Transport of Hydrocarbons in the Oil and Gas Industries

Information Paper

This Paper is an exploratory attempt to examine the distribution of raw and refined petroleum products by all transport modes over the period 1971-72 to 1986-87. The modal shares of the hydrocarbon movements task have been estimated together with the average growth rate of movements by each mode for that same period. Some origin-destination analysis has been undertaken with analyses of coastal shipping and pipeline movements being the most recent. Annually aggregated tonnages moved by the separate transport modes are the primary focus of this study. This study examines petroleum product movements up to 1986-87 and growth rates have been derived for each of the modal tasks up to this date. No forecasting of future movements shares, which would use these growth rates, is attempted.

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Transport of Hydrocarbons in the Oil and Gas Industries

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ABSTRACT

Raw and refined petroleum products are vital to the functioning of the Australian economy. This study examines the distribution of these raw and refined products in Australia in the period 1971-72 to 1986-87.

Road, rail, coastal vessel and both refined and crude pipeline tasks are examined as well as their respective modal shares. These shares were distributed across pipelines with a 42.7 per cent share, road transport with a 39.6 per cent share, coastal shipping with a 14.6 per cent share, and rail with a 3.1 per cent share of the total task.

Road transport is dominated by articulated tankers mainly operating within capital cities. Forty per cent of the coastal shipping task involves the transport of crude oil and refined products. In Australia there are 13 000 kilometres of pipelines. Ten thousand kilometres of this pipeline network transports the fifteen billion cubic metres of natural gas consumed by Australian users. Transport of petroleum by rail, although small, has continued to grow as a proportion of the total petroleum transport task.

The transport of petroleum products is also modified by a series of distribution arrangements which reduce the need for long distance flows. These arrangements include refinery exchange, borrow and loan practices and the transport freight subsidy scheme.

FOREWORD

This Information Paper was originally prepared for and presented at the Australian Institute of Petroleum's Conference, 'From Reservoir to Retailer', held in Adelaide in September 1988. The original Paper has now been expanded with additional information provided through industry discussions.

A comprehensive outline of the national hydrocarbon movements task is presented and current modal transport shares for this industry, whose logistic operations support both the Australian passenger and freight transport tasks of the Australian economy, are examined.

The analysis, research and preparation to this Paper was undertaken by Mr Kim Hassall. The assistance of many industry sources and the Australian Institute of Petroleum is gratefully acknowledged.

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March 1989

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Queensland Rail

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CHAPTER 1 SUMMARY AND OVERVIEW

Raw and refined petroleum products are vital to the functioning of the Australian economy. In 1985-86, half of the total final energy demand in the Australian economy was met by refined petroleum products. Natural gas satisfied a further 16 per cent of that demand. Revenue from government excises has provided about 11 per cent of Commonwealth receipts since 1983-84. Petroleum products used by the transport industry is the principal fuel supporting the transport of coal, iron ore and grain both nationally and internationally. By the year 1990, some 250 000 international and domestic jet movements to capital cities alone are forecast to carry both international and domestic passengers and tourists. As hydrocarbon fuels support all sectors and industries of the national economy, the distribution systems for these fuels can be considered as major national energy arteries.

This Paper is an exploratory attempt to examine the distribution of raw and refined petroleum products by all transport modes over the period 1971-72 to 1986-87. The modal shares of the hydrocarbon movements task have been estimated together with the average growth rate of movements by each mode for that same period. Some origin-destination analysis has been undertaken with analyses of coastal shipping and pipeline movements being the most recent. All movements mentioned in this Paper refer to tonnages and not to vehicle movements. The frequencies of vehicle movement services have not been examined. Annually aggregated tonnages moved by the separate transport modes are the primary focus of this study.

This study examines petroleum product movements up to 1986-87 and growth rates have been derived for each of the modal tasks up to this date. No forecasting of future movements shares, which would use these growth rates, is attempted. This is because important data are not available on:

- the effects of the 1988 oil industry deregulation policies and their impact on the coastal shipping task (see Appendix I); and

- the current rail/road balance, following partial rail deregulation in Western Australia in 1988 and full rail petroleum deregulation in Queensland in 1987.

The analysis has not taken into account the emergence or impact in the short or medium-term of the use of possible new fuels. These would include compressed natural gas (CNG), petranol, distillates derived from natural gas or shale oil. The information sources used in the compilation of this study are listed in the Bibliography and Acknowledgements.

TABLE 1.1 CURRENT DOMESTIC RAW AND REFINED PETROLEUM PRODUCTS[a]: MODAL TRANSPORT SHARES, 1986-87

Mode	*('000) tonnes*	*Per cent (excluding refined product pipelines)*	*Per cent (including refined product pipelines)*
Road	45 887[b]	50.1	39.6
Coastal ship	17 006	18.5	14.6
Rail	3 614	3.9	3.1
Pipelines			
Crude feedstocks	25 164	27.5	21.7
Refined products[c]	(24 440)	..	21.0
Total	91 671 (116 111)	100	100

a. Excludes ethane and natural gas.
b. The road share was calculated from the latest available ABS Survey of Motor Vehicle Use. Data was at 30 September 1985.
c. This figure equals 1986-87 refinery output which is delivered from refinery to urban storage, airport, sea and rail terminals by pipeline. Previous BTE freight movements studies have excluded this pipeline class. All pipelines would therefore command a 42.7 per cent share of non-gaseous hydrocarbon movements.
.. Not applicable.

Sources ABS (1986). Australian Institute of Petroleum Limited (1987a, 1987b). Department of Primary Industries and Energy (1988b, 1988c, 1988d). DTC (1988). Railway Industry Council (pers. comm.).

Table 1.1 demonstrates the primacy of road and the combined crude and refined product pipeline effort in transporting petroleum products in Australia. These modes account for 39.6 per cent and 42.7 per cent respectively of the hydrocarbon transport task. If, however, the refined product pipeline task is considered more as an 'intermediate' distribution mode, essentially being a 'refinery extension' whose operations cease where terminal distribution begins, then road movements dominate the national task with a 50 per cent share of all petroleum-based hydrocarbon movements. Though generally true, it is not appropriate to treat all refined product pipelines as 'refinery extensions'. There are significant exceptions, for example, the Sydney to Newcastle product line.

Natural gas movements are considered separately and are not included in Table 1.1. This is because this commodity is served by its own dedicated pipeline infrastructure and this infrastructure does not compete with other transport modes for its delivery.

Coastal shipping is the third largest mode for hydrocarbons transport with an 18.5 per cent share of the total task. This is nearly five times greater than the 3.9 per cent share held by rail systems.

Figure 1.1 presents a simplified overview of the complete hydrocarbons transport task in Australia and Table 1.2 depicts the modal interconnections in this system.

These interconnections represent the use of various single modes and modal combinations to move hydrocarbons from a current location to the next node in the movements flow. Table 1.2 outlines the most common combinations of modes used in the national hydrocarbon movements progression. 'Terminal' in this table refers to all types of terminal and not just to major distribution terminals. 'Consumer' is used synonymously with retail site or outlet. The terminal (node 4) to consumer (node 6) connection can be direct in some instances, the most notable being tankers operating from terminals directly to service station.

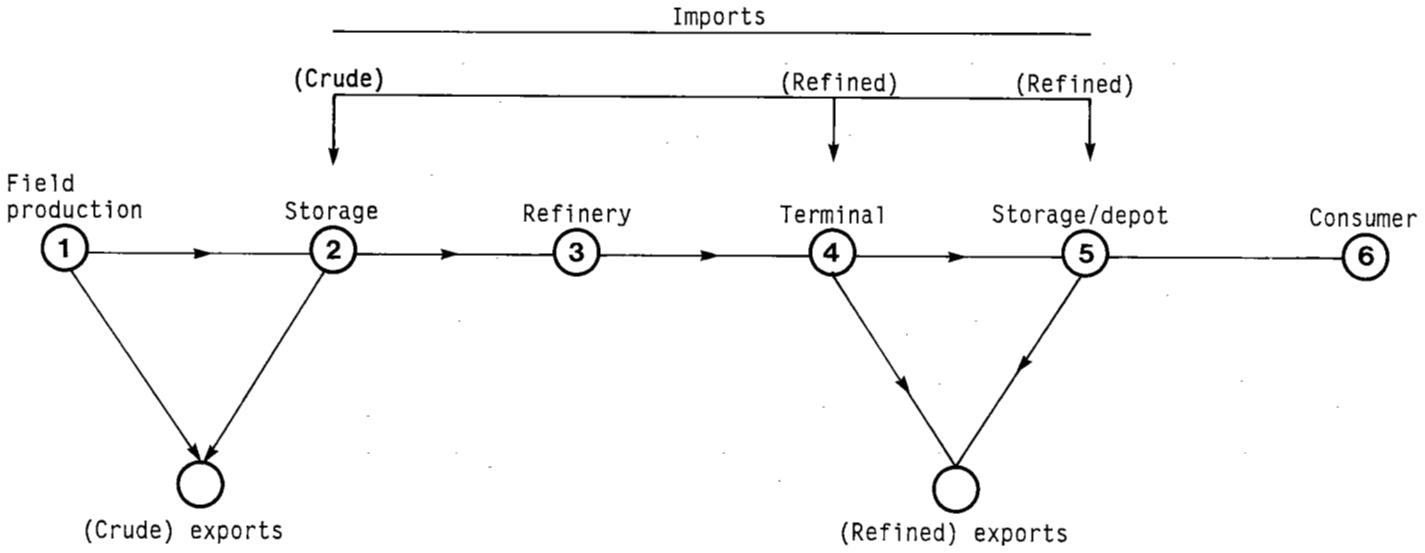


Figure 1.1 The hydrocarbons transport task

TABLE 1.2 GENERALISED MODAL CONNECTIONS FLOW

Current location	*Destination* 2 *Storage*	3 *Refinery*	4 *Terminal*	5 *Depot*	6 *Consumer*	*Export*
1 Field	Pipe Road Sea/pipe Road/pipe Pipe/rail Pipe/road	Pipe	..	..	..	Pipe/sea Sea
2 Storage	..	Pipe	..	..	..	Pipe/sea
3 Refinery	..	..	Pipe	Pipe	(Pipe)	..
4 Terminal	..	..	..	Road Rail Sea/Pipe	Road (Pipe)	Pipe/sea Pipe/air
5 Depot	..	..	..	..	Road (Pipe)	Pipe/sea Pipe/air
6 Overseas	Sea/pipe	..	Sea/pipe	Sea/pipe	..	..

.. Not applicable.

Notes 1. Mode 1/mode 2 indicates mode 1 is employed in conjunction with and followed by mode 2.
2. Parentheses indicate hypothetical connections.

Source BTCE interpretation.

TABLE 1.3 SUMMARY OF PETROLEUM MOVEMENTS BY MODE

	Mode ('000 tonnes)					
		Coastal ship				
Year	*Road*	*Crude*	*Total bulk liquid*	*Pipeline*[a]	*Rail*	*Natural gas (million cu.m)*
1971-72	31 577	na	16 717	15 898	2 022	na
1975-76	35 240	na	18 168	20 520	2 601	na
1979-80	na	na	na	na	2 794	na
1981-82	na	9 398	na	na	na	11 550[b]
1985-86	45 887	11 400	17 600	na	na	14 714[b]
1986-87	na	12 610	17 006	25 164[c]	3 614	15 032[c]
Growth rate (per cent)	2.9	5.9	0.0	3.0	3.9	5.4

a. Crude oil, LPG and condensate.
b. Calendar year applies, that is, 1982 and 1986 respectively.
c. 1987 figure.
na Not available.

Sources ABS (1986). Australian Institute of Petroleum Limited (1987a, 1987b). BTE (1976, 1978, 1979, 1983). Department of Primary Industries and Energy (1988b, 1988c, 1988d). Railway Industry Council (pers. comm.). Travers Morgan (1986).

TABLE 1.4 REGIONAL NATURE OF PETROLEUM MOVEMENTS

Mode	*Regional service*	*State service*
Road	Intraregional	Intrastate (intracapital)
Rail	Interregional	Intrastate
Sea	Interregional	Interstate/overseas
Pipeline	Interregional	Inter/intrastate

Source BTCE interpretation.

CHAPTER 2 TRANSPORT BY ROAD

Road transport carries nearly 40 per cent of all non-gaseous hydrocarbons transported in Australia.[1] This figure includes products transported not only by rigid and articulated tankers but also by panel vans and utilities. As such, it includes some element of transport from retailers by particular consumers, as well as from producer to retailers.

For the purpose of the present study, no attempt has been made to produce a detailed origin-destination analysis of road transport movements although such a detailed analysis has been attempted for the transport of non-gaseous hydrocarbons by other modes (see Appendixes II and III). Instead, transport by road has been approached by defining vehicle movements as either intra or interregional.[2] This approach has been adopted because 68 per cent of all road movements are in fact intraregional[3] involving product movements within a particular Statistical Division or region. Indeed, some 56 per cent of intraregional movements occur within State capital cities.

This same pattern is reflected in service station retail sales (Table IV.5) which show that up to 70 per cent of product sales are within capital cities. These figures, in turn, reflect the amounts of refined product which must be moved to these retail sales outlets in order to satisfy urban demand.[4] In fact, product sold through service

---

1. This figure may in fact increase when the 1988 ABS Survey of Motor Vehicle Use is released. The latest survey's preliminary finding will be released in April 1989.
2. Region refers to the statistical subdivisions as used in the Census of Population and Housing, 30 June 1971. This remains consistent with regions used in BTE 1976 and 1978.
3. The ABS categories of 'within capital city of state of registration' and 'outside capital city and within 100 km of base' were adopted as proxy intraregional estimators.
4. For estimation of aggregated intraregional movements it is assumed that all interregional deliveries by road, rail and sea will then be moved intraregionally by road. Urban movements can then be estimated from these interregional movements to non capital city areas by all of these non-road modes.

station outlets in capital cities accounted for 61.2 per cent of all service station retail sales.

The essence of road hydrocarbon movements is encapsulated in Table 2.1. Three salient facts that emerge from the data of this table are that:

- Total road movments in 1985 were higher, by a factor of 1.8, than total refinery production in 1985-86 (Table IV.4). Thus, temporarily disregarding distribution by rail or coastal shipping, the road task alone moved almost twice the total national refinery equivalent output for that period. The implication of these figures is that considerable double handling occurs in road transport activities.
- The size of the intraregional task, which is approximated by the combined 'intracapital' and 'within 100 km of base, non capital' data categories (see footnote 3), is 68 per cent of all road movements.
- Total interstate road movements accounted for only 3.5 per cent of total road movements, reflecting the very strong intrastate nature of the road task.

Table 2.2 shows how this road haulage task has changed. In the period 1971-72 to 1985 tonnages hauled increased at a steady 2.9 per cent per annum.

VEHICLE FLEET COMPOSITION

As can be seen in Table 2.3 and Table 2.4, the composition of the vehicle fleet used to haul petroleum products in no way reflects the magnitude of the task borne by different classes of vehicle.

The ratio of utilities to articulated trucks is approximately inversely proportional to the ratio of the respective tonnages of petroleum products carried. The figure for utilities and panel vans is a utility and panel van resource figure. That is, if 100 panel vans all spend 1 per cent of their time carting petroleum products this is equivalent to 1 panel van being dedicated to fuel product cartage. Table 2.4 does imply that there are 64 566 panel vans and utility equivalent resource units used for petroleum movements. As shown in Table 2.3, articulated trucks have the greatest share of the road haulage task.

Table 2.5 outlines the growth rate in the tonnages carried by inter-regionally bound articulated trucks over the analysis period. This was a high 14.6 per cent per annum.

The resources devoted to the manning of petroleum tankers have been estimated by the Transport Workers' Union to be 3000 employee drivers. Some 1500 of these are directly employed by the petroleum companies with an equivalent number being employed by company agents and contractors.

CURRENT ROAD REGULATIONS AND POSSIBLE FUTURE DIRECTIONS

Rail deregulation in Queensland in 1987 and partial deregulation in Western Australia in 1988 heralded a changing climate for future road petroleum transport. Non economic constraints on road transport still exist in the form of State government regulation of the types of truck used in petroleum haulage. Table 2.6 outlines the current restrictions in each State regarding the use of either B-Doubles or road trains.

The National Association of Australian State Road Authorities (1985) Review of Road Vehicle Limits recommended an increase in road vehicle mass limits to 42.5 tonnes. The 77th Australian Transport Advisory Council (ATAC) meeting, in September 1988, endorsed the raising of vehicle weight limits to this 42.5 tonne level. ATAC also proposed that State legislation be in place by 1 January 1989 and that this legislation be enacted by 1 July 1989. Further to this, ATAC proposed that the current system of State permits for heavier vehicles be phased out thus securing a uniformity across State vehicle regulations.

Also of great importance to any argument supporting the economic gains and efficiencies associated with higher vehicle mass limits is the acceptance of the greater road damage that results from allowing higher mass limits. Road damage is strongly related to the pressure exerted through axle loadings. Therefore, raising allowable mass limits will increase road damage directly. However, an important question which must be now addressed, as 42.5 tonne limits are established, is whether consideration should be given to the introduction of those currently non-standard vehicle types whose axle configurations will cause less road damage than standard six axle articulated trucks hauling 42.5 tonnes. The B-Double is a good example of such a medium combination vehicle (MCV). B-Doubles being considered will be a two trailer and prime mover combination up to 23 metres in length supported by eight axles. The potential for such a vehicle type has been supported by the recommendations of the Royal Commission into Grain Storage, Handling and Transport (1988), as well as being acknowledged by the 1988 Victorian Road Freight Transport Industry Council Task Force findings on B-Doubles. This Task Force was convened by the Victorian Minister of Transport. State support

TABLE 2.1 MOVEMENTS OF HYDROCARBONS BY ROAD: TONNES CARRIED, 1985
('000 tonnes)

	Region							
Vehicle type	*Within capital city of State of registration*	*Outside capital city <100 km of base*	*Outside capital city >100 km of base*	*Between capital city and rest of State*	*Intercapital*	*Other interstate <100 km of base*	*Other interstate >100 km of base*	*Total*
	Petroleum and petroleum products							
Utility and panel van	164	1 132	112	21	2	143	4	1 559
Rigid truck	4 439	7 052	902	316	8	65	21	12 803
Articulated truck	9 168	3 080	5 299	5 123	80	69	1 068	23 887
Total	13 771	11 245	6 313	5 460	90	277	1 093	38 249

TABLE 2.1 (Cont.) MOVEMENTS OF HYDROCARBONS BY ROAD: TONNES CARRIED, 1985
('000 tonnes)

	Region							
Vehicle type	*Within capital city of State of registration*	*Outside capital city <100 km of base*	*Outside capital city >100 km of base*	*Between capital city and rest of State*	*Intercapital*	*Other interstate <100 km of base*	*Other interstate >100 km of base*	*Total*
	Other fuel products[a]							
Utility and panel van	72	129	115	1	-	-	-	317
Rigid truck	750	1 664	105	217	-	1	-	2 737
Articulated truck	2 831	699	699	252	33	-	70	4 584
Total	3 653	2 492	919	470	33	1	70	7 638
Total	17 424	13 737	7 232	5 930	123	278	1 163	45 887

a. LPG and other liquified gases.
- Nil.

Note Due to rounding figures may not add to totals.

Source ABS (1986).

for the future introduction of B-Double operations differs widely. Views range across questions of allowability, the continuance of associated permit systems, the relegation of vehicle operations to specific routes, and safety considerations. Safety issues were addressed by the Inter-State Commission (ISC 1988) which raised no undue safety concerns in relation to B-Double operations.

Industry reaction to future allowable load increases of up to 4 tonnes per vehicle has been unquestionably favourable, with potential efficiency gains far outweighing possible vehicle registration increases.

TABLE 2.2 THE GROWTH IN AUSTRALIAN PETROLEUM ROAD HAULAGE

Year	*('000 tonnes)*
1971-72	31 576
1975-76	35 240
1985	45 887
Total period growth rate (per cent)	2.86[a]

a. Compounded over 53 financial quarters, this is, 13.25 years.

Sources ABS (1986). BTE (1976, 1978).

TABLE 2.3 DIVISION OF ROAD HAULAGE BY VEHICLE TYPE, 1985
(per cent)

Vehicle type	*Total fleet*	*Tonnage movements*
Utilities and panel vans	65.0	4.1
Rigid trucks	31.3	33.9
Articulated trucks	3.7	62.0

Sources ABS (1986). BTCE estimates.

TABLE 2.4 RESOURCES DEVOTED TO ROAD HYDROCARBON MOVEMENTS, 1985

	Number of vehicles		
Vehicle type	*Petroleum products*	*Other fuels*	*Total*
Utilities and panel vans	64 566	9 641	74 207
Rigid trucks			
2 axles	27 209	4 643	
3 axles	1 815	483	
>3 axles	1 153	293	35 596
Articulated trucks			
<5 axles	619	84	
5 axles	642	120	
6 axles	2 106	269	
>6 axles	371	17	4 228
Total	98 481	15 550	114 031

Source ABS (1986).

TABLE 2.5 THE GROWTH IN AUSTRALIAN INTERREGIONAL ARTICULATED TRUCK MOVEMENTS

Year	*('000) tonnes*
1971-72	2 087
1975-76	3 680
1985	12 693
Total period growth rate (per cent)	14.6[a]

a. Compounded over 53 financial quarters, that is, 13.25 years.

Sources ABS (1986). BTE (1976, 1978).

TABLE 2.6 STATE RESTRICTIONS OPERATING ON LARGER TANKER VEHICLES, JULY 1988

State	*Vehicle type*	*State restrictions*
New South Wales	B-Doubles	Constrained to specific routes
	Triples[a]	Restricted to permitted routes (outback NSW). Permits required
Victoria	B-Doubles	Vehicles of 41 tonnes require permits
	Triples	Not allowed
Queensland	B-Doubles	Permits required for specific routes
	Triples	Permitted in Western Queensland
South Australia	B-Doubles	Permits required. Restricted to specific Adelaide and rural routes
	Triples	Restricted routes north from Port Augusta. Permits required
Western Australia	B-Doubles	Restrictions to major citites
	Triples	Permits required
Tasmania	B-Doubles	Not allowed
	Triples	Not allowed
Northern Territory	B-Doubles	Operations allowed except in Darwin
	Triples	No permits required. These conditions applicable for both vehicle types

a. Road trains.

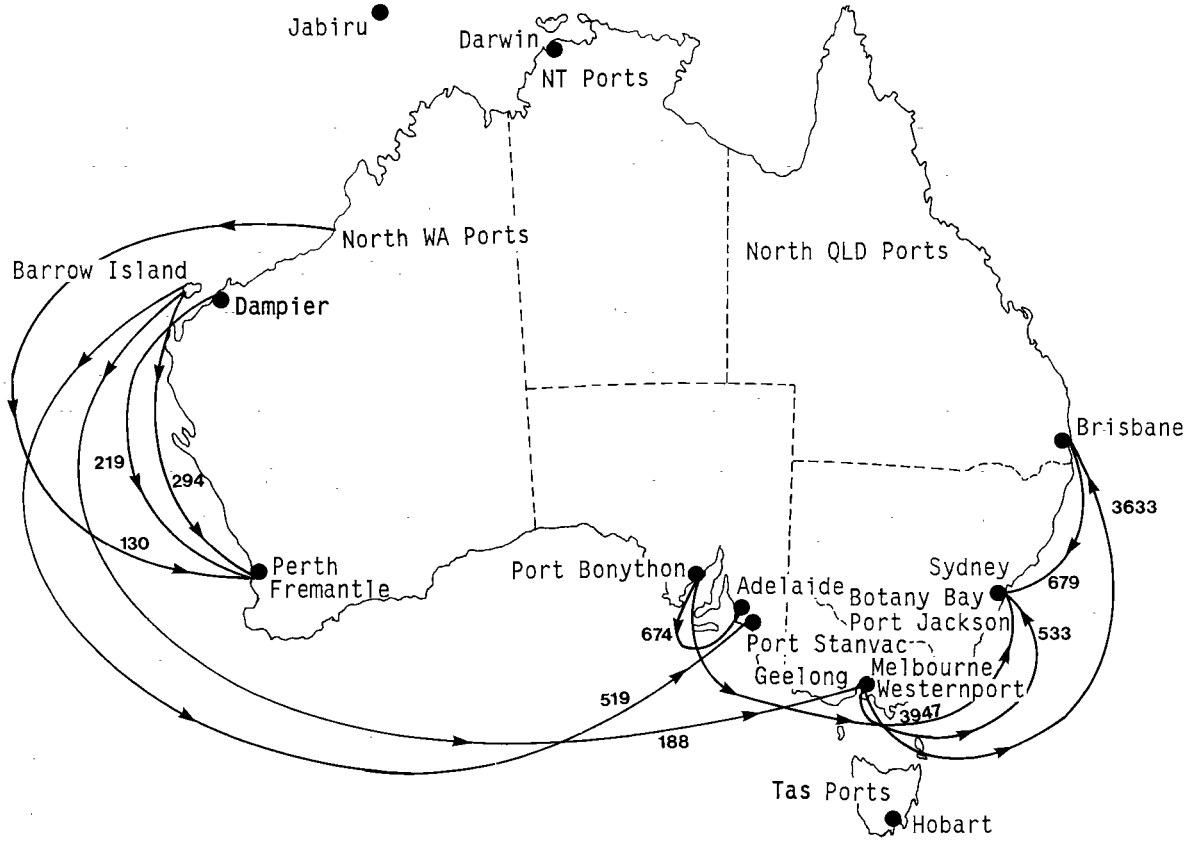
Sources DTC (pers. comm.). ISC (1987).

CHAPTER 3 TRANSPORT BY COASTAL SHIPPING

In 1986-87, domestic coastal shipping carried approximately 17 million tonnes of crude and refined petroleum products around Australia. Coastal shipping carried the third largest share of hydrocarbons and is responsible for hauling tonnages nearly five times greater than those handled by rail (Table 1.1). Refined and crude petroleum movements were responsible for 39 per cent of the entire coastal shipping task. The task is undertaken by seventeen vessels which include two LPG carriers, seven crude tankers, six product tankers and two crude/product tankers (see Table II.3).

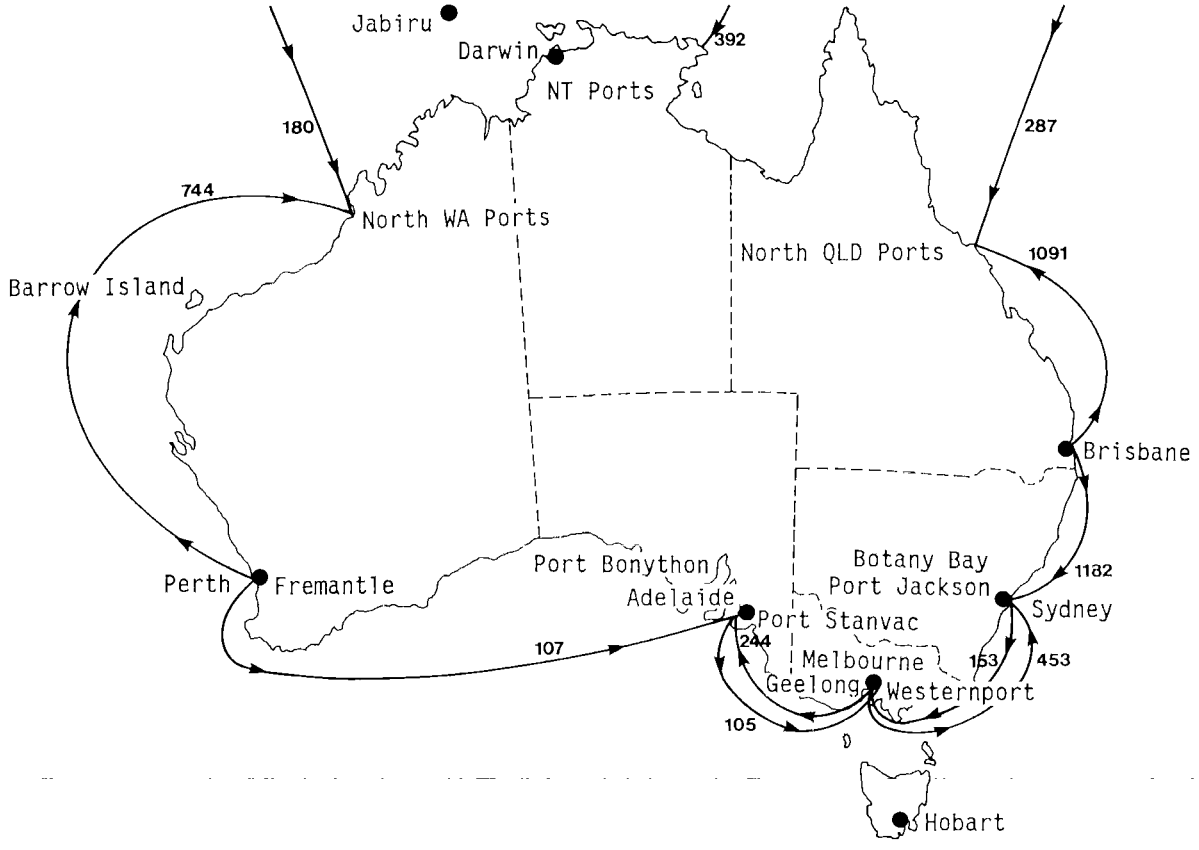
These vessels are not, however, restricted to the coastal domain. Recently, the *B.P. Achiever* successfully negotiated the Gulf of Hormuz, escorted by a British warship, and returned from what may herald a future more active role for Australian vessels in the import and export trade.

Unlike other modes, the growth rate of hydrocarbon tonnages moved by coastal shipping has remained close to zero over the fifteen-year period from 1971-72 to 1986-87. There have been, however, both positive and negative deviations from the 1986-87 figure. Despite this fact, there has been a nearly 6 per cent per annum increase in the haulage of crude oil by coastal vessels over the period 1980-81 to 1986-87 (Table 3.1). The overall zero growth in the coastal shipping task therefore implies that refined petroleum product movements have declined at 6 per cent per annum over this period. Given that total refinery production and aggregate product consumption has not changed at this same rate over the past six years, it can be assumed that coastal shipping has, in fact, lost its share of the refined product haulage at the rate of 6 per cent per annum, to either other modes of transport or to imports. Coastal discharges of feedstocks and refined products are shown in Figures 3.1 and 3.2 respectively.



Source DTC (1988) pers. comm.

Figure 3.1 Major coastal discharges of feedstock ('000 tonnes)



Source DTC (1988) pers. comm.

Figure 3.2 Major coastal discharge of refined petroleum products ('000 tonnes)

REGULATORY EFFECTS

With the Federal Government's oil industry deregulation on 1 January 1988 came the end of the Crude Oil Allocation Scheme and, therefore, the Bass Strait Coastal Freight Adjustment rebate. Refiners were no longer required to use Bass Strait crude or any other indigenous crude feedstocks. The market was freed for refineries to 'shop-around' for better crude oil deals.

As transport from Bass Strait is no longer subsidised, some refineries, in future, may choose crude imports over indigenous crude hauled by coastal ship. The possible effects on coastal shipping of this oil industry deregulation may be that:

- both imports and exports will increase;
- Australian-flagged vessels will start to compete in the import and export trades;
- coastal movements of crude oil will lessen; and
- coastal movements of refined product may lessen unless Australian vessels become competitive with foreign import vessels.

Therefore, despite the *Ships Capital Grants Act 1987* (Cwlth) and the associated ship replacement investment incentives, coastal vessels, handling indigenous crude and refined products, will be required to be increasingly competitive with foreign vessels handling the potentially growing crude and refined import tasks. The most recent data on coastal shipping flows for the movements of hydrocarbons around Australia are contained in Appendix II. However, the impact of regulatory changes on coastal shipping and import patterns may not be reflected in data sources until 1989.

CABOTAGE: A LONG-TERM COASTAL REGULATION

Foreign vessels are prohibited from operating in the Australian coastal trade unless they obtain a single voyage permit (SVP).

An SVP may only be issued when:

- no licensed ship is available to perform the service;
- the service carried out by a licensed ship or ships is inadequate to meet the needs of a port or ports; and
- the Minister of Transport and Communications is satisfised that it is desirable, in the public interest, that an unlicensed ship be allowed to engage in that trade.

In 1986-87, 26 shipments (61 000 tonnes) were licensed under the SVP system. The dominant cargoes were phosphate rock and caustic soda. No petroleum products were carried under these conditions. Since deregulation of the oil industry, however, an application has been made to the Department of Transport and Communications (DTC) for a petroleum SVP.

The practice of cabotage is not peculiar to Australia and affects industries other than the oil industry. It is mentioned here because it forms an important part of the regulatory framework affecting coastal petroleum movements which are a significant part of the total coastal task.

THE IMPORT AND EXPORT TASK

Since 1985-86, Australia's three major sources of petroleum product imports have been Saudi Arabia and Kuwait (supplying crude oil and feedstocks) and Singapore (which was the largest refined product exporter to Australia).

Australia's two largest export destinations are Japan and the USA, with both absorbing large crude oil consignments. The third largest export market was the supply of fuel oil and avtur to foreign-owned ships and aircraft outward bound from Australia.

In 1986-87, shipping was responsible for carrying 5 856 000 tonnes of petroleum exports and 10 121 000 tonnes of imports. Domestic coastal loadings of hydrocarbons[1] amounted to 17 006 000 tonnes which only just exceeded these combined import and export tonnages. This essentially equated the coastal shipping and import and export tasks as being of similar magnitude.

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1. Commodity categories 3300-3410 were included in coastal totals.

TABLE 3.1 GROWTH OF PETROLEUM BULK LIQUIDS: MOVEMENTS BY DOMESTIC COASTAL SHIPPING TO 1986-87
('000 tonnes)

Product	*Year*									*Growth rate (per cent)*
	1971-72	*1975-76*	*1980-81*	*1981-82*	*1982-83*	*1983-84*	*1984-85*	*1985-86*	*1986-87*	
Crude oil and feedstocks	na	na	8 960	8 398	8 345	10 401	10 513	11 400	12 610	5.9
Total bulk liquid loadings	16 717	18 168	na	na	na	na	na	17 600	17 006	(assumed to be zero)

na Not available.

Sources BTCE (1976, 1978). DTC (1988). Travers Morgan (1986).

CHAPTER 4 TRANSPORT BY PIPELINE

Three types of pipeline are considered in this study:

- refined product pipelines usually connecting refineries to distribution terminals;
- raw product pipelines which include crude and other liquid pipelines; and
- natural gas pipelines comprising major delivery pipelines and reticulated mains pipelines.

REFINED PRODUCT PIPELINES

This class of pipeline is generally not considered in modal movements analyses as calculations usually begin with movements emanating from terminal operations sites. Considering just two examples, namely the North Geelong to Newport and the Sydney to Newcastle refined product lines, it seems logical, that such modes of delivery should be incorporated into an analysis of petroleum products transport. An upper bound on movements of such refined petroleum products can be set at the level of refinery output. This was done in introductory Table 1.1.

In 1986-87, such refined product pipelines serving either rail, airport, sea, intra or interurban storage terminals would, therefore, have accounted for some 21 per cent of the petroleum transport task. This is despite the fact that upon delivery to the terminal site these products would be loaded onto another transport mode. If these assumptions are valid, then the task handled by refined product pipelines is totally dependent upon refinery production levels and, over the period 1977 to 1986, declined by less than 1 per cent per annum.

RAW PRODUCT PIPELINES

To estimate the movements of raw petroleum products by pipeline, production fields which depend on pipelines for the removal of raw

products from field sites have been identified. These fields included Gippsland, Moomba, Jackson, Moonie, Mereenie and Blina/Sundown.

Crude oil shipments by road from Eromanga also augmented tonnages at Jackson and Moonie. Transfers of crude from pipelines to road occurred 29 kilometres from the Blina/Sundown fields, destined for Broome, whilst transfers from pipeline to rail occurred at Alice Springs, destined for Adelaide. Other pipeline origin-destinations are outlined in Table 4.1.

Even though, over the 15.5 years that crude oil movements have been examined in this analysis pipeline tonnages of raw liquids increased by 3 per cent per annum, it should be noted that tonnages carried by this mode are totally dependent on field production (see Table 4.2). This means that the total raw product tonnage carried by pipelines is very sensitive to Gippsland production levels. (The transport movements from all field sites are shown in Figure 4.1). Currently, Gippsland produces around 75 per cent of Australia's total crude, condensate and naturally occurring liquefied petroleum gas (LPG). With production expected to drop considerably in this basin by the mid-1990s, raw product pipeline tonnages can also be expected to fall. This however, will however, be compensated for by increased imports which will still require pumping from ports to refineries.

NATURAL GAS PIPELINES

The infrastructure involved with natural gas deliveries accounts for over 10 000 kilometres of inter and intraregional connections and almost 50 000 kilometres of urban reticulated pipelines (see Tables 4.3 and 4.5). The major Australian networks, and proposed extension to those networks are shown in Figure 4.2. The three largest Australian natural gas production fields are Moomba, Gippsland and the North-West Shelf respectively (see Table 4.4). Exports of liquefied natural gas (LNG) will occur in 1989, operating from the North-West Shelf to Japan. It is expected that there will be three Australian LNG tankers forming part of that operational fleet, effectively introducing a new transport mode into the hydrocarbons transport task.

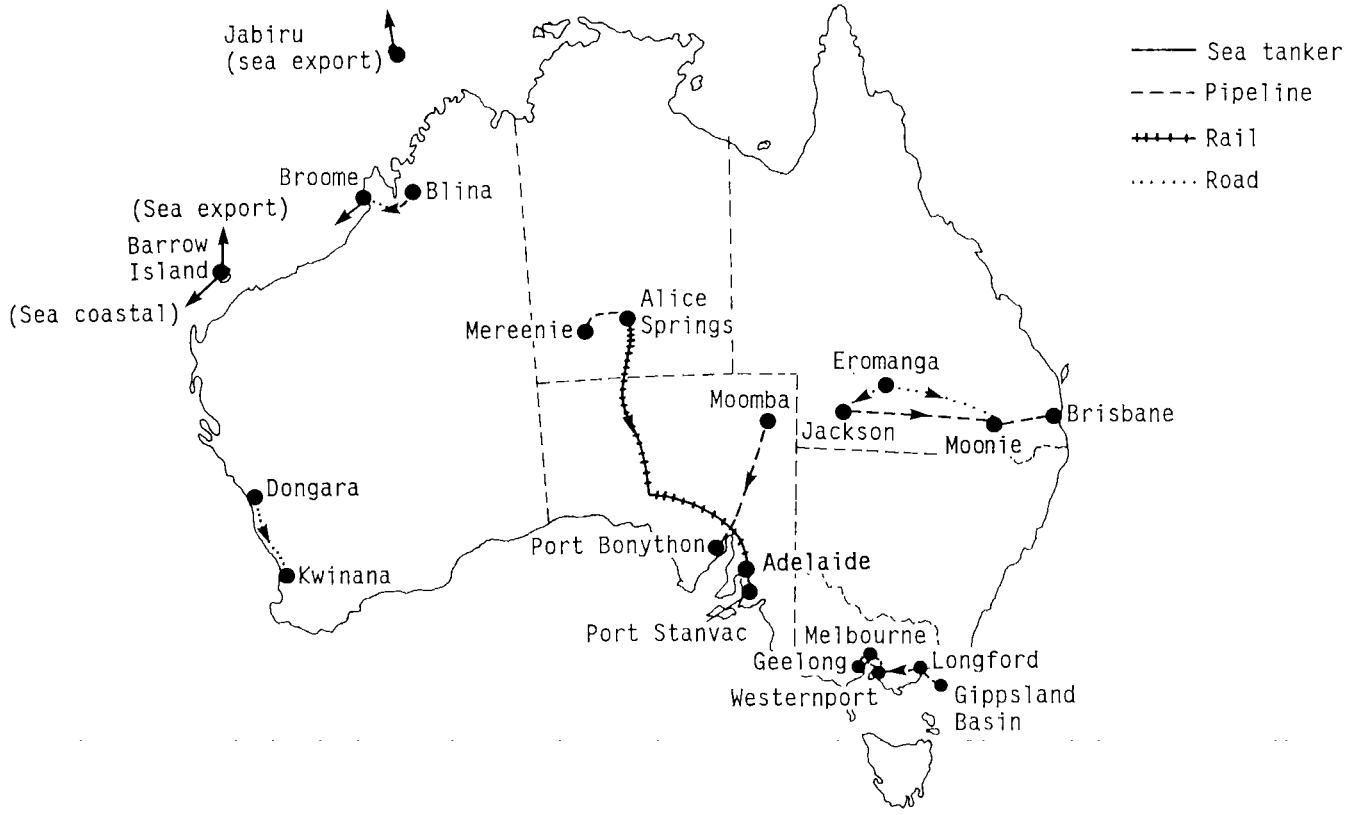
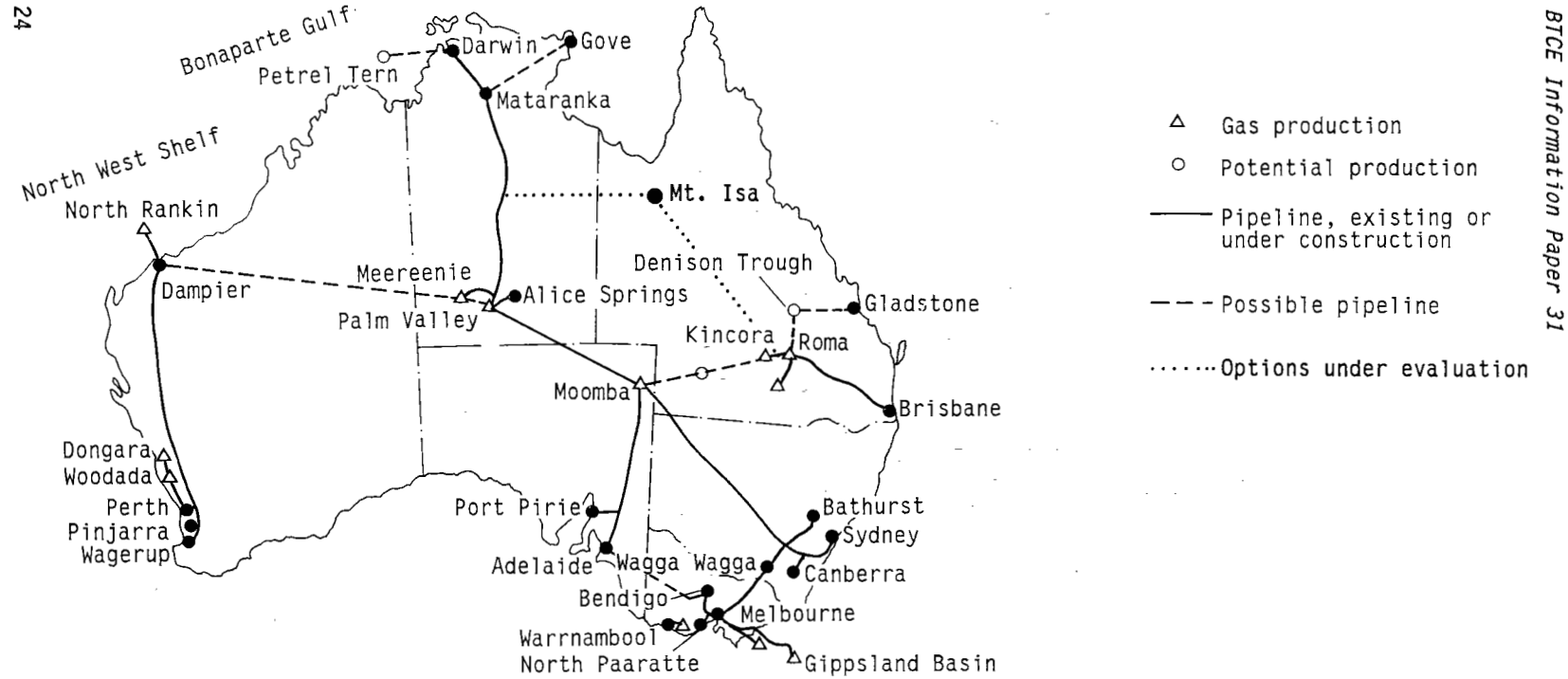


Figure 4.1 Crude oil movements from field by transport mode, 1987-88



Note The proposed pipeline from Dampier to Palm Valley is considered to be a longer term possibility only. The other proposed pipelines are considered to be short to medium term projects.

Sources DPIE (1988a) (adapted). Mount Isa Mines, pers comm.

Figure 4.2 Natural gas pipelines in Australia

TABLE 4.1 INDIGENOUS CRUDE OIL[a] MOVEMENTS FROM PRODUCTION SITE, 1985 TO 1988

Field/site	*Destination*	*Mode*	*Distance (km)*	*Year ('000 tonnes)* 1985	1986	1987	1988
Gippsland	Westernport	Pipeline	330	21 911.0	17 792.0	18 565.0	na
Barrow Island	Coastal/overseas	Sea tanker	various	938.4	893.8	815.0	na
Moomba	Port Bonython	Pipeline	659	988.8	1 181.0	1 040.0	na
Jabiru	Overseas	Sea tanker	various	0.0	253.7	962.5	1 540[b]
Eromanga[c]	Jackson	Road	180	na	na	na	na
Eromanga	Moonie	Road	1 000	na	na	na	217[d]
Jackson	Moonie	Pipeline	780	894.0	na	1 184.5	na
Moonie	Brisbane	Pipeline	306	972.0	na	1 246.2	na
Dongara	Kwinana	Road	409	5.9	7.5	6.3	na
Blina/Sundown	Northern Highway	Pipeline	29	34.5	50.1	27.7	na
Northern Highway	Broome	Road	34	34.5	50.1	27.7	na
Broome	Fremantle	Sea tanker	2 226	34.5	na	na	na
Mereenie	Alice Springs	Pipeline	270	104.7	158.5	119.0	93.0
Alice Springs	Adelaide	Rail	1 555	na	na	na	93.0
Adelaide	Port Stanvac	Road	44	na	na	na	93.0

a. Excludes condensate and naturally occurring LPG.
b. Based on expected sustained rate of production of 35 500 b/d. This was only achieved in May 1988. Flows were 29 000 b/d prior to May.
c. 217 000 tonnes from Eromanga is presented as a total only and not broken down into the individual links to Jackson and Moonie.
d. Based on current daily movements to Jackson and Moonie of 4700 b/d.
na Not available.

Sources BTCE (1987). Department of Primary Industries and Energy (pers. comm.).

TABLE 4.2 THE AUSTRALIAN FEEDSTOCKS PIPELINE TASK TO 1987
('000 tonnes)

Feedstock	*Year*				*Growth rate (per cent)*
	1971-72	*1975-76*	*1984-85*	*1987*	
Crude oil, LPG and condensate	15 898	20 520	23 062	25 164	3.0[a]

a. Estimated over 15.5 years.

Sources BTE (1976, 1978). Department of Primary Industries and Energy (1988b, 1988c, 1988d).

TABLE 4.3 LENGTHS OF MAJOR NON REFINED PRODUCT PIPELINES BY STATE, 1987
(kilometres)

State	*Onshore*			*Offshore*			
	Crude oil	*Other*[a]	*Natural gas*	*Crude oil*	*Other*	*Natural gas*	*Total*
NT	270.0	-	1 802.8	-	-	-	2 072.8
WA	39.3	1.0	2 335.8	10.0	-	134.0	2 520.1
SA	64.2	760.3[b]	1 217.4	-	-	-	2 041.9
Vic	87.2	768.1[c]	1 986.7	198.5	122.7	108.7	3 271.9
Qld	1 106.0	28.0	589.0	-	-	-	1 723.0
NSW	-	-	2 036.0	-	-	-	2 036.0
Total	1 566.7	1 557.4	9 967.7[d]	208.5	122.7	242.7	13 665.7

a. Includes oil and gas, liquids and other gases and stabilised crude.
b. Includes Moomba to Stony Point carrying liquids.
c. Includes Longford to Long Island Point carrying stabilised crude.
d. 7234 km are considered as major natural gas pipelines (Department of Primary Industries and Energy 1988a).
- Nil.

Sources Bureau of Mineral Resources, Geology and Geophysics (1987). Department of Primary Industries and Energy (1988a).

TABLE 4.4 SELECTED MAJOR NATURAL GAS PIPELINES

Basin	*Origin site*	*Destination*	*Length (km)*	*Basin production, 1987 (million cubic metres)*
Amadeus	Palm Valley	Darwin	1 512	
		Alice Springs	145	246.9
Bowen	Wallumbilla	Brisbane	397	
	Kincora	Wallumbilla	53	
	Silver Springs	Wallumbilla	102	583.6
Carnarvon[a]	North Rankin A	Withnell Bay	134	
	Withnell Bay	Wagerup	1 482	3 306.2
Perth	Dongara (includes Woodada)	Pinjarra	445	334.1
Cooper	Moomba	Adelaide	781	
		Wilton (Sydney)	1 300	5 332.5
Ottway	Paaratte	Allansford	34	11.6
Gippsland	Snapper	Shore to Longford	37/54[b]	
	Marlin	Shore to Longford	53/55	
	Barracouta	Shore to Longford	24/32	
	Longford	Dandenong	174	
	Westernport	Dandenong	39	
	Dandenong	West Melbourne	36/44/82	5 178.8

a. Includes the North-West Shelf.
b. Length 1/length 2 indicates two pipelines of differing lengths are available for this origin-destination.

Sources Bureau of Mineral Resources, Geology and Geophysics (1987). Department of Primary Industries and Energy (1988b, 1988c, 1988d).

TABLE 4.5 RETICULATED PIPELINES IN URBAN CENTRES BY STATE, 1985-86
('000 kilometres)

State	*Mains*
New South Wales	13.900
Victoria	20.834
Queensland	2.943
Western Australia	6.119
South Australia	5.549
Tasmania	0.186
Australian Capital Territory	0.537

Source Australian Gas Association (1987).

TABLE 4.6 THE AUSTRALIAN NATURAL GAS PIPELINE TASK TO 1987
(million cubic metres)

Year						
1982	*1983*	*1984*	*1985*	*1986*	*1987*	*Growth rate (per cent)*
11 550	11 915	12 602	13 470	14 714	15 032	5.4

Source Department of Primary Industries and Energy (1988b, 1988c, 1988d).

The natural gas task, as presented in Table 4.6, has expanded over the past five years at a rate of 5.4 per cent per annum. Up to 1987, the pipeline transport of natural gas has shown the fastest rate of growth in terms of volume of all modes of hydrocarbons transport examined in this study. Factors which will affect the future volume of this task are the growth in urban and industry demand offset by the depletion of natural gas reserves. At sustained current production levels, natural gas reserves will last for another 60 years and will satisfy a 16.7 per cent share of national energy demand at the turn of the century (Department of Primary Industries and Energy 1988a).

In this analysis, natural gas has been measured in million cubic metres whereas all other hydrocarbons have been measured in tonnes. To approximately compare these two transport tasks, 1986 natural gas

production of 14 700 million cubic metres was equivalent to crude oil output of 250 000 barrels per day. In the same year, total Australian refinery output was equivalent to 547 200 barrels per day. By implication, natural gas pipeline movements were equivalent to 45 per cent of refinery output. This volume had previously been assumed to be handled by refined product pipelines, and these pipelines accounted for 21 per cent of Australia's non-gaseous hydrocarbon movements.

REFINED PRODUCT PIPELINE DEVELOPMENT

The Victorian Transport Study into the transport of petroleum products (Ministry of Transport Victoria 1980) considered the establishment of refined product pipelines to service major country areas in its review of alternative transport possibilities. The committee suggested that the establishment costs of pipeline infrastructure would be offset by the long-term savings in operational resources required by either road or rail operations. This is to say nothing of advantages measured by the removal of the social disbenefits associated with very large suburban terminal operations. As well as this, savings in reduced road and rail accidents, (not mentioning the disruption caused by industrial disputation), can be achieved.

It should be noted, however, that Victoria's major country centres lie somewhat closer to major refineries than is the case for major rural centres in other States. Such geographic considerations may well make pipeline developments less economically viable in other States even though the Sydney to Newcastle product line now exists. TNT have proposed a pipeline between Brisbane and Southport but this, as yet, has not been built.

CHAPTER 5 TRANSPORT BY RAIL

In this analysis transport by rail refers to those petroleum movements performed by government rail systems. Commodities carried by non-government rail systems, excluding, iron ore, sugar and coal accounted for less than 1 per cent of the tonnage hauled by these services. As the petroleum component of these 'other' commodities would be but a fraction of 1 per cent, any shipments of refined petroleum product by non-government railways have been excluded from this study.

The data cover the period 1971-72 to 1986-87. However, one major problem affects the data on rail freight movements from older 1979 and 1983 BTE sources. In those sources, petroleum is amalgamated with other bulk liquids carried by rail; molasses, acid and water. Petroleum products comprise the vast majority of this bulk liquids group and the data have, therefore, been used as a proxy for petroleum product movements. A rough correction factor has been applied to the total haulage figure by subtracting the Mackay and the Townsville intraregional bulk liquid figures which have been assumed to be for intraregional molasses movements.

THE RAIL TASK

The current pattern of movements, and those for the previous fifteen years, are presented in Tables 5.1 and 5.2 respectively. Major rail corridors for bulk liquids, (the proxy for refined product movements), are presented in Appendix III for the years 1975-76 and 1979-80 respectively.

Railways carry the smallest share of the Australian hydrocarbons transport task, being responsible for only 3.9 per cent of the national task in 1986-87. The growth rate of rail petroleum movements for the period 1971-72 to 1986-87 was also 3.9 per cent per annum. This was the highest achieved growth rate of all delivery or distribution modes transporting non-gaseous products. Discussions with industry revealed that rail could still be the preferred mode of transport in some Victorian transport corridors, even under a

TABLE 5.1 NATIONAL RAIL HAULAGE OF PETROLEUM RELATED PRODUCTS BY CARRIER, 1986-87

Service	*'000 tonnes*
Australian National	621.3[a]
Westrail	450.0
State Rail Authority	1 200.0
Queensland Rail	915.4[b]
V/Line	427.0
Total	3 613.7

a. The Tasmanian estimate was based on percentage share of product delivered by sea.
b. Queensland Rail estimate based on median estimate of bulk liquids to other minerals ratio in 1975-76 and 1979-80 applied for 'general merchandise' freight share 1986-87.

Sources BTCE estimates. Railway Industry Council (pers. comm.).

TABLE 5.2 NATIONAL RAIL HAULAGE OF BULK LIQUID PRODUCTS TO 1986-87

Year	*'000 tonnes*
1971-72[a]	2 022
1975-76[a]	2 601
1979-80[a]	2 794
1986-87[b]	3 614
Growth rate over 15 years (per cent)	3.9

a. Molasses correction applied for Mackay and Townsville. The size of correction factor varied from 9 to 3 per cent.
b. Figures include estimates for Queensland Rail and Australian National operations in Tasmania.

Sources BTE (1979, 1983). Railway Industry Council (pers. comm.).

hypothetical scenario of deregulation[1], whilst for Queensland it was observed that recent State deregulation has made little impact on road distribution systems except, perhaps, in the Townsville to Mount Isa corridor.

However, forecasting with this 3.9 per cent growth rate should be tempered by the fact that the full effects of rail deregulation in Queensland, the partial rail deregulation in Western Austalia (March 1988) and the likely increased use of B-Doubles on many road corridors in line with the Review of Road Vehicle Limits recommendations (National Association of Australian State Road Authorities 1985), have not been considered in this analysis. This does not detract from the fact that rail has seemingly maintained its place as a viable long-haul competitive mode as shown by it having the highest rate of growth for non-gaseous hydrocarbon products of all transport modes (see Table 5.2). As an indication of its competitiveness, rail recently won supply contracts against coastal shipping for Perth to Bunbury and Perth to Geraldton traffic.

1. Currently intrastate petroleum product movements, further than 80 kilometres, are regulated to travel by rail transport.

CHAPTER 6 OTHER DISTRIBUTION ARRANGEMENTS

REFINERY EXCHANGE

An important dimension in the Australian refined products transport task emanates from the existence of refinery exchange agreements operating between the petroleum companies. In essence, these agreements allow a company to draw upon the refined product of another company in one Australian State to help service the borrower's market in that State. In return, in another State, a reciprocal arrangement exists between these two companies with the roles of borrower and host reversed. That is, the company being the initial provider of product in one State becomes the borrower of an equivalent amount of product in other States.

Refinery exchange was pioneered in Australia in 1955. Agreements, as they currently exist, began operating in 1965.

The impact of not having refinery exchange agreements would be considerable for a petroleum company's operations in a State where it did not own a refinery or large storage facilities. For example, a company based in an eastern State would incur large transport costs in supplying a market in the west. Without refinery exchange agreements, any company would build up a natural monopoly in the State housing its own refinery or terminals owing to an associated transport logistics advantage.

In brief, the refinery exchange scheme promotes access to a free trading environment for all participant companies within a particular State, regardless of which company controls the refinery. It is possible though for companies to enter the market without having operating control of a refinery. Such companies have developed, for example, Amoco, Total and Golden Fleece (H. C. Sleigh), but these have been subsumed through take overs involving the larger companies. These companies did, however, hold processing agreements with Caltex refiners.

Transaction settlements for transport costs incurred in the operation of the refinery exchange scheme, that is, for sea transport, are resolved between companies biannually. (Refinery exchange terminals are shown in Figure 6.1). Similarly, the operational responsibilities of the companies supplying these transport services are also renegotiated at these times.

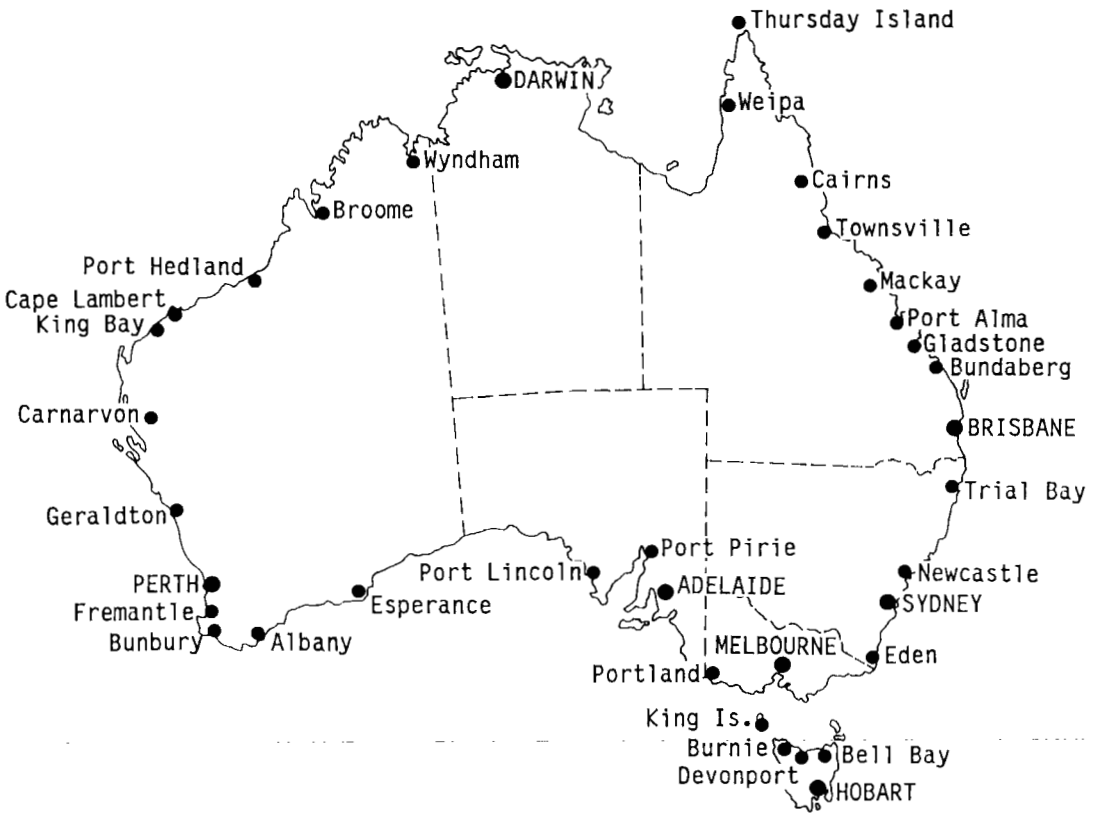
BORROW AND LOAN PRACTICES

An operational adjunct to refinery exchange agreements are Borrow and Loan arrangements. These arrangements provide for the multi-user sharing of refined product terminal storage infrastructure. Thus companies with either ownership in, or a negotiated right, can draw product from a participating terminal. The associated supply fees for drawing-off terminal stocks are currently near to 10 dollars per tonne (0.8 cents per litre). This price may vary depending upon the rural or urban location of a terminal, as well as the economies of scale offered through terminal size. As companies are, in effect, charged for their utilisation of a terminal, the frequency of road tanker services and the terminal draw-off fee may weigh as important considerations in a company's assessment of the the long-term benefits of establishing its own terminal infrastructure at specific locations. Borrow and Loan terminal transactions are settled between companies on a monthly basis.

PETROLEUM PRODUCTS FREIGHT SUBSIDY SCHEME

A further scheme which affects the pattern of hydrocarbon transport in Australia is the 'Petroleum Products Freight Subsidy Scheme'. This scheme operates between retailers and customs authorities. The transport cost of a litre of product to a particular location is first determined. This transport cost is defined as the freight 'differential' to that location and is calculated by the Prices Surveillance Authority. Currently, the transport differential is calculated on the basis of the running cost of a standard tanker to supply a particular location. This involves the calculation of a fixed and variable cost component.

Destinations are defined as depot towns, link towns or special locations, and allowances are made in the calculation of the transport differential for each case. In the case of a link town (which would be a satellite of a major storage facility at some larger town), the differential is calculated with consideration given to a transport cost of delivery to the associated depot town, a 'standing' vehicle capital cost and a running cost per kilometre to the link town in question. Allowances are made for vehicle depreciation in the



Source Caltex Oil (Australia) Pty. Ltd. 1988.

Figure 6.1 Operational borrow and loan terminals

calculation of a capital standing cost but leasing costs are not included. The determination of the differential is then made by taking the average of the lowest three transport operator costs to that location.

At present, there are about 4000 locations for which there are associated price differentials calculated. Prior to 1984-85, there were approximately 10 000 approved locations which included delivery up to farm gate in some instances. The differential at that time was calculated across an average of the service costs of the lowest four operators supplying services to that location.

The transport freight differential is used in conjunction with a government declared threshold rate, which can be considered as the user pays margin, to calculate the level of obtainable rebate. Where the transport differential is lower than this declared threshold then transport costs must be absorbed by the distributor. Where the differential is greater than the declared threshold then a subsidy equal to this difference is available. Currently, the declared government threshold is 10.9 cents per litre. Subsidies available for locations whose differentials are above this level bring returns of between 10 to 15 million dollars per annum to distributors. In 1984, the declared government threshold of 1.2 cents per litre afforded distributors between 250 to 300 million dollars in rebates. Raising this threshold to 10.9 cents per litre has forced distributors to absorb full transport costs to many more locations thus reducing rebates by a factor of twenty on previous levels.

Australia's highest differential of 35 cents per litre is to Lord Howe Island. Transport to this location would result in an available rebate of 24.1 cents per litre.

CHAPTER 7 FUTURE DEVELOPMENTS OF HYDROCARBON TRANSPORT

In Chapters 1 to 5 the size of the petroleum transport task and the modal shares associated with this task have been outlined for the period 1971-72 to 1986-87. Some important data, to be contained in the following forthcoming publications, are not yet available. These include 'Port Authority Cargo Movements, 1987-88' (DTC forthcoming) and 'Survey of Motor Vehicle Use, Australia 1988' (ABS forthcoming). The first of these publications will show some of the initial impact of the 1 January 1988 Oil Deregulation policies, and the second will demonstrate the increase of petroleum product and other fuel movements since the last SMVU (1985). The 1988 SMVU will also capture the diversion from rail to road produced by the full or partial rail deregulation in Queensland and Western Australia in 1987 and 1988 respectively.

The adoption of the Australian Transport Advisory Council (ATAC) recommendations of September 1988 may well see road vehicle mass limits raised uniformly to a level of 42.5 tonnes in all States. It might also be expected that further utilisation of medium combination vehicles (B-Doubles) will follow on from the adoption of these increased uniform weight limits. Although there are obvious efficiencies to be gained from the use of such vehicles, each State must decide the associated licensing and permit provisions for the operation of such vehicles. The introduction of medium combination vehicles may well impact on the future rail share of the petroleum movements task. This, in turn, will put pressure on the railways to further improve their operating efficiency.

Pressures for improved efficiency in coastal shipping operations will follow the abolition on 1 January 1988 of the Bass Strait Crude Allocation Scheme. Refiners may now become more cost conscious towards using Bass Strait crude, hauled by coastal vessels, in comparison to importing increased volumes of feedstocks from Asia or the Middle East. The sensitivity of transport costs will be an important consideration in this future choice, especially for Kwinana and Brisbane refiners.

The use of pipelines to deliver refined products is increasing. Altona to Tullamarine, Sydney to Newcastle and Geelong to Newport are current examples of direct delivery. A Brisbane to Southport pipeline has also been proposed. In connecting centres of high demand this mode will offer long-term cost savings even though the initial infrastructure costs are high. Proposals for large increases in the natural gas pipelines system might also soon be realised. A pipeline from Moomba to Gladstone via the Denison Trough, and a pipeline to Mount Isa tapping into the Alice Springs to Darwin link are strong future possibilities.

The adoption of new fuels, for example compressed natural gas (CNG), before the year 2000 may well affect the current task shares of both sea and land transport modes. Widespread adoption of a new fuel like CNG, especially in the capital cities, could radically alter the existing balance in the modal shares. Over 100 000 vehicles have adopted this new fuel in New Zealand and already in Australia several company fleets have converted to CNG. However, it is not envisaged that the adoption of CNG will have an immediate impact into existing modal transport shares in the short-term. Forecasts suggest that there will be over 96 000 trucks and buses operating on CNG in Australia by the year 2003 (Australian Gas Association 1988).

APPENDIX I THE DEREGULATED OIL MARKET

On 1 January 1988, the Commonwealth Government abolished the Crude Oil Allocation Scheme and effectively lifted the restrictions on refiners to process indigenous crude oil. The Crude Oil Allocation Scheme was introduced in 1965 and had been modified in subsequent years. After 1 January 1985 the partial allocation scheme allocated crude oil from small ventures (those producing up to 50 000 barrels per day) and the first 350 000 barrels per day of Bass Strait production to refiners and marketers in proportion to their respective market share of sales of certain refined products.

The abolition of the Crude Oil Allocation Scheme has also brought to an end the Bass Strait Coastal Freight Adjustment Scheme which partially reimbursed the cost of transporting Bass Strait crude to the refinery. In brief, the effects of the deregulated market should:

- allow refiners to compete against the current levels of product being imported;
- allow producers and refiners to play the current Australian crude oil price advantage; and
- increase both exports and imports.

With respect to Australian shipping:

- Australian-flagged vessels will have to compete in both the import and export trade; and
- some coastal movements of Bass Strait crude to refineries will be replaced by imports, enabling certain of the Australian-flagged tankers to enter into international trading. (This does not include the three Australian-flagged LNG tankers proposed to serve the North-West Shelf export operations beginning in 1989.)

Not only will the deregulated oil market bring about such international shipping involvement but the continuing depletion of Gippsland crude will also lessen the demand for coastal activity from Westernport. This too will release resources for an expanded international shipping task.

APPENDIX II SELECTED SHIPPING MOVEMENTS, 1986-87

The following tables present a selection of major coastal, import and export shipping movements as well as the resources involved in the Australian shipping task.

TABLE II.1 IMPORT OF MAJOR HYDROCARBONS BY SELECTED PORTS, 1986-87
('000 tonnes)

Hydrocarbon	*Port of landing*						
	Botany Bay	*Fremantle*	*Geelong*	*Melbourne*	*Newcastle*	*Port Stanvac*	*Port Jackson*
Crude oil	796	630	267	117	-	480	917
Other feedstocks	-	29	-	-	-	80	-
Motor spirit	144	105	77	330	12	-	99
Aviation turbine fuel	30	17	-	-	-	-	7
Aviation gasoline	-	-	-	-	-	10	-
Kerosene and other oils	-	-	1	-	-	3	-
Distillate	81	71	23	182	-	-	3
Residual oils	25	602	-	-	-	-	-
Lubricating oils	1	3	-	16	-	-	4
Fuel oils	-	216	-	-	-	395	-
Other residual petroleum products	243	2	-	11	-	-	3
Naptha solvent	55	81	-	-	-	78	26
Bitumen	-	-	66	9	231	-	-
Liquefied petroleum gas	41	7	-	15	-	-	1
Heavy distillate	-	-	450	-	41	-	-
Petroleum oils	-	-	258	-	-	-	-
Petroleum products unspecified	-	-	163	-	-	-	304

\- Nil.
Source DTC (1988).

TABLE II.2 EXPORT OF MAJOR HYDROCARBONS BY SELECTED PORTS, 1986-87
('000 tonnes)

Hydrocarbon	*Port of loading*						
	Port Bonython	*Botany Bay*	*Brisbane*	*Fremantle*	*Geelong*	*Port Stanvac*	*Westernport*
Crude oil	29	-	-	-	-	-	3 864
Other feedstocks	-	-	-	-	-	35	-
Motor spirit	-	9	-	31	89	7	-
Aviation turbine fuel	-	-	-	83	-	-	-
Aviation gasoline	-	-	-	7	-	-	-
Kerosene and other oils	-	-	-	4	156	-	-
Distillate	-	10	-	4	296	-	-
Residual oils	-	-	-	62	-	53	-
Lubricating oils	-	12	-	16	2	140	-
Fuel oils	-	-	-	68	30	215	-
Other residual petroleum products	-	-	-	-	-	-	-
Naptha solvent	-	-	-	-	-	-	-
Bitumen	-	-	-	-	-	-	-
Liquefied petroleum gas	351	16	-	-	-	-	1 032
Heavy distillate	-	-	-	14	-	-	-
Petroleum oils	-	-	-	-	-	-	-
Petroleum products unspecified	-	-	226	-	4	-	-

- Nil.
Source DTC (1988).

TABLE II.3 AUSTRALIAN-FLAGGED PETROLEUM VESSELS, 1988

Ship name	*Tanker type*	*DWT*	*Manning level*	*Owner/operator*
Australia Star	Crude/product	94 569	27	H.C. Sleigh Services
Island Gas	LPG	6 033	26	BHP Pty Co Ltd
Wiltshire	Product	12 280	33	Associated Steamships
B.P. Enterprise	Product	19 792	41	Associated Steamships
John Hunter	Product	24 245	40	H.C. Sleigh Services
Esso Gippsland	Product	24 380	37	Associated Steamships
W.M. Leonard	Product	25 500	39	Ampol Petroleum (Qld)
Mobil Australis	Product	27 070	39	Associated Steamships
Conus	Product	31 950	36	Associated Steamships
Australian Spirit	Crude/product	32 605	29	Associated Steamships
Arthur Phillip	Crude	65 103	39	H.C. Sleigh Services
Era	Crude	94 290	31	Howard Smith Industries Pty Ltd
Canopus	Crude	94 350	31	Ampol Petroleum (Qld)
Ampol Sarel	Crude	101 900	37	Ampol Petroleum (Qld)
Nivosa	Crude	124 754	34	Associated Steamships
B.P. Achiever	Crude	129 700	34	Associated Steamships
Mobil Flinders	Crude	149 235	34	Associated Steamships

Source DTC (1988).

TABLE II.4 DESTINATION AND ORIGIN OF HYDROCARBONS BY PORT: DISCHARGED INTERSTATE, 1986-87

Hydrocarbon	*Port of destination*	*Port of origin*	*Total ('000 tonnes)*
Crude oil (and other feedstocks)	Botany Bay	Westernport	2 844
		Brisbane	316
		Port Bonython	206
	Geelong	Barrow Island	188
	Port Stanvac	Westernport	79
		Barrow Island	519
	Port Jackson	Westernport	908
		Brisbane	363
		Port Bonython	316
		Barrow Island	73
		Dampier	36
	Fremantle	Westernport	1 377
		Port Stanvac	70
		Port Bonython	62
		Dampier	219
	Brisbane	Westernport	3 633
Motor spirit	Adelaide	Botany Bay	29
		Melbourne	5
		Geelong	130
		Brisbane	70
		Fremantle	99
	Botany Bay	Melbourne	12
		Brisbane	51
	Launceston	Westernport	55
		Fremantle	7
	Melbourne	Newcastle	11
		Botany Bay	100
		Brisbane	10
		Port Stanvac	17
		Fremantle	3
		Burnie	4
	Newcastle	Melbourne	2
		Brisbane	62
		Gladstone	3

TABLE II.4 (Cont.) DESTINATION AND ORIGIN OF HYDROCARBONS BY PORT: DISCHARGED INTERSTATE, 1986-87

Hydrocarbon	*Port of destination*	*Port of origin*	*Total ('000 tonnes)*
Motor spirit	Port Lincoln	Melbourne	10
		Geelong	31
	Port Pirie	Geelong	3
	Port Jackson	Geelong	35
		Brisbane	11
	Trial Bay	Brisbane	33
Aviation turbine fuel	Adelaide	Melbourne	1
		Geelong	2
	Botany Bay	Melbourne	11
		Brisbane	7
		Port Stanvac	18
	Port Jackson	Geelong	16
		Port Stanvac	5
		Fremantle	4
	Twofold Bay	Brisbane	1
Kerosene and other oils	Adelaide	Fremantle	1
	Port Stanvac	Melbourne	1
Distillate	Adelaide	Botany Bay	26
		Melbourne	5
		Geelong	19
		Brisbane	11
		Fremantle	4
	Botany Bay	Melbourne	5
		Brisbane	4
	Darwin	Fremantle	14
	Melbourne	Botany Bay	17
		Port Stanvac	68
		Whyalla	29
		Burnie	10
	Newcastle	Melbourne	3
	Port Kembla	Port Stanvac	2
	Port Lincoln	Melbourne	24
		Geelong	44

TABLE II.4 (Cont.) DESTINATION AND ORIGIN OF HYDROCARBONS BY PORT: DISCHARGED INTERSTATE, 1986-87

Hydrocarbon	*Port of destination*	*Port of origin*	*Total ('000 tonnes)*
Distillate	Port Pirie	Melbourne	4
		Geelong	2
	Port Jackson	Geelong	20
	Trial Bay	Brisbane	14
	Twofold Bay	Brisbane	1
Residual oils	Fremantle	Melbourne	15
	Melbourne	Newcastle	4
		Whyalla	2
		Fremantle	2
Lubricating oils	Darwin	Fremantle	1
	Launceston	Westernport	46
		Fremantle	4
	Melbourne	Botany Bay	6
		Port Stanvac	20
		Fremantle	6
	Port Jackson	Geelong	9
		Port Stanvac	2
		Fremantle	14
	Adelaide	Botany Bay	1
		Geelong	3
Fuel oils	Fremantle	Botany Bay	9
	Geelong	Port Jackson	18
	Launceston	Westernport	12
	Mackay	Melbourne	1
	Newcastle	Melbourne	7
		Geelong	5
		Brisbane	6
	Port Kembla	Port Stanvac	26
	Port Latta	Melbourne	15
		Whyalla	5
	Adelaide	Melbourne	3
		Geelong	52
		Brisbane	8
		Fremantle	13

TABLE II.4 (Cont.) DESTINATION AND ORIGIN OF HYDROCARBONS BY PORT: DISCHARGED INTERSTATE, 1986-87

Hydrocarbon	*Port of destination*	*Port of origin*	*Total ('000 tonnes)*
Residual petroleum products (3390)[a]	Botany Bay	Port Stanvac	9
	Port Jackson	Port Stanvac	5
Other residual petroleum products (3399)[a]	Botany Bay	Westernport	9
		Port Stanvac	18
		Port Bonython	9
	Geelong	Port Jackson	14
	Port Kembla	Port Stanvac	5
Naptha solvent	Port Jackson	Geelong	9
Bitumen	Adelaide	Geelong	22
	Launceston	Port Kembla	9
	Newcastle	Whyalla	28
Heavy distillate	Adelaide	Botany Bay	28
	Newcastle	Melbourne	21
		Geelong	2
		Brisbane	8
Liquefied petroleum gas	Botany Bay	Westernport	292
		Brisbane	2
	Gladstone	Westernport	5
	Launceston	Westernport	12
	Norfolk Island	Brisbane	1
	Port Jackson	Port Bonython	1
		Westernport	10
Unspecified petroleum products (3300)[a]	Brisbane	Port Jackson	1
		Botany Bay	89
		Melbourne	46
		Geelong	126
		Port Bonython	81
		Fremantle	17
		Northern Territory ports	102

TABLE II.4 (Cont.) DESTINATION AND ORIGIN OF HYDROCARBONS BY PORT: DISCHARGED INTERSTATE, 1986-87

Hydrocarbon	*Port of destination*	*Port of origin*	*Total ('000 tonnes)*
Unspecified petroleum products (3300)[a]	Cairns	Melbourne	8
	Devonport	Geelong	150
		Westernport	13
	Townsville	Geelong	116
	Gladstone	Port Jackson	20
		Botany Bay	10
		Melbourne	5
		Geelong	38
		Port Jackson	12
		Melbourne	10
	Port Jackson	Melbourne	37
		Geelong	49
		Westernport	109
		Port Bonython	11

a. ABS commodity classification number.

Source DTC (1988).

TABLE II.5 DESTINATION AND ORIGIN OF HYDROCARBONS BY PORT: DISCHARGED INTRASTATE, 1986-87

Hydrocarbon	*Port of destination*	*Port of origin*	*Total ('000 tonnes)*
Crude oil	Fremantle	Barrow Island	294
		Broome	28
		Dampier	83
		Yampi Sound	19
	Port Stanvac	Port Bonython	618
Motor spirit	Bunbury	Fremantle	113
	King Island	Launceston	2
	Newcastle	Botany Bay	1
	Trial Bay	Botany Bay	97
	Twofold Bay	Botany Bay	39
Kerosene	Twofold Bay	Botany Bay	2
Distillate	Exmouth Gulf	Fremantle	8
	Flinders Island	Launceston	5
	Port Kembla	Botany Bay	13
	Trial Bay	Botany Bay	59
	Twofold Bay	Botany Bay	28
	Yampi Sound	Fremantle	8
Residual oils (3335)[a]	Fremantle	Bunbury	38
		Dampier	20
		Esperance	2
	Port Jackson	Botany Bay	38
Fuel oils	Mackay	Gladstone	11
		Brisbane	13
	Newcastle	Botany Bay	2
Liquefied petroleum gas	Gladstone	Brisbane	1
	Townsville	Brisbane	1
Heavy distillate	Newcastle	Botany Bay	5

a. ABS commodity classification number.

Source DTC (1988).

APPENDIX III RAIL ORIGIN AND DESTINATION MOVEMENTS, 1975-76 AND 1979-80

Following are a selection of major interregional origin-destination corridors for rail movements of petroleum and other bulk liquid products. The sample chosen represents approximately two-thirds of bulk liquid movements in the years for which origin-destination data are available.

TABLE III.1 SELECTED RAIL BULK LIQUID CORRIDORS, 1975-76

Origin	*Regional destination*	*Major towns*	*'000 tonnes*
Sydney	Central Macquarie	Dubbo	89
	Central Tablelands	Bathurst	71
	Lachlan	Parkes	77
	Southern Tablelands	Goulburn	51
	ACT/Queanbeyan	Canberra	155
Newcastle	Northern Slopes	Tamworth	69
Melbourne	Northern Victoria	Bendigo	87
	Albury/Wodonga	Albury	88
Brisbane	Widebay/Burnett	Bundaberg	54
	Darling Downs	Toowoomba	202
Fitzroy	Fitzroy	Rockhampton	94
Mackay	Mackay	Mackay	139[a]
Northern Qld	North West	Mount Isa	62
Perth	Central Agricultural	Northam	126
Perth	Eastern Goldfields	Kalgoorlie	95
Eastern Goldfields	Eastern Goldfields	Esperance	79
North West Tasmania	North West Tasmania	Burnie	98
Total sample			1 824
Total bulk liquid movements for 75-76			2 864
Corridor sample (per cent)			63.7

a. Molasses movements.

Source BTE (1979).

TABLE III.2 SELECTED RAIL BULK LIQUID CORRIDORS 1979-80

Origin	*Regional destination*	*Major towns*	*'000 tonnes*
Sydney	Central Macquarie	Dubbo	131
	Central Tablelands	Bathurst	78
	Lachlan	Parkes	82
	Southern Tablelands	Goulburn	59
	ACT/Queanbeyan	Canberra	29
Newcastle	Northern Slopes	Tamworth	89
	North Central Plains	Moree	40
Wollongong	Newcastle	Newcastle	56
Adelaide	Far West	Broken Hill	50
Melbourne	Loddon/Campaspe	Korong Vale	41
	North Mallee	Mildura	60
	Wodonga	Wodonga	76
Brisbane	Widebay/Burnett	Bundaberg	41
	Darling Downs	Toowoomba	269
	South West	Charleville	51
Qld Northern	Qld Northern[a]	Townsville	23
Fitzroy	Fitzroy	Rockhampton	105
Mackay	Mackay[a]	Mackay	65
Northern Qld	North Western	Mount Isa	90
Perth	Midlands	Northam	125
Perth	South Eastern	Kalgoorlie	77
South Eastern	South Eastern	Esperance	97
Hobart	North Western	Devonport	41
North Western	North Western	Burnie	49
Total sample			1 824
Total bulk liquid movements for 79-80			2 882
Corridor sample (per cent)			63.3

a. Molasses movements.

Source BTE (1983).

APPENDIX IV BACKGROUND STATISTICS

TABLE IV.1 BACKGROUND STATISTICS: PRODUCTS

Major product consumed ('000 tonnes)	*Year*			*Growth rate (per cent)*
	1971-72	*1977*	*1986*	
Petrol	7 912	10 412	11 724	2.75
Avtur	1 032	1 546	1 984	4.60
Automotive diesel fuel	3 193	5 131	7 192	5.76
Fuel oils	6 486	6 062	2 250	-7.00

Source Australian Institute of Petroleum Limited (1981, 1987a, 1987b).

TABLE IV.2 BACKGROUND STATISTICS: VEHICLES, POPULATION

Total motor vehicles ('000)	*Year (at 30 September)*					*Growth rate (per cent)*
	1976	*1979*	*1982*	*1985*	*1987*[a]	
Total	6 556.9	7.285.3	8 132.6	8 865.2	9 373.7	3.30

Australian population ('000)	Year			Growth rate (per cent)
	1971-72	1975-76	1986-87	
Total	13 176.9	13 920.3	16 132.8	1.35

a. At 30 June 1987.

Source ABS (1978, 1981, 1983, 1984, 1986).

TABLE IV.3 SERVICE STATION STATISTICS, 1985-86

Capital/ State pair	*Number of establishments*[a]	*Turnover ($'000)*	*Retail sales*[b] *($'000)*	*State capital share*
Sydney	1 487	1 525 674	1 424 692	0.57
New South Wales	3 114	2 659 991	2 496 673	
Melbourne	1 254	1 267 549	1 193 960	0.70
Victoria	2 164	1 824 406	1 703 402	
Brisbane	572	532 116	490 500	0.45
Queensland	1 518	1 178 486	1 095 033	
Adelaide	472	419 540	393 059	0.70
South Australia	797	596 857	560 999	
Perth	527	504 531	470 900	0.68
Western Australia	926	746 350	691 735	
Hobart	109	82 312	78 262	0.41
Tasmania	355	201 657	188 814	
Northern Territory	68	88 537	80 675	na
Australian Capital Territory	80	108 040	98 341	na
Australia	9 022	7 404 325	6 915 671	..

a. As at 30 June 1986.
b. Excludes sales of petrol on commission.
na Not available.
.. Not applicable.

Source ABS (pers. comm.).

TABLE IV.4 AUSTRALIAN REFINERY CAPACITY, 1 JULY 1987

('000 tonnes per year)

	Capacity	
	Refinery	*Lubricating oil refinery*
Kurnell (NSW)	4 900	196
Altona (Vic)	5 040	..
Geelong (Vic)	5 000	145
Clyde (NSW)	3 100	..
Kwinana (WA)	5 543	120
Adelaide (SA)	..	245
Port Stanvac (SA)	3 340	..
Lytton (Qld)	3 000	..
Bulwer Island (Qld)	2 217	..
Eromanga (Qld)	69	..
Total	32 209	706

.. Not applicable.

Source Australian Institute of Petroleum Limited (1987b).

TABLE IV.5 PRODUCTION OF SELECTED REFINED PRODUCTS, 1984-85 AND 1986-87

('000 tonnes)

Product	*1984-85*	*1986-87*
Liquefied petroleum gas	525.2	387.0
Automotive gasoline	11 377.0	11 200.0
Aviation gasoline	113.8	141.3
Avtur	2 063.0	2 176.0
Lighting kerosine	86.4	56.9
Power kerosine	9.5	6.7
Heating oil	107.7	179.8
Automotive distillate	6 742.2	6 888.9
Industrial diesel fuel	359.8	205.0
Fuel oil	2 680.5	2 135.4
Lubricating oil	536.9	516.5
Bitumen	529.4	533.8
Total	25 148.8	24 440.3

Source Department of Primary Industries and Energy (1988b, 1988c, 1988d).

TABLE IV.6 IMPORTS AND EXPORTS OF REFINED PRODUCTS, 1986-87

('000 tonnes)

Product	*Imports*	*Exports*
Liquefied petroleum gas	19.5	1 407.0
Automotive gasoline	934.7	183.7
Aviation gasoline	4.7	46.9
Avtur	173.5	736.7
Automotive diesel oil	853.8	373.4
Industrial and marine diesel fuel	10.4	106.0
Fuel oils	1 156.4	1 277.7
Lubricating oils	39.1	204.4
Bitumen	13.1	0.92
Other	255.3	159.1

Source Department of Primary Industries and Energy (1988).

TABLE IV.7 TOTAL FINAL ENERGY DEMAND BY MAJOR FUEL TYPE AND CONSUMING SECTOR: AUSTRALIA, 1985-86
(petajoules)

	Coal and coal products	*Petroleum products*	*Gas*	*Electricity*	*Wood and bagasse*	*Solar*	*Total*	*Per cent*
Agriculture	-	47.2	-	6.5	-	-	53.7	2.3
Mining	3.9	27.3	54.9	22.8	-	-	108.9	4.7
Iron and steel	60.6	1.9	20.4	14.5	0.2	-	97.6	4.2
Non-ferrous metals	50.7	42.5	67.9	69.9	-	-	231.0	9.9
Chemical	17.7	39.4	48.2	10.3	87.6	-	364.7	15.7
Other industry	54.6	53.3	113.3	55.7	87.6	-	364.7	15.7
Road transport	-	718.5	-	-	-	-	718.5	30.9
Rail transport	-	27.2	-	4.0	-	-	31.2	1.3
Air transport	-	92.9	0.4	0.3	-	-	93.6	4.0
Sea transport	3.2	52.1	-	0.3	-	-	119.8	5.2
Commercial	6.1	10.6	28.2	74.2	0.7	-	119.8	5.2
Residential	0.9	18.1	74.0	124.1	68.4	2.5	288.0	12.4
Lubricants, bitumen, etc.		47.0	-	-	-	-	47.0	2.0
Total final energy demand	197.7	1 178.3	407.3	382.6	156.9	2.5	2 325.3	100.0

- Nil.

Note Total final energy demand is equal to total energy consumption less energy consumption and loss in the production of the derived fuels by the conversion sector.

Source Department of Primary Industries and Energy (1988a).

TABLE IV.8 PETROLEUM DEMAND BY SECTOR TO 1999-2000

	1975-76		*1980-81*		*1985-86*		*1999-2000e*	
Sector	*(peta-joules)*	*(per cent)*	*(peta-joules)*	*(per cent)*	*(peta-joules)*	*(per cent)*	*(peta-joules)*	*(per cent)*
Agriculture	36.0	(2.6)	43.6	(3.2)	47.2	(3.6)	69.4	(4.2)
Mining	28.5	(2.1)	27.6	(2.0)	24.8	(1.9)	36.3	(2.2)
Manufacturing	388.1	(28.6)	333.9	(24.2)	251.4	(18.9)	279.3	(16.9)
Transport	711.7	(52.4)	828.5	(60.1)	890.7	(67.1)	1 138.9	(68.9)
Commercial	28.1	(2.1)	19.0	(1.4)	10.6	(0.8)	13.2	(0.8)
Residential	50.9	(3.8)	26.7	(1.9)	18.1	(1.4)	25.1	(1.5)
Electricity generation, etc.	67.1	(5.0)	52.5	(3.8)	37.3	(2.8)	34.7	(2.1)
Lubes, greases, bitumen, solvents	45.6	(3.4)	46.6	(3.4)	47.0	(3.5)	56.7	(3.4)
Total	1 356.0	(100)	1 378.4	(100)	1 327.1	(100)	1 653.6	(100)

e Estimated.

Source Department of Primary Industries and Energy (1988a).

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Abbreviations

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AGPS	Australian Government Publishing Service
BTCE	Bureau of Transport and Communications Economics
BTE	Bureau of Transport Economics
DTC	Department of Transport and Communications
ISC	Inter-State Commission

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ABBREVIATIONS

ABS	Australian Bureau of Statistics
AGPS	Australian Government Publishing Service
ATAC	Australian Transport Advisory Council
b/d	barrels per day
BTCE	Bureau of Transport and Communications Economics
BTE	Bureau of Transport Economics
CNG	compressed natural gas
DTC	Department of Transport and Communications
dwt	deadweight tonnes
ISC	Inter-State Commission
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MCV	medium combination vehicle
SMVU	Survey of Motor Vehicle Use
SVP	single voyage permit
TNT	Thomas Nationwide Transport Ltd