would be likely to increase by approximately half from 1988 levels by 2005, if Australianflag ships maintain a constant share in our international trade, and if voyages are shorter on average with changing trade patterns. The model suggests that fuel used by Australia's international ships would then increase by about one-third even if fuel efficiency continues to increase at the same rate as over the past 20 years or so. In the absence of increased use of alternative fuels such as natural qas, greenhouse emissions from this assumed task could be expected to increase by about the same proportion.

For domestic aircraft, if the current size mix of aircraft in the fleet is maintained, and even if the fuel efficiency of the domestic air fleet continues to improve at a rate similar to that in the past two decades, the amount of fuel used is likely to grow by about 35 to 40 per cent over 1988 levels by the year 2005. Emissions of  $CO_2$  in 2005 could be expected to be at least 1.5 megatonnes (or 35 per cent) above 1988 levels (see appendix III).

However, significantly increased use of the most fuelefficient wide-bodied aircraft and of the most fuel-efficient small aircraft in the domestic fleet could perform the increased domestic passenger task predicted for 2005 without a significant increase in emissions. Improvements in fuel efficiency which would be possible if economies of aircraft size could be achieved throughout the fleet would greatly outweigh likely improvements from technical advances in aircraft and engine design.

Fuel used by Qantas is likely to almost double even if fuel efficiency continues to increase as it has in the recent past. All international aircraft operating to and from Australia

could emit an additional 7 or 8 megatonnes  $CO_2$  (from 1988 levels) in 2005. Qantas, if it maintained its current market share of about 40 per cent, would be responsible for an additional 3 megatonnes of  $CO_2$  above 1988 levels in 2005, given forecasts of growth in traffic.

Overall, under a 'business-as-usual' scenario, emissions from ships and aircraft in domestic transport seem likely to increase by about 8 per cent or 0.5 megatonne of  $CO_2$  from 1988 to 2005. This increase equates to only about 0.7 per cent of total 1988 emissions from domestic transport. Emissions in Australian-flag international shipping and aviation could increase by about 63 per cent or 3.5 megatonnes of  $CO_2$  from 1988 levels of emissions by 2005, under the scenarios examined in appendix III.

The proportional increase in the total greenhouse effect from commercial aircraft is likely to be significantly larger than the increase in their use of fuel, because of the high altitude emissions of oxides of nitrogen  $(NO_x)$  and because of the emissions of water vapour into the troposphere and stratosphere.

APPENDIX I SPREADSHEET MODELS FOR THE FLEETS OF AUSTRALIAN COASTAL AND INTERNATIONAL SHIPS. 5 0

#### REGRESSION FOR FUEL CONSUMPTION OF REPLACEMENT SHIPS

. .. ... ...

	NAMB	TTPB ·	DWT	BUILT	SPEED	FUBL /DAY	TONNES /DAT	DWT/1000	BUILT -1965	SPEED	TBAR REPLACED	RBPLACED -1965	VESSEL TONNES/DA	1.1*DWT /1000	REPLACENEO VRSSBL	RIG SHI	SPC TONNES/DAY
••••					********												
	ACCOLADE II	B	8410	1982	10.2	14.0	2.64	2.13	2.8332	2.32	1997	3.47	7.19	2.22	7.47	9.09	7.88
	CANIRA	8	4120	1980	12.0	9.0	2.20	1.42	2.7081	2.48	1995	3.40	7.63	1.51	7.93	9.87	8.16
	SANDRA WARIE	B	5680	1986	14.2	13.8	2.62	1.12	3.0445	2.65	2001	3.58	11.17	1.81	11.61	13.65	12.80
	GOLIATH	B	4270	1977	14.0	14.0	2.64	1.45	2.4849	2.64	1992	3.30	10.93	1.55	11.36	14.79	11.25
	WALLARAH	B	6666	1986	11.6	11.5	2.44	1.90	3.0445	2.60	2001	3.58	10.93	1.99	11.36	13.36	12.52
	WARDEN POINT	B	6000	1978	11.0	11.5	2.44	1.79	2.5649	2.40	1993	3.33	7.66	1.89	7.95	10.19	7.99
	BXPRBSS	B	17000	1990	13.0	17.6	2.87	2.83	3.2189	2.56	2005	3.69	14.22	2.93	11.11	16.93	16.93
	ORMISTON	B	16580	1979	14.8	30.0	3.40	2.81	2.6391	2.69	1994	3.31	20.39	2.90	21,19	26.74	21.55
	CENENTCO	B	16510	1978	15.2	32.0	3.47	2.80	2.5649	2.12	1993	3.33	21.89	2.90	22.75	29.13	22.83
	TRON BARON	B	37557	1985	14.1	25.0	3.22	3.63	2.9957	2.65	2000	3.56	24.16	3.72	25.10	29.15	27.38
	IRON CAPRICORN	B	35244	1975	13.5	34.5	3.54	3.66	2.3026	2.60	1992	3.30	23.79	3,66	24.72	34.43	24.48
	IRON CAPRICORN	B	35244	1975	15.0	44.5	3.80	3.66	2.3026	2.11	1992	1.10	29.33	3.66	30.48	42.45	30.1B
	IRON CARPENTARIA	8	45310	1977	9.5	16.0	2.11	3.81	2.4849	2.25	1992	3,30	13.09	3,91	11.60	17.71	13.47
	IRON CARPENTARIA	B	45310	1977	13.5	31.0	3.43	3.81	2,4849	2,60	1992	3.30	26.32	3.91	27.35	35.60	27.08
	IRON CURTIS	8	45310	1978	9.5	16.0	2.11	3.81	2.5649	2.25	1993	3.33	12.92	3.91	13.42	17.19	13.47
	IRON CURTIS	B	45310	1978	13.5	32.0	3.41	3.81	2.5649	2.60	1993	3,33	25.97	3.91	26.98	34.55	27.08
	IRON PRINCE	B	21735	1981	13.5	23.0	3.14	3.08	2.7728	2.60	1996	3.43	18.60	3.17	19.33	23.79	20.15
	IRON PRINCE	8	21735	1981	14.5	29.0	3.37	3.08	2.1128	2.61	1996	3.43	21.44	3.17	22.28	21.42	23.23
	IRON STURT	8	22100	1979	13.5	23.1	3.14	3.10	2.6391	2.60	1994	3.37	19.20	3.19	19.95	25.18	20.29
	LRON STURT	8	22100	1979	15.0	30.1	3.40	3.10	2.6391	2.71	1994	3.37	23.67	3.19	24.59	31.04	25.01
	KOWULKA	B	23258	1984	13.0	20.0	3.00	3.15	2.9444	2.56	1999	3.53	17.13	3.24	17.80	21.28	19.21
	LINDESAY CLARE	B	29510	1985	13.0	20.0	3.00	3.38	2.9951	2.56	2000	3.56	18.65	3.48	19.38	22.98	21.14
	RIVER TORRENS	B	31921	1977	14.6	36.4	3.59	3.46	2.4845	2.68	1992	3.30	26.64	3.56	27.68	36.02	27.41
	PORTLAND	Ĥ	36500	1988	13.4	29.0	3.37	3.60	3.1358	2.60	2003	3.64	21.02	3.69	21.85	25.35	24.57
	FLINDERS RANGE	B	27500	1978	14.8	36.4	3.59	3.31	2.5649	2.68	1993	3.33	24.75	3.41	25.71	32.93	25.81
	ERON RESTREL	B	27270	1974	14.0	30.0	3.40	3.31	2.1972	2.64	1992	3.30	23.08	3.40	23.96	34.72	23.73
	IRON KESTREL	B	27270	1974	15.0	38.0	3.64	3.31	2.1972	2.71	1992	3.30	26.45	3.40	27.49	39.82	27.22
	TRON LIRBY	B	27299	1974	14.0	30.0	3.40	3.31	2.1972	2.64	1992	3.30	23.07	3,40	23.97	34.73	23.74
	IRON KIRBY	8	27299	1974	15.0	38.0	3.64	3.31	2.1972	2.71	1992	3.30	26.46	3,40	27.50	39.84	27.23
	HOWARD SNITH	8	43300	1981	13.8	35.3	3.56	3,11	2.112	2.63	1996	3.43	25.79	3.86	26.80	32.99	21.94
	TNT ALLTRANS	8	35218	1983	14.5	33.0	3.50	3.56	2.890	2.67	1998	3,50	25.44	3.68	6 26.43	31.88	28.21
	AUSTRALIAN PROGRE	IS B	139400	1977	14.0-	72.0	4.28	4.94	2.484	2.64	1992	3.30	44.48	5.03	46.22	60.15	45.17
	AUSTRALIAN PROSPB	IC B	139400	1976	14.0	72.5	4.28	4.94	2.397	2.64	1992	3.30	44.48	5.03	46.22	62.14	45.77
	IRON NEWCASTLE	B	148140	1985	12.50	37.0	3.61	5.00	2.995	2.53	2000	3.56	33.04	5.09	34.33	40.69	37.45
	IRON NEWCASTLE	B	148140	1985	14.0	45.0	3.81	5.00	2.995	2.64	2000	3.56	i 41.38	5.09	43.00	50.91	46.90
	IRON PACIFIC	B	231850	1985	11.0	38.0	3.64	5.45	3.044	2.40	2001	3.58	30.37	5.5	31.56	37.12	34.79
	IRON PACIFIC	B	231850	1986	14.0	62.0	4.1	5.45	3.044	2.64	2001	3.56	8 49.04	5.5	50.96	59.94	56.17
	IRON SHORTLAND	8	107140	1979	12.5	40.0	3.69	4.61	2.639	2.53	1994	3.31	31.10	4.7	7 32.32	40.79	32.87
	IRON SHORTLAND	B	107140	1979	15.0	79.0	4.31	4.61	2.639	2.71	1994	3.31	44.68	4.7	1 46.43	58.60	47.22
	IRON SPENCER	B	141475	1981	13.0	44.5	3.8(	4.95	2.112	2.56	5 1996	3.43	36.68	5.0	5 38.11	46.92	39.74
	IRON SPENCER	Ð	141475	1981	14.0	61.5	4.1	4.95	2.172	2.64	1996	3.4	42.50	5.0	5 44.16	54.31	16.04
	LRON WHYALLA	B	141435	1981	13.0	43.5	3.7	4.95	2.112	2.50	5 1996	3.4	36.68	5.0	38.11	46.92	39.73
	THON WHYALLA	B	141435	1981	14.0	58.1	4.0	4.95	2.772	2.64	1996	3.4	42.49	5.0	5 44.16	54.36	46.04
	TRON TEMELA	B	148150	1986	12.5	37.(	3.6	5.00	3.044	2.5	2001	3.5	32.69	5.0	9 33.97	39,96	37.45
	TRON REMBLA	8	148150	1986	14.0	45.0	3.8	1 5,00	3.044	2.6	1 2001	3.5	8 40.95	5.0	9 42.55	50.05	46.91
				1980.35		33.9(	i 3.4	3.61	2.132	Z.59							
KAL (	JANGU								B R	L							

BULI Regression	Output:			
Constant		-2.21		
Std Brr of Y Bst		0.13		
R Squared		0:94		
No. of Observations		45.00		
Degrees of Preedom		41.00		
I Coefficient(s)	0.40	-0.37	1.99	
Std Brr of Coef.	0.02	0.07	0.17	

Regression Output:

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TABLE I.1

TABLE I.1 (cont) REGRESSION FOR FUEL CONSUMPTION OF REPLACEMENT SHIPS

5																					
	FRANCES BAY G	/0	2106	1981	11.0	9.0	2.20	0.14	2.7726	2.40	1996	3.43	5.84	0.84	6.09	6.11	5.95	Constant		- 2 05	
	JON SANDERS O	/0	3168	1988	12.5	1.1	1.96	1.15	1.1355	2.52	2003	3.64	8.75	1.25	9.13	9.13	9.06	Std Ree of V Rat		0 19	
	ROBERTA JULL G	/C	3400	1990	10.4	6.6	1.88	1.22	1.2189	2.14	2005	1.69	6.12	1.12	6 50	6 57	6 67	D Savered		0.13	
	C.Y.O'CONNOR G	/0	3168	1988	12.1	8.9	2.18	1.15	1.1155	2.49	2003	1 54	8 10	1 95	9 65	33.0	0.51	N aquareu		14 00	
	IRON ARNHEN G	/C	8362	1973	12.0	12.5	2.53	2.12	5.0794	9 48	1999	1 10	15 90	1.25	11 11	14 15	19 09	NG, DI UDBEFYACIONS		10.00	
	LROW ARNHEN G	/c	8362	1973	13.5	15.5	2.74	2.12	5.0194	2.50	1992	1 10	16 00	1 11	16 99	19.13	16.01	vegrees of Freedom		10.00	
	WAREHAN BAY	VC	2925	1987	12.0	R.0	2.08	1 07	1 0010	9 48	9002	1 61	9 66	1 17	0 91	11,10	10.19	* Confficient(a)			
	WARY DURACK	/c	3168	1988	12.3	1.5	2.01	1.15	3.1355	2.51	2001	1 64	8 61	1 95	0.61	0.66	0.13	A COEFFICIENC(#)	0.11	-0.08	1.90
	FRANK KONBONY O	/C	3400	1990	10.4	5.6	1.88	1.99	1.9189	2.14	9005	1 60	6 19	1.20	6 60	0,01	0.01	Sta Brr of Goel.	0,13	0.11	0.71
	GORDON REID G	/0	3400	1990	10.4	6.6	1.88	1.99	1 9180	2 14	2005	1 60	6 19	1 19	6 80	0191	0.31				
	INBNE GREENWOOD G	/0	21760	1982	14.3	12.0	1.41	1.08	9 8119	2 66	1997	1 47	26 77	1 10	0,03	. 0'bl	0.31				
	PILBARA G	/c	12760	1978	14.0	21.0	1.04	2.55	2.5649	2.64	1991	1 11	20.71	9 64	51.51 51 KG	20.60	21.32				
	KOOLINDA G	/0	12760	1978	14.0	21.0	3.04	2.55	2.5649	2.64	1993	1 11	20.71	2.04	21.55	22.00	20.30				
						13.58	2.45	1.59	RDR	2.51	1	4140		2.04	61.33	22.00	20.30				
							••••		BRR	••••											
CONTAIN	l R								BRR												
	AUSTRALIAN TRADER	C	8450	1978	13.7	22.1	3.10	2.13	2.5649	2.62	1993	3.33	13.96	2.23	14.35	25.24	15.23				
	TRANZTAS TRADBR C		14101	1988	15.2	25.5	3.24	2.65	3.1355	2.72	2003	3.64	16.56	2.74	17.03	24.41	22.89	CONTR Regression Of	itout:		
	AUSTRALIAN ADVANCE	C	35407	1983	17.2	50.2	3.92	3.51	2.8904	2.85	1998	3.50	32.85	3.66	33.78	52.45	40.70	Constant		~1.90	
	AUSTRALIAN BEPORTE	C	27978	1972	14.9	67.0	4.20	3.33	1.9459	2.70	1992	3.30	24.93	3,43	25.63	10.70	26.45	Std Brr of Y Rat		0.16	
	AUSTRALIAN VENTURB	С	39450	1977	18.9	110.5	4.71	3.68	2.4849	2.94	1992	3.30	49.78	3.77	51.20	93.12	52.43	R Squared		0.95	
	AUST ENDBAVOUR C		45500	1991	19.5	53.0	3.97	3.82	3.2581	2.97	2006	3.71	40.73	3,91	41.88	57.90	59.68	No. of Observations		8.00	
	AUST ENDURANCE C		45500	1991	19.5	53.0	3.97	3.82	3.2581	2.97	2006	3.11	40.73	3.91	41.88	57.90	59.68	Degrees of Freedom		1.00	
	IRON PLINDERS C		17370	1986	15.0	32.6	3.48	2.85	3.0445	2.71	2001	3.58	17.14	2.95	18.24	26.89	23.51	regices of filedos			
							3.82	3.23	BRR	2.81								Y Coefficient(s)	0.29	-0 77	7 48
Ro/Ro									ERR									Std Rep of Coef	0 29	0 19	1 40
									BRR									bou bii vi buci,	v.23	V.13	1.10
	NELBOURNE TRADER R	0/R0	1201	1975	15.9	34.1	3.53	1.98	2.3026	2.76	1992	3.30	32.06	2.07	33.66	14.98	32.28				
	BASS TRADER R	0/R0	7845	1976	17.1	37.3	3.62	2.06	2.3979	2.84	1992	3.30	41.84	2.16	41.91	45.28	42.11				
	GUTE R	0/R0	2400	1979	16.3	18.0	2.89	0.88	2.6391	2.79	1994	3.37	19.61	0.97	20.58	20 90	16 87	RO/RO Regression O			
	SRAWAY HOBART R	0/R0	7161	1976	15.2	36.5	3.60	1.97	2.3979	2.72	1992	3.30	28.03	2.05	29.43	30.33	28.22	Constant	icpuc:	-5 27	
	SBAWAY NELBOURNE R	0/R0	7180	1977	15.8	37.3	3.62	1.97	2.4849	2.16	1992	3.10	31.63	2.07	31.20	33.96	31.84	Std Rep of Y Cat		0.16	
	TASMANIA B R	0/R0	4100	1982	15.5	24.5	3.20	1.55	2.8332	2.74	1997	3.41	23.67	1.64	24.85	25 02	94 19	D Savered		0.00	
	IRON WONARCH R	0/R0	14855	1973	11.5	16.0	2.11	2.70	2.0794	2.44	1992	1.30	17.21	2.79	18.07	10 16	17 13	No of Observations		11 00	
	SBAROAD NERSEY R	0/80	3287	1991	16.0	24.0	3.18	1.19	3.2581	2.11	2006	1.71	21.99	1 99	22 14	22 15	22 23	No. of Concervations		11.00	
	SEAROAD TAWAR R	O/RO	9958	1991	16.0	35.0	3.56	2.30	3.2581	2.11	2006	1.71	37.11	2 20	10 11	10 67	10 11	nefices of Liecon		3.00	
	BASS RESPER	0/R0	2745	1978	13.8	15.1	2.15	1.01	2.5649	2.82	1001	1 11	19 71	1 11	11 16	11 69	19 86	T. Confficient(a)		0.00	
	ANRO AUSTRALIA R	0/R0/C	22200	1977	13.3	34.5 -	1.54	3.10	2.4849	2.59	1997	1.10	11 22	1 20	14 97	15.02	12.00	A COELICIEAL(S)	0.00	-0.03	3.08
	ANRO KELBOURNE R	0/R0/C	23617	1975	14.5	54.3	3.99	3.16	2.3026	2.68	1992	1,10	11.91	1 26	41.01	49 00	15 21	SCU BEF OL COEL.	0.00	0.14	V.10
	AUSTRALIAN EMBLEM R	0/80	23450	1975	14.5	54.3	3.99	3.15	2.3026	2.68	1992	3.30	44.75	3.25	46.98	AR 81	45 05				
							3.40	2.08	BRR	2,71					10100	10.00	10.00				
PRODUCT	TANKER								BRR												
	BP ENTERPRISE P	T	19792	1968	13.8	37.0	3.61	2.99	1.0986	2.62	1992	3.30	21.31	3.08	22.66	35.04	21.69	P.TANKER Regression O	utput:		
	JOHN KUNTER P	T	24245	1975	12.6	30.4	3.41	3.19	2.3026	2.53	1992	1.30	24.00	3.28	25.51	30.04	24.42	Constant		1.54	
	AUSTRALIA SEV P	T	33239	1989	13.4	26.8	3.29	3.50	3.1781	2,50	2004	3.66	27.26	3.60	28.98	30.43	30.15	Std Rer of Y Ret		0.14	
	AUSTRALIAN SPIRIT P	T	32605	1987	13.5	25.0	3.22	3.48	3.0910	2.60	2002	3.61	27.28	3.58	29.00	30.68	29.81	R Squared		0.88	
	NOBIL AUSTRALIS P	T	26642	1972	16.0	30.5	3.42	3.28	1.9459	2.11	1992	3.30	26.32	3.38	21.99	35.73	26.79	No. of Observations		13 00	
	WW LBONARD P	t	25500	1973	16.0	35.0	3.56	3.24	2.0794	2.77	1992	3,30	25.59	3.33	27.21	33.70	26.04	Degrees of Freedom		9.00	
	AMPOL TYA P	T	32000	1990	14.00	30.0	3.40	3.47	3.2189	2.54	2005	3.69	26.61	3.56	28.29	29.60	29.60	ACTION AT LECTAR		2.00	
	NOBIL TASMAN P	T	32000	1990	13.00	31.6	3.45	3.47	3.2189	2.56	2005	3.69	26.35	3.56	28.01	29.30	29.30	X Coefficient(s)	0.64	-0.23	0.11
	ESSO GIPPSLAND P	Ť	24380	1972	14.5	39.3	3.67	3.19	1.9459	2.51	1992	3.30	24.54	3.29	26.09	33.31	24.97	Std Rrr of Coef	0.08	0.06	0.58
	CONUS P	t	31950	1981	14.5	38.3	3.65	3.46	2,1726	2.67	1995	3.43	28.30	3.56	30.08	32,86	29.71	··· », », vvii			4150
	WILTSHIRE	PG	12280	1968	15.0	24.0	3.18	2.51	1.0986	2.11	1992	3.30	15.87	2.60	16.87	26.09	16.15				
	RELAIN L	PG	13453	1990	14.5	19.0	2.94	2.60	3.2189	2.67	2005	3.69	15.33	2.69	16.29	17.05	17.05				
	ISLAND GAS L	PG	6033	1976	13.5	11.6	2.45	1.80	2.3979	2.60	1992	3.30	9.91	1,89	10.54	12.15	10.09				
							3.33	3,09	BRR	2.65											

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# TABLE I.1 (cont)

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REGRESSION FOR FUEL CONSUMPTION OF REPLACEMENT SHIPS

CRUDE 7	ANEER: WAIN ENGINES	ONLY		-					ERR												
	ANPOL SARBL	CT -	101900	1979	15.5	67.5	4.21	4.62	2.6391	2.74	1994	3.37	40.72	4.72	43.51	63.31	44.55	C.TANKER Regression Ou	tput:		
	ARTHUR PHILLIP	CT .	65103	1974	16.0	62.0	4.13	4.18	2.1972	2.77	1992	3.30	33.15	1.27	35.42	64.50	34.73	Constant		-2.82	
	CANOPUS	CT	94347	1986	13.9	38.5	3.65	4.55	3.0445	2.63	2001	3.58	27.32	4.64	29.19	37.88	34.08	Std Brr of Y Bet		0.13	
	BRA	CT	94287	1986	13.7	39.1	3.67	4.55	3.0445	2.62	2001	3.58	26.47	4.64	28.28	36.70	33.02	R Squared		0.87	
	AUSTRALIA STAR	CT	94560	1986	13.2	42.5	3.75	4.55	3.0445	2.58	2001	3.58	24.77	4.64	26.47	34.34	30.90	No. of Observations		11.00	
	BP ACHIBVER	CT	129700	1983	13.3	40.0	3.69	4.87	2.8904	2.58	1998	3.50	32.76	4.96	35.00	47.30	38.76	Degrees of Freedom		7.00	
	NOBIL PLINDERS	CT	149235	1982	15.0	75.0	4.32	5.01	2.8332	2.11	1997	3.47	46.90	5.10	50.10	68.80	54.46				
	NIVOSA	CT	124754	1984	13.0	40.0	3.69	4.83	2.9444	2.56	1999	3.53	30.17	4.92	32.24	42.93	36.35	X Coefficient(s)	0.69	-0.61	1.96
	IRON GIPPSLAND	CT	87000	1989	14.0	34.0	3.53	4.47	3.1781	2.84	2004	3.66	24.99	4.56	26.70	33.53	32.71	Std Brr of Coef.	0.19	0.17	0.76
	IRON GIPPSLAND	CT	87000	1989	14.4	31.2	3.44	4.47	3.1781	2.67	2004	3.56	26.40	4.56	28.21	35.43	34.57				
	IRON GIPPSLAND	CT	87000	1989	15.1	36.8	3.61	4.41	3,1781	2.11	2004	3.66	28.90	1.56	30.87	38.78	37.83				
							3.79	4.59	BRR	2.66		· · .									
TOTAL						3497.33			BRR				2601.59		2722.13	3410.50	2853.77				
X DIPPE	Rence			-		-			BRR				0.7439		0.7785	0.9752	0.8160				
									BRR												
									BRR		-							-		1	
LARGE T	ANKER: BOILER ETC /	ADDBD TO M	AIN BNGINBS	CONSUMPTI	EON .	· · ·			BRR									· · ·			
	ANPOL SARBL	CT	101900	1979	15.5	72.5			2.6391		1994	3.37	45.72		48.51		49.55				
	ARTHUR PHILLIP	CT -	65103	1974	16.0	62.0			2.1972		1992	3.30	33.15		35.42		34.73				
	CANOPUS	CT	94347	1986	13.9	56.0			3.0445		2001	3.58	44.82		46.69		51.58				
	8RA	CT	94287	1985	13.7	51.4			3.0445		2001	3.58	38.77		40.58		45.32				
	AUSTRALIA STAR	CT	94560	1986	13.2	42.5			3.0445		2001	3.58	24.77		26.47		30.90				
	BP ACHIEVER	CT	129700	1983	11.5	60.0			2.8904		1998	3.50	52.76		55.00		58.76				
	NOBIL PLINDERS	CT	149235	1982	15.0	15.0			2.8332		1997	3.47	46.90		50.10		54.46				
	NIVOSA	CT	124754	1984	13.0	42.6			2.9444		1999	3.53	32.17		34.84		38.95				
	IRON GIPPSLAND	CT	87000	1989	14.0	64.0			3.1781		2004	3.66	54.99		56,70		62.71				
		)																			
OTHER																					
	STOLT AUSTRALIA	CHT	8900	1986	14.0	13.4	2.59	2.19	3.0445	2.64	<b>2</b> 001	3.58	11.98	Z.28	12.74	13.54	13.01 AS	FOR PRODUCT TANKER			
-	ZINCHASTER	SP	17530	1975	14.0	29.0	3.37	2.86	2.3026	2.64	1992	3.30	19.30	2.96	20.06	27.94	19.87 AS	FOR BULK			
	SBACAT TASHANIA	P/CF	2000	1990	35.0	75.0	4.32	0.69	3.2189		2005	3.69									
_	AUSTRALIAN SBARO	AD CC	9033	1982	17.5	29.0	3.37	2.20	2.8332	2.86	1997	3.47	23.49	2.30	24.16	39.37	29.23 AS	FOR CONTAINBR			
coal	RIVER ENBLEY	8	76305	1983	13.1	144.0	4.97	4.33	2.8904	2.57	1998	3.50	28.21	4.43	29.31	35.35	31.28 AS	FOR DIRSEL BULK			
coal	RIVER BOYNE	B	76355	1982	13.5	147.0	4.99	4.34	2.8332	2.60	1997	3.47	30.30	4.43	31.49	38.35	33.22 AS	FOR DIESEL BULK			
coal	THT CAPRICORNEA	B	75140	1983	15.0	148.0	5.00	4.32	2.8904	2.11	1998	3.50	36.91	4.41	38.36	46.26	40.93 AS	FOR DIBSEL BULK			
coal	THT CARPENTARIA	B	75105	1983	15.0	148.0	5.00	4.32	2.8904	2.71	1998	3.50	36.91	4.41	38.35	46.25	40.93 AS	FOR DIESEL BULK			
	ABBL TASHAN	RO/RO/P	2063	1975	19.5	60.0	4.09	0.72	2.3026	2.97	1990	3.22	32.26	0.82	33.86	34.96	32.26 AS	FOR RO/RO			
	NW SANDBRLING	CNC	72870	1989	17.0	93.0	4.53	4.29	3.1781	2.83	2004	3.66	32.30	4.38	34.51	46.31	45.18 AS	FOR CRUDE TANKER: MAIN ENGIN	IES		
	NW SNEPB	LNG	72870	1990	17.0	93.0	4.53	4.29	3.2189	2.83	2005	3.69	31.81	4.38	33.98	45.18	45.18 AS	FOR CRUDE TANKER: MAIN BHGIN	IES		
	NV SANDPIPER	LNG	72870	1992	17.0	93.0	4.53	4.29	3.2958	2.83	2007	3.74	30.88	4.38	32.99	43.12	45.18 AS	FOR CRUDE TANKER: NATH RUGIN	IRS		

# TABLE I.2COASTAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME<br/>SIZE A S E X I S T I N G VESSELS (EMISSIONS BASIS)

			<b>7711</b>	7 (177)	TEL/MT			1	OFFER PUR	L / DAT	OP VESSEL	ND RH	ACERENT V	ESSEL				******	•••••				
	TTPE	DIT	MILT	(	TOTES)	1988	1989	1990	1991	1992	1991	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
<b>MININ MI</b> GI	1	27500	1978	14.4	36.4	36.4															******		••••••
LTSLORT STDEATOUR	RO/RO	11819	1973	18,0	RICE.	45.1																	
ILLIT BOLTILLI	G/C	3340	1971	15.0	NICE.	13.2																	
EXCOUNT TRADIN	RO/RO	7207	1975	15.9	31.1	31.1																	
ELD RECEATE	KO\KO	2745	1978	15.0	14.9	14.9		14.5	14.9	14.9	14.9	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
CHILLINGIA 1	10/10	339	1979	15.0	REGR.	15.9	15.9																
PRESEAT FORTH	GC GC	9332	1976	14.7	27.9	27.9	27.9																
IN TRACTORIES	11	19792	1968	14.5	36.0	36.0	36.0	36.0															
INNE CUINTOOD	G/C	21760	1982	14.5	32.0	32.0	32.6	32.0															
JOIL TUTTIK	11	24245	1975	14.5	30.4	30.4	30.4	30.4															
LOOPIEDT	0/C	12760	1978	14.0	21.4	21.0	21.0	21.0															
TILTOTILL	LPG	12280	1968	15.0	24.0	26.0	24.0	24.0															
ABEL YASHAD	20/20/P+	2063	1975	19.5	68.0	60.0	60.0	60.0	60.0	60.0													
RUU IN	10/10/24	4110	1986	20.4							31.9	31.9	31.9	31.9	31,9	31.9	31.9	31.9	31.9	24.0	24.0	24.0	24.0
FCCOLYDE II	1	8410	1942	10.2	14.0	14.0	14.0	16.4	14.9	14.4	14.0	14.0	14.0	14.0	14.0	1.1	1.2	1.1	1.2	7.2	1.1	7.2	7.2
TUDOT STRET	CT	101900	1979	15.5	12.5	72.5	72.5	72.5	12.5	72.5	72.5	72.5	45.7	65.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7
ARYNNE PEILLIP	CT	65103	1974	16.0	62.0	62.0	62.0	62.0	62.0	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2
AUTYBALIA SET	n	33239	1989	12.1	26.8	26.8	26.8	26.8	26.8	26.4	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	27.3
AUTTRALIAE SPIRIT	11	32605	1987	13.5	25.0	25.4	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.8	25.0	25.0	25.0	27.3	27.3	27.3
	10/10	7846	1976	17.1	37.3	37.3	37.3	37.3	37.3	37.3	37.3	41.8	41.8	61.8	41.8	41.8	61.8	41.8	41.8	61.8	41.6	41.8	41.8
CATTER		6170	1980	12.0	9.0	9.8	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.6	7.6	7.6	7.6	7.6	1.6	7.6	7.6	7.6	1.6
CAROPUS	CT .	94347	1986	13.9	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	44.8	44.8	44.8	44.8
CHRENTCO	1	16510	1978	15.2	32.0	32.0	32.0	32.0	32.0	32.0	32.0	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.5	21.9
CORES	11	31950	1981	14.5	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	28.3	28.3	28.3	28,3	28.3	28.3	28.3	28.3	28.3
	CT	94287	1986	13.7	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	38.8	18.8	38.8	38.8
SESU ELPPSLADD	n ti	24380	1972	14.5	39.3	39.3	39.3	39.3	39.3	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5
TARCES BAY	6/C	2106	1981	11.0	9.8	9.9	9.0	9.0	9.0	9.8	9.0	9.0	9,0	9.0	5,8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
COLITI	1	4270	1977	14.0	14.1	14.0	14.0	14.0	14.0	14.0	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9
GTTE	10/10	2499	1979	16.3	\$8.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6
INCU BARON		37557	1985	14.1	25.6			25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	24.2	24.2	24.2	24.2	24.2
IBON CAPHICORN	1	35244	1975	13.5	34.5	34.5	34.5	34.5															
HOR CUBARADIA	1	45310	1977	9,5	16.8	16.0	16.0	16.0	16.0	13.1	13.1	11.1	11.1	13.1	13.1	13.1	11.1	13.1	11.1	13.1	13.1	13.1	13.1
IRON CURTIS	1	45310	1978	9.5	16.0	16.0	16.0	16.0	16.0	16.0	16.0	12.9	12.9	12.9	12.9 -	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
LEON ROUARCE	RO/RO	14855	1973	11.5	16.0	16.0	16.0	16.0	16.0	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2
IEVE FRIECE		21735	1981	11.5	23.8	23.0	23.0	23.0	23.0	23.0	23.0	23.4	23.0	23.0	18.6	18.6	10,6	18.6	18.6	18.6	18.6	18.6	18.6
TRAN START	5 1 80	(4100	17/7	13.5	23.1	13.1	11.1	23.1	23.1	23.1	23.1	23.1	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2
ISPERIAL AT	6 <b>1</b> 6	6V33	17/8	11.3	11.6	11.6	11.6	11.6	11.6	- 3.3	9.9	9.9	9.9	9.9	9.9	3.9	9.9	5.5	9.9	9.9	9.9	9.9	9.9
AAA STRAFTS	U/C	1010	1740	14.3	1.1	1.1	1.1	7.1															
KSUTIO POMPTYA	276	13433	1770	14.3	19.0			19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0
TTERPORT ATTRE		13138	1784	13.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	17.1	17.1	17.1	17.1	17.1	17.1
NARRESAT CLARK	6 17	47310	1783	13.0	49.0	10.0	20.0	10.0	20.0	20.0	20.0	20.0	20.0	ZQ.Q	20.0	20.0	20.0	20.0	18.7	18.7	18,7	18.7	18.7
AVAID AVAILALIA	ri B	16644	19/2	10.0	JV.3	JQ.3	JQ.3	30.5	14.4														
VARIEIVE DTCREDE	eic	19764	1977	19.6	JV.V 21 A	38.8	JU.U 11 A	39.0	30.0	JQ.Q	3V.V	39,0	20.4	70.4	20.4	20.4	20.4	20.4	20.4	20.4	20.6	20.4	20.4
POPTLER		36540	1010	14.4	41.V 76 6	41.V 78 A	41.V 14 A	41.V 98.8	61.V 94 A	41.4	41.0	49.1	20.1	19.1	20.1	20.1	20.1	10.1	20.7	20.7	20.7	20.7	20.7
BITTE BATER	# # [east1	16165	1004	11.1	47.0	47.V	47.0	47.8	47.0	47.1	49.0	67.8	47.V	29.0	29.9	29.0	ZY.Q	29.0	29.0	29.0	29.0	ZI.0	21.0
BITTE PARTY	B [coal]	78323	1704	11.1	144.5	116.4	144.7	144.3	144.5	144.7	144.5	144.9	144.9	144.9	144.9	30.3	30.3	30.3	30.3	39.3	30.3	38.3	30.3
DITTE TABLE	= [evel]	11471	14793	11 6	149,0	100.0	140.0	110.0	16.0	148.6	148.6	149.8	149.0	149.4	149.0	146.0	28.2	28.2	28.2	28.2	28.2	28.2	28.2
	i	5584	1984	14.3	11.4	11.1	11.8	11.8	11.4	11.1	49.9	49,9	11 #	11 4	19.9	10.0	49.8	48.8	28.8	26.6	20.0	26.6	24.6

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TABLE I.2 (cont)	COASTAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAN
	SIZE AS EXISTING VESSELS (EMISSIONS BASIS)

SEAVAT HODARY R0/R0 7161 1976 15.2 36.5 36.5 36.5 36.5 36.5 28.0 28.0 28.0 28.0 28.0 28.0 28.0 28.0 28.0 28.0 28.0 28.0 28.0 28.0 SEAVAY RELBOURDE RO/RO 7180 1977 15.8 37.3 37.3 37.3 37.3 37.3 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 37.3 12.0 6900 11.7 13.7 13.7 13.7 13.7 13.7 13.7 12.0 12.0 12.0 STOLT AUSTRALIA CET 1986 14.0 REGR. 13.7 11.7 13.7 13.7 13.7 13.7 13.7 20/20 4700 1982 24.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 23.7 23.7 23.7 23.7 23.1 23.7 23.7 23.7 TASKARIA D 15.5 24.5 24.5 147.9 36.9 36.9 THT CAPRICORDIA B [coal] 75140 1983 14.5 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 -147.9 147.9 36.9 36.9 36.9 36.9 36.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 36.9 36.9 36.9 36.9 36.9 36.9 36.9 THT CARPENTARIA B [coal] 75105 1983 14.5 147.9 TH LEOFARD 21 -25500 1973 16.0 35.0 35.0 35.0 35.0 11.5 10.9 10.9 10.9 10.9 VALLARAE 6666 1986 13.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 19.3 19.3 19.3 19.3 19.3 **ZIECHASTER** SPt 17530 1975 14.0 29.0 29.0 29.0 29.0 29.0 19.3 19.3 19.3 19.3 19.3 19.3 19.3 19.3 19.3 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 ARPOL TVA 27 32000 1990 14.0 30.0 30.9 30.0 30.0 30.0 30.0 1.1 VARDER POINT 1978 11.5 11.5 i1.5 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1 6000 11.0 11.5 11.5 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 ROBERTA JULL C/C 3400 1990 10.4 \$.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 LIPRESS 17000 1990 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6-8 13.5 17.6 NOBIL TASKAR PŤ 32000 1990 14.7 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 SEARCAD HERSEY R0/R0 \$775 1991 16.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 TARRA RIVER 1 30000 1982 13.0 REGR. 27.2 27.2 27.2 27.2 27.2 27.2 21.2 19.5 19.5 19.5 19.5 19.5 19.5 19.5 19.5 SEAROAD TAKAR 20/20 9575 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 1991 16.9 34.1 34.1 34.1 -----TOBBES OF FORL PER DAY (CONSTANT TASK AFTER 1991) 2015.5 1874.7 1987.1 1821.9 1756.8 1710.2 1695.2 1655.5 1655.2 1637.6 1507.7 1167.2 1164.3 1162.1 1125.5 1127.8 1119.9 1120.3 INDER OF FUEL USED (1988 BASE: CONSTANT TASE AFTER 1991) 100.0 93.0 98.6 90.4 87.2 84.9 84.1 82.2 82.1 81.3 74.8 57.9 57.8 57.7 55.8 56.0 55.6 55.6 DEADWRIGHT TORUS - NAUTICAL MILES PER DAT 4.82+08 4.62+08 5.12+08 4.62+08 4.62+08 4.62+08 4.62+08 4.62+08 4.62+08 4.62+08 4.62+08 4.62+08 4.62+08 4.62+08 3.70 3.61 3.61 3.57 3.29 2.55 2.54 2.53 2.45 2.44 . 2.44 FLEET AVERAGE TOBBES OF FUEL / COODWY / 1000 BAUTICAL MILES 3.97 3.83 3.73 2.46 4.18 4.05 3.92 INDEX OF FLEET FUEL EFFICIENCE (1988 BASE) 100.0 103.0 104.1 104.8 108.2 110.7 111.5 113.5 114.5 121.2 139.0 139.2 139.3 141.2 141.1 141.5 141.5

Note: It is assumed that vessels are replaced at age 15 years or 1992 if already older.

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Batimates of fuel consumption were obtained from shipping companies, else from regression equations for tonnes of fuel per 000DWT per day from BTCE database INTSEAB.WEL For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships. The database regression equations for existing ships for which data was not obtained are:

Bulk ships: exp[-1.749625-0.4925291a(DWT/1000)+0.2223081a(1991-year built)+1.1066371a(speed) Tankers : exp[-3.6707-0.4059221a(OWT/1000)+0.1780081a[1991-year built)+1.7822731a[speed] Ro/Ko : exp[-4.0451212-0.5072761a[OWT/1000)+0.046391a[1991-year built)+2.2343771a[speed] Container : exp[-6.641991-0.5643671a[OWT/1000]+0.3955331a[1991-year built)+2.9106741a[speed] Gen Cargo : exp[-5.347061-0.510471a[OWT/1000]+0.0715651a[1991-year built)+2.6579191a[speed] Gen Tanker: exp[-0.570247-0.359211a[OWT/1000]+0.0715651a[1991-year built)+2.6579191a[speed]

SOURCES: AUSTRALIAN SHIPPING 1990 and earlier editions, BYCE DATABASE

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# TABLE I.3COASTAL SHIPS: 1990 SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING<br/>VESSELS (EMISSIONS BASIS)

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			YEAR	SPRRD	FUBL/DAY AT SPRED			t	ONNES PUE	L / DAY	D <b>P VBSSBL</b>	AND RBPL	ACBNBNT VI	BSSBL									
NAKB	TYPE	DWT	BUILT		(TONNES)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
PLINDERS RANGE	B	27500	1978	14.6	36.4	36.4																	
LYSAGHT BNOBAVOUR	RO/RO	11810	1973	18.0	REGR.	45.1																	
NARY ROLYNAN	C/C	3340	1971	15.0	RBGR.	13.2																	
NBLBOURNE TRADER	RO/RO	7207	1975	15.9	31.1	31.1																	
SID NCGRATH	RO/RO	2745	1978	15.0	14.9	14.9		14.9	14.9	14.9	14.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
CHALLBNGBR B	RO/RO	3390	1979	15.0	RECR.	15.9	15,9																
PREBNAT NORTH	GC	9332	1978	14.7	27.9	27.9	27.9																
BP ENTERPRISE	PT	19792	1968	14.5	36.0	36.0	36.0	36.0															
IRENE GREENWOOD	G/C	21760	1982	14.5	32.0	32.0	32.0	32.0															
VONA NUNIBE	PT 0/0	44412	1919	14.9	30,4	30.4	30.4	30.4															
AVVELNDA Melmontop	6/C	14100	1000	11.0	41.0	21.0	21.0	21.0															
ADDI BACMIN ADDI BACMIN	570 80/80/8+	16680	1344	10.0	60.0	69.0	24.0	24.0	** *														
ADBU LADRAR Accoladr II	RU/RU/P+	2003	1919	19.9	80.0	14 0	14.0	60.0	60.0	32.3	32.3	32.3	32.3	32.3	32.3	JZ.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3
AUGUGADE LL Andre Carri	0 (•	101000	1986	15 5	19.0	19.V 99.K	19.0	14.0	19.0	14.U 93 K	14.U 22.K	14.0	14.0	14.0	14.0	1.9	1.9	1.9	7,9	7.9	7.9	7.9	7,9
ABTOND DATLETD	CT .	65101	1979	16.0	62.0	69 0	69 0	62.0	16.9 69 0	14.7	16.0	1610	49.0	49.0	43.0	43.0	43.0	49.0	43.0	43,0	49.0	49.0	49.0
AUSTRALIA STV	DT.	11219	1989	19 1	26.0	26.9	96 B	26.0	96 9	26.9	26.9	96.0	34.1	95 0	34.1	25 0	39,7 96 9	34.1	96 0	3411	39,7	39.1	39.1
AUSTRALIAN SPIRIT	PT	32605	1987	13.5	25.0	25.0	25.0	25.0	25.0	25.9	25.0	25.0	25.0	20.0	20.0	25 0	20,0	20.0	20.0	20.0	20.8 29.9	20.0 29 8	30.2 90 9
BASS TRADER	RO/RO	7846	1976	11.1	37.3	37.3	37.3	37.3	37.3	37.3	37.3	42.1	42.1	42.1	42.1	42 1	42 1	42.1	42 1	42 1	42 1	42 1	42 1
CANTRA	8	4120	1980	12.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	R.2	8.2	8.2	8 2	8 2	8 9	8 2	8 9	8 9	8 2
CANOPUS	CT	94347	1986	13.9	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	51.6	51.6	51.6	51.6
CBNBNTCO	8	16510	1978	15.2	32.0	32.0	32.0	32.0	32.0	32.0	32.0	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8
CONUS	PT	31950	1981	14.5	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7
BRA ·	CT	94287	1986	13.7	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	45.3	45.3	45.3	45.3
BSSO GIPPSLAND	PT	24380	1972	14.5	39.3	39.3	39.3	39.3	39.3	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
PRANCES BAY	G/C	2106	1981	11.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
GOLIATH	8	4270	1977	14.0	14.0	14.0	14.0	14.0	14.0	14.0	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
GUTB	RO/RO	2400	1979	16.3	18.0	18.0	18.0	18.0	18.0	18.0	18,0	18.0	19.9	19.9	19.9	19.9	19,9	19.9	19.9	19.9	19.9	19.9	19.9
IRON BARON	B	37557	1985	14.1	25.0			25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	27.4	27.4	27.4	27.4	27.4
IRON CAPRICORN	8	35244	1975	13.5	34.5	34.5	34.5	34,5															
IRON CARPENTARIA	8	45310	1977	9.5	16.0	16.0	16.0	16.0	16.0	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
IRON CURTIS	8	45310	1978	9.5	16.0	16.0	16.0	16.0	16.0	16.0	16.0	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
IRON MONARCE	RO/RO	14855	1973	11.5	16.0	16.0	16.0	16.0	16.0	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3
IRON PRINCE	8	21735	1981	13.5	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2
IRON STURT	B	22100	1979	13.5	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
ISLAND GAS	LPG	6033	1976	13.5	11.6	11.6	11.6	11.6	11.6	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1
TON SYMPRES	G/C	2640	1988	12.5	7.1	1.1	7.1	7.1															
R R P A I M	696	13453	1990	14.5	19.0	** *		19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0
LUNULLA	15 12	23258	1984	13.0	20.0	ZU, U	20.0	20.0	20.0	20.0	20.0	20.0	ZU.0	20.0	20.0	20.0	20.0	19.2	19.2	19.2	19.2	19.2	19.2
ULRUBDAT CUARA	0 07	23010	1985	13.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	Z0.0	20.0	21.1	21,1	21.1	21.1	21.1
NARIO VASLEVELS	21	16590	1914	16.0	30.5	30.5	30.5	30.5	10.0														
0110101 04419104	в с/с	19760 19760	13/9	14.8	3U.U 91 0	JU.U 91 A	3U.U 91 0	JU, U	30.0	JU.U 91 0	JV,U 91 0	JU.U 20.0	21.0	21.6	21.5	21.6	21.6	21.6	21.6	21,6	21.6	21.6	21.5
E LUDAAA 644 1400	u/v 8	16100	1310	14.0	41.V 90 P	21.V 90 0	41.0	61.V	51.V 20.0	61.U 30 0	41.0	20.9	6V.Y	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9
TURILARD DIVED DAVNE	D R (cont)	76166	1000	19.4	111 0	144 0	62.0	43.U 111 0	69.0 144 a	111 0	43,0	49.0	43.0	63.0	29,0	29.0	29.0	29.0	29.0	29.0	29.0	24,0	24.0
BIVER RWALEY	B (coall	10335	1981	13.3	146 9	146.8	146 9	146.9	146.9	141.3	146.9	146.0	144.9	116 9	149.3	33.6	33.6	33.2	33.6	33.2	33.2	33,Z	JJ,Z
RIVER TORRES	a feasti	31921	1977	14.5	16.4	36.4	36.4	35.4	16.4	1910	27 4	190.0 97 4	210.0	190.0 97 4	29 4	190.0 97 /	31.3 97 4	31.3	31.3	31.3	31.3	31.3	31.3 97.4
SANDRA WARTE	B	5580	1986	14.2	13.8	13.8	13.8	13.8	13.8	13.9	13.8	13.8	13.8	13.8	41+1 13.8	13 8	13 8	11.9	11 9	12.8	12 8	12 9	12 8
SBAWAY HOBART	RO/RO	7161	1976	15.2	36.5	36.5	36.5	36.5	36.5	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2
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SRAWAY WELBOURNE	RO/RO	7180	1971	15.8	37.3	37.3	37.3	37.3	37.3	37.3	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8
STOLT AUSTRALIA	CHT*	8900	1986	14.0	REGR.	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.1	. 13.1	13.0	13.0	13.0	13.0
TASBANIA B	RO/RO	4700	1982	15.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2
THT CAPRICORNIA	B [coal]	75140	1983	14.5	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147,9	147.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9
THT CARPENTARIA	B (coal)	75105	1983	14.5	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9
WN LEONARD	PT	25500	1973	16.0	35.0	35.0	35.0	35.0															
WALLARAH	B	6666	1986	13.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	12.5	12.5	12.5	12.5
ZINCHASTER	SP*	17530	1975	14.0	29.0	29.0	29.0	29.0	29.0	19.9	19.9	19.9	19,9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9
ANPOL TVA	PT	32000	1990	14.0	30.0			30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
WARDEN POINT	8	6000	1978	11.0	11.5			11.5	11.5	11.5	11.5	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
ROBERTA JULL	G/C	3400	1990	10.4	6.8			6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
BIPRESS	B	17000	1990	13.5	17.6			17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6
NOBIL TASMAN	PT	32000	1990	14.7	31.5			31.6	31.5	31.6	31.6	31.6	31.6	31.6	31.6	31.8	31.6	31.5	31.6	31.6	31.6	31.8	31.6
SBAROAD BERSEY	RO/RO	5775	1991	16.0	24.0				24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
YARRA RIVER	В	30000	1982	13.0	REGR.				27.2	27.2	27.2	27.2	27.2	21.2	21.2	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21,4
SBAROAD TAMAR	RO/RO	9575	1991	16.9	34.1				34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1
TOWNES OF FUEL P	BR DAY (CON	STANT TASK	AFTER 19	91)		2015.5	1874.7	1987.1	1821.9	1732.5	1715.3	1702.8	1670.4	1669.6	1655.1	1531.2	1201.7	1201.0	1204.5	1193.3	1198.1	1193.7	1197.1
INDER OF FUEL US	BD (1988 BAS	SE; CONSTA	NT TASE A	FTBR 1991	} .	100.0	93.0	98.6	90.4	86.0	85.1	84.5	82.9	82.8	82.1	76.0	59.6	59.6	59.8	59.2	59.4	59.2	59.4
DBADWBIGHT TONNE	- NAUTICAL	BILES PER	DAY			4.88+08	4.6B+08	5.0B+08	4.6E+08	4.6B+08	4.6E+08	4.68+08	4.68+08	4.68+08	4.8B+08	4.68+08	4.68+08	4.68+08	4.68+08	4.68+08	4.68+08	4.6B+08	4.6E+08
FLEET AVERAGE TO	NNES OF FUEL	L / 000DWT	/ 1000 N	AUTICAL N	ILSS	4.19	4.07	3.94	3.99	3.79	3.76	3.73	3.66	3.68	3.63	3.35	2.83	2.63	2.54	2.61	2.62	2.61	2.62
INDEX OF FLEET F	UBL BEFICIES	KCY (1988	BASE)			100.0	103.0	105.1	104.8	109.5	110.4	111.0	112.7	112.8	113.5	120.0	137.2	137.3	137.1	137.7	137.4	137.8	137.5

COASTAL SHIPS: 1990 SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME

Note: It is assumed that vessels are replaced at age 15 years or 1992 if already older.

Swtimates of fuel consumption were obtained from shipping companies, else from regression equations for tonnes of fuel per 0000WT per day from BTCE database INTSBAS.WII

AS EXTENTING VESSELS (EMISSIONS BASIS)

For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

The database regression equations for existing ships for which data was not obtained are:

CT77

Bulk ships: exp(-1.749625-0.4925291n(DWT/1000)+0.2223081n(1991-year built)+1.1068771n(speed) Tankers : exp[-3.67077-0.4059221n(DWT/1000)+0.1780881n(1991-year built)+1.7822731n(speed) Ro/Ro : exp[-4.005212-0.5072761n(DWT/1000)+0.0484391n(1991-year built)+2.2343771n(speed) Container : exp[-6.641991-0.5843671n(DWT/1000)+0.3985331n[1991-year built)+2.9106741n(speed) Gen Cargo : exp[-6.347061-0.510471n(DWT/1000)+0.0471931n(1991-year built)+2.6578191n[speed] Gas Tanker: exp[-0.592047-0.359211n(DWT/1000]+0.0715851n(1991-year built)+0.7775281n(speed)

SOURCES: AUSTRALIAN SHIPPING 1990 and earlier editions, BTCB DATABASE

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TABLE I.3 (cont)
#### TABLE I.4 COASTAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS 10 PER CENT LARGER THAN EXISTING VESSELS (EMISSIONS BASIS)

•				43474	FUEL/DAY			•••••	OMES PUT	IL / DAY	OF VESSEL	AND REPL	AC <b>ENEN</b> T V	<b>ISSE</b> L									
NANK	TTPE	PUT	INAN BUILT	37669	TORNES)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
PLINDERS RANGE	•	17500	1978	14.6	36.4	38.4										******							
GIBAGHT BHUSAVUUS	100/100	11810	1913	18.0	KKGK.	45.1																	
BART NULTBAR	0/C	3340	1971	18.0	REGR.	13.2																	
ALBOURKS TRADER	NO/NO NO/NO	1201	1976	15.9	31.1	31.1																	
JID BOURATH	KU/KU R0/R0	2745	1918	15.0	14.9	14.9		14.9	14.9	14.9	14.9	13.4	13.4	13.4	13.4	13.4	513.4	13.4	13.4	13.4	13.4	13.4	13.4
CHALLENGER B	KU/KU	3390	1979	16.0	REGR.	16.9	16.5																
PRESVAT AURTS	GC	9332	1976	14.1	21.3	27.9	27.9																
TAPNE OFFICE	PT 0/0	19792	1308	14.0	36.0	38.0	36.0	36.0															
INDER UNSCRIVUD	U/C	21760	1982	14.5	32.0	32.0	3Z.0	3Z.O															
JUER EUNIER	PT	24243	1970	14.0	30.4	30.4	30.4	30.4															
NTI MATER	100	1000	1970	14.0	21.0	21.0	21.0	21.0															
ATT DACHAN	Dru Ro/Ro(Dè	18280	1300	10.0	24.0	Z4.0	24.0	24.0															
ADES TADEAN	W/W/Y*	200J	1000	19.0	60.0	10.0	60.0	. 60.0	0.0	33.9	33.9	33.5	33.9	33.5	33.9	33.5	33.9	33.9	33.9	33.9	33.9	33.9	33.9
ACCORADE II	5 00	8410	1962	10.2	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	1.5	1.5	1.6	1.5	1.5	1.5	7.5	7.5	1.5
487V2 84855	UT	101300	1913	19.9	12.5	12.0	12.0	72.5	72.6	72.5	12.5	12.5	48.5	48.5	48.5	48.6	48.5	48.5	18.5	48.5	48.5	41.5	48.5
ABIRUE POISSIP	UT	82103	1914	16.0	62.0	62.0	62.0	62.0	62.0	35.4	35.4	35.4	36.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4
AVAINALLA ALI	PT	33239	1393	12.1	26.8	26.0	26.1	28.8	26.8	26.8	26.8	26.8	26.8	28.8	26.8	21.1	26.8	25.8	26.8	26.8	28.8	26.8	29.0
AVDIKALLAN OPIKIT	PT	32605	1987	13.5	25.0	15.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	29.0	29.0	29.0
DADD TKAVER	10/10	7640	1976	11.1	31.3	31.3	37.3	37.3	37.3	37.3	37.3	43.9	43.9	41.1	43.5	43.5	43.9	43.9	43.9	(3.9	43.9	43.9	43.9
CANODIS	8	4130	1980	12.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.5	1.9	7.9	1.9	1.1	1.9	1.9	1.3	7.9	7.9
CANOPUS	GT .	91347	1986	13.9	\$6.0	56.0	55.0	66.0	56.0	66.0	58.0	66.0	\$6.0	\$6.0	<b>56</b> .0	56.0	66.0	55.0	56.0	46.7	46.7	46.7	45.7
CHEBRICO	5 19	10010	1978	10.2	32.0	32.0	32.0	32.0	32.0	32.0	32.0	22.8	22.8	11.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8
	ri ce	31330	1981.	14.5	38.3	3813	38.3	38.3	38.3	38'3	38.3	38.3	38.3	38.3	30.1	30.1	30.1	30.1	30.1	30.1	30,1	30.1	30.1
PERA CTADELLEN		3110/	13864	11.1	91.4	\$1.4	91.4	01.4	61.4	61.4	61.4	61.4	51.4	\$1,4	51.4	51.4	61.4	51.4	51.4	40.6	40.5	40.6	40.6
PROV ULFFOLING	ri 0/0	64380	1941	14.0	11.2	33.3	33.3	33.3	39.3	20.1	25.1	26.1	26.1	20,1	26.1	26.1	11.1	25.1	26.1	26.1	26.1	26.1	26.1
PRANCED DA1	W/U	4190	1951	11.0	3.0	9.0	9.0	9.0	8.0	3.0	9.0	9.0	9.0	5.0	6.1	<b>6.1</b>	6.1	6.1	6.1	6.1	6.1	6.1	6.1
CUSTAIN CONTRACT	8 80/80	44/0	1911	14.0	14.0	14.0	14.0	14.0	14.0	14.0	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4
TRON BIRON	10/100	4100	1913	10.3	18.0	18.0	19.0	18.0	16.0	18.0	18.0	18.0	20.6	20.6	20.6	20.8	20.5	20.6	20.6	20.5	20.6	20.6	20.6
TRON CARDICODN	D	91991	1946	19.1	80.U			25.0	25.0	26.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.1	25.1	25.1	25.1	25.1
TRON CAPRICORN TRON CAPRENELETA	0	46414	1944	1913	34.3	34.5	34.9	34.0															
TRAN CERTERIABLE		48410	1878	3.0	10.0	10.0	1010	18.0	18.0	13.0	13.0	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
THOM NOWLDCH	0 80/80	11022	1910	310 11 E	14.0	10.0	10.0	10.0	10.0	10.0	16.0	13.4	13.4	13.4	13.4	13.4	13.4	11.4	13.4	13.4	13.4	13.4	13.4
TRAN DELVCE	100/100 1	19070	1001	11.7	10.0	10.0	10.0	10.0	16.0	18.1	18.1	18.1	18.1	18.1	18.1	10.1	18.1	18.1	18.1	18.1	18.1	10.1	18.1
1808 (81805 1808 (81805		44166	1876	19.9	49.0	23.0	89.0	23.0	23.0	23.0	23.0	23.0	23.0	11.0	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3
TELAND OLUMI	5	66144	1919	1919	49.1	43.1	23.1 	23.1	23.1	23.1	23.1	23.1	20.0	10.0	20.0	20.0	20.0	10.0	20.0	20.0	20.0	20.0	20.0
TOM CANDERS	5ru 0/0	0033	1910	19.9	11.0	11.0	11.4	11.0	11.6	10.5	10.5	10.5	10.5	10.5	10.6	10.5	10.5	10.5	10.6	10.5	10.5	10.5	10.5
TOR BERUBLA	100	14455	1996	14.9	1.1	1.1	1.1	1.1															
KOVBLEA	a a	41929	1001	19.0	19.0			10.0	19.0	13.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0
THOREAN, CLARK	•	44214	1301	13.0	20.0	20.0	20.0	10.0	20.0	20.0	· 20.0	20.0	20.0	10,0	20.0	20.0	20.0	17.6	17.8	17.8	17.8	17.8	17.8
MARTI INCORRE	0	49910	1849	13.9	20.0	20.0	20.0	20.0	10.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	19.4	19.4	19.4	19.4	19.4
UDID SVDINADID		10044	1916	10.0	JV.D	30.0	30.5	30.5															
PTI.RABA	o/c	19946	1040	14.0	41 0	JU.U 41 A	30.0	30.0	30.0	30.0	30.0	30.0	11.1	21.2	11.1	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2
PORTLAND	1	16500	1998	14 4	4L.V 94 n	41.V 49 A	98 A	41.0	61.V 98.0	41.0	41.0	41.0	0,1A	31.0	31.0	41.9	31.0	Z1.8	21.6	21.6	21.5	21.5	Z1.6
RIVER BOTHE		76166	1889	1915	144 0	144 4	111 4	49.V 144 A	U. EA	48.U 111 A	0.82	29.0	23.0	29.0	29.0	29.0	23.0	29.0	29.0	Z\$.0	29.0	21.9	z1.9
BIVER PUBLEY	B [coal]	78365	1881	19.0	14413	144.8	118.0	144.3	144.3	199.3	144.3	144.9	144.3	144.9	144.3	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5
RIVER TODEFIC	B [cost]	10003	1444	14.1	18.0	140.0	190.0	140.6	140.8	140.6	140.0	149.8	148.8	140.0	146.8	146.4	29.3	29.3	29.3	29.3	29.3	29.3	29.3
CINNEL VARIA	ĩ	6544	1986	14 4	18.8	19.5	JU.9	38,9 19 A	40.4 14 A	38.4	61.1 19 A	41.1	41.1	27.7	21.1	81.T	21.T	X7.T	87.T	21.1	21.1	21.1	11.1
FREVER CARLE	# B0/80	9000 41 <i>0</i> 1	1200	19.4	18.8	11.8	13.4	13.8	13.8	19.8	11.8	13.8	11.8	13.6	13.8	13.4	13.6	13.8	11.1	11.6	11.0	11.6	11.6
PRATAI RUDARÍ	w/w	1101	1510	19.2	38.8	30.0	10.0	18.8	11.9	11.(	27.4	19.4	29.4	39.4	29.4	29.4	39.4	29.4	11.4	11.4	29.4	29.4	29.4

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### COASTAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS 10 PER CENT LARGER THAN EXISTING VESSELS (EMISSIONS BASIS)

33.2 13.2 33.2 33.2 33.2 33.2 33.2 33.2 SRAWAY KELBOURNE RO/RO 1120 1977 15.8 37.3 31.3 37.3 37.3 31.3 37.3 33.2 33.2 33.2 33.2 33.2 11.7 13.1 13.1 12.7 12.1 12.7 12.1 STOLT AUSTRALIA CETA 2900 1986 14.0 1191. 13.7 13.7 13.7 13.7 11.7 13.7 13.7 13.7 13.1 13.7 13.7 24.9 TARNANIA B 10/10 4780 1982 15.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 24.1 24.9 24.9 24.9 24.9 24.9 24.9 38.4 38.4 38.4 38.4 38.4 THE CAPRICORDIA B [coal] 75140 1983 14.5 147.5 147.9 147.5 147.9 147.5 147.9 147.9 147.9 147.5 147.9 147.9 147.9 38.4 38.4 THT CARPENTARIA 38.4 38.4 38.4 B [coal] 15105 1983 14.5 147.8 147.9 147.9 141.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 38.4 38.4 38.4 38.4 . THE LEONARD PT 25500 1973 16.0 35.0 35.0 35.0 35.0 VALLARAS 8 1111 1986 13.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.4 11.4 11.4 11.4 ZINCHASTER SP# 17530 1975 14.0 29.0 29.0 29.0 29.0 29.0 20.1 20.1 20.1 20.1 20.1 20.1 20.1 20.1 20.1 20.1 20.1 20.1 20.1 20.1 32000 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 10.0 30.0 ANPOL TVA PT 1990 14.0 30.0 30.0 30.0 VARDER POINT 6000 1978 11.0 11.5 11.5 11.5 11.5 11.5 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 R.0 . ROBERTA JULL G/C 3400 1990 10.4 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 17.6 ETPLESS 17000 1990 13.5 17.6 17.6 17.6 17.8 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 8 MODIL TASMAN PT 32000 1990 14.1 31.6 31.6 31.6 31.8 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 STAROAD MELSEY RO/10 5115 1991 16.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 22.4 24.0 24.0 YARRA RIVER R 30000 1982 13.0 BEGE. 27.2 21.2 27.2 21.2 27.2 21.2 27.2 20.3 20.3 20.3 20.3 20.3 20.3 20.3 20.3 SEABOAD TANAR 10/20 9675 34.1 34.1 1991 16.9 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 ...... TOWNES OF FUEL PER DAY (CONSTANT TASK AFTER 1991) 1713.5 1680.1 1579.0 1657.7 1537.0 1201.2 1199.0 2015.5 1874.7 1987.1 1821.9 1738.6 1723.2 1198.5 1175.1 1179.1 1171.9 1172.5 INDEX OF FUEL USED (1988 BASE: CONSTANT TASE AFTER 1991) 100.0 93.0 11.6 90.4 86.3 85.5 85.0 83.4 83.3 82.2 16.3 59.5 59.5 59.5 58.3 58.5 58.1 58.2 STADURIGHT TOWNE - MAUTICAL WILES PER DAY (CONSTANT SHIP SIZE) 4.818+08 4.668+08 RR 4.568+08 4.568+08 4.568+08 4.568+08 4.568+08 4.568+08 4.568+08 4.568+08 4.568+08 4.568+08 4.568+08 4.568+08 4.568+08 4.568+08 4.568+08 ADDITIONAL DUT-NU PER DAY (DUE TO LARGER REPLACEMENT SHIPS) 3.438+06 5.598+06 7.608+06 1.538+07 1.548+07 1.738+07 2.018+07 2.778+07 2.858+07 3.078+07 3.718+07 3.918+07 4.038+07 4.128+07 TOTAL DRADWRIGHT TORME - HAUTICAL WILKS PER DAY 4.812+08 4.862+08 ERE 4.56E+08 4.59E+08 4.62E+08 4.63E+08 4.71E+08 4.71E+08 4.73E+08 4.76E+08 4.83E+08 4.84E+08 4.85E+08 4.93E+08 4.95E+08 4.95E+08 4.97E+08 FLEET AVERAGE TOWNES OF FUEL / GOODWT / 1000 MAUTICAL MILES TRR. 3.70 3.51 3.23 4.19 4.02 4.00 3.79 3.73 3.57 3.56 2.49 2.48 2.46 2.35 2.38 2.36 2.36 100.0 104.0 INDER OF PLEET FUEL REFFICIENCY (1988 BASE) RL 104.6 109.7 111.0 111.8 114.9 115.0 116.4 122.9 140.1 140.9 141.2 143.1 -143.1 143.6 143.7 

Note: It is assumed that vescels are replaced at age 15 years or 1992 if already older.

Estimates of fuel consumption were obtained from shipping companies, else from regression equations for tonnes of fuel per 000DWT per day from BTCE database INTSEAS.WEI For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

The database regression equations for existing ships for which data was not obtained are:

Bulk ships: exp(-1.749525-0.4925291a(DUT/1000)+0.2223081a(1991-year built)+1.1086771a(speed) Tenbers : exp(-3.67077-0.4059221a(DUT/1000)+0.1766681a(1991-year built)+1.7822731a(speed) Bo/Ko : exp(-4.005212-0.5072761a(DUT/1000)+0.0464391a(1991-year built)+2.310571a(speed) Costainer : exp(-6.641991-0.5843671a(DUT/1000)+0.0453931a(1991-year built)+2.5105741a(speed) Gen Cargo : exp(-5.347061-0.510471a(DUT/1000)+0.0471091a(1991-year built)+2.5105741a(speed) Gan Tanker: exp(-0.592047-0.359211a(DUT/1000)+0.0471091a(1991-year built)+2.5758191a(speed)

SOURCES: AUSTRALIAN SHIPPING 1990 and earlier editions, STCE DATABASE

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TABLE I.4 (cont)

## TABLE I.5

## COASTAL SHIPS: 20 YEAR SHIP LIFE, TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING VESSELS (EMISSIONS BASIS)

																							·
			Y KAR	<b>\$788</b> 0 /	FUEL/DAY At speed			T	ONNES FUE	5 / DAY (	)& ARBRRP	AND REPLI	ACIGRIMAT VI										
FATE	TYPE	DWT	BUILT	1	(TONNES)	1948	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
PLINDERS RANGE	B	27500	1978	14.6	36.4	38.4																	
LYSAGHT ENDRAVOUR	R0/R0	11810	1973	18.0	LIGL.	46.1																	
NARY HOLTVAN	0/C	3340	1971	15.0	REGR.	13.2																	
NELBOURNE TRADER	RO/RO	7207	1976	15.9	\$1.1	\$1.1																	
SID NCGRATE	10/10	2745	1978	15.0	14.9	14.9		14.9	14.9	14.9	14.9	14.9	14.8	14.9	14.9	14.9	12.6	12.6	12.6	12.6	12.6	12.6	12.6
CHALLENGER B	RO/RO	3390	1979	15.0	REOR.	15.9	15.9																
PRETVAT NORTH	9C	9332	1978	14.7	27.9	27.9	27.9																
BP RUTTRPRISE	PT	19192	1948	14.5	36.0	36.0	38.0	36.0															
IRENE GREENWOOD	G/C	21760	1982	14.6	32.0	32.0	32.0	32.0															
JOHN NUNTER	PT	24245	1976	14.6	30.4	30.4	30.4	30.4															
LOOLINDA	0/C	12760	1978	14.0	21.0	21.0	21.0	21.0															
VILTSUIRE	LPG	12280	1968	15.0	24.0	24.0	24.0	24.0															
ADEL TASVAR	RO/RO/P#	2063	1975	19.5	60.0	60.0	60.0	60.0	80.0	80.0	60.0	60.0	60.0	31.8	31.0	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8
ACCOLADE II	3	8410	1962	10.2	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	<b>14.0</b>	0.8	0.5	8.0
ANDOL RANKE	CT	101900	1979	16.5	11.5	72.5	12.5	12.5	12.5	72.5	12.5	12.6	12.9	12.5	12.5	12.5	12.0	42.0	42.0	42.0	42.0	42.0	.42.0
ARTHUR PHILLIP	CT	65103	1974	16.0	62.O	82.0	62.0	52.0	62.0	82.0	52.Q	62.O	31.7	31.1	31.7	31.1	31.7	31.1	31.7	31.1	31.7	31.7	31.7
AUSTRALIA SEY	PT	33239	1989	12.1	26.8	26.8	26.8	26.8	28.8	16.6	26.8	26.8	26.8	26.8	26.8	28.8	26.8	26.8	26.8	28.8	20.8	28.6	20.8 AC A
AUSTRALIAN SPIRIT	r PT	32605	1987	13.5	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	29.0	20.0	49.0	49.0
BASS TRADER	10/10	7846	1976	17.1	37.3	31.3	31.3	37.3	31.2	21.3	37.3	31.3	31.3	31.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	91.3	41.3
CANINA		4120	1980	12.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	3.0	1.2	1.2	1.2	1.2	1.4
CANOPUS	CT	96347	1986	13.5	56.0	56.0	55.0	55.0	55.0	56.0	56.0	56.0	56.0	56.0	55.0	56.0	56.0	38.0	38.0	50.0	50.0	30.0	30.0
CENERTCO	9	16510	1978	15.2	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32,0	32.0	32.0	32.0	32.0	20.6	20.6	20.6	20.6	20.6	41.0	20.0
CONUS	PT	31950	1981	14.5	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38,3	38.3	21,4	41.4 61.4	41.1	41.4
<b>FIL</b>	CT	94287	1986	13.1	51.4	91.4	51.4	51.4	01.4	01.4	01.4	01.4	91.4	01.4	91.4	51.4	01.4	91.4 44 X	01.4	91.4	9119	91.9	91.1
EESO OLPPSLAND	PT	24380	1972	14.5	39,3	39.3	28.2	33.3	38.3	39.3	24.5	24.5	24.5	24.9	24.5	24.5	24.0	24.2	41.2	41.0	2413	49.7	41.3
FRANCES BAT	6/C	2106	1981	11.0	9,0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.0	9.0	3.0	3.0	3.0	3.0	9.0	2.0	2.0	9.0 10 1
GULLATE	B	4270	1977	14.0	14.9	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	19.0	14.0	10.3	10.3	10.3	10.3	10.3	10.4	10.3	10.5
GUTE	100/100	2400	1919	10.3	18.0	,18.0	10.0	10.0	10.0	18.0	10.V	10.0	10.0	10.0	10.0	10.0	10.0	13.J 95.A	95 0	96.0	95.0	95 0	25.0
LINUE DARUR	<b>B</b>	31331	1385	14.1	15.0			29.0	23.0	29.0	60 · U	49.V	63.V	49.V	47.V	49 i V	49.0	4910		63.0		2414	6414
INCH CAPRICORN		J7699	1444	13.0	34.3	34.2	39.2	34.5	14.0	18.4	18.6	16.0	16.0	16.0	16.0	19.1	12.1	19.5	19.1	19.8	12 1	19.1	12.3
TRON CARPSHIARIA	D	40310	1478	3.0	10.0	16.0	16.0	16.0	16.0	16.0	18 0	16.0	18.0	16.0	16.0	16.0	12.2	19.9	12.2	12.2	12.2	12.2	12.2
TROM CONTES	0 90/80	14955	1673	11 8	16.0	18.0	16.0	18.0	16.0	16.0	16.0	17.9	17.9	17.2	17.2	17.2	17.9	11.2	17.1	17.2	11.2	17.2	17.2
TRAN DETHCE	8	21915	1981	11.5	51.6	93.0	21.0	21.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	17.6	11.6	17.6	17.6
TRON STORT	ñ	22100	1979	13.5	23.1	21.1	21.1	21.1	21.1	23.1	23.1	21.1	23.1	23.1	23.1	23.1	21.1	18.1	18.1	18.1	18.1	18.1	18.1
TRLAND GAS	LPO	6033	1976	11.5	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.4	9.6	9.6	9.6	9.6	9.5	9.6	9.6	9.6	9.6
JON SANDERS	C/C	2540	1988	12.5	1.1	1.1	1.1	1.1															
KELVIN	LPG	13453	1990	14.5	19.0			19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0
KOVULKA	8	23258	1984	13.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	16.3
LINDESAY CLARE	8	29510	1985	13.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
NOBIL AUSTRALIS	PT	26642	1972	18.0	30.5	30.5	30.5	30.5															
OMISTON	B	16680	1979	14.8	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	19.2	19.2	19.2	19.2	19.2	19.2
PELBARA	0/C	12760	1978	14.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	20.4	20.4	20.4	20.4	20.4	20.4	20.4
PORTLAND	, B	36500	1988	13.4	29.0	19.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0
RIVER BOTHE	B [com1]	16355	1982	13.5	144.9	144.1	144.9	144.9	144.9	144.5	144.5	144.9	144.9	144.9	144.8	144.9	144.5	144.9	144.9	144.9	28.1	28.7	28.1
RIVER EXELET	B [coal]	76305	1983	11.1	146.8	146.8	148.8	146.0	146.8	148.8	146.8	146.8	146.0	146.8	146.8	148.8	148.8	146.8	148.8	146.8	146.8	26.8	26.8
RIVER TORRESS	8	31921	1977	14.6	38.4	36.4	38.4	38.4	36.4	38.4	36.4	36.4	38.4	36.4	36.4	25.0	25.0	25.0	25.0	25.0	25.0	25.0	15.0
SANDRA NARIE	B	5580	1986	14.2	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.4	13.6	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
SEAWAY ROBART	110/110	7161	1976	15.2	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	38.5	21.1	21.1	27.7	27.7	21.1	21.1	27.7	27.7	21.7

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TABLE I.	5 (co	nt) 🕤		COAST	FAL S	HIPS	5: 20	YEA	R SHI	IP LI	FE,	TRENI	) SPE	CIFI	CFU	ET CC	NSUM	PTIO	N FOI	ર			
	ī			REPL	ACEME	INT S	SHIPS	THE	SAME	SIZ	E AS	EXIS	STING	VES	SELS	(EMI	SSIO	NS B	ASIS			•	··.
SEAVAY MELBOURNE	10/10	7180	1977	15.8	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	31.2	31.2	31.2	31.2	31.2	31.2	31.2	31.2
STOLT AUSTRALIA	CETT	8900	1986	14.0	LEGR.	13.7	13.7	11.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7
TASKANIA B	10/10	4700	1982	15.5	- 24.5	24.5	24.5	24.5	24.5	. 14.5	. 24.5	24.5	24.5	24.5	24.6	24.5	24.5	24.5	- 24.5	24.5	23.4	23.4	23,4
THT CAPRICORNIA	B [coal]	75140	1983	14.5	147.5	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	141.9	147.9	147.9	35.0	35.0
THT CARPENTARIA	B [coal]	75105	1993	14.5	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.9	147.5	147.9	147.9	147.9	147.5	147.9	147.9	147.9	35.0	35.0
WY LEONARD	PT	25500	1973	14.0	35.0	35.0	35.0	35.0															
VALLARAN	<b>N</b>	6666	1988	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
THEWASTER	SPA	17530	1975	14.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	11.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6
ANPOL TVA	PT .	12068	1990	14.0	30.0			30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
WARDEN POINT		6000	1978	11.0	11.5			11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.6	1.2	1.1	1.2	1.2	1.2	1.2	1.2
BORRETA JULI.	e/c	1400	1990	10.4	6.6			6.6	6.6	6.6	6.6	6.6	8.6	8.8	6.6	6.6	5.6	6.5	5.6	6.6	6.6	6.5	6.6
TOPPER	1	17000	1990	11.6	17.4			17.4	17.6	17.8	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6
NORTE TASKAN	D¥	19000	1990	14.7	31.6			31.5	31.6	31.4	31.6	31.6	\$1.6	31.6	31.6	31.6	31.6	31.4	31.6	31.6	31.6	31.8	31.6
CRACAT TARMANTA	<b>p/cp</b>	300	1510	35.6	75.0			75.0	75.0	15.0	75.0	15.0	75.0	75.0	75.0	75.0	75.0	15.0	75.0	15.0	75.0	75.0	. 75.0
	20/20	6995	1441	16.0	94.0				24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
TANDA STUTS	3	10000	1989	11.0	8202				27.2	27.2	27.2	27.2	27.2	27.2	21.2	21.2	27.2	27.2	27.2	27.2	18.5	18.5	. 18.5
ERABOAD TANAD	80/10	9575	1991	16.9	34.1				34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1
					••••				••••		••••												-
																			·····				
TOWNES OF PUEL P	BR DAY (CON	STANT TASE	AFTER 1	<b>99</b> 1)		2015.6	1874.7	2062.1	1896.9	1896.9	1482.2	1883.3	1863.1	1414.4	1807.8	1782.7	1760.2	1715.2	1113.4	1233'8	1960.6	1214.8	1311.1
INDER OF FUEL US	ED (1988 BA	SE; CONSTA	NT TASE	AFTER 199	1)	100.0	\$3.0	102.3	\$4.1	94.1	93.4	93.4	\$1.\$	90.0	89.7	88.4	87.3	85.1	\$5.0	84.0	11.4	60.3	60.1
DEADWEIGHT TOPIE	- NAUTICAL	VILES PER	DAT			4.88+08	4.78+08	6.0E+08	4.6E+08	4.6 <b>K</b> +08	4.\$B+08	4.6B+08	4. <b>62</b> +08	4.65+08	4. <b>61</b> +08	4. <b>61</b> +08	<b>{.52+</b> 08	4.5E+08	4. <b>62</b> +08	4.6 <b>E</b> +08	4.68+08	4.6E+08	4.58+08
FLEET AVERAGE TO	THES OF FUE	L / 000DUT	/ 1000	NAUTICAL S	ILLES	4.11	3.91	4.09	4.16	4.16	4.13	4.13	4.01	3.98	3.97	3.91	3.86	3.16	3.16	3.72	3.42	2.67	2.56
INDEX OF FLEET F	UBL EFFICIE	NCY (1988	DASE)			100.0	105.2	102.4	100.7	100.7	101.5	101.4	103.0	105.0	105.4	106.7	107.9	110.2	110.3	111.3	118.3	136.4	136.6

Note: It is assumed that vessels are replaced at age 10 years or 1992 if already older.

Estimates of fuel consumption were obtained from shipping companies, else from regression equations for tonnes of fuel per 0000WT per day from BTCE database INTERAS.WII

For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

The database regression equations for existing ships for which data was not obtained are:

Bulk ships: exp(-1.749625-0.4925191m(DWT/1000)+0.2223081m(1991-year built)+1.1066771m(speed) Tankers : exp(-3.67077-0.4069221m(DWT/1000)+0.1780881m(1991-year built)+1.7822731m(speed) Bo/Bo : exp(-4.005212-0.5072761m(DWT/1000)+0.0464381m(1991-year built)+2.2343771m(speed) Container : exp(-5.641951-0.5543571m(DWT/1000)+0.0485331m(1991-year built)+2.6578191m(speed) Gen Cargo : exp(-5.347061-0.510471m(DWT/1000)+0.0471091m(1991-year built)+2.6578191m(speed) Gas Tanker: exp(-0.592047-0.359211m(DWT/1000)+0.0716861m(1991-year built)+2.6578191m(speed) Gas Tanker: exp(-0.592047-0.359211m(DWT/1000)+0.0716861m(1991-year built)+0.7775281m(speed)

SOURCES: AUSTRALIAN SHIPPING 1990 and earlier editions, BTCE DATABASE

TABLE 1.6 COASTAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS 10 PER CENT LARGER THAN EXISTING VESSELS AND 10 PER CENT SLOWER (EMISSIONS BASIS)

••••••				45385	FUEL/DAY			ĩ	ONNES PUBL	, / DAY	F VESSEL	AND REPLI	CBNBNT VI	SSEL									
MANE	TYPE	DWT	BUILT	arkty i	(TOWNES)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
FLINDERS RANGE	B	27500	1978	14.6	36.4	36.4																	
LTSAGET ENDRAVOUR	RO/RO	11810	1973	18.0	REGR.	45.1																	
WARY HOLYBAN	G/C	3340	1971	15.0	REGR.	13.2																	
NELBOURNE TRADER	R0/R0	1201	1975	15.9	31.1	31.1																	
SID NCGRATH	10/10	2745	1978	15.0	14.9	14.9		14.9	14.9	14.9	14.9	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3
CHALLENGER B	RO/RO	3390	1979	15.0	BEGR.	15.9	15.9																
PRESERVAY NUNTH	GC	933Z	1978	14.1	21.5	21.9	21.9																
BP ENTERPRISE	PT	19792	1968	14.5	36.0	36.0	36.0	36.0															
IKERK GREENVOOD	U/C	21760	1982	14.5	32.0	32.0	32.0	32,0															
JOBA HUATER	PT	24243	1919	14.9	30.4	30.4	30.4	30.4															
NUL PETTOP	100	12700	1310	11.0	21.0	84 0	21.0	54.0															
APPI PACKAN	BO (BO (DA	14400	1960	19.0	40.0	60.0	44.0	44.0	60.0	** *													
ACCOLARD IT	NU/NU/T*	2003	1499	13.5	14 0	14 0	14 0	14 0	14 0	14 0	14.0	14.0	14 0	14.6	14.0	8 1		6.1	<b>E</b> 1	6 1	6 1	6 1	6.1
ANDOI CAPPI	0 (19	101000	1070	16.6	79.5	79 6	14.0 19.K	14.0 44 E	T9 E	79 6	19.0	19.0	10 7	18 7	10 1	10.1	10.1	18 7	10 1	19 7	10.1	19 7	10 7
ARTOD DERDU	CT	66103	1974	16.0	89.0	£1 A	69 0	89 6	69 0	10.5	10.5	10.0 10 K	10 5	10 5	10 6	30.5	10 5	30.5	10 5	10 5	10.5	10.5	10 5
ADETDAL FAISLIF	DT DT	11719	1924	19.1	76.8	26.8	14 1	76.1	26.8	26.8	26.8	36.8	16.9	26.8	26.1	28.8	76.8	26.8	26.8	26.8	26.8	26.8	27.4
AUSTRALIAN SPIRT	11	32605	1987	11.5	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	27.8	27.8	27.8
BASS TRADER	10/10	7846	1976	17.1	37.3	37.3	37.3	37.3	37.3	37.3	37.3	31.4	31.4	31.4	31.4	31.4	31.4	31.4	31.4	31.4	31.4	31.4	31.4
CANIRA	8	4120	1980	12.0	9.9	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	6.5	8.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
CANOPUS	CT	94347	1986	13.9	56.0	58.0	56.0	58.0	56.0	56.0	56.0	56.0	56.0	55.0	58.0	56.0	58.0	\$6.0	56.0	40.8	40.8	40.8	40.8
CENENTCO	B	16510	1978	15.2	32.0	32.0	32.0	32.0	32.0	32.0	32.0	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.5
CONUS	PT	31950	1981	14.5	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	28.9	28.9	28.9	28.9	28.9	28.9	28.9	28.9	28.9
RRA .	CT	94287	1985	13.7	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	34.9	34.9	34.9	34.9
ESSO GIPPSLAND	PT	24380	1972	14.5	39.3	39.3	39.3	39.3	39.3	25.3	25.3	25.3	26.3	26.3	26.3	26.3	26.3	25.3	26.3	26.3	26.3	26.3	26.3
FRANCES BAY	0/C	2105	1981	11.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
OOLIATE	B	4270	1977	14.0	14.0	14.0	14.0	14.0	14.0	14.0	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
GUTE	RO/RO	2400	1979	16.3	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	14.7	14.7	14.7	14.7	14.7	14.1	14.7	14.7	14.7	14.7	14.7
I NON BARON	8	37557	1985	14.1	25.0 -			25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	20.5	20.5	20.5	20.5	20.5
IBON CAPRICORN	B	35244	1975	13.5	34.5	34.5	34.5	34.5															
IRON CARPENTARIA	B	45310	1977	9.5	16.0	18.0	16.0	16.0	16.0	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1
IRON CURTIS	B	45310	1978	9.5	16.0	16.0	18.0	16.0	16.0	16.0	16.0	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9
ILON NONARCE	RO/RO	14855	1973	11.5	16.0	15.0	16.0	16.0	16.0	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1
IRON PRINCE	B	21735	1981	13.5	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	15.8	15.8	15.8	15.0	15.8	15.8	15.8	15.8	15.8
IRON STURT	B	22100	1979	13.5	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	19.2	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	15.3
ISLAND GAS	LPG	6033	1976	13.5	11.6	11.6	11.5	11.6	11.6	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.Z	10.Z
JON SANDERS	U/C	2640	1988	12.5	7.1	1.1	1.1	1.1															
ERPAIN CONTRACTOR	649	13453	1990	14.5	19.0			19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0
LUVULLA	5	23258	1364	13.0	20.0	29.0	ZU.0	20.0	20.0	20.0	Z0.0	20.0	Z0.0	20.0	20.0	ZU.U	20.0	14.5	14.5	14.5	14.5	14.9	14.5
LINUESAY CLARK	8 2=	29510	1985	13.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	Z0.0	20.0	20.0	Z0.0	15.8	15.8	15.8	15.8	15.8
AUSIG AUSTRALIS	ri n	20042	1972	19.0	30.5	30.8	30.5	30.5	** *														
	D C/C	19760	1313	14.6	30.0	30.0	30.0	3U.U 11 A	14 4	30.0	10.0	30.0	17.0	17.5	11.3	11.3	17.3	11.3	11.3	17.3	17.3	17.3	11.5
DASTING	u/u	16500	1000	19.0	11.0 11.0	44 4	16 0	41.V 96 0	11.1	40.0	10.3	90.0	98.6	10.0	11.3	11.3	90.0	98.6	50 0	11.9	10.0	19.9	19.5
PINER BANK	9 (ees))	10200	1960	19-9	43.0	144 4	144 4	142 4	144 4	144 0	47.0	43.V	67.V	49.0	144 6	45.0	45.0	45.0	42.0	9C 4	45.0	95 6	9C E
BIVER PUBLET	D [CQUI] D [cos]]	10373	1304	13.3	116 4	146 4	144.3	148.8	144.7	144.3	144.3	146.0	144.9	144.7	116.0	49.0 144 4	43.0	23.0	49.0 91 A	40.0 91 A	47.0 91 A	55.0	47.U 91 6
BITER BEDLET	B [COTT]	91091	1244	14.1	140.0	190.0	190.5	110.0	114.0	140.5	94 4	44 1	140.0	146'9	44 4	0,071 44 1	49.3	44 4	63.3 94 1	49 1	63,J 94 9	6J.J 99 1	43.3 99 1
CARDEA WARTP	D D	51761 8688	1911	14.0	19 4	11 4	11 8	30.9 19 A	30.4	3079 19 A	19 4	11 4	11 4	11 0	11 8	66.J	11 1	11 4	11 P	4 F	4 5	4 1.5	• • •
SBAVAT TOBALT	RO/RO	7161	1976	15.2	36.5	36.5	36.5	36.5	36.5	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0

TABLE I.6 (cont)

### COASTAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS 10 PER CENT LARGER THAN EXISTING VESSELS AND 10 PER CENT SLOWER (EMISSIONS BASIS)

23.7 23.1 23.7 23.1 23.1 23.1 23.1 23.1 23.7 SRAVAY MELBOURNE RO/RO 1180 1977 15.8 37.3 37.3 37.3 37.3 37.3 37.3 23.7 23.7 23.7 23.7 13.7 13.1 13.7 13.7 13.7 13.7 13.7 13.7 13.7 12.2 12.2 12.2 12.2 STOLY AUSTRALIA CHT\* 8900 1986 14.0 REGR. 13.1 13.7 13.7 13.7 13.7 24.5 TASNANIA B 20/10 4700 1981 15.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 11.1 17.7 17.1 17.7 17.7 17.7 11.1 17.7 THT CAPRICORNIA B [coal] 75140 1983 14.5 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 29.2 29.2 29.2 29.2 29.2 29.2 29.2 14.5 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 147.9 29.2 29.2 29.2 29.2 29.2 29.2 29.2 TWY CARPENTARIA B [cosl] 75105 1983 147.9 147.9 25500 1973 16.0 35.0 35.0 35.0 35.0 AN PRONVED PT 11.5 11.5 11.5 9.3 VALLARAN 6666 1986 13.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 9.3 9.3 9.3 8 SP4 17530 29.0 29.0 29.0 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 ZINCHASTER 1975 14.0 29.0 29.0 16.9 PŤ 32000 1990 14.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30,0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 ANPOL TVA 6.5 **WARDEN** POINT 9 6000 1978 11.0 11.5 11.5 11.5 11.5 11.5 6.5 6.5 6.5 8.5 6.5 6.5 6.5 6.5 6.5 6,5 6.5 ROBERTA JULL G/C 3400 1990 10.4 6.6 \$.5 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 8.6 6.6 6.6 6.6 6.6 6.6 17.8 17.6 17.6 17.6 **EXPLESS** B 17000 1990 13.5 17.6 17.6 17.5 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 PT 32000 31.6 31.6 31.6 31.6 31.8 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 NOBIL TASMAN 1990 14.7 31.6 31.6 80/80 SKABOAD KERSET 5115 1991 16.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 TAREA BIVER 8 30000 1982 13.0 REGR. 21.2 27.2 21.2 27.2 27.2 21.2 27.2 16.5 16.5 16.5 16.5 16.5 16.5 16.5 16.5 SEAROAD TABAR 10/10 9575 1991 18.9 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1. 34.1 34.1 34.1 ----TORNES OF FUEL PER DAY (CONSTANT TASK AFTER 1991) 2015.5 1874.7 1987.1 1818.9 1137.5 1845.0 1613.0 1560.3 1554.9 1534.3 1389.6 1029.2 1023.8 1015.1 975.4 978.2 967.0 967.6 INDER OF PUEL USED (1988 BASE; CONSTANT TASK AFTER 1991) 100.0 93.0 18.6 90.2 81.6 80.0 11.4 11.1 76.1 68.9 51.1 50.8 50.4 48.4 48.5 48.0 48.0 86.2 DRADWRIGHT TONNE - NAUTICAL WILES PER DAY 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 4.82+08 - 4.62+08 - 5.02+08 - 4.62+08 - 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 FLEET AVERAGE TOWNES OF FUEL / COODWY / 1000 MAUTICAL WILES 4.19 4.01 3.94 3.98 3.81 3.60 3.53 3.42 3.41 3.36 3.04 2.25 2.24 2.22 2.14 2.14 2.12 2.12 INDEE OF FLEET FUEL REFICIENCY (1988 BASE) 100.0 103.0 106.1 105.0 109.2 114.4 115.7 118.5 118.8 119.8 127.4 146.2 146.5 -147.0 149.0 148.9 149.5 149.4 ------

Note: It is assumed that vessels are replaced at age 15 years or 1992 if already older.

Satimates of fuel consumption were obtained from shipping companies, else from regression equations for tonnes of fuel per 000DWT per day from BTCE database INTSBA8.WEI For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

SOURCES: AUSTRALIAN SHIPPING 1990 and earlier editions, BTCB DATABASE

#### TABLE I.7 COASTAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING VESSELS (ENERGY BASIS)

				#7.80A	FUEL/DAY			1	CONNES FUE	IL / DAY	OF VESSEL	AND REPL	ACENENT V	ESSEL									
NAVE	TYPE	DWT	BUILT	91.28A	AT SPEED (TONNES)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
FLINDERS BANGE	B	27500	1978	14.6	36.4	38.4				********								**-******					
LTRACET ENDEAVOUR	RO/RO	11810	1973	18.0	REGR.	45.1																	
WARY HOLYNAN	G/C	3340	1971	15.0	REGR.	13.2																	
HELBOURNE TRADER	ro/ro	7207	1975	15.9	31.1	\$1.1																	
SID NCGRATH	RO/RO	2745	1978	15.0	14.9	14.9		14.9	14.9	14.9	14.9	12.7	12.7	12.7	12.7	12.7	12.7	12.1	12.7	12.1	12.7	12.1	12.7
CHALLENGER B	RO/RO	3390	1979	15.0	REGR.	16.9	15.9																
FREEWAY HORTH	GC	9332	1978	14.1	27.9	27.9	27.9																
BP ENTERPRISE	PT	19792	1968	14.6	36.0	36.0	36.0	.36.0															
IRENE GREENWOOD	G/C	21760	1982	14.5	32.0	32.0	32.0	32.0															
JOHN HONTER	PT	24245	1975	14.6	30.4	30.4	30.4	30.4															
LOOLINDA	0/C	12160	1978	14.0	11.0	21.0	21.0	21.0															
VILTBRIER	LPO	12280	1966	15.0	11.0	24.0	24.0	24.0															
ADEL TASEAN	RO/RO/P	2063	1975	19.5	60.0	60.0	60.0	60.0	60.0	60.0													
PETER PAN	RO/RO/P*	4110	1986	20.0							31.9	31.9	31.9	31.9	31.9	31.9	\$1.9	31.9	31.9	24.0	24.0	24.0	24.0
ACCOLADE II	8	8410	1982	10.2	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	7.2	1.2	1.2	1.2	7.2	1.2	7.2	1.2
ANPOL SAREL	CT	101900	1979	15.5	72.5	12.5	12.5	12.5	72.5	12.5	12.5	12.5	45.7	45.7	45.1	45.7	45.7	45.1	45.1	45.7	45.1	45.1	45.7
ARTHUR PHILLIP	CT	65103	1974	16.0	62.0	51.0	62.0	62.0	62.0	33.2	33.2	33.2	33.2	33.2	33,2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2
AUSTRALIA SEY	PT	33238	1989	12.1	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	25.8	26.8	26.8	26.8	26.8	26.8	21.3
AUSTRALIAN SPIRIT	PT	32605	1987	13.5	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	21.3	27.3	27.3
BASS TRADER	RO/RO	7846	1976	17.1	37,3	37.3	37.3	37.3	37.3	37.3	37.3	41.8	41.8	41.8	41.8	41.8	41.8	41.8	41.8	41.8	41.8	41.8	41.8
CANTRA	B	4120	1980	12.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.6	1.6	1.6	1.6	1.6	7.6	1.6	7.6	1.6	7.6
CANOPUS	CT	94347	1986	13.9	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	58.0	58.0	56.0	56.0	56.0	44.8	44.8	44.8	44.8
CENENTCO	B	16510	1978	15.2	32.0	32.0	32.0	32.0	32.0	32.0	32.0	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9
CONUS	PT	31950	1981	14.5	38.3	38.3	38.3	38.3	38.3	.38.3	38.3	38.3	38.3	38.3	28.3	28.3	28.3	28.3	28.3	28.3	28.3	28.3	28.3
	CT	94281	1986	13.7	51.4	51.4	51.4	51.4	51.4	\$1.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	38.8	38.8	38.8	38.8
ESSO GIPPSLAND	Pt	24380	1972	14.5	39.3	39.3	39.3	39.3	39.3	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5
PRANCES BAY	G/C	2106	1981	11.0	9.0	9.0	9.0	9.0	\$.0	9.0	9.0	9.0	9.0	9.0	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
OCLIATE	8	4210	1977	14.0	14.0	14.0	14.0	14.0	14.0	14.0	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9
GUTE	RO/RO	2400	1979	16.3	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	19.6	19.5	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6
IRON BARON	B	37557	1985	14.1	25.0			25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	24.2	24.2	24.2	24.2	24.2
IBON CAPRICORN	В	35244	1975	13.5	34.5	34.5	34.5	34.5															
IBON CARPENTARIA	8	45310	1977	1.5	15.0	16.0	16.0	16.0	16.0	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	11.1	13.1	11.1
IBON CURTIS	8	45310	1978	9.5	16.0	16.0	16.0	16.0	15.0	16.0	16.0	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
TRON MOWARCH	RO/RO	14855	1973	11.5	16.0	16.0	16.0	15.0	16.0	17.2	17.2	17.2	17.2	17.2	11.2	17.2	17.2	17.2	17.2	11.2	11.2	11.2	17.2
IBON PRINCE	B	21735	1981	13.5	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6
LBON STORT	B	22100	1979	13.5	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.9	19.9	19.2	10.0
ISLAND GAS	LPO	6033	1976	13.5	11.6	11.5	11.6	11.6	11.6	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9
JON SANDERS	C/C	2640	1988	12.5	1.1	7.1	1.1	1.1							•••			••••	••••	••	•••	••••	
ERTAIN	LPG	13453	1990	14.5	19.0			19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0
ROWULEA	6	23258	1984	,13.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	17.1	11.1	11.1	11.1	17.1	17.1
LINDESAY CLARE	8	29510	1985	13.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	10.0	18.7	18.7	18.7	18.7	19.7
NOBIL AUSTRALIS	PT	26642	1972	16.0	30.5	10.5	30.5	30.5															1011
ORNISTON	B	16580	1979	14.8	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.4	. 20.4	20.4
PILBANA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7
PORYLAND	8	36500	1988	13.4	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	24 1	91.0	91 A
BIVER BOYNE	B [coal]	76355	1982	13.5	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	30.3	30.3	30.3	30.1	30.3	16.1	16 1	10 1
RIVER ENDLEY	B [com]]	76305	1983	13.1	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.8	121.6	28.2	28.2	28.2	28.2	58 5	JU.J 98 9	40 4
RIVER TORRENS	B	31921	1977	14.5	36.4	38.4	36.4	36.4	36.4	36.4	26.6	26.6	28.6	11.1	28.6	26.6	26.6	26.6	26.6	26.6	26 6	16.6	10.4 96 E
SANDRA WARIK	8	5580	1985	14.2	13.8	13.8	13.8	13.8	11.8	11.8	13.8	11.8	13.8	11.1	11.8	13.4	13.8	11.8	11 1	11 9	11 9	11 9	11 9

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#### TABLE I.7 (cont) COASTAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING VESSELS (ENERGY BASIS)

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SRAVAT BOBART 28.0 28.0 28.0 28.0 28.0 28.0 28.0 28.0 28.0 28.0 28.0 28.0 28.0 10/10 1161 1976 15.2 38.5 36.5 36.5 36.5 36.5 28.0 SEAWAY YELBOURNE RO/RO 37.3 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.6 7180 1977 15.8 37.3 37.3 37.3 37.3 37.3 31.6 STOLT AUSTRALIA CHT# 8900 1986 14.0 REGR. 13.7 13.7 13.7 13.7 13.7 13.7 13.1 13.7 13.7 13.7 13.7 13.1 13.7 13.7 12.0 12.0 12.0 12.0 23.7 TASMANIA B RO/RO 4700 1982 15.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 24.5 23.1 23.7 23.7 21.7 23.1 23.1 23.7 THY CAPRICORNIA B [cos1] 1983 122.4 122.4 122.4 122.4 122.4 122.4 122.4 122.4 122.4 36.9 36.9 36.9 36.9 36.9 35.9 36.9 15140 14.5 122.4 122.4 122.4 THT CARPENTARIA B [coal] 122.4 122.4 122.4 122.4 122.4 122.4 35.9 36.9 36.9 36.9 36.9 36.9 36.9 1983 122.4 122.4 122.4 122.4 122.4 75105 14.5 122.4 WE LEONARD PT 25500 1973 18.0 35.0 35.0 35.0 35.0 WALLARAH 6666 1986 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 11.5 10.9 10.9 10.9 10.9 8 13.5 11.5 11.5 11.5 11.5 LINCHASTER 19.3 19.3 SP# 17530 1975 14.0 29.0 29.0 29.0 29.0 29.0 19.3 19.3 19.3 19.3 19.3 19.3 19.3 19.3 19.3 19.3 19.3 19.3 ANPOL TVA PT 32000 1990 14.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 30.0 VARDER POINT 1.1 1.1 1.1 R 6000 1978 11.0 11.5 11.5 11.5 11.5 11.5 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 ROBERTA JULL C/C 6.6 6.6 6.6 3400 1990 10.4 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 6.6 17.6 EXPLESS 17000 1990 13.5 17.8 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 11.6 BOBIL TASHAN PŤ 32000 1990 14.7 31.6 31.6 31.6 31.6 31.6 31.6 31.6 31.8 31.6 31.6 31.6 31.6 31.8 31.6 31.6 31.6 31.6 SEAROAD MERSET E0/E0 5115 1991 16.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 24.0 YARRA REVER R 30000 1982 13.0 BEGL. 21.2 27.2 27.2 27.2 27.2 27.2 21.2 19.5 19.5 19.5 19.5 19.5 19.5 19.5 19.5 STAROAD TAWAR R0/R0 34.1 34.1 9575 1991 16.9 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 34.1 TONNES OF FUEL PER DAY (CONSTANT TASE AFTER 1991) 1914.4 1773.7 1886.0 1720.9 1655.7 1609.1 1594.2 1555.5 1554.1 1536.5 1431.6 1167.2 1164.3 1162.1 1125.5 1127.8 1119.9 1120.3 INDER OF FUEL USED (1988 BASE; CONSTANT TASE AFTER 1991) 100.0 92.6 98.5 11.5 86.6 84.1 83.3 81.3 81.2 80.3 74.8 61.0 60.8 60.7 58.8 58.9 58.5 58.5 DRADWRIGHT TOWNE - WAUTICAL MILRS PER DAY 4.88+08 4.68+08 5.18+08 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 4.68+08 FLEET AVERAGE TORNES OF FUEL / DOODWY / 1000 MAUTICAL MILES 3.97 3.83 3.72 3.75 3.61 3.51 3.48 3.39 3.39 3.35 3.12 2.55 2.54 2.53 2.45 2.46 2.44 2.44 INORI OF FLERT FUEL REPICIENCE (1988 BASE) 100.0 103.4 106.2 105.4 109.0 111.5 112.3 114.5 114.5 115.5 121.3 135.8 136.0 136.1 138.1 138.0 138.4 138.4 

Note: It is assumed that vessels are replaced at age 15 years or 1992 if already older.

Satimates of fuel consumption were obtained from shipping companies, else from regression equations for tonnes of fuel per 000DWT per day from BTCE database INTSBA8.VKI For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

SOURCES: AUSTRALIAN SHIPPING 1990 and earlier editions, BTCE DATABASE

TABLE 1.8COASTAL SHIPS: 1990 SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING<br/>VESSELS (ENERGY BASIS)

				40 <b>7</b> 00	FURL/DAY			1	ONNES FUE	L / DAY	OF VEESEL	AND REPL	ACENENT V	BSSBL		******							
NAVE	TTPB	DVT	BOILT		(TONNES)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
PLINDERS RANGE	8	27500	1978	14.4	36.4	36.4							********	********						•••••			
LYSACET ENDEAVOUR	RO/RO	11810	1973	18.0	REOR.	45.1																	
WARY BOLYNAN	G/C	3340	1971	15.0	REGR.	13.2																	
NELBOULNE TRADER	RO/NO	7207	1976	15.9	31.10	31.1																	
SID MCORATH	RO/RO	2745	1978	15.0	14.9	14.9		14.9	14.9	14.9	14.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
CHALLENGER B	RO/RO	3390	1979	15.0	IEGR.	15.9	15.9																
FREEWAY NORTH	GC	9332	1978	11.7	27.9	21.9	27.9																
<b>DP KUTERPRISE</b>	PT	19792	1968	14.5	36.0	36.0	36.0	36.0															
IRENE GREENWOOD	G/C	21760	1982	14.5	32.0	32.0	32.0	32.0															
JOHN HUNTER	PT	24245	1975	14.5	30.4	30.4	30.4	30.4															
LOOLINDA	G/C	12160	1978	14.0	21.0	21.0	21.0	21.0															
WILTSNIRK	LPG	12200	1968	15.0	24.0	24.0	24.0	24.0															
ABEL YASYAN	RO/RO/P*	1063	1975	19.5	60.0	50.0	80.0	60.0	50.0	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3
ACCOLADE IL	B	8410	1982	10.2	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
ABPUL SANEL	UT	101300	1919	15.5	12.0	12.5	72.0	12.6	12.5	72.5	72.5	72.5	49.6	49.6	49.6	49.6	43.6	43.6	49.6	49.6	49.5	49.6	49.6
ARIBUR PELULIP		831UJ	. 1374	10.0	62.U	02.0	6Z.U	6Z.U	62.0	34.7	34.1	34.7	34.1	34.7	34.1	34.1	34.7	34.7	34.7	34.7	34.1	34.7	34.1
AVBIAAULA BLI		77773	1203	14.1	20.8	20.8	20.8	20.8	20.0	20.8	26.8	26.8	26.8	26.8	Z8.8	26.8	26.8	25.8	26.8	Z6.8	26.8	26.8	30.Z
AUDIERLIAN SPIKII	PD / PO	34043	1307	13.0	20.0	23.0	Z9.U	25.0	25.0	29.U	25.0	25.0	25.0	25.0	Z5.0	25.0	25.0	25.0	25.0	25.0	29.8	29.8	29.8
CARLEA CRAVER	3	4190	1040	111	37.3	31.3	31.3	31.3	J1.J	37.3	31.3	42.1	42.1	42.1	12.1	42.1	42.1	42.1	42.1	42.1	42.1	42.1	42.1
CANOPUS	ст.	4140	1000	14.0	3.V KA A	3.0	3.4	3.0	7.V K# 0	3.V 68.A	3.0	3.V Ke 0	3.0	8.4	8.2	0.6	0.4	8.4	0.4	8.2	8.4	8.4	8.4
CBNBX900	2	18610	1898	10.0	30.0	30.0	30.0	90.0	90.V	30.0	90.V	90.V	00.0	30.0	90.U	30.0	98.0	90.U	00.U	21.0	51.0	91.0	91.0
COURT	0 0 <b>9</b>	10010	1310	10.4	36.0	32.0	32.0	36.0	32.0	32.0	32,0	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8
194	Г1 Л¥	04987	1096	14.0	50.5	50.3	38.3	38.3 K1 A	38.3	38.3	30.3 K1 J	38.3	36,3	38,3	49.1	29.1	29.7	29.1	29.1	29.7	29.1	29.7	29.1
RESO GIPPRLAND	DT	94180	1079	18.1	10 1	10 3	90 1	91.1	91.9	96.0	9119	9119	91.4	21.4	91.4 48 A	91.4	91.9	91.9	91.1	42.3	17.3	47.3	49.3
PRANCES BAY	n/c	2106	1981	11 0	33.3	43.4	6 A	4 0	9319	0.0	6 0	69.0	23.0	4910	29.V E A	43.0	23.0	20.V	20.0	40.0	29.0	23.0	29.0
GOLIATE	R	4210	1977	14.0	14.0	14.0	14.0	14.6	14 0	14 0	11 1	11 1	11 1	31 1	11 1	11 1	11 1	11 1	11 1	11 1	11 9	11.1	11 1
GUTE	RO/RO	2400	1979	16.3	18.0	11.0	18 0	18.0	18.0	18.0	19 0	10 0	14 4	10 0	10.0	10 0	10 0	10.0	10 0	10 0	10 0	10 0	10.0
TRON BARON	8	31551	1985	14.1	25.0		10.0	25.0	25.0	25.0	25 0	25 0	95.0	25.0	95 0	55 0	55 A	95 0	97 2	97 4	97 4	97 1	39 4
TRON CAPRICORN	B	35244	1975	13.5	34.5	34.5	34.5	14.5															
IBON CARPENTARIA	B	45310	1977	9.5	16.0	18.0	16.0	16.0	16.0	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	11.5	13.5
IRON CURTIS	B	45310	1978	9.5	16.0	15.0	16.0	16.0	16.0	16.0	16.0	13.5	13.5	13.5	11.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
IRON NONARCH	RO/RO	14855	1973	11.5	16.0	16.0	16.0	16.0	16.0	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	11.3	11.3	17.3	17.1
INON PRENCE	B	21735	1981	13.5	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2
IRON STURT	B	22100	1979	13.5	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
ISLAND GAS	LPO	6033	1976	13.5	11.6	11.6	11.6	11.6	11.6	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1
JON SANDERS	C/C	2640	1988	12.5	1.1	1.1	7.1	7.1															
<b>TBLAIN</b>	LPO	13453	1990	14.5	19.0			19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0
TOWULEA	B	23258	1984	13.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	19.2	19.2	19.2	19.2	19.2	19.2
LINDESAY CLARE	B	29510	1985	13.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	21.1	21.1	21.1	21.1	21.1
NOBIL AUSTRALIS	PT	26642	1972	16.0	30.5	30.5	30.5	30.5															
OBNISTON	8	16580	1979	14.8	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6
PILDANA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9
PORTLAND	8	36500	1988	13.4	29.0	29.0	29.0	29.0	29.0	29.0	19.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	24.6	24.6
REVER BOTHE	B [coal]	76355	1982	13.5	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2
ALVER BUBLEY	B [coal]	76305	1983	13.1	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.6	31.3	31.3	\$1.3	31.3	31.3	\$1.3	31.3
RIVER TORRENS	B	31921	1977	14.5	36.4	36.4	36.4	36.4	36.4	36.4	21.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
SAUDRA WARIE	B	5580	1986	14.2	13.8	13.8	13.8	13.8	13.8	13.8	13.6	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	12.8	12.8	12.8	12.8
SEAVAY EOBART	KO/KO	7161	1976	15.1	36.5	36.5	36.5	36.5	36.5	28.2	28.2	18.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2

<del>б</del>

	· .			EXIS	PING	VES	SELS	(EN	ERGY	BASI	S)												
SRAVAY NELBOURNE	RO/RO	7180	1977	15.8	37.3	37.3	37.3	37.3	37.3	37.3	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8
STOLT AUSTRALIA	CBT*	8900	1986	14.0	REGR.	13.7	13.7	11.1	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.0	13.0	13.0	13.0
TASNANIA B	RO/RO	4700	1982	15.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2
THT CAPRICORNIA	B [coal]	75140	1983	14.5	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	40.9	40.9	40.9	40.9	40.9	40.9	40.9
THT CARPENTARIA	B [coal]	75105	1983	14.5	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	40.9	40.9	40.9	40.9	40.9	40.9	40.9
W LEONARD	PT	25500	1973	16.0	35.0	35.0	35.0	35.0															
VALLARAS	B	6666	1986	13.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	12.5	12.5	12.5	12.5
ZINCHASTER	SPO	17530	1975	14.0	29.0	29.0	29.0	29.0	29.0	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19,9	19.9	19.9	19.9
ANPOL TVA	PT	32000	1990	14.0	30.0			30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
WARDEN POINT	B	6000	1978	11.0	11.5			11.5	11.5	11.5	11.5	8.0	8.0	8.0	- 8,0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
ROBERTA JULL	0/C	3400	1990	10.4	6.6			6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
RIPRES	B	17000	1990	13.5	11.6			17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.5
NODIL TASNAN	PT .	32000	1990	14.7	31.4			31.6	31.5	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6
SKAROAD MERSEY	RO/RO	5115	1991	16.0	24.0				24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
YARRA RIVER	B	30000	1962	13.0	RECR.				27.2	27.2	27.2	27.2	27.2	21.2	21.2	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4
SEAROAD TAWAR	RO/RO	9575	1991	18.9	34.1				34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1
TORNES OF FUEL P	BR DAY (CON	STANT TASE	APTBR 1	991)		1914.4	1113.1	1886.0	1720.9	1631.4	1614.2	1601.7	1569.4	1568.5	1554.0	1455.1	1201.7	1201.0	1204.5	1193.3	1198.1	1193.7	1197.1
INDEL OF FUEL US	KD (1988 BA	SE; CONSTA	NT TASE	AFTER 1991	()	100.0	92.6	98.5	89.9	85.2	84.3	83.7	82.0	81.9	81.2	76.0	62.8	62.7	62.9	62.3	62.6	62.4	62.5
BEADVELGET TONNE	- WAUTICAL	HILKS PBR	DAY			4.8B+08	4.6B+08	5.08408	4.68+08	4.6B+08	4.68+08	4.5E+08	4.6B+08	4.58+08	4.68+08	4.68+08	4.68+08	4.68+08	4.58+08	4.68+08	4.6B+08	4.6B+08	4.68+08
FLEET AVERAGE TO	INES OF FOR	L / DOODWT	/ 1000	HAUTICAL I	EI L <b>KS</b>	3,98	3.85	3.14	3,17	3.57	3.54	3.51	3.44	3.44	3.40	3.19	2.63	2.63	2.64	2.61	2.62	2.61	2.62
INDEX OF PLEET FO	IRC REPICIE	NCT (1988	BASK)			100.0	103.4	106.2	105.3	110.3	111.2	111.9	113.7	113.7	114.5	120.0	133.9	133.9	133.8	134.4	134.1	134.3	134.2

COASTAL SHIPS: 1990 SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS

Note: It is assumed that vessels are replaced at age 15 years or 1992 if already older.

Estimates of fuel consumption were obtained from shipping companies, else from regression equations for tonnes of fuel per ODDBWT per day from BYCE database INYSEAS.VKI For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

SOURCES: AUSTRALIAN SHIPPING 1990 and earlier editions, BTCE DATABASE

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TABLE I.8 (cont)

### TABLE I.9

# 9 COASTAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT OF SHIPS 10 PER CENT LARGER THAN EXISTING VESSELS (ENERGY BASIS)

				50000	TUBL/DAY			Ť	ONNES PUB	L / DAY	OP VESSEL	AND REPL	ACBUBNT V	RESBL									
WANE	TYPE	DWT	BUILT	07580 J	TONNES)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
PLINDERS RANGE	B	21500	1978	14.6	36.4	35.4																	
LYSAGET BUDBAVOUP	R 110/120	11810	1973	18.0	REGR.	45.1																	
NARY BOLYNAN	G/C	3340	1971	15.0	REGR.	13.2																	
RELBOURNE TRADER	RO/RO	7207	1975	15.9	31.1	31.1																	
SID NCORATH	RO/RO	2745	1978	15.0	14.9	14.9		14.9	14.9	14.9	14.9	13.4	11.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
CHALLBNGER B	RO/RO	3390	1979	15.0	REGR.	15.9	15.9																
PREEWAY NORTH	GC	9332	1978	14.1	27.9	27.9	21.9																
BP BNTERPRISE	PT	19792	1968	14.5	36.0	36.0	36.0	36.0															
IRENE GREENWOOD	G/C	21760	1982	14.5	32.0	32.0	32.0	32.0															
JOHN HUNTER	PT	24245	1975	14.5	30.4	30.4	30.4	30.4															
ROOFINDY	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0															
WILTBUIKK	LYG	12280	1968	15.0	24.0	24.0	24.0	24.0															
ABEL TASEAN	RO/RO/PU	2063	1975	19.5	60.0	60.0	60.0	60.0	60.0	33.9	33.9	33.9	33.9	33.9	33.9	33.9	33,9	33.9	33.9	33.9	33.9	33.9	33.9
ACCOLADE IL	8	8410	1982	10.2	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	1.5	7.5	7.5	1.5	1.5	7.5	1.5	7.5
AMPOL SARKL	CT	101900	1979	15.5	12.5	72.5	12.6	12.6	12.5	72.5	12.5	72.5	48.5	48.5	48.5	48.5	48.5	48.5	48.5	48.5	48.5	48.5	48.5
ARTHUR PHILLIP	CT	65103	1974	16.0	6Z.O	62.0	82.0	62.0	62.0	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4	35.4
AUSTRALIA SLY	PT	33239	1989	12.1	26.8	26.8	26.8	26.8	26.8	26.8	25.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	29.0
AUSTRALIAN SPINIT	T PT	JZEUS	1987	13.6	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	29.0	29.0	29.0
DADD THAUBH	100/100 D	7848	1978	17.1	37.3	37.3	31'3	31'3	31.3	37.3	37.3	43.3	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9
CANODIE	B (19)	4140	1980	12.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	1.1	7.9	7.9	7.9	7.9	7.9	7.9	7.9	f.9	7.9
CREVIUS		34347	1750	13.3	50.V	55.0	36.0	56.0	56.0	96.0	56.0	56.0	55.0	56.0	56.0	55.0	56.0	56.0	56.0	46.7	46.7	46.1	46.7
CONTR	0 1944	10010	1978	19.2	32.0	JZ.0	32.0	3Z.U	JZ.0	32.0	32.0	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8
00803 894	11	31330	1981	14.5	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1
BRA Reco otabet into		94267	1980	13.7	51.4	51.4	51.4	\$1,4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	\$1.4	51.4	40.6	40.6	40,6	40.6
BALKOPO DIV	ri 0/0	24380	1912	19.5	33'3	33.3	39.3	39.3	39.3	26.1	Z6.1	Z6.1	25.1	26.1	26.1	26.1	26.1	26.1	25.1	26,1	26.1	26.1	26.1
PRARUES BAT	G/C	2106	1391	11.0	3.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
GULIAIN AND	8 00/00	4210	1977	14.0	14.0	14.0	14.0	14.0	14.0	14.0	11.4	11.4	11.4	11.4	11.4	11.4	11,4	11.4	11.4	11.4	11.4	11.4	11.4
UV18	160/160 10	2400	1979	10.3	18.0	18.0	19.0	18.0	18.0	18.0	18.0	18.0	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.5	20.6	20.5
INCH DANCH	D	31331	1989	14.1	29.0	<b>1</b> 1		25.U	25.U	25.0	Z5.0	25.0	Z5.0	25.0	25.0	25.0	Z5.0	25.0	25.1	25.1	25.1	25.1	25.1
THE CAPADONA DIA	D D	33244	1915	13.3	34.3	34.3	34.5	34.3	10.0														
TRON CHATCHIANIA	2	40310	1040	3.3	10.0	10.0	10.0	10.0	10.0	19.0	13.0	13.0	13.0	13.0	13.0	13.6	13.6	13.6	13.6	13.6	13.6	13.5	13.5
TROM MONADUR		1/155	1073	11 6	14 6	10.0	10.0	10.0	10.0	10.4	10.0	19.4	19.4	14.4	1914	13.4	13.4	11.4	13.4	13.4	13.4	13.4	13.4
TROM BUTWCR	10/100 11	91716	1010	11.7	10.0	10.0	10.0	10.0	10.0	10.1	18.1	10,1	15.1	18.1	18.1	18.1	18.1	18.1	18,1	18.1	18.1	18.1	18.1
TRAN STUDY	1	99100	1876	19.0	44 1	49.1	44 1	44 1	44 1	69.V 89 1	23.0	23.0	23.0	49.0	13.3	18.3	19.3	19.3	19.3	18.3	19.3	18.3	19.3
TELAND CAR	0	8011	1078	19.9	4411 11 R	49.1	11 8	11 6	11 6	43,1 18 E	4J.1	23.1	20.0	20.0	20.0	ZU.U	20.0	20.0	20.0	20.0	20.0	20.0	20.0
JON SANDERS	0/0	9616	1000	19.9	11.0	4 1	9 1	11.0	11.0	10.9	14.5	10.5	10'9	10.5	10.5	10.2	10.5	10.5	10.5	10.5	10.5	10.5	10.5
TRLVIN	LPC	13453	1990	14.5	19.0	1.1	111	10.0	10 0	10 0	16.0	10.0	10.0	10 0	10.0	14.4	10.0	10.0	10.0	14.4			
TOTULEA	1	23258	1984	13.0	20.0	20.0	20.0	90.0	90.0	13.V 90.0	10.0	90.0	13.0	19.0	13.0	19.0	19.0	19.0	19.0	14.0	13.0	19.0	19.0
LINDRRAY CLARK	i.	29510	1985	11.0	20.0	20.0	90.0	50.0	50.0	90.0	90 0	90.0	90.0	50.0	90.0	40.0	30.0	11.0	16.8	1110	11.0	5,11	11.8
NOBIL AUSTRALIS	PT	26642	1972	16.0	30.5	30.5	10.5	10.5		2010	20.0	40.0	64.4	20.0	20.0	20.0	20.0	20.0	13.4	19.4	18-4	1314	13.4
OBNISTON	8	16580	1979	14.8	30.0	30.0	30.0	10.0	30.0	30.0	10.0	10.0	91.9		91 9	91 9	91 9			41.4			
PILBARA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0	21.0	21.0	91.6	91 K	91 R	91.6	51.6 91.6	91 6	91 6	61+6 91 6	41.6	61.C 91.E	61.2	41.Z	41.2
PORTLAND	8	36500	1988	13.4	29.0	29.0	29.0	29.0	99.0	21.0	29.0	20 0	90 0	90 0	50 0	41.0 90 A	51.0 90 A	41.0 46 A	61,0 90 A	0.12	41.0	0.15	21.0
LIVER BOTHE	B [coal]	76155	1989	11.6	119 9	110 0	119 0	110 0	110 0	110 0	110 0	119 4	110 0	110 4	43.V 110 A	43.V 91 E	43.U 91 F	67.V 91 F	43.0	43.0	29.0	41.3	21.9
REVER ENGLEY	B [coal]	76106	1981	11 1	191 #	191 6	191 6	191 6	110.0	191 8	191 6	191 8	191 6	118.8	141 6	J],3	31.D	31.3	J1.3	31.0	J1.0	31'2	31.5
BLAKE AUDBERKS	S (cost)	110909	1074	14 K	161.0	18 /	161.0	141.0	141.0	161.0	141.0	161.0	141.0	141.0	141.0	141.0	27.3	2313	23.3	29.3	29.3	29.3	Z9.J
SAUDDA MADIR	3	651761	1084	11.2	19.9	30.9	30.9	J0.4 19.4	J0.4 19 0	38,4	61.1 19.0	61.1	41.1	21.1	21.1	21.1	21.1	11.7	21.1	27.7	21.1	27.7	21.1
SEAVAT ROBART		7161	1976	15.2	36.5	36.5	36.5	36.5	36.5	29.4	29.4	29.4	29.4	29.4	13.8	13.8	13.8	13.6	13.8	29.4	11.0 29.4	11.5	11.6 94.4

	-			THAN	EXIS	STING	VES	SELS	(ENE	RGY	BASI	S)				-							
															11 9	11 9		11 2	11.2	11.2	33.2	33.2	33.2
LAWAY MELBOURNE	RO/RO	7180	1977	15.8	37.3	37.3	37.3	37.3	37.3	31.3	JJ.Z	33.2	JJ.2 14 8	33.6	19.8	19 9	11 9	19 9	19 9	12.7	12.1	12.7	12.1
OLT AUSTRALIA	CHT*	8900	1986	14.0	REGR.	13.7	13.7	13.7	13.7	13.7	13.1	13.7	13.7	44 6	13.1 94 E	19.1	94 9	94 9	94.9	24.9	24.9	24.9	24.9
ASWANIA B	10/10	4700	1982,	15.5	24.5	24.5	24.5	- 24.0	24.0	24.5	29.3	41.2	41.2	144.2	119 4	199 4	11 4	19.3	18 4	38.4	38.4	38.4	38.4
T CAPELCORNIA	B [coal]	75140	1983	14.5	122.4	122.4	122.4	122.4	122.4	122.4	122.4	166.9	144.4	199 4	144 4	199 4	18.4	19 1	18 4	38.4	18.4	38.4	38.4
IT CARPENTARIA	B [coal]	75105	1983	14.5	122.4	122.4	122.4	122.4	122.4	122.4	144.4	166.9	146.4	166.9	146.4	166.4	4014	0014		4011			
I LEONARD	PT	25500	1973	15.0	35.0	35.0	35.0	35.0					11 E	11.6	11 6	11.6	11 8	11.6	11.6	11.4	11.4	11.4	11.4
ALLARAH	8	6655	1986	13.5	11.5	11.5	11.5	11.5	11.0	11.5	11.9	11.3	11.7	11.0	11.7	90.1	90.1	50 1	90.1	20 1	20.1	20.1	20.1
INCHASTER	SP#	17530	1915	14.0	29.0	29.0	29.O	29.0	29.0	20.1	20.1	20.1	20.1	20.1	10.1	40.1	20.1	40.1 90.0	10.1	30.0	30.0	30.0	30.0
IPOL TVA	PT	32000	1990	14.0	30.0			30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	8.0	8.6	8.0	8.0	8.0	8.0
ARDEN POINT	B	6000	1978	11.0	11.5			11.5	11.6	11.5	11.5	8.0	8.0	8.0	8.U E E	0.V 8.6	6.0	0.0	5.5	6.6	6.6	5.5	5.5
DBBRTA JULL	G/C	3400	1990	10.4	6.6			6.6	6.6	6.6	0.0	0.0	0.0	0.0	1.0	19 6	19 6	19 6	17.6	17.6	17:6	17.6	11.6
L'PRESS	8	17000	1990	13.5	17.5			17.5	17.6	17.6	17.0	11.0	11.0	11.0	17.0	11.0	11.0	-91 6	31.6	31.6	31.6	31.6	31.6
DBIL TASNAN	PT	32000	1990	14.1	31.6			31.6	31.5	31.6	31.0	31.0	31.0	31.0	31.0	31.U 94.A	91.0	94 0	94 6	24 0	24.0	24.0	24.0
ABOAD WERSEY	RO/RO	5715	1991	16.0	24.0				24.0	24.0	24.0	Z4.0	24.0	24.0	29.0	41.0	59.0	40.1	90 1	90 1	20 1	20.3	20.3
ARRA RIVER	B -	30000	1982	13.0	REGR.				21.2	21.2	27.2	21.2	21.2	21.2	21.2	20.3	20.3	14 1	94 1	14 1	14 1	34.1	34.1
ABOAD TANAR	RO/RO	9676	1991	16.9	34.1				34.1	34.1	34.1	34.1	34.1	34.1	34.1	99+1	34.1	44.1	97.1		•111	••••	••••
						1914.4	1773.7		1720.9	1637.5	1622.1	1611.8	1579.0	1578.0	1563.2	1461.6	1201.2	1199.0	1198.4	1175.0	1179.0	1171.9	1174.1
UNNES OF FUEL PE	A UAS (UUN A /1444 BA	STURI INSP STURI INSP	ATION : • • • • • •		11	100 0	9.60	98.5	89.9	85.5	84.7	84.2	82.5	82.4	81.7	76.3	62.7	62.6	62.6	61.4	61.6	61.2	\$1.3
BURY ON LORP OF	NU (1300 DA	WIIDO DDA		ACIDE 100 NUCTINE CU	1) TD 01991	A 918109 /	1.662108	Rad	4.56R+08	4.568+08	4.588+08	4.56R+08	4.56E+08	4.56B+08	4.56E+08	4.56B+08	4.568+08	4.568+08	4.56E+08	4.568+08	4.568+08	4.56B+08	4.568+08
BAUWBIGHT TURKS	- PAULLUAN 	(DUN 00 14)	UA1 (UU	VKO1AN1 00 Di 100249999	enthe\	41010100	11000100	U.R.		3.438+06	5.99R+08	7.60R+06	1.538+07	1.54R+07	1.73E+07	2.01E+07	2.71B+07	2.858+07	3.07E+01.	3.718+07	3.91E+07	4.038+07	4.12B+07
DUITIONAL DWT-NB	PER DAT	UNUS TO DA		LACERSEI VAL	DELLO	4	66.433	200	4.558408	A 598+88	4.528+08	4.63R+08	4.718+08	4.71R+08	4.738+08	4.76B+08	4.83E+08	4.845+08	4.868+08	4.93B+08	4.95E+08	4.96E+08	4.97E+08
UTAL DEADWEIGHT	IUNNE - 94	UIIGRE 1116	80 888   / 1004	WANNTAAT		1 00 F	1 1 2 2	200	3.98	3.67	3.81	3.48	3,35	3,35	3.11	3.07	2.49	2.48	2.46	2.39	2.38	2.36	2.35
LEST AVERAGE TON	INKS UF FUE	66 / VOUNT 1400 /1400	. 1000 1 1000	RAUITCAL	#1539	3.30 100 A	104 4	220	105.1	110.4	111.7	112.6	115.8	115.9	117.0	122.8	137.6	137.8	138.1	140.1	140.1	140.6	140.7
MARY OF RUREL LO	JEG STFICIE	MPI (1900	DASS			100.0	14414		10011														

COASTAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT OF SHIPS 10 PER CENT LARGER

Note: It is assumed that vessels are replaced at age 15 years or 1992 if already older.

Estimates of fuel consumption were obtained from shipping companies, else from regression equations for tonnes of fuel per 000DWT per day from BTCE database INTSEAS.WEL For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

SOURCES: AUSTRALIAN SHIPPING 1990 and earlier editions, BTCE DATABASE

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TABLE I.9 (cont)

TABLE 1.10COASTAL SHIPS: 20 YEAR SHIP LIFE, TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE<br/>SAME SIZE AS EXISTING VESSELS (ENERGY BASIS)

		********			FURL/DAY			T	ONNES PUR	L / DAY	OF VESSEL	AND REPL	ACBUBNT V	RSSRL									
VANE	TYPE	DWT	IBAK BUILT	SPEED	AT BERED (TOBBES)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
PLINDERS RANGE	9	27500	1978	14.6	36.4	38.4				*******													
LTRACET ENDEAVOUR	1 RO/RO	11810	1973	18.0	REOR.	45.1																	
NARY BOLYNAN	0/C	3340	1971	15.0	REGIL.	13.2																	
NELBOURNE TRADER	RO/RO	1201	1975	15.9	31.1	31.1																	
BID NCGRATH	10/10	2745	1978	15.0	14.9	14.9		14.9	14.9	14.1	14.9	14.9	14.9	14.9	14.9	14.9	12.6	12.6	12.6	12.6	12.6	12.6	12.6
CHALLENGER B	RO/RO	3390	1979	15.0	LEGE.	15.9	15.9																
FREEWAY NORTH	GC	9332	1978	14.7	27.9	27.9	27.9																
BP ENTERPRISE	PT	19792	1968	14.5	36.0	36.0	36.0	36.0															
IRENE GREENWOOD	G/C	21760	1982	14.5	32.0	32.0	32.0	32.0															
JOHN NUNTER	PT	24245	1975	14.5	30.4	30.4	30.4	30.4															
TOOLINDA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0															
WIGTSBIRG	LPC	12280	1968	15.0	24.0	24.0	24.0	24.0								1							
ABEL TASWAN	RO/RO/P#	2063	1975	19.5	60.0	60.0	60.0	60.0	60.0	80.0	60.0	60.0	60.0	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8	31.8
ACCOLADE II	B	8410	1982	10.2	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	6.8	6.8	6.8
ANPOL SAREL	CT	101900	1979	15.5	72.5	72.5	12.5	72.5	72.5	72.5	12.5	12.5	12.5	72.5	12.5	12.5	72.5	42.0	42.0	42.0	42.0	42.0	42.0
ARTBUR PHILLIP	CT	65103	1974	18.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	31.7	31.7	\$1.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.1
AUSTRALIA SEV	PŤ	33239	1989	12.1	28.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8 /	26.8	26.8	26.8	26.8	26.8	26.0	26.8	26.8	26.8	26.8
AOSTRALIAN SPIRIS	t PT	32605	1987	13.5	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
BASS TRADER	R0/R0	7846	1976	17.1	37.3	37.3	37.3	37.3	37.3	31.3	37.3	37.3	37.3	37.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	(1.3
CANENA	B	4120	1980	12.0	9.0	9.0	9.0	9.0	9.0	1.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	1.2	1.2	1.2	1.2	1.2
CANOPUS	CT	94347	1986	13.9	55.0	58.0	58.0	58.0	56.0	\$6.0	56.0	56.0	56.0	56.0	56.0	56.0	58.0	56.0	56.0	55.0	55.0	56.0	56.0
CILII BINTCO	B	16510	1978	15.2	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	20.5	20.6	20.6	20.6	20.6	20.5	20.5
CONUS	PT	31950	1981	14.5	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	21.4	27.4	21.4	27.4
RL	CT .	94287	1988	13.7	51.4	51.4	51.4	81.4	51.4	\$1.4	\$1.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4
ESSO GIPPSLAND	PT	24380	1972	14.5	39.3	39.3	39.3	39,3	39.3	39.3	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5
FRANCES BAT	G/C	2106	1981	11.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9,0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	5.8	5.8	5.8	5.8
OOLIATH	8	4270	1977	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
GOTE	RO/RO	2400	1979	16.3	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	19.3	19.3	19.3	19.3	19.3	19.3
TRON BABON	B	37657	1985	14.1	25.0	<i>P</i>		25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
IRON CAPRICORN	8	35244	1975	13.5	34.5	34.5	34.5	34,5										••••					
IRON CARPENTARIA	B	45310	1977	9.5	16.0	16.0	16.0	16.0	16.0	18.0	16.0	16.0	18.0	16.0	16.0	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3
IRON CURTIS	B	45310	1978	9.5	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	12.2	12.2	12.2	12.2	12.2	12.2	12.2
IRON MONARCE	<b>R</b> 0/ <b>R</b> 0	14855	1973	11.5	16.0	16.0	16.0	16.0	16.0	16.0	16.0	17.2	17.2	17.2	17.2	17.2	11.2	11.2	17.2	17.2	17.2	17.2	17.2
TRON PRENCE	8	21735	1981	13.5	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	21.0	23.0	11.6	17.6	17.6	17.6
LEON STURT	8	22100	1979	13.5	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	18.1	18.1	18.1	18.1	18.1	18.1
ISLAND CAS	LPO	6033	1976	13.5	11.6	11.6	11.6	11.6	11.5	11.6	11.6	11.6	11.6	11.5	9.6	9.6	9.6	9.6	9.8	9.6	9.6	9.6	9.6
JON SANDERS	G/C	2640	1988	12.5	1.1	1.1	1.1	1.1								••••	••••		•••		•••		
RBLVIN	LPG	13453	1990	14.5	19.0			19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	t\$.0	19.0	19.0
LOVULKA	B	23258	1984	13.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	16.3
LINDESAY CLARE	B	29510	1985	13.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
NOBIL AUSTRALIS	PT	26642	1972	16.0	30.5	30.5	30.5	30.5								••••							
OBMISTON	B	16580	1979	14.8	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	19.2	19.2	19.2	19.2	19.2	19.2
PILBARA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	20.4	20.4	20.4	20.4	20.4	20.4	20.4
PORTLAND	8	36500	1988	13.4	29.0	29.0	29.0	23.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0
RIVER BOTHE	B [coal]	76355	1982	13.5	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	28.7	28.7	28.1
REVER EXOLEY	B [coal]	76305	1983	13.1	121.5	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.6	121.8	121.6	121.6	121.5	26.8	26.8
RIVER TORRENS	B	31921	1977	14.5	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
SANDRA MARIE	8	5580	1986	14.2	13.8	13.8	13.8	11.8	13.6	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.4	13.4	13.8	13.8	13.8	13.8
SEAVAY BOBART	NO/NO	7161	1976	15.2	36.5	38.5	36.5	36.5	36.6	38.5	38.5	36.5	36.5	16.5	21.1	27.1	21.1	21.1	27.7	27.7	21.1	21.1	11.1

		-		SAME	SIZE	AS	EXIS	STING	VES	SELS	(ENE	RGY	BASI	S)									
SEAVAY NELBOURNE	10/10	7180	1977	15.8	37.3	37.3	37.3	37.3	37:3	37.3	37.3	37.3	37.3	37.3	37.3	31.2	31.2	31.2	31.2	31.2	31.2	31.2	31.2
STOLT AUSTRALIA	CHT#	8900	1986	14.0	REGR.	13.7	13.7	13.7	13.7	13.7	13.1	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.1	13.7	13.7
TASVANIA B	RO/RO	4700	1982	15.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	23.4	23.4	23.4
THT CAPRICORNIA	B [coal]	15140	1983	14.5	122.4	122.4	122.4	122.4	112.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	35.0	35.0
THT CARPENTARIA	B [coal]	75105	1983	- 14.6	122.4	122,4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	122.4	35.0	35.0
WM LEONARD	PT	25500	1973	16.0	35.0	35.0	35,0	35.0															
WALLARAB	B	6666	1986	13.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
ZINCUASTER	SP4	17530	1975	14.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6
ANPOL TVA	PT	32000	1990	14.0	30.0			30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
VARDEN POINT	B	6000	1978	11.0	11.5			11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	1.2	1.2	1.2	1.2	1.2	1.2	7.2
BOBERTA JULL	G/C	3400	1990	10.4	6.6			6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
KLPRESS	B	17000	1990	13.5	17.6			17.6	17.6	17.6	17.8	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6
HOBIL TASHAN	PT	32000	1990	14.7	31.6			31:6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6
SBACAT TASUANIA	P/CF	200	1990	35.0	75.0			15.0	15.0	75.0	75.0	15.0	75.0	15.0	15.0	15.0	75.0	75.0	75.0	15.0	75.0	15.0	75.0
SKAROAD NERSEY	RO/RO	5775	1991	16.0	24.0				24.0	24.0	24.0	24.0	24.0	24.0	24.0	. 24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
YARRA RIVER	8	30000	1982	13.0	REGR.				21.2	21.2	21.2	27.2	21.2	27.2	27.2	27.2	27.2	21.2	27.2	27.2	18.5	18.5.	18.5
SEARDAD TANAN	RO/RO	9515	1991	16.9	34.1				34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1	34.1
TORRES OF FUEL PI	IR DAY (CON	STANY TASK	APTER 1	991)		1914.4	1773.7	1961.0	1795.9	1795.9	1781.1	1782.3	1752.0	1713.3	1706.6	1681.6	1659.1	1614.1	1612.3	1592.8	1484.5	1214.8	1211.1
INDEE OF FUEL USI	KD (1988 BA	SE; CONSTA	IT TASE	APTER 1991	1	100.0	92.6	102.4	93.8	93.8	93.0	93.1	91.5	89.5	89.1	87.8	86.7	84.3	84.2	83.2	11.5	63.5	63.3
DEADWEIGHT TONNE	- WAUTICAL	BILES PER	DAY			. BR+08	4.78+08	5.02+08	4.08+08	4.68+08	4.68+08	4.5B+08	4.6B+08	4.6B+08	4.6B+08	4.6B+08	4.5B+08	4.6E+08	4.68+08	4.6B+08	4.6B+08	4.6B+08	4.6B+08
TURBE AVERAGE TO	IRAS OF FUE	L / 0000 <b>07</b>	/ 1000	BAUTICAL B	1683	3.98	3.76	3.89	3.94	3.94	3.91	3.91	3.84	3.76	3.74	3.69	3.64	3.64	3.54	3,49	3.26	2.67	2.66
THANKY ON APPRENT AN	BU REFICIE	ICI (1988	M92)			100.0	105.6	102.J	101.0	101.0	101.9	101.8	103.5	105.6	108.0	107.3	108.5	111.1	111.2	112.2	118.2	133.1	133.3

COASTAL SHIPS: 20 YEAR SHIP LIFE, TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS

Note: It is assumed that vessels are replaced at age 20 years or 1992 if already older. Estimates of fuel consumption were obtained from shipping companies, else from regression equations for tonnem of fuel per 000DWT per day from BTCE database INTERIS.WII for replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

SOURCES: AUSTRALIAN SHIPPING 1998 and earlier editions, STCE DATABASE

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TABLE I.10 (cont)

#### TABLE I.11 INTERNATIONAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REFLACEMENT SHIPS THE SAME SIZE AS EXISTING VESSELS

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			-		FUBL/DAY			1	IONNES FU	RL / DAY	OF VESSE	L AND RBP	LACENENT (	VBSSBL									
WAWB	TYPE	DWT	TBAN. BUILT	57880	AT SPBBD (TONNBS)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AUSTRALIAN BNBL	BN RO/RO	23450	1975	14.5	54.3	54.3																	
AUSTRALIAN PURP	OSB B	122750	1977	15.7	REGR.	15.1	75.7																
IRON KESTREL	8	27270	1974	14.0	30.0	30.0	30.0	30.0															
ANNO AUSTRALIA	RO/RO/C	22200	1977	13.3	34.5	34.5	34.5	34.5	34.5	34.5	33.2	33,2	33,2	33.2	33.2	33.2	33,2	33,2	33.2	33.2	33.2	33.2	33.2
ANRO MBLBOURNB	RO/RO/C	23617	1975	. 14.5	54,3	54.3	54.3	54.3											• • •				
AUSTRALIA STAR	CT	94560	1986	13.2	42.5	42.5	42.5	42.5	42.5	42.5	4Z.5	42.5	42.5	42.5	42.5	42.5	4Z.5	Z4.8	24.8	24.8	24.8	24.8	24.0
AUSTKALLAN AUVA	ACK C	35407	1983	17.2	5U.Z	50,Z	50.Z	50.Z															
AUSTRALIAN BAPU	ALP C P	110400	1974	14.5	19 0	57.U	99 0	19 0	11 0	13 0					44.6		11.5		11.5		44.5	44.5	
AUSTRALIAN PROG		110400	1076	14.0	99 5	14.0	99 8	99.6	16.0 99 K	14 5	44.5	44.5	44.6	11.5	44.5	44.5	44.5	44.5	11.3	11.5	44.2	44.2	44.5
AUCTRALIAN CRAD		9011	1097	19.6	10.J	79 A	99 0	39 0	70.J	29 A	94 N	99.0	90 0	11.5 79 A	29 0	91 5	91 5	91 6	91 6	21 5	91 5	91 K	99.6
AUSTRALIAN TRAD	RP C	8450	1978	13.7	22.1	22.1	22 1	22 1	22 1	22.1	22.1	14 0	14.0	14.6	14 0	14.0	14 0	14 0	14 0	14 0	14 0	14 0	14 0
AUSTRALIAN VENT	URR C	39450	1977	18.9	110.5	110.5	110.5	110.5	110.5	110.5	49.8	49.8	49.8	49.8	49.8	49.8	49.8	49.8	49.8	49.8	49.8	49.R	49.8
BP ACHIEVER	CT	129700	1983	13.5	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	52.8	52.8	52.8	52.8	52.8	52.8	52.8
C.T.O'CONNOR	G/C	2640	1988	12.1	6.8	5.8	6.8	6.8	6.8														
ROWARD SWITH	B	(3300	1981	11.8	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	15.1	25.8	25.8	25.8	25.8	25.8	25.8	25.8	25.8	25.8
IRON ARNHEN	C/C	8362	1973	12.0	12.5	12.5	12.5	12.5								••••	••••						
IRON GIPPSLAND	CT	87000	1989	14.0	64.0		64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	55.0	55.0
IRON EBUBLA	B	148150	1986	12.5	37.0	37.0	37.0	31.0	37.0	37.0	31.0	31.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	32.7	32.7	32.7	32.1
TRON KIRBY	B	27299	1974	14.0	30.0	30.0	30.0	30.0	30.0	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1
IRON NEWCASTLE	B	148140	1985	12.5	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	33.0	33.0	33.0	33.0	33.0
IRON PACIFIC	B	231850	1986	11.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	30.4	30.4	30.4	30.4
IRON SHORTLAND	B	107140	1979	12.5	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1
IRON SPENCER	B	141475	1981	13.0	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	36.7	36.7	36.7	36.7	36.7	36.7	36.7	36.7	36.7
IRON WEYALLA	B	141435	1981	13.0	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	36.7	36.7	36.7	36.7	36.7	36.1	36.1	36.1	36.7
NARKHAN BAY	G/C	2925	1987	12.0	1.9	7.9	7.9	7.9	7.9	7.9	1.9	7.9	7.9	7.9	7.9	7.9	7.9	1.9	7.9	7.9	1.9	7.9	7.9
HARY DURACE	G/C	Z640	1388	12,3	1.5	7.5	7.5	7.5												• • • •			
NOBIL PLINDERS	CT	149235	1982	15.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	46.9	46.9	46.9	46.9	46.9	46.9	46.9	46.9
NA CIMUBBILING		129/29	1999	13.0	42.0	42.0	96.0	92.0	46.0	46.0	44.0	42.0	92.0	42.0	42.9	42.0	42.0	34.8	32.8	34.8	32.8	JZ.8	32.8
THE ALLERANC	R	15919	1993	14 5	11 0	11 0	13.0	33.0	11 0	33.0	33.0	33.0	11 6	33.0	11 0	33.0	95 4	95 4	95 4	33.U 95.£	33.0	95.0	95 4
THE RIPERSS	B/C\$	41151	1994	14.4	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54 0	54.0	54 0	54 0	54 0	54 0	17 8	12 8	19 8	19 8	17 8	12 8
TRANZTAS TRADER	1 C	14101	1988	15.2	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	16.6	16.6
NV SNIPB	LNC	72870	1990	17	93.0			••••	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0
AUST ENDEAVOUR	C	45500	1991	19.5	53.0				53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0
AUST BNDURANCE	C	45500	1991	19.5	53.0				53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0
PRANE LONBONY	G/C	3400	1990	13.3	7.0			7.0	1.0	7.0	7.0	7.0	7.0	7.0	1.0	7.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
GORDON ABID	C/C	3400	1990	13.3	1.0			T.O	7.0	7.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.0	7.0	1.0	1.0	7.0
IRON PLINDERS	C	17370	1986	15.0	32.6				32.6	32.5	32.6	32,6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	13.4	13.4	13.4	17.7
NV SANDPIPBR	LNG	12870	1992	17	93,0						93.0 	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0
TOWNES OF PUBL	PBR DAY (CO	NSTANT TASI	APTER 1	993)		1344.7	1447.4	1385.7	1395.8	1354.1	1357.5	1349.4	1340.5	1340.5	1316.3	1282.7	1267.9	1219.1	1215.2	1184.1	1184.1	1166.1	1151.8
THREE OF FORD O	1980 (1988 B	ASE; CONST/	IRT TASE .	AVTEN 19	211	100.0	107.6	103.1	103.8	100.7	101.0	100.4	99.7	99.7	97.9	95.4	94.3	90.7	90.4	88.1	88.1	85.7	85.7
DEADWEIGHT TOWN	IB - NAUTICA	L ALLES PE	L VAT 1 / 1000 -			1.2R+08	7.7K+U8	7.38408	1.0E+08	1.08408	7.98+08	1.9R+08	7.98408	1.38408	1.9R+08	7.98408	1.9K+08	1.8R+08	1.98408	7.9K+08	1.98408	1.9K+08	T.98+08
FUBBI AVERAUS T	UNNES UF FU	66 / VVVDW) PNCW (1000	/ 1000 . DACR1	NAUTICAL	H1083	1,87	1.00	1,21	101 -	1.13	1,72	1.11	1.70	1.70	1.07	1.03	1,01	1195	110.0	1.00	1.90	1.18	1.40
THREA OF FREEL	rusb sprivi	22222222222 Puri (1399	DN981			100.0	,,, ,,,,	¥,18 	14111	104.3	101.3	110.4	103.0	103.0	110.1	113.0	119.0	\$1113 •••••••••	6,111 	112'1	1121	14V,¥	141.9

Note: It is assumed that vessels are replaced at age 15 years or 1992 if already older.

Batimatem of fuel consumption were obtained from shipping companies, else from regression equations for tonnes of fuel per 000DWT per day from BTCB database INTSBA8.whl

For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

The database regression equations for ships for which data was not obtained are:

Bulk ships: exp(-1.48525-0.45253)n(DWT/1000]+0.1780861n(1991-year built)+1.1822731n(speed) Tankers : exp(-3.57077-0.4069221n(DWT/1000)+0.1780861n(1991-year built)+1.7822731n(speed) Ro/Ro : exp(-4.005212-0.5072761n(DWT/1000)+0.484391n(1991-year built)+2.2343771n(speed)

Container : exp(-5.641991-0.5843671n(DWT/1000)+0.3985331n(1991-year built)+2.9106741n(speed)

Gen Cargo : exp(-5.347061-0.510471n(DWT/1000)+0.0471091n(1991-year built)+2.6578191n(speed)

Gas Tanker: exp(-0.592047-0.359211n(DWT/1000)+0.0715851n(1991-year built)+0.7775281n(speed)

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# TABLE I.12

## 12 INTERNATIONAL SHIPS: 1990 SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING VESSELS

			¥918		FUEL/DAT				TONNES FU	BL / DAY	OF VESSE	L AND REPI	ACBURNT	VBSSSL									
NANS	TYPE	DWT	BUILT	8748U	(TONNES)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AUSTRALIAN BUBL	BK RO/RO	23450	1975	14.5	54.3	54.3																	
AUSTRALIAN PURP	OSE B	122750	1977	15.7	REGR.	75.7	15.7																
IRON EBSTREL	B	27270	1974	14.0	30.0	30.0	30.0	30.0															
ANNO AUSTRALIA	RO/RO/C	22800	1977	13.3	34.5	34.5	34.5	34.5	34.5	34.5	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.4
VINO BRIBOONNE	RO/RO/C	23611	-1975	-14.5	- 54.3	54.3	54.3	54.3										·		·			
AUSTRALIA STAR	CT	94580	1986	13.2	42.5	42.5	42.5	42.5	42.5	42.5	42.5	42.5	42.5	42.5	42.5	42.5	42.5	23.8	29.8	29.8	29.8	29.8	30.9
AUSTRALIAN ADVA	NUK U	35407	1883	11.2	50.Z	50.Z	50.2	50.Z									-						
AUSTRALIAN SIPU	RTK C	27918	1972	14.9	67.0	67.0	67.0	67.0															
AUSTRALIAN PROU	863 D D#r b	110400	1311	11.0	12.0	12.0	12.0	12.0	12.0	12.0	43.1	43.7	43.1	43.1	43.1	43.1	43.1	43.1	43.7	43.7	43.7	43.7	45.8
AURTRALIAN SPAD	110 D	102100	1049	19.0	90 0	90 0	90 0	90 0	14.5	90.0	90.0	90 0	90 0	48.1	90.9	43.7	43.7	43.7	43.7	13.7	43.7	43.1	10.0
AUSTRALIAN TRAD		9450	1906	11 9	23.0	99 1	23.0	99 1	49.0	23.0	49.1	16 9	15 9	15 9	15 -9	15 9	67.6	43.6	15 9	16 9	15 9	15 9	15 4
AUSTRALIAN VENT		39466	1917	19.1	116 5	110 5	110 5	110 6	110 8	110 8	59 8	59 8	59.8	89.0	59.9	19.6	51.6	19.4	19.6	19.6	59.0	59.6	19.6
RP ACRIEVER	67	129700	1981	11.5	60.0	60.0	60.0	60.0	60 0	60.0	60.0	60.0	60.0	60.0	60 0	60.0	56.9	56.9	56.9	56.0	54.0	56.0	56.5
C.T.O'CONNOR	6/C	2640	1988	12.1	6.8	6.8	5.8	6.6	\$ 1	00.0					00.0	00.0	44.5	20.4		30.2	30.2	30.4	50.0
BOWARD SWITH	R	43300	1001	11.9	15 1	15 1	16 1	16 1	16 1	15.1	15 1	15 1	15.1	15 1	98.9	16 7	16 1	36 7	95.9	76 7.	96.7	16.1	17 0
TRON ARNHRN	a/c	.8362	1973	-12.0	12.5	12.5	12.5	12.5	4014	****			****				29.1	40.1	20.1	20.1	20.1	60.1	41.3
INON GIPPSLAND	CT CT	87000	1989	14.0	64.0	10.4	64.0	64.0	Ŕ4. Ň	84.0	64.0	\$4.0	84.0	84.0	64.0	84.0	64.0	64.0	64 0	64 0	64 O	64 0	67 7
IRON LENBLA	B	148150	1988	12.5	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	35.7	35.7	35.7	11.5
IRON KIRBY	9 ·	27299	1974	14.0	30.0	30.0	30.0	30.0	30.0	22.1	22.7	22.7	22.1	22.7	22.1	22.7	22.7	22.7	22.7	22.7	22.1	22.7	23.7
IRON NEWCASTLE	B	148140	1985	12.5	37.0	37.0	31.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	35.7	35.7	35.7	35.7	37.5
INON PACIFIC	8	231850	1986	11.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	33.1	33.1	33.1	34.8
IRON SHORTLAND	8.	107140	1979	12.5	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	31.3	32.9
IRON SPENCER	B	141475	1981	13.0	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	39.7
IRON WHYALLA	B	141435	1981	13.0	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	31.9	37.9	37.9	37.9	37.9	31.9	37.9	37.9	39.7
MARKRAN BAY	0/C	2925	1987	12.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	7.4	1.4	8.1
NARY DURACE	G/C	2540	1988	12.3	1.5	7.5	1.5	1.5			· ·												•••
NOBIL FLINDERS	CT	149235	1982	15.0	75.0	75.0	15.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	50.4	50.4	50.4	50.4	50.4	50.4	50.4	54.5
NIVOSA	CT	124754	1984	13.0	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.5	42.8	42.5	42.5	42.5	42.5	34.1	34.1	34.1	34.1	34.1	39.0
NV SANDBRLING	LNG T	72870	1989	17.0	93.0		93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	. 93.0	93.0	93.0	92.0
THT ALLTRANS	B	35218	1983	14.5	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	25.9	26.9	26.9	26.9	26.9	25.9	28.2
THT BIPRESS	B/C#	41151	1984	16.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	35.7	36.7	36.7	36.7	36.7	36.7
TRANZTAS TRADER	C	14101	1988	15.2	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	22.9	22.9
NA SNI52	- LNG	72870	1990	17	93.0				93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0
AUST BNDEAVOUR	C	45500	1991	19.5	53.0				53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0
AUST BNDURANCE	C	45500	- 1991	19.5	53.0				53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0	53.0
ARTHE RONRCHA	0/C	3400	1990	13.3	7.0			1.0	7.0	1.0	7.0	7.0	1.0	1.0	1.0	1.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
GORDON REID	G/C	3400	1950	13.3	1.0			7.0	7.0	7.0	7.0	7.0	7.0	7.0	1.0	1.0	1.0	7.0	7.0	7.0	7.0	1.0	1.0
INCH FLINDERS	C	11370	1986	15.0	32.6				32.6	32.6	32.5	32.6	32.6	3Z.5	32.6	32.6	32.6	32.5	32.6	23.5	23.5	23.5	23.5
NW SANDPIPER	110	12810	1992	17	93.0	•					93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0
TOWNES OF FUEL	PER DAY (CO)	ISTANT TAS	E APTER 1	 993]		1344.8	1447.5	1385.8	1396.0	1352.9	1358.6	1351.8	1343.0	1343.0	1322.3	1297.7	1287.8	1249.3	1248.0	1232.6	1232.0	1229.4	1259.2
INDEX OF FUEL U	SBD (1988 B/	ASE; CONST	ANT TASK	AFTER 19	93)	100.0	107.6	103.1	103.8	100.6	101.0	100.5.	99.9	99.9	98.3	96.5	95.8	92.9	92.8	91.7	91.6	91.4	93.6
DEADWEIGHT TOWN	8 - NAUTICA	L WILES PE	R ÓAY			7.2E+08	1.12+08	1.32+08	T.62+08	7.6E+08	7.98108	7.98+08	7.9E+08	7. <b>92</b> +08	7.92+08	7.9 <b>8</b> +08	7.98+08	7. <b>3</b> 8+08	7.98+08	1.9B+08	1.9B+0B	7.9B+08	7.9B+08
FLEET AVERAGE T	OWNES OF FUI	RL / 000DW	T / 1000	WAUTICAL	NILSS	1.87	1.88	1.91	1.84	1.79	1.73	1.72	1.11	1.71	1.68	1.65	1.64	1.59	1.58	1.57	1.56	1.56	1.60
INDER OF FLEET	FUBL EFFICI	ENCT (1988	BASE)			100.0	99.5	97.9	101.7	104.6	107.8	108.3	108.9	108.9	110.3	112.0	112.6	116.2	115.3	116.4	116.4	116.6	114.6

Note: It is assumed that vessels are replaced at age 15 years or 1992 if already older.

Estimates of fuel communities were obtained from shipping companies, else from regression equations for tonnes of fuel per ODDDWT per day from BTCE database INYSEAS.whi For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

SOURCES: AUSTRALIAN SHIPPING 1990 and caller editions, BTCE DATABASE

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TABLE I.13	INTERNATIONAL	SHIPS: TREND	SPECIFIC FUE	L CONSUMPTION	FOR	REPLACEMENT	SHIPS	10	PER	CENT	LARGER
•	THAN EXISTING	VESSELS									

			TRAD	SPRED	FUEL/DAY					TOWNES PU	BL / DAY	OF VESSE	L AND REP	LACENENT	VBS8BL								
AYE	TTPB	DWT	BUILT		(TOWNES)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	20
OBTRALIAN RUDLE	n ro/ro	23450	1975	14.5	54.3	54.3														•			
USTRALIAN PORPO	SK B	122750	1977	16.1	REGR.	16.1	15.1																
NU LESTEL	8 D0/D0/4	21270	1974	14.0	30.0	30.0	30.0	30.0															
NEO AVOTEALIA	NU/NU/C	22200	1911	13,3	34.5	34.5	34.5	34.5	34.5	34.5	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34
DETRALIA RTAR	CT	94580	1919	19.0	49.5	24.3	24.3	24.3	13.6	19.5	49 K	19.6	49.5			44 F							
USTRACTAN ADVAN		35407	1981	17.2	50.9	12.J KA 9	12.3	14.9	46.0	44.9	44.0	16.3	44.9	42.3	44.3	42.5	44.9	20.9	20.9	20.5	20.5	20.5	20
ISTRALIAN RIPOR	TR C	27478	1972	14.9	67 0	67 A	67 0	67 0															
STRALIAN PROGR	RS B	139400	1911	14.0	12.0	12.0	72.0	72.0	77.0	72.0	46.2	46 2	46.2	46.2	46.2	46.2	46.9	46.2	46.1	46.3	16.9	46.1	
STRALIAN PROSP	BC B	139400	1976	14.0	12.6	12.5	12.5	12.6	12.5	46.2	40.2	48.2	46.2	46.2	48 9	46.5	46 2	48.2	40.2	46.5	40.2	40.6	
STRALIAN SRARO	AD CC+	9033	1582	17.5	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	24.0	24 2	94 9	54 5	91.9	94.9	94 9	94.9	;
STRALIAN TRADE	L C	8450	1978	13.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14 4	11 4	14 4	1
ISTRALIAN VENTU	RB C	39450	1977	18.9	110.5	110.5	110.5	110.5	110.5	110.5	61.2	51.2	51.2	51.2	51.2	51.2	51.9	51.2	51.9	\$1.9	51.9	51.9	5
ACRIEVER	CT	129700	1983	13.5	60.0	60.0	60.0	60.0	60.0	\$0.0	60.0	60.0	60.0	60.0	60.0	60.0	55.0	55.0	55.0	55.0	55.0	55 0	5
.Y.O'CONNOR	G/C	2640	1988	12.1	5.8	6.8	6.8	6.8	6.8														
OWARD SWITE	8	43300	1981	13.8	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	26.8	26.8	26.8	26.8	26.A	26.8	26.R	26.8	
NOW ARXIED	0/C	8362	1973	12.0	12.5	12.5	12.5	12.5															
RON GIPPSLAND	CT	87000	1989	14.4	64.0		64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	5
LON KENBLA	8	148150	1986	11.5	37.0	37.0	31.0	37.0	31.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	34.0	34.0	34.0	3
LON LIRBY	B	27299	1974	14.0	30.0	30.0	30.0	30.0	30.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	2
ION NEWCASTLE	B	148140	1985	12.5	37.0	37.0	37.0	37.0	37.0	37.0	37.0	31.0	37.0	31.0	31.0	31.0	37.0	37.0	34.3	34.3	34.3	34.3	3
ION PACIFIC	B	231850	1986	11.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	31.5	31.6	31.6	3
ION SHORTLAND	B	107140	1979	12.5	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3	32.3	3
ION SPENCER	8	141475	1981	13.0	44.5	44.5	44.5	41.5	44.5	44.5	44.5	44.5	44.5	44.5	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	3
ION WEYALLA	8	141435	1981	13.0	43.5	41.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5	38.1	38.1	38.1	38.i	38.1	38.1	38.1	38.1	3
ARKUAN BAY	G/C	2925	1987	12.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.2	8.2	
LEY DURACE	G/C	2540	1988	12.3	7.5	1.5	1.5	1.5															
DELL FLIKDERS	UT	149235	1982	15.0	75.0	T5.0	15.0	75.0	75.0	75.0	75.0	15.0	15.0	75.0	15.0	50.1	50.1	50.1	50.1	50.1	50.1	50.1	5
LVUSA	CT	124754	1984	14.0	42.6	42.6	42.5	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	34,8	34.8	34.8	34.8	34.8	3
N BANDERLING	LNG T	12870	1989	11.0	93.0		93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	10
T AUDILAND	8 8/04	39218	1393	14.5	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	26.4	26.4	26.4	26.4	26.4	26.4	2
NI BILBESS NI BILBESS	B/C*	14101	1364	10.0	94.U 4K K	94.V 46 6	94.0	94.V	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	54.0	34.0	34.0	34.0	34.0	34.0	3
WANTER IMADE	LNC .	99890	1000	19.6	69.0	49.9	19.9	23.3	23.2	23.3	29.9	49.9	49.9	49.9	49.9	40.0	29.9	23.3	23.5	25.5	29.9	17.0	1
TEP PUBPAYOUR	0	45500	1934	10 6	53.0				53.0	33.0	99.U 69.0	23.0	33.0	33.0	3J.V K3 A	33.0	93.0	93.0	37.0	33.0	93.0	93.0	3
	č	15500	1001	10.0	55.V 53.V				93.U 84 A	33.V 64 A	33.V K4 A	53.0	53.0	33.0	53.U 59.A	33.0	33.0	33.V	53.U	53.0	53.0	33.U	2
NAME FORCE	0/C	13300	1084	19.9	93.V 7 A			• •	93.0	99.U 4 A	99.0	93.0	03.0	33,0	93.0	33.0	33.0	53.0	23.0	53.0	53.0	53.0	3
	G/C	5400	1000	14.4	1.U T ()			1.0	1.0	7.0	7.0	1,0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1,0	1.0	
BON PLINDER	c, c	111170	1016	15.0	19 6			1.0	1.0	19 6	19 6	15 6	19 6	1.0	110	1.0	1.0	1.0	1.0	10 1	10 4	10.4	1
W CAWNDIDED	LIG	19870	1995	17.0	01 h				36.0	34.0	41.0	94.0	34.0	32.0	32,0	32.0 63 A	44,0	34.0	34.0	10.4	10.6	10.6	14
· VAPUTTER	5 <b>6</b> 0	12010	1772	11.4	3310						3919	34.4	33.0	33,0	33.0	33.0	33.0	33.0	33.0	33.0	39.0	33.0	
ONNES OF FUEL P	BR DAY (CO	NSTANT TASI	APTER 1	(993)		1344.8	1447.5	1385.8	1396.0	1356.8	1365.1	1357.4	1349.7	1349.7	1329.4	1299.6	1268.1	1244.3	1241.6	1217.8	1218.0	1209.6	121
NDEL OF FUEL US	ED (1988 B	ASE; CONST.	NT TABE	APTER 19	93)	100.0	107.5	103.1	103.8	100.9	101.5	100.9	100.4	100.4	98.9	96.6	95.8	92.5	92.3	90.6	90.6	89.9	9
ADVEIGET TONNE	- NAUTICA	L NILES PE	DAY (CO	NATANT S	BIP SIZE)	1.218+08	1.138+08	7.298+08	7.628+08	7.618+08	7.91E+08	7.918+08	T.918+08	7.918+08	T.918+08	7.918+08	7.918+08	7.918+0A	T.918+08	7.918+0A	7.918+08	7.91E+0A	1.91
DDITIONAL DWT-N	I PER DAY	(DUE TO LA	IGER REPL	ACENERT	SHIPS)				•		1.218+07	1.218+07	1.54E+07	1.548+07	2.60E+07	1.14B+07	3.688+07	4.568+01	5.008+07	6.12E+07	6.12B+07	6.17B+07	6.118
OTAL DEADWEIGHT	TONNE-NAU	TICAL NILES	5 PER DAT	· ·		1.21B+08	1.138+08	7.298+08	7.62B+08	7.618+08	8.03B+08	8.03E+08	8.07B+08	8.07B+08	8.178+08	8.23B+08	8.282+08	8.37B+08	8.418+08	8.52B+08	8.52E+08	8.53B+08	8.59B
LERT AVERAGE TO	NNES OF PU	IEL / 000DW1	1000	NAUTICAL	NIL88	1.86	1.87	1.90	1.83	1.18	1.70	1.69	1.67	1.67	1.63	1.58	1.56	1.49	1.48	1.43	1.43	1.42	1
		BWCV (1988	B1651			100.0	66 K	98.0	101 8	104 4	168 8	100 4	114.4					184.6		184 2		169.0	14/

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Note: It is assumed that vessels are replaced at age 15 years or 1991 if already older. Retimates of fuel consumption were obtained from shipping companies, else from regression equations for tonnes of fuel per OOODWT per day from BTCE database INTSEAS.wki For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

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SOURCES: AUSTRALIAN SHIPPING 1990 and ealier editions, BTCE DATABASE

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## TABLE I.14 INTERNATIONAL SHIPS: 20 YEAR SHIP LIFE, TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING VESSELS

				-	FUEL/DAY			1	ONNES PUE	L / DAY	OF VESSEL	AND RBPL	AC <b>ENENT</b> V	<b>B</b> SSBL									
IANK .	TTPE	DWT	BUILT	BYBRU	(TONNES)	1988	1989	1990	1991	1992	1993	1994	1995	1998	1997	1998	1999	2000	2001	2002	2003	2004	200
USTRALIAN RUBLE	r R0/R0	23450	1975	14.5	54.3	54.3																	
OSTRALIAN PURPO	51 5	122750	1977	15.7	REGR.	75.7	75.7																
RON EESTREL	B	37370	1374	14.0	30.0	30.0	30.0	30.0															
KNO AUSTRALIA	LO/KO/C	22200	1977	13.3	34.5	34.5	34.9	34.5	34.5	34.5	34.9	34.5	34.5	34.5	34.5	32.1	32.1	32.1	32.1	32.1	36.1	42.7	32.
AND REPORTS	10/10/U	£3017	1919	14.9	24.3	24.3	34.3	24.3	19.2	/4 X	19 6	/* E	19.5	19.6	 15 K	19.6	49.5	49 5	49.5	19 5	49 5	12 5	12.
UDINALIA DIAK Referentian adven		34300	1990	13.4	44.0	42.9 En 9	14.0	44.3	46.9	16.0	96.5	46.9	4619	10.0	16.4	1819	42.5	7814	1017	1010	14.0	14.14	101
COLLAGIAN ADVAN		37478	1903	11.4	47 A	67 G	57.6	67 0															
STRACTAR DROCK	70 B	119400	1975	14.0	19 A	79.0	72.0	72.0	12.0	12.0	72.0	72.0	72.0	72.0	12.0	41.8	41.8	41.8	41.8	41.8	41.8	41.8	41.
ISTRALIAN PROSP	10 B	139400	1976	11.0	72.5	12.5	72.5	12.5	12.5	12.5	72.5	72.5	12.5	12.5	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.
USTRALIAN SRARO		9033	1982	17.5	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	21.0	21.0	21.
STRALIAN TRADE	1 0	8450	1978	11.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	12.3	12.3	12.3	12.3	12.3	12.3	12.
USTRALIAN VENTU	R C	39450	1977	18.9	110.5	110.5	110.5	110.5	110.5	110.5	110.5	110.5	110.5	110.5	110.5	43.7	43.7	43.7	43.7	43.7	43.1	43.1	43.
P ACHIEVER	CT	129700	1983	13.5	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	80.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	50.1	50.
.Y.O'CONNOR	G/C	2640	1988	12.1	1.1	6.8	8.8	5.8	8.8														
OWARD SWITE	B	43300	1981	13.8	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	35.3	24.4	24.4	24.4	24.
RON ARNERY	G/C	8362	1973	12.0	12.5	12.5	12.5	12.5															
RON GIPPSLAND	CT	87000	1989	14.0	64.0		64.0	64.0	64.0	84.0	64.0	64.0	64.0	64.0	61.0 .	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.
RON TEMBLA	8	148150	1986	12.5	37.0	31.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	31.0	37.0	37.0	37.0	37.0	37.
RON LIRBY	B	27299	1974	14.0	) 30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.
RON NEWCASTLE	B	148140	1985	12.5	i 37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.
RON PACIFIC	B	231850	1986	11.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.9	38.0	38.0	38.0	38.0	38.
NON SHORTLAND	B	107140	1979	12.5	i 40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	29.3	29.3	29.3	29.3	29.3	29.
ROM SPENCER	B	141475	1981	13.0	) 44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	44.5	41.5	34.7	34.7	34.7	34.
RON WEYALLA	B	141435	1981	13.0	) 43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.6	43.5	43.5	43.5	43.5	43.5	43.5	43.5	34.7	34.7	34.7	34.
IA <b>RXH</b> AN BAY	G/C	2925	1987	12.0	) 8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.
IARY DURACE	C/C	2640	1988	12.3	1.5	1.5	1.5	7.5															
OBIL FLINDERS	CT	149235	1982	15.0	) 15.0	75.0	75.0	75.0	T5.0	75.0	75.0	75.0	15.0	75.0	75.0	75.0	75.0	75.0	15.0	15.0	43.0	43.0	93. 90
IVOSA	CT	124754	1984	13.0	42.6	42.6	42.6	42.6	42.6	42.6	42.8	42.0	42.6	42.0	42.0	42.0	42.0	42.0	92.0	44.0	96.0	46.0	30.
IV SANDERLING	LNG T	12810	1989	11.0	93.0		93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	33.0	99.0	33.0	33.0	33.0	33.0	11 0	94 1	33. 94
WT ALLTRANS	8	35210	1983	14.3	5 33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.U KA A	53.0	33.0 64 A	53.0	54.0	11
TAT BIPRESS	8/C#	41151	1984	16.0	0 04.0	54.0	94.0	54.0	96.0	04.U 45.5	94.0	96.0	94.U 95.5	39.0	94.U 45.K	94.U 96.K	95.0	95.5	95.5	25 5	35.5	25.5	25
TRANZTAS TRAUKR	Ç t Na	14101	1965	19.7	29.0 44 A	29,9	Z9.9	20.0	49.9	49.0	49.9	20.0	29.9	43.9 09 A	69.9 61 A	29.9 01 A	41 G	91.0	93.0	91.0	93.0	93.0	93
NE SALPE	100 0	12610	1999	10.1	r 53.V				33.U 61 A	53.0	53.0	53.0 53.0	53.0 81 A	53.0	53.0 53.0	51.0	53.0	53.0	53.0	53.0	53.0	53.0	53
NUSI BUBBATUVE	С С	40000	1971	18.5	5 53.V				53.0	53.0	53.0	53.0 51 A	59.0	£1 A	61 6	53.0	51.0	53.0	53.0	53.0	53.0	53.0	51
LUST BRUUKANUS	U	1000	1371	19.3				• •	93.0	9910	55.0	53.0	5.0	7 0	7 0	7.0	7.0	1.0	7.0	7.0	1.0	7.0	1
SOBDON PPID	6/C	3400	1990	19.5	a 7.0			7.0	7.0	1.0	7.0	7.0	7.0	7.0	1.0	7.0	1.0	1.0	1.0	7.0	1.0	7.0	1
INCH PLINDERS	0/0 C	17376	1416	15.1	1 12.6				32.6	32.6	32.6	32.6	32.8	32.6	32.6	32.6	32.6	32.5	32.6	32.6	32.6	32.6	32
W SANDPIPER	LNG	72870	1992	1	7 93.0					••••	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93,
IN SHIPE AUST ENDRAVOUR AUST ENDUAANCE PRAME KONECHY SORDOW REID LROM PLINDERS IN SANDPIPER	LNG C C/C C/C C LNG	72870 45500 45500 3400 3400 17370 72870	1990 1991 1991 1990 1990 1990 1992	_	1 19.1 19.1 13.1 13.1 15.1 1	17 93.0 19.5 53.0 19.5 53.0 13.3 7.0 13.3 7.0 15.0 32.6 17 93.0	17 93.0 19.5 53.0 19.5 53.0 13.3 7.0 15.3 7.0 15.0 32.6 17 93.0	17 \$3.0 19.5 53.0 19.5 53.0 13.3 7.0 13.3 7.0 15.0 32.6 17 93.0	17   \$3.0     19.5   \$3.0     19.5   \$3.0     13.3   7.0   7.0     15.0   \$2.6     17   \$3.0	17 93.0 93.0   19.5 53.0 53.0   19.5 53.0 53.0   13.3 7.0 7.0   13.3 7.0 7.0   15.0 32.6 32.6   17 93.0	17 93.0 93.0 93.0   19.5 53.0 53.0 53.0   19.5 53.0 53.0 53.0   13.3 7.0 7.0 7.0   13.3 7.0 7.0 7.0   15.0 32.6 32.6 32.6   17 93.0	17 93.0 93.0 93.0 93.0   19.5 53.0 53.0 53.0 53.0   19.5 53.0 53.0 53.0 53.0   13.3 7.0 7.0 7.0 7.0   13.3 7.0 7.0 7.0 7.0   15.0 32.6 32.6 32.6 32.6   17 93.0 93.0 93.0	17 93.0 93.0 93.0 93.0 93.0   19.5 53.0 53.0 53.0 53.0 53.0   19.5 53.0 53.0 53.0 53.0 53.0   13.3 7.0 7.0 7.0 7.0 7.0   15.0 32.6 32.6 32.6 32.6 32.6   17 93.0 93.0 93.0 93.0	17 93.0 93.0 93.0 93.0 93.0 93.0   19.5 53.0 53.0 53.0 53.0 53.0 53.0   19.5 53.0 53.0 53.0 53.0 53.0 53.0   13.3 7.0 7.0 7.0 7.0 7.0 7.0   15.0 32.6 32.6 32.6 32.6 32.6 32.6   17 93.0 93.0 93.0 93.0 93.0	17 93.0 <	17   93.0   <	17 93.0 <	17   93.0   53.0   <	17   93.0   53.0   <	17   93.0   53.0   <	17   93.0   <	17   93.0   <	17   93.0   <
 , E	BR DAT (CO) BD (1988 B)	ISTANT TASI ASE: CONST	APTER I NT TASE	993) AFTER 1		1344.8 100.0	1447.5 107.6	1385.8 103.1	1396.0 103.8	1389.1 103.3	1482.1 110.2	1482.1 110.2	1474.6 109.7	1474.6 109.7	1444.4 107.4	1345.5 100.1	1335.1 99.3	1325.0 98.5	1325.0 98.5	1295.4 96.3	1255.4 93.4	12	36.6 92.0
REGET TOWN	- NAUTICA	L NILES PEI	DAY	-	•	1.28+08	7.18+08	7.3E+08	7.88+08	7.8E+08	T.98+08	<b>1.92</b> +08	7.9B+08	7.9E+08	T.98+08	T.9E+08	7.9B+08	7.9B+08	7.9E+08	1,9B+08	7.9B+0B	1.98+08	1
RET AVERAGE T	NURS OF PU	KL / 0000W1	/ 1000	NAUTICA	L WILRS	1.87	1.88	1.91	1.84	1.83	1.88	1.88	1.87	1.87	1.83	1.71	1.70	1.58	1.68	1.65	1.59	1.57	
											1117												

Note: It is assumed that versels are replaced at age 20 years or 1992 if already older.

Satimates of fuel consumption were obtained from shipping companies, eise from regression equations for tonnes of fuel per 0000007 per day from BYCE database INYSEAS.wkl For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

APPENDIX II SPREADSHEET MODELS FOR AUSTRALIAN DOMESTIC AND INTERNATIONAL AIRCRAFT FLEETS.

TABLE II.1 REGRESSIONS FOR FUEL CONSUMPTION OF AIRCRAFT

AIRCRAPT TYPB	DATE Nodel First	1991 Nuxbbi Op	FLIGHT AVBRAGE LITRES	LONG RANGB CRUISING SPEED	LITRES PER SEAT KILOWETER	SBAT - KK Per	SBAT NILBS PBR US GALLON	LOG Seat-ek	LOC YEAR INTR -1955	LOG SBATS	LOG Speed	REPLACENEN BSTINATED	T AIRCRAP Seat-am p	T'S Er litre			
	INTRODUCE	SBATS	PBR KK	KNA		LITRE	(SMPUSG)	/LITRE				1990	1995	2000	2005		
. TDUB TIDUDIDA																	
BORTHG 747-200	1972	397	14.32	910	0.036	27.723	65.086	3.322279	2.833213	5.983936	6.813444	33.7	35.6	37.4	39.1	LARGE Regression Output:	
SOEING 747-300	1983	386	14.45	910	0.037	26.713	62.713	3.285142	3.332204	5.955837	6.813444	32.2	34.1	35.8	37.4	Constant 83.17239	
BOBING 747-400	1989	406	13.30	910	0.033	30.526	71.665	3.418589	3.526360	6.006353	6.813444	34.9	36.9	38.8	40.5	Std Err of Y Est 0.180782	
AIRBUS A300-6R	1987	288	5.09	850	0.018	56.582	132.836	4.035682	3.465735	5.662960	6.745236	50.4	53.3	56.0	58.6	R Squared 0.688919	
AIRBUS A300-B4	1975	230	11.17	850	0.049	20.591	48.341	3.024847	2.995732	5.438079	6.745236	35.4	37.5	39.4	41.2	No. of Observations 10	
BOBING 767-300	1986	230	7.30	850	0.032	31.507	73.968	3.450204	3.433981	5.438079	6.745236	5 35.4	37.5	39.4	41.2	Degrees of Preedom 6	
80EING 767-300BR	1988	230	6.78	850	0.029	34.024	79.877	3.527056	3.496501	5.438079	6.145238	35.4	37.5	39.4	41.2		
BOBING 747-SP	1976	313	12.79	900	0.041	24.472	57.453	3.197539	3.044522	5.746203	6.802394	26.9	28.4	29.9	31.2	X Coefficient(s) 0.421951 1.565581 -	-13.2861
30BING 167-200	1982	211	6.19	850	0.032	31.075	72.955	3.436407	3.295836	5.351858	6.745236	31.0	32.8	34.4	36.0	Std Brr of Coef. 0.279985 0.669563 5	5.441263
BOBING 767-2008R	1984	216	6.57	850	0.030	32.877	77.184	3.492764	3.367295	5.375278	6.745236	32.1	34.0	35.7	37.3		
NEDIUM AIRCRAPT																NBDIUM Regression Output:	
508ING 727-200	1966	144	5.76	865	0.040	25.000	58.692	3.218875	2.397895	4.969813	6.762729	28.9	29.4	29.8	30.2	Constant 9.985463	
90BING 737-400	1988	146	4.42	800	0.030	33.032	17.548	3.497466	3.496507	4.983606	6.684611	32.8	33.3	33.8	34.2	Std Err of Y Est 0.021146	
AIRBUS A320	1988	132	4.17	850	0.036	27.573	64.968	3.320455	3.496507	4.882801	6.745238	5 28.2	28.6	29.0	29.4	R Squared 0.998292	
BOBING 737-300	1984	109	4.05	795	0.037	26.914	63.185	3.292631	3.367295	4.691347	6.678342	27.7	28.1	28.5	28.9	No. of Observations 5	
909	1965	92	5.55	950	0.060	16.577	38.917	2.807990	2.302585	4.521788	6.856461	19.2	19.5	19.8	20.0	Degrees of Preedom 1	
																I Coefficient(s) 0.120633 0.606477 -	-1.48817
-							,									Sto BFF 01 Cdel. 0.030329 0.004050 0	1.203331
SHALL AIRCAAFT	1981	75	1 13	690	0.055	18,160	12 614	2 899210	3.132204	4.317488	6.536691	19.1	19.4	19.7	19.9		
P38-1000	1978	72	1 54	655	0.049	20.119	47.750	3.012539	3.135494	4.276666	6.484635	20.8	21.2	21.5	21.8		
720-1000	1958	50	2.00	470	0.040	25.000	58.692	3.218875	1.098612	3.912023	6.152732	33.7	34.3	34.8	35.2	SKALL Regression Output:	
F50	1986	50	1.33	445	0.027	37.594	88.259	3.626844	3.433987	3.912023	6.098074	38.2	38.0	39.4	39.9	Constant 14.18036	
CASE 8	1984	37	1.39	467	0.038	26.619	62.492	3.281614	3.367295	3.610917	6.146329	27.2	27.6	28.0	28.4	Std Brr of Y Est 0.034978	
																R Squared 0.996109	
																No. of Observations 5	

Degrees of Freedom

1

X Coefficient(s) 0.120920 0.762259 -2.28742 Std Err of Coef. 0.019038 0.134194 0.194492

XOTE: Fuel efficiency may vary considerably within a particular type. For example, the newer versions of the Boeing 147-200 are about 20% more fuel efficient than some of the older examples of the aircraft.

SOURCES: AEROCOST, AN AIRCRAFT COSTING MODEL:OPERATING MANUAL (BTCE 1990) LLOYD'S AIRCRAFT TYPES & PRICE GUIDELINES 1990-91, Dotac

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#### DOMESTIC AIRCRAFT: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT, 15 YEAR TABLE II.2 ł ECONOMIC LIFE

	rend		RELY TH	(I)?.TY							1454											
TTPE	BOILT	SELTS	PER LITRE	PER YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
A100-200	1980	210	20.6	3.348+08	20.6	20.6	10.6	10.6	20.6	20.5	20.6	20.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
A300-200	1981	230	20.6	3.348+08	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	56.6	56.6	56.6	56.6	56.5	56.6	56.6	56.6	56.6
A300-200	1982	230	20.6	3.34B+08	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.5	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.5
A300-200	1982	230	20.6	3.346+08		20.6	20.6							•• •		•• •						
A300-6008	1990	200	36.6	4.188+08			38.8	58.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
AJOD-BUUR	1990	285	38.8	4.186+08			36.6	38.8	36.6	56.6	38.6	56.5	56.6	36.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
¥300-POOK	1990	288	36.6	4.181+08				38.8	56.6	56.8	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	58.6	56.6	56.6	56.6
A300-600K	1990	288	36.6	4.188+08				38.8	38.8	36.0	35.6	28.6	36.6	38.6	36.6	36.5	58.5	36.6	36.6	56.6	56.6	56.6
VICO-POCK	1990	288	36.6	4.106+08				30.0	36.0	38.0	30.0	36.6	38.8	39.6	36.6	36.8	38.8	38.8	36.6	38.6	36.6	54.5
A310	1770	(11	91.3	3.036106				41.1	41.3	41.3	11.3	11.3	<b>11.3</b>	91.5	91.J	11.3	\$1.J	<b>41.3</b>	41.3	\$1.5	41.3	41.3
1140	1760	132	41.1	1.14540		21.1	41.1	17.7	47 7	41.1	21.1	11.1	21.1	21.1	11.1	41.1	21.1	11.1	21.1	11.1	29.3	29.3
A320	1000	111	21.1	1.145400		17 7	21.1	21.1	41.1	41.1	27.7	21.1	41.1	41.1	41.7	21.1	11.7	17.1	21.1	11.1	29.3	13.3
A320	1707	117	21.1	1 148408		27.7	27 7	41.1	27.1	21.1	21.1	41.1	41.1 97 T	37 1	11.1	21,1	11.1	47 7	27.7	41.1	27.7	43,3
1170	1489	112	21 1	1 142+08		21 1	21 1	27.7	27 7	37 7	27 7	27 7	27 1	27.7	27 7	27 1	27.7	17 7	21.7	27.7	27.7	27.2
1120	1989	112	27.7	1 148+08		27 1	27 7	27.7	27 7	27 7	27 7	21 1	27 1	27 7	17 7	27 7	21.1	27 T	37.7	21 1	27.7	16 0
1176	1484	112	27 7	1.148+08		27.7	27 1	17 1	21 7	27 7	77 7	97 7	97 7	27 1	37 7	27 7	17 7	27.7	21 7	37 1	27.7	10.J
1170	1989	132	27.7	1.148+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	21.1	21.1	27 7	11.1	27.7	27 1	27.7	27.7	27 1	29.5
1320	1989	112	21.1	1.148+08		•••••	••••	27.7	27.1	27.7	27.7	27.7	27.7	27.7	27.1	27.7	27.7	27.1	21.1	21.7	11.1	11.5
1170	1989	112	21.7	1.148+08				11.1	21.1	27.7	27.7	27 3	27 7	27 7	27 7	17.7	27.7	77 7	27 7	27 1	27 1	24 5
1320	1989	132	21.7	1.148+08				11.1	27.7	27.7	21.1	27.7	27.7	27.1	27.7	27.7	11.7	27.7	27.7	21.1	27.1	29.5
RAE146-20	1985	75	18.2	1.648+08	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.7	18 7	18 2	18.2
848146-20	1985	75	18.2	1.648+08	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2
BAE146-20	1988	15	18.2	1.642+08		18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2
BAE146-20	1988	15	18.2	1.641+08		18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2
BA2146-20	1989	75	18.2	1.648+08		18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18,2	18.2	18.2	18.2	18.2
BAT146-30	1990	96	22.5	2.18K+08				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
DAX146-30	1990	96	22.5	2.18 <b>E</b> +08				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
BAR146-30	1990	96	22.5	2.185+08				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
BAK146-30	1990	96	22.5	2,188+08				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
BAB146-30	1990	96	22.5	2.18E+08				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
121-200 C	1972	144	25.0	2.972+08	25.0																	
727-200 C	1973	144	25.0	2.97 <b>6</b> +08	25.0																	
727-200 C	1974	144	25.0	2.978+08	25.0																	
721-200 C	1974	144	25.0	2.978+08	25.0																	
727-200 C	1974	144	25.0	2.978+08	25.0	25.0																
727-200 C	1974	144	25.0	2.976+08	25.0	25.0	25.0	25.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0
121-100 C	1975	144	25.0	2.918+08	25.8	25.0	25.0	25.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0
727-200 C	1975	144	25.0	2.978+08	25.0	25.0	25.0	25.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0
727-200 C	1976	144	25.0	2.915+08	25.0	25.0	25.0	25.0	33.0	13.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0
727-200 C	1976	144	25.0	2.538408	15.0	25.0	15.0	25.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0
727-200	1978	144	25.0	2.971+08	25.0	25.0	25.0	25.0	25.0	25.0	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2
121-200	1979	144	23.0	2.3/5tU8	13.U 95.A	43.U 25.A	23.0	23.U 25.0	43.U 15.A	43.0	13.Q	33.J	33.3	33.3	11.3	11.1	11,1	11.3	11.3	JJ.]	11.3	13.3
121-200	1313	144	23.U 15.A	2.3/6+98	15.0	13.0	13.V 95 A	13.0	12.0	13.0	13.0	33.5	33.3	13.1	33.3	33.3	13.3	33,3	33.3	33.3	33.3	33.3
121-200	17/7	144	43.U 95.A	2.3/8+U8 2.87#L04	43.V 16.A	15.0	13.V 15.A	15.U 15.A	23.U 25.6	23.U 25.A	23.0	JJ.J 11 1	JJ.J 77 7	33.J 11 1	33.3	11.1	33,3	JJ.J	11.J	JJ.]	33.3	13.3
727.200	1373	144	25.0	2.312100	23.U 15.A	15.U 15 A	23.0	23.V 95.A	23.V 95.A	43.U 95.0	19.V 16.A	11.1	11.1	33.3 31 7	11.1	11.1	11.1	33.3	33.3 77.7	33.3 11 1	33,3	JJ.J 11 1
777.780	1980	111	23.V 25.A	2.714744	25.0	25 0	25.0	25.0	13.V 25.A	15.V 25.A	25 A	33.3 25 A	11 1	11 4	23.3	11 4	33.J 11.4	11 /	11 /	11 4	33.3	11.1
721_766	1690	117	25.0	2.378700	25.0	15.0 15 A	75 A	25.V 25 A	25 A	25 A	25.V 75.A	25.V 25.A	11 1	17 4	11 4	11 1	19 1	19.9	11 1	11 /	11.1	33.9
727.700	1981	1//	25.0	2 972404	25.0	25.0	15 B	25.0	25.0	25.0	25.0	25.6	JJ. T 25 0	11 5	11.5	33.5	11.1	יד. 11 ג	11.1	11.1	11.5	11.1
121-200	1001	111	25 6	2 412168	25 A	25.V	25 A	25 A	25.0	75 A	75 A	25.0	25 A	11 4	11 5	11.5	11 6	11 5	11 6	11 6	11 6	11 1

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TABLE II.2 (cont)

## DOMESTIC AIRCRAFT: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT, 15 YEAR ECONOMIC LIFE

1	717.788	1681	144	75 A	2 978+08	25.0	25.0	25.0	25.0	25.0	25.9	25.0	25.0	25.0	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5
2 2	111 100	1901	111	25.0	2 878408	75 0	25.6	25 0	25.0	25.0	25.0	25.0	-25.0	25.0	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5
ŵ	121-200	1301	111	63.V	5.778700 3.178108	5J.V 96 B	26.8	96.8	76.0	16-6	26.8	26.6	26.6	26.4	76 9	26.9	26 9	26.4	26.9	34.0	34.0	34.0	34.0
	131-300	1906	103	49.7	6.1767VG	44.7	40.3	20.7	20.2	10.5	76.8	16 6	16 5	16.6	76 9	76 9	26.4	26.9	26.4	34.0	34.0	16.0	34.0
	131-300	1980	109	0.7	2.115700	4.5	40.7	40.7	40.7	40.7	40.7	20.7	20.7	26.0	26 8	26.4	26 8	76.9	26.4	34.0	14.0	14.0	34.6
	737-300	1366	109	Z6.9	2.1/6+08	20.3	20.7	49.7	(1.7	41.7	20.3	40.7	20.7	40.3	20.3	76 0	26.0	76.0	76 9	34.0	14.0	36.0	34.0
	737-300	1986	109	26.9	2,175+08	26.9	26.9	26.9	24.7	20.7	26.9	20.7	41.7	40.3	40.7	20.3	40.3	26.0	20.5	14.0	14.0	34.0	14.0
	737-300	1986	109	26.9	2,178+08	26.9	26.9	26.9	26.9	76.9	26.9	26.9	20.5	26.5	20.3	40.3	10.5	40.7	20.7	39.0 14 A	34.0	14.0	14.0
	737-300	1986	109	26.9	2.171+08	26.9	26.9	26.9	26.9	26.9	26.9	24.9	26.9	20.7	49.7	40.7	20.7	20.7	10.3	34.0	34.0	34.0	14.0
	737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	24.9	26.9	48.7	24.7	29.7	40.7	40.7	20.7	34.0	34.0	28.0	24.0
	737-300	1986 -	109	26.9	2.176+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	.26.9	. 20.9	20.7	20.3	20.7	34.0	39.0	34.0	34.0
	737-300	1986	109	26.9	2.175+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.0	-34.0	34.0	34.0
	737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.0	34.0	34.0	34.0
	737-300	1986	109	26.9	2.171+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.0	34.0	34.0	34.0
	737-300	1986	109	26.9	2.17E+08	26.5	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.0	34.0	34.0	34.0
	737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.0	34.0	34.0	34.0
	737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.0	34.0	34.9	34.0
	737-300	1986	109	26.9	2.175+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.0	34.0	34.0	34.0
	737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.0	34.0	34.0	34.0
	737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.0	34.0	34.0	34.0
	737-300	1986	109	26.9	2.175+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.0	34.0	34.0	34.0
	717-100	1986	109	25.5	2,178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.0	34.0	34.0	34.0
	737-300	1986	109	26.9	2.178+98	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.0	34.0	34.0	34.0
	717-100	1986	184	26.4	7.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.0	34.0	34.0	34.0
	737-100	1887	108	26.6	9 178108	26.4	26.6	76.9	26.9	26. 9	26 4	26.4	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.1	34.1	34.1
	111-200	1707	107	20.7	1 178100	14 1	20.5	26.9	26.9	26.4	26.4	76 4	26.9	26.9	26.4	26.9	26.9	26.9	26.9	26.9	34.1	34.1	34.1
	131-300	1707	108	16.0	5 178400	16.6	26.6	26.9	76 9	76.9	26 4	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.1	34.1	34.1
	131-300	1301	105	26.8	2.176740 9.178488	16.4	- 26 8	26.6	26.9	26 4	76.9	76. 4	26.9	26.9	26.4	25.1	26.9	26.9	26.9	26.9	26.9	34.1	34.1
	737-300	1700	107	49.3	1.178-00 1.178-00	44.5	44.5	20.0	20.5	26.5	26.9	76.0	26.4	76 9	76 4	26.9	26.4	26.9	26.9	26.9	26.9	34.1	34.1
	737-300	1700	143	40.) 20 A	1 178-68		20.3	26 6	26.0	26.5	26.6	26.0	26.9	26. 4	76.9	76.9	26.9	26.9	26.9	26.9	26.9	34.1	34.1
	131-300	1300	107	20.5	2.1/BTU0 9.179.65		20.7	20.3	20.3	26.9	26.9	26.9	76.9	76 1	26.4	26.9	26.9	26.9	26.9	26.9	26.9	34.1	34.1
	131-300	1300	105	20.7	2.1/2700		20.5	20.7	20.5	26.5	26.4	76.9	76.9	26.4	26 9	26.9	26.9	26.9	26.9	26.9	26.9	34.1	34.1
	131-300	1848	100	20.3	2.178.08		26.4	26.6	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	34.2
	737-300	1707	108	16.4	2.175700		16.4	26.0	26.9	26.9	76.4	26.4	26.9	76.9	26.9	26.4	26.9	26.9	26.9	26.9	25.9	26.9	34.2
	131-300	1989	103	20.7	2.1/5+05		48.3	10.7	31 0	20.3	11 0	11 8	11 0	11 0	11 0	33.6	11 0	11.0	33.0	33.0	33.0	33.0	33.0
	/3/-400	1990	149	33.0	2.716100			33.0	33.0	33.0	11 0	11 6	33.0	11 0	33.0	11 0	33.0	11 8	11 0	33.9	33.0	33.0	33.0
	737-400	1990	140	33.0	2.916+08			33.0	33.0	33.0	33.0	22.0	33.0	11 0	11 6	11 0	13 0	11 0	11 0	33.0	33.0	33.0	33.0
	131-400	1770	199	33.0	2,714+06			33.0	13.0	33.0	33.0	33.0	33.0	23.0	33.0	11 0	33.0	11 0	11 0	11.0	33.0	31.0	33.0
	131-400	1990	146	33.0	2.915+08			33.0	33.0	33.0	33.0	33.0	33.0	11.0	33.0	11 1	19 6	39.0	39.0	19 6	39.0	39.0	39.0
	167-200	1985	211	31.1	9.001100	31.1	31.1	31.1	31.1	31.1	91.1	11 1	11 1	11 1	11 1	11 1	18 1	19 6	19 0	19 0	19.0	39.0	39.0
,	767-200	1983	211	31.1	4.005+08	11.1	31.1	31.1	31.1	31.1	31.1	21.1	11 1	21.1	11 1	11 1	39.0	19.0	10 0	39.0	19 6	19.0	39.6
	767-200	1983	211	31.1	4.00E+08	31.1	31.1	31.1	31.1	31.1	31,1	31.1	11 1	11 1	11 1	11 1	14 0	19 0	39.0	19 0	39.0	39.0	39.0
	161-200	1303	411	31.1	4.001+00	31.1	31.1	31.1	31.1	31.1	31.1	11.1	11 1	11 1	11 1	11 1	11 1	19 4	19.4	39.4	39.4	39.4	19.4
	767-ZQU	1784	211	31.1	4.006+08	31.1	31.1	11.1	31.1	31.1	11.1	31.1	31.1	31.1		4111		•//	•// 1	••••	••••	••••	••••
	DCY		"	10.0	1.3/6+90	19.9	10.0																
	BCY		"	10.0	1.3/6700	10.0	10.0																
	DC9		21	16.6	1.3/8408	10.0																	
	DC9		92	16.6	1.3/8+08	10.4																	
	DCY		92	16.6	1.378408	16.6																	
	127	1959	50	25.0	3.328+07	25.0	25.0																
	127	1966	50	25.0	3.328+07	Z5.0	Z5.0																
	227	1966	50	25.0	3.328+07	25.0	25.0																
	127	1968	50	25.0	3.328+07	25.0	25.0														-		
	127	1976	50	25.0	3.328+07	25.0	25.0																
	127	1981	50	25.0	3.328+07	25.0	25.0																
	227	1981	50	25.0	3.328+07	25.0	25.0																
	127	1984	50	25.0	3.328+07	25.0	25.0																
	127		50	25.0	3.328+07	25.0	25.0																
	227		50	25.0	3.328+07	25.0	25.0																
	127		50	25.0	3.325+07	25.0	25.0																

TABLE	11.2	(cont)
TUDUC		(CONC)

DOMESTIC AIRCRAFT: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT, 15 YEAR ECONOMIC LIFE

ASE (AVAIL INDEE OF P TASE (HILL INDEE OF T LOAD FACTO INDEE OF R	ABLE STAT- LEET FUEL ION PASSEN ASE (1988 R UEL USED (	EN) EPFICIER (GERS] DASE) 1988 DAS	CY (1988 B) B)	ISE }	1.98+10 100.0 14.3 100.0 0.774 100.0	1.98+10 -100.7 10.4 12.7 0.742 75.3	2.18+10 105.1 12.9 90.2 0.716 92.8	2.328+10 108.8 16.7 116.8 0.746 111.3	2.328+10 110.8 14.5 101.4 0.74 95.7	2.328+10 110.8 15.3 107.0 0.74 101.0	2.328+10 111.2 16.1 112.6 0.74 105.9	2.328+10 : 113,2 16.8 117.5 0.74 108.5	2.328+10 2 115.5 17.5 122.4 0.74 110.8	2.328+10 : 118,8 18,2 127,3 0.74 112,1	2.328+10 120.4 18.9 132.2 0.74 114.8	2.328+10 122.1 19.5 136.4 0.74 116.8	2.328+10 122.7 20.1 140.6 0.73 121.4	2.328+10 122.7 21.0 146.9 0.73 126.9	2.328+10 128.7 21.9 153.1 0.73 126.2	2.328+10 129.7 22.8 159.4 0.73 130.4	2.328+10 131.3 23.7 165.7 0.73 133.0	2.328+10 132.4 24.6 172.0 0.73 137.8
TRIGHTED A	VERAGE SEA	1-RE/L (	reighted by	seat-kn perfor	24.8	25.0	26.1	27.0	27.5	27.5	27.6	20.1	28.6	29.4	29.8	30.3	30.4	30.4	31.5	32.1	32.6	32.8
150	1987	50	37.6	4.308+07 2.698+10	17.6																	
150	1987	50	37.6	4.308+07	37.6																	
750	1987	50	17.4	4.308+07	37.6			••	*,,*		••	•,,•		••	•,••		•				••••	•
P50	1987	50	17.6	4.308+07	17.6		37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	17.6	37.6	37.6	39.7	39.7	39.7
230	1987	50	11.6	4 162+67	17.6	31.0	37.4	17.6	37.6	17.6	17.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	31.7	19.7	39.1
23V 866	1987	20 5A	11.0	4.JUB#V/ 4 109±07	37.6 17.6	J/.0 17.6	31.0	37.0	37.0 17.6	J/.8 17.0	37.b 17.6	J/.4 17 £	27.0 17.6	37.0	J1,0 17 6	37.0 17.6	37,6 17.6	17.6	17.0	37.1	11.1	37.7
750	1987	50 50	37.6	4.JUE+07	37.6 11.4	37.6	37.6	J/.5 17.4	37.6	J7.0	3/.6	JJ.6 11 C	37.6	31,6 21 C	17.6 17.6	17.6 17.6	37.6 17.4	37.0	17.6	39.7	19.7 14 1	33.7
750	1987	50	17.6	4.308+07	11.6	17.6	37.6	37.6	37.6	17.6	37.6	37.6	37.6	37.6	37.6	37,6	37.6	17.6	37.6	39.7	39.7	39.1
P50	1987	50	37.6	4.30X+07	17.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	39.7	39.7	39.7
728-4000	1984	72	20.3	1.158+08			20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	21.5	21.5	21.5	21.5	21.5	21.5
728-4000	1984	72	20.3	1.158+08	20.3		20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	21.5	21.5	21.5	21.5	21.5	21.5
728-4000	1984	12	20.3	1.158+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20,3	21.5	21.5	21.5	21.5	21.5	21.5
728-4000	1983	11	20.3	1.158+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	21.4	21.4	21.4	21.4	21.4	21.4	21.4
728-4000	1983	12	20.3	1.158+08	20.3	20.3	20,3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	21.4	21.4	21.4	21.4	21.4	21.4	21.4
P28-4000	1982	12	20.3	1.158+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4
728-4000	1979	12	20.3	1.152+08	20.3	20.3	20.3	20.3	20,3	20.3	20,3	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2
728-3000		72	20.3	1.152+08	20.1	20.1	20.1															
20-1000 279_3000		12	20,3	1.136700 1 158408	20.3	20.1	28 1															
F25-1000		12	20.J 20.1	1,136400	20.3																	
728-1000	1971	72	20.3	1.158408	20.3	20.3	20.3	20.3	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
728-1000	1970	12	20.3	1.155+00	Z0.3	20.3	20.3	Z0.3	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
728-1000	1970	12	20.3	1.158+00	20.3	20.3	20.3	20.3	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
728-1000	1970	72	20.3	1.158+08	20.3	20.3	20.3	20.3	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
728-1000	1969	12	20.3	1.158+08	20.3	20.3	20.3	20.3	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
727		50	25.0	3.326+07	25.0																	
127		50	25.0	3.328+07	25.0						,											
121		50	25.0	3.328+07	25.0																	
121		50	25.0	3.328+07	25.0																	
#2T		50	25 A	3 328+07	25.0	13.0																
#23		50	25.0	3 378+07	25 0	25.0																
247 897		50	2J.V 25.A	3 119461	55.0	23.0 35 A																
#11		56	75 6	1 128407	25 A	25 A																

1078: Aircraft replaced at 15 years or 1992 earliest. 727-200 replaced by 737-400; 767-200 replaced by 767-300; 737-300 replaced BT 737-400; A300-200s by A300-600s; BAX 146-200s by BAX146-300s A310 skm/l by proportion on number of seats from A300-600R

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SOURCES: DORESTIC AIRCRAFT UTILISATION (various years), AEROCOST, SUBETRAN (1984)

TABLE II.3

DOMESTIC AIRCRAFT: 1990 SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT

	TRAP		AVBRAGE SRAT EK	TYPE AVGE SEAT-EN			5	KAT-LLLON	BTERS PER	LITRE OF	POBL											
TPB	BUILT	SBAT8	PBR LITRE	PER TEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1994	1999	2000	2001	2002	2003	2004	20
300-200	1980	230	20.6	3.348+08	20.8	20.6	20.6	20.6	20.6	20.6	20.6	20.6	56.6	56.5	56.6	58.6	56.6	56.6	56.6	56.6	56.6	56
100-290	1861	230	- ZU.6	3.348+08	20.8	-29.6	20.0	20.5	20.6	20.6	20.5	20.8	20.6	56.6	56.6	56.6	56,6	56.6	58.6	56.5	. 56.6	56
00-200 -	1982	230	20.0	3.345+08	20.0	20.0 90 K	20.0	ZU.0	2U.9	20.6	Z0.8	20.6	Z0.6	20.6	b8.5	56.8	55.6	\$6.6	55.5	56.5	56.6	56
00-600R	1990	288	56.6	4.18R+08			56.6	58.6	56.6	58.8	58.8	58.6	56 6	56 <b>6</b>		56 6	55 6	56 <b>6</b>	56 <b>6</b>	56.6	56 5	56
00-600R	1990	288	56.6	4.188+08			56.6	58.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	50.0	56.6	56.6	56.6	5/
00-600 <b>r</b>	1990	288	58.6	4.18B+08				58.6	56.6	58.8	56.6	56.6	56.6	55.5	56.6	56.6	56.6	56.6	56.6	56.6	56.8	5
00-600R	1990	288	56.6	4.18 <b>6</b> +08				58.8	56.6	56.6	56.6	58.6	56.6	58.6	56.6	56.6	56.6	56.6	56.6	55.6	56.6	5
0-400R	1990	288	56.6	4.18E+08				56.6	56.6	56.6	58.6	56.6	58.6	58.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	5
10	1990	210	41.3	3.058+08				41.3	41,3	41.3	- 41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	- 41.3	41.3	41.3	- 4
20	1988	132	27.7	1.148+08		27.7	27.1	27.1	21.1	27.7	27.7	27.7	21.1	27.7	27.7	27.7	27.7	27.1	27.7	27.7	27.1	2
20	1988	112	27.7	1.148+08		21.1	21.1	27.7	27.7	21.1	27.7	27.7	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	2
2V 90	1959	132	27.1	1.148+08		27.7	27.7	21.7	21.1	27.7	21.1	27.7	21.1	21.1	27.7	27.7	21.1	27.1	27.1	27.7	21.7	2
20	1010	136	37 7	6.14B7V8 1 1484Å8		44.4	47.4	49.9	49.9	61.1	47.7	41.1	21.1	21,1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	2
20	1989	119	27.7	1 148408		99.9	- 4111 - 97 - 7	99.9	99 9	99 9	97 7	99.9	99.9	49.9	49 9	47.7	44 4	44.4	44 4	44.4	41.1	-
20	1989	132	21.1	1.148+08		27.1	29.7	27.7	27.1	27.7	27.1	27.7	97 7	57 7	57 9	49.9	61.1 97 7	41.1	49 9	49.9	49 9	4
0	1989	132	27.1	1.148+08		21.7	21.1	21.1	21.1	27.7	21.1	21.1	27.1	27.7	21.1	27.1	97.7	97 7	57 7	99.9	99 9	
20	1989	132	21.1	1.148+08		••••	••••	27.1	27.1	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	21.1	27.7	27.7	
0	1989	132	21.1	1.148+08				21.1	27.7	21.1	27.1	21.1	21.1	21.1	21.1	21.1	21.7	21.1	21.1	21.1	27.7	
10	1989	132	27.7	1.148+08				21.1	21.1	27.7	21.1	27.7	21.1	21.1	27.7	21.1	27.7	27.7	27.7	27.7	21.1	į
3146-20	1985	15	18.2	1.542+08	18.2	18.2	18.2	18.2	10.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	22.5	22.5	22.5	22.5	ļ
146-20	1985	15	18.2	1.648+08	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	22.5	22.5	22.5	22.5	
8146-20	1988	75	18.2	1.642+08		18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	22.5	
146-20	1988	15	18.2	1.648+00		18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	22.5	;
8146-20	1989	75	18.2	1.648+08		18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	1
B146-30	1990	96	22.5	2.18E+08				22.5	22.5	22.5	22.5	12.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
<b>K</b> 146-30	1990	96	22.5	2.18 <b>K</b> +08				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	1
146-30	1330	30	22.5	5.18R+08				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
5146-90 2146-90	1990	50	66.9 44 5	2.10ETV0				22.3	22.3	22.9	22.5	22.5	22.9	22.5	22.5	22.9	22.5	22.5	22.5	22.5	22.5	
5140~30 5.966 C	1979	144	26.J 95 A	5.105700 9 87P+08	16.0			66.0	64.3	44.3	22.3	22.9	22.3	22.9	22.9	22.0	22.5	22.5	22.5	22.5	ZZ.\$	
-200 C	1671	144	25.0	5 978108	55.0																	
-200 C	1974	144	25.0	2.978+08	25.0																	
-200 C	1974	144	25.0	2.978+08	25.0																	
-200 C	1974	144	25.0	2.978+08	25.0	25.0																
-200 C	1974	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	
-200 C	1975	144	25.0	2.91B+08	25.0	25.0	25.0	25.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	
-200 C	1975	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	:
-200 C	1976	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	:
-200 C	1976	144	25.0	2.97B+08	25.0	25.0	25.0	25.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	
-200	1978	144	25.0	2.978+08	25.0	25.0	25.0	25.0	25.0	25.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	31.0	
-200	1979	144	25.0	2.978+08	25.0	25.0	25.0	25.0	25.0	25.0	26.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	
1-ZUÜ	1979	144	Z9.0	Z.978+08	25.0	23.Ū	Z9.0	25.0	25.0	Z5.0	25.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	1
1-200	1913	144	23.0	2.3167U8 9 840.04	20.0	20.0	20.U 96 A	29.0	20.0	29.0	20.0	33,0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	
1~6UU 9_900	1313	144	40.V 46 A	6.3/81U0 9 090.04	49.V 96 A	20.U 45 A	23.V 45.A	29.U 95 A	20.V	25.0	29.V 95 A	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	
1-6VV 7900	1980	144	47.V 98 A	2.3(BTV8 9 672404	47.U 95.A	27.V 95 A	49.V 96.A	49.V 96 A	27.0	49.0	49.V 95 Å	JJ.V 96 A	33.U 99.A	33.0	33.0	33.0	33.0	33.0	33.0	12'0	33.0	3
7-200	1000	114	25 0	5.978400 5.978468	25 A	25 6	26 A	25.0	25.0	25 6	25.0	95 A	11 0	11 A	11 1	33.U 11 A	33.U 19 A	33,U 99 A	33.U 11 A	JJ.U 34 A	33.U 99 A	1
7-200	1981	111	25.8	2.972101	25 0	25 0	25 N	25 A	26 A	25 6	15.V 15 0	25 6	96 A	11 0	33.V 11 A	33.0 11 A	99.V 99 A	33.0 11 A	33.4 19 A	JJ.U 11 A	13.V 19 A	
	1401		50.V	9 878408	16 6	45.0	45 A	46 6	46.4	63.V 95 A	46 6	46 4	69.V AR A	44.4	44.4	88.V	39.0	99.4	- 99°A -			

TABLE	II.3	(cc	ont)	DOMES	FIC	AIRCR	AFT:	1990	SPE	CIFIC	FUEL	, co	ONSUME	TION	FOR	REPI	ACEM	ENT	AIRCF	AFT		
727-200	1981	144	25.0	2.97B+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.0	33.0	33.0	33.0	33.0	31.0	33.0	33.0	33.0
727-200	1981	144	25.0	2.978+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0
131-300	1986	109	26.9	2.172+08	26.9	26.9	26.9	26.9	28.9	26.9	26.9	26.9	28.1	26.9	26.9	26.9	26.9	26.9	33.0	33.0	33.0	33.0
737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	28.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	33.0	33.0	33.0	33.0
737-300	1986	109	26.9	2.17E+08	26.9	26.9	26.9	26.9	26.9	28.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	33.0	33.0	33.0	33.0
737-300	1985	109	26.9	2.17B+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	16.9	26.9	26.9	26.9	26.9	33.0	33.0	33.0	33.0
131-300	1788	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	33.0	33.0	33.0	33.0
131-300	1986	103	20.9	2.11B+V8 9 190:00	20.9	28.9	20.9	20.9	25.3	26.9	25.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	33.0	33.0	33.0	33.0
137-300	1986	109	26.9	4.1784V0 9 178408	10.3 16 0	20.3	40.3 94 4	20.3 98 A	20.3	20.3 96 g	28.9	20.9 46 A	20.9	20.9	26.9	26.9	26.9	26.9	33.0	33.0	33.0	33.0
131-300	1986	109	26.9	2.178+08	28.9	26.9	26.9	20.3	26 4	20.3	58 9	40.J 96 Q	20.3	20.3 96 g	20.9 98 0	30.3 96 0	20.3	20.3	33.0	33.0	33.0	33.0
131-300	1986	109	26.9	2.17E+08	26.5	26.5	26.9	26.9	26.9	26.9	28.9	26.9	26.4	26.9	26.9	20.3	58.9	36 9	11 0	11 0	11 0	33.0
737-300	1986	109	26.9	2.178+08	26.9	28.9	26.9	28.9	26.9	28.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	28.4	33.0	11 0	11 0	11 0
137-300	1986	109	26.9	2.17E+08	26.9	26.9	25.9	26.9	26.9	25.9	26.9	26.9	26.9	26.9	26.9	26.9	25.9	26.9	33.0	33.0	33.0	33.0
137-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	33.0	33.0	33.0	33.0
131-300	1986	109	26.9	2.17B+08	26.9	26.9	26.9	26.9	26.9	26.9	25.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	33.0	33.0	33.0	33.0
737-300	1985	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	28.9	26.9	26.9	26.9	26.9	26.9	33.0	33.0	33.0	33.0
131-300	1986	109	26.9	2.178+08	26.9	26.9	26.5	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	33.0	33.0	33.0	33.0
131-300	1986	109	20.9	2.178408	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	25.9	26.9	33.0	33.0	33.0	33.0
117-300	1996	100	20.3	2.178408	20.3	20.9	28.9	26.9	26.9	26.9	26.3	26.9	26.9	26.9	26.9	26.9	26.9	26.9	33.0	33.0	33.0	33.0
717-300	1986	100	20.3	1 17P+00	16 4	20.3	10.7	18 0	20.7	28.7	20.3	20.9	26.9	26.9	26.9	26.9	26.9	26.9	33.0	33.0	33.0	33.0
111-100	1946	109	26.9	5 178+08	26.9	20.2	96 0	10.J 76 Q	44.J 96 g	40.J 92 G	14 4	49.3 96 A	49.3	20.3	20.9	20.3	24.9	20.3	33.0	33.0	33.0	33.0
737-300	1987	109	26.9	2.178+08	26.1	26.1	26.9	24.9	20.3	26.4	20.7	10.7	20.3	16 4	20.3	46 0	20.9	20.3	33.U 98.0	33.0	33.0	33.0
737-300	1987	109	26.9	2.178+08	26.9	26.9	26.9	26.9	28.9	26.9	28.9	26.9	24.1	26.9	28.9	26.9	20.9	26.9	20.3 9 36	11 0	11 0	33.0
737-300	1987	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.5	26.9	26.9	26.9	26.9	26.9	26.9	26.9	33.0	31.0	31.0
131-300	1988	109	26.9	2.178+08	26.9	25.9	26.9	26.9	26.9	26.9	26.8	26.9	26.9	28.9	26.9	26.9	26.9	26.9	26.9	26.9	33.0	11.0
737-300	1988	109	26.9	2.17B+08		26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	33.0	33.0
137-300	1988	109	26.9	2.17B+08		28.9	2	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	33.0	33.0
131-300	1988	109	26.9	2.17B+08		26.9	28.9	26.9	26.9	26.9	26.9	26.9	26.9	26.5	26.9	26.9	26.9	26.5	26.9	26.9	33.0	33.0
131-300	1988	109	26.9	2.178+08		26.9	26.9	28.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	33.0	33.0
131-300	1989	109	20.3	2.17K+98		26.9	28.9	26.9	26.9	26.9	26.3	26.9	28.9	24.9	26.9	26.9	28.9	26.9	26.9	26.9	26.9	33.0
111-408	1990	146	11.0	3 618468		40.3	11 0	11 0	11 0	11 0	11 6	11 6	48.3	48.9	20.9	28.9	20.9	20.9	26.3	26.9	26.9	33.0
737-400	1990	146	33.0	2.918+08			11.0	33.0	33.0	33.0	33.0	31.0	33.0	33.0	11 0	11 0	33.0	33.0	33.0	33.0	33.0	33.0
131-400	1990	146	33.0	2.918+08			33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	11 0	11 0	11 0	11 0	11 0	33.0	11 0	11 6
737-400	1990	146	13.0	2.918+08			33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	31.0	33.0	11.0	33.0	11 0	11 0
167-200	1983	211	31.1	4.008+08	31.1	31.1	31.1	31.1	\$1.1	31.1	31.1	31.1	31.1	11.1	11.1	31.5	31.5	11.5	31.5	31.5	31.5	31.5
767-200	1983	211	31.1	4.00E+08	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.5	31.5	31.5	31.5	31.5	31.5	31.5
787-200	1983	211	\$1.1	4.00E+08	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	11.1	31.5	31.5	31.5	\$1.5	31.5	31.5	31.5
767-200	1983	211	31.1	4.00E+08	31.1	31.1	31.1	31.1	31.1	31.1	31.1	\$1.1	31.1	31.1	31.1	\$1.6	\$1.5	\$1.5	\$1.5	31.5	31.5	\$1.5
767-200	1984	211	31.1	4.002+08	31.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	\$1.1	31.1	11.1	31.1	31.5	31.5	31.5	\$1.5	31.5	31.5
DCS		92	18.6	1.37 <b>8</b> +08	10.6	16.6																
8C3		11	10.0	1.378408	10.8	10.0																
DCA		47	16.6	1.378408	16.6																	
DCS		92	16.6	1.378408	16.6																	
121	1959	50	25.0	3.32B+07	25.0	25.0									•							
F21	1966	50	25.0	3.328+07	25.0	25.0																
F21	1966	50	25.0	3.328+07	25.0	25.0																
F27	1968	50	25.0	3.328+07	25.0	25.0																
F27	1976	50	25.0	3.328+07	25.0	25.0																
F21	1981	50	25.0	3.32E+07	25.0	25.0																
F21	1981	50	25.0	3.32B+07	25.0	25.0																
741 897	1394	9V 60	20.U 95 A	J.JZ8+U7 4 440.04	29.0 48 A	29.0																
P41		5V 50	474V 95 A	3.3667V/ 3.398407	49.U 98.A	40.V 96.A										•						
F21		50	25.0	3.32E+07	25.0	25.0													•			

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TABLE	II.3	(co	nt)	DOMES	STIC	AIRC	RAFT:	1990	SPI	CIFIC	: FUE	сL	CONS	SUME	TION	FOR	REP	LACEN	ENT	AIRC	RAFT		
F21		50	25.0	3.328+01	25.0	25.0																	
127		50	25.0	3.328+07	25.0	25.0																	
F21		50	25.0	3.328+07	25.0	25.0																	
F21		50	25.0	3.328+07	25,0																		
F27		50	25.0	3.328+07	25.0	-																	
F27		50	25.0	3.328+07	25.0																		
F27		50	25.0	3.328+07	25.0																		
827		50	25.0	3.328+07	25.0																		
F28-1000	1969	12	20.3	1.158+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.	.) 2	0.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
F28-1000	1970	12	20.3	1.15B+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20	.3 2	0.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
F28-1000	1970	72	20.3	1.15B+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20	.1 2	0.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
F28-1000	1970	72	20.3	1.15E+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20	.1 2	0.1	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
F28-1000	1\$71	12	20.3	1.158+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20	.1 2	0.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
F28-1000		72	20.3	1.15E+08	20.3													-					
F28-1000		72	20.3	1.158+08	20.3																		
F28-3000		12 -	20.3	1.15E+08	20.3	20.3	20.3																
F28-3000		72	20.3	1.158+08	20.3	20.3	20.3		-														
F28-4000	1979	12	20.3	1.15B+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20	.1 2	0.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1982	12	20.3	1.15 <b>E+08</b>	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20	.3 2	0.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1983	12	20.3	1.15E+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20	,3 2	0.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1983	12	20.3	1.158+08	20.3	20,3	20.3	20.3	20.3	20.3	20.3	20	,3 2	0,1	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1984	12	20.3	1.158+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20	.3 1	0,1	20.3	20,3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1984	12	20.3	1.158+08	20.3		20.3	20.3	20.3	20.3	20.3	20	.3 1	0.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1984	12	20.3	1.158+08			20.3	20.3	20.3	20.3	20.3	20	.1 1	0.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
F50	1987	50	37.6	4.30 <b>8</b> +01	37.6	31.6	37.6	37.6	37.6	37.6	37.6	31	.6 1	17.8	37.6	37.6	37.6	37.6	37.6	37.6	31.6	37.6	37.6
F50	1987	50	37.6	4.30B+07	37.6	37.6	37.6	37.6	37.6	37.6	37.6	31	.6 3	1.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6
F50	1987	50	37.4	4.308+07	37.5	37.6	37.6	37.6	37.6	37.6	37.6	37	.6 3	7.6	37.6	37.6	37.6	37.6	37.6	31.6	37.6	37.5	37.6
P50	1987	50	37.6	4.308+01	37.6	37.4	37.6	37.6	37.6	37.6	37.6	31	.6 1	7.6	37.6	37.6	31.6	37.6	37.6	37.6	37.6	31.6	37.6
F20	1987	50	37.6	4.302+07	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37	.6 1	17.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.5	37.6
750	1987	50	37.6	4.30 <b>8</b> +07	37.6		37.6	37.6	31.6	37.6	37.8	31	.6 1	1,6	37.6	37.6	37.6	37.6	37.6	37.4	37.6	37.6	37.6
F50	1987	50	37.6	4.302+07	37.6		37.5	37.6	37,6	31.6	37.5	31	.6 1	17.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	31.6
P50	1987	50	37.6	4.30E+07	37.6																		
<b>F</b> 50	1987	50	37.6	4.308+07	37.6																		
P50	1987	50	37.6	4.308+07	37.6																		
¥	BIGHTED AVER	AGE SEA	T-EM/L (weighte	d by seat-	24.8	25.0	26.1	27.0	27.4	27.4	27.6	28	.0	18.6	29.4	29.8	29.8	29.8	29.9	31.2	31.4	31.8	32.1
1.	ASE (SBAT-IN	0			1.9E+10	1.9B+10	2.18+10 2	.328+10 2.	32E+10	2.32B+10 2.	32B+10 2	. 32E+	10 2.32	8+10 2.	32B+10 2.	32B+10 2	32B+10	2.32B+10 2	2.32B+10	2.32B+10	1.32E+10 1	.328+10	2.328+10
I	NDEX OF FLEE	T PUEL	EFFICIENCY (198	8 BASE)	100.0	100.7	105.1	108.8	110.7	110.7	111.1	113	.0 11	5.3	118.5	120.0	120.1	120.2	120.1	125.8	126.6	128.5	129.3
Ť	ASE [WILLION	PASSEN	GBRS ]		14.3	10.4	12.9	16.7	14.5	15.3	16.1	16	. 1	17.5	18.2	18.9	19.5	20.1	Z1.0	21.9	22.8	23.1	24.6
I	NDEL OF TASE	(1988	BASE)		100.0	12.1	90.2	116.8	101.4	107.0	112.6	- 117	.5 12	12.4	127.3	132.2	136.4	140.6	145.9	153.1	159.4	165.1	172.0
U	OAD FACTOR				0.774	0.742	0,716	0,745	0.14	0.74	0.14	0.	14	1.14	0.74	9.74	0.14	0.73	0.73	0.73	0.73	0.73	0.73
I	NDEX OF FUEL	USED (	1988 BASE)		100.0	15.3	92,8	111.3	35.8	101.1	100.0	108	.7 1		112.4	119.2	118.7	124.0	129.0	129.1	133.6	130.8	141.1

NOTE: Aircraft replaced at 15 years or 1992 earliest. T2Ts replaced with 737-400s, 167-200s replaced with 767-300s. SOURCES: DONESTIC AIRCRAFT UTILISATION (various years), AEROCOST, SUBSTMAN (1994)

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#### DOMESTIC AIRCRAFT: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT, TABLE II.4 20 YEAR ECONOMIC LIFE

	7738		AVERAGE EPIS TH	TTPE ATGE			1	BAT-RILOU	RTERS PER	LITRE OF	FORL							•				
21	BUILT	SEATS	PER LITER	PIL TIM	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0-200	1980	230	20.6	3.346+08	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	39.8	39.8	39.8	39.8	39.8	39.8	39.8	39.8	39.8	39.8
0-200	1981	230	20.6	3.348+08	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2
0-200	1982	230	20.6	3.346+08	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6	40.6
0-200	1982	230	20.6	3.348+08		20.6	20.6															
0-600R	1990	288	56.6	4.18 <b>6</b> +08			56.6	56.6	56.6	56.6	56.6	\$6.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
0-6001	1990	288	56.6	4.18E+08			56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
Q-6001	1990	288	56.6	4.185+08				56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
0-600K	1990	288	38.6	4.188408				56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
0-000X	1999	285	28.8	4.186408			,	-16.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
U A	1994	410	91.3	3.036408				41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.1	41.3	41.3	41.3	41.3	41.3	41.1
14 14	1900	112	11.1	1.146400		21.1	11.1	11.1	21.1	11.1	11.1	21.1	11.1	11.7	21.1	11.1	11.1	11.1	11.1	11.1	21.1	27.7
Ŷ	1988	111	111	1.145700		21.1	41.1	41.1	11.1	41.1	11,1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	27.1
20	1000	134	47.7	1.195700		43.1	41.1	41.1	41.1	41.1	11.1	11.1	11.1	11.1	11.1	21.1	11.1	21.1	11.1	11.1	11.1	27.1
0	1968	137	41.1	1.148400		17.7	21.1	41.1	41.1	41.1	41.1	41.1	11.1	21.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	27.1
.v.	1707	111	41.1	1.148700		27.7	41.1	41.1	11.1	41.1	21.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1
10	1707	117	17.7	1.148700		11 1	11.1	41.1	49.9	41.1	41.1	11.1	21.1	11.1	11.1	11.1	21.1	21.1	11.1	11.1	11.1	21.1
.v 10	1985	117	17.7	1 148400		17.1	41.7	11.1	41.1	21.1	41.1	41.1	11.1	41.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1
t t	1989	111	17.7	1 148400		41.1	41.1	41.1	41.1	41.1	41.1	41.1	41.1	41.1	11.1	21.1	11.1	21.1	11.1	11.1	11.1	11.1
, \	1484	117	17 7	1 148400				21.1	47.5	41.1	47.7	41.1	21.1	47.1	11.1	41.1	21.1	21.1	11.1	11.1	11.1	11.1
•	1989	117	11 1	1 148400				21.1	27.7	51.1	41.1	47.1	41.1	41.1	41.1	41.1	11.1	21.1	11.1	11.1	11.1	21.1
• 146.70	1988	15	18 2	1 647468		18.9		19.9	41.1	41.1	47.7	41.5	41.1	11.1	41.1	41.1	41.1	41.1	41.1	11.1	11.1	21.1
146.36	1948	15	18.2	1.648408	18 2	10.4	10.1	10.4	10.2	10.1	10.2	10.2	10.2	10.2	10.4	16.2	10.2	18.2	18.2	18.2	18.2	18.2
146-70	1989	75	18.7	1 648468	10.4	16.2	10.2	10.4	10.6	10.4	10.2	10.1	10.1	10.2	10.4	10.2	10.7	16.2	18.2	10.2	18.2	10.2
166-70	1989	15	18 7	1 647484		18 2	10.4	10.1	10.4	10.2	10.1	10.4	10.1	10.4	10.1	10.1	18.2	18.2	10.2	10.2	18.2	10.2
146-20	1989	75	18.7	1 642468		19.4	18 2	18.2	10.1	10.4	10.4	10.4	10.4	18 9	10.4	10.2	10.4	18.2	18.2	10.2	18.2	18.7
146-10	1990	96	22.5	2 182+68		14.1	10.1	99 K	77 6	10.4 22 L	99 6	10.5	19.4 99 E	10.1	10.1	10.1	10.2	10.4	10.2	10.4	10.2	16.2
146-30	1990		22 5	7 1AX+0A				77 5	22.5	17 5	22.5	11.3 99 C	11.J 99 E	11 6	22.3	41.3	44,3	11.3	44.3	11.3	11.3	11.5
146-30	1990	16	11.5	2.188408				27 5	27 5	22.5	22.5	22.2	22.3	17 5	11.3	22.3	11.3 19 E	11.3	11.3 79 K	11.5	11.3	22.3
146-30	1990	96	12.5	2.151+08				11 5	22.5	22 5	22.5	77 5	22.5	22.5	22.5	37 5	37 5	22.3	39 6	11.3	11.3	44.3
146-30	1990	96	22.5	2.18K+D8				22.5	22 5	37 5	22 5	37 5	33 5	37 5	11.5	39 5	37 6	44.J 99 C	44.3	41.3	19 6	11.1
-200 C	1972	144	25.0	2.978+08	25.0			•••••		•••					****		****	44.3	**.*	££.J	44.3	44.3
-200 C	1973	144	25.0	2.978+08	25.0																	
-200 C	1974	144	25.0	2.976+08	25.0																	
-200 C	1974	144	25.0	2.978+08	25.0																	
-200 C	1974	144	25.0	2.978+08	25.0	25.0																
-200 C	. 1974	144	25.0	2.978+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.3	33.3	11.1	33.1	11 1	11 1	11.1	11.1	11.1	11.1	11 1
200 C	1975	144	25.0	2.978+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	11.4	11.4	31.4	33.4	11 4	31 4	11 4	11 4	11 4	11 4
200 C	1975	144	25.0	2.978+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.0	11.0	31.0	33.0	11.0	11 0	11 0	11 0	11 0	11 4
200 C	1976	144	25.0	2.978+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	11.5	33.5	11.5	11.5	11.5	33.5	33.5	11 5	11 4
200 C	1976	144	25.0	2.978+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.5	33.5	33.5	33.5	13.5	31.5	11.5	13.5	11.5
-200	1978	144	25.0	2.978+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	11.1	33.1	31.1	33.7	33.7	11.7	33.7
-200	1979	144	25.0	2.978+05	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	13.8	33.4	13.6	11.8	33.4	11.8
-200	1979	144	25.0	2.971+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	11.8	11.8	33.8	11.8	11.4	11.8
1-200	1979	144	25.0	2.971+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.4	33 A	33 1	33 #	11 4	11 4
7-200	1979	144	25.0	2.978+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	31.8	13.8	11.8	33.0	11 1	11 8
7-700	1474	14	25.0	7 972+68	25.6	25 6	75 A	95 6	25 6	25.0	25.0	25.0	96.0	98 A	91 A	16 A		11 .	11.4			

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FABLE	II.	4	(cont)	DO	MEST	FIC 2	AIRC	RAFI	C: T	REND	SP	ECIF	IC I	FUEL	CON	SUMP	TION	FOF	RE RE	EPLA	CEMEI	NT Z	<b>IRCRAFT</b>
				20	YEZ	AR E	CONC	MIC	LIF	Έ													
8727-268	1980	144	25 A	7 472+AL	<b>15 A</b>	23.6	25.0	25 B	<b>35 A</b>	25 B	25 A	25 A	<b>25 A</b>	25.6	25 A	<b>25 a</b>	75 A	11 4	11.6	11.0	11.6	11 4	
R127-200	1980	14	25 A	2.478+88	25 6	25 A	25.0	35 1	25-6	25.0	25 6-	25 0	25-6	25.6	15.0	25 A	25 6	11 0	11 4	11 4	11.4	11.0	
8727-700	1981	- 144	25.0	2 978+08	25.0	25 0	25 6	25.0	25.0	25 6	25.0	25 8	25.0	75.6	25.0	22.4	25.6	25 A	14 1	u 1	14 1	34.1	
127-208	1981	14	25.0	7 972+08	25 6	25.6	75 6	75.0	25.0	25 6	25.0	25 A	25 A	25. N	25.0	25.6	75 0	25.0	14 1	14 1	34.1	14 1	
121-200	1981	144	25.0	2 978+08	25.0	75.0	75.0	75 6	25.0	25 0	25 1	25 A	75 0	25 A	25.0	25.0	25.0	25 0	14 1	14 1	14 1	14 5	
727-200	1981	144	25.0	2.978+08	25.0	25 0	25.0	75.0	25.0	25.0	75 B	25.0	25 n	25.0	25.0	25 M	25.0	25.0	14 1	14 1	14 1	14.1	
737-300	1986	109	26.9	7.178+08	26.8	24. 4	26.4	26 1	26.0	26.4	76 4	26 4	26.9	76 4	26.4	16 9	76.4	76 4	76 0	76.9	76.4	26.4	
737-300	1986	109	26.9	2.178+08	26.9	26.4	26.9	26.9	26.9	26.3	26.9	26.4	26 4	26.9	76 4	26 4	26 1	26.9	26.4	26.9	76.9	76. 4	
8737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	76.4	26.4	26.1	75.9	26.4	26.4	76.4	76.4	76 4	76 1	76.4	76 4	26.4	76.4	76.9	
737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.5	26.9	26.4	26.4	26.9	26.4	26.9	26.9	26.9	26.9	26.9	26.9	76. 4	
1737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	76.4	76. 4	26. 1	26.4	16.4	16.4	76.9	15 4	76.4	76.4	75.4	76.4	76.4	76.4	76 4	
8737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.4	26.9	26.9	26.9	26.4	26.9	76.9	26.9	26.9	26.9	16.9	26.9	26.9	26.9	
8737-300	1986	109	26.9	2.178+08	26.9	26.3	26.9	26.9	25.9	26.3	26.9	26.4	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	25.9	26.9	26.9	26.9	26.9	26.4	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.3	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
737-300	1986	109	26.9	2.178+08	26.9	25.9	26.9	26.9	26.9	26.9	26.9	26.9	25.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
8737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
8737-308	1986	109	26.9	2.178+08	26.9	26.5	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.5	26.9	26.9	
1737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.5	26.9	26.9	26.9	26.9	26.9	26.3	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
8737-300	1986	109	26.9	2.175+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.5	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
9737-300 .	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.5	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
8737-300	1986	109	26.9	2.178+08	26.9	25.9	26.9	25.9	26:9	26.9	26.3	25.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
1737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
737-300	1986	109	26.9	2.17 <b>5+</b> 08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
8737-300	1986	109	26.9 -	2.176+08	26.9	26.9	26.9	. 26.9	26.9	26.3	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
1737-300	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
8737-300	1987	109	26.9	2.17 <b>E+08</b>	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
8737-300	1987	109	26.9	2.17 <b>E+0</b> 8	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	- 26.9	26.9	
8737-300	1987	109	26.9	2.172+08	26.9	26.9	26.5	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
737-300	1988	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
8737-300	1988	109	26.9	2.17\$+08		26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
B737-300	1988	109	26.9	2.17E+08		26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
B737-300	1988	109	26.9	2.178+08		26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
8737-300	1988	109	26.9	2.178+08		26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
<b>B</b> 737-300	1989	109	26.9	2.178+08		26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
1737-300	1989	109	26.9	2.178+98		26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	
37-490	1990	145	33.0	2.918+08			33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	
/3/-400	1770	149	33.0	2.918400			33.0	33.0	33.0	33.0	33.0	33.0	13.0	33.0	33.0	33.0	33.0	33.0	11.0	33.0	33.0	33.0	
/3/-400	1770	140	33.0	Z.918+06			33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	
/3/-400	1990	- 144	33.0	2.928+08			33.0	33.0	33.9	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33,0	33.0	33.0	33.0	
107-200	1985	- 111	n.1	4,008408	31.1	11.1	11.1	31.1	11.1	31.1	31.1	31.1	11.1	31.1	31.1	39.0	39.0	39.0	39.0	39.0	40.8	40.8	
/0/-2VU 761_360	1983	111	JI.1	\$.VUL+VG	31.1	31.1	11.1	31.1	31.1	31.1	31.1	31.1	31.1	31.1	51.1	39.0	39.0	39.0	JY.U	17.0	40.8	40.8	
181-690 767 988	1981	211	31.1	4.001100	31.1	31.1	31.1	31.1	11.1	31.1	31.1	31.1	31.1	31.1	31.1	39.0	\$9.0	59.0	39.0	39.0	40.8	40.8	
167-388	1101	211	31.1	4.002100	21.1	32.2	31.1	31.1	31.1	31.1	31'1	31.1	11.1	11.1	11.1	39.0	12.0	39.0	39.0	17.0	40.6	40.8	
101-200	1244	87	JI.I 16 6	4.0VETUS 1 172408	JI.I 16 6	31.1 16 6	11.1	31.1	31.1	31.1	11.1	31.1	11.1	31.1	11.1	31.1	17.4	17.4	37.4	37.4	33.4	41.2	
101		17	16 6	1 378188	16.6	16 4																	
nr <b>s</b>		47	16.6	1.378+00	14 4	14.4																	
10		34	16 6	1.3/8700 1.179188	16.6																		
nc4		974	14.4	1 338104	16.6																		
171	1858	54	29.0	1,372400	10.0 10.0	<b>35 A</b>																	
***	1956	30 60	75 0-	3.325703	4J.V 95 A	23.U 95.A																	
167 917	1700	34 EV	63.V 98.A	2.36BTV/ 3.368.43	43.4	43.9																	

TADLE	; 11.4	: (	cont)	DC 20	) ye	FIC AR E	AIR	CRAF' OMIC	T: T LIN	reni Fe	) SP	ECIFI	IC 1	FUEL	CON	SUME	PTION	N FO	RR	SPLA	CEME	NT
121	1968 .	50	25.0	3.325+07	25.0	25.0																
127	1976	50	25.0	3.328+07	25.0	25,0																
111	1981	50	25.0	3.325+07	25.0	25.0																
727	1901	50	25.0	3.328+07	25.0	25.0																
127	1984	50	25.0	3.328+07	25.0	25.0																
227		50	25.0	3.328+07	25.0	25.0																
127		50	25.0	3.328+07	25.0	25.0																
727		50	25.0	3.328+07	25.0	25.0																
111		50	25.0	1 378+07	25.0	25.0																
121		50	25.6	1 178+07	15.8	25.0																
101		SA	25 n	1 197407	25.0	35.0																
¥97		50	25.0	1 319467	43.4	43.0																
247 911		50	15.0	3.325707	43.V 95.A																	
#11			15.0	3.328707	15 6																	
#13		50	75.0	1 138407	25 A																	
¥71		50	75.0	1 178107	23.0 15 A																	
*** 778~1000	1464	19	20.1	3.3667V/ 1 158189	13.V 7A 1	20 1	7.6 1	<b>20 3</b>	91 A	91 A	11.0	11 A	91 A	<b>31 A</b>	11 4	91 A		11 A	41 4			
P78-1000	1470	33	4V.J 20 3	1 158164	20.3	20.3	20,3	44,3	41.Q	41.V 11 A	41.0	11.0	41.0	41.0	11 A	41.0	21.U 21.0	41.0	21.0	21.0	21.0	21.0
P28-1000	1970	11	20.J	1 159148	20.3	10.1	20.3	29.3	21.V 11.A	11.0	21.9	£1.V	41.0	11.0	21.V	41.0	11.0	21.0	21.0	11.0	21.0	21.0
110-1004	1.876	14	10.3	1.136740	10.3	20.3	20,3	20.3	41.0	11.0	21.V	41.0	11.0	11.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
P28-1000	1471	12	20.3	1.1357468	29.3	20.3	10.3	20.3	21.0	21.0	21.0	21.0	11.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
110-1004	1011	14	20.3	1.138440	14.3	24.3	20.3	20.3	41.V	41.0	11.0	<i>11.</i> V	11.0	11.0	21.0	21.0	21.0	71.0	21.0	21.0	21.0	21.0
838 1844		14	10.3	1.136400	10.3																	
#10.1000		14	10.3	1.136400	20.3	14 1																
F20-3000		14	10.3	1.136900	10.3	20.J	20.3															
F10-JUUV		11	20.J	1.136400	20.3	20.3	20.3															
F18-400V	17(7	14	20.3	1.136490	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	11.5	21.5	21.5	21.5	21.5	21.5
828-4948	1704	14	20.3	1.136100	20.3	20.3	20.3	20,3	20.3	20.3	20.1	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	11.6	21.6	21.6
ET0-4000	1703	14	10.3	1.136100	20.3	20.3	20.3	20.3	20.3	20.3	· 20.J	10.3	20.3	20.3	20.3	20.J	20.3	20.3	20.3	20.3	21.7	21.1
FTG-404A	1903	14	20.3	1.136106	20.3	20.3	20.3	20.3	20.3	20.3	20.3	19.3	20.3	20,3	20.1	20.3	29.3	20.3	20.3	20.3	21.7	21.7
210-4000	1784	14	20.3	1.136400	20.3	20.3	20.3	20.3	20,3	20.3	20,3	20.3	20.3	20,3	20.3	20,3	20.3	20.3	20.3	20.3	20.3	21.0
F10-4000	1904	14	20.3	1.136408	20.3		20.3	20.3	20.3	20,1	20.3	20.3	20.3	20.3	20.3	Z0.3	20.3	20.3	20.3	20.3	20.3	21.0
728-400V	1964	14	20.3	1.136+00			20.3	20.3	20.3	20.3	20.3	20.3	10.1	20.1	20.1	20.3	ZQ.3	20,3	20.3	79.3	20.3	21.8
F 34 #F 4	130/	30	37.9	4.306107	31.8	37.8	31.4	31.6	11.6	37.6	37.6	37.6	31.6	11.6	37.6	37.6	31.6	37.6	37.6	37.6	11.6	31.6
F SV B C A	170/	34	37.6	4.JUE+U/	37.8	37.8	31.1	37.0	31.5	37.5	37.6	37.6	31.6	31.6	37.6	31.6	37.6	37.6	37.6	17.6	17.6	37.6
[ ]V    [ ]	170)	34	37.0	4.30610/	37.8	37.0	37.6	37.8	37.0	11.6	37.0	31.5	37.6	11.6	11.4	37.6	31.5	37.6	31.6	37.6	37.6	37.6
F 3V 864	1907	30	17.6	4.JUE+U/	37.8	37.5	31.4	37.6	37.6	31.6	37.6	37.6	31.6	37.6	37.6	37.4	37.6	37.6	37.6	37.6	37.6	17.6
E 3V 864	1907	1U E A	37.0	4.JUETU/	37,8	31.0	37.9	37.0	11.4	37.6	37.6	37.8	11.6	37.5	31.6	37.6	37.5	37.6	11.1	37.6	17.6	37.6
P10	1707	76 20	17.6	4.30EPU/ 4.30FT0/	11.0		1778 - 37.4	11.8	37.8	11.0 17.4	37,8 17.4	17.0 17.4	17.0	17.8 17.8	31.6	31.6	37.6	11.1	11.6	17.6	37.6	37.6
2 J V #56	1707	3V 50	37.0	4.30810/ 4.30810/	11.0		31.9	11.0	31.8	31.0	11.0	37.0	11.0	37.6	11.6	\$1.6	11.0	37.6	31.6	37.6	37.6	31.6
F 1 V	1987	JU Ça	17.0 17.6	4.JUB90/ 1 107:07	17.6																	
7 S A	1987	30 60	37.0	4.JUETU/ 4.JUETU/	17.4																	
£ 34	170/	30	J/.W	2.698+10	11.0																	
T T	RIGUTED AVER ASE (SEAT-EN	AGX SI )	ILT-II/L (veigh	ted by seat-	24.8 1.98+10	25.0 1.98+10	26.1 2.18+10	27.0 2.328+10	27.0 2.328+10	27.0 2.32 <b>2</b> +10	27.0 2.32 <b>8</b> +10	27.1 1.328+10 2.	27.5 328+10	28.0 2.328+10 2	28.3 .328+10 2	28,8 .328+10 2	29.4 	29.7 .328+10 2	30.2 2.32 <b>1</b> +10	30.2 2.328+10 2	30.3 .328+10 2	30.3 328+10
1	IDII OF FLEE	T 701	L REFICIENCE (1	960 BASE)	100.0	100.7	105.1	108.8	109.0	109.0	109.0	109.3	111.1	113.0	114.1	116.0	118.7	119.7	121.6	121.7	122.1	122.4
1	THE FULLION	2122	EUGERS]		14.3	10.4	12.9	16.7	14.5	15.3	16.1	16.8	17.5	18.2	18.9	19.5	20.1	21.0	21.9	22.8	23.7	24.6
1	EDIX OF THSE	(198	8 BASE)		100.0	12.7	90.2	116.8	101.4	107.0	112.6	117.5	122.4	127.3	132.2	136.4	140.6	146.9	153.1	159.4	165.7	172.0
L	OLD FACTOR				0.774	0.742	0.716	0.746	0.69	0.69	0.69	0.69	0.69	0.69	0.70	0.70	0.71	0.71	0.12	0.72	0.73	0.73

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TOTE: Alternat replaced at 20 years or 1992 entilder. 121-200 replaced by 737-400; 767-200 replaced by 767-300; 737-300 EXPLACED BY 737-400 A310 skm/1 by proportion on number of seats from A300-600R.

SOURCES: BOURSVIC AIRCHAFY WYLLISAPION (various years), ARBOCOST, SURSYMAN (1984)

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#### 8 8 TABLE II.5 ..

# DOMESTIC AIRCRAFT: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT, 25 YEAR ECONOMIC LIFE

	**19		AVERAGE	TIPE AVGE			5	EAT-RILON	ETERS PER	LITRE OF	POEL											
TTPE	BUILT	SEATS	PER LITRE	PER YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
A300-200	1980	230	20.6	3.345+08	20.6	20.6	20.6	. 20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6
A300-200	1981	230	20.6	3.346+08	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.A.
A300-200	1982	230	20.6	3.342+08	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6
A300-200	1982	230	20.6	3.348+08		20.6	20.6															
A300-600R	1990	288	56.6	4.18 <b>1</b> +08			56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.8	56.6	56.6	56.6	56.6	56.8	56.6
A300-600R	1990	288	56.6	4.18E+08			56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
A300-600R	1990	288	56.6	4.182+98				56.6	56.6	56.6	56.6	56.6	58.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
A300-600R	1990	288	56.6	4.186+08				56.6	56.6	56.4	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
A309-600R	1990	288	56.6	4.18E+08				56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
AJ10 1120	1999	210	/ 11.J	3.036+08			41 1	41.3	41.3	41.3	41.3	41.3	41.3	41.3	11.1	41.3	41.3	41.3	41.3	41.3	41.3	41.5
A 320	1540	131		1.146100		41.1	27.7	41.1	21.1	41.1	41.1	41.1	27.7	21.1	41.1	11.1	21.1	41.1	41.1	41.1	21.1	21.1
1120	1700	134	1 17 7	1.146400		21.1	41.1	41.1	41.1	41.1	41.1	21.1	21.1	21.1	41.1	- 41.1	(1.)	11.1	41.1	21.1	. (1,1	21.1
1336	1707	134		1.146+00		11.1	41.1	47.7	41.1	41.1	21.1	11.1	21.1	41.1	11.1	11.1	11.1	41.1	21.1	21.1	41.1	21.1
AJ24 1320	1707	132	21.1	1.146+00		41.1	41.1	21.1	27.7	21.1	21.1	21.1	21.1	27.7	21.1	11.1	21.1	21.1	21.1	11.1	21.1	21.1
AJ40 3320	1707	111		1.145400		21.1	21.1	11.1	11 1	21.1	41.1	17 7	41.1	11.1	21.1	41.1	11.1	11.1	27.7	21.1	41.1	21.1
AJ2V 1170	1886	112	1 27.1 1 9 <b>1 1</b>	1 1/8400		27.7	21.1	27.7	21.1	21.1	21.1	27.7	21.1	21.1	21.1	27.7	27.1	21.1	11 1	11.1	11.1	21.1
1176	1484	112	277	1 148468		27.7	37.7	27,7	27.7	21.7	27.7	37 7	21.1	21.1	21.1	37.7	21.1	27.7	21.7	21.1	21.7	27.1
1120	1993	112	27 7	1.145400		21.1	41.1	27.7	27.7	21.1	21.1	23 7	27.7	21.1	11.1	21.1	27.7	21.7	21.1	11.1	27.7	21.1
1120	1989	117	27 7	1 145+08				21.1	21.7	27 1	27 7	27.7	21 1	27.1	21 1	. 27 7	21 1	27.7	27.7	27.7	27.7	27 7
1370	1989	132	211	1 142+08				27.7	27.7	21 1	27.7	21 1	21 1	27.7	21.1	21.1	27 1	21 7	27.7	27.7	27 7	27.7
BAE146-20	1985	75	5 18.2	1 648+08	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.7	18.7	18.2	18 2
BAE146-20	1985	75	18.2	1.648+08	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.7	18.7	18.2	18.7
BAE146-20	1988	75	18.2	1.642+08		18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.7	18.2
BAE146-20	1988	75	18.2	1.641+08	•	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2
BAE146-20	1989	75	18.2	1.646+08		18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2
BAE146-30	1990	96	22.5	2.181+08				22.5	22.5	22.5	22.5	22.5	22:5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
BAE146-30	1990		22.5	2.18E+08				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
BAE146-30	1990	96	22.5	2.181+08				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
BAE146-30	1990	96	22.5	2.188+08				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
BAE146-30	1990		22.5	2.18E+08				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
127-200 C	1972	144	25.0	2.97E+08	25.0																	
727-200 C	1973	144	25.0	2.972+08	25.0																	
727-200 C	1974	144	25.0	2.97E+08	25.0																	
727-200 C	1974	144	25.0	2.97E+08	25.0																	
727-200 C	1974	144	25.0	2.97E+08	25.0	25.0																
727-200 C	1974	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.8	33.8	33.8	33.8	33.8	33.8
727-200 C	1975	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.9	33.9	33.9	33.9	33.9
727-200 C	1975	144	25.0	2.972+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.9	33.9	33.9	33.9	33.9
727-200 C	1976	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	34.0	34.0	34.0	34.0
727-200 C	1976	144	25.0	2.978+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	34.0	34.0	34.0	34.0
727-200	1978	14	25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	34.1	34.1
727-200	1979	- 144	25.0	2.972+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	34.2
727-200	1979	14	25.0	2.976+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	14.2
121-200	1979	144	1 25.0	2.975+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	34.2
727-200	1979	14	25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	34.2
127-200	1979	144	1 25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	34.2

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## TABLE II.5 (cont) DOMESTIC AIRCRAFT: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT, 25 YEAR ECONOMIC LIFE

727-20u	1980	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
727-200	1980	144	25.0	2.972+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
727-200	1981	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
727-200	1981	144	25.0	2.972+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25 0	25 0	25.6
727-200	1981	144	25.0	2.972+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25 A	25 0	25 0	25.6	25.0	25 0	25 6	95 n
127-200	1981	144	25.0	2.978+08	25.0	25.0	25.0	25.0	25 0	25.0	25 0	25 0	25.0	25.0	25 0	25 0	25 1	25.0	25.0	25.0	25.0	23.0
717-100	1986	109	26. 4	2 178408	76.4	76 9	26.6	76.9	16 0	26 0	76 4	26.0	26.0	16 0	25.0	26.0	25.0	23.0	23.0	21.0	23.0	23.U 96 A
717-100	1986	109	36.0	1 174.08	26.4	26 4	26 4	26.9	20.3	20.3	20.7	16 0	20.5	20.7	20.7	20.7	20.7	20.3	20.7	20.7	20.7	20.7
717-100	1406	100	76 0	7 17840	16.8	16.0	16.0	10.7	10.7	20.7	20.7	20.7	20.3	20.7	20.3	20.7	20.7	20.3	20.9	20.9	26.9	20.9
717-100	1000	104	20.7	1 175-00	16 4	20.7	20.7	10.7	20.3	20.3	20.7	20.7	40.7	29.7	49.9	20.7	20.9	20.3	26.9	20.9	26.9	26.9
717 200	1709	107	20.7	2.1/6+00	10.7	20.9	20.9	20.9	28.9	26.9	26.9	26.9	26.9	24.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
711 100	1704	107	20.7	2.1/1400	28.3	10.9	20.9	26.9	26.9	24.9	24.7	26.9	20.5	24.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
737 300	1300	107	20.7	2.176+08	20.9	10.7	26.9	28.9	24.9	26.9	26.9	<i>1</i> 6.9	26.5	24.9	26.9	28.9	26.9	26.9	26.9	26.9	26.9	26.9
717-100	1986	109	28.9	2.172100	26.3	20.9	28.9	20.9	26.9	26.9	26.9	26.9	26.3	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
737-300	1806	100	10.7	2.172400	10.3	10.7	10.7	10.7	4.5	20.3	20.7	20.3	20.7	40.7	24.9	26.7	26.7	(0.7	26.9	28.9	<b>n</b> .y	20.9
717-100	1006	147	24.7	2,172,00	20.3	20.7	16.5	28.3	26.5	20.3	16.9	20.3	20.9	20.9	20.9	20.9	24.9	26.9	26.9	26.9	26.9	26.9
737-300	1000	109	29.7	2.175-00	20.7	20.7	20.7	20.7	48.3	20.7	20.7	20.5	20.9	20.7	24.7	20.9	26.9	20.9	26.9	26.9	26.9	26.9
737-300	1000	107	20.3	2.172.00	10.7	10.7	20.7	10.7	20.3	10.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.9	10.9	10.7	26.9
731 100	1000	107	16.7	2.172400	20.7	20.3	20.3	20.3	40.9	26.7	26.9	20.9	20.9	26.9	20.9	20.9	26.9	28.3	26.9	26.9	26.9	26,9
737-300	1406	100	20.7	2.1/6+00	20.7	20.9	20.9	20.7	10.7	20.9	20.9	26.9	20.9	26.9	26.9	20.9	26.9	26.9	26.9	26.9	26,9	26.9
737-300	1000	109	(b.)	2.172+08	26.9	10.9	24.5	20.5	26.9	16.7	26.7	26.9	24.9	26.9	14.9	26.9	24.9	26.9	26.9	26.9	26.9	26.9
737-300	1700	107	20.7	2.176+08	26.9	10.9	16.9	26.9	28.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
737-300	1390	109	4.7	2.172+08	14.9	16.9	1.7	26.9	26.9	26.9	16.9	26.9	26.9	26.9	26.9	- 26.9	26.9	26.9	26.9	26.9	26.9	26.9
/3/-300	1986	109	26.9	2.172+08	26.9	26.9	26.9	26.9	28	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
731-300	1906	107	14.9	2.1/2+08	26,9	25.9	24.9	74.9	24.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
131-300	1986	109	26.7	2.1/2+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
131-300	1986	109	16.9	2.172+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
737-300	1986	109	26.9	2.170408	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
137-300	1987	109	26.9	2.17E+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.5	26.9
737-300	1987	109	26.9	Z.17E+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
737-300	1987	109	26.9	2.172+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	28.9	26.9	26.9	26.9	26.9	26.9	26.9	25.9	26.9	26.9
737-300	1988	109	26.9	2.17E+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
737-300	1988	109	26.9	2.17E+06		26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
737-300	1988	109	26.9	2.17E+08		26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
737-300	1988	109	26.9	2.172+08		26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
737-300	1988	109	26.9	2.17E+08		26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
717-300	1989	109	26.9	2.17E+08		26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
737-300	1989	109	26.9	2.17E+08		26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9
737-400	1990	146	11.0	2.915+08			33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	11.0	33.0	33.0	33.0
737-400	1990	146	33.0	2.91E+08			33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	13.0	11.0
737-400	1990	146	33.0	2.912+08			33.0	33.0	13.0	33.0	33.0	33.0	33.0	33.0	33.0	11.0	13.0	11.0	33.0	11.0	11.0	31.0
737-400	1990	146	33.0	2.912+08			33.0	33.0	33.0	33.0	11.0	13.0	33.0	33.0	33.0	13.0	13.0	11.0	33.0	11.0	11 0	31.0
767-200	1983	211	31.1	4.002+08	31.1	31.1	31.1	31.1	11.1	11.1	11.1	31.1	11.1	11.1	11.1	31.1	11.1	31.1	11.1	11.1	31.1	11 1
767-200	1983	211	31.1	4.002+08	31.1	31.1	11.1	31.1	31.1	11.1	11.1	31.1	31.1	11.1	11.1	11.1	31.1	11 1	11.1	31 1	31 1	11 1
767-200	1983	211	11.1	4.002+08	11.1	31.1	11.1	11.1	11.1	31.1	11.1	11.1	31.1	31.1	31.1	31.1	11.1	11 1	31.1	11 1	11 1	11 1
767-200	1983	211	11.1	4.00E+08	31.1	31.1	11.1	11.1	31.1	31.1	11.1	31.1	11.1	31.1	31.1	11.1	11 1	11 1	11 1	11 1	11 1	31 1
767-200	1984	211	31.1	4.00E+08	11.1	31.1	31.1	11.1	11.1	11.1	11.1	11.1	31.1	11.1	11 1	11 1	11 1	11 1	15 1	11 1	11 1	31 1
DC9		92	16.6	1.378+08	16.6	16.6				••••	••••	••••			****		****	71.1			71.1	11.1
DC		92	16.6	1.372+08	16.6	15.6																
DC		92	16.6	1 178+08	16 6																	
DCI		92	16.6	1 17E+08	16.6																	
009		\$7	16.6	1 178+08	16 6																	
F) 7	1959	50	25 0	1 175+07	25 8	25.0																
127	1966	50	25.0	1 125+07	25 0	25 0																
\$77	1966	50	25.0	1 128407	25 0	25.0																

ABLE	II.	5 (	cont)	DO 25	MES: YE	TIC AR E	AIRO	CRAFT	I: T LIF	REND E	SPI	ECIF	IC F	UEL	CON	SUME	TION	FOF	RE	PLA(	Cemei	NT AIF
121	1968	50	25.0	3.325+07	25.0	25.0																
127	1976	50-	25.0	3.322+07	25.0	25.0																
127	1981	50	25.0	3.326+07	25.0	25.0																
11	1701	30	23.0	3.326407	23.0	23.0																
21	1304	30	23.0	3.328407	25.0	25.0																
1		50	23.0	3.326+07	25.0	25.0	-	-														
44		20	23.0	3.326+07	45.0	23.0																
11		90	23.0	3.326+01	23.0	25.0																
11		30	23.V 15.0	3.322+01	23.0	23.0																
47 97	• •	50	23.0	3.366797	23.0	23.0						-			-			• •				
117		50	23.9	3.328+07 1 198×87	23.0	11.0																
21		50	25.0	1 175+01	25.0																	
27		50	22.0	3.326.07	V.L1 15 A																	
		50	25.0	1 175407	25.0																	
121		50	25.0	3.325+07	75 A																	
728-1000	1969	12	20.3	1 156408	76 1	28 1	70 1	20 1	20 1	20 3	70.7	21.2	21.2	21.2	11 1	** *	21 2	91 2	<b>31 3</b>	21.2	21.2	
778-1000	1970	17	20 1	1 158+08	20.3	20.3	28.3	20.3	20.3	20.3	. 20.3	20.1	21.2	21.2	21.2	21.2	21.2	21.4	41.4	41.2	21.2	41.4
PCR-1400	1970	17	76 1	1 155+68	20.3	20.3	20.3	20.5	29.3	20.3	20.3	20.3	21.3	21.J 91 9	21.J 71 1	21.3	21.3	41.J 91.9	21.J 11.1	41.J 21.3	21.3	21.3
728-1990	1970	17	20.0	1 158+08	20.1	20.3	20.3	20.3	20.3	20.3	20.3	20.3	21.3	11 1	21.3	21.3	21.3	21.3	41.J 21.1	21.3	21.J 21.2	21.J 31.3
728-1000	1971	32	20.3	1 158+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3
P28-1000	••••	12	20.3	1 156+08	20.3		44.3	20.4	20.3	44.4	20.0	24.3	40.3	41.1		41.3	41.3	41.3	11.3	41.3	41.3	41.3
F78-1000		12	20.3	1 158+08	70 3																	
778-1000		12	20.3	1 158108	20.3	20.1	20.3															
F 60- JVVV F 78. 1000		72	20.3	1 158.00	20.3	20.3	20.3															
20-300V 999.4000	1878	12	10.3	1.138700	20.3	20.3	20.3	** *	10.1	10.1		10.1	10.1	14.1		10.1	44.4.	10. 1	44 9	10.1		
830-4000 830-1000	17/7	11	20.3	1.136+08	20.3	20.3	20.3	20.J	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.J	20.3	20.3	20.3	11.8
#14 6000	1704	12.	20.3	1.136+08	20.3	20.3	20.J	20.J	20.3	20.3	20.3	20.J	20.3	20.3	20.3	20.3	20.3	20.J	20.3	20.3	20.3	20.3
E 20-4000	1703	14	20.3	1.136+08	20.3	20.J	29.3	20.3	20,3	20.3	20.3	20.3	20.J	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
210-9000 238 1008	1703	72	20.3	1.136+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.1	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
F20-9988 #38 1888	1705	14	20.3	1.136900	20.3	20.3	20.3	10.3	20.J	20.3	20.3	20.3	20.3	20.3	20.J	£U.3	20.3	20.J	20.3	20.3	20.3	20.3
210-9VVV 918 4000	1709	12	20.3	1.135+00	20.3		20.3	20.J	- 20.3	20.3	20.3	20.J	20.J	10.3	29.3	20.3	20.J	20.3	20.3	20.3	20.3	20.3
//0-4000 #64	1701	12	20.3	1.136+00		•• •	20.3	20.3	28.3	20.3	20.3	20.3	20.3	10.3	20.3	20.3	11.6	20.3	20.3	20.3	20.3	20.3
2 3 V 1 C A	170/	30	J/.0	4.302+07	37.0	31.8	37.0	17.8	37.0	17.0	37.8	37.0	11.0	31.0	37.0	31.0	37.0	31.0	37.0	31.0	37.0	37.6
10	1701	70	37.0	4.JUL+0/	37.6	31.0	37.0	11.0	11.0	37.0	37.0	31.0	37.0	37.0	2/.0	11.0	37.0	31.0	37.0	37.0	37.0	J7.0 17.0
F 3V	170/	30	37.8	4.306107	37.8	37.6	31.6	37.6	37.6	31.0	37.6	37.0	37.8	37.6	37.6	37.8	17.6	37.0	37.0	37.8	37.0	31.0
F 3 V • C A	170/	3U 5 A	17.0 17.0	4.JVE+U/	11.1	37.6	51.6	37.6	37.8	37.0	11.0	31.0	37.8		31.0	37.0	11.0	37.0	37.0	31.6	J/.0	11.0 11.6
130	1707	90 A 20	17.8	4.JUL+V/	31.0	37.4	37.0	37.8	37.8	37.0	37.0	17.6	37.0 17.6	31.0	37.0 17.4	37.4	17.0	37.0	37.8 17.6	11.6	37.0	37.0
1 J V 96 A	170/	3V 50	37.0	9.JU610/	31.0		37.0	37.6	17.8 17.6	31.0	37.4 17.6	31.0 31.6	37.0 17.6	37.0 17.4	31.0 17.4	17.5	31.0 3 TC	37.6	31.0 31.6	17.0	11.6	37.0
130 15A	1987	50 CA	17.6	5.306+07 1 308+07	37.0 17.0		31.6	31.0	31.0	31.4	31.0	31.0	37.0	37.0	31.0	31.0	11.0	31.0	31.9	ar.#	37.0	41.0
2 J V 9 C A	1707	20	17 4	4 105107	17.0																	
1 3 V 1 5 V	1941	20 50	37.0 17.6	4.308707 1 309107	37.0 17.6																	
, , ,	1707	70	37.8	2.692+10	31.4									-								
WEIGHTED AN TASK (SEAT-	VERAGE SEA ·EN)	Y-KN/L I	veighted by so	eat-kn perfor	24.8 1.96+10	25.0 1.96+10	26.1 2.15+10	27.0 2.326+10 2	27.0 1.326+10	27.0 2.32E+10 2	27.0 .32E+10 2	27.0 1.328+10 2	27.0 .328+10 7	27.0 1.326+10 2	27.0 2.328+10	27.0 2.326+10	27.1 2.328+10 2	27.3 328+10 2.	27.5 328+10 7	27.5 2.326+10 1	27.6 1.328+10 2	28.2 .328+10
INDER OF FL	LEET POLL	EFFICIE	ICT (1988 BASE)	)	100.0	100.7	105.1	108.8	108.8	108.8	108.8	108.9	109.0	109.0	109.0	109.0	109.4	110.2	111.0	111.0	111.4	113.7
ASK (NILL)	OF PASSE	ICERS)			14.3	10.4	12.9	16.7	14.5	15.3	16.1	16.8	17.5	18.2	18.9	19.5	20.1	21.0	21.9	22.8	23.7	24.6
INDEX OF TH	SK (1988	BASE)			100.0	72.7	90.2	116.8	101.4	107.0	112.6	117.5	122.4	127.3	132.2	136.4	140.6	146.9	153.1	159.4	165.7	172.9
LOAD FACTOR	1				0.774	0.742	0.716	0.746	0.69	0.69	0.69	0.69	0.69	0.69	0.70	0.70	0.71	0.71	0.72	0.72	0.73	0.73
			121		166.8	75.1	\$7 B	111.1	104 5	110.3	116.0	171 0	176 0	111 0	114 1	118 1	F1A 1	145.3	148 1	154.4	157 7	160.5

NOTE: Aircraft replaced at 25 years or 1992 earliest.

727-280 replaced by 737-660; 767-200 replaced by 767-300; 737-300 replaced BY 737-400; \$300-200m by \$300-600m; BAE 166-200m by BAE166-300m \$310 SEM/L BY PROFORTION OF BURBER OF SEATS PROM \$380-600R

SOURCES: DOMESTIC AIRCEART UTILISATION (various years), AIROCOST, SUBSTRAM (1984)

	**13		AVERAGE ERLS VI	TTPE ATGE			1	lat-XILON	nu un	LITRE OF	TAT										*******	
1778	BUILT	SELTS	PIR LITRE	711 TLL	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
300-200	1980	230	20.6	3.348+08	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	·····
399-200	1981	230	20.6	3.342+88	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.5	20.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
380-200	1982	230	20.6	3.345+08	20.6	28.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
308-200	1982	230	20.6	3.348+08		20.6	20.6															••••
100-600X	1990	288	56.6	4.18X+88			56.6	\$6.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	55.6
800-600R	1990	286	55.5	4.18X+08			56.6	56.5	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
100-6001	1990	200	56.6	4.10X+08				56.6	56.6	56.6	56.6	55.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
100-600R	1990	268	56.6	4.181+08				56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
108-500E	1990	288	56.6	4.18 <b>1+6</b> 8				56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
10	1990	210	41.3	3.85X+08				41.3	41.3	41.3	41.3	41.3	41.1	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3
120	1988	132	27.7	1.142+08		27.7	27.7	11.1	27.1	27.7	27.7	27.7	21.7	27.7	27.1	27.7	27.1	11.1	21.1	27.7	56.6	56.6
)Z <b>Q</b>	1988	132	27.7	1.141+08		27.7	27.7	27.1	27.7	27.7	27.1	27.7	27.7	27.7	27.7	27.7	27.1	27.7	27.1	27.7	56.6	56.6
20	1989	132	27.7	1.145+08		21.1	11.1	27.7	27.7	27.7	17.1	21.1	27.7	27.1	27.7	27.1	27.7	27.7	27.1	27.7	27.7	56.6
10	1989	131	11.1	1.148+08		11.1	27.7	27.7	27.7	27.7	27.7	27.1	11.1	27,7	27.7	27.7	27.7	27.7	21.1	27.7	11.1	56.6
20	1989	111	21,1	1.148+08		27.7	27.1	11.1	11.1	21.7	27.7	27.7	27.1	27.7	27.1	21.1	21.1	27.7	27.7	27.7	27.7	55.1
20	1989	112	27.1	1.148+08		27.7	27.7	27.7	27.7	21.1	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	56.6
10	1989	132	21.1	1.148+08		11.1	11.1	17.1	27.7	27.7	27.1	27.7	27.7	27.7	21.1	11.1	27.7	27.7	27.7	27.1	27.7	56.6
20	1989	132	21.1	1.141+08		17.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	21.1	27.7	27.1	27.7	21.7	21.1	27.7	27.7	56.
10	1949	111	21.1	1.141+00				11.1	27.7	27.7	21.1	11.1	27.7	11.1	21.7	27.1	27.7	27.1	27.7	27.7	27.7	56.
20	1989	132	21.1	1.148+88				27.7	11.7	27.7	27.7	27.1	27.7	21.1	21.1	27.7	27.7	27.1	21.1	27.1	27.7	- 56.
19	1783	131	21.1	1.14%+88				27.7	27.7	27.7	27.7	27.7	27.7	21.1	21.1	27.7	27.1	27.7	21.1	27.7	27.7	56,1
K146-ZU	1985	15	18.7	1.642+08	18.2	16.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	37.6	37.6	37.6	37.6	37.0
1149-20	1765	13	18.2	1.648+00	18.2	10.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	17.6	17.6	37.6	37.6	37.
8149-20	1785	15	18.2	1.648+08		18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18,2	18.2	18.2	18.2	18.2	18.2	37.6	37.1
1198-2V V126 98	1988	10	10.2	1.648498		18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	37.6	37.6
8149-19	1301		10.2	1.846408		10.2	18.2	18.7	18.2	18.Z	18.2	18,2	18.2	18.2	18.2	18.2	10.2	18.2	10.2	18.2	18.2	37.0
8148-30	1990	36	11.5	Z.188+08				22.5	22.5	12.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
1148-10	1990	54	11.5	7.186+00				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.
8140-JQ	1990	16	11.5	2.106+08				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
8148-JQ 8146-JQ	1770		11.5	7.108400				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	n
1190-JV	1370		11.5	2.186408				22.5	22.5	11.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
7-200 C	1374	144	(),U 15.6	2.7/6+06	23.4																	
7-200 C	1972	1/4	43.V 16 A	2.716tV0 3.87Ft04	43.V 25.A																	
1-200 C	1974	111	15 0	1.7/LTU0	43.V 15.6																	
1.766 C	1974	144	11.V 75 A	2.775744	15.0																	
1-760 C	1974	144	25.0	2.376700	15.4	16.4	76 A	15 A														
7-766 C	5475	144	25 0	2.378400	25.0	15.0	23.0	43.V 96.A	30.0 KC C	30.0	38.8 KC C	30.0	11.6	31.1	38,8	38.8	36.6	38.8	36.6	36.6	38.6	56.0
1-200 C	1975	14	25.0	2.478+68	25.6	25	25 0	23.V 25 A	56.6	30.0	56.6	38.8	30.0 50.0	38.8	39,8	30.0 56.6	38.8	36,6	36.6	36.6	36.6	36.1
1-200 C	1976	14	25.0	7 478468	25.0	75 0	25.0	25.0	56.6	38.0 56.6 -	14.4	38.8	30.8	30.8 56.6	30,0 66 6	39.9	39.6 56.6	38.8	38.8	38.8	56.6	- 36.1
7-200 C	1976	144	25.0	2.972+08	25.6	25 6	25 0	25 0	56.6	56.6	56.6	56.6	56.6	56.6	38.8 56.6	30.0 56 C	30.0 56.4	30.0 56.6	30,0 56 6	36.0 56.0	38.8 66.4	36.I
27-200	1978	14	15.0	2.978+08	25.0	25.0	25.0	25.0	25.0	75 0	56.6	56.6	56.6	56.6	56.6	56.0	56.6	30.0 K( (	30,0	10.0	30,0 66.6	30.1
27-200	1979	111	15.4	2 972.62	25.8	25.8	25.0	25 a	25.0	95 A	35.5	56 6	56.6	38.8 SC C	56.6	30.0 66.6	30,0 66.6	30.0 66.6	38.8	30.0 17.7	39.9	- 10.0
27-280	1979	144	25.1	2.978+88	25 4	25 .	25 4	25 6	25 A	25 A	25 A	56.6	56.6	56.6	10.0	30.0 56.6	30.0	20.0 66.4	10.0 K( (	38.8	10.0 12.2	30.
27-200	1979	144	25.0	2.978+08	25.8	25.0	25.0	75 0	25.8	75.6	25 8	56.6	56.6	56.6	56.0	30.8 56.6	39.4 66.6	30,0 66 6	38.8	30,0 KC C	38.8	30.0
27-200	1979	14	25.0	2.978+88	25.0	25.0	25.0	25.0	25.0	25.0	25.8	56.6	56.6	56.6	56.6	56.6	56.6	56.6	30.0 52.2	38.8 66.6	10,0 10,0	- 38.I
111.100	1474	111	25.4	2 478+48	25 6	15.6	76.6	75 6	16 8	15 6	15 A	56.6	56.6	50.0	66.6	54.4	10.0 64 4	11.1	38.0	10.0	10.0	31.1

#### TABLE II.6 DOMESTIC AIRCRAFT: REPLACEMENT OF ALL EXISTING MEDIUM AND LARGE AIRCRAFT WITH WIDE-BODIED A300-600RS, AND ALL SMALL AIRCRAFT WITH F50S

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TABL	E II	. 6	(cont)		DOME	STIC	: AI	RCRA	FT:	RE	PLAC	EMEI	NT (	of a	$\mathbf{L}\mathbf{L}$	EXIS	STING	ME	DIUM	ANI	נכ	LARGE	AIRCRAFT
-					WITH	WI	DE-E	ODIE	D 2	4300-	-600	RS,	AND	ALL	SM	ALL A	AIRCF	AFT	WITH	F5	0S		
2727.788	1888	111	25 A	7 478168	25 A	 25 A	25 A		25 A	25 A	. 75 6	25.0		56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	
1737.286	1988	111	25.8	2 872185	25 A	75 6	75 6	75 1	25 A	25 0	25 0	75 B	55.6	56.6	56.6	56.6	56.6	55.6	56.6	56.6	56.6	56.6	
1177-766	1941	111	75 6	7 478461	25.0	25 8	25.6	25.0	25.0	25.0	25.0	25.6	25.0	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	
1717-100	1985	- 14	75 6	2 472+01	25.0	25.0	25 A	25.6	75 6	25 0	25.0	25.0	25.0	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6 -	
1777-286	1981	iu	25 0	7 978.60	25.6	25 B	25.0	25.4	25.0	25.0	25.0	25.0	25.0	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	
1727-200	1981	14	25.6	2.97840	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	55.5	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	
737-300	1986	109	26.9	2.178+01	26.9	26.9	26.9 -	26.9 -	26.4	26.9	26.9	26.9	-26.9	26.3	26.9	26.9	26.9	26.9	56.6	56.6	\$6.6	56.6	
737-300	1986	109	26.9	2.178+0	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	25.9	26.9	56.6	56.6	56.6	56.6	
717-300	1986	109	26.9	2.171+00	26.9	26.9	26.9	26.9	16.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	56.6	56.6	56.6	56.6	
737-300	1986	109	26.9	2.178+00	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	56.6	56.6	56.6	56.6	
737-300	1986	109	26.9	2.178+00	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	56.6	56.6	- 56.6	56.6	
737-380	1986	109	26.9	2.178+08	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	56.6	56.6	56.6	56.6	
737-300	1986	109	26.9	2.171+00	26.9	26.9	26.9	26.9	26.9	26.5	26.5	26.9	26.9	26.9	26.5	26.9	26.9	26.9	56.6	56.6	56.6	56.6	
737-300	1986	109	26.9	2.173+0	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	56.6	56.6	56.6	56.6	
737-300	1986	109	26.9	2.178+40	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	56.6	56.6	56.6	56.6	
737-300	1986	109	26.9	2.178+00	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	56.6	56.6	56.6	56.6	
737-300	1986	109	26.9	2.172+0	26.9	26.9	25.9	25.3	26.9	26.9	26.9	26.9	26.9	26.9	26.5	26.3	26.9	26.9	56.6	56.6	56.6	56.6	
737-300	1986	109	26.9	2.178+6	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.5	26.9	26.9	26.9	56.6	56.6	56.6	56.6	
737-300	1986	109	26.9	2.175+0	3 26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	) 26.9	26.9	26.9	56.6 .	56.6	56.6	56.6	
737-300	1986	- 109	26.9	2.178+00	26.9	26.9 -	26.9	- 26.9	28.9	26.9	28.9	26.9	26.9	26.9	26.5	24.9	26.9	26.9	56.6	56.6	56.6	56.6	
737-300	1986	109	26.9	2.178+0	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	56.6	56.6	56.6	56.6	
737-300	1986	109	26.9	2.178+0	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	- 16.5	26.9	26.9	26.9	56.6	56.6	- 56.6	56.6	
737-300	1986	109	26.9	2.178+0	5 26.9	26.9	26.5	26.9	24.3	26.9	24.9	26.9	24.9	26.9	26.5	) 26.9	26.9	26.9	56.6	35.6	- 56.6	56.6	
737-300	1986	109	26.9	2.178+0	26.9	26.9	26.9	26.9	28.5	26.9	26.9	26.9	26.9	26.9	28.1	1 26.9	26.9	26.5	56.6	56.6	56.6	56.6	
737-300	1986	109	26.9	2.178+9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.5	9 26.9	26.9	26.5	56.6	56.6	- 56.6	36.6	
737-308	1986	109	26.9	2.178+0	1 26.9	26.9	26.9	26.9	- 26.9	26.9	26.9	26.9	26.9	26.9	26.9	· 26.9	24.9	26.9	56.6	58.6	56.6	56.6	
737-300	1986	109	26.9	2.178+0	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	24.9	26.9	26.9	26.9	26.9	126.5	56.6	36.5	36.6	34.4	
137-300	1987	109	26.9	2.178+0	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.5	) 26.9	76.9	A.J	26.9	38.8	36.6	39.9	
737-300	1987	109	26.9	2.17E+0	26.9	26.9	26.9	26.9	- 26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.9	26.5	56.6	36.6	38.8	
137-300	1967	107	26.9	7.17K+0		26.9	24.9	24.9	- 74.9	26.9	26.9	24.9	24,9	78.9	76.5	1 20.7	10.7	10.5	48.7	38.8	38.8	30.0	
137-300	1700	147	28.7	2.1/698	1 41.3	48.9	28.9	(0.)	4.7	49.7	10.J	(8.7	48.9	28,3	40.5	7 20.7 1 26.4	40.7	46.3	44.7	19.7	30.0	30.0	
737-388	1700	100	28.7	4 198.41		49.3	20.7	10.7	4.7	48.7	46.5	49.7	48.7	20.3	41.3	5 <u>28.7</u> 6 <u>76</u>	40.7 96 A	20.3	- 44.7	16 4	30.0	10.1	
137-300	1700	144	10.5	2.17840		48.7	20.7	40,7	- 49.7	28.7	20.7	28,7	20.7	20.7	20.3	5 20.5 5 26.4	16.6	26.8	16.6	20.7	56.6	56.6	
737-308	1988	100	28.5	2 13816		26.7	20.3	28.3	48.7 36.8	26.0	26.5	26.9	20.3	26.4	20.2	26 A	20.3	76 4	76 4	76 4	56.6	56.6	
717-100	1989	169	26.9	7 17848	, 1	26.9	76.0	76.0	20.5	26.9	76 4	76 1	20.7	26.9	26.9	26 4	26.9	26.3	26.4	76.4	26.4	56.6	
717-300	5484	189	76.4	7 17846		76 8	26.1	26.9	76.4	26. 4	26.9	25.9	26.9	26.9	26 (	26.4	76 9	76 1	76. 8	76. 4	26.4	56.6	
717-400	1998	146	13.0	2. 912+8		49.7	11 6	11 0	13.0	11 6	11 8	13 6	11 0	11.0	33.0	0 33.0	31.0	33.0	33.0	33.0	31.0	11.0	
737-400	1990	146	11.6	2.912.8			11 6	11.6	11 0	11 6	11 0	11 6	11 0	33.0	33.0	6 33.6	11.0	33.0	13.0	33.0	33.0	33.0	
737-408	1998	146	33.0	2.912+0			33.6	11 0	11.6	11 6	11 6	11.6	11 0	33.6	33.0	0 13.0	11.0	11.0	33.6	33.0	33.0	31.0	
717-400	1990	146	33.0	7.91E+6	í		13.4	11.0	11.0	33.0	11.0	33.0	33.0	11.0	33.6	0 33.0	33.0	33.0	33.0	33.0	33.0	33.6	
767-280	1983	211	11.1	4.862+01	11.1	11.1	11 1	11 1	11 1	11 1	31.1	31.1	11 1	31.1	31.1	56.6	55.6	56.6	56.6	56.6	56.6	56.6	
767-200	1983	211	31.1	4.002+0	1 11 1	11 1	11 1	31.1	11 1	31 1	31.5	31 1	31 3	35.5	31.1	56.6	56.6	56.6	56.6	56.6	56.6	56.6	
767-200	1983	211	31.1	4.002+0	11.1	31.1	31.1	31.1	11.1	11.1	11.1	11.1	11 1	31.1	11.1	56.6	54.4	56.6	56.6	56.6	56.6	56.6	
767-200	1983	215	11 1	4.902+01	1 11	11 1	11 1	11 1	11 1	15 5	31.1	11 1	11 1	11 1	11	1 56.6	56.6	55.6	55.6	56.6	56.6	56.6	
167-200	1984	211	31.1	£.682+6	111	11 1	11 1	11 1	11	11 1	11 1	11 1	31.1	11 1	11 1	1 11 1	56.6	56.6	56.6	56.6	56.6	56.6	
301			15.6	1 178+0	16.6	16 6	41.1			****	****	*1.1	••••	41.1	••••	• ••••				••••			
201			16.6	1.378+0	1 16.6	16.6																	
RC9		92	16.6	1.378+0	16.6	10.0																	
DCS			16.6	1,372+0	111.6																		
DCS		17	16.6	1.172+0	16.6																		
121	1959	Sa	25.4	1. 178+4	25.0	25.A																	
111	1966	50	25.0	1.172+6	25.0	25.4																	
111	1966	56	75.1	1.177+6	7 25 6	25.6																	
		~*	****	*******																			

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TAB	LE II	. 6	(cont)	I	DOME	STIC	IA :	RCRA	FT ;	REE	LAC	EMEN	ТО	FA	LL F	EXIS	TING	ME	DIUM	AN	DL	ARGE	AIRCRAFT
				¥	NITH	WII	)E-B(	DIE	D A3	800-	600R	S, A	ND 2	ALL	SMAI	L A	IRCR	AFT	WITH	F5	os –		IIII OIUII I
11	1968	50	25.0	3.328+07	25.0	25.0																	
117	1976	50	25.8	3.328+47	25.0	25.0																	
127	1981	50	25.0	3.321+07	25.0	25.0																	
111	1981	50	25.0	3.328+07	25.0	25.0																	
111	1754	3U 66	23.0	3.328907	25.0	23.0 25.0																	
777		50	25.4	1 198101	23.0 25 A	22.0																	
111		50	25.0	3.328+47	25.0	25.8																	
127		50	25.0	3.328+07	25.0	25.0																	
127		50	25.0	3.328+07	25.0	25.0																	
127		50	25.0	3.328+07	25.0	25.8																	
11		50	25.0	3.328407	25.0			•															
121		30 50	25.0	3.378497	25.0																		
#27		50	25.0	1 378487	25.0																		
127		50	25.0	3.328+07	25.0																		
728-1000	1969	12	20.3	1.158+08	20.3	20.3	20.3	20.3	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	17.6	
728-1000	1970	12	20.3	1.158+08	20.3	20.3	20.3	20.3	17.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	17.6	
P28-1000	1970	n	20.3	1.158+08	20.3	20.3	20.3	20.3	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	
P28-1000	1970	12	20.3	1.151+08	20.3	20.3	20.3	20.3	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	
728-1000	1941	11	20.3	1.155+08	20.3	20.3	20,3	20.3	37.6	37,6	37.6	37.6	37.6	11.6	37.5	37.6	37.6	37.6	37,6	31.6	37.6	37.6	
728-1000		17	20.3	1 152+08	20.3																		
728-3000		'n	20.3	1.158+08	20.3	28.3	28.3																
F28-3000		12	20.3	1.151+08	20.3	20.3	20.3																
720-4000	1979	72	20.3	1.158+00	20.3	20.1	20.3	20.3	28.3	20.3	20.3	37.6	17.6	37.6	17.6	37.6	37.6	37.6	37.6	37.6	37.6	17.6	
228-1000	1982	11	20.3	1.151+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	37.6	17.6	37.6	17,6	37.6	37.6	37.6	37.6	
728-4000	1983	n	20.3	1.158+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	37.6	37.6	37.6	37.6	11.6	17.6	37.6	
F18~4000 F18~4000	1983	12	20.3 18 3	1.138408	10.3	10.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	70.3	20.3	37.6	37.6	37.6	37.6	31.6	37.6	31.6	
778-4900	1984	72	20.1	1 157+01	20.3	44.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	17.6	17.6	37.0	37.8	37.8	11.6	
728-4000	1984	12	20.3	1.158+08			20.3	20.3	20.3	20.3	20.3	20.3	20.1	24.3	20.3	20.3	37.6	17.6	37.6	37.6	37.5	37.6	
750	1987	50	37.6	4.302+07	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	17.6	37.6	
250	1987	50	37.6	4.30 <b>6+0</b> 7	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	
P50	1987	50	37.6	4.30X+07	17.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	17.6	37.6	37.6	37.6	37.6	37.6	37.6	17.6	37.6	
P50 P50	1987	20	37.6	4.308407	31.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	17.6	
750	1987	50	17.6	4. 102+07	17.6		37.6	17.6	11.6	17.6	11 6	17.6	17.6	17.6	17.6	17.6	17.6	37,0	17.0	17.6	17 6	37.8	
750	1987	50	17.6	4.301+07	37.6		37.6	37.6	37.6	37.6	37.6	31.6	37.6	17.6	17.6	37.6	37.6	31.6	11.6	11.6	37.6	17.6	
<b>2</b> 50	1987	50	37.6	4.308+07	17.4							••••										••••	
250	1987	50	37.6	4. JOE+07	37.6																		
220	1987	50	37.6	4.301+07	37.6																		
				2.698+10																			
	VRIGETED AN	TRACK S	IAT-IM/L (weigh	hted by seat-	- 24.6	25.0	26.1	27.0	28.5	28.5	28.7	30.1	31.0	32.6	33.2	34.1	35.4	15.9	41.6	42.6	45.5	48.5	i.
	TASE (SEAT	<b>M</b> )			1.91+10	1.98+10	2.1 <b>8+10</b>	2.328+10	2.321+10	2.328+10	2.328+10	2,328+10	2.328+10	2.328+10	2.328+10	2.328+10	2.328+10 2	1.328+10 2	.328+10 2	32 <b>8</b> +10 7	1.328+10 1	.326+10	
	INDEX OF PI	RET PUR	L EPPICIALCE (	1968 BASE)	100.0	100.7	105,1	108.8	115.0	115.0	116.0	121.3	125.2	131.7	134.1	139,8	142.7	144.7	167.8	171.8	183.4	195.7	
	TASK (NILL)	OF PASS	LIGIRS}	•	11.3	10.4	12.9	16.7	14.5	15.3	16.1	16.8	17.5	18.2	18.9	19.5	20.1	21.0	21.9	12.8	23.7	24.6	
	INDIA OF T	SK (198	8 BASE)		109.0	72.7	\$0.2	116.8	101.4	107.0	112.6	117.5	122.4	127.3	132.2	136.4	140.6	146.9	153.1	159.4	165.7	172.0	
	LOAD FACTO		(		0.114	0.742	0.716	0.746	0.69	0.69	0.69	1.69	1.69	0.69	0.70	0.70	0.71	0.71	0.72	9.72	0.73	0.73	
	THORY OF L	IPP A27D	[1305 HASE]	,	144.0	13.3	97. <b>(</b>	111.3	78.9	194.4	198.5	140.6	109.7	100.4	109.0	107.5	107.4	110.6	30.1	55.8	55.8	93.2	

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SOTE: Aircraft replaced at 15 years or 1992 marliest. All aircraft replaced by Al00-600Bs or Fiss. Allo sku/l by proportion from Al00-600B on number of seats. Al20 utilisation for 1989-90.

SOURCES: DOMESTIC AIRCRAFT UTILISATION (various years), AEROCOST, SUBTRAN (1984)

# TABLE II.7 INTERNATIONAL AIRCRAFT: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT, 15 YEAR ECONOMIC LIFE

3 1

		**1.9		AVERAGE	CRUISING			51	NOLIT-RECE	ITERS PER	LITHE OF	701L												
	1151	BUILT	SEATS	IN LINK	(III/81)	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
11-114	747 52	1981	313	24.5	900	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	
7 <b>6-81</b> B	747 52 -	1981	313	24.5	900	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	
YE-181	747 238	1971	397	27.7	910	27.7	27.7	27.7	27.7	35.1	35.7	35.1	35.7	35.7	35.7	35.7	35,7	35.7	35.7	35.7	35.7	35.7	35.7	
7 <b>8-</b> 883	747 238	1971	397	21.1	910	27.7	21.1	27.7	21.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	
YE-195	747 238	1974	397	27.7	910	27.7	21.7	27.7	27.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	
YH-181	747 238	1974	397	21.1	910	27.7	<b>11.1</b>	27.7	27.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.1	35.7	35.7	15.7	35.7	
YE-IBJ	747 238	1975	397	27.7	910	27.7	21.7	27.7	27.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	
YE-IBK	747 238	1975	397	27.7	910	27.7	21.1	27.7	27.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.1	35.7	35.7	35.7	35.7	35.7	
VE-IH	747 238	1976	397	21.7	910	27.7	27.7	11.1	11.1	35.7	35.7	35.7	35.7	35.1	35.7	35.7	35.1	35.7	35.7	35.7	35.7	35.7	13.1	
4E-19H	747 238	1977	397	11.1	910	11.1	11.1	11.1	11.1	11.1	36.1	36.1	38.1	36.1	36.1	JN.1	19.1	10.1	39.1	30.1	38.1	39.1	30.1	
48-181	747 238	1977	397	11.1	910	11.1	11.1	11.1	11.1	11.1	36.1	36.1	36.1	31.1	10.1	J0.1	39.1	30.1	39.1	30.1	38.1	30.1	30.1	
AH-RBO	747 238	. 1978	397	27.1	910	11.1	21.1	27.7	11.1	11.1	21.1	36.5	36.5	38.5	36.3	38.5	38.3	39.3	38.3	38.3	38.3	39.3	38.3	
18-185	147 238	1978	311	. 11.1	910	11.1	11.1	11.1	11.1	11.1	21.1		39.3	39.3	10.3	38.3	10.3	38.3	38.3	39.3	30.3 30.3	38.3	10.0	
AR-RAD	141 238	1979	. 397	11.1	910	11.1	11.1	11.1	21.1	11.1	21.1	11.1	38.3	38.9	11.7	38.7	10.7	39.7	38.7	38,7	38.7	38.7	30.7	
TE-SER	147 238	1980	397	11.1	910	11.1	11.1	11.1	11.1	11.1	11.1	21.1	21.1	37.3	17.1	37.3	37.3	31.3	31.3	31.3	31.3	37.3	37.3	
TE-LOS	747 238	1981	391	11.1	910	11.1	11.1	11.1	11.1	11.1	4.1	41.1	41.1	41.1	11.1	\$1.1	31.1	31.1	31.1	11.1	31.1	31.1	31.1	
VA-ICI	141 Z38C	17/7			710																			
YE-SCC	141 2380	1313	147		714				16.1	** 1	16.1	46.9	** 1	16.7	16 1	1¢ 1	16 1	10.0	10.0	18.6	18.8	18.8	18.8	
TE-BOT	747 330	1764	100	40.1	710	49.1	69.1	49.1	46.1	20.1	16 1	40,1	49.1	16.7	16 1	20.1	20.7	30.0	16 1	28 5	16 1	10.0	34 1	
YE-590	141 335	1983	106	19.1	210	49.1	40.7	· 49.1	20.1	49.1	40.7	40.1	49.7	40.1	24.1	20.1	24.1	76 7	10 1	39.1	10.1	35.1	39.1	
YE-68Y	747 338	1983-	100	10.1	710	10.1	20.1	20.1	20.1	16.1	26.1	20.1	20.1	16 7	16 7	26.7	26.7	20.1	26 7	39.1	18 5	19.5	19.5	
14-184	141 330	1700	300	49.1	714	49.1	16.1	20.1	20.7	20.7	40.7	40.1	26.1	26.7	16 7	26.7	26 7	26.1	26.7	16 5	18 5	10 5	18.5	
YE-LEL	141 330	1700	100	10.1	710	49.1	26.7	29.1	20.7	28.1	26.1	20.1	26.1	26 1	26.7	26 1	26.7	76 1	26.7	26.7	16 8	10 .8	19.8	
YE-181	747 330	1987	300	10.1	910	49.1	30.5	10.5	10.7	30.7	10.5	10.5	38 5	16 5	10.5	18 5	16 5	10.5	10.5	30.5	30.5	10.5	40.5	
	747 438	1997	104	10.3	510		30.5	30.3	38 5	30.5	10.5	10 5	30.5	16 5	10 5	30.5	10 5	10 5	30.5	30.5	10.5	30.5	40.5	
10-010	747 430	1707	444	39.3	910		30.3	30.5	30.3	10.5	30.5	10 5	10 5	10 5	30.5	30.5	10 5	10 5	10.5	30.5	30.5	30.5	44.5	
10-010	141 430	1307	106	30.3	910		30.3	10.5	30.5	30.5	10.5	30.5	10.5	30.5	10.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
10-000	747 418	1665	406	30.5	410			10 5	30.5	10.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	10.5	30.5	30.5	30.5	30.5	30.5	
10-076	141 430	1996	206	10.5	610				38 5	30.5	30.5	10.5	30.5	30.5	30.5	30.5	30.5	30.5	10.5	30.5	30.5	30.5	30.5	
10-036	747 418	1665	406	30.5	910				30.5	30.5	30.5	30.5	30.5	10.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
14-0JU	747 438	1990	106	10.5	910				30.5	38.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	10.5	30.5	30.5	30.5	
78-028 98.677	747 438	1996	100	16 5	910				10.5	10.5	38.5	10.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
98.AT	747 438	1881	406	10 5	\$10					30.5	10.5	30.5	30.5	30.5	30.5	39.5	30.5	30.5	10.5	30.5	30.5	30.5	30.5	
10-0JA	747 430	1661	104	10 5	910					30.5	10.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	10.5	30.5	30.5	30.5	30.5	
78-035	141 418	1841	101	10.5	910					30.5	30.5	10.5	10.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
14-VV4	141 418	1801	406	10.5	\$10					10 5	30.5	30.5	30.5	30.5	30.5	30.5	10.5	10.5	30.5	10.5	30.5	30.5	30.5	
10-010	747 418	1992	406	10 5	910						30.5	30.5	30.5	30.5	30.5	10.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
TE-OJP	747 438	1992	406	30.5	910						30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
TE-RIJ	767 2388B	1985	216	32.9	850	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	39.8	39.8	39.8	39.8	39.8	
TE-INT	767 23888	1985	216	32.9	850	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	39.8	39.8	39.8	39.8	39.8	
18-111	767 23884	1985	216	32.9	850	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	39.8	39.8	39.8	39.8	39.8	
TR-DAM	767 23888	1985	216	32.9	850	12.9	12.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	12.9	32.9	32.9	39.8	39.8	39.8	39.8	39.8	
18-218	767 21889	1986	216	12.4	850	32.9	32.9	32.3	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	40.1	49.1	40.I	40.1	
18-210	767 71APP	1986	216	12.4	850	32.9	12.9	32.9	32.9	12.9	32.9	12.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	40.1	40.1	40.1	40.1	
TR-RIA	767 23ARB	1987	216	32.1	850	12.9	12.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	40.5	40.5	40.5	
TABLE II.7 (cont)	INTERNATIONAL A	IRCRAFT:	TREND	SPECIFIC	FUEL	CONSUMPTION	FOR	REPLACEMENT	AIRCRAFT,															
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	15 YEAR ECONOM	IC LIFE							•															

100.0 100.1 108.2 111.5 114.4 117.6 122.2 127.8 133.3 138.1 144.9 152.1 158.4 141.4 165.0 170.3 176.4 180.3

VE. M. 147 11878 1878 117 14 850 14 6 14 6 14 6 14 6 14 6 14 6 14 6 14	0 40.8 40.8
lg.nam ini 970me 71nd 79'n 94'n 94'n 94'n 94'n 94'n 94'n 94'n 9	
VE-06C 767 338ER 1988 230 34.0 850 34.0 34.0 34.0 34.0 34.0 34.0 34.0 34.	0 40.8 40.8
YE-OGD 767 338EE 1988 230 34.0 850 34.0 34.0 34.0 34.0 34.0 34.0 34.0 34.	0 40,8 40.8
VE-OGE 767 338ER 1989 230 34.0 850 34.0 34.0 34.0 34.0 34.0 34.0 34.0 34.	0 34.0 41.2
VE-OC7 767 33888 1990 230 34.0 850 34.0 34.0 34.0 34.0 34.0 34.0 34.0 34.	0 34.0 34.0
YE-GGG 767 33888 1990 230 34.0 850 34.0 34.0 34.0 34.0 34.0 34.0 34.0 34.	0 34.0 34.0
YE-OGE 767 33628 1990 230 34.0 850 34.0 34.0 34.0 34.0 34.0 34.0 34.0 34.	0 34.0 34.0
FE-GGT 767 3361R 1991 230 34.0 850 34.0 34.0 34.0 34.0 34.0 34.0 34.0 34.	0 34.0 34.0
VE-007 767 3388 1991 230 34.0 850 34.0 34.0 34.0 34.0 34.0 34.0 34.0 34.	0 34.0 34.0
VE-OGE 767 338ER 1991 230 34.0 850 34.0 34.0 34.0 34.0 34.0 34.0 34.0 34.	0 34.0 34.0
YE-OGL 167 338ER 1991 230 34.0 850 34.0 34.0 34.0 34.0 34.0 34.0 34.0 34.	0 34.0 34.0
	1 14 4 15 1
	7 1 698407 1 698407
	1 175 1 177 0
	1 17 414 18 7
	7 220 9 210 6
	5 6 75 6 75

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MOTE: Aircraft replaced at 15 years or 1992 earliest.

1988 task adjusted for change in 747s seat numbers between 1988 and 1991.

Regression values for latest series used for replacements for earlier series.

Aircraft numbers as at 30 June.

INDEX OF FUEL USED (1988 BASE)

SOURCES: ARROCOST, Transport and Communications Indicators March 1989, Quatum annual reports,

Current seat numbers for 747s from DoTaC

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# INTERNATIONAL AIRCFAFT; 1990 SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT, 15 YEAR ECONOMIC LIFE

				AVERAGE	CRUISIN	]			SEAT-EILC	METERS PI	R LITRE C	P PUEL										
	TTPE	TEAR	SEATS	SEAT EN PER LITRE	SPKKI [IM/HI	2] 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
7E-131	747 SP	1981	313	24.5	900	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5
YH-KAN VH-KAN	747 5P 747 738	1981 1971	313	24.5	908 916	24.3	24.3	24.5	24.3	24.5	24.5	24.5	24.3	24.5	24.3	24.5	24.3	24.3 30.5	29.3 30.5	24.3	24.3 30.5	24.3 30.5
VE-KEB	747 238	1971	397	27.7	910	27.7	27.7	27.7	27.7	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VH-RHE	747 238	1974	397	27.7	910	27.7	27.7	27.7	27.7	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30,5	30.5
VH-BBI	747 238	1974	397	27.7	910	21.1	27.7	27.7	27.7	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VE-SEJ VE-PRT	747 238 747 238	1973	391 107	21,1	910	) 21.1 ) <b>21.1</b>	21.7	21.1	- 21.1	30.5	30.5 30 5	39.5 71 5	30.5	30.5	30.5 30.5	38.5	30.3 30.5	30.5	30.5	30.3 78 S	30.5	30.5
VH-IBL	747 238	1976	397	27.7	910	21.7	27.7	27.7	27.7	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VE-RBE	747 238	1977	397	27.7	910	27.7	27.7	27.7	27.7	27.7	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
YE-KBI	747 238	1977	397	27.7	910	27.7	27.7	27.7	27.7	27.7	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
AN-BBD AN-BBD	141 238	19/8	391	21.1	910	) [].]	21.1	21.1	21.1	21.1	21.1	30.3 20 5	30.5	30.5	30.5	30.3 20 5	30.3	30.3 70 S	30.5 70 C	10.5	10.5	30.5
VE-EBO	747 238	1979	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	21.7	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VE-IBR	747 238	1980	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VE-LES	747 238	1981	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30,5
VE-ICB	747 2380	1979	248		910	}																
VA-BUU VA-KBT	747 338	1984	290 386	26.7	910	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	30.5	30.5	30.5	30 5	30.5
VE-SBU	747 338	1985	386	26.7	910	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	30.5	30.5	30.5	30.5
VE-KBV	747 338	1985	386	26.7	910	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	30.5	30.5	30.5	30.5
VE-LEV	747 338	1986	386	26.7	910	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	34.9	34.9	30.5
VA-BBA	747 338	1987	300	26.7	910	26.7	26.7	26.7	26.7	28.7	26.1	26.7	26.7	26.1	26.7	20.1	26.7	26.1	26.7	30.3 26.7	30.3 30.5	30.5
VE-OJA	747 438	1989	406	30.5	910		30.5	30.5	30.5	30.5	30.5	30,5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VE-OJE	747 438	1989	406	30.5	910	1	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VE-OJC	747 438	1989	405	30.5	910		30.5	30.5	30.5	30.5	. 30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
78-0JU 78-0JU	/4/ 438 747 438	1990	4Uð 206	30.5	910	1		30,5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VH-OJT	747 438	1990	406	30.5	910			30.3	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.0	30.5
VE-OJG	747 438	1990	406	30.5	910	)			30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VH-OJH	747 438	1990	406	30.5	910	)			30.5	39.5	30.5	30,5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VE-OJJ	747 438	1998	406	30.5	910				30.5	- 30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VH-OJL	747 438	1991	406	30.5	910	1				30.5	30.5	30.5	30.5	30.5 38 5	30.5 10.5	30.5	30.3 30.5	30.5	30.5	30.5	10.5 18 5	30.5
VE-OJK	747 438	1991	406	30.5	910					30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30,5	30,5
VE-OJE	747 438	1991	406	30.5	910	1				30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VH-OJO	747 438	1992	406	30.5	910						30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
TE-OJF	141 430	1332	440	30.3	711						30.3	30,3	30.3	20.2	30.3	30.3	20.3	30.3	30.3	30.3	34.3	34.3
VE-RAJ	767 Z38ER	1985	216	32.9	850	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	34.0	34.0	34.0	34.0
VE-ENI	767 238BR	1985	216	32.9	850	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	34.0	34.0	34.0	34.0
VE-SAL VE-SAL	767 2385R	1985	216	3Z.9	858	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	34.0	34.0	34.0	34.0
VH-KAN	767 238ER	1986	216	32.9	850	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.5	32.9	32.9	32.9	39.0	34.0	34.0	34.0 34.0
VH-ELO	767 238ER	1986	216	32.9	850	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	34.0	34.0	34.0
VE-ERO	767 238ER	1987	216	32.9	850	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	34.0	34.0
VE-OGA	767 338ER	1988	230	34.0	859		34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VE-OGB	767 3385R	1988	230	34.0	850		34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VE-OGC	767 338ER 767 778ER	1988	Z30	34.0	850		34.0	34.0	34.8	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0 37.0	34.0	34.U 74.0	34.0	34.U 34.0
VH-OGK	767 338KR	1989	230	34.0	850		34.4	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VE-067	767 338KR	1990	230	34.0	850			••	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VE-OCG	767 338ER	1990	230	34.0	850				34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VE-OGE	767 338ER	1990	230	34.0	850				34.0	34.0	34.0	34.0	34.0	34.8	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VE-OGI	767 138EP	1991	230	14.U 74.B	63V 850					34.0	34.U 34.B	34.U 34.A	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VE-OGI	767 338KR	1991	230	34.0	850					34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.8	34.0	34.0	34.0
VE-OGL	767 338BR -	1991	230	34.0	850					34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
1770107	(219.FN/r			••••••				79 7	76 1		70 A	20 1	 2n 7	 3A 3	••••••	 2A 1	 1A 7	20 4	7n c	 ۱۸ ۵	¥1 A	11 N
TASE (SE	NT-EK/ER)				;	8.885+06 9.	. BOE+06 1	.188+07 1.	.398+07 1	.62E+07 1	.69 <b>5</b> +07 1	.698+07 1	.69E+07 1	.695+07 1	.698+07 1	.69E+07 1	.698+07 1	.69E+07 1	.698+07 1	. 698+07 1	1.69 <b>2</b> +07 1	.69E+07 1.6!
INDEX OF	PLEET FUEL 1	RPPICIERC)	T (1988	BASE)		100.0	103.0	104.5	105.9	108.8	109.3	109.8	110.0	110.3	110.5	110.5	110.5	110.8	111.7	112.7	113.1	112.8 :
TASE [10	TAL INTERNATI	IONAL PAS	S. NOVI	NEUTS: will	ions]	7.894	8.14	8.93	9.32	10.05	10,437	10.975	11.547	12.119	12.72	13.352	14.015	14.712	15.349	16.015	16.711	17.439
LOAD PAC	TASE (1988 ) 109	HA38)				108.0	103.1 075	113.1	118.1	127.3	13Z.Z 0 75	139.0	146.3	153.5	161.1	169.1 n 74	177.5	186.4	194.4	202.9 A 75	211.7	220.9 :
INDER OF	FORL OSED (1	1988 BASK	١			100.0	100.1	108.2	111.5	117.0	120.9	126.6	132.9	139.2	145.8	153.0	160.6	168.1	174.1	180.0	187.2	195.9 :

NOTE: Aircraft replaced at 15 years or 1992 earliest. 1988 task adjusted for change in 747s seat numbers between 1988 and 1991. Regression values for latest series used for replacements for earlier series.

Lincraft numbers as at 30 June. SOURCES: AFROCOST, Fransport and Communications Indicators March 1989, Gantas annual reports, -Current seat numbers for 747s from BoTaC

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## INTERNATIONAL AIRCRAFT: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT, 20 YEAR ECONOMIC LIFE

TH         EX         101         EX         101					AVERAGE	CRUISING				SEAT-RIL	WITERS P	SR LITRE (	)? YOLL											
Teal         199         198         198         199         198         190         120 <th></th> <th>TIPI</th> <th>YLAR BUILT</th> <th>SEATS</th> <th>FIR LITER</th> <th>SPKED [III/ER</th> <th>] 1988</th> <th>1989</th> <th>1990</th> <th>1991</th> <th>1992</th> <th>1993</th> <th>1994</th> <th>1995</th> <th>1996</th> <th>1997</th> <th>1998</th> <th>1999</th> <th>2000</th> <th>2001</th> <th>2002</th> <th>2003</th> <th>2004</th> <th>2005</th>		TIPI	YLAR BUILT	SEATS	FIR LITER	SPKED [III/ER	] 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Name         Name <th< th=""><th>TE-EN</th><th>747 52</th><th>1981</th><th>313</th><th>24.5</th><th>900</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>30.4</th><th>30.4</th><th>30.4</th><th>30.4</th></th<>	TE-EN	747 52	1981	313	24.5	900	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	30.4	30.4	30.4	30.4
Term         Term <th< th=""><th>YE-548 TR.PR</th><th>747 238</th><th>1981</th><th>313 787</th><th>24.3</th><th>500</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.5</th><th>24.3</th><th>24.3 15 T</th><th>24.3</th><th>14.2</th><th>24.5</th><th>24.5</th><th>24.3</th><th>30.4</th><th>30.4</th><th>30.4</th><th>30.9</th></th<>	YE-548 TR.PR	747 238	1981	313 787	24.3	500	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.3	24.3 15 T	24.3	14.2	24.5	24.5	24.3	30.4	30.4	30.4	30.9
Nete         O	TE-IND	747 238	1971	397	27.7	910	27.7	27.7	27.7	27.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.7	35.1	35.7	35.7	35.7
Best         No.18         201         80         201         80         201         80       <	YE-IBE	747 238	1974	397	27.7	910	27.7	27.7	27.7	27.7	34.5	34.5	34.5	36.5	36.5	36.9	36.5	36.9	36.9	36.9	36.9	36.9	36.9	36.9
Bios         Dial         Dial <thdial< th="">         Dial         Dial         <thd< th=""><th>YE-REI</th><th>747 238</th><th>1974</th><th>397</th><th>27.7</th><th>910</th><th>27.7</th><th>11.1</th><th>21.7</th><th>27.7</th><th>34.5</th><th>34.5</th><th>34.5</th><th>36.9</th><th>36.5</th><th>36.9</th><th>36.5</th><th>36.9</th><th>36.9</th><th>36.9</th><th>36.9</th><th>36.5</th><th>36.9</th><th>36.9</th></thd<></thdial<>	YE-REI	747 238	1974	397	27.7	910	27.7	11.1	21.7	27.7	34.5	34.5	34.5	36.9	36.5	36.9	36.5	36.9	36.9	36.9	36.9	36.5	36.9	36.9
TATE         TATE <th< th=""><th>TH-LDJ VH-TRI</th><th>747 238</th><th>1972</th><th>337 197</th><th>27.7</th><th>910</th><th>21.1</th><th>21.7</th><th>27.7</th><th>27.7</th><th>21.1</th><th>27.7</th><th>21.7</th><th>27.7</th><th>37.3</th><th>37.3</th><th>37.3</th><th>37.3</th><th>37.3</th><th>37.3</th><th>37.3</th><th>37.3</th><th>37.3</th><th>37.3</th></th<>	TH-LDJ VH-TRI	747 238	1972	337 197	27.7	910	21.1	21.7	27.7	27.7	21.1	27.7	21.7	27.7	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3
9:H0         0f         10         201         0f         20.         0f         0f        0f         0f	VE-SEL	747 238	1976	397	27.7	910	27.7	27.7	27.7	27.7	27.1	27.7	27.7	21.7	21.1	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.1	37.7
NETH         00         100 <th>YE-BBH</th> <th>747 238</th> <th>1977</th> <th>397</th> <th>27.1</th> <th>910</th> <th>27.7</th> <th>27.7</th> <th>27.7</th> <th>27.7</th> <th>27.7</th> <th>27.1</th> <th>21.7</th> <th>21.7</th> <th>27.1</th> <th>17.7</th> <th>38.1</th> <th>38.1</th> <th>38.1</th> <th>38.1</th> <th>38.1</th> <th>38.1</th> <th>38.1</th> <th>38.1</th>	YE-BBH	747 238	1977	397	27.1	910	27.7	27.7	27.7	27.7	27.7	27.1	21.7	21.7	27.1	17.7	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
No.         No. <th>VE-KDI</th> <th>747 238</th> <th>1977</th> <th>397</th> <th>27.1</th> <th>910</th> <th>27.7</th> <th>21.7</th> <th>27.7</th> <th>27.7</th> <th>21.1</th> <th>21.1</th> <th>27.7</th> <th>27.7</th> <th>27.7</th> <th>17.7 27.7</th> <th>38.1</th> <th>38.1</th> <th>38.1</th> <th>38.1</th> <th>38.1</th> <th>38.1</th> <th>38.1</th> <th>38.1</th>	VE-KDI	747 238	1977	397	27.1	910	27.7	21.7	27.7	27.7	21.1	21.1	27.7	27.7	27.7	17.7 27.7	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
9         9         0         0.1	TE-IBP	747 238	1978	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	21.7	27.7	27.1	38.5	38.5	38.5	38.5	38.5	38.5	38.5
Here         Ho         19         210	VE-IBQ	747 238	1979	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.1	27.7	27.7	21.1	27.7	27.1	27.7	38.8	38.8	38.8	38,8	38.8	38,8
No. 10         No.10         No.10         No.10 <th>YE-BER</th> <th>747 238</th> <th>1980</th> <th>397</th> <th>27.7</th> <th>910</th> <th>21.7</th> <th>27.7</th> <th>21.7</th> <th>21.1</th> <th>27.7</th> <th>27.1</th> <th>27.7</th> <th>27.7</th> <th>27.7</th> <th>27.7</th> <th>21.1</th> <th>27.7</th> <th>27.1</th> <th>39.1</th> <th>39.1</th> <th>39.1</th> <th>39.1</th> <th>39.1</th>	YE-BER	747 238	1980	397	27.7	910	21.7	27.7	21.7	21.1	27.7	27.1	27.7	27.7	27.7	27.7	21.1	27.7	27.1	39.1	39.1	39.1	39.1	39.1
Targer 16 210:         101         103         113	TE-LES	141 238 747 7380	1981	397	11.1	910 610	21.1	11.1	<b>21.</b> 1	11.]	27.1	21.1	11.1	27.7	21.1	$n_{i}$	11.1	11.1	11.1	21.1	39.4	39.4	39.4	39.4
Tend         19/13         19/44         19/54         19/54         19/5         18/5         18/7       <	VE-LCC	747 238C	1979			910																		
TEAM         TO         195         185         187 <th>YE-KBT</th> <th>747 338</th> <th>1984</th> <th>386</th> <th>26.7</th> <th>910</th> <th>26.7</th> <th>25.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>40.5</th>	YE-KBT	747 338	1984	386	26.7	910	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	25.7	26.7	26.7	26.7	26.7	26.7	26.7	40.5
Birler         Birler<	TE-IBU	747 338	1985	386	26.1	910	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7
TETE         TOTAL         1993         MA         X.3         NA         X.3         X.3 <thx.3< t<="" th=""><th>YH-121 78-121</th><th>747 338</th><th>1986</th><th>356 186</th><th>26.7</th><th>910</th><th>24.1</th><th>26.7</th><th>26.1</th><th>26.7</th><th>26.7</th><th>26.1</th><th>26.7</th><th>20.1 76.7</th><th>26.7</th><th>26.1 16.1</th><th>26.7</th><th>26.7</th><th>26.1 76.7</th><th>20.3 26 J</th><th>26.7</th><th>20.1</th><th>26.7</th><th>26.7</th></thx.3<>	YH-121 78-121	747 338	1986	356 186	26.7	910	24.1	26.7	26.1	26.7	26.7	26.1	26.7	20.1 76.7	26.7	26.1 16.1	26.7	26.7	26.1 76.7	20.3 26 J	26.7	20.1	26.7	26.7
H-D2         107 <th>TE-TEL</th> <th>747 338</th> <th>1986</th> <th>386</th> <th>26.7</th> <th>910</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>25.7</th> <th>26.7</th> <th>25.7</th> <th>26.7</th>	TE-TEL	747 338	1986	386	26.7	910	26.7	26.7	26.7	26.7	26.7	25.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	25.7	26.7
Re-LA         101 </th <th>YE-KBY</th> <th>747 338</th> <th>1987</th> <th>386</th> <th>26.7</th> <th>510</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>28.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th> <th>26.7</th>	YE-KBY	747 338	1987	386	26.7	510	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	28.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7
Head         No         10         No         10         1	TE-OJA	747 438	1989	406	30.5	910		30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
THE-DT         TOP CDT         DIS         DIS <thdis< th="">         DIS         DIS         <thdi< th=""><th>75-0JC</th><th>747 438</th><th>1989</th><th>406</th><th>30.5</th><th>910</th><th></th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th></thdi<></thdis<>	75-0JC	747 438	1989	406	30.5	910		30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
TH-CDT         TM-CDT         TM-CDT<	TE-OJD	747 438	1990	406	30.5	910			30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
THE AT         THE AT<	VE-OJE	747 438	1990	606	30.5	910			30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
Te-tor         Tor         Tor <thtor< th=""> <thtor< t<="" th=""><th>YH-OJY</th><th>747 438</th><th>1990</th><th>405</th><th>30.5</th><th>910</th><th></th><th></th><th></th><th>30.5 14 t</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5 10 K</th></thtor<></thtor<>	YH-OJY	747 438	1990	405	30.5	910				30.5 14 t	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5 10 K
TR-07         TV F08         199         66         31.5         91.5 <th< th=""><th>VE-OJE</th><th>747 438</th><th>1990</th><th>406</th><th>30.5</th><th>910 910</th><th></th><th></th><th></th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>~ 30.5 ~ 30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th></th<>	VE-OJE	747 438	1990	406	30.5	910 910				30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	~ 30.5 ~ 30.5	30.5	30.5	30.5	30.5
TH-CAT         TAT         TAT <thtat< th=""> <thtat< t<="" th=""><th>VE-OJJ</th><th>747 438</th><th>1990</th><th>405</th><th>30.5</th><th>910</th><th></th><th></th><th></th><th>3¢.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th><th>30.5</th></thtat<></thtat<>	VE-OJJ	747 438	1990	405	30.5	910				3¢.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
UE-01.         44/18         191         64/18         191         64/18         191         64/18         191         64/18         191         64/18         10.5	VE-OJI	747 438	1991	406	30.5	910					30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
TE-CAT         NO         Dist         NO         Dist         NO         Dist         NO         Dist         NO         Dist         Dist <thdist< th=""> <thdist< th=""> <thdist< th=""></thdist<></thdist<></thdist<>	VE-OJL VE-OTV	747 438 747 438	1991	406	38.5	910 910					30.5	30.5	30.5	30.5 36 5	30.5	30.5	30.5	30.5	30.5	30.5	30.5 30.5	30.5	38.5	30.5 30.5
TE-007         747         488         192         465         31.5         91.5         31.5         91.5         31.5         91.5         31.5         91.5         31.5         91.5         31.5         91.5         31.5         9	TE-OJE	747 438	1991	406	30.5	910				~	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	. 30.5	30.5	30.5	30.5	30.5
TE-COP       TAT GR       1992       406       30.5       51.0       31.5	- VE-OJO	747 438	199Z	406	30.5	910						30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
TE-GL       NOT TANKE       1985       215       32.9       31.9       32.9	- YE-OJP	747 438	1992	405	30.5	910						30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
Terlar       No. 1088       1012       10133       1013       1013 <th>YE-KAJ</th> <th>767 238<b>88</b></th> <th>1985</th> <th>216</th> <th>32.9</th> <th>850</th> <th>32.9</th> <th>32.9</th> <th>32.9</th> <th>32.9</th> <th>32.9</th> <th>32.5</th> <th>32.9</th> <th>32.9</th> <th>32.9</th> <th>12.9</th> <th>32.3</th> <th>32.9</th> <th>32.9</th> <th>32.9</th> <th>32.9</th> <th>32.9</th> <th>32.9</th> <th>32.9</th>	YE-KAJ	767 238 <b>88</b>	1985	216	32.9	850	32.9	32.9	32.9	32.9	32.9	32.5	32.9	32.9	32.9	12.9	32.3	32.9	32.9	32.9	32.9	32.9	32.9	32.9
YE-LAN       167 2382R       1965       216       32.9	VE-SAL	767 238ER	1985	216	32.5	850	32.9	32.9	32.9	32.9	32.9	12.9	32.9	32.9	32.5	32.9	32.9	32.9	32.5	32.9	32.9	32.5	32.5	32.9
VE-Lat       167       2188       1986       216       32.9       31.9       32.9	VE-KAN	767 238ER	1985	216	32.9	850	32.9	32.5	32.9	32.5	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32,9	32.9	32.9	32.5	32.9	32.9	32.9
TF-LAD       767       32.5       850       32.5	YE-LAN	767 238KB	1986	218	32.9	850	32.9	32.9	32.9	32.5	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9
Hereast (V) down	VE-JAD	767 23888 767 73888	1985	216	32.9	850	32.9	32.9	32.9	32.5	32.9	32.3	32.9	32.9	32.9	32.9	32.3	37.9	32.9	32.9	32.9	32.5	32.9	32.9
VE-OGD       767       3388       1986       233       34.0	VE-OGA	767 338ER	1988	230	34.0	850	46.3	34.0	34.1	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
WE-GC       767       33822       1988       233       34.0       850       34.0	VE-OGB	767 338ER	1988	230	34.0	850		34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.6	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
YE-GGE 767 338EE 1950       230       34.0 <td< th=""><th>VE-OGC</th><th>767 338KR</th><th>1988</th><th>230</th><th>34.0</th><th>850</th><th></th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th></td<>	VE-OGC	767 338KR	1988	230	34.0	850		34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
Actor of 3388       190       210       34.0 <th>VE-OGD VE-OGT</th> <th>767 33888</th> <th>1958</th> <th>230 230</th> <th>34.0</th> <th>850 150</th> <th></th> <th>34.0</th> <th>34.0 14.0</th> <th>34.0</th> <th>34.0</th> <th>34.0 34.0</th> <th>34.0</th> <th>34.0</th> <th>34.0</th> <th>34.0 14.0</th> <th>34.0</th> <th>34.0</th> <th>34.0</th> <th>34.0 14.0</th> <th>34.0</th> <th>34.0 37.0</th> <th>34.0 34.0</th> <th>34.0 14 n</th>	VE-OGD VE-OGT	767 33888	1958	230 230	34.0	850 150		34.0	34.0 14.0	34.0	34.0	34.0 34.0	34.0	34.0	34.0	34.0 14.0	34.0	34.0	34.0	34.0 14.0	34.0	34.0 37.0	34.0 34.0	34.0 14 n
TE-OGG       767       338Ex       1990       230       34.0       850       34.0	VE-OGT	767 338EE	1990	230	34.0	850			29.0	34.8	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
RE-GER 767 338ER 1990       220       34.0       859       34.0	VE-OGG	767 338 <b>ER</b>	1990	230	34.0	850				34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
TE-UGI 767 338ER 1991       210       34.0 <td< th=""><th>TE-OGE</th><th>767 338EE</th><th><u>1990</u> 1881</th><th>230</th><th>34.0</th><th>850 850</th><th></th><th></th><th></th><th>34.8</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th><th>34.0</th></td<>	TE-OGE	767 338EE	<u>1990</u> 1881	230	34.0	850 850				34.8	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
TH-OGK 77 338ER 1991 230 34.0 850       34.0 34.0 34.0 34.0 34.0 34.0 34.0 34.0	VE-OGI	767 33812	1991	230	34.0 34.0	850 850					34.0	34.0 34 D	34.0	34.U 34.D	34.8 36 B	34.V 34.D	14.0 14.0	34.0	34.V 34.0	34.0 14.0	34.0 74.0	34.V 34.0	34.U 34.D	34.0
YH-OGL 767 338ER 1991       230       34.0       850       34.0	VE-OGX	767 338KR	1991	230	34.0	850					34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
ATTRACK SLAT-EM/L         27.9         28.3         28.7         29.1         30.3         30.0         30.1         30.5         30.6         21.0         31.5         31.7         31.9         32.4 <th>VE-OGL</th> <th>767 338<b>ER</b></th> <th>1991</th> <th>230</th> <th>34.0</th> <th>850</th> <th></th> <th></th> <th></th> <th></th> <th>34.0</th>	VE-OGL	767 338 <b>ER</b>	1991	230	34.0	850					34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
TAIL (SEAT-EX/EE)         8.888+06 9.802+06 1.168+07 1.592+07 1.692+07	)4803CE	SEAT-EN/1.		•••••			·····	78 1	78 7		18 1	 1A A	30 A	 1/1 (	 10 5	10 6	າ <u>1</u> ກ	11 6	11 7	<u>۱</u> ۹	17 1	17 1	19 1	17 1
INDIX OF FLKET FUEL KFFICIENCT (1988 BASE)         100.0         101.5         102.9         104.3         107.6         107.7         106.0         109.3         110.0         111.4         112.9         113.7         114.5         116.4 <th>TASI (SE</th> <th>H-B/B)</th> <th></th> <th></th> <th></th> <th></th> <th>8.888+06 S</th> <th>1.80X+06 1</th> <th>.188+07</th> <th>1.398+07</th> <th>.628+07</th> <th>1.698+07 :</th> <th>L.698+07</th> <th>1.691+07</th> <th>1.69X+07</th> <th>1.698+07</th> <th>1.691+07</th> <th>1.691+97</th> <th>1.691+07</th> <th>1.69<b>5</b>+07 :</th> <th>1.698+07</th> <th>1.698+07</th> <th>1.692+07 :</th> <th>1.691107</th>	TASI (SE	H-B/B)					8.888+06 S	1.80X+06 1	.188+07	1.398+07	.628+07	1.698+07 :	L.698+07	1.691+07	1.69X+07	1.698+07	1.691+07	1.691+97	1.691+07	1.69 <b>5</b> +07 :	1.698+07	1.698+07	1.692+07 :	1.691107
TASE [TOTAL BETERRATIONAL PASS, BUYLEKETS: BILLIONS]         7.894         8.14         8.77         9.72         10.3         10.8         11.3         11.9         12.5         13.2         13.9         14.8         15.5         16.9         16.1         19.4         20.8         22.3           HNDE OF TASE (1988 BASE)         100.0         103.1         111.1         125.7         136.6         143.1         150.7         156.3         167.2         175.1         187.5         200.2         214.1         229.3         245.8         263.5         282.5           LOAD FACTOR         0.75	INDIA OF	FLEET FOEL	IFFICIERC	T (1988	BASE)		100.0	101.5	102.9	104.3	107.6	107.7	107.7	108.0	109.3	110.0	111.4	112.9	113.7	114.5	116.4	116.4	116.4	117.4
Number         Numer         Numer         Numer <th>TASE [10</th> <th>TAL LUTKRRAT VART (1660</th> <th>TOBAL PAS</th> <th>5. IOVI</th> <th>ALETS: Bil.</th> <th>lichs</th> <th>7.894 184 A</th> <th>8.14 101 5</th> <th>B.77</th> <th>9.92 175 T</th> <th>10.3 514 S</th> <th>10.8</th> <th>11.3</th> <th>11.9</th> <th>12.5</th> <th>13.2</th> <th>13.9</th> <th>14.8 187 F</th> <th>15.8</th> <th>16.9</th> <th>18.1</th> <th>19.4</th> <th>20.8 261 x</th> <th>77.3</th>	TASE [10	TAL LUTKRRAT VART (1660	TOBAL PAS	5. IOVI	ALETS: Bil.	lichs	7.894 184 A	8.14 101 5	B.77	9.92 175 T	10.3 514 S	10.8	11.3	11.9	12.5	13.2	13.9	14.8 187 F	15.8	16.9	18.1	19.4	20.8 261 x	77.3
INDEX OF PULL USED (1988 BASE)         100.0         101.6         107.9         129.5         121.2         127.0         132.9         139.6         144.9         152.1         158.1         166.0         196.3         197.1         211.2         226.5         240.7	LOAD FAC	IOR	-a				0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
	INDEX OF	PURL USED (	1988 BASE	1)			100.0	101.6	107.9	129.5	121.2	127.0	132.9	139.6	144.9	152.1	158.1	166.0	176.0	186.9	197.1	211.2	226.5	240.7

BOTE: Aircraft replaced at 15 years or 1992 earliest.

1988 task adjusted for change in 747s seat numbers between 1988 and 1991.

SOURCES: AEROCOST, Transport and Communications Indicators Harch 1989, Qantas annual reports, Current seat numbers for 747s from DoTaC

				AVERAGE C	RUISING				SEAT-EILC	METERS PI	R LITRE (	IP POEL					•••••	••••••				
	TTPE	BUILT	SEATS	PER LITER	SPEED [III/III]	] 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
VE-EXA	747 SP	1981	313	24.5	900	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5
VU-SAU VH-KRA	747 SP 747 238	1981	313 .397	24.5	900 910	24.5	24.5	24.5	24.3	24.5	24.3	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5
VH-IBB	747 238	1971	397	27.7	910	27.7	27.7	27.7	27.7	27.1	27.7	27.7	27.7	27.7	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3
VH-BBE	747 238	1974	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	38.8	38.8	38.8	38.8	38.8
VH-KBI VV-VN1	747 Z38 JA7 218	1974	397	27.7	910 910	21.7	27.7	27.7	27.7	27.1	27.7	27.7	27.7	21.7	27.7	27.7	27.7	38.8	38.8	38.8	38.8	38.8
VE-BBK	747 238	1975	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	21.7	27.7	27.7	39.1	39.1	39.1	39.1
VE-EBL	747 238	1975	397	27.7	910	27.7	27.7	27.7	27.7	27.1	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	39.4	39.4	39.4
VH-KBA	747 238	1977	397	27.7	. 910	27.7	27,1	27.7	27.7	27.1	27.7	27.7	27.7	27.7	21.1	27.7	27.7	27.7	27.1	27.7	39.8	39.8
VH-KHU VH-KHO	747 238	1977	397	- 21.1	910 910	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	27.7	27.7	27.7	39.8	39.8
VE-SBP	747 238	1978	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.1	27.7	27.7	27.7	27.7	27.7	27.7	40.2
VX-680	747 238	1979	397	27.7	910	27.7	27.7	27.1	27.7	27.7	27.7	27.7	27.7	27.1	27.7	27.7	27.1	27.7	27.7	27.7	27.7	27.7
VE-KOR	747 238	1980	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	27.7	21.1	27.7	21.1	27.7	27.7	27.1	27.7	27.7	27.7	27.7
VH-585 VH-565	747 238	1981 1979	231	21.1	918 918	21.1	11,1	21.1	<i>u.</i> )	21.)	11.1	21.1	11.1	27.7	21.1	21.7	21.1	27.1	21.1	27.7	21.7	21.1
VE-LCC	747 238C	1979			910																	
VE-RET	747 338	1984	385	26.7	910	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	25.7
VH-880	747 338	1985	386	- 26.7	910	26.7	26.7	26.7	26.7	25.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	25.7	26.7	26.7	26.7	26.7
18-LBT	747 338	1986	386	26.7	910	26.7	26.1	26.7	26.7	28.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.1	20.1	26.7	26.7	28.7
VE-KBI	747 338	1986	386	26.7	910	25.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7
VE-RBY	747 338	1987	386	26.7	910	26.7	25.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7
VE-OJA	747 438	1989	406	30.5	910		30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VH-OJC	747 438	1989	406 406	30.3	910		10.5	30.3 30.5	30.5 30.5	30.3	30.5	30.5	30.3 10 5	30.5	30.5 30.5	30.5	30.5 10.5	38.5 70 5	30.5 38.5	30.5	38.5	30.5
VE-OJD	747 438	1990	406	: 30.5	910			30.5	30.5	30.5	10.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VE-OJE	747 438	1990	406	30.5	910			30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VE-OJP	747 438	1990	406	30.5	910				30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VH-OJH	747 438	1990	406 406	30.5	910				30.5 10.5	30.5	10.5	30.5	30.5 10.5	30.3 78 5	30.5 30.5	10.5 10.5	38.3	30.3 78 5	30.5 10 G	30.5	30.5	30.5
VE-OJJ	747 438	1990	406	30.5	910				30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VE-OJI	747 438	1991	406	30.5	910					30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VE-OJL	747 438	1991	405	30.5	910					30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VE-OJE VE-OJE	747 438	1991	406	30.5	910					30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VE-OJO	747 438	1992	406	30.5	910						30.5	30.5	30,5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VE-OJP	747 438	1992	406	30.5	910					.*	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
VH-KAJ	767 238ER	1985	216	32.9	850	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9
VH-SAL VH-SAL	767 2305R	1905	216	32.9	850 856	32.9	32.9	32.9	.37.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	3Z.9	32.9	32.9	32.9	3Z.9
VE-LAN	767 238ER	1985	216	32.9	850	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9
VE-RAI	767 Z38KR	1986	216	32.9	850	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9
VE-INO	767 238KR	1986	216	32.9	850	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9
15-275	101 2305K	1391	216	32.9	900	34.9	32.9	32.9	32.9	32.9	34.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	\$2.9	52.9	32.9	32.9
VH-OGA	767 338EE	1988	230	34.0	850		34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VE-OGC	767 3388P	1988	230	34.0	850		34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VE-OGD	767 338KR	1988	230	34.0	850		34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VH-OGE	767 338ER	1989	230	34.0	850			34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VE-OGY	767 338ER	1990	230	34.0	850				34.0	34.0	34.0	34.0	34.0 14 A	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VE-OGH	767 3388P	1990	230	34.0	850				34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VE-OGI	767 338ER	1991	230	34.0	850				••••	34.0	34.0	34.0	34.9	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VH-OGJ	767 338ER	1991	230	34.0	850					34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0	34.0
VH-OGI	767 33888 767 33888	1991 1991	230	34.0 34.0	850 850					34.0 34 A	34.0 34.0	34.0 34.0	34.0 14.0	34.0 34.0	34.0 14 0	34.0 14 n	34.0 34.0	34.0 34.0	34.0 14.0	34.0 14 D	34.0 34.0	34.0 34.0
. 1 . 002	101 JJ054	1771	234		330					47.Ÿ	47.0	37.9	47.0	****	37.0	JT.V	41.4	JT.V	21.4	41.0	JT.V	93.9
AVERAGE	SBA?-EM/L					27.4	28.3	28.7	29.1	29.4	29.4	29.4	29.4	29.4	29.8	29.8	29.8	30.2	30.6	30.8	.31.3	31.7
TASE (SE				-	1	8.888+06 9	.808+06 1	.188+07 1	.398+07 1	.62E+07 1	107 2	107 7	1.69%+07 . 107 7	1.695+07 : 107 7	1.698+07	1.698+07	1.698+07	1.69E+07 :	111 5	1.698+87 : 117 3	117 A	69E+07 1.
TASE (90	TEEET TUKL TAL THYRDDE	ATTICIES HONAL PA	CT (1988 CT (1988	MERTS: mill	lionsl	100.0 7,894	103.0 8,14	104.3	9.97	107.1	107.3	11.3	107.5	12.5	105.6	13.0	100.0	110.0	111.3	112.J 18.1	19.4	20.8
INDER OF	TASE (1988	BASE)			1	100.0	103.1	111.1	125.7	130.5	136.8	143.1	150.7	158.3	167.2	176.1	187.5	200.2	214.1	229.3	245.8	263.5
LOAD FAC	TOR		_,			0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
INDER OF	FUEL USED	1968 BAS	6) 			100.0	100.1	106.3	118.7	121.8	127.5	133.4	140.5	147.6	154.0	16Z.Z	172.7	182.0	192.0	Z04.Z	Z15.7	227.8

NOTE: Aircraft replaced at 15 years or 1992 earliest.

1988 task adjusted for change in 747s seat numbers between 1988 and 1991.

Regression values for latest series used for replacements for earlier series.

Aircraft numbers as at 30 June. SOURCES: AEROCOST, Transport and Communications Indicators March 1989, Qantas annual reports, Current seat numbers for 747s from DoTaC

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### APPENDIX III GREENHOUSE GAS EMISSIONS

An attempt has been made to estimate the effects of improved fuel economy in ships and aircraft on  $CO_2$  emissions. Arbitrary assumptions have been made about the future policy environment in predicting the future levels of transport tasks. Changes in policy have the potential to render these projections meaningless.

As well, there is no consensus regarding the way in which responsibility for emissions from international transport might be allocated under any global agreement to reduce greenhouse emissions. The responsibility may or may not rest with the ownership of the carrier. Australian-flag ships carry only a small percentage of the huge tonnages of Australian imports, and more especially, exports which are transported over very long distances. Qantas may have significant overseas ownership in the future.

No attempt has been made to estimate the effects of improved fuel economy on the emissions of other greenhouse gases, such as CO, hydrocarbons (HC) or nitrous oxide  $(N_2O)$ . It should be noted, however, that improved fuel economy is likely to increase the rate of NOx emissions, including  $N_2O$ , per unit of fuel consumed, due to the increased engine temperatures this implies.

#### SHIPPING

#### Coastal

If the coastal shipping task were to follow recent trends, the total tonne-kilometres performed would remain fairly static. In this case it would seem that, without increased use of

alternative fuels such as natural gas<sup>6</sup>. or increased use of better quality fuels in diesel engines, the amount of fuel used by, and hence emissions from, the coastal shipping major trading fleet would fall by about 40 per cent from 1988 levels by 2005.

Coastal shipping would thus have a positive, though small, contribution to make to the mitigation of greenhouse emissions, even in the absence of modal shifts which may occur in the future (see below). Coastal shipping has been estimated to have emitted only about 4 per cent of the greenhouse emissions from Australian domestic transport (BTCE 1991).

The potential reduction in emissions (from 1988 levels) from the coastal shipping major trading fleet suggested by the model is almost 1 megatonne of CO, in 2005. This is less than 1 per cent of the estimated emissions of about 100 megatonnes from Australian domestic transport in 2005 suggested by projections of energy (1991). ABARE's ABARE's usage projections already incorporate some assumed future gains in fuel efficiency for the various modes of transport.

Were the task of the coastal major trading fleet to grow at 1 per cent per year on average, then the model suggests that fuel used, and hence emissions, would still be some 16 per cent (or almost 0.4 megatonnes) below 1988 levels in 2005. If this growth in task were to be the result of modal shift, then total emissions from transport would be reduced still further.

<sup>6</sup> The Australian coastal ship Accolade II operates primarily on CNG, with diesel used as a pilot fuel to promote fuel ignition. LNG tanker ships carrying exports of LNG from the NW shelf are fuelled largely by boil-off from the cargoes they carry, although HFO may be used as a supplement. Some cargo is retained in the tanks for fuel on the return voyage. No problems have been experienced by the operator with LNG as a fuel (1991 personal communication with operators).

#### Modal shift

For non-bulk freight, general cargo coastal ships, with an average emissions rate of around  $27^7$  grams of  $CO_2$  per tonnekilometre (based on the ANMA data in table 2.1, and assuming a speed of 13 knots, with an average load factor of two-thirds), had a much lower rate of emissions than rail (46 grams per tonne kilometre), and about one-quarter the rate of emissions from the average articulated truck: 104 grams per tonne kilometre (BTCE 1991, as revised).

For the bulk freight task in 1988, the rate of emissions from coastal shipping is about 7 grams per tonne-kilometre, based on the ANMA data in table 2.1). This is lower than that of private railways (10 grams per tonne-kilometre, largely for mineral railways running to the coast), and considerably lower than that of government bulk rail: 35 grams of  $CO_2$  per tonne-kilometre (BTCE 1991, as revised).

However, the scope for modal shift to coastal shipping may be limited.

7 Lloyd's Register has completed the fist stage of its Marine Exhaust Emissions Programme, which reports steady state operation  $CO_2$  emission rates of 3165 kg and 3250 kg per tonne of fuel for low speed and medium speed marine diesel engines respectively, when used in ships in international trade (*Lloyd's Register* 1991a, 1991b, *Lloyd's Ship Manager* 1992).

Using a fuel consumption rate of 2.97 tonnes of fuel per 1000 DWT for general cargo ships from table 2.1, and assuming an average speed of 12 knots, and a load factor of 66.67 per cent, then these Lloyds values translate as 26.4 grams and 27.1 grams of  $CO_2$  per tonne-kilometre respectively.

Lloyd's Register (1991a,b) gives the following values for other emissions from marine diesel engines:

	medium speed	slow speed
NOx	59 kg/tonne fuel	84 kg/tonne fuel
CO	8 kg/tonne fuel	9 kg/tonne fuel
HC	2.7 kg/tonne fuel	2.5 kg/tonne fuel
Sulphur		
Dioxide	(21.9 * S)-2.1 kg/tonne fuel	21 * S kg/tonne fuel
	where $S = sulphur content of$	fuel (% by weight)

(Lloyd's Register 1991a, 1991b)

#### International

The international shipping task to and from Australia (in terms of cargo tonnages) has been growing at about 5 per cent per year on average over the past decade or so: inwards cargo tonnages at 4.6 per cent per year on average over the period 1982-83 to 1989-90, and outward cargo tonnages, which are about 8 times as large as inwards tonnages, at just over 5 per cent per year on average over the period 1980-81 to 1989-90 (ABS 1991). If such a growth rate were to be maintained, the international shipping task to and from Australia would increase by about 130 per cent from 1988 levels by 2005.

However, continuance of past growth rates for international shipping to and from Australia is perhaps unlikely, especially if global greenhouse mitigation efforts involved a reduction In 1987 the Bureau of Mineral Resources in coal usage. published forecasts for Australia's mineral exports to the year 2000 (BMR 1987). The BMR considered four scenarios involving, inter alia, different future rates of world GDP These scenarios implied tonnage growth rates for growth. Australian mineral exports varying from 0.4 per cent per year to 4.4 per cent per year on average. The expected value of the growth rate of Australian mineral export tonnages was 2.9 per cent per year, based on the probabilities assigned to the various scenarios. At this rate of growth, mineral exports would increase by over 60 per cent from 1988 to 2005. Α similar rate of growth has been assumed for Australia's much smaller tonnages of imports: Australia's average rate of GDP growth over the ten years to 1990-91 was also 2.9 per cent (Treasury 1991).

At this rate of growth the task of Australian-flag ships engaged in international trade would be likely to increase by approximately half from 1988 to 2005, *if Australian-flag ships maintained a constant share in our international trade*, and given the probability of shorter average voyages with changing trade patterns. The model then suggests that fuel used by Australia's international ships would increase by about onethird even if fuel efficiency continues to increase at the same rate as over the past 20 years or so. In the absence of

increased use of alternative fuels such as natural gas, greenhouse emissions could be expected to increase by about the same proportion.

The spreadsheet model suggests that the fuel consumed by the Australian-flag international fleet was only two-thirds that of the coastal fleet (as classified by the DoTC): emissions from the international fleet would thus have been about 1.5 megatonnes of  $CO_2$  in 1988. For Australian-flag international shipping therefore, at trade levels suggested by the expected value of the 1987 BMR projections, the outcome would be an increase of about 0.5 megatonnes. It is entirely possible however, that global action to reduce emissions of greenhouse gases could have an adverse impact on Australia's exports of coal, slowing the projected increase in the international shipping task.

### AIRCRAFT

The fuel economy projections in chapter 5 can be used to estimate the likely growth in fuel used by, and greenhouse gas from, Australian aircraft emissions in domestic and international aviation to the year 2005, given predicted task Estimates of task have been made by scaling up growths. available seat-kilometres of the current fleet using projections of passenger numbers. For the short run, passenger numbers are taken from the BTCE's Transport and Communications Indicators database, and for the longer term from forecasts published by the Federal Airports Corporation (FAC 1991). The FAC forecasts are for:

> 16.8 million passengers in 1995; 20.1 million passengers in 2000; and 29.1 million passengers in 2010.

As a graph of passenger numbers (FAC 1991) is shown as linear between these points, the figure for 2005 may be interpolated as 24.6 million domestic passengers in 2005, a 72 per cent increase over the high figure of 14.3 million in 1988 (the figure for 1990 was 12.9 million).

Indications are that a substantial jump in domestic passenger traffic occurred in 1991 with the price competition following deregulation and the entry of Compass Airlines into the market. In 1991, 16.7 million passengers were uplifted by the domestic airlines, a figure which the FAC (1991) forecast would be reached in 1995. However, as the major concern is with levels at 2005, and as it is not clear how much of this will be translated into a permanent increase in demand levels, the FAC forecasts, which were prepared in a deregulation context, have not been altered after 1991.

Preliminary estimates of revenue passenger kilometres (RPKs) indicate a 22 per cent jump to about 17.7 billion. The model, which incorporated the Compass Airlines fleet, is based on available seat kilometres (ASKs) and used a figure of 23.2 billion ASKs for 1991. This corresponds with the estimate for RPKs at an average load factor of 76.3 per cent or ASKs of 23.7 billion. The provisional estimate for the 1991 average factor is 74.6 per cent. load The variation might be explained by part-year effects, as the model deals only with whole years. The fuel estimates for domestic aviation have been adjusted for load factor, with the assumption that load factors, recently at historically high levels, would in future return to pre-deregulation levels (FAC 1991).

If the same size mix of aircraft in the domestic fleet is maintained in future, then it would seem that even if the fuel efficiency of the domestic air fleet continues to improve at a rate similar to that in the past 20 years or so, the amount of fuel used will grow by about 35 to 40 per cent over 1988 levels by the year 2005. In the absence of alternative fuels such as hydrogen, emissions from domestic aviation would increase in proportion. Given that emissions from domestic aviation were some 4.35 megatonnes of  $CO_2$  in 1988, then emissions in 2005 could be expected to be some 1.5 to 1.75 megatonnes above 1988 levels. Figure III.1 shows indices of passenger task and fuel used by domestic aviation, assuming that the present size mix of the fleet is maintained.

However, if traffic patterns, growth in the number of passengers, and real fuel prices were to be such as to







FIGURE III.2 AUSTRALIAN INTERNATIONAL AIRCRAFT: TASK AND FUEL USED

persuade operators to increase significantly the use of the fuel-efficient wide-bodied aircraft in the domestic most fuel-efficient choose the most small and also to fleet, aircraft, then the increased passenger task predicted for 2005 significant increase without a in could be performed The model indicates that in the unlikely event emissions. that all aircraft in the domestic fleet were either A300-600Rs or F50s, then total emissions in 2005 could be almost 7 per cent lower than in 1988, despite a 72 per cent increase in task.

Figure III.2 shows indices of passenger task and fuel used by Qantas aircraft engaged in international aviation. Estimates of passenger task (based on international passenger movements) have, for the short term, been taken from the *Transport and Communications Indicators* database, and for the longer term from forecasts published by the Federal Airports Corporation (FAC 1991). The FAC forecasts 18.2 international passengers in 2005, a 130 per cent increase from the 7.9 million in 1988. Given the huge variation in forecasts from various sources for international air traffic to and from Australia, no attempt was made to adjust the fuel estimates for changes in load factor or changes in the market share of Australian-flag carriers.

The model suggests that fuel used by Qantas is likely to increase by about 80 per cent from 1988 levels, even if fuel efficiency continues to increase at the same rate as over the past 20 years or so. Without significant use of alternative hydrogen, emissions such as would increase in fuels International aircraft operating to and from proportion. Australia are estimated to have emitted 10 about 9 to megatonnes of  $CO_2$  in 1988 (BTCE 1991). The model thus suggests in 2005 from total additional 7 or 8 megatonnes an international flights to and from Australia. If Oantas Australian-flag international any other (together with carriers which might emerge) were to maintain a market share of approximately 40 per cent, it could emit an additional 3 However, the point megatonnes above 1988 levels in 2005. future ownership of Qantas, made earlier in about the

connection with the question of responsibility for emissions from international transport, should be borne in mind.

The relatively high levels of oxides of nitrogen  $(NO_x)$  in emissions from aircraft engines must also be remembered. NO. has a 500-year radiative effect some 14 times that of the same weight of carbon dioxide and a short term (20-year) effect about 150 times as large (Barrett 1991). As commercial aircraft emissions are produced at considerable altitudes, their effects may be more serious than those emitted at ground level. Barrett (1991) cites estimates that  $NO_x$  emissions from aircraft have up to 50 times the Global Warming Potential of  $NO_x$  emissions at the surface, through effects on tropospheric and lower stratospheric ozone: ozone is an active greenhouse gas at these altitudes. Moreover, the proportion of  $\text{NO}_{\boldsymbol{x}}$  in total emissions is likely to increase combustion as temperatures in engines increase with higher fuel efficiency. As well, water vapour is emitted from aircraft engines at a rate of about 1.25 kilograms for every kilogram of avtur fuel burnt (hydrogen, if used as an aircraft fuel in the future, would produce at least double the water vapour). Above about 9000 metres, water vapour may form ice-crystal clouds which reflect heat back to earth while allowing sunlight to pass through, and also act as sites for chemical reactions attacking ozone (Barrett 1991).

There is currently 'no comprehensive scientific analysis' to show the magnitude of the  $NO_x$  and water vapour effects (Barrett 1991). However, the proportional increase in greenhouse effect due to commercial aircraft is likely to be significantly larger than their increase in fuel use.

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## Abbreviations

ABARE	Australian Bureau of Agricultural and Resource
	Economics
ABS	Australian Bureau of Statistics
BMR	Bureau of Mineral Resources (BMR)
BTCE	Bureau of Transport and Communications Economics
DotC	Department of Transport and Communications
FAC	Federal Airports Corporation
IAC	Industries Assistance Commission
IEA	International Energy Agency
OECD	Organisation for Economic Co-operation and
	Development

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# ABBREVIATIONS

ABARE	Australian Bureau of Agricultural and Resource
	Economics
ABS	Australian Bureau of Statistics
ANMA	Australian National Maritime Association
AVTUR	Aviation turbine fuel (for jet aircraft)
bhp	brake horsepower
BMR	Bureau of Mineral Resources
BTCE	Bureau of Transport and Communications Economics
CO	carbon monoxide
CO2	carbon dioxide
DWT	deadweight tonnage
DoTC	Department of Transport and Communications
FAC	Federal Airports Corporation
HC	hydrocarbon emissions
IAC	Industries Assistance Commission
ICAO	International Civil Aviation Organisation
IEA	International Energy Agency
LNG	liquified natural gas
MIDC	Maritime Industry Development Committee
N <sub>2</sub> 0	nitrous oxide
NO <sub>x</sub>	oxides of nitrogen
OECD	Organisation for Economic Co-operation and
	Development
ro-ro	roll on, roll off
SFC	specific fuel consumption
SWATH	small waterplane-area twin-hull
S	sulphur
SO <sub>x</sub>	sulphur oxides
UHBR	ultra high bypass ratio
UDF	unducted fan
VEC	variable exhaust closing
VIT	variable injection timimg
VLCC	very large crude carrier