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.

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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.

The paper was prepared by Neil Kelso, under the general direction of Beryl Cuthbertson, and while Michael Cronin was Research Manager.

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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, but increases in propulsion system efficiency are still possible. Higher thermal efficiencies are still theoretically possible from turbocharging and turbo-compounding, from ceramic coated engine components, automated engine monitoring and management systems and from technologies which will 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 a spreadsheet model which listed each ship, and its fuel consumption per day, in the Australian coastal major trading fleet (over 2000 deadweight tonnes), and in the Australian-flag international fleet. It was assumed, unless more definite information was available, that ships would 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 international fleets and its fuel consumption per seat-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 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 *Greenhouse Gas Emissions in Australian Transport*. 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_2, 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 shipping (IAC 1988). These data show improvements in fuel 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 engine technologies, improved hull designs and 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)

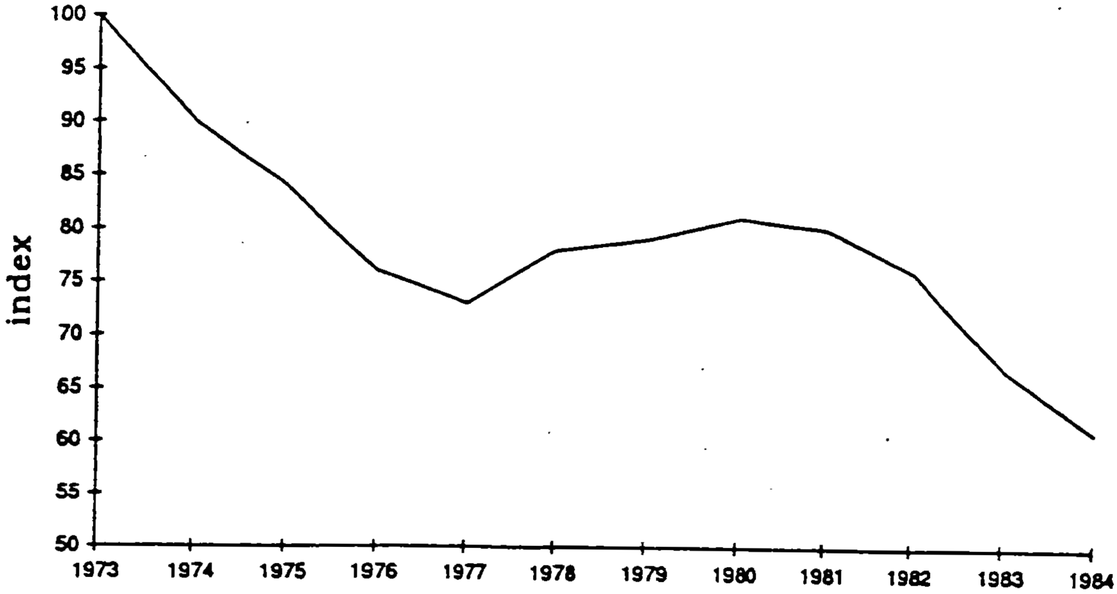
	1975	*1980*	*1985*	*1987*
General cargo	3.68	4.13	3.22	2.97
Dry bulk	1.04	0.92	0.74	0.52
Tankers	1.23	1.14	0.86	0.75

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

TABLE 2.2 EXAMPLES OF FUEL CONSUMPTION OF REPLACEMENT SHIPS IN THE AUSTRALIAN-FLAG FLEET

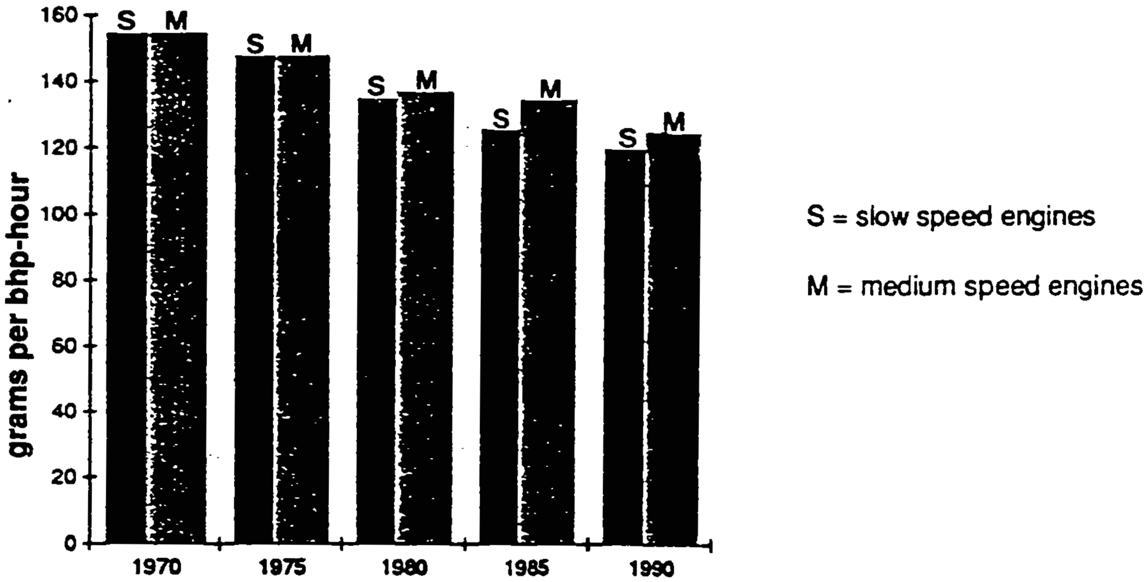
Size (DWT)	*Speed (knots)*	*Fuel consumption (per day)*
1981 bulk 141 000	14	60 tonnes fuel oil + 1.5 tonnes diesel
replaced by		
1985 bulk 148 000	14	45 tonnes fuel oil + nil diesel
1968 tanker 19 000	14	36 tonnes fuel oil
replaced by		
1989 tanker 32 000	13	19 tonnes fuel oil
1974 bulk 27 000	15	36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

Source Department of Transport and Communications.



Source International Energy Agency (1987)

FIGURE 2.1 ENERGY INTENSITY IN WORLD SHIPPING



bhp = brake horsepower

Source: Verhelst (1990)

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

TABLE 2.3 EXAMPLES OF INCREASES IN MARINE ENGINE EFFICIENCY

	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

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 and 100 per cent continuous power rating, and variable 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 efficiency gains in vessels 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 non-propulsive 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, including ceramic coatings, and more automated 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 consumption than earlier generations of VLCCs (*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 1988*c) 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 a speed calculated to maintain schedule), the optimal 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 fuel, containing a much 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

There are significant economies of size in the fuel consumption of conventional shipping[1]. 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 larger and more fuel efficient ships would allow new 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[2]. As an example of the way in which the rate of fuel consumption rises

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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[3].

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

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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 Capital Grants scheme (1987) and the Maritime Industry Development Committee (MIDC) scheme. Up to 1992, the original 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 ordered. A DoTC source expected that by 1997 just about all 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.

As a result, about 60 to 70 per cent of the existing Australian-flag major trading fleet would probably be replaced by 2005, with vessels which could typically be some 15 to 25 per cent more fuel efficient if today's technology is utilised. By the time many of these vessels do come to be 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 Australian-flag 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:

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

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

TABLE 3.1 REGRESSION EQUATIONS FOR FUEL CONSUMPTION OF REPLACEMENT SHIPS

Ship class	*Constant*	*a*	*b*	*c*	R^2
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

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 DWT-kilometre, 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 effects of increased ship size and reduced speeds are 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 fuel oil burning motor ships. On an energy basis, the improvement is about 38 per cent. For the Australian-flag 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, as discussed in chapter 2, 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 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.

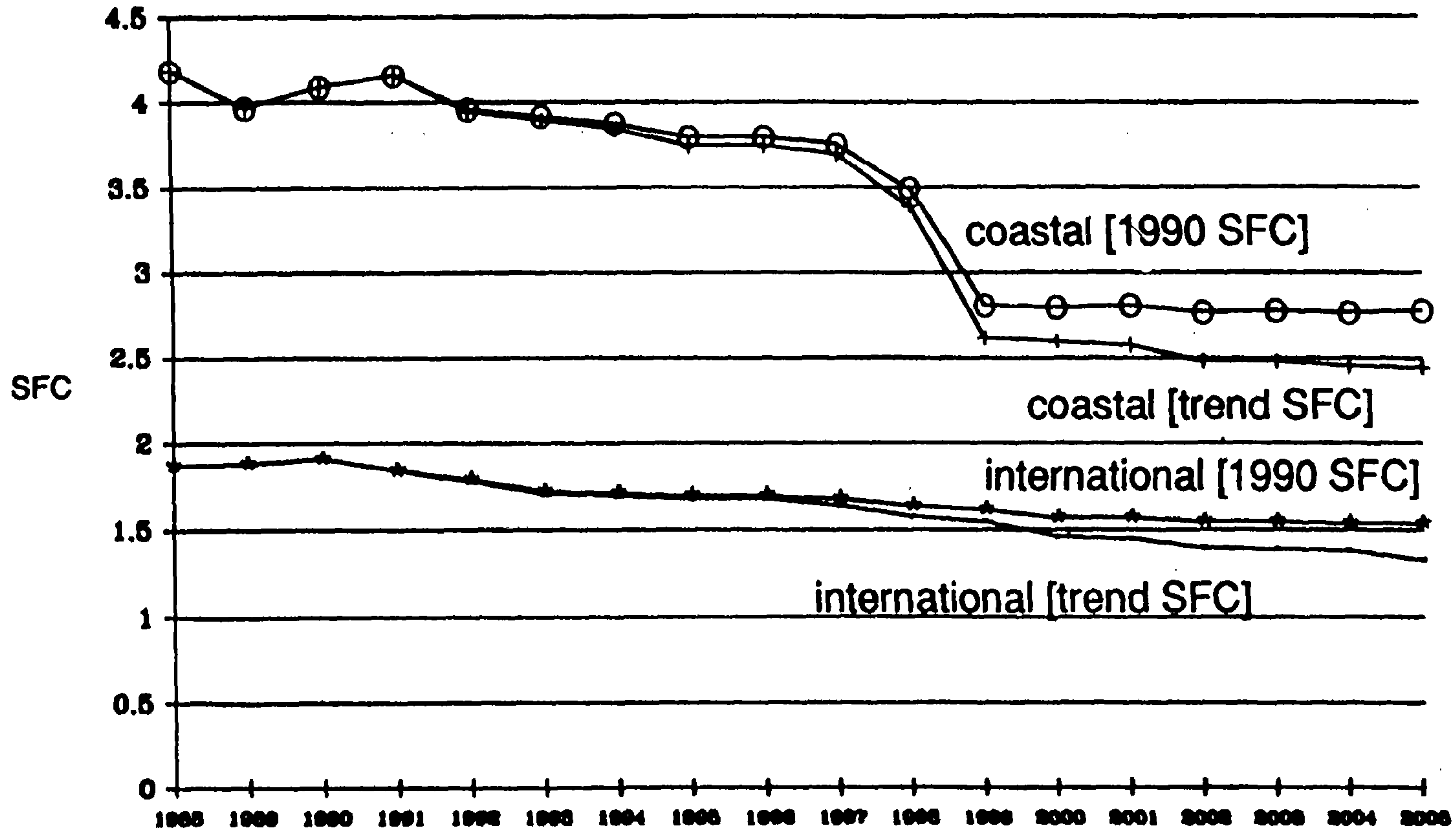
This version of the model suggests somewhat lower fleet average improvements in fuel efficiency from 1988 levels by

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 larger in deadweight tonnage, the model shows a fuel efficiency improvement of the coastal fleet of some 3 percentage points higher (by 2005) than if vessels were replaced by vessels of the same size. For the international 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



Note: SFC = tonnes of fuel per 1000DWT per 1000 nautical miles

Source BTCE estimates

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

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

	Coastal[a]		
	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[b]	37	34	15
Replacement vessels 10 per cent larger[b]	44	41	24
Replacement vessels 10 per cent larger and 10 per cent slower[b]	49	na	

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_2 emissions from shipping (see appendix III).

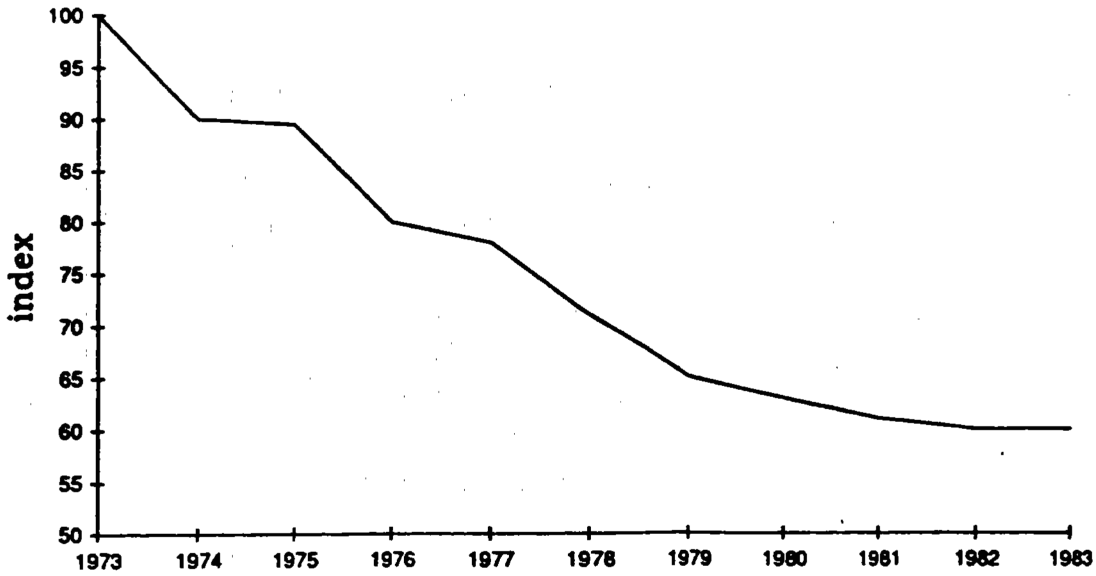
CHAPTER 4 TRENDS IN THE FUEL EFFICIENCY OF AIRCRAFT

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

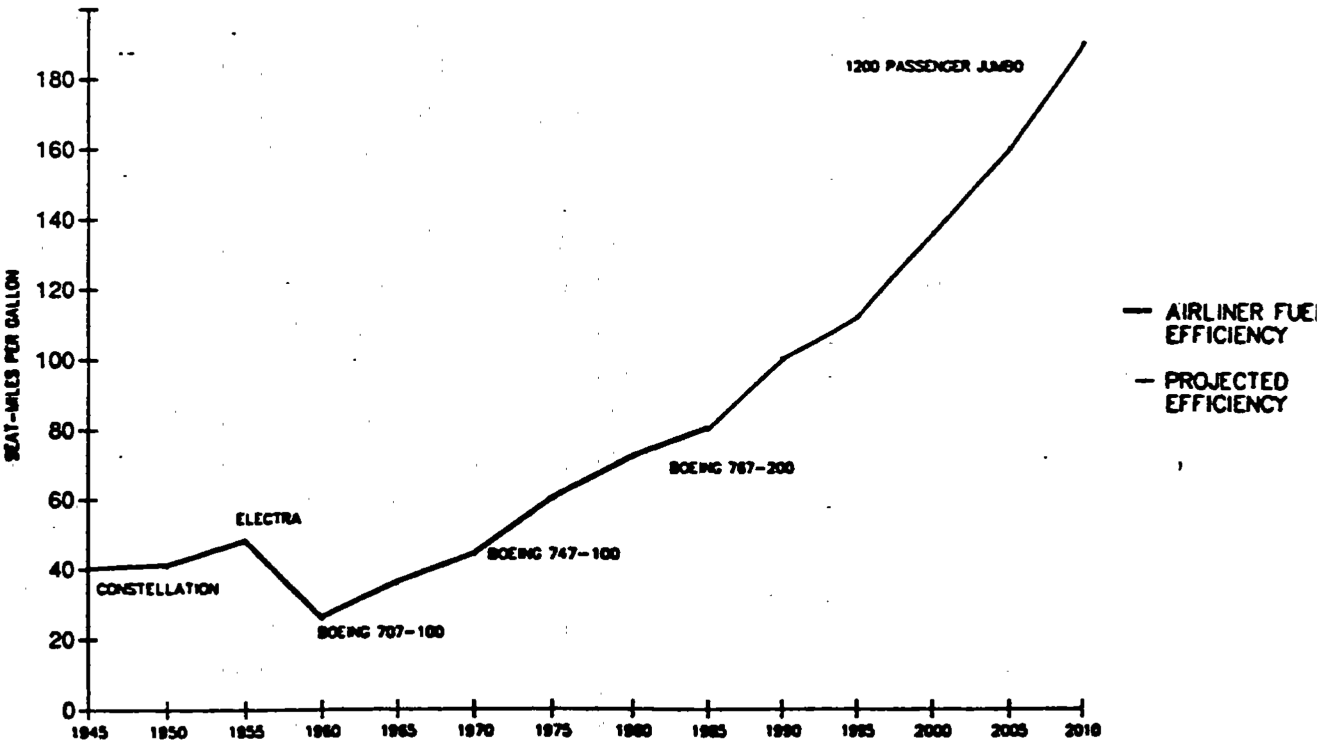
The improving trend in the energy intensity of aviation in OECD countries from 1973 to 1983 is shown in figure 4.1 (IEA 1987). The overall index of energy intensity for the aircraft fleets fell by some 40 per cent over the decade following the oil price shocks of 1973, although with a slowing of the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



Source International Energy Agency (1987)

FIGURE 4.1 ENERGY INTENSITY IN WORLD AVIATION



Source Sweetmon (1984)

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 two-thirds 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 task. The effect is both direct, from the extra time the 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 prices. For example, in October *Avmark Aviation Economist* (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[4].

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 double-deck 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 in *Avmark Aviation Economist* (1990b). The projected McDonnell-Douglas MD12 will be initially designed as a 500 seat aircraft, with later stretched versions having a one-class 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 high-aspect-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[5] 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 units. The UDF had by 1989, 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 engine. Development had been shelved pending the appearance 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 emerge. Other engine sizes would require an additional number 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 seat-kilometre, 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,

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5 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 high-efficiency 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 1990s. Ford (1989) notes that the Rolls Royce RB211-534E4 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 chord fan engine. [Ford noted fuel efficiency improvements 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 high-thrust 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 jet 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 burned. Price states that there 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 a Boeing 747 compared to 121 600 kg of jet fuel). The consequent higher cruising altitude possible (36 000 feet compared to 31 000 feet) reduces fuel consumption at a given speed. Length of runway on takeoff would be reduced, as would 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 international fleets (not including domestic commuter airlines), and its fuel consumption per seat-kilometre. It was assumed for the base case, unless more definite 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 by 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. This is 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:

$$\begin{aligned}\ln(\text{seat-kilometres per litre}) = {} & \text{constant} \\ & + a * \ln(\text{date model introduced} - 1955) \\ & + b * \ln(\text{number of seats}) \\ & + c * \ln(\text{long range cruising speed})\end{aligned}$$

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.

TABLE 5.1 REGRESSION EQUATIONS FOR FUEL CONSUMPTION OF REPLACEMENT AIRCRAFT

Aircraft class	*Constant*	*a*	*b*	*c*	R^2
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

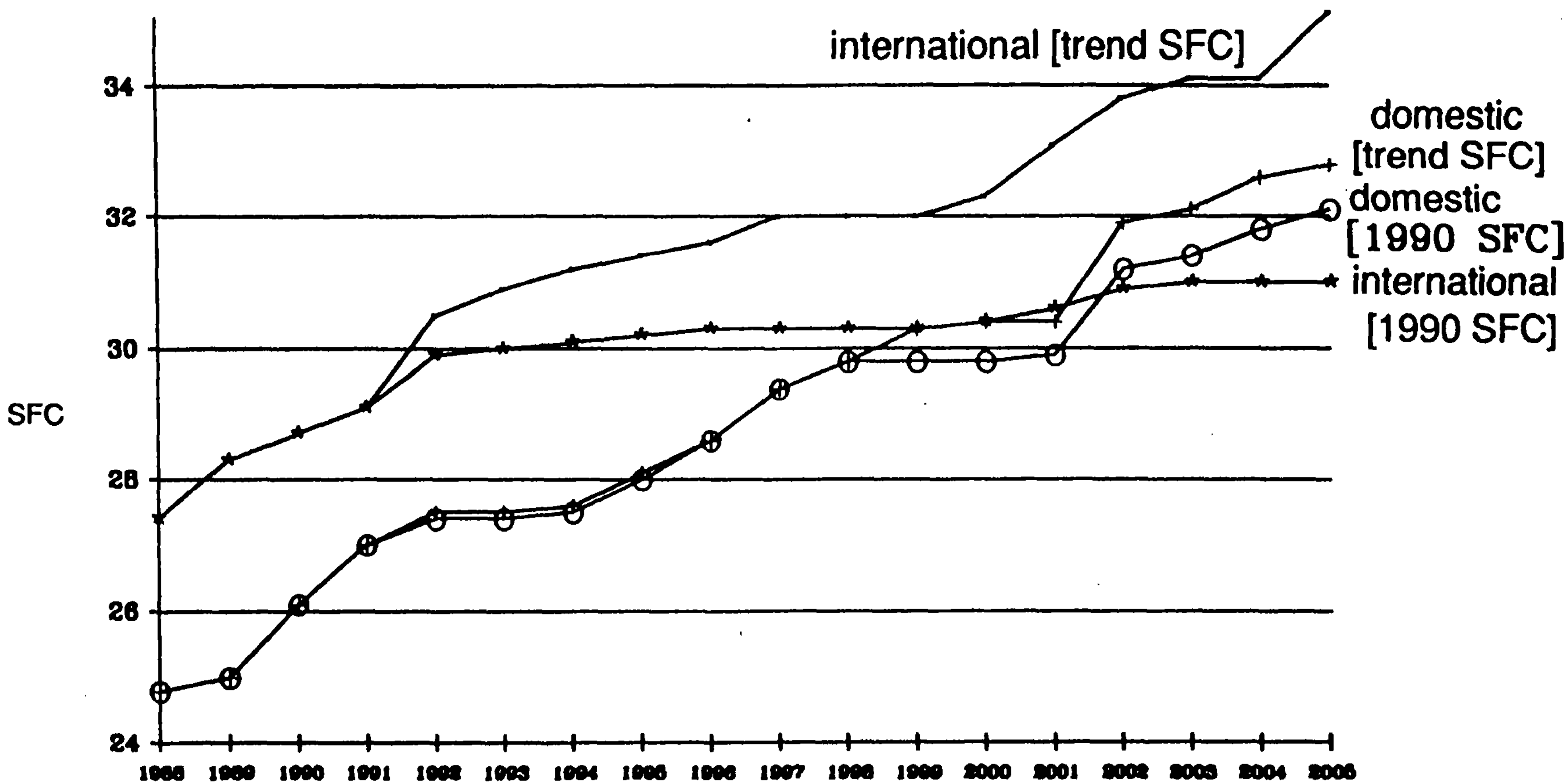
Note Numbers in brackets are t-statistics

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 that 727s would be replaced by 737-400s 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 litre, while the 737-300 uses 4.05 litres per kilometre (*Aerocost* model) and produces only 27 seat-kilometres per litre. It is assumed that growth in passenger traffic would 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 seat-kilometres per litre. This resulted in a 96 per cent increase in fleet average fuel efficiency between 1988 and 2005.



Note: SFC is weighted average seat-kilometres per litre.
1990 SFC assumes aircraft replaced by latest series of type available in 1990; also 727s replaced by 737-400s in domestic fleet.

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 5.2 AUSTRALIAN AIRCRAFT: PERCENTAGE INCREASES IN FLEET AVERAGE SEAT-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[1]	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 Australian-flag 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 gas, 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 fuel-efficient 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.

TABLE I.1 REGRESSION FOR FUEL CONSUMPTION OF REPLACEMENT SHIPS

NAME	TYPE	DWT	YEAR BUILT	SPEED	TONNES FUEL /DAY	LOG TONNES /DAY	LOG DWT/1000	LOG YR BUILT -1965	LOG SPEED	YEAR REPLACED	LOG YR REPLACED -1965	REPLACEMENT VESSEL TONNES/DA	LOG 1.1*DWT /1000	10% LARGER REPLACEMENT VESSEL	REGR FOR ORIG SHIP	1990.00 SFC TONNES/DAY
BULK																
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
CAMIRA	B	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 MARIE	B	5680	1986	14.2	13.8	2.62	1.72	3.0445	2.65	2001	3.58	11.17	1.81	11.61	13.66	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	13.5	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	7.96	10.19	7.99
EXPRESS	B	17000	1990	13.0	17.6	2.87	2.83	3.2189	2.56	2005	3.69	14.22	2.93	14.77	16.93	16.93
ORMISTON	B	16580	1979	14.8	30.0	3.40	2.81	2.6391	2.69	1994	3.37	20.39	2.90	21.19	26.74	21.55
CEMENTCO	B	16510	1978	15.2	32.0	3.47	2.80	2.5649	2.72	1993	3.33	21.89	2.90	22.75	29.13	22.83
IRON 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	29.75	27.38
IRON CAPRICORN	B	35244	1975	13.5	34.5	3.54	3.56	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	3.56	2.3026	2.71	1992	3.30	29.33	3.66	30.48	42.45	30.18
IRON CARPENTARIA	B	45310	1977	9.5	16.0	2.77	3.81	2.4849	2.25	1992	3.30	13.09	3.91	13.60	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	B	45310	1978	9.5	16.0	2.77	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	3.47	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	2.7726	2.60	1996	3.43	18.60	3.17	19.33	23.79	20.15
IRON PRINCE	B	21735	1981	14.5	29.0	3.37	3.08	2.7726	2.67	1996	3.43	21.44	3.17	22.28	27.42	23.23
IRON STURT	B	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
IRON STURT	B	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 CLARK	B	29510	1985	13.0	20.0	3.00	3.38	2.9957	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	2.4849	2.68	1992	3.30	26.64	3.56	27.68	36.02	27.41
PORTLAND	B	36500	1988	13.4	29.0	3.37	3.60	3.1355	2.60	2003	3.64	21.02	3.69	21.85	25.35	24.57
FLINDERS RANGE	B	27500	1978	14.6	36.4	3.59	3.31	2.5649	2.68	1993	3.33	24.75	3.41	25.71	32.93	25.81
IRON KESTREL	B	27270	1974	14.0	30.0	3.40	3.31	2.1972	2.64	1992	3.30	23.06	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
IRON KIRBY	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	B	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 SMITH	B	43300	1981	13.8	35.3	3.56	3.77	2.7726	2.63	1996	3.43	25.79	3.86	26.80	32.99	27.94
TNT ALLTRANS	B	35218	1983	14.5	33.0	3.50	3.56	2.8904	2.67	1998	3.50	25.44	3.66	26.43	31.88	28.21
AUSTRALIAN PROGRES	B	139400	1977	14.0	72.0	4.28	4.94	2.4849	2.64	1992	3.30	44.48	5.03	46.22	60.15	45.77
AUSTRALIAN PROSPEC	B	139400	1976	14.0	72.5	4.28	4.94	2.3979	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	2.9957	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	2.9957	2.64	2000	3.56	41.38	5.09	43.00	50.97	46.90
IRON PACIFIC	B	231850	1986	11.0	38.0	3.64	5.45	3.0445	2.40	2001	3.58	30.37	5.54	31.56	37.12	34.79
IRON PACIFIC	B	231850	1986	14.0	62.0	4.13	5.45	3.0445	2.64	2001	3.58	49.04	5.54	50.96	59.94	56.17
IRON SHORTLAND	B	107140	1979	12.5	40.0	3.69	4.67	2.6391	2.53	1994	3.37	31.10	4.77	32.32	40.79	32.87
IRON SHORTLAND	B	107140	1979	15.0	79.0	4.37	4.67	2.6391	2.71	1994	3.37	44.68	4.77	46.43	58.60	47.22
IRON SPENCER	B	141475	1981	13.0	44.5	3.80	4.95	2.7726	2.56	1996	3.43	36.68	5.05	38.11	46.92	39.74
IRON SPENCER	B	141475	1981	14.0	61.5	4.12	4.95	2.7726	2.64	1996	3.43	42.50	5.05	44.16	54.37	46.04
IRON WHYALLA	B	141435	1981	13.0	43.5	3.77	4.95	2.7726	2.56	1996	3.43	36.68	5.05	38.11	46.92	39.73
IRON WHYALLA	B	141435	1981	14.0	58.5	4.07	4.95	2.7726	2.64	1996	3.43	42.49	5.05	44.16	54.36	46.04
IRON KEMBLA	B	148150	1986	12.5	37.0	3.61	5.00	3.0445	2.53	2001	3.58	32.69	5.09	33.97	39.96	37.45
IRON KEMBLA	B	148150	1986	14.0	45.0	3.81	5.00	3.0445	2.64	2001	3.58	40.95	5.09	42.55	50.05	46.91
			1980.36		33.96	3.40	3.63	2.7320	2.59							
GENERAL CARGO								ERR								
FREEWAY NORTH	GC	9332	1978	14.7	27.9	3.33	2.23	2.5649	2.69	1993	3.33	19.89	2.33	20.74	21.19	20.08

BULK Regression Output:			
Constant		-2.21	
Std Err of Y Est		0.13	
R Squared		0.94	
No. of Observations		45.00	
Degrees of Freedom		41.00	
X Coefficient(s)	0.40	-0.37	1.93
Std Err of Coef.	0.02	0.07	0.17

G/C Regression Output:

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

FRANCES BAY	G/C	2106	1981	11.0	9.0	2.20	0.74	2.7726	2.40	1996	3.43	5.84	0.84	6.09	6.17	5.95
JON SANDERS	G/C	3168	1988	12.5	7.1	1.96	1.15	3.1355	2.52	2003	3.64	8.76	1.25	9.13	9.13	9.06
ROBERTA JULL	G/C	3400	1990	10.4	6.6	1.88	1.22	3.2189	2.34	2005	3.69	6.32	1.32	6.59	6.57	6.57
C.Y.O'CONNOR	G/C	3168	1988	12.1	8.9	2.18	1.15	3.1355	2.49	2003	3.64	8.30	1.25	8.65	8.65	8.59
IRON ARNHEM	G/C	8362	1973	12.0	12.5	2.53	2.12	2.0794	2.48	1992	3.30	12.79	2.22	13.33	14.13	12.87
IRON ARNHEM	G/C	8362	1973	13.5	15.5	2.74	2.12	2.0794	2.60	1992	3.30	16.09	2.22	16.77	17.78	16.19
MARKHAM BAY	G/C	2925	1987	12.0	8.0	2.08	1.07	3.0910	2.48	2002	3.61	7.88	1.17	8.21	8.22	8.13
MARY DURACK	G/C	3168	1988	12.3	7.5	2.01	1.15	3.1355	2.51	2003	3.64	8.51	1.25	8.87	8.87	8.81
FRANK KONECNY	G/C	3400	1990	10.4	6.6	1.88	1.22	3.2189	2.34	2005	3.69	6.32	1.32	6.59	6.57	6.57
GORDON REID	G/C	3400	1990	10.4	6.6	1.88	1.22	3.2189	2.34	2005	3.69	6.32	1.32	6.59	6.57	6.57
IRENE GREENWOOD	G/C	21760	1982	14.3	32.0	3.47	3.08	2.8332	2.66	1997	3.47	26.77	3.18	27.91	28.20	27.32
PILBARA	G/C	12760	1978	14.0	21.0	3.04	2.55	2.5649	2.64	1993	3.33	20.71	2.64	21.59	22.06	20.90
KOOLINDA	G/C	12760	1978	14.0	21.0	3.04	2.55	2.5649	2.64	1993	3.33	20.71	2.64	21.59	22.06	20.90
					13.58	2.45	1.69	ERR	2.51							
								ERR								
CONTAINER								ERR								
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 TRADER	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
AUSTRALIAN ADVANCE	C	35407	1983	17.2	50.2	3.92	3.57	2.8904	2.85	1998	3.50	32.85	3.66	33.78	52.45	40.70
AUSTRALIAN EXPORTE	C	27978	1972	14.9	67.0	4.20	3.33	1.9459	2.70	1992	3.30	24.93	3.43	25.63	70.70	26.45
AUSTRALIAN VENTURE	C	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	52.83
AUST ENDEAVOUR	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
AUST ENDURANCE	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
IRON FLINDERS	C	17370	1986	15.0	32.6	3.48	2.85	3.0445	2.71	2001	3.58	17.74	2.95	18.24	26.89	23.51
						3.82	3.23	ERR	2.81							
Ro/Ro								ERR								
								ERR								
MELBOURNE TRADER	RO/RO	7207	1975	15.9	34.1	3.53	1.98	2.3026	2.76	1992	3.30	32.06	2.07	33.66	34.98	32.28
BASS TRADER	RO/RO	7846	1976	17.1	37.3	3.62	2.06	2.3979	2.84	1992	3.30	41.84	2.16	43.93	45.28	42.13
GUTE	RO/RO	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	19.87
SEAWAY HOBART	RO/RO	7161	1976	15.2	36.5	3.60	1.97	2.3979	2.72	1992	3.30	28.03	2.06	29.43	30.33	28.22
SEAWAY MELBOURNE	RO/RO	7180	1977	15.8	37.3	3.62	1.97	2.4849	2.76	1992	3.30	31.63	2.07	33.20	33.96	31.84
TASMANIA B	RO/RO	4700	1982	15.5	24.5	3.20	1.55	2.8332	2.74	1997	3.47	23.67	1.64	24.85	25.02	24.19
IRON MONARCH	RO/RO	14855	1973	11.5	16.0	2.77	2.70	2.0794	2.44	1992	3.30	17.21	2.79	18.07	19.15	17.33
SEAROAD MERSEY	RO/RO	3287	1991	16.0	24.0	3.18	1.19	3.2581	2.77	2006	3.71	21.29	1.29	22.34	22.15	22.23
SEAROAD TAMAR	RO/RO	9958	1991	16.0	35.0	3.56	2.30	3.2581	2.77	2006	3.71	37.44	2.39	39.31	38.97	39.11
BASS REEFER	RO/RO	2745	1978	13.8	15.7	2.75	1.01	2.5649	2.62	1993	3.33	12.73	1.11	13.36	13.62	12.86
ANRO AUSTRALIA	RO/RO/C	22200	1977	13.3	34.5	3.54	3.10	2.4849	2.59	1992	3.30	33.22	3.20	34.87	35.67	33.44
ANRO MELBOURNE	RO/RO/C	23617	1975	14.5	54.3	3.99	3.16	2.3026	2.68	1992	3.30	44.91	3.26	47.15	49.00	45.21
AUSTRALIAN EMBLEM	RO/RO	23450	1975	14.5	54.3	3.99	3.15	2.3026	2.68	1992	3.30	44.75	3.25	46.98	48.83	45.05
						3.40	2.08	ERR	2.71							
PRODUCT TANKER								ERR								
BP ENTERPRISE	PT	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
JOHN HUNTER	PT	24245	1975	12.6	30.4	3.41	3.19	2.3026	2.53	1992	3.30	24.00	3.28	25.51	30.04	24.42
AUSTRALIA SKY	PT	33239	1989	13.4	26.8	3.29	3.50	3.1781	2.60	2004	3.66	27.26	3.60	28.98	30.43	30.15
AUSTRALIAN SPIRIT	PT	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
MOBIL AUSTRALIS	PT	26642	1972	16.0	30.5	3.42	3.28	1.9459	2.77	1992	3.30	26.32	3.38	27.99	35.73	26.79
WM LEONARD	PT	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
AMPOL TVA	PT	32000	1990	14.00	30.0	3.40	3.47	3.2189	2.64	2005	3.69	26.61	3.56	28.29	29.60	29.60
MOBIL TASMAN	PT	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
ESSO GIPPSLAND	PT	24380	1972	14.5	39.3	3.67	3.19	1.9459	2.67	1992	3.30	24.54	3.29	26.09	33.31	24.97
CONUS	PT	31950	1981	14.5	38.3	3.65	3.46	2.7726	2.67	1996	3.43	28.30	3.56	30.08	32.86	29.71
WILTSHIRE	LPG	12280	1968	15.0	24.0	3.18	2.51	1.0986	2.71	1992	3.30	15.87	2.60	16.87	26.09	16.15
KELVIN	LPG	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	LPG	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	ERR	2.65							

Constant		-2.95	
Std Err of Y Est		0.19	
R Squared		0.91	
No. of Observations		14.00	
Degrees of Freedom		10.00	
X Coefficient(s)	0.44	-0.08	1.95
Std Err of Coef.	0.13	0.17	0.71

CONTR Regression Output:

Constant		-1.90	
Std Err of Y Est		0.16	
R Squared		0.95	
No. of Observations		8.00	
Degrees of Freedom		4.00	
X Coefficient(s)	0.29	-0.77	2.48
Std Err of Coef.	0.29	0.19	1.40

RO/RO Regression Output:

Constant		-5.77	
Std Err of Y Est		0.15	
R Squared		0.90	
No. of Observations		13.00	
Degrees of Freedom		9.00	
X Coefficient(s)	0.51	-0.09	3.08
Std Err of Coef.	0.06	0.14	0.48

P.TANKER Regression Output:

Constant		1.54	
Std Err of Y Est		0.14	
R Squared		0.88	
No. of Observations		13.00	
Degrees of Freedom		9.00	
X Coefficient(s)	0.64	-0.23	0.13
Std Err of Coef.	0.08	0.06	0.58

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

CRUDE TANKER:MAIN ENGINES ONLY									ERR									
	AMPOL SAREL	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	
	ARTHUR PHILLIP	CT	65103	1974	16.0	62.0	4.13	4.18	2.1972	2.77	1992	3.30	33.15	4.27	35.42	64.50	34.73	
	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	
	ERA	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	
	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	
	BP ACHIEVER	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	
	MOBIL FLINDERS	CT	149235	1982	15.0	75.0	4.32	5.01	2.8332	2.71	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	
	IRON GIPPSLAND	CT	87000	1989	14.0	34.0	3.53	4.47	3.1781	2.64	2004	3.66	24.99	4.56	26.70	33.53	32.71	
	IRON GIPPSLAND	CT	87000	1989	14.4	31.2	3.44	4.47	3.1781	2.67	2004	3.66	26.40	4.56	28.21	35.43	34.57	
	IRON GIPPSLAND	CT	87000	1989	15.1	36.8	3.61	4.47	3.1781	2.71	2004	3.66	28.90	4.56	30.87	38.78	37.83	
							3.79	4.59	ERR	2.66								
TOTAL						3497.33			ERR				2601.59		2722.73	3410.50	2853.77	
% DIFFERENCE									ERR				0.7439		0.7785	0.9752	0.8160	
									ERR									
									ERR									
LARGE TANKER: BOILER ETC ADDED TO MAIN ENGINES CONSUMPTION									ERR									
	AMPOL SAREL	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	
	ERA	CT	94287	1986	13.7	51.4			3.0446		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	13.5	60.0			2.8904		1998	3.50	52.76		55.00		58.76	
	MOBIL FLINDERS	CT	149235	1982	15.0	75.0			2.8332		1997	3.47	46.90		50.10		54.46	
	NIVOSA	CT	124754	1984	13.0	42.6			2.9444		1999	3.53	32.77		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	2001	3.58	11.98	2.28	12.74	13.54	13.01	AS FOR PRODUCT TANKER
	ZINCMASTER	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
	SEACAT TASMANIA	P/CF	2000	1990	35.0	75.0	4.32	0.69	3.2189		2005	3.69						
	AUSTRALIAN SEAROAD	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 CONTAINER
coal	RIVER EMBLEY	B	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 DIESEL 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	TNT CAPRICORNIA	B	75140	1983	15.0	148.0	5.00	4.32	2.8904	2.71	1998	3.50	36.91	4.41	38.36	46.26	40.93	AS FOR DIESEL BULK
coal	TNT 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
	ABEL TASMAN	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 SANDERLING	LNG	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 ENGINES
	NW SNIPE	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 ENGINES
	NW 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: MAIN ENGINES

C.TANKER Regression Output:			
Constant		-2.82	
Std Err of Y Est		0.13	
R Squared		0.87	
No. of Observations		11.00	
Degrees of Freedom		7.00	
X Coefficient(s)	0.69	-0.61	1.96
Std Err of Coef.	0.19	0.17	0.76

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

NAME	TYPE	DWT	YEAR BUILT	SPEED	FUEL/DAY AT SPEED (TONNES)	TONNES FUEL / DAY OF VESSEL AND REPLACEMENT VESSEL 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																	
LYSAGHT ENDEAVOUR	RO/RO	11810	1973	18.0	REGR.	45.1																	
MARY HOLYMAN	G/C	3340	1971	15.0	REGR.	13.2																	
MELBOURNE TRADER	RO/RO	7207	1975	15.9	31.1	31.1																	
SID MCGRATH	RO/RO	2745	1970	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	12.7	12.7	12.7	12.7	12.7	12.7
CHALLENGER B	RO/RO	3390	1979	15.0	REGR.	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 HUNTER	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															
WILTSHIRE	LPG	12280	1968	15.0	24.0	24.0	24.0	24.0															
ABEL TASMAN	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	31.9	31.9	31.9	24.0	24.0	24.0	24.0
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	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
AMPOL SAREL	CT	101900	1979	15.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7
ARTHUR PHILLIP	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
AUSTRALIA SKY	PT	33239	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	26.8	26.8	26.8	26.8	26.8	26.8	27.3
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	27.3	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
CANIRA	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	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	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	56.0	56.0	56.0	56.0	56.0	44.8	44.8	44.8	44.8
CHERRYCO	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
ERA	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	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
FRANCES 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	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
GOLIATH	B	4270	1977	14.0	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
GYRE	RO/RO	2400	1979	16.3	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	19.6	19.6	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
IRON CAPRICORN	B	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	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 CURTIS	B	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
IRON MONARCH	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
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	23.0	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6
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	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2
ISLAND GAS	LPG	6033	1976	13.5	11.6	11.6	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	G/C	2640	1988	12.5	7.1	7.1	7.1	7.1															
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
KOWULKA	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	17.1	17.1	17.1	17.1	17.1	17.1
LINDSAY CLARK	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	18.7	18.7	18.7	18.7	18.7
MOBIL AUSTRALIS	PT	26642	1972	16.0	30.5	30.5	30.5	30.5															
ORMISTON	B	16580	1979	14.0	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
PILBARA	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
PORTLAND	B	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	29.0	21.0	21.0
RIVER BOYNE	B [coal]	76355	1982	13.5	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3
RIVER EMBLEY	B [coal]	76305	1983	13.1	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	28.2	28.2	28.2	28.2	28.2	28.2	28.2
RIVER TORRENS	B	31921	1977	14.5	36.4	36.4	36.4	36.4	36.4	36.4	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6
SANDRA MARIE	B	5580	1986	14.2	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	11.2	11.2	11.2	11.2

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

SEAWAY HOBART	RO/RO	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
SEAWAY MELBOURNE	RO/RO	7180	1977	15.8	37.3	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
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	13.7	13.7	12.0	12.0	12.0	12.0
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	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7
TNT 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	36.9	36.9	36.9	36.9	36.9	36.9	36.9
TNT 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	36.9	36.9	36.9	36.9	36.9	36.9	36.9
WM 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	10.9	10.9	10.9	10.9
ZINCMASTER	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	19.3	19.3
AMPOL EVA	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	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
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
EXPRESS	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
MOBIL TASMAN	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
SEAROAD MERSEY	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	B	30000	1982	13.0	REGR.				27.2	27.2	27.2	27.2	27.2	27.2	27.2	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5
SEAROAD 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
TONNES OF FUEL PER DAY (CONSTANT TASK AFTER 1991)						2015.5	1874.7	1987.1	1821.9	1756.8	1710.2	1695.2	1656.5	1655.2	1637.6	1507.7	1167.2	1164.3	1162.1	1125.5	1127.8	1119.9	1120.3
INDEX OF FUEL USED (1988 BASE; CONSTANT TASK 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
DEADWEIGHT TONNE - NAUTICAL MILES PER DAY						4.8E+08	4.6E+08	5.1E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08
FLEET AVERAGE TONNES OF FUEL / 000DWT / 1000 NAUTICAL MILES						4.18	4.05	3.92	3.97	3.83	3.73	3.70	3.61	3.61	3.57	3.29	2.55	2.54	2.53	2.45	2.46	2.44	2.44
INDEX OF FLEET FUEL EFFICIENCY (1988 BASE)						100.0	103.0	106.1	104.8	108.2	110.7	111.5	113.5	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.
Estimates of fuel consumption were obtained from shipping companies, else from regression equations for tonnes of fuel per 000DWT per day from BTCE database INTSEA8.WK1
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(-1.749625-0.492529ln(DWT/1000)+0.222308ln(1991-year built)+1.106877ln(speed))
Tankers : exp(-3.67077-0.406922ln(DWT/1000)+0.178088ln(1991-year built)+1.782273ln(speed))
Ro/Ro : exp(-4.005212-0.507276ln(DWT/1000)+0.048439ln(1991-year built)+2.234377ln(speed))
Container : exp(-6.641991-0.584367ln(DWT/1000)+0.398533ln(1991-year built)+2.910674ln(speed))
Gen Cargo : exp(-5.347061-0.51047ln(DWT/1000)+0.047109ln(1991-year built)+2.657819ln(speed))
Gas Tanker: exp(-0.592047-0.35921ln(DWT/1000)+0.071585ln(1991-year built)+0.777528ln(speed))

SOURCES: AUSTRALIAN SHIPPING 1990 and earlier editions, BTCE DATABASE

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

NAME	TYPE	DWT	YEAR BUILT	SPEED	FUEL/DAY AT SPEED (TONNES)	TONNES FUEL / DAY OF VESSEL AND REPLACEMENT VESSEL 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																	
LYSAGHT ENDEAVOUR	RO/RO	11810	1973	18.0	REGR.	45.1																	
MARY HOLYMAN	G/C	3340	1971	15.0	REGR.	13.2																	
MELBOURNE TRADER	RO/RO	7207	1975	15.9	31.1	31.1																	
SID MCGRATH	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	REGR.	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 HUNTER	PT	24245	1975	14.5	30.4	30.4	30.4	30.4															
KOOLINDA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0															
WILTSHIRE	LPG	12280	1968	15.0	24.0	24.0	24.0	24.0															
ABEL TASMAN	RO/RO/P*	2063	1975	19.5	60.0	60.0	60.0	60.0	60.0	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 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	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
ANPOL SAREL	CT	101900	1979	15.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6
ARTHUR PHILLIP	CT	65103	1974	16.0	62.0	62.0	62.0	62.0	62.0	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7
AUSTRALIA SKY	PT	33239	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	26.8	26.8	26.8	26.8	26.8	26.8	30.2
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	29.8	29.8	29.8
BASS TRADER	RO/RO	7846	1976	17.1	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
CAMIRA	B	4120	1980	12.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	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
CEMENTCO	B	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
ERA	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
ESSO 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
FRANCES 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	B	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
GUTE	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	B	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	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	B	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 MONARCH	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	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	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
JON SANDERS	G/C	2640	1988	12.5	7.1	7.1	7.1	7.1															
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
KOWULKA	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 CLARK	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
MOBIL AUSTRALIS	PT	26642	1972	16.0	30.5	30.5	30.5	30.5															
ORMISTON	B	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
PILBARA	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	B	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	29.0	24.6	24.6
RIVER BOYNE	B (coal)	76355	1982	13.5	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2
RIVER EMBLEY	B (coal)	76305	1983	13.1	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	31.3	31.3	31.3	31.3	31.3	31.3	31.3
RIVER TORRENS	B	31921	1977	14.5	36.4	36.4	36.4	36.4	36.4	36.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
SANDRA MARIE	B	5580	1986	14.2	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	12.8	12.8	12.8	12.8
SEAWAY 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

TABLE I.3 (cont) COASTAL SHIPS: 1990 SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING VESSELS (EMISSIONS BASIS)

SEAWAY MELBOURNE	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	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	13.7	13.7	13.0	13.0	13.0	13.0
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	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2
TNT 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
TNT 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
ZINCMASTER	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
AMPOL 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	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
EXPRESS	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
MOBIL TASMAN	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
SEAROAD MERSEY	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	B	30000	1982	13.0	REGR.				27.2	27.2	27.2	27.2	27.2	27.2	27.2	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4
SEAROAD 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
TONNES OF FUEL PER DAY (CONSTANT TASK AFTER 1991)						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
INDEX OF FUEL USED (1988 BASE; CONSTANT TASK AFTER 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
DEADWEIGHT TONNE - NAUTICAL MILES PER DAY						4.8E+08	4.6E+08	5.0E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08
FLEET AVERAGE TONNES OF FUEL / 000DWT / 1000 NAUTICAL MILES						4.19	4.07	3.94	3.99	3.79	3.76	3.73	3.66	3.66	3.63	3.35	2.63	2.63	2.64	2.61	2.62	2.61	2.62
INDEX OF FLEET FUEL EFFICIENCY (1988 BASE)						100.0	103.0	106.1	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	137.6	137.5

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 INTSEA8.WK1
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(-1.749625-0.492529ln(DWT/1000)+0.222308ln(1991-year built)+1.106877ln(speed))
Tankers : exp(-3.67077-0.406922ln(DWT/1000)+0.178088ln(1991-year built)+1.782273ln(speed))
Ro/Ro : exp(-4.005212-0.507276ln(DWT/1000)+0.048439ln(1991-year built)+2.234377ln(speed))
Container : exp(-6.641991-0.584367ln(DWT/1000)+0.398533ln(1991-year built)+2.910674ln(speed))
Gen Cargo : exp(-5.347061-0.51047ln(DWT/1000)+0.047109ln(1991-year built)+2.657819ln(speed))
Gas Tanker: exp(-0.592047-0.35921ln(DWT/1000)+0.071585ln(1991-year built)+0.777528ln(speed))

SOURCES: AUSTRALIAN SHIPPING 1990 and earlier editions, BTCE DATABASE

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

NAME	TYPE	DWT	YEAR BUILT	SPEED	FUEL/DAY AT SPEED (TONNES)	TONNES FUEL / DAY OF VESSEL AND REPLACEMENT VESSEL																	
						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																	
LYSAGHT ENDEAVOUR	RO/RO	11810	1973	18.0	REGR.	45.1																	
MARY HOLTMAN	G/C	3340	1971	15.0	REGR.	13.2																	
MELBOURNE TRADER	RO/RO	7207	1975	15.9	31.1	31.1																	
SID MCGRATH	RO/RO	2745	1978	15.0	14.9	14.9		14.9	14.9	14.9	14.9	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
CHALLENGER B	RO/RO	3390	1979	16.0	REGR.	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 HUNTER	PT	24245	1975	14.6	30.4	30.4	30.4	30.4															
KOOLINDA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0															
WILTSHIRE	LPG	12280	1968	15.0	24.0	24.0	24.0	24.0															
ABEL TASMAN	RO/RO/P*	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 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	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
AMPOL SAREL	CT	101900	1979	15.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	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	62.0	62.0	62.0	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 SKY	PT	33239	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	26.8	26.8	26.8	26.8	26.8	26.8	29.0
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	29.0	29.0	29.0
BASS TRADER	RO/RO	7846	1976	17.1	37.3	37.3	37.3	37.3	37.3	37.3	37.3	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9
CANIRA	B	4120	1980	12.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
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	46.7	46.7	46.7	46.7
CEMENTCO	B	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	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1
ERA	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	40.6	40.6	40.6	40.6
ESSO GIPPSLAND	PT	24380	1972	14.5	39.3	39.3	39.3	39.3	39.3	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1
FRANCES 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	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
GOLIATH	B	4270	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
GUTE	RO/RO	2400	1979	16.3	18.0	18.0	18.0	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	20.6	20.6	20.6
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	25.1	25.1	25.1	25.1	25.1
IRON CAPRICORN	B	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	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
IRON CURTIS	B	45310	1978	9.5	16.0	16.0	16.0	16.0	16.0	16.0	16.0	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
IRON MONARCH	RO/RO	14855	1973	11.5	16.0	16.0	16.0	16.0	16.0	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1
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	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3
IRON STURT	B	22100	1979	13.5	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
ISLAND GAS	LPG	6033	1978	13.5	11.6	11.6	11.6	11.6	11.6	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
JON SANDERS	G/C	2640	1988	12.5	7.1	7.1	7.1	7.1															
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
KOWULKA	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	17.8	17.8	17.8	17.8	17.8	17.8
LINDESAY CLARK	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	19.4	19.4	19.4	19.4	19.4
MOBIL AUSTRALIS	PT	26642	1972	16.0	30.5	30.5	30.5	30.5															
ORMISTON	B	16580	1979	14.8	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2
PILBARA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6
PORTLAND	B	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	29.0	21.9	21.9
RIVER BOYNE	B [coal]	76355	1982	13.5	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5
RIVER EMBLEY	B [coal]	78305	1983	13.1	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	29.3	29.3	29.3	29.3	29.3	29.3	29.3
RIVER TORRENS	B	31921	1977	14.5	36.4	36.4	36.4	36.4	36.4	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
SANDRA MARIE	B	5580	1986	14.2	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	11.6	11.6	11.6	11.6
SEAWAY HOBART	RO/RO	7161	1976	15.2	36.5	36.5	36.5	36.5	36.5	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4

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

SEAWAY MELBOURNE	RO/RO	7180	1977	15.8	37.3	37.3	37.3	37.3	37.3	37.3	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
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	13.7	13.7	12.7	12.7	12.7	12.7
TASMANIA B	RO/RO	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	24.9
TNT 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	38.4	38.4	38.4	38.4	38.4	38.4	38.4
TNT 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	38.4	38.4	38.4	38.4	38.4	38.4	38.4
WM LEONARD	PT	25500	1973	16.0	35.0	35.0	35.0	35.0															
WALLARAH	B	6686	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
ZINCMASTER	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
AMPOL 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	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
EXPRESS	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
MOBIL TASMAN	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
SEAROAD MERSEY	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	22.4
YARRA RIVER	B	30000	1982	13.0	REGR.				27.2	27.2	27.2	27.2	27.2	27.2	27.2	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
SEAROAD 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
TONNES OF FUEL PER DAY (CONSTANT TASK AFTER 1991)						2015.5	1874.7	1987.1	1821.9	1738.6	1723.2	1713.5	1680.1	1679.0	1657.7	1537.0	1201.2	1199.0	1198.5	1175.1	1179.1	1171.9	1172.5
INDEX OF FUEL USED (1988 BASE; CONSTANT TASK AFTER 1991)						100.0	93.0	98.6	90.4	86.3	85.5	85.0	83.4	83.3	82.2	76.3	59.6	59.5	59.5	58.3	58.5	58.1	58.2
DEADWEIGHT TONNE - NAUTICAL MILES PER DAY (CONSTANT SHIP SIZE)						4.81E+08	4.86E+08	ERR	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08
ADDITIONAL DWT-NM PER DAY (DUE TO LARGER REPLACEMENT SHIPS)										3.43E+06	5.99E+06	7.60E+06	1.53E+07	1.54E+07	1.73E+07	2.01E+07	2.77E+07	2.85E+07	3.07E+07	3.71E+07	3.91E+07	4.03E+07	4.12E+07
TOTAL DEADWEIGHT TONNE - NAUTICAL MILES PER DAY						4.81E+08	4.86E+08	ERR	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	4.86E+08	4.93E+08	4.95E+08	4.96E+08	4.97E+08
FLEET AVERAGE TONNES OF FUEL / 000DWT / 1000 NAUTICAL MILES						4.19	4.02	ERR	4.00	3.79	3.73	3.70	3.57	3.56	3.51	3.23	2.49	2.48	2.46	2.39	2.38	2.36	2.36
INDEX OF FLEET FUEL EFFICIENCY (1988 BASE)						100.0	104.0	ERR	104.6	109.7	111.0	111.8	114.9	115.0	116.4	122.9	140.7	140.9	141.2	143.1	143.1	143.6	143.7

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 INTSEA8.WK1
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(-1.749625-0.492529ln(DWT/1000)+0.222308ln(1991-year built)+1.108877ln(speed))
Tankers : exp(-3.67077-0.406922ln(DWT/1000)+0.178888ln(1991-year built)+1.782273ln(speed))
Ro/Ro : exp(-4.005212-0.507276ln(DWT/1000)+0.048439ln(1991-year built)+2.234377ln(speed))
Container : exp(-6.641991-0.584367ln(DWT/1000)+0.398533ln(1991-year built)+2.910674ln(speed))
Gen Cargo : exp(-5.347061-0.51047ln(DWT/1000)+0.047109ln(1991-year built)+2.657819ln(speed))
Gas Tanker: exp(-0.592047-0.35921ln(DWT/1000)+0.071585ln(1991-year built)+0.777528ln(speed))

SOURCES: AUSTRALIAN SHIPPING 1990 and earlier editions, BTCE DATABASE

TABLE I.5 COASTAL SHIPS: 20 YEAR SHIP LIFE, TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING VESSELS (EMISSIONS BASIS)

					FUEL/DAY	TONNES FUEL / DAY OF VESSEL AND REPLACEMENT VESSEL																	
NAME	TYPE	DWT	YEAR BUILT	SPEED	AT SPEED (TONNES)	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																	
LYSAGHT ENDEAVOUR	RO/RO	11810	1973	18.0	REGR.	45.1																	
MARY HOLYMAN	G/C	3340	1971	15.0	REGR.	13.2																	
MELBOURNE TRADER	RO/RO	7207	1975	15.9	31.1	31.1																	
SID MCGRATH	RO/RO	2745	1978	15.0	14.9	14.9		14.9	14.9	14.9	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	REGR.	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	21780	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															
KOOLINDA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0															
WILTSHIRE	LPG	12280	1968	15.0	24.0	24.0	24.0	24.0															
ABEL TASMAN	RO/RO/P*	2063	1975	19.5	60.0	60.0	60.0	60.0	60.0	60.0	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
AMPOL SAREL	CT	101900	1979	16.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	42.0	42.0	42.0	42.0	42.0	42.0
ARTHUR PHILLIP	CT	65103	1974	16.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7
AUSTRALIA SKY	PT	33239	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	26.8	26.8	26.8	26.8	26.8	26.8	26.8
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	25.0	25.0	25.0
BASS TRADER	RO/RO	7846	1976	17.1	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3
CANIRA	B	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	9.0	7.2	7.2	7.2	7.2	7.2
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	56.0	56.0	56.0	56.0
CEMENTCO	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	20.6	20.6	20.6	20.6	20.6	20.6	20.6
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	27.4	27.4	27.4	27.4
ERA	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	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 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	9.0	9.0	9.0	9.0	9.0	5.8	5.8	5.8	5.8
GOLIATH	B	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
GUTE	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
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	25.0	25.0	25.0	25.0	25.0
IRON CAPRICORN	B	35244	1976	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	16.0	16.0	16.0	16.0	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 MONARCH	RO/RO	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	17.2	17.2	17.2	17.2	17.2	17.2	17.2
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	23.0	23.0	23.0	23.0	23.0	17.6	17.6	17.6	17.6
IRON STURT	B	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 GAS	LPG	6033	1976	13.5	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
JON SANDERS	G/C	2840	1988	12.5	7.1	7.1	7.1	7.1															
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
KOWULKA	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 CLARK	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
MOBIL AUSTRALIS	PT	26642	1972	16.0	30.5	30.5	30.5	30.5															
ORMISTON	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
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	B	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	29.0	29.0	29.0
RIVER BOYNE	B [coal]	76355	1982	13.6	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	28.7	28.7	28.7
RIVER EMBLEY	B [coal]	76305	1983	13.1	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	26.8	26.8
RIVER TORRENS	B	31921	1977	14.6	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	B	5580	1986	14.2	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
SEAWAY HOBART	RO/RO	7161	1976	15.2	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7

TABLE I.5 (cont) COASTAL SHIPS: 20 YEAR SHIP LIFE, TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING VESSELS (EMISSIONS BASIS)

SEAWAY MELBOURNE	RO/RO	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	REOR.	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	13.7	13.7	13.7
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	24.5	24.5	24.5	24.5	24.5	23.4	23.4	23.4
TNT 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	147.9	147.9	147.9	147.9	147.9	35.0	35.0
TNT 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	147.9	147.9	147.9	147.9	147.9	35.0	35.0
WN LEONARD	PT	25500	1973	16.0	35.0	35.0	35.0	35.0															
WALLARAH	B	6666	1988	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
ZINCMASTER	SP*	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
AMPOL 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	11.5	11.5	11.5	11.5	11.5	7.2	7.2	7.2	7.2	7.2	7.2	7.2
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	6.5	6.6
EXPRESS	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
MOBIL TASMAN	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
SEACAT TASMANIA	P/CF	200	1990	35.0	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
SEAROAD MERSEY	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	B	30000	1982	13.0	REOR.				27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	18.5	18.5	18.5
SEAROAD 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
TONNES OF FUEL PER DAY (CONSTANT TASK AFTER 1991)						2015.6	1874.7	2062.1	1896.9	1896.9	1882.2	1883.3	1863.1	1814.4	1807.6	1782.7	1760.2	1715.2	1713.4	1693.8	1560.6	1214.8	1211.1
INDEX OF FUEL USED (1988 BASE; CONSTANT TASK AFTER 1991)						100.0	93.0	102.3	94.1	94.1	93.4	93.4	91.9	90.0	89.7	88.4	87.3	85.1	85.0	84.0	77.4	60.3	60.1
DEADWEIGHT TONNE - NAUTICAL MILES PER DAY						4.8E+08	4.7E+08	5.0E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08
FLEET AVERAGE TONNES OF FUEL / 000DWT / 1000 NAUTICAL MILES						4.19	3.97	4.09	4.16	4.16	4.13	4.13	4.07	3.98	3.97	3.91	3.86	3.76	3.76	3.72	3.42	2.67	2.66
INDEX OF FLEET FUEL EFFICIENCY (1988 BASE)						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 20 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.WK1
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(-1.749625-0.492529ln(DWT/1000)+0.222308ln(1991-year built)+1.106877ln(speed))
Tankers : exp(-3.67077-0.408922ln(DWT/1000)+0.178088ln(1991-year built)+1.782273ln(speed))
Ro/Ro : exp(-4.005212-0.507278ln(DWT/1000)+0.048439ln(1991-year built)+2.234377ln(speed))
Container : exp(-6.641991-0.584367ln(DWT/1000)+0.398533ln(1991-year built)+2.910674ln(speed))
Gen Cargo : exp(-5.347061-0.51047ln(DWT/1000)+0.047109ln(1991-year built)+2.657819ln(speed))
Gas Tanker: exp(-0.592047-0.359211ln(DWT/1000)+0.071585ln(1991-year built)+0.777528ln(speed))

SOURCES: AUSTRALIAN SHIPPING 1990 and earlier editions, BTCE DATABASE

TABLE I.6 COASTAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS 10 PER CENT LARGER THAN EXISTING VESSELS AND 10 PER CENT SLOWER (EMISSIONS BASIS)

NAME	TYPE	DWT	YEAR BUILT	SPEED	FUEL/DAY AT SPEED (TONNES)	TONNES FUEL / DAY OF VESSEL AND REPLACEMENT VESSEL																	
						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																	
LYSAGHT ENDEAVOUR	RO/RO	11810	1973	18.0	REGR.	45.1																	
MARY HOLYMAN	G/C	3340	1971	15.0	REGR.	13.2																	
MELBOURNE TRADER	RO/RO	7207	1975	15.9	31.1	31.1																	
SID MCGRATH	RO/RO	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	REGR.	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 HUNTER	PT	24245	1975	14.5	30.4	30.4	30.4	30.4															
KOOLINDA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0															
WILTSHIRE	LPG	12280	1968	15.0	24.0	24.0	24.0	24.0															
ABEL TASMAN	RO/RO/P*	2063	1975	19.5	60.0	60.0	60.0	60.0	60.0	60.0													
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	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
AMPOL SAREL	CT	101900	1979	15.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	39.7	39.7	39.7	39.7	39.7	39.7	39.7	39.7	39.7	39.7	39.7
ARTHUR PHILLIP	CT	65103	1974	16.0	62.0	62.0	62.0	62.0	62.0	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
AUSTRALIA SKY	PT	33239	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	26.8	26.8	26.8	26.8	26.8	26.8	27.4
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	27.8	27.8	27.8
BASS TRADER	RO/RO	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
CAMIRA	B	4120	1980	12.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
CANOPUS	CT	94347	1986	13.9	56.0	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	40.8	40.8	40.8	40.8
CEMENTCO	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	18.6
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
ERA	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	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	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3
FRANCES 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	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
GOLIATH	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
GUYE	RO/RO	2400	1979	16.3	18.0	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	14.7	14.7	14.7	14.7	14.7
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	20.5	20.5	20.5	20.5	20.5
IRON CAPRICORN	B	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	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	16.0	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
IRON MONARCH	RO/RO	14855	1973	11.5	16.0	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	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	23.0	15.8	15.8	15.8	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	16.3
ISLAND GAS	LPG	6033	1976	13.5	11.6	11.6	11.6	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	10.2	10.2
JON SANDERS	G/C	2640	1988	12.5	7.1	7.1	7.1	7.1															
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
KOWULKA	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	14.5	14.5	14.5	14.5	14.5	14.5
LINDESAY CLARK	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	15.8	15.8	15.8	15.8	15.8
MOBIL AUSTRALIS	PT	26642	1972	18.0	30.5	30.5	30.5	30.5															
ORMISTON	B	16580	1979	14.8	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3
PILBARA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9
PORTLAND	B	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	29.0	17.7	17.7
RIVER BOYNE	B (coal)	76355	1982	13.5	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	144.9	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6
RIVER EMBLEY	B (coal)	76305	1983	13.1	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	146.8	23.9	23.9	23.9	23.9	23.9	23.9	23.9
RIVER TORRENS	B	31921	1977	14.5	36.4	36.4	36.4	36.4	36.4	36.4	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3
SANDRA MARIE	B	5580	1986	14.2	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	9.5	9.5	9.5	9.5
SEAWAY HOBART	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)

SEAWAY MELBOURNE	RO/RO	7180	1977	15.8	37.3	37.3	37.3	37.3	37.3	37.3	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7
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	13.7	13.7	12.2	12.2	12.2	12.2
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	24.6	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7
TNT 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
TNT 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	29.2	29.2	29.2	29.2	29.2	29.2	29.2
WW 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	9.3	9.3	9.3	9.3
ZINCMASTER	SP*	17530	1975	14.0	29.0	29.0	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	16.9
AMPOL 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	11.6			11.6	11.5	11.5	11.6	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
ROBERTA JULL	G/C	3400	1990	10.4	6.6			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
EXPRESS	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
MOBIL TASMAN	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
SEAROAD MERSEY	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	B	30000	1982	13.0	REGR.				27.2	27.2	27.2	27.2	27.2	27.2	27.2	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5
SEAROAD 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
TONNES OF FUEL PER DAY (CONSTANT TASK AFTER 1991)						2015.5	1874.7	1987.1	1818.9	1737.5	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
INDEX OF FUEL USED (1988 BASE; CONSTANT TASK AFTER 1991)						100.0	93.0	98.6	90.2	86.2	81.6	80.0	77.4	77.1	76.1	68.9	51.1	50.8	50.4	48.4	48.5	48.0	48.0
DEADWEIGHT TONNE - NAUTICAL MILES PER DAY						4.8E+08	4.6E+08	5.0E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08
FLEET AVERAGE TONNES OF FUEL / 000DWT / 1000 NAUTICAL MILES						4.19	4.07	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
INDEX OF FLEET FUEL EFFICIENCY (1988 BASE)						100.0	103.0	106.1	105.0	109.2	114.1	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.
Estimates of fuel consumption were obtained from shipping companies, else from regression equations for tonnes of fuel per 000DWT per day from BTCE database INTSEA8.WK1
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 I.7 COASTAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING VESSELS (ENERGY BASIS)

NAME	TYPE	DWT	YEAR BUILT	SPEED	FUEL/DAY AT SPEED (TONNES)	TONNES FUEL / DAY OF VESSEL AND REPLACEMENT VESSEL 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																	
LYSAGHT ENDEAVOUR	RO/RO	11810	1973	18.0	REQR.	45.1																	
MARY HOLYMAN	G/C	3340	1971	15.0	REQR.	13.2																	
MELBOURNE TRADER	RO/RO	7207	1975	15.9	31.1	31.1																	
SID MCGRATH	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	12.7	12.7	12.7	12.7	12.7	12.7
CHALLENGER B	RO/RO	3390	1979	15.0	REQR.	15.9	15.9																
FREEWAY NORTH	GC	9332	1978	14.7	27.9	27.9	27.9																
BP ENTERPRISE	PT	19792	1988	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	14.6	30.4	30.4	30.4	30.4															
KOOLINDA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0															
WILTSHIRE	LPG	12280	1988	15.0	24.0	24.0	24.0	24.0															
ABEL TASMAN	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	31.9	31.9	31.9	24.0	24.0	24.0	24.0
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	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
AMPOL SAREL	CT	101900	1979	15.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7
ARTHUR PHILLIP	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
AUSTRALIA SKY	PT	33239	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	26.8	26.8	26.8	26.8	26.8	26.8	27.3
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	27.3	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
CAMIRA	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	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	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	56.0	56.0	56.0	56.0	56.0	44.8	44.8	44.8	44.8
CEMENTCO	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
ERA	CT	94287	1988	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	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
FRANCES 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	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
GOLIATH	B	4270	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	19.6	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
IRON CAPRICORN	B	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	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 CURTIS	B	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
IRON MONARCH	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
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	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6
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	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2
ISLAND GAS	LPG	6033	1976	13.5	11.6	11.6	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	G/C	2640	1988	12.5	7.1	7.1	7.1	7.1															
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
KOWULKA	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	17.1	17.1	17.1	17.1	17.1	17.1	17.1
LINDESAY CLARK	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	18.7	18.7	18.7	18.7	18.7	18.7
MOBIL AUSTRALIS	PT	25642	1972	16.0	30.5	30.5	30.5	30.5															
ORMISTON	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
PILBARA	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
PORTLAND	B	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	29.0	21.0	21.0
RIVER 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	30.3	30.3	30.3	30.3	30.3
RIVER EMBLEY	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	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2
RIVER TORRENS	B	31921	1977	14.5	36.4	36.4	36.4	36.4	36.4	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6
SANDRA MARIE	B	5580	1986	14.2	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	11.2	11.2	11.2	11.2

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

SEAWAY HOBART	RO/RO	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
SEAWAY MELBOURNE	RO/RO	7180	1977	15.8	37.3	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
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	13.7	13.7	12.0	12.0	12.0	12.0
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	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7
TNT 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	36.9	36.9	36.9	36.9	36.9	36.9	36.9
TNT 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	36.9	36.9	36.9	36.9	36.9	36.9	36.9
WM 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	10.9	10.9	10.9	10.9
ZINCMASTER	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	19.3	19.3
AMPOL 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	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
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
EXPRESS	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
MOBIL TASMAN	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
SEAROAD MERSEY	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	B	30000	1982	13.0	REGR.				27.2	27.2	27.2	27.2	27.2	27.2	27.2	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5
SEAROAD 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
TONNES OF FUEL PER DAY (CONSTANT TASK 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
INDEX OF FUEL USED (1988 BASE; CONSTANT TASK AFTER 1991)						100.0	92.6	98.5	89.9	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
DEADWEIGHT TONNE - NAUTICAL MILES PER DAY						4.8E+08	4.6E+08	5.1E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08
FLEET AVERAGE TONNES OF FUEL / 000DWT / 1000 NAUTICAL 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
INDEX OF FLEET FUEL EFFICIENCY (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.
Estimates of fuel consumption were obtained from shipping companies, else from regression equations for tonnes of fuel per 000DWT per day from BTCE database INTSEA8.WK1
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 I.8 COASTAL SHIPS: 1990 SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING VESSELS (ENERGY BASIS)

NAME	TYPE	DWT	YEAR BUILT	SPEED	FUEL/DAY AT SPEED (TONNES)	TONNES FUEL / DAY OF VESSEL AND REPLACEMENT VESSEL																	
						1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
FLINDERS RANGE	B	27500	1978	14.8	36.4	36.4																	
LYSAGHT ENDEAVOUR	RO/RO	11810	1973	18.0	REGR.	45.1																	
MARY HOLYMAN	G/C	3340	1971	15.0	REGR.	13.2																	
MELBOURNE TRADER	RO/RO	7207	1975	15.9	31.10	31.1																	
SID MCGRATH	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	REGR.	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 HUNTER	PT	24245	1975	14.5	30.4	30.4	30.4	30.4															
KOOLINDA	G/C	12760	1976	14.0	21.0	21.0	21.0	21.0															
WILTSHIRE	LPG	12280	1968	15.0	24.0	24.0	24.0	24.0															
ABEL TASMAN	RO/RO/P*	2063	1975	19.5	60.0	60.0	60.0	60.0	60.0	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 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	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
AMPOL SAREL	CT	101900	1979	15.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6
ARTHUR PHILLIP	CT	65103	1974	16.0	62.0	62.0	62.0	62.0	62.0	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7	34.7
AUSTRALIA SKY	PT	33239	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	26.8	26.8	26.8	26.8	26.8	26.8	30.2
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	29.8	29.8	29.8
BASS TRADER	RO/RO	7846	1976	17.1	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
CAMIRA	B	4120	1980	12.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	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
CEMENTCO	B	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
ERA	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
ESSO 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
FRANCES 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	B	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
GUTE	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	B	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	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	B	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 MONARCH	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	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	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
JON SANDERS	G/C	2640	1988	12.5	7.1	7.1	7.1	7.1															
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
KOWULKA	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 CLARK	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
MOBIL AUSTRALIS	PT	26642	1972	16.0	30.5	30.5	30.5	30.5															
ORMISTON	B	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
PILBARA	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	B	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	29.0	24.6	24.6
RIVER 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	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2
RIVER EMBLEY	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	31.3	31.3	31.3	31.3	31.3
RIVER TORRENS	B	31921	1977	14.6	36.4	36.4	36.4	36.4	36.4	36.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
SANDRA MARIE	B	5580	1986	14.2	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	12.8	12.8	12.8	12.8
SEAWAY 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

TABLE I.8 (cont) COASTAL SHIPS: 1990 SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING VESSELS (ENERGY BASIS)

SEAWAY MELBOURNE	RO/RO	7180	1977	16.0	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	REQR.	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	13.0	13.0	13.0	13.0
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	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2
TNT 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
TNT 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
WM 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
ZINCMASTER	SP*	17530	1976	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
AMPOL 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	O/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
EXPRESS	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
MOBIL TASMAN	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
SEAROAD MERSEY	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	B	30000	1982	13.0	REQR.				27.2	27.2	27.2	27.2	27.2	27.2	27.2	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4
SEAROAD 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
TONNES OF FUEL PER DAY (CONSTANT TASK AFTER 1991)						1914.4	1773.7	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
INDEX OF FUEL USED (1988 BASE; CONSTANT TASK 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
DEADWEIGHT TONNE - NAUTICAL MILES PER DAY						4.8E+08	4.6E+08	5.0E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08
FLEET AVERAGE TONNES OF FUEL / 000DWT / 1000 NAUTICAL MILES						3.98	3.85	3.74	3.77	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 FLEET FUEL EFFICIENCY (1988 BASE)						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

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 INTSEA8.WK1
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 I.9 COASTAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT OF SHIPS 10 PER CENT LARGER THAN EXISTING VESSELS (ENERGY BASIS)

NAME	TYPE	DWT	YEAR BUILT	SPEED	FUEL/DAY AT SPEED (TONNES)	TONNES FUEL / DAY OF VESSEL AND REPLACEMENT VESSEL 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																	
LYSAGHT ENDEAVOUR	RO/RO	11810	1973	18.0	REGR.	45.1																	
MARY HOLYMAN	G/C	3340	1971	15.0	REGR.	13.2																	
MELBOURNE TRADER	RO/RO	7207	1975	15.9	31.1	31.1																	
SID MCGRATH	RO/RO	2745	1978	15.0	14.9	14.9		14.9	14.9	14.9	14.9	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
CHALLENGER B	RO/RO	3390	1979	15.0	REGR.	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 HUNTER	PT	24245	1975	14.5	30.4	30.4	30.4	30.4															
KOOLINDA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0															
WILTSHIRE	LPG	12280	1968	15.0	24.0	24.0	24.0	24.0															
ABEL TASMAN	RO/RO/P*	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 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	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
AMPOL SAREL	CT	101900	1979	16.5	72.5	72.5	72.6	72.6	72.5	72.5	72.5	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	62.0	62.0	62.0	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 SKY	PT	33239	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	26.8	26.8	26.8	26.8	26.8	26.8	29.0
AUSTRALIAN SPIRIT	PT	32605	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
BASS TRADER	RO/RO	7846	1976	17.1	37.3	37.3	37.3	37.3	37.3	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
CAMIRA	B	4120	1980	12.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
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	46.7	46.7	46.7	46.7
CEMENTCO	B	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	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1	30.1
ERA	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	40.6	40.6	40.6	40.6
ESSO GIPPSLAND	PT	24380	1972	14.5	39.3	39.3	39.3	39.3	39.3	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1	26.1
FRANCES 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	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
GOLIATH	B	4270	1977	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	11.4
GUTE	RO/RO	2400	1979	16.3	18.0	18.0	18.0	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	20.6	20.6	20.6
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	25.1	25.1	25.1	25.1	25.1
IRON CAPRICORN	B	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	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
IRON CURTIS	B	45310	1978	9.5	16.0	16.0	16.0	16.0	16.0	16.0	16.0	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
IRON MONARCH	RO/RO	14855	1973	11.5	16.0	16.0	16.0	16.0	16.0	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1
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	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3
IRON STURT	B	22100	1979	13.5	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
ISLAND GAS	LPG	6033	1978	13.5	11.6	11.6	11.6	11.6	11.6	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
JON SANDERS	G/C	2640	1988	12.5	7.1	7.1	7.1	7.1															
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
KOWULKA	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	17.8	17.8	17.8	17.8	17.8	17.8
LINDESAY CLARK	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	19.4	19.4	19.4	19.4	19.4
MOBIL AUSTRALIS	PT	26642	1972	16.0	30.5	30.5	30.5	30.5															
ORMISTON	B	16580	1979	14.8	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2
PILBARA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6
PORTLAND	B	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	29.0	21.9	21.9
RIVER 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	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5
RIVER EMBLEY	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	29.3	29.3	29.3	29.3	29.3	29.3	29.3
RIVER TORRENS	B	31921	1977	14.5	36.4	36.4	36.4	36.4	36.4	36.4	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
SANDRA MARIE	B	5580	1986	14.2	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	11.6	11.6	11.6	11.6
SEAWAY HOBART	RO/RO	7161	1976	15.2	36.5	36.5	36.5	36.5	36.5	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4

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

SEAWAY MELBOURNE	RO/RO	7180	1977	15.8	37.3	37.3	37.3	37.3	37.3	37.3	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
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	13.7	13.7	12.7	12.7	12.7	12.7
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	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9
TNT 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	38.4	38.4	38.4	38.4	38.4	38.4	38.4
TNT 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	38.4	38.4	38.4	38.4	38.4	38.4	38.4
WM 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	11.4	11.4	11.4	11.4
ZINCMASTER	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
AMPOL 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	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
EXPRESS	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
MOBIL TASMAN	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
SEAROAD MERSEY	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	B	30000	1982	13.0	REGR.				27.2	27.2	27.2	27.2	27.2	27.2	27.2	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
SEAROAD TAMAR	RO/RO	9676	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
TONNES OF FUEL PER DAY (CONSTANT TASK AFTER 1991)						1914.4	1773.7	1886.0	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
INDEX OF FUEL USED (1988 BASE; CONSTANT TASK AFTER 1991)						100.0	92.6	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	61.3
DEADWEIGHT TONNE - NAUTICAL MILES PER DAY (CONSTANT SHIP SIZE)						4.81E+08	4.66E+08	ERR	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08
ADDITIONAL DWT-NM PER DAY (DUE TO LARGER REPLACEMENT SHIPS)										3.43E+06	5.99E+06	7.60E+06	1.53E+07	1.54E+07	1.73E+07	2.01E+07	2.77E+07	2.85E+07	3.07E+07	3.71E+07	3.91E+07	4.03E+07	4.12E+07
TOTAL DEADWEIGHT TONNE - NAUTICAL MILES PER DAY						4.81E+08	4.66E+08	ERR	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	4.86E+08	4.93E+08	4.95E+08	4.96E+08	4.97E+08
FLEET AVERAGE TONNES OF FUEL / 000DWT / 1000 NAUTICAL MILES						3.98	3.81	ERR	3.78	3.57	3.51	3.48	3.35	3.35	3.31	3.07	2.49	2.48	2.46	2.39	2.38	2.36	2.36
INDEX OF FLEET FUEL EFFICIENCY (1988 BASE)						100.0	104.4	ERR	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

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 INTSEA8.WK1
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 I.10 COASTAL SHIPS: 20 YEAR SHIP LIFE, TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING VESSELS (ENERGY BASIS)

					FUEL/DAY	TONNES FUEL / DAY OF VESSEL AND REPLACEMENT VESSEL																	
NAME	TYPE	DWT	YEAR BUILT	SPEED	AT SPEED (TONNES)	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																	
LYSAGHT ENDEAVOUR	RO/RO	11810	1973	18.0	REQR.	45.1																	
MARY HOLYMAN	G/C	3340	1971	15.0	REQR.	13.2																	
MELBOURNE TRADER	RO/RO	7207	1975	15.9	31.1	31.1																	
SID MCGRATH	RO/RO	2745	1978	15.0	14.9	14.9		14.9	14.9	14.9	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	16.0	REQR.	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 HUNTER	PT	24245	1975	14.5	30.4	30.4	30.4	30.4															
KOOLINDA	G/C	12760	1978	14.0	21.0	21.0	21.0	21.0															
WILTSHIRE	LPG	12280	1968	15.0	24.0	24.0	24.0	24.0															
ABEL TASMAN	RO/RO/P*	2063	1975	19.5	60.0	60.0	60.0	60.0	60.0	60.0	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
AMPOL SAREL	CT	101900	1979	15.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	42.0	42.0	42.0	42.0	42.0	42.0
ARTHUR PHILLIP	CT	65103	1974	16.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.7
AUSTRALIA SKY	PT	33239	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	26.8	26.8	26.8	26.8	26.8	26.8	26.8
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	25.0	25.0	25.0
BASS TRADER	RO/RO	7846	1976	17.1	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3
CAMIRA	B	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	9.0	7.2	7.2	7.2	7.2	7.2
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	56.0	56.0	56.0	56.0
CEMENTCO	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	20.6	20.6	20.6	20.6	20.6	20.6	20.6
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	27.4	27.4	27.4	27.4
ERA	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	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 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	9.0	9.0	9.0	9.0	9.0	5.8	5.8	5.8	5.8
GOLIATH	B	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
GOYE	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
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	25.0	25.0	25.0	25.0	25.0
IRON CAPRICORN	B	35244	1975	13.6	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	16.0	16.0	16.0	16.0	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 MONARCH	RO/RO	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	17.2	17.2	17.2	17.2	17.2	17.2	17.2
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	23.0	23.0	23.0	23.0	23.0	17.6	17.6	17.6	17.6
IRON STURT	B	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 GAS	LPG	6033	1976	13.5	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
JON SANDERS	G/C	2640	1988	12.5	7.1	7.1	7.1	7.1															
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
KOWULKA	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 CLARK	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
MOBIL AUSTRALIS	PT	26642	1972	16.0	30.5	30.5	30.5	30.5															
ORMISTON	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	B	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	29.0	29.0	29.0
RIVER 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	119.9	119.9	119.9	119.9	119.9	28.7	28.7	28.7
RIVER EMBLEY	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	121.6	121.6	121.6	121.6	121.6	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	B	5580	1986	14.2	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8
SEAWAY HOBART	RO/RO	7161	1976	15.2	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7

TABLE I.10 (cont) COASTAL SHIPS: 20 YEAR SHIP LIFE, TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS SAME SIZE AS EXISTING VESSELS (ENERGY BASIS)

SEAWAY MELBOURNE	RO/RO	7180	1977	16.8	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	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7
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	24.5	24.5	24.5	24.5	24.5	23.4	23.4	23.4
TNT CAPRICORNIA	B [coal]	75140	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
TNT 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															
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	11.5	11.5	11.5	11.5
ZINCMASTER	SP*	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
AMPOL 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	11.5	11.5	11.5	11.5	11.5	7.2	7.2	7.2	7.2	7.2	7.2	7.2
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
EXPRESS	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
MOBIL TASMAN	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
SEACAT TASMANIA	P/CF	200	1990	35.0	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
SEAROAD MERSEY	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	B	30000	1982	13.0	REGR.				27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	18.5	18.5	18.5
SEAROAD 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
TONNES OF FUEL PER DAY (CONSTANT TASK AFTER 1991)						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
INDEX OF FUEL USED (1988 BASE; CONSTANT TASK AFTER 1991)						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	77.5	63.5	63.3
DEADWEIGHT TONNE - NAUTICAL MILES PER DAY						4.8E+08	4.7E+08	5.0E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08	4.6E+08
FLEET AVERAGE TONNES OF FUEL / 000DWT / 1000 NAUTICAL MILES						3.98	3.76	3.89	3.94	3.94	3.91	3.91	3.84	3.76	3.74	3.69	3.64	3.54	3.54	3.49	3.26	2.67	2.66
INDEX OF FLEET FUEL EFFICIENCY (1988 BASE)						100.0	105.6	102.3	101.0	101.0	101.9	101.8	103.5	105.6	106.0	107.3	108.6	111.1	111.2	112.2	118.2	133.1	133.3

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 tonnes of fuel per 000DWT per day from BTCE database INTSEA8.WK1
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 I.11 INTERNATIONAL SHIPS: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT SHIPS THE SAME SIZE AS EXISTING VESSELS

NAME	TYPE	DWT	YEAR BUILT	SPEED	FUEL/DAY AT SPEED (TONNES)	TONNES FUEL / DAY OF VESSEL AND REPLACEMENT VESSEL 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AUSTRALIAN EMBLEM	RO/RO	23450	1975	14.5	54.3	54.3																	
AUSTRALIAN PURPOSE	B	122750	1977	15.7	REGR.	75.7	75.7																
IRON KESTREL	B	27270	1974	14.0	30.0	30.0	30.0	30.0															
ANRO 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 MELBOURNE	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	42.5	42.5	42.5	42.5	42.5	42.5	42.5	24.8	24.8	24.8	24.8	24.8	24.8
AUSTRALIAN ADVANCE	C	35407	1983	17.2	50.2	50.2	50.2	50.2															
AUSTRALIAN EXPORTE	C	27978	1972	14.9	67.0	67.0	67.0	67.0															
AUSTRALIAN PROGRES	B	139400	1977	14.0	72.0	72.0	72.0	72.0	72.0	72.0	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
AUSTRALIAN PROSPEC	B	139400	1976	14.0	72.5	72.5	72.5	72.5	72.5	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	44.5
AUSTRALIAN SEAROAD	CC*	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	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5
AUSTRALIAN TRADER	C	8450	1978	13.7	22.1	22.1	22.1	22.1	22.1	22.1	22.1	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
AUSTRALIAN VENTURE	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	49.8	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.Y.O'CONNOR	G/C	2640	1988	12.1	6.8	6.8	6.8	6.8	6.8														
HOWARD SMITH	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	25.8	25.8	25.8	25.8	25.8	25.8	25.8	25.8	25.8
IRON ARNHEM	G/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 KEMBLA	B	148150	1986	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	32.7	32.7	32.7	32.7
IRON 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 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	36.7	36.7	36.7	36.7	36.7	36.7	36.7	36.7	36.7
MARKHAM BAY	G/C	2925	1987	12.0	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
MARY DURACK	G/C	2640	1988	12.3	7.5	7.5	7.5	7.5															
MOBIL FLINDERS	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
NIVOSA	CT	124754	1984	13.0	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	32.8	32.8	32.8	32.8	32.8	32.8
NW SANDERLING	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	74.4
TNT 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	25.4	25.4	25.4	25.4	25.4	25.4	25.4
TNT EXPRESS	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	32.8	32.8	32.8	32.8	32.8	32.8
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	16.6	16.6
NW SNIPE	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 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 ENDURANCE	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
FRANK KONECNY	G/C	3400	1990	13.3	7.0			7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
GORDON REID	G/C	3400	1990	13.3	7.0			7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
IRON FLINDERS	C	17370	1986	15.0	32.6				32.6	32.6	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
NW SANDPIPER	LNG	72870	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
TONNES OF FUEL PER DAY (CONSTANT TASK AFTER 1993)						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
INDEX OF FUEL USED (1988 BASE; CONSTANT TASK AFTER 1993)						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	86.7	85.7
DEADWEIGHT TONNE - NAUTICAL MILES PER DAY						7.2E+08	7.7E+08	7.3E+08	7.6E+08	7.6E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08
FLEET AVERAGE TONNES OF FUEL / 000DWT / 1000 NAUTICAL MILES						1.87	1.88	1.91	1.84	1.79	1.72	1.71	1.70	1.70	1.67	1.63	1.61	1.55	1.54	1.50	1.50	1.48	1.46
INDEX OF FLEET FUEL EFFICIENCY (1988 BASE)						100.0	99.5	97.9	101.7	104.5	107.9	108.4	109.0	109.0	110.7	113.0	114.0	117.3	117.6	119.7	119.7	120.9	121.9

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 INTSEA8.wk1

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(-1.749625-0.492529ln(DWT/1000)+0.222308ln(1991-year built)+1.106877ln(speed))
Tankers : exp(-3.67077-0.406922ln(DWT/1000)+0.178088ln(1991-year built)+1.782273ln(speed))
Ro/Ro : exp(-4.005212-0.507276ln(DWT/1000)+0.048439ln(1991-year built)+2.234377ln(speed))
Container : exp(-6.641991-0.584367ln(DWT/1000)+0.398533ln(1991-year built)+2.910674ln(speed))
Gen Cargo : exp(-5.347061-0.51047ln(DWT/1000)+0.047109ln(1991-year built)+2.657819ln(speed))
Gas Tanker: exp(-0.592047-0.35921ln(DWT/1000)+0.071585ln(1991-year built)+0.777528ln(speed))

SOURCES: AUSTRALIAN SHIPPING 1990 and ealier editions, BTCE DATABASE

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

NAME	TYPE	DWT	YEAR BUILT	SPEED	FUEL/DAY AT SPEED (TONNES)	TONNES FUEL / DAY OF VESSEL AND REPLACEMENT VESSEL 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AUSTRALIAN EMBLEM	RO/RO	23450	1975	14.5	54.3	54.3																	
AUSTRALIAN PURPOSE	B	122750	1977	15.7	REQR.	75.7	75.7																
IRON KESTREL	B	27270	1974	14.0	30.0	30.0	30.0	30.0															
ANRO 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
ANRO MELBOURNE	RO/RO/C	23617	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	29.8	29.8	29.8	29.8	29.8	30.9
AUSTRALIAN ADVANCE	C	35407	1983	17.2	50.2	50.2	50.2	50.2															
AUSTRALIAN EXPORTE	C	27978	1972	14.9	67.0	67.0	67.0	67.0															
AUSTRALIAN PROGRES	B	139400	1977	14.0	72.0	72.0	72.0	72.0	72.0	72.0	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	45.8
AUSTRALIAN PROSPEC	B	139400	1976	14.0	72.5	72.5	72.5	72.5	72.5	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	43.7	45.8
AUSTRALIAN SEAROAD	CC*	9033	1982	17.5	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2
AUSTRALIAN TRADER	C	8450	1978	13.7	22.1	22.1	22.1	22.1	22.1	22.1	22.1	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2
AUSTRALIAN VENTURE	C	39450	1977	18.9	110.5	110.5	110.5	110.5	110.5	110.5	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8
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	56.2	56.2	56.2	56.2	56.2	56.2	58.8
C.Y.O'CONNOR	G/C	2640	1988	12.1	6.8	6.8	6.8	6.8	6.8														
HOWARD SMITH	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	26.7	26.7	26.7	26.7	26.7	26.7	26.7	26.7	27.9
IRON ARNHEM	G/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	64.0	62.7
IRON KEMBLA	B	148150	1986	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	37.5
IRON KIRBY	B	27299	1974	14.0	30.0	30.0	30.0	30.0	30.0	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	23.7
IRON NEWCASTLE	B	140140	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	35.7	35.7	35.7	35.7	37.5
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	33.1	33.1	33.1	34.8
IRON SHORTLAND	B	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	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	39.7
MARKHAM 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	7.4	7.4	8.1
MARY DURACK	G/C	2640	1988	12.3	7.5	7.5	7.5	7.5															
MOBIL FLINDERS	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	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	42.6	42.6	42.6	42.6	42.6	42.6	34.1	34.1	34.1	34.1	34.1	39.0
NW SANDERLING	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
TNT 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	26.9	26.9	26.9	26.9	26.9	26.9	28.2
TNT EXPRESS	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	36.7	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
NW SNIPE	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 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 ENDURANCE	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
FRANK KONECNY	G/C	3400	1990	13.3	7.0			7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
GORDON REID	G/C	3400	1990	13.3	7.0			7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
IRON FLINDERS	C	17370	1986	15.0	32.6				32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	23.5	23.5	23.5	23.5
NW SANDPIPER	LNG	72870	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
TONNES OF FUEL PER DAY (CONSTANT TASK AFTER 1993)						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 USED (1988 BASE; CONSTANT TASK AFTER 1993)						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 TONNE - NAUTICAL MILES PER DAY						7.2E+08	7.7E+08	7.3E+08	7.6E+08	7.6E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08
FLEET AVERAGE TONNES OF FUEL / 000DWT / 1000 NAUTICAL MILES						1.87	1.88	1.91	1.84	1.79	1.73	1.72	1.71	1.71	1.68	1.65	1.64	1.59	1.58	1.57	1.56	1.56	1.60
INDEX OF FLEET FUEL EFFICIENCY (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 consumption were obtained from shipping companies, else from regression equations for tonnes of fuel per 000DWT per day from BTCE database INTSEA8.wk1
For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

SOURCES: AUSTRALIAN SHIPPING 1990 and ealier editions, BTCE DATABASE

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

NAME	TYPE	DWT	YEAR BUILT	SPEED	FUEL/DAY AT SPEED (TONNES)	TONNES FUEL / DAY OF VESSEL AND REPLACEMENT VESSEL																	
						1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AUSTRALIAN EMBLEM	RO/RO	23450	1975	14.5	54.3	54.3																	
AUSTRALIAN PURPOSE	B	122750	1977	15.7	REGR.	75.7	75.7																
IRON KESTREL	B	27270	1974	14.0	30.0	30.0	30.0	30.0															
ANRO AUSTRALIA	RO/RO/C	22200	1977	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	34.9
ANRO MELBOURNE	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	42.5	42.5	42.5	42.5	42.5	42.5	42.5	26.5	26.5	26.5	26.5	26.5	26.5
AUSTRALIAN ADVANCE	C	35407	1983	17.2	50.2	50.2	50.2	50.2															
AUSTRALIAN EXPORTE	C	27978	1972	14.9	67.0	67.0	67.0	67.0															
AUSTRALIAN PROGRES	B	139400	1977	14.0	72.0	72.0	72.0	72.0	72.0	72.0	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2
AUSTRALIAN PROSPEC	B	139400	1976	14.0	72.5	72.5	72.5	72.5	72.5	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2
AUSTRALIAN SEAROAD	CC*	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	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2
AUSTRALIAN TRADER	C	8450	1978	13.7	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	14.4	14.4	14.4
AUSTRALIAN VENTURE	C	39450	1977	18.3	110.5	110.5	110.5	110.5	110.5	110.5	51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2
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	55.0	55.0	55.0	55.0	55.0	55.0	55.0
C.Y.O'CONNOR	G/C	2640	1988	12.1	6.8	6.8	6.8	6.8	6.8														
HOWARD SMITH	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	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8
IRON ARNHEM	G/C	8362	1973	12.0	12.5	12.5	12.5	12.5															
IRON 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	56.7
IRON KEMBLA	B	148150	1986	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	34.0	34.0	34.0	34.0
IRON KIRBY	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	24.0
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	34.3	34.3	34.3	34.3	34.3
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	31.6	31.6	31.6	31.6
IRON 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	32.3
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	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
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	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
MARKHAM 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	8.2
MARY DURACK	G/C	2640	1988	12.3	7.5	7.5	7.5	7.5															
MOBIL FLINDERS	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	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1
NIVOSA	CT	124754	1984	14.0	42.6	42.6	42.6	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	34.8
NW SANDERLING	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	102.3
TNT 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	26.4	26.4	26.4	26.4	26.4	26.4	26.4
TNT EXPRESS	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	34.0	34.0	34.0	34.0	34.0	34.0
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	17.0	17.0
NW SNIPE	LNG	72870	1990	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
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 ENDURANCE	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
FRANK KONECNY	G/C	3400	1990	13.3	7.0			7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
GORDON REID	G/C	3400	1990	13.3	7.0			7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
IRON FLINDERS	C	17370	1986	15.0	32.6				32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	18.2	18.2	18.2	18.2
NW SANDPIPER	LNG	72870	1992	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
TONNES OF FUEL PER DAY (CONSTANT TASK AFTER 1993)						1344.8	1447.5	1385.8	1396.0	1356.8	1365.1	1357.4	1349.7	1349.7	1329.4	1299.6	1288.1	1244.3	1241.6	1217.8	1218.0	1209.6	1211.6
INDEX OF FUEL USED (1988 BASE; CONSTANT TASK AFTER 1993)						100.0	107.6	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	90.1
DEADWEIGHT TONNE - NAUTICAL MILES PER DAY (CONSTANT SHIP SIZE)						7.21E+08	7.73E+08	7.29E+08	7.62E+08	7.61E+08	7.91E+08	7.91E+08	7.91E+08	7.91E+08	7.91E+08	7.91E+08	7.91E+08	7.91E+08	7.91E+08	7.91E+08	7.91E+08	7.91E+08	7.91E+08
ADDITIONAL DWT-NM PER DAY (DUE TO LARGER REPLACEMENT SHIPS)											1.21E+07	1.21E+07	1.54E+07	1.54E+07	2.60E+07	3.14E+07	3.68E+07	4.56E+07	5.00E+07	6.12E+07	6.12E+07	6.17E+07	6.77E+07
TOTAL DEADWEIGHT TONNE-NAUTICAL MILES PER DAY						7.21E+08	7.73E+08	7.29E+08	7.62E+08	7.61E+08	8.03E+08	8.03E+08	8.07E+08	8.07E+08	8.17E+08	8.23E+08	8.28E+08	8.37E+08	8.41E+08	8.52E+08	8.52E+08	8.53E+08	8.59E+08
FLEET AVERAGE TONNES OF FUEL / 000DWT / 1000 NAUTICAL MILES						1.86	1.87	1.90	1.83	1.78	1.70	1.69	1.67	1.67	1.63	1.58	1.56	1.49	1.48	1.43	1.43	1.42	1.41
INDEX OF FLEET FUEL EFFICIENCY (1988 BASE)						100.0	99.5	98.0	101.8	104.4	108.8	109.4	110.2	110.2	112.7	115.2	116.6	120.2	120.8	123.4	123.3	123.9	124.3

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 INTSEA8.wk1
For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

SOURCES: AUSTRALIAN SHIPPING 1990 and ealier editions, BTCE DATABASE

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

NAME	TYPE	DWT	YEAR BUILT	SPEED	FUEL/DAY AT SPEED (TONNES)	TONNES FUEL / DAY OF VESSEL AND REPLACEMENT VESSEL 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AUSTRALIAN EMBLEM	RO/RO	23450	1975	14.5	54.3	54.3																	
AUSTRALIAN PURPOSE	B	122750	1977	15.7	REOR.	75.7	75.7																
IRON KESTREL	B	27270	1974	14.0	30.0	30.0	30.0	30.0															
ANRO AUSTRALIA	RO/RO/C	22200	1977	13.3	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	32.7	32.7	32.7	32.7	32.7	32.7	32.7	32.7
ANRO MELBOURNE	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	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
AUSTRALIAN ADVANCE	C	35407	1983	17.2	50.2	50.2	50.2	50.2															
AUSTRALIAN EXPORTE	C	27978	1972	14.9	67.0	67.0	67.0	67.0															
AUSTRALIAN PROGRES	B	139400	1977	14.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	41.8	41.8	41.8	41.8	41.8	41.8	41.8	41.8
AUSTRALIAN PROSPEC	B	139400	1976	14.0	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3
AUSTRALIAN SEAROAD	CC*	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	21.0
AUSTRALIAN TRADER	C	8450	1978	13.7	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	12.3
AUSTRALIAN VENTURE	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	43.7	43.7	43.7
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	60.0	60.0	60.0	60.0	60.0	50.1	50.1
C.Y.O'CONNOR	G/C	2640	1988	12.1	6.8	6.8	6.8	6.8	6.8														
HOWARD SMITH	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	24.4
IRON ARNHEM	G/C	6362	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	64.0	64.0
IRON KEMBLA	B	148150	1986	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	37.0	37.0	37.0	37.0
IRON KIRBY	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	22.5
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	37.0	37.0	37.0	37.0	37.0
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	38.0	38.0	38.0	38.0
IRON SHORTLAND	B	107140	1979	12.5	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	29.3
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	44.5	44.5	44.5	44.5	44.5	34.7	34.7	34.7	34.7
IRON WHYALLA	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	34.7
MARKHAM 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	8.0
MARY DURACK	G/C	2640	1988	12.3	7.5	7.5	7.5	7.5															
MOBIL FLINDERS	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	75.0	75.0	75.0	75.0	75.0	43.0	43.0	43.0
NIVOSA	CT	124754	1984	13.0	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	30.4
NW SANDERLING	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	93.0
TNT 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	33.0	33.0	33.0	33.0	33.0	24.1	24.1
TNT EXPRESS	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	54.0	54.0	54.0	54.0	54.0	31.2
TRANZTAS TRADER	C	14101	1988	15.2	25.5	25.5	25.5	25.6	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
NW SNIPE	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 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 ENDURANCE	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
FRANK KONECNY	G/C	3400	1990	13.3	7.0			7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
GORDON REID	G/C	3400	1990	13.3	7.0			7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
IRON FLINDERS	C	17370	1986	15.0	32.6				32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
NW SANDPIPER	LNG	72870	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
TONNES OF FUEL PER DAY (CONSTANT TASK AFTER 1993)						1344.8	1447.5	1385.8	1396.0	1389.1	1482.1	1482.1	1474.6	1474.6	1444.4	1345.5	1335.7	1325.0	1325.0	1295.4	1255.4	1236.6	1201.5
INDEX OF FUEL USED (1988 BASE; CONSTANT TASK AFTER 1993)						100.0	107.6	103.1	103.8	103.3	110.2	110.2	109.7	109.7	107.4	100.1	99.3	98.5	98.5	96.3	93.4	92.0	89.3
DEADWEIGHT TONNE - NAUTICAL MILES PER DAY						7.2E+08	7.7E+08	7.3E+08	7.6E+08	7.6E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08	7.9E+08
FLEET AVERAGE TONNES OF FUEL / 000DWT / 1000 NAUTICAL MILES						1.87	1.88	1.91	1.84	1.83	1.88	1.88	1.87	1.87	1.83	1.71	1.70	1.68	1.68	1.65	1.59	1.57	1.53
INDEX OF FLEET FUEL EFFICIENCY (1988 BASE)						100.0	99.5	97.9	101.7	102.1	99.4	99.4	100.0	100.0	102.0	108.7	109.4	110.1	110.1	112.1	114.8	116.1	118.5

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 tonnes of fuel per 000DWT per day from BTCE database INTSEA8.wk1
For replacement ships, estimates were obtained by regression on the values obtained for existing and past ships.

SOURCES: AUSTRALIAN SHIPPING 1990 and ealier editions, BTCE DATABASE

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

TABLE II.1 REGRESSIONS FOR FUEL CONSUMPTION OF AIRCRAFT

AIRCRAFT TYPE	DATE MODEL FIRST INTRODUCE	1991 NUMBER OF SEATS	FLIGHT AVERAGE LITRES PER KM	LONG RANGE CRUISING SPEED KMH	LITRES PER SEAT KILOMETER	SEAT -KM PER LITRE	SEAT MILES PER US GALLON (SMPUSG)	LOG SEAT-KM /LITRE	LOG YEAR INTR -1955	LOG SEATS	LOG SPEED	REPLACEMENT AIRCRAFT'S ESTIMATED SEAT-KM PER LITRE 1990	1995	2000	2005
LARGE AIRCRAFT															
BOEING 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
BOEING 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
BOEING 747-400	1989	406	13.30	910	0.033	30.526	71.666	3.418589	3.526360	6.006353	6.813444	34.9	36.9	38.8	40.5
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
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
BOEING 767-300	1986	230	7.30	850	0.032	31.507	73.968	3.450204	3.433987	5.438079	6.745236	35.4	37.5	39.4	41.2
BOEING 767-300ER	1988	230	6.76	850	0.029	34.024	79.877	3.527056	3.496507	5.438079	6.745236	35.4	37.5	39.4	41.2
BOEING 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
BOEING 767-200	1982	211	6.79	850	0.032	31.075	72.955	3.436407	3.295836	5.351858	6.745236	31.0	32.8	34.4	36.0
BOEING 767-200ER	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
MEDIUM AIRCRAFT															
BOEING 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
BOEING 737-400	1988	146	4.42	800	0.030	33.032	77.548	3.497466	3.496507	4.983606	6.684611	32.8	33.3	33.8	34.2
AIRBUS A320	1988	132	4.77	850	0.036	27.673	64.968	3.320455	3.496507	4.882801	6.745236	28.2	28.6	29.0	29.4
BOEING 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
DC9	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
SMALL AIRCRAFT															
BA146-200	1983	75	4.13	690	0.055	18.160	42.634	2.899210	3.332204	4.317488	6.536691	19.1	19.4	19.7	19.9
F28-4000	1978	72	3.54	655	0.049	20.339	47.750	3.012539	3.135494	4.276666	6.484635	20.8	21.2	21.5	21.8
F27	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
F50	1986	50	1.33	445	0.027	37.594	88.259	3.626844	3.433987	3.912023	6.098074	38.2	38.8	39.4	39.9
DASH 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

LARGE Regression Output:			
Constant		83.17239	
Std Err of Y Est		0.180782	
R Squared		0.688919	
No. of Observations		10	
Degrees of Freedom		6	
X Coefficient(s)	0.421951	1.565581	-13.2861
Std Err of Coef.	0.279985	0.669563	5.441263

MEDIUM Regression Output:			
Constant		9.985463	
Std Err of Y Est		0.021146	
R Squared		0.998292	
No. of Observations		5	
Degrees of Freedom		1	
X Coefficient(s)	0.120633	0.606477	-1.48817
Std Err of Coef.	0.030329	0.064650	0.283931

SMALL Regression Output:			
Constant		14.18036	
Std Err 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

NOTE: Fuel efficiency may vary considerably within a particular type. For example, the newer versions of the Boeing 747-200 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

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

TYPE	YEAR BUILT	SEATS	AVERAGE SEAT KM PER LITRE	TYPE AVGE SEAT-KM PER YEAR	SEAT-KILOMETERS PER LITRE OF FUEL 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
A300-200	1980	230	20.6	3.34E+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	56.6
A300-200	1981	230	20.6	3.34E+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	56.6	56.6	56.6	56.6	56.6
A300-200	1982	230	20.6	3.34E+08	20.6	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	56.6	56.6	56.6	56.6
A300-200	1982	230	20.6	3.34E+08		20.6	20.6															
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	4.18E+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	4.18E+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
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
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
A310	1990	210	41.3	3.05E+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	41.3
A320	1988	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	29.3	29.3
A320	1988	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	29.3	29.3
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	29.5
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	29.5
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	29.5
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	29.5
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	29.5
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	29.5
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	29.5
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	29.5
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	29.5
BAE146-20	1985	75	18.2	1.64E+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	1985	75	18.2	1.64E+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	75	18.2	1.64E+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	75	18.2	1.64E+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	1.64E+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	2.18E+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	2.18E+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	2.18E+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	2.18E+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	2.18E+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
727-200 C	1972	144	25.0	2.97E+08	25.0																	
727-200 C	1973	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																	
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	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	2.97E+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	33.0
727-200 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	33.0
727-200 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	33.0
727-200 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	33.0
727-200	1978	144	25.0	2.97E+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
727-200	1979	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3
727-200	1979	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3
727-200	1979	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3
727-200	1979	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3
727-200	1979	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3
727-200	1980	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4
727-200	1980	144	25.0	2.97E+08	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	33.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4
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	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5
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	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5

TABLE II.2 (cont) DOMESTIC AIRCRAFT: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT, 15 YEAR ECONOMIC LIFE

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	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5
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	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	1986	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	34.0	34.0	34.0	34.0
737-300	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	34.1	34.1	34.1
737-300	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	34.1	34.1	34.1
737-300	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	34.1	34.1	34.1
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	34.1	34.1
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	34.1	34.1
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	34.1	34.1
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	34.1	34.1
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	34.1	34.1
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	34.2
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	34.2
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	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	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	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	33.0	33.0
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	39.0	39.0	39.0	39.0	39.0	39.0	39.0
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	39.0	39.0	39.0	39.0	39.0	39.0	39.0
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	39.0	39.0	39.0	39.0	39.0	39.0	39.0
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	39.0	39.0	39.0	39.0	39.0	39.0	39.0
767-200	1984	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	31.1	39.4	39.4	39.4	39.4	39.4	39.4
DC9		92	16.6	1.37E+08	16.6	16.6																
DC9		92	16.6	1.37E+08	16.6	16.6																
DC9		92	16.6	1.37E+08	16.6																	
DC9		92	16.6	1.37E+08	16.6																	
DC9		92	16.6	1.37E+08	16.6																	
F27	1959	50	25.0	3.32E+07	25.0	25.0																
F27	1966	50	25.0	3.32E+07	25.0	25.0																
F27	1966	50	25.0	3.32E+07	25.0	25.0																
F27	1968	50	25.0	3.32E+07	25.0	25.0																
F27	1976	50	25.0	3.32E+07	25.0	25.0																
F27	1981	50	25.0	3.32E+07	25.0	25.0																
F27	1981	50	25.0	3.32E+07	25.0	25.0																
F27	1984	50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																

TABLE II.2 (cont) DOMESTIC AIRCRAFT: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT, 15 YEAR ECONOMIC LIFE

F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F28-1000	1969	72	20.3	1.15E+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
F28-1000	1970	72	20.3	1.15E+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
F28-1000	1970	72	20.3	1.15E+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
F28-1000	1970	72	20.3	1.15E+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
F28-1000	1971	72	20.3	1.15E+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
F28-1000		72	20.3	1.15E+08	20.3																	
F28-1000		72	20.3	1.15E+08	20.3																	
F28-3000		72	20.3	1.15E+08	20.3	20.3	20.3															
F28-3000		72	20.3	1.15E+08	20.3	20.3	20.3															
F28-4000	1979	72	20.3	1.15E+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
F28-4000	1982	72	20.3	1.15E+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
F28-4000	1983	72	20.3	1.15E+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
F28-4000	1983	72	20.3	1.15E+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
F28-4000	1984	72	20.3	1.15E+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
F28-4000	1984	72	20.3	1.15E+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
F28-4000	1984	72	20.3	1.15E+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
F50	1987	50	37.6	4.30E+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	39.7	39.7	39.7
F50	1987	50	37.6	4.30E+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	39.7	39.7	39.7
F50	1987	50	37.6	4.30E+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	39.7	39.7	39.7
F50	1987	50	37.6	4.30E+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	39.7	39.7	39.7
F50	1987	50	37.6	4.30E+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	39.7	39.7	39.7
F50	1987	50	37.6	4.30E+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	39.7	39.7	39.7
F50	1987	50	37.6	4.30E+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	39.7	39.7	39.7
F50	1987	50	37.6	4.30E+07	37.6																	
F50	1987	50	37.6	4.30E+07	37.6																	
F50	1987	50	37.6	4.30E+07	37.6																	
				2.69E+10																		
WEIGHTED AVERAGE SEAT-KM/L (weighted by seat-km perfor					24.8	25.0	26.1	27.0	27.5	27.5	27.6	28.1	28.6	29.4	29.8	30.3	30.4	30.4	31.9	32.1	32.6	32.8
ASK (AVAILABLE SEAT-KM)					1.9E+10	1.9E+10	2.1E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10
INDEX OF FLEET FUEL EFFICIENCY (1988 BASE)					100.0	100.7	105.1	108.8	110.8	110.8	111.2	113.2	115.5	118.8	120.4	122.1	122.7	122.7	128.7	129.7	131.3	132.4
TASK (MILLION PASSENGERS)					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 TASK (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	172.0
LOAD FACTOR					0.774	0.742	0.716	0.746	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.73	0.73	0.73	0.73	0.73	0.73
INDEX OF FUEL USED (1988 BASE)					100.0	75.3	92.8	111.3	95.7	101.0	105.9	108.5	110.8	112.1	114.8	116.8	121.4	126.9	126.2	130.4	133.8	137.8

NOTE: Aircraft replaced at 15 years or 1992 earliest.
727-200 replaced by 737-400; 767-200 replaced by 767-300; 737-300 replaced BY 737-400; A300-200s by A300-600s; BAE 146-200s by BAE146-300s
A310 skm/l by proportion on number of seats from A300-600R

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

TABLE II.3 DOMESTIC AIRCRAFT: 1990 SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT

TYPE	YEAR BUILT	SEATS	AVERAGE SEAT KM PER LITRE	TYPE AVGE SEAT-KM PER YEAR	SEAT-KILOMETERS PER LITRE OF FUEL 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
A300-200	1980	230	20.6	3.34E+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	56.6
A300-200	1981	230	20.6	3.34E+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	56.6	56.6	56.6	56.6	56.6
A300-200	1982	230	20.6	3.34E+08	20.6	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	56.6	56.6	56.6	56.6
A300-200	1982	230	20.6	3.34E+08		20.6	20.6															
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	4.18E+08			56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	[illegible]	56.6	56.6	56.6	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
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
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
A310	1990	210	41.3	3.05E+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	41.3
A320	1988	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1988	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
BAE146-20	1985	75	18.2	1.64E+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	22.5
BAE146-20	1985	75	18.2	1.64E+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	22.5
BAE146-20	1988	75	18.2	1.64E+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	22.5
BAE146-20	1988	75	18.2	1.64E+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	22.5
BAE146-20	1989	75	18.2	1.64E+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	22.5
BAE146-30	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
BAE146-30	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
BAE146-30	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
BAE146-30	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
BAE146-30	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
727-200 C	1972	144	25.0	2.97E+08	25.0																	
727-200 C	1973	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																	
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	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	2.97E+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	33.0
727-200 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	33.0
727-200 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	33.0
727-200 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	33.0
727-200	1978	144	25.0	2.97E+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	33.0	33.0
727-200	1979	144	25.0	2.97E+08	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	33.0	33.0
727-200	1979	144	25.0	2.97E+08	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	33.0	33.0
727-200	1979	144	25.0	2.97E+08	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	33.0	33.0
727-200	1979	144	25.0	2.97E+08	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	33.0	33.0
727-200	1979	144	25.0	2.97E+08	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	33.0	33.0
727-200	1980	144	25.0	2.97E+08	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	33.0
727-200	1980	144	25.0	2.97E+08	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	33.0
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	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0
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	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0

TABLE II.3 (cont) DOMESTIC AIRCRAFT: 1990 SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT

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	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0
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	33.0	33.0	33.0	33.0	33.0	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	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
737-300	1986	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	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	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
737-300	1986	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	33.0	33.0	33.0	33.0
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	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	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
737-300	1986	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	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	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
737-300	1986	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	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	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
737-300	1986	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	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	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
737-300	1986	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	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	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
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	33.0	33.0	33.0	33.0
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	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	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
737-300	1986	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	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	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
737-300	1986	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	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	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
737-300	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	33.0	33.0	33.0
737-300	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	33.0	33.0	33.0
737-300	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	33.0	33.0	33.0
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	33.0	33.0
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	33.0	33.0
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	33.0	33.0
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	33.0	33.0
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	33.0	33.0
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	33.0
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	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	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	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	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	33.0	33.0
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
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
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
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
767-200	1984	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	31.1	31.5	31.5	31.5	31.5	31.5	31.5
DC9		92	16.6	1.37E+08	16.6	16.6																
DC9		92	16.6	1.37E+08	16.6	16.6																
DC9		92	16.6	1.37E+08	16.6																	
DC9		92	16.6	1.37E+08	16.6																	
DC9		92	16.6	1.37E+08	16.6																	
F27	1959	50	25.0	3.32E+07	25.0	25.0																
F27	1966	50	25.0	3.32E+07	25.0	25.0																
F27	1966	50	25.0	3.32E+07	25.0	25.0																
F27	1968	50	25.0	3.32E+07	25.0	25.0																
F27	1976	50	25.0	3.32E+07	25.0	25.0																
F27	1981	50	25.0	3.32E+07	25.0	25.0																
F27	1981	50	25.0	3.32E+07	25.0	25.0																
F27	1984	50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																

TABLE II.3 (cont) DOMESTIC AIRCRAFT: 1990 SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT

F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F28-1000	1969	72	20.3	1.15E+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	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	20.3	20.3	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	20.3	20.3	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	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3
F28-1000	1971	72	20.3	1.15E+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	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	1.15E+08	20.3																	
F28-3000		72	20.3	1.15E+08	20.3	20.3	20.3															
F28-3000		72	20.3	1.15E+08	20.3	20.3	20.3															
F28-4000	1979	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1982	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1983	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1983	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1984	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1984	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	20.3
F28-4000	1984	72	20.3	1.15E+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	20.3	20.3	20.3	20.3
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6
F50	1987	50	37.6	4.30E+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	37.6
F50	1987	50	37.6	4.30E+07	37.6																	
F50	1987	50	37.6	4.30E+07	37.6																	
F50	1987	50	37.6	4.30E+07	37.6																	
WEIGHTED AVERAGE SEAT-KM/L (weighted by seat-					24.8	25.0	26.1	27.0	27.4	27.4	27.6	28.0	28.6	29.4	29.8	29.8	29.8	29.9	31.2	31.4	31.8	32.1
TASK (SEAT-KM)					1.9E+10	1.9E+10	2.1E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10
INDEX OF FLEET FUEL EFFICIENCY (1988 BASE)					100.0	100.7	105.1	108.8	110.7	110.7	111.1	113.0	115.3	118.5	120.0	120.1	120.2	120.7	125.8	126.6	128.5	129.3
TASK (MILLION PASSENGERS)					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 TASK (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	172.0
LOAD FACTOR					0.774	0.742	0.716	0.746	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.73	0.73	0.73	0.73	0.73	0.73
INDEX OF FUEL USED (1988 BASE)					100.0	75.3	92.8	111.3	95.8	101.1	106.0	108.7	111.0	112.4	115.2	118.7	124.0	129.0	129.1	133.6	136.8	141.1

NOTE: Aircraft replaced at 15 years or 1992 earliest.
727s replaced with 737-400s, 767-200s replaced with 767-300s.

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

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

TYPE	YEAR BUILT	SEATS	AVERAGE SEAT KM PER LITRE	TYPE AVGE SEAT-KM PER YEAR	SEAT-KILOMETERS PER LITRE OF FUEL 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
A300-200	1980	230	20.6	3.34E+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
A300-200	1981	230	20.6	3.34E+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
A300-200	1982	230	20.6	3.34E+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
A300-200	1982	230	20.6	3.34E+08		20.6	20.6															
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	4.18E+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	4.18E+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
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
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
A310	1990	210	41.3	3.05E+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	41.3
A320	1988	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1988	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
BAE146-20	1988	75	18.2	1.64E+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	75	18.2	1.64E+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	1989	75	18.2	1.64E+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	1.64E+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	1.64E+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	2.18E+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	2.18E+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	2.18E+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	2.18E+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	2.18E+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
727-200 C	1972	144	25.0	2.97E+08	25.0																	
727-200 C	1973	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																	
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	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3
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	33.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4
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	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	33.4
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	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5
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	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5	33.5
B727-200	1978	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	33.7	33.7	33.7	33.7	33.7	33.7	33.7
B727-200	1979	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
B727-200	1979	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
B727-200	1979	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
B727-200	1979	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
B727-200	1979	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

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

B727-200	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	33.9	33.9	33.9	33.9	33.9
B727-200	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	33.9	33.9	33.9	33.9	33.9
B727-200	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	34.1	34.1	34.1	34.1
B727-200	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	34.1	34.1	34.1	34.1
B727-200	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	34.1	34.1	34.1	34.1
B727-200	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	34.1	34.1	34.1	34.1
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	1986	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
B737-300	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	26.9	26.9
B737-300	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	26.9	26.9
B737-300	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	26.9	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	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	2.17E+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	2.17E+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	2.17E+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	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
B737-300	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	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	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	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	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	33.0	33.0
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	39.0	39.0	39.0	39.0	39.0	40.8	40.8
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	39.0	39.0	39.0	39.0	39.0	40.8	40.8
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	39.0	39.0	39.0	39.0	39.0	40.8	40.8
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	39.0	39.0	39.0	39.0	39.0	40.8	40.8
767-200	1984	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	31.1	39.4	39.4	39.4	39.4	39.4	41.2
DC9		92	16.6	1.37E+08	16.6	16.6																
DC9		92	16.6	1.37E+08	16.6	16.6																
DC9		92	16.6	1.37E+08	16.6																	
DC9		92	16.6	1.37E+08	16.6																	
DC9		92	16.6	1.37E+08	16.6																	
F27	1959	50	25.0	3.32E+07	25.0	25.0																
F27	1966	50	25.0	3.32E+07	25.0	25.0																
F27	1966	50	25.0	3.32E+07	25.0	25.0																

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

F27	1968	50	25.0	3.32E+07	25.0	25.0																
F27	1976	50	25.0	3.32E+07	25.0	25.0																
F27	1981	50	25.0	3.32E+07	25.0	25.0																
F27	1981	50	25.0	3.32E+07	25.0	25.0																
F27	1984	50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F28-1000	1969	72	20.3	1.15E+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
F28-1000	1970	72	20.3	1.15E+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
F28-1000	1970	72	20.3	1.15E+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
F28-1000	1970	72	20.3	1.15E+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
F28-1000	1971	72	20.3	1.15E+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
F28-1000		72	20.3	1.15E+08	20.3																	
F28-1000		72	20.3	1.15E+08	20.3																	
F28-3000		72	20.3	1.15E+08	20.3	20.3	20.3															
F28-3000		72	20.3	1.15E+08	20.3	20.3	20.3															
F28-4000	1979	72	20.3	1.15E+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
F28-4000	1982	72	20.3	1.15E+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	20.3	20.3	20.3	21.6	21.6	21.6
F28-4000	1983	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	21.7	21.7
F28-4000	1983	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	21.7	21.7
F28-4000	1984	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	20.3	21.8
F28-4000	1984	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	21.8
F28-4000	1984	72	20.3	1.15E+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	20.3	20.3	20.3	21.8
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6
F50	1987	50	37.6	4.30E+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	37.6
F50	1987	50	37.6	4.30E+07	37.6																	
F50	1987	50	37.6	4.30E+07	37.6																	
F50	1987	50	37.6	4.30E+07	37.6																	
				2.69E+10																		
WEIGHTED AVERAGE SEAT-KM/L (weighted by seat-					24.8	25.0	26.1	27.0	27.0	27.0	27.0	27.1	27.5	28.0	28.3	28.8	29.4	29.7	30.2	30.2	30.3	30.3
TASK (SEAT-KM)					1.9E+10	1.9E+10	2.1E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10
INDEX OF FLEET FUEL EFFICIENCY (1988 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
TASK (MILLION PASSENGERS)					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 TASK (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	172.0
LOAD 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	0.72	0.72	0.73	0.73
INDEX OF FUEL USED (1988 BASE)					100.0	75.3	92.8	111.3	104.4	110.2	115.9	120.5	123.6	126.4	128.1	130.0	129.1	133.8	135.3	140.8	143.9	149.1

NOTE: Aircraft replaced at 20 years or 1992 earlier.
727-200 replaced by 737-400; 767-200 replaced by 767-300; 737-300 REPLACED BY 737-400
A310 skm/l by proportion on number of seats from A300-600R.

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

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

TYPE	YEAR BUILT	SEATS	AVERAGE SEAT KM PER LITRE	TYPE AVGE SEAT-KM PER YEAR	SEAT-KILOMETERS PER LITRE OF FUEL																	
					1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
A300-200	1980	230	20.6	3.34E+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	3.34E+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	3.34E+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	3.34E+08		20.6	20.6															
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	4.18E+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	4.18E+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
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
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
A310	1990	210	41.3	3.05E+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	41.3
A320	1988	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1988	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
BAE146-20	1985	75	18.2	1.64E+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	1985	75	18.2	1.64E+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	75	18.2	1.64E+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	75	18.2	1.64E+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	1.64E+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	2.18E+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	2.18E+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	2.18E+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	2.18E+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	2.18E+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
727-200 C	1972	144	25.0	2.97E+08	25.0																	
727-200 C	1973	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																	
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	2.97E+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	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	2.97E+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	1978	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	34.1	34.1
727-200	1979	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	34.2
727-200	1979	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	34.2
727-200	1979	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	34.2
727-200	1979	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	34.2
727-200	1979	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	34.2

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

727-200	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	2.97E+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	2.97E+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	2.97E+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	2.97E+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	2.97E+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
737-300	1986	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	1986	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	1986	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	1986	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	1986	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	1986	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	1986	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	1986	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	1986	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	1986	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	1986	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	1986	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	1986	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	1986	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	1986	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	1986	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	1986	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	1986	109	26.9	2.17E+08	26.9	26.9	26.9	26.9	[illegible]	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	2.17E+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	1986	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	1986	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	1986	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	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	26.9	26.9
737-300	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	26.9	26.9
737-300	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	26.9	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+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
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	2.17E+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
737-300	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	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	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	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	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	33.0	33.0
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	31.1	31.1	31.1	31.1	31.1	31.1	31.1
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	31.1	31.1	31.1	31.1	31.1	31.1	31.1
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	31.1	31.1	31.1	31.1	31.1	31.1	31.1
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	31.1	31.1	31.1	31.1	31.1	31.1	31.1
767-200	1984	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	31.1	31.1	31.1	31.1	31.1	31.1	31.1
DC9		92	16.6	1.37E+08	16.6	16.6																
DC9		92	16.6	1.37E+08	16.6	16.6																
DC9		92	16.6	1.37E+08	16.6																	
DC9		92	16.6	1.37E+08	16.6																	
DC9		92	16.6	1.37E+08	16.6																	
F27	1959	50	25.0	3.32E+07	25.0	25.0																
F27	1966	50	25.0	3.32E+07	25.0	25.0																
F27	1966	50	25.0	3.32E+07	25.0	25.0																

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

F27	1968	50	25.0	3.32E+07	25.0	25.0																
F27	1976	50	25.0	3.32E+07	25.0	25.0																
F27	1981	50	25.0	3.32E+07	25.0	25.0																
F27	1981	50	25.0	3.32E+07	25.0	25.0																
F27	1984	50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F28-1000	1969	72	20.3	1.15E+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
F28-1000	1970	72	20.3	1.15E+08	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	21.3
F28-1000	1970	72	20.3	1.15E+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3
F28-1000	1970	72	20.3	1.15E+08	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3
F28-1000	1971	72	20.3	1.15E+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
F28-1000		72	20.3	1.15E+08	20.3																	
F28-1000		72	20.3	1.15E+08	20.3																	
F28-3000		72	20.3	1.15E+08	20.3	20.3	20.3															
F28-3000		72	20.3	1.15E+08	20.3	20.3	20.3															
F28-4000	1979	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	20.3	21.8
F28-4000	1982	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1983	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1983	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1984	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	20.3	20.3
F28-4000	1984	72	20.3	1.15E+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	20.3	20.3	20.3	20.3	20.3
F28-4000	1984	72	20.3	1.15E+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	20.3	20.3	20.3	20.3
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6
F50	1987	50	37.6	4.30E+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	37.6
F50	1987	50	37.6	4.30E+07	37.6																	
F50	1987	50	37.6	4.30E+07	37.6																	
F50	1987	50	37.6	4.30E+07	37.6																	
				2.69E+10																		
WEIGHTED AVERAGE SEAT-KM/L (weighted by seat-km perfor					24.8	25.0	26.1	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.1	27.3	27.5	27.5	27.6	28.2
TASK (SEAT-KM)					1.9E+10	1.9E+10	2.1E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10
INDEX OF FLEET FUEL EFFICIENCY (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
TASK (MILLION PASSENGERS)					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 TASK (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	172.0
LOAD 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	0.72	0.72	0.73	0.73
INDEX OF FUEL USED (1988 BASE)					100.0	75.3	92.8	111.3	104.5	110.3	116.0	121.0	126.0	131.0	134.1	138.3	140.1	145.3	148.3	154.4	157.7	160.5

NOTE: Aircraft replaced at 25 years or 1992 earliest.

727-200 replaced by 737-400; 767-200 replaced by 767-300; 737-300 replaced BY 737-400; A300-200s by A300-600s; BAE 146-200s by BAE146-300s
A310 SKM/L BY PROPORTION OF NUMBER OF SEATS FROM A300-600R

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

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

TYPE	YEAR BUILT	SEATS	AVERAGE SEAT KM PER LITRE	TYPE AVGE SEAT-KM PER YEAR	SEAT-KILOMETRES PER LITRE OF FUEL 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
A300-200	1980	230	20.6	3.34E+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	56.6
A300-200	1981	230	20.6	3.34E+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	56.6	56.6	56.6	56.6	56.6
A300-200	1982	230	20.6	3.34E+08	20.6	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	56.6	56.6	56.6	56.6
A300-200	1982	230	20.6	3.34E+08		20.6	20.6															
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	4.18E+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	4.18E+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
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
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
A310	1990	210	41.3	3.05E+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	41.3
A320	1988	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	56.6	56.6
A320	1988	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	56.6	56.6
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	56.6
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	56.6
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	56.6
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	56.6
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	56.6
A320	1989	132	27.7	1.14E+08		27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	56.6
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	56.6
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	56.6
A320	1989	132	27.7	1.14E+08				27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	56.6
BAE146-20	1985	75	18.2	1.64E+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	37.6	37.6	37.6	37.6	37.6
BAE146-20	1985	75	18.2	1.64E+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	37.6	37.6	37.6	37.6	37.6
BAE146-20	1988	75	18.2	1.64E+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	37.6
BAE146-20	1988	75	18.2	1.64E+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	37.6
BAE146-20	1989	75	18.2	1.64E+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	37.6
BAE146-30	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
BAE146-30	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
BAE146-30	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
BAE146-30	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
BAE146-30	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
727-200 C	1972	144	25.0	2.97E+08	25.0																	
727-200 C	1973	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																	
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	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
727-200 C	1975	144	25.0	2.97E+08	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	56.6	56.6	56.6	56.6	56.6
727-200 C	1975	144	25.0	2.97E+08	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	56.6	56.6	56.6	56.6	56.6
727-200 C	1976	144	25.0	2.97E+08	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	56.6	56.6	56.6	56.6	56.6
727-200 C	1976	144	25.0	2.97E+08	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	56.6	56.6	56.6	56.6	56.6
B727-200	1978	144	25.0	2.97E+08	25.0	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	56.6	56.6	56.6
B727-200	1979	144	25.0	2.97E+08	25.0	25.0	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	56.6	56.6
B727-200	1979	144	25.0	2.97E+08	25.0	25.0	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	56.6	56.6
B727-200	1979	144	25.0	2.97E+08	25.0	25.0	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	56.6	56.6
B727-200	1979	144	25.0	2.97E+08	25.0	25.0	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	56.6	56.6
B727-200	1979	144	25.0	2.97E+08	25.0	25.0	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	56.6	56.6

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

B727-200	1980	144	25.0	2.97E+08	25.0	25.0	25.0	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	56.6
B727-200	1980	144	25.0	2.97E+08	25.0	25.0	25.0	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	56.6
B727-200	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	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
B727-200	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	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
B727-200	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	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
B727-200	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	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	1986	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	56.6	56.6	56.6	56.6
737-300	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	56.6	56.6	56.6
737-300	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	56.6	56.6	56.6
737-300	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	56.6	56.6	56.6
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	56.6	56.6
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	56.6	56.6
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	56.6	56.6
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	56.6	56.6
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	56.6	56.6
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	56.6
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	56.6
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	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	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	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	33.0	33.0
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	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
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	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
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	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
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	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
767-200	1984	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	56.6	56.6	56.6	56.6	56.6	56.6	56.6	56.6
DC9		92	16.6	1.37E+08	16.6	16.6																
DC9		92	16.6	1.37E+08	16.6	16.6																
DC9		92	16.6	1.37E+08	16.6																	
DC9		92	16.6	1.37E+08	16.6																	
DC9		92	16.6	1.37E+08	16.6																	
F27	1959	50	25.0	3.32E+07	25.0	25.0																
F27	1966	50	25.0	3.32E+07	25.0	25.0																
F27	1966	50	25.0	3.32E+07	25.0	25.0																

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

F27	1968	50	25.0	3.32E+07	25.0	25.0																
F27	1976	50	25.0	3.32E+07	25.0	25.0																
F27	1981	50	25.0	3.32E+07	25.0	25.0																
F27	1981	50	25.0	3.32E+07	25.0	25.0																
F27	1984	50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0	25.0																
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F27		50	25.0	3.32E+07	25.0																	
F28-1000	1969	72	20.3	1.15E+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
F28-1000	1970	72	20.3	1.15E+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
F28-1000	1970	72	20.3	1.15E+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
F28-1000	1970	72	20.3	1.15E+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
F28-1000	1971	72	20.3	1.15E+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
F28-1000		72	20.3	1.15E+08	20.3																	
F28-1000		72	20.3	1.15E+08	20.3																	
F28-3000		72	20.3	1.15E+08	20.3	20.3	20.3															
F28-3000		72	20.3	1.15E+08	20.3	20.3	20.3															
F28-4000	1979	72	20.3	1.15E+08	20.3	20.3	20.3	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
F28-4000	1982	72	20.3	1.15E+08	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	37.6	37.6	37.6	37.6
F28-4000	1983	72	20.3	1.15E+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	37.6	37.6	37.6
F28-4000	1983	72	20.3	1.15E+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	37.6	37.6	37.6
F28-4000	1984	72	20.3	1.15E+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	37.6	37.6	37.6	37.6	37.6	37.6
F28-4000	1984	72	20.3	1.15E+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	37.6	37.6
F28-4000	1984	72	20.3	1.15E+08			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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6	37.6
F50	1987	50	37.6	4.30E+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	37.6
F50	1987	50	37.6	4.30E+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	37.6
F50	1987	50	37.6	4.30E+07	37.6																	
F50	1987	50	37.6	4.30E+07	37.6																	
F50	1987	50	37.6	4.30E+07	37.6																	
				2.69E+10																		
WEIGHTED AVERAGE SEAT-KM/L (weighted by seat-					24.8	25.0	26.1	27.0	28.5	28.5	28.7	30.1	31.0	32.6	33.2	34.7	35.4	35.9	41.6	42.6	45.5	48.5
TASK (SEAT-KM)					1.9E+10	1.9E+10	2.1E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10	2.32E+10
INDEX OF FLEET FUEL EFFICIENCY (1988 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 (MILLION PASSENGERS)					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 TASK (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	172.0
LOAD FACTOR					0.776	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
INDEX OF FUEL USED (1988 BASE)					100.0	75.3	92.0	111.3	98.9	104.4	108.9	108.6	109.7	108.4	109.0	107.9	107.4	110.6	98.1	99.8	95.8	93.2

NOTE: Aircraft replaced at 15 years or 1992 earliest.
All aircraft replaced by A300-600Rs or F50s.
A310 skm/l by proportion from A300-600R on number of seats.
A320 utilisation for 1989-90.

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

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

	TYPE	YEAR BUILT	SEATS	AVERAGE SEAT KM PER LITRE	CRUISING SPEED (KM/HR)	SEAT-KILOMETERS PER LITRE OF FUEL 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
VH-EAA	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	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	
VH-EAB	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	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	29.0	
VH-EBA	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	35.7	35.7	35.7	35.7	
VH-EBB	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	35.7	35.7	35.7	35.7	
VH-EBH	747 238	1974	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	35.7	35.7	35.7	35.7	
VH-EBI	747 238	1974	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	35.7	35.7	35.7	35.7	
VH-EBJ	747 238	1975	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	35.7	35.7	35.7	35.7	
VH-EBK	747 238	1975	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	35.7	35.7	35.7	35.7	
VH-EBL	747 238	1976	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	35.7	35.7	35.7	35.7	
VH-EBM	747 238	1977	397	27.7	910	27.7	27.7	27.7	27.7	27.7	36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1	
VH-EBN	747 238	1977	397	27.7	910	27.7	27.7	27.7	27.7	27.7	36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1	36.1	
VH-EBO	747 238	1978	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	
VH-EBP	747 238	1978	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	
VH-EBQ	747 238	1979	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	27.7	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	
VH-EBR	747 238	1980	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	
VH-EBS	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	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	
VH-ECB	747 238C	1979			910																			
VH-ECC	747 238C	1979			910																			
VH-EBT	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	26.7	26.7	38.8	38.8	38.8	38.8	38.8	38.8	
VH-EBU	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	39.1	39.1	39.1	39.1	39.1	
VH-EBV	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	39.1	39.1	39.1	39.1	39.1	
VH-EBW	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	39.5	39.5	39.5	39.5	
VH-EBX	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	39.5	39.5	39.5	39.5	
VH-EBY	747 338	1987	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	26.7	39.8	39.8	39.8	
VH-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	40.5	
VH-OJB	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	40.5	
VH-OJC	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	40.5	
VH-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	
VH-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	30.5	
VH-OJF	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	
VH-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	30.5	
VH-OJH	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	
VH-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	30.5	
VH-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	30.5	
VH-OJL	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	
VH-OJM	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	
VH-OJN	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	
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	30.5	
VH-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	
VH-EAJ	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	39.8	39.8	39.8	39.8	39.8	
VH-EAK	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	39.8	39.8	39.8	39.8	39.8	
VH-EAL	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	39.8	39.8	39.8	39.8	39.8	
VH-EAM	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	39.8	39.8	39.8	39.8	39.8	
VH-EAN	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	40.1	40.1	40.1	40.1	
VH-EAO	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	40.1	40.1	40.1	40.1	
VH-EAQ	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	40.5	40.5	40.5	

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

VH-OGA	767 338ER	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	40.8	40.8
VH-OGB	767 338ER	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	40.8	40.8
VH-OGC	767 338ER	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	40.8	40.8
VH-OGD	767 338ER	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	40.8	40.8
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	41.2
VH-OGF	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	34.0
VH-OGG	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	34.0
VH-OGH	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	34.0
VH-OGI	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	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	34.0
VH-OGK	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	34.0
VH-OGL	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	34.0
AVERAGE SEAT-KM/L						27.4	28.3	28.7	29.1	30.5	30.9	31.2	31.4	31.6	32.0	32.0	32.0	32.3	33.1	33.8	34.1	34.4	35.1
TASK (SEAT-KM/HR)						8.08E+06	9.00E+06	1.10E+07	1.39E+07	1.62E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07
INDEX OF FLEET FUEL EFFICIENCY (1988 BASE)						100.0	103.0	104.5	105.9	111.2	112.5	113.8	114.5	115.2	116.7	116.7	116.7	117.6	120.4	123.0	124.3	125.3	127.9
TASK (TOTAL INTERNATIONAL PASS. MOVEMENTS: millions)						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	18.2
INDEX OF TASK (1988 BASE)						100.0	103.1	113.1	118.1	127.3	132.2	139.0	146.3	153.5	161.1	169.1	177.5	186.4	194.4	202.9	211.7	220.9	230.6
LOAD FACTOR						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 FUEL USED (1988 BASE)						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	161.4	165.0	170.3	176.4	180.3

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

TABLE II.8 INTERNATIONAL AIRCRAFT; 1990 SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT, 15 YEAR ECONOMIC LIFE

	TYPE	YEAR BUILT	SEATS	AVERAGE SEAT KM PER LITRE	CRUISING SPEED [KM/HR]	SEAT-KILOMETERS PER LITRE OF FUEL 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	
VH-EAA	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	
VH-EAB	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	
VH-EBA	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-EBB	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-EBE	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-EBI	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-EBJ	747 238	1975	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-EBK	747 238	1975	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-EBL	747 238	1976	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-EBM	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	
VH-EBN	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	
VH-EBO	747 238	1978	397	27.7	910	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	30.5	30.5	
VH-EBP	747 238	1978	397	27.7	910	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	30.5	30.5	
VH-EBQ	747 238	1979	397	27.7	910	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	30.5	
VH-EBR	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	
VH-EBS	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	
VH-ECB	747 238C	1979	248		910																		
VH-ECC	747 238C	1979	248		910																		
VH-EBT	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	26.7	26.7	30.5	30.5	30.5	30.5	30.5	
VH-EBU	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	
VH-EBV	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	
VH-EBW	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	
VH-EBX	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	30.5	30.5	30.5	
VH-EBY	747 338	1987	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	26.7	30.5	30.5	
VH-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-OJB	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	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-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	
VH-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	
VH-OJF	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-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	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-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	
VH-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	
VH-OJL	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	
VH-OJM	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	
VH-OJN	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	
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	
VH-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-EAJ	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	34.0	34.0	34.0	34.0	
VH-EAK	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	34.0	34.0	34.0	34.0	
VH-EAL	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	34.0	34.0	34.0	34.0	
VH-EAM	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	34.0	34.0	34.0	34.0	
VH-EAN	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	
VH-EAO	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	
VH-EAQ	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	
VH-OGA	767 338ER	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-OGB	767 338ER	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-OGC	767 338ER	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-OGD	767 338ER	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	
VH-OGF	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	
VH-OGG	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	
VH-OGH	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	
VH-OGI	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-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-OGK	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-OGL	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	
AVERAGE SEAT-KM/L						27.4	28.3	28.7	29.1	29.9	30.0	30.1	30.2	30.3	30.3	30.3	30.3	30.4	30.6	30.9	31.0	31.0	
TASK (SEAT-KM/HR)						8.88E+06	9.80E+06	1.18E+07	1.39E+07	1.62E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.6
INDEX OF FLEET FUEL EFFICIENCY (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	:
TASK [TOTAL INTERNATIONAL PASS. MOVEMENTS: millions]						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	
INDEX OF TASK (1988 BASE)						100.0	103.1	113.1	118.1	127.3	132.2	139.0	146.3	153.5	161.1	169.1	177.5	186.4	194.4	202.9	211.7	220.9	:
LOAD FACTOR						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 FUEL USED (1988 BASE)						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.
Aircraft numbers as at 30 June.

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

TABLE II.9 INTERNATIONAL AIRCRAFT: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT, 20 YEAR ECONOMIC LIFE

	TYPE	YEAR BUILT	SEATS	AVERAGE SEAT KM PER LITRE	CRUISING SPEED [KM/HR]	SEAT-KILOMETERS PER LITRE OF FUEL																	
						1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
VH-EAA	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	30.4	30.4	30.4	30.4
VH-EAB	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	30.4	30.4	30.4	30.4
VH-EBA	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	35.7	35.7	35.7	35.7
VH-EBB	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	35.7	35.7	35.7	35.7
VH-EBH	747 238	1974	397	27.7	910	27.7	27.7	27.7	27.7	34.5	34.5	34.5	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9
VH-EBI	747 238	1974	397	27.7	910	27.7	27.7	27.7	27.7	34.5	34.5	34.5	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9
VH-EBJ	747 238	1975	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3
VH-EBK	747 238	1975	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3	37.3
VH-EBL	747 238	1976	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7	37.7
VH-EBM	747 238	1977	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
VH-EBN	747 238	1977	397	27.7	910	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7	38.1	38.1	38.1	38.1	38.1	38.1	38.1	38.1
VH-EBO	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	27.7	27.7	38.5	38.5	38.5	38.5	38.5	38.5	38.5
VH-EBP	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	27.7	27.7	38.5	38.5	38.5	38.5	38.5	38.5	38.5
VH-EBQ	747 238	1979	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	38.8
VH-EBR	747 238	1980	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	27.7	39.1	39.1	39.1	39.1	39.1
VH-EBS	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	27.7	27.7	27.7	27.7	27.7	39.4	39.4	39.4	39.4
VH-ECB	747 238C	1979			910																		
VH-ECC	747 238C	1979			910																		
VH-EBT	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	26.7	26.7	26.7	26.7	26.7	26.7	26.7	40.5
VH-EBU	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	26.7	26.7	26.7	26.7	26.7
VH-EBV	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	26.7	26.7	26.7	26.7	26.7
VH-EBW	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	26.7	26.7	26.7	26.7
VH-EBX	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	26.7	26.7	26.7	26.7
VH-EBY	747 338	1987	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	26.7	26.7	26.7	26.7
VH-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
VH-OJB	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
VH-OJC	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
VH-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
VH-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	30.5
VH-OJF	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
VH-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	30.5
VH-OJH	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
VH-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	30.5
VH-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	30.5
VH-OJL	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
VH-OJM	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
VH-OJN	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
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	30.5
VH-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
VH-EAJ	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	32.9
VH-EAK	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	32.9
VH-EAL	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	32.9
VH-EAM	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	32.9
VH-EAN	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	32.9	32.9	32.9	32.9
VH-EAO	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	32.9	32.9	32.9	32.9
VH-EAQ	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	32.9	32.9	32.9
VH-OGA	767 338ER	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
VH-OGB	767 338ER	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
VH-OGC	767 338ER	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
VH-OGD	767 338ER	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
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	34.0
VH-OGF	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	34.0
VH-OGG	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	34.0
VH-OGH	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	34.0
VH-OGI	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	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	34.0
VH-OGK	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	34.0
VH-OGL	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	34.0
AVERAGE SEAT-KM/L						27.9	28.3	28.7	29.1	30.0	30.0	30.0	30.1	30.5	30.6	31.0	31.5	31.7	31.9	32.4	32.4	32.4	32.7
TASK (SEAT-KM/HR)						8.88E+06	9.80E+06	1.18E+07	1.39E+07	1.62E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07
INDEX OF FLEET FUEL EFFICIENCY (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
TASK [TOTAL INTERNATIONAL PASS. MOVEMENTS: millions]						7.894	8.14	8.77	9.92	10.3	10.8	11.3	11.9	12.5	13.2	13.9	14.8	15.8	16.9	18.1	19.4	20.8	22.3
INDEX OF TASK (1988 BASE)						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	282.5
LOAD FACTOR						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 FUEL USED (1988 BASE)						100.0	101.6	107.9	120.5	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

NOTE: 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 March 1989, Qantas annual reports,
Current seat numbers for 747s from DoTaC

TABLE II.10 INTERNATIONAL AIRCRAFT: TREND SPECIFIC FUEL CONSUMPTION FOR REPLACEMENT AIRCRAFT, 25 YEAR ECONOMIC LIFE

				AVERAGE	CRUISING	SEAT-KILOMETERS PER LITRE OF FUEL																
	TYPE	YEAR BUILT	SEATS	SEAT KM PER LITRE	SPEED [KM/HR]	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
VH-EAA	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
VH-EAB	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
VH-EBA	747 238	1971	397	27.7	910	27.7	27.7	27.7	27.7	27.7	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-EBB	747 238	1971	397	27.7	910	27.7	27.7	27.7	27.7	27.7	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-EBH	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-EBI	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-EBJ	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	27.7	27.7	27.7	39.1	39.1	39.1	39.1
VH-EBK	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	27.7	27.7	27.7	39.1	39.1	39.1	39.1
VH-EBL	747 238	1976	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	27.7	27.7	39.4	39.4	39.4
VH-EBM	747 238	1977	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	27.7	27.7	27.7	39.8	39.8
VH-EBN	747 238	1977	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	27.7	27.7	27.7	39.8	39.8
VH-EBO	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	27.7	27.7	27.7	27.7	27.7	27.7	27.7	40.2
VH-EBP	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	27.7	27.7	27.7	27.7	27.7	27.7	27.7	40.2
VH-EBQ	747 238	1979	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	27.7	27.7	27.7	27.7	27.7
VH-EBR	747 238	1980	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	27.7	27.7	27.7	27.7	27.7
VH-EBS	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	27.7	27.7	27.7	27.7	27.7	27.7	27.7	27.7
VH-ECB	747 238C	1979			910																	
VH-ECC	747 238C	1979			910																	
VH-EBT	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	26.7	26.7	26.7	26.7	26.7	26.7	26.7
VH-EBU	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	26.7	26.7	26.7	26.7
VH-EBV	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	26.7	26.7	26.7	26.7
VH-EBW	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	26.7	26.7	26.7
VH-EBX	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	26.7	26.7	26.7
VH-EBY	747 338	1987	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	26.7	26.7	26.7
VH-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-OJB	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	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-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
VH-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
VH-OJF	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-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	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-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
VH-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
VH-OJL	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
VH-OJM	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
VH-OJN	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
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
VH-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-EAJ	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-EAK	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-EAL	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-EAM	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-EAN	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	32.9	32.9	32.9
VH-EAO	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	32.9	32.9	32.9
VH-EAQ	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	32.9	32.9
VH-OGA	767 338ER	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-OGB	767 338ER	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-OGC	767 338ER	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-OGD	767 338ER	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
VH-OGF	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
VH-OGG	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
VH-OGH	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
VH-OGI	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-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-OGK	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-OGL	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
AVERAGE SEAT-KM/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
TASK (SEAT-KM/HR)						8.88E+06	9.80E+06	1.18E+07	1.39E+07	1.62E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07	1.69E+07 1.
INDEX OF FLEET FUEL EFFICIENCY (1988 BASE)						100.0	103.0	104.5	105.9	107.1	107.3	107.3	107.3	107.3	108.6	108.6	108.6	110.0	111.5	112.3	113.9	115.7
TASK [TOTAL INTERNATIONAL PASS. MOVEMENTS: millions]						7.894	8.14	8.77	9.92	10.3	10.8	11.3	11.9	12.5	13.2	13.9	14.8	15.8	16.9	18.1	19.4	20.8
INDEX OF TASK (1988 BASE)						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 FACTOR						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 FUEL USED (1988 BASE)						100.0	100.1	106.3	118.7	121.8	127.5	133.4	140.5	147.6	154.0	162.2	172.7	182.0	192.0	204.2	215.7	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

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[6] 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_2 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 ABARE's projections of energy usage (1991). ABARE's 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.

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6 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 tonne-kilometre (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.

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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 coal usage. In 1987 the Bureau of Mineral Resources 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 growth. These scenarios implied tonnage growth rates for 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. A 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 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 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 emissions from, Australian aircraft in domestic and international aviation to the year 2005, given predicted task growths. Estimates of task have been made by scaling up 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.

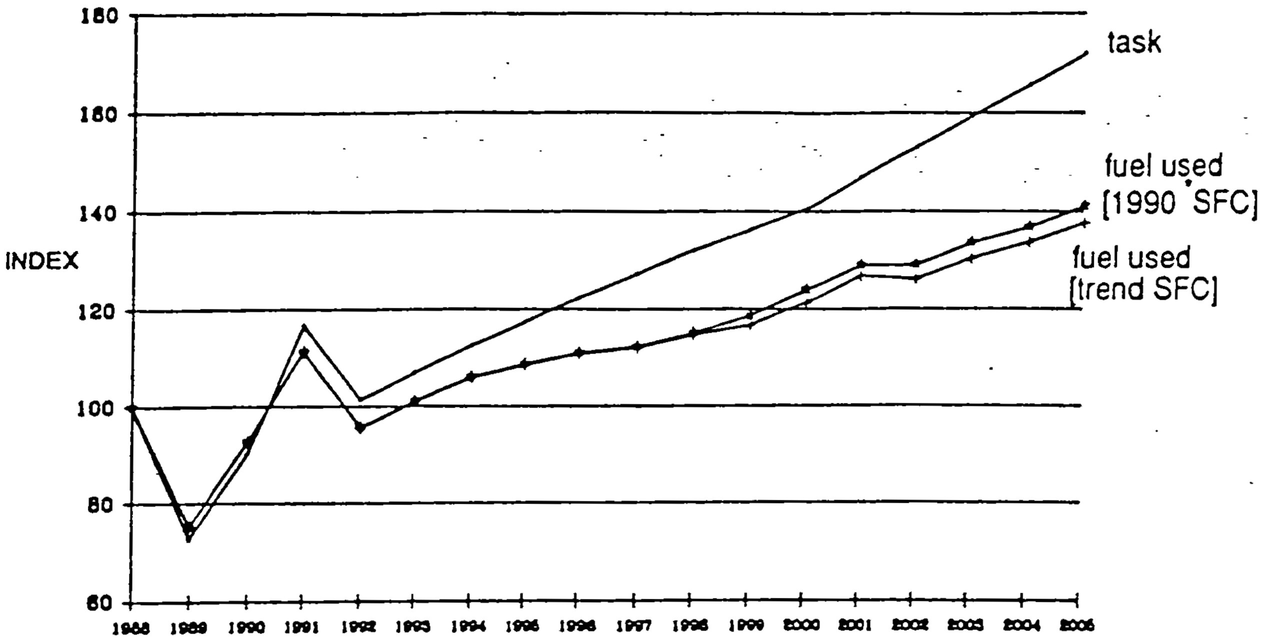
As a graph of passenger numbers (FAC 1991) is shown as linear between these points, the figure for 2005 may be interpolated as 24.6 million domestic passengers in 2005, a 72 per cent increase over the high figure of 14.3 million in 1988 (the figure for 1990 was 12.9 million).

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 load factor is 74.6 per cent. 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.

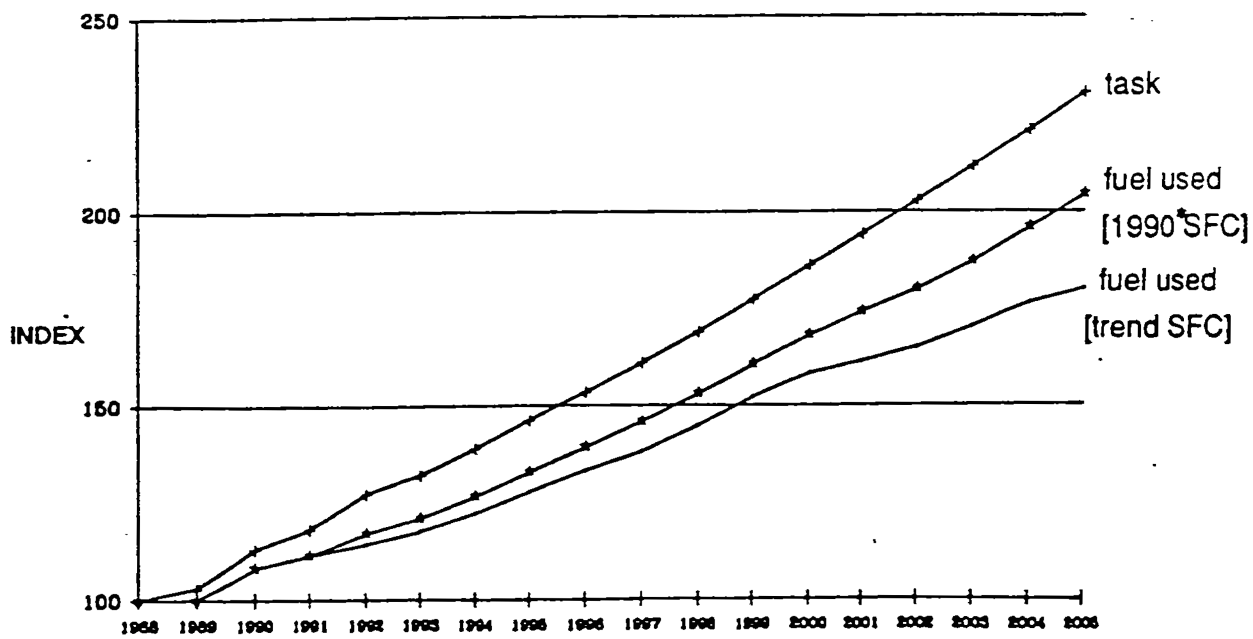
However, if traffic patterns, growth in the number of passengers, and real fuel prices were to be such as to



* Aircraft replaced by the latest series of the type available in 1990; 727s replaced by 737-400s.

Source BTCE estimates

FIGURE III.1 AUSTRALIAN DOMESTIC AIRCRAFT: TASK AND FUEL USED



* Aircraft replaced by latest series of type available in 1990

Source BTCE estimates

FIGURE III.2 AUSTRALIAN INTERNATIONAL AIRCRAFT: TASK AND FUEL USED persuade operators to increase significantly the use of the most fuel-efficient wide-bodied aircraft in the domestic fleet, and also to choose the most fuel-efficient small aircraft, then the increased passenger task predicted for 2005 could be performed without a significant increase in emissions. The model indicates that in the unlikely event 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 fuels such as hydrogen, emissions would increase in proportion. International aircraft operating to and from Australia are estimated to have emitted about 9 to 10 megatonnes of CO_2 in 1988 (BTCE 1991). The model thus suggests an additional 7 or 8 megatonnes in 2005 from total international flights to and from Australia. If Qantas (together with any other Australian-flag international carriers which might emerge) were to maintain a market share of approximately 40 per cent, it could emit an additional 3 megatonnes above 1988 levels in 2005. However, the point about the future ownership of Qantas, made earlier in 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_x 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 NO_x in total emissions is likely to increase as combustion 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
CO_2	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_20	nitrous oxide
NO_x	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_x	sulphur oxides
UHBR	ultra high bypass ratio
UDF	unducted fan
VEC	variable exhaust closing
VIT	variable injection timimg
VLCC	very large crude carrier