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No. 1

ALEX HUNTER

Oil Supply in Australia's Defence Strategy

The Australian refining industry processes efficiently and economically nearly all of Australia's requirements of petroleum products. But at present some 90 per cent of the raw material is imported, from the Middle East and Indonesia. In an attempt to overcome dependence on foreign supplies, the Commonwealth government heavily subsidises oil exploration in Australia.

Dr Hunter examines the nature and extent of Australia's dependence on foreign oils; the susceptibility to political disturbance of the areas supplying the oil; the dangerousness of the tanker routes in time of war, insurrection, or regional disputes; the prospects of discovering adequate indigenous supplies located conveniently to the refining centres.

He presents a complex picture, for no one can forecast with any accuracy the kinds of defence emergency Australia may have to face over the next ten to twenty years. What is certain, however, is the vulnerability of tanker routes and consequently of the industries dependent on the imported raw material—crude oil.

Dr Hunter therefore examines the kind of measures appropriate for guarding against short-term interruptions of supply and analyses the long-term policies required to make the Australian refining industry either less vulnerable or else effectively and economically self-sufficient in crude oil supplies.

This study will find a ready audience among politicians and economists, students of strategy, defence, and international relations, administrators of Defence and External Affairs, and—not least—Australian taxpayers.

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Oil Supply in Australia's Defence Strategy

ALEX HUNTER

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OIL SUPPLY IN AUSTRALIA'S DEFENCE STRATEGY

AMONG the defence considerations of any developed country the continuous supply of crude oil to refineries, and subsequently of products to industry, agriculture and transport, looms as one of the largest single problems. It is not merely that, in modern conditions, without petroleum products the economy would cease to function and military operations become impossible. There is also the sheer physical size of the international oil trade. The movement of oil and oil products by sea internationally accounts for 54 per cent by weight of all trade; and of the ocean-going ships of the world tankers make up 38.5 per cent of the gross tonnage.[1] One need only remind oneself, if reminder is necessary, of the growing submarine component in the naval forces of the world to appreciate the vulnerability of the oil trade today.

Australia is among the more sensitive countries of the world in this respect. It has a high *per capita* consumption of motor spirit, for example, coming after only the United States and Canada; and transportation absorbs some 7-8 per cent of the gross national product. The search for indigenous supplies of crude oil in the sedimentary basins of

[1] Chamber of Shipping of the United Kingdom, *Annual Report* 1966-67 (London, 1967).

the continent is now proceeding quickly and begins to show signs of very substantial success. But at present (1968) only some 8-9 per cent of refinery throughput comes from Australian fields. The remainder is imported over ocean routes which, if one were to rely on Australian resources, would be extremely difficult to defend against attack by a major maritime power.

AUSTRALIA'S DEPENDENCE ON PETROLEUM PRODUCTS

APPROXIMATELY 46 per cent of the primary energy of Australia is derived from petroleum products (see Table 1). In the main this degree of dependence is unavoidable. Any sizable decrease in the supplies of crude oil or products coming to this country could have catastrophic effect on the operation of the economy and its capacity to provide the matériel of defence.

TABLE 1 Primary Energy Consumption: Australia 1956–76
(percentages of million million British Thermal Units)

ENERGY SOURCE	1956–7*	1960–1*	1966–7*	1969–70†	1974–5†
Coal—					
black	46·2	41·9	34·5	32·4	30·3
brown	9·7	12·2	12·6	10·9	11·9
Total	55·9	54·1	47·1	43·3	42·2
Petroleum products (inc. refinery fuel)	34·7	38·1	46·4	47·0	42·3
Hydro power	1·0	1·3	1·6	2·0	1·8
Natural gas	n.a.	n.a.	neg.‡	3·8	10·6
Firewood, bagasse, etc.	8·4	6·5	4·9	3·9	3·0
Total	100	100	100	100	100

* Actual † Estimates ‡ Negligible

Source: Fuel Branch, Department of National Development (reproduced in Petroleum Information Bureau, *Oil and Australia 1967*). Consumption of primary energy in Australia rises at around 7 per cent per annum.

Note: Petroleum products competitive with natural gas and/or coal are residual or furnace oils, industrial diesels and domestic heating oil. Petroleum products NOT competitive are motor spirit, aviation spirit, aviation kerosene, automotive diesel oil, lubricants and certain solvents, waxes, and chemical feedstock.

To elaborate this point, let us first examine the uses to which petroleum products are put in normal times. Table 2, on the inputs of petroleum products into the various industry groups during 1958-9,

reveals the perhaps surprising fact that personal consumption of petroleum products accounted for only 18.3 per cent of the total consumption.[2] The situation has changed since 1958-9 in that the use of domestic heating oils is more common and the proportion of motor vehicles registered for private use has risen from 70 per cent of all private and commercial registrations of motor vehicles in 1959 to 77 per cent in 1967. This will not make for a large shift in the inputs of petroleum products. Between 1958-9 and 1966-7, when consumption rose from 2,816 to 5,001 million gallons, it is probable that the proportion going to personal consumption rose only to about 22 per cent of all petroleum products. If this is correct then the agricultural and pastoral

TABLE 2 Inputs of Petroleum Products by Industry Group* (1958-9)

Industry Group	Petroleum Products $m		Petroleum Products %	
Agriculture and pastoral		54·6		11·3
All mining		4·6		1·0
Manufacturing industry—				
Metals, engineering, and vehicles	10·4		2·2	
Chemicals	6·2		1·3	
Food and drink	4·0		0·8	
Other manufacture	4·2		0·9	
Gas, water, and electricity	7·2		1·5	
Petroleum exports and bunkers	43·4	75·4	8·9	15·6
Building and construction		37·6		7·6
Trade and transport †		215·0		44·2
Personal and government services ‡		9·6		2·0
Personal consumption		89·4		18·3
Total §		486·2		100·0

* At producers' prices (ex works) including excise for all domestically produced or imported petroleum products.

† Trade and transport inputs include transport for hire, transport provided by producer or distributor and distributive margins on petroleum products.

‡ Mainly for private motoring but including also petroleum products used in heating, lighting, etc.

§ Does not include investment in stocks.

Source: C.B.C.S. Canberra, *Input Output Tables 1958-9*. Since 1958-9 the percentage shares going into exports have declined and those going to manufacturing industry (chemicals), mining, and personal consumption (heating and private motoring) have increased slightly, but the picture is not likely to be substantially different.

[2] Bureau of Census and Statistics, *Input Output Tables 1958-9* (Canberra. 1959).

industries, the mining industry, manufacturing industry (including some exports of petroleum products), building and construction, transport industry, and personal and government services absorb as much as 78 per cent of all petroleum products. Clearly, there is little scope for a straight economising exercise in petroleum products. It could only hinder economic growth.

Second, consider the possibilities of substitutes for petroleum products. Australia has ample coal reserves which could be expanded to meet new needs. Nevertheless it is clear that coal could not easily displace petroleum. Electrical power generation, which demands large quantities of fuel, might appear to be one of the most promising areas of substitution, but most of Australia's electricity (75 per cent) already is generated in thermal stations using black or brown coal.[3] The only major exceptions among thermal stations on the mainland are the base-load stations in metropolitan South Australia and Western Australia, which operate on residual oils from the local refineries because state coal reserves are inadequate in quality and/or are too distant. Minor exceptions are also to be found in Melbourne and Sydney peak-load and standby stations and in diesel-fuelled stations in outback areas in all states. (Hydro electric power makes a contribution of course—about 1.6 per cent. But, outside of the heavy rainfall area of Tasmania, there appears to be only very limited scope for its further application. The Snowy Mountains scheme can offer, and is designed for, only peak-load distribution to New South Wales and Victoria.)

In industry there is some scope for substitution. Coal-burning is technically feasible for furnace heating in a wide range of industry, for heat processes in foundries and in sheet metal treatment, for extrusion work, for food processing and bakeries, in cement and chemicals, bricks and tiles, among others, and indeed will continue to be used in many of these areas of industry. However, the thermal efficiency, cleanliness, relative freedom from air pollution, and the convenience of petroleum products (mainly furnace oil and industrial diesels) has progressively predisposed industry towards employment of the 'black oils' as fuel. The intensive price competition offered by the refinery companies, usually taking the form of long-term contracts, made easier the task of converting industry from coal-burning to oil fuels. The economics of the situation indeed made conversion mandatory for many industries. In 1953-4 the petroleum industry had only 27 per cent of the primary

[3] Electricity Supply Association of Australia, *Statistics of the Electric Supply Industry 1960-65.*

energy market in Australia.[4] By 1966-7 it had 46 per cent, the greater part of the increase consisting of the inroads made by black oils into the black coal market.

Natural gas—an indigenous fuel—will reduce to a degree Australia's dependence on petroleum products and therefore on shipments of crude oil from abroad. Undoubtedly this fuel, for reasons of thermal efficiency, cheapness, cleanliness, and convenience, will in its turn displace some of the black oil products of the refinery industry. It will replace residual oil for electricity generation in Adelaide, Perth, and possibly in some other State capitals. It will also be preferred for many uses in domestic and industrial heating and for heat processes in industry, thus substituting for some industrial diesels and light heating oils. Further, the gasification of middle distillates, for the manufacture of town gas, gradually will cease in all states. But natural gas will not entirely eliminate the black oils.[5] With present refining plant, they must be manufactured anyway: even now they are produced in excess over domestic demands and therefore require disposal as exports. In order to retain some major portion of the domestic market they will be priced even more keenly if possible. Natural gas will at best diminish the share of the black oils by one-third and the share of all petroleum products in the energy market by perhaps 5-6 per cent only (see Table 1).

This remarkably small diminution of petroleum products' share in primary energy to be brought about by natural gas helps stress a most significant factor—the uniqueness of the contribution made by petroleum products. The majority of products (motor spirit, aviation spirit and aviation turbine fuel, kerosenes, automotive diesel fuels and lubricants) are the only practicable, economic fuels for most of Australia's transport task (estimated as accounting for 7-8 per cent of the Australian gross national product). They are necessary to meet transport functions which neither coal nor gas, without a radical change in the technology we employ for powering our transport media, can hope to undertake.

One can be more precise. Coal is a practicable but uneconomical substitute for railway locomotives. Some 46 per cent of our locomotives are steam-powered; but they accomplish much less than this proportion of the railways' tasks and are steadily going out of use. Coal can be used to propel steamships; but less than 6 per cent of Australia's trading fleet is so powered and the proportion is rapidly diminishing. For most

[4] Joint Coal Boards, *Twentieth Annual Report 1966-7* (Sydney, 1967).

[5] Alex Hunter, 'Natural Gas in Australia', *Australian Economic Papers*, vol. 5 no. 8 (June 1967), pp. 25-46.

purposes outside of large generating stations the raising of steam by means of oil-burning is still less expensive and certainly more convenient and maintenance free than coal-burning. No naval power could contemplate going back to coal for its warships. Natural gas, purified and bottled, is technically capable of powering heavy transport engines. But, bearing in mind the cost of adapting, rebuilding, or replacing heavy transport prime movers (and making no mention of the possible clumsiness and low thermal efficiency of such engines in an engineering sense), it is unlikely that any move in this direction would be economic. Further, it would give Australian heavy transport an unorthodox technology which, in defence emergencies when spares and replacements are required quickly and possibly in large number from other countries, could cripple our heavy transport system. Substitution away from petroleum products for transport purposes, then, besides being uneconomic, seems to raise more problems than it solves.

The 'white oils' group together make up about 58-60 per cent of refinery production.[6] The technical constraints imposed by the present structure of the refinery industry are such, however, that even if these products were the only ones demanded in Australia, the same throughput of crude oil would be required to produce them—i.e. the black oils are inevitable by-products.

Two developments could reduce the gross throughputs of crude oil required to produce the white products group by means of a decrease, relatively and absolutely, of black products produced. The first would mean the introduction of more complex catalytic cracking and reforming equipment into Australian refineries in order to obtain a larger proportion of motor spirit from the predominantly heavy crudes imported from the Persian Gulf. This is a solution expensive in capital equipment and one which takes time. The second development requires the use of crudes which by nature yield from primary distillation processes a higher motor spirit and kerosene content. Indonesian crudes are somewhat superior to Middle East crudes in this respect. Australian crudes so far discovered have an unusually high motor spirit yield from primary distillation. To this extent they are better adapted to Australian market conditions (see Table 3 for comparisons of demand in Australia and various other countries). But Australian crudes are not ideal. They produce an excess of middle distillates which require extra cracking facilities for conversion into motor spirit and other useful products. They are deficient in fuel oils, giving only a 6-7 per cent yield. And they produce practically no bitumen.

[6] Petroleum Information Bureau (Melbourne), *Oil and Australia, 1967*.

TABLE 3 Consumption by Type of Petroleum Product: Developed and Underdeveloped Countries (1966). (%)

	Mogas and Avgas	Kero-senes and Avturb	Auto diesel and ind. diesel	Furnace fuels	Other pro-ducts	Total Con-sumption (Million barrels p.a.)
Developed Areas						
U.S.A.	46	6	19	15	14	4,120
W. Europe	19	4	29	34	14	2,797
Japan	13	6	12	52	17	706
Australasia	*46*	*8*	*18*	*20*	*8*	*144*
Underdeveloped Areas						
African and Middle East	24	17	27	26	6	311
India, Pakistan, Burma and Ceylon	14	26	29	23	28	126
Other Asia	35	12	25	24	4	211
Latin America and the Caribbean	33	9	18	28	12	618

Source: Petroleum Information Bureau, *Oil and Australia, 1967.*

Assuming—as seems most likely—that further substantial discoveries of Australian crudes are made, adjustments in refinery techniques must take place. Their extent, and direction, depend uniquely on government policy. If the government continues to compel refining companies to process all the indigenous crudes which are produced in Australia (the effect of the present tariff arrangements), then coversions of refinery equipment as expensive as any required for adapting Middle East crudes to Australian conditions will be necessary. Even so, some imports of foreign crudes for blending, to provide lubricating oil stock and for fuel oil and bitumens, would be most desirable. If, on the other hand, refiners are permitted to purchase crudes freely, taking in the proportion of indigenous crude which can be processed economically on existing equipment, then little conversion of equipment would be necessary. Apart from being the more economic policy decision, such an arrangement does not seriously run contrary to balance of payments or defence interests. The indigenous crudes not refined here can be sold abroad to earn foreign exchange. And in the event of a cessation of foreign supplies, they will always be available for processing in Australian refineries which, allowing for technical losses, can refine any crude in an emergency. To secure (some of) the advantages of each of these alternative policies,

refiners could be required to process a proportion of indigenous crude —say up to 30 per cent of refinery capacity—to enable them to refine an economical blend, meanwhile permitting them to make a gradual adjustment to a fuller utilisation of indigenous crudes.[7]

Australian refineries (1968 onwards) manufacture 95-8 per cent of our requirements in petroleum products. (Some 1 per cent of them are brought into the Northern Territory and the north-west from Singapore-Malaysia refineries and small cargoes of special blends of aviation spirit, lubricants, and special solvents are shipped from the United States, the Caribbean, and the United Kingdom, for example.) Petroleum refining in Australia, most of it established since 1951, is a modern, efficient industry—the only manufacturing industry developed in Australia since World War II which can operate without benefit of tariff protection. Its locational distribution, around the six mainland capital cities, corresponds roughly to the distribution of industrial demand. Perth has, in Kwinana, a larger refinery than is justified by this criterion but finds additional markets in exports to the eastern states and through being the major bunkering port of the country. Brisbane also has more refining capacity than is required by Queensland's demands, and the companies there ship cargoes of products south as well as north along the Queensland coast. Tasmania is supplied mainly from Melbourne refineries.

But, of the crude oil required for the refinery industry (Table 4), around 95 per cent comes from abroad (see Table 5): from the Middle East 68 per cent of total refinery throughput, from Indonesia 23 per cent, from Malaysia-Brunei rather less than 5 per cent, and from various minor sources such as Nigeria and the United Kingdom, a few special cargoes making up about 0.3 per cent.[8] Only 4.8 per cent of refinery throughput was produced in Australia in 1966-7. (In 1968 the Australian contribution is around 8-9 per cent.)

[7] It is difficult to predict what proportion of indigenous crudes would be processed in Australian refineries given a free market situation (no import controls, tariffs, or compulsory purchase). Their value relative to foreign crudes would depend on: (i) their yield pattern in relation to Australian demand for petroleum products; (ii) their price at the refinery gate relative to the landed price of foreign crudes; (iii) the c.i.f. price Australian crudes could command in foreign markets; and (iv) the internal economics of the international oil companies. (On this last point, international companies with large reserves in Indonesia and the Middle East could find that, despite low prices for indigenous crudes, the overall group profit, and taxation, situation points to continued processing of foreign crudes since almost all of the profitability of the large international companies is in crude production and the rate of return on investment in refineries in most countries—including Australia—is very low.)

[8] Petroleum Information Bureau, *Oil and Australia 1967*.

TABLE 4 Australian Refining and Consumption 1966–67

	MMB *	Mill. Gall.
Crude oil throughput	144·67	5063·5
Refinery production— (incl. chemical feedstock and industrial solvents)	145·23	5083·5
Imports of refined products	7·62	268·1 †
Exports of refined products	9·7	338·6 ‡
Domestic consumption of products	142·9	5001·8
Total Refining Capacity (1967: at 503,000 Barrels per Stream Day)	183·59	6425·6

* MMB = million barrels.

† From Middle East 53 per cent; from Malaysia-Singapore 28 per cent.

‡ To New Zealand 10 per cent; Malaya-Singapore 30 per cent; Japan 8 per cent.

Source: Petroleum Information Bureau, *Oil and Australia 1967*.

TABLE 5 Supply Sources of Australian Crude Feedstock (%)

Annual Refinery Throughputs	Middle East	Indo-nesia	Malaysia Brunei	Aus-tralia	Others
1966–7					
133 MMB or 365,000 BPSD *	68	23	4·8	4	>1
1970–1					
172 MMB or 500,000 BPSD	22	18	2·0	57	>1
1976–7					
223 MMB or 641,000 BPSD	4–22	0–10	0–2·0	65–95	>1

* MMB = million barrels; BPSD = barrels per Stream Day.

Source: Petroleum Information Bureau, *Oil and Australia 1967* (for market estimates and probable refinery throughputs).

Note: The percentages for 1966-7 are calculated from actual imports. The 1970-1 proportions represent a reasonable expectation based on plans presently contemplated by local producers and refiners. And the 1976-7 percentage distribution is designed to show how uncertain is the position beyond 1971. What new distribution of oil sources Australia will develop depends on whether more oil is found and in what quantities; where the new oil reservoirs are located relative to Australian refineries (it may be more sensible to export than to supply local refineries—see on p. 8, n. 7); which companies discover it and what is their liaison with refining companies; and what refineries it is decided should phase out of foreign oils in favour of employing local crudes. The policy of the government on protection and compulsory consumption of local crudes after 1970 is, of course, yet one more uncertainty in the situation.

Thus Australia's special problem is that our refinery industry, and with it almost all of our transport industry, most agriculture and a large part of manufacturing industry, at present depends on foreign supplies of crude oil.

There is no danger of a physical shortage as such. In the Middle East alone there is about seventy years of production,[9] at present rates, in the ground and available. This area accounts for 60 per cent of all world reserves. The course of discovery is likely to prove even higher reserves. All of the countries around the Persian Gulf, including Iran, Iraq, Kuwait, Saudi Arabia, Abu Dhabi and Bahrein could double their outputs fairly rapidly without any discomfort, if the markets existed to absorb the crude and marine terminals and transport were available to take it away. In Indonesia the reserves are less, but there is at least forty-eight years production in the ground.[10] And since there has been little onshore exploration of the archipelago since 1939 and virtually no offshore exploration of Indonesia's very extensive shallow-water areas at any time, the chances are that here reserves also will stay well ahead of production and demand.[11]

The real danger of course is that there will be some form of interruption to supplies for political reasons or because of war or war-like episodes.

However, before going on to discuss the possibilities of such events, one point should be made clear. The strategic problem—if it should arise—is not simply one of available oil supplies. That is only one half of the problem. The other half is a transportation problem. About sixty to seventy tankers are engaged all the year round in bringing crude oil 4,000-5,000 miles from central Sumatra and Brunei and 7,000 miles from the Persian Gulf. This is around 2.1 to 2.5 per cent of the world tanker fleet.[12] Any shortage of tanker capacity, because of events in other parts of the world (for example the Suez Canal closures of 1956 and 1967), or any direct interdiction of supply routes or sinking of tankers, can as easily affect Australia's supply position as any stoppage of the crude supplies themselves.[13]

[9] *World Oil* (Houston, Texas), August 1966 and 1967 issues on reserves.

[10] Ibid.

[11] Alex Hunter, 'The Indonesian Oil Industry', *Australian Economic Papers*, vol. 5, no. 1 (June 1966), pp. 59-106.

[12] John F. Jacobs & Co. Ltd, *World Tanker Fleet Review* (London, 1967).

[13] Note that this tanker problem is one which would exist even if we had no refinery industry. Before the creation of the present Australian oil refining industry, between 1951 and 1956 about 90 per cent of our petroleum products requirements were brought in from refineries abroad, from the Middle East, Indonesia, and

POSSIBLE EMERGENCIES

ONCE the international character of the oil industry and the distances over which crudes must be transported are appreciated, one is compelled to take a very wide view of the range of emergencies which can influence significantly the supply of petroleum products in Australia. The sources of crude oil supply, and tanker fleets, can be affected by a variety of events throughout the globe.

We must therefore consider not only (i) the defence of Australia in the strict sense of resisting aggression or (ii) involvement of this country in military and/or naval engagements in South-East Asia, in the Pacific, or in the Indian Ocean, but also (iii) war in all parts of the globe, and (iv) war-like episodes arising out of insurrection, rebellion, or revolution in the more unstable areas of the world. Indeed we must look beyond military or quasi-military events. Supply areas or tanker routes may also be influenced by (v) political penetration of under-developed countries. China, Algeria, Egypt, Syria, France, and the Soviet Union are some of the countries having ambitions which could lead them to influence the oil affairs of other countries in the Middle East and Africa.[14] Besides, there may be (vi) internal political developments leading to intervention in the oil industry—the nationalisation of oil fields, the takeover of the Suez or Panama canals, embargoes on foreign exploration onshore or in continental shelf waters, the closure of important shipping routes, and so on.

This list of possible episodes is formidable. For systematic examination it is convenient to categorise the various possibilities which may affect Australian supplies of crude oil in terms of the geographical areas which may be the source of the dislocation. Consider the following.

Malaysia/Singapore, in proportions not greatly different from the present crude supply position except that the U.S.A. was a significant supplier.

[14] For example, the government of Iraq at the end of 1967 took unilateral action to withdraw from the Iraq Petroleum Company (London-based, with partners B.P., Compagnie Française des Pétroles, Standard Oil of New Jersey, Mobil, and the Royal Dutch-Shell group) some unexplored areas of their very large concessions, established in 1924. Later an agreement was announced under which the U.S.S.R., in partnership with the Iraq National Oil Company, will in future explore and exploit these unexplored areas and certain other provinces in northern Iraq. Payment for technical aid and equipment from the U.S.S.R. would be made in crude taken from INOC fields. A similar agreement for certain other areas in Iraq was, around the same period, made between the INOC and the French government. Thus both agreements were made with countries which supported the Arab position after the end of the Arab-Israeli war. Also, it is of interest to note that the U.S.S.R. has no need of Iraq as a supply source. The Soviet bloc has a surplus of oil and is a significant exporter.

The Western Hemisphere

In the South American continent and the Caribbean area, insurrections, revolutions, and political actions affecting the oil industry are quite likely to occur from time to time: Mexico expropriated oil companies in the 1930s; Argentina and Brazil intervene substantially in the importation of crude oil and in internal oil affairs; Cuba took over the refineries from the international companies after Dr Castro's successful revolution and now uses only feedstock from the distant Soviet Union; and Venezuela, a militant member of the Organisation of Petroleum Exporting Countries (OPEC), could conceivably inherit a government eager to disfranchise United States and British-Dutch companies. However, leaving aside Venezuela, the rest of the South American countries are not large consumers of crude oil. Many countries in the area are underdeveloped and do not require substantial inputs, and half of these they can secure from indigenous resources anyway (see Tables 3 and 6). Consequently, only a small part of world oil movements go to the South Americas.[15] To provide for this movement only 4-5 per cent of the world fleet of ocean-going tankers is required.

The North American continent is a stable enough area. The United States, the world's largest consumer of petroleum products (35 per cent of all refined products in 1966),[16] imports around 22 per cent of its crude oil inputs. That proportion, about two-thirds, which has its source in the Caribbean (mainly Venezuela), could be considered a trifle unreliable although it is most unlikely that Venezuela *willingly* would risk sacrificing its largest market. But if there were any cessation of supplies from the Caribbean, the United States could compensate by increasing production quotas in Texas and the other oil-producing states and by falling back on Canada for a larger proportion of imports. Such an event would have the effect only of releasing tankers for employment elsewhere in the world. Looking at the western hemisphere as a whole, only the involvement of the United States in a global war could have a serious effect on world supply sources or on the size and disposition of the ocean-going tanker fleet. Otherwise, the United States, because of its size, actually provides a stabilising factor for the international oil industry. Its reserves, and tanker fleet, can be used to meet emergencies caused by events in other parts of the world.

[15] British Petroleum, *Statistical Review of the World Oil Industry 1966* (London, 1967).

[16] Ibid.

TABLE 6 Inter Area Crude and Product Movement and Estimated Work Tanker Fleet Activity (1966)*
(% of exports to destination areas)

From	To: U.S.A.	Canada	Other Western Hemisphere	Western Europe and U.K.	Africa	South Asia	Japan	Australasia	Other Eastern Hemisphere	Destination Unknown	Total Exports (mill. tons)
U.S.A.†	—	28·33	13·00	33·33	5·00	—	20·33	—	—	—	9·75
Canada	100·0	—	—	—	—	—	—	—	—	—	19·25
Caribbean	52·48	10·48									
Other Western Hemisphere	100·00	—	7·60	25·48	—	—	1·48	0·12	0·25	2·50	164·75
Western Hemisphere	14·00	2·50	4·75	—	28·75	7·00	4·75	2·50	4·75	31·00	3·00
Middle East	3·75	1·50	3·50	51·00	6·00	2·50	19·75	4·00	4·00	4·25	10·50
North Africa	3·00	0·50	—	95·25‡	0·25	—	0·25	—	0·25	0·50	428·50
West Africa	2·00	4·00	8·00	80·00§	—	—	—	—	4·00	2·00	170·50
South-East Asia	17·87	—	—	10·12	—	1·50	43·75	25·00	—	1·50	25·00
U.S.S.R and Eastern Europe ‖	—	0·50	13·75	65·25	4·50	4·25	10·50	—	1·50	—	17·25
Other Eastern Hemisphere	7·00	—	—	14·25	7·00	21·75	7·00	7·00	21·75	14·25	53·25
											3·50
										Exports: Grand Total	841·25

* Excludes movements between Canada and the U.S.A. which are mainly by pipeline.
† U.S.A. exports are over 99 per cent in the form of petroleum products and bunkers.
‡ Mainly to Europe. § Mainly to the U.K.
‖ U.S.S.R. and Eastern Europe exports are 45 per cent in the form of products.

Source: British Petroleum, *Statistical Review of World Oil Industry 1966;* Bureau of Mines, U.S.A., *International Petroleum Quarterly 1966.*

Western Europe

Until there is a settlement of the German question, the involvement of Western European countries in a war, which is likely also to bring into the arena the United States and the Soviet Union, is always a possibility despite the determination of both to avoid such a dangerous contingency. Any such war in the European area will not affect the supply sources of Australia; but it could absorb, and cause the sinking of, a large proportion of the tanker fleet. Approximately 50 per cent of the ocean-going tankers of the world are employed in taking crude oil and products to Western Europe and the United Kingdom (see Table 6). Consequently any military episode in this area has far-reaching and possibly disastrous consequences for all parts of the international oil economy—including distant Australia.

The Soviet Bloc

Providing the Soviet bloc of countries remains uninvolved in great power struggles in Europe, the Mediterranean, the Middle East, and elsewhere—and they seem resolved to take only political steps which fall short of actual belligerence—events in this area are unlikely to affect either Australia's oil supply sources or the availability of tankers. Internal episodes are self-insulating because the Soviet bloc countries have their own supplies or are connected to the internal network of oil pipelines fed from U.S.S.R. oil fields. The U.S.S.R., it is true, is not an unimportant exporter (6 per cent of international oil and product movements).[17] But over two-thirds of this export trade travels on short sea routes to Western Europe and Italy (more than half of it in the form of residual oils and low grade motor spirit); only one-tenth of it goes to distant Japan; and small quantities go to Cuba, Ceylon, and certain African states. In the near future some of the supplies to Italy and Western Europe are likely to move by pipeline (instead of tanker) through Eastern Europe. But, in any event, neither the termination of the Soviet bloc exports or their redeployment along different tanker routes could readily upset the Australian situation.

The Middle East

Emergencies in this area are always liable to affect one or a number of the principal, crude-oil-exporting economies of the world. From the

[17] Ibid.

Middle East group originates 51 per cent of all international oil movements (see Table 6). It is certain therefore that Middle Eastern events will have at least a marginal effect on the Australian oil supply position. Consider some possibilities. Another Arab-Israeli war seems probable. And the British have declared their intention (1968) to withdraw armed forces from the Persian Gulf and South Arabia. In themselves these events are unlikely to have serious repercussions for Australia, but they could lead to an increase in U.S.S.R. influence in Egypt and Iraq.[18] Without much encouragement from the Soviet bloc, Egypt itself could attempt to dislodge the régimes controlling Saudi Arabia, Kuwait, and the Persian Gulf minor sheikdoms. Arab nations of the Middle East may thus come to fight among themselves to achieve, or to frustrate, some Pan-Arabian hegemony of the whole area. Also, the U.S.S.R. could be successful in accomplishing one of the classic, long-term, Russian political objectives—to undermine the present dynasty and political structure of its southern neighbour, Iran. If one took the worst possible view of the prospects of instability in this area the oil economies could be so involved in war, or revolution, as to become ineffective suppliers; or, as the consequence of their political and military alliances, they could place oil embargoes on, say, all British and American countries, and their allies including Australia.

But there are various reasons for believing that damage to the effectiveness of the Middle East oil economies will never reach more than a fraction of these dimensions. These reasons can be summarised (they are examined in more detail when Australia's dependence on Middle Eastern supplies are considered later) along the following lines: (i) The Arabian oil economies will go to great lengths to prevent any stoppage of oil exports. The fabric of their economies depends on oil. They are otherwise subsistence economies, for the most part with few goods to export other than some citrus fruits, dates, carpets, pearls, etc. (ii) Although there are substantial political differences among the Arab countries, they also have strong ethnic ties. Coups, and palace revolutions, are more typical than hostilities which could damage oil installations. (iii) The oil fields of the Middle East are operated in the main by American, British, French, and Japanese companies. By law (or until contrary legislation is passed) they own the oil they produce. Their expatriate employees tend to work in small enclaves separate from the national life of the country and are therefore not easily upset by revolutions or regional wars, except where these actually interfere with the operation of the physical assets,

[18] See n. 14

notably pipelines. (iv) There are four large oil producers in the Middle East: in order of production they are Saudi Arabia, Kuwait, Iran, and Iraq; and there is also a significant number of minor producers. It is unlikely that all simultaneously will be so involved in war and politics that none of them can supply. And (v) one of the big four, Iran, although a Moslem country, is not Arabian and tends to dissociate itself from the mainly Arabian political movements of the Middle East and therefore is in a position to take up markets relinquished by the others.

It is worth noting that, in the twenty politically difficult years since 1947 in the Middle East, the most serious decreases in the flow of oil exports have arisen from the closure of the Suez Canal in 1956 and 1967 and not through any direct interference in oil supply. No country actually ceased production and lowered outputs for more than 3-4 weeks except in so far as tankers were not available to remove the product.[19] The first of these occasions was serious indeed for European countries—the longer supply route and the consequent shortage of tankers compelled petrol and fuel rationing in the United Kingdom and most of Western Europe. The second occasion was much less serious because African supplies were available to compensate; and some 4,000,000 DWT of tankers could be taken from a laid-up state or from wheat-carrying in order to meet the scarcity. It is unlikely that in future a similar closure will have any significant consequences for the capacity of the oil industry to deliver crude oil as scheduled. African oil fields, in Libya, Algeria and Nigeria, will be further developed; and tankers of 120,000 DWT and above, which can carry oil economically by the the Cape route, will be extensively employed or chartered by oil companies on the Persian Gulf to Europe run. The inconvenience to Australia of these canal closures was small—little greater than a temporary rise in freight rates.

[19] The 1951-4 period, when Iranian oil and products were unavailable on world markets as a result of the Iranian government's abortive attempt to nationalise all the fields and refineries of the Anglo-Iranian Oil Co. (now British Petroleum) cannot be counted as an effective interdiction caused by international incident. The Iranian nationals could not operate the refinery plant; and the international companies boycotted Iranian crude supplies. The sole result of this period was that Saudi Arabian and Kuwait production (half of which was owned by Anglo-Iranian) were increased to take over former Iranian markets. The almost complete inability of the nationalising country to sell its crude, when the international companies (which then, and now, control over two-thirds of the world's refineries) were unwilling to buy, conveyed a lesson not likely to be forgotten by Middle Eastern countries.

South Asia

The Indian Ocean is *potentially* Australia's most vulnerable defence area, since 67 per cent of present oil supplies traverse the 5,000 miles across this ocean. Fortunately, one can see few real emergencies in this area. India, a country with absorbing domestic problems and one committed to neutralism in world affairs, is not likely to go to war with any large naval power. True, India will doubtless continue its border disagreements with Pakistan and China; but such contretemps make for land wars and cannot easily interrupt sea routes to Australia. East African and South Arabian nations could become involved in regional wars. But, since none of them is a significant naval power, again it does not appear that oil supply routes will be affected. Nevertheless, the Indian Ocean area deserves careful observation. The projected withdrawal of British forces could, unless compensating arrangements are made, leave this large area unoccupied by a strong naval power for the first time in 300 years.

South-East Asia and the Pacific

In this area close to Australia several types of war or war-like activity could occur: (i) Insurrectionist activity created by nationalist or religious groups (Indonesia, Cambodia, South Vietnam, Laos) or by local communist parties (Malaysia, Indonesia, and the Philippines). These could result in continuous 'brush-fire' wars over quite long periods. (ii) Regional wars on a greater scale, because of border issues, nationalistic regional ambitions, or ideological disagreements (Indonesia and Malaysia, Malaysia and Singapore, Indonesia and the Philippines, Thailand and the Indo-China group of countries). (iii) Great-power wars. They could originate in the United States' involvement, and the Soviet Union's interest, in Vietnam. China must also be classified as a great power in this area. Some of its traditional preoccupations—to have control over Formosa, to influence border countries such as Burma, North Vietnam, and Korea, and possibly to accomplish an ideological revision in Japan—could well bring this country into conflict with other great powers, at first on regional-type disputes, but possibly developing into conflicts in which nuclear weapons are employed. Serious disputes with the Soviet Union concerning mutual border areas in North China and Outer Mongolia are particularly dangerous in view of the ideological schism between the two powers.

The first two types of belligerency, on recent past experience, can be expected to take the form of guerilla and partisan activity principally. These must be small-scale land wars, in the main, with only insignificant coastal activity requiring minor naval vessels. Substantial activities bringing into play large naval forces seem unlikely. Therefore insurrectionist activity or regional wars will not spread out to such an extent as to interfere with supply routes from the Middle East across the Indian Ocean. In some circumstances, supplies of oil ex-Dumai in Central Sumatra (23 per cent of Australian input at present and unlikely to be less than 18 per cent for some time to come—see Table 5) could be precluded from passage through the Java and Arafura Seas to the east coast of Australia. The longer passage westabout via the Indian Ocean could become necessary for deliveries of Indonesian oil. On past experience the supplies themselves are unlikely to be cut off. Although, since 1946 the country has experienced revolution, civil war, 'confrontation', and the attempted *coup d'état* of September 1965, with its counter-coup, the Indonesian government has never permitted these episodes seriously to interfere with its valuable exports of crude oil to its main markets in Japan, Australia, and the Philippines.[20]

The prospects latent in the third type of conflict—great-power wars—are altogether more serious. One cannot plausibly indicate any specific danger to Australia at this point in time; nevertheless it would be foolish to discount the idea that future events will bring this country more definitely within the system of commitments of one of the great powers. In the South-East Asian and Pacific regions, Australia has already aligned itself firmly, possibly inextricably, with the foreign policies of the United States. So long as the United States continues to maintain self-assumed, substantial military and naval obligations in the region (for example, a willingness to undertake mainland engagements such as Korea and the Vietnam affair and the retention of a major fleet presence to support the *status quo* in respect of Korea, Japan, Formosa, the Philippines, Malaysia, and Indonesia), the results of Australia's alignment are held at arm's length. These countries do not touch directly the mainland of Australia.

But events may not permit Australia to maintain this relatively safe and pleasant posture in foreign policy. The United States, in a resurgence of isolationism, may withdraw; and/or other great powers may attempt to replace the American hegemony in the region. Looking well ahead one

[20] Confrontation did cut off trade in petroleum products to Malaysia from Indonesian refineries; also the oil exploration program of the Indonesian archipelago was set back some fifteen to twenty years by the country's long-term preoccupation with politics and internal disturbance (see Hunter, 'Indonesian Oil Industry').

can see that the third industrial power of the world, Japan, may well wish to fill the role. Its almost total reliance on foreign supplies of metallic ores, oil, and raw chemicals may compel Japan to become, once again, a major Pacific naval power. The Soviet Union is another long-run candidate, although at the moment it displays no strong interest in the area and no disposition to interfere in what is *de facto* an American bailiwick. Such permissiveness, however, may not last forever: consider the emergence, over a long period, of the Soviet Union as a naval and military power in the Mediterranean and the Middle East.

China constitutes a proposition of more immediate importance. It borders on South-East Asia. One must keep in mind both its traditional policy of controlling or strongly influencing border countries and its current, but let us hope temporary enthusiasm for the export of revolutionary fervour. As it develops its nuclear capacity, to become more effectively one of the front rank of the great powers, China may well enter, in the not too distant future, into a more active political and military phase in the region. Indeed, it seems almost certain that one of its primary aims is to resume its ancient hegemony over South-East Asia and the western Pacific.

Once Chinese forces intervene directly in political or military conflicts outside her national borders, Australia becomes a logical enough target: Australia is an active, not a passive, ally of the United States; it provides a useful base for certain naval and air force purposes; and it is the location of an important communications centre for American Polaris-type submarines. In short, parts of Australia, including some or all of the capital cities, could become at least ancilliary targets in a great-power conflict.

In some respects Australia offers a tempting target. Most industrial facilities and naval and air bases are heavily concentrated in the capital-cities areas.[21] It is otherwise a large empty continental mass with a 12,000 mile coastline defended by only a partial radar screen, a small fighter and medium-bomber air force, and a small navy principally geared towards submarine hunting. Of its tiny army, a majority of the fighting personnel is liable to be holding a line of defence somewhere in South-East Asia. If it should come about that allies are preoccupied elsewhere than in the Pacific and South-East Asia, Australia is in an extremely vulnerable position.

If we suppose that any great-power war in South-East Asia and Pacific

[21] G. J. R. Linge, 'The Location of Manufacturing in Australia', ch. 2 in Alex Hunter (ed.), *The Economics of Australian Industry* (Melbourne, 1963 and 1966).

regions will be conducted using conventional (non-nuclear) weapons then the defence of oil-supply routes will not be impossible although undoubtedly most difficult, even assuming assistance from naval powers such as the United States and Britain. The Soviet Union already has a very large fleet of ocean-going submarines, some of them nuclear-powered and therefore possessing indefinite cruising range. A substantial proportion is based on Pacific ports. If the Soviet Union were involved, the supply routes from Indonesia, which cause tankers to pass through and exit from narrow archipelagian straits easily patrolled by submarines, would have to be given up. Further, keeping in mind the development of the radar-scanning equipment it is now possible to install in ocean-going submarines, the passage of tankers from the Middle East across the Indian Ocean could, in the event, become unendurably hazardous. China is less of a danger in this respect. Most of its submarine fleet is of a medium range, conventionally-armed type which could operate in the Indian and Pacific Oceans only for restricted periods of time. So far, it has only two really long-range vessels armed with guided missiles armament (probably the missiles are of restricted range), although it is reported that more are under construction. However, it is clear that it has a fleet sufficiently large to harass the shipping approaches of the eastern and southern seaboards of Australia—a wide enough area of operation and difficult to defend even with the assistance of shore based aircraft.[22]

But one cannot rule out the possibility of nuclear attacks on Australia. The prospect of a generalised, nuclear war in the northern hemisphere appears to be held in check. The combined resolution of the United States and the Soviet Union to avoid such a catastrophe—so far as the two leading nuclear powers are concerned—has been effective so far. But as smaller powers build up their nuclear weapons and discover

[22] The U.S.S.R. has about 400 operational submarines, half of them ocean-going. About sixty are nuclear-powered with indefinite cruising ranges; the diesel electric types have a 20-30,000 mile range. About eighty of the ocean-going types are fitted with missile launchers: some are guided missiles with ranges of up to 200 miles; others, about thirty-five or more, appear to be equipped with ballistic missiles with ranges between 600 and 3,000 miles. A further thirty submarines are under construction.

The People's Republic of China has two Russian-designed conventional (diesel electric) submarines, armed with guided missiles, with a range of 28,000 miles; twenty-five medium range vessels (13-16,000 miles), also Russian designed, equipped with torpedoes and/or for minelaying; and seven short-range (up to 9,000 miles) submarines for coastal protection and training: R.V.B. Blackman, *Jane's Fighting Ships 1967-8* (London, 1967). Otherwise its fleet is composed only of destroyers, escort vessels, submarine chasers, etc.

reasons, possibly quite parochial, for using or threatening to use them, the situation becomes increasingly unstable.

Given Australia's geographical context and political affiliations, one must again take notice of China in this connection. China already has nuclear weapons. By 1967 it seems probable that Chinese technology will have advanced to the point where intercontinental missiles will have been constructed capable of delivering nuclear warheads as far as the south-eastern areas of Australia. Or Polaris type missiles could be launched from submarines at much closer range. Thus, in a great-power war in the South-East Asia and Pacific regions—even though this country may not be a main participant—Australian metropolitan areas, and strategic targets such as communications centres and tracking stations, could be the object of nuclear attacks. These attacks may well be by-products of a more general conflict—designed to discourage mobilisation or to eliminate useful military bases and repair facilities in this country. Alternatively—a daunting thought—Australia could be in the front line as the recipient of the *first* of such attacks if China chose to bombard an Australian city for the 'demonstration' effect or in an effort to blackmail the United States through the destruction or crippling of one of its less important allies.

As between conventional and nuclear wars it would be unwise to assume that participants will choose to keep to the former. Small nations, or emergent great powers such as China and Japan, may reason that the only way open to them to break the existing hegemony of another power in, for example, the South-East Asian and Pacific regions, is to employ the ultimate weapon. Also, it is arguable that if, by any chance, Australia's affiliations caused its relations with one of the other great powers to deteriorate to the condition where this country becomes an important although subsidiary target, then the further step, from using conventional weapons to employing nuclear warheads for the elimination of strategic bases and facilities, would be a small one.

Attacks on the mainland of Australia brought about by such circumstances of course go beyond simple interdiction of oil supply routes. If an Australian metropolitan area were devastated by means of a blanket nuclear attack the fallout would automatically render refineries, as well as other manufacturing installations, unusable. Further, the chances are strong that fire would totally destroy refineries and bulk storage capacity. For assistance, such areas would require tanker loads of products from other metropolitan areas of Australia or from other countries. Even if the employment of nuclear weapons were restricted to strategic targets

this probably would not assist the refinery industry to remain intact or in reasonable working order. The location of all Australian refineries (except one) and most bulk storage is on tidewater. This circumstance, combined with their vulnerability to fire, makes them excellent targets for missiles delivered from submarines or surface craft, whether carrying nuclear or conventional warheads. Destruction of a refining centre again would necessitate deliveries of petroleum products, by tanker, from another capital city or from outside Australia.

Summary on Defence Emergencies

The possibility that political and/or war-like episodes in various parts of the world could combine to cut off all of Australia's oil supply sources simultaneously, or interfere with all tanker routes at the same time, seems remote indeed. Even in the Middle East, Australia's supply source for two-thirds of its crude imports and notoriously one of the world's unstable areas, military or political events have never halted supplies to Australia in twenty years. (Admittedly, much of Australia's freedom from difficulty lies in its location on the eastern side of the Suez Canal.)[23] Nearer home in South Asia, South-East Asia and the Pacific it is difficult to detect, on this side of a five-year time horizon, anything more substantial than border incidents, local insurrectionist activity sponsored and led by nationalist, religious, or communist forces, possibly a civil war or two and a regional dispute over territory. All of these episodes are, characteristically, land engagements. With diplomacy and some military assistance they are kind of phenomenon which can successfully be isolated, as the British did during confrontation.

If we take a ten-year time horizon the prospects are less certain; and, at the same time, the kind of events which may occur offer grimmer prospects. Three factors important over this longer period are to be stressed: (i) the probable increasing proliferation of nuclear weapons among small powers and the apparent inability of either the United Nations or

[23] This bottleneck, it should be noted, is decreasing in danger even for West European countries. The oil industry responded effectively with alternative oil supplies and tankers in 1956 (although there was significant rationing and near dislocation of some industries). In 1967 the reaction was even more effective—supplies from Texas, Venezuela, and North Africa, plus a rapid build-up of tanker availability, met the problem. No rationing was required, only a higher price for extra transportation costs. The steps now being taken by the international oil industry—to build tankers in excess of 120,000 DWT and going up to 500,000 DWT in order to reduce their dependence on the Canal to insignificant proportions —will ensure that even this problem is removed or rendered negligible.

the great-power nations to control this development; (ii) the fact that tankers are around 38 per cent of the gross tonnage of all the world's ships and carry cargoes which constitute 55 per cent of the world's internationally traded goods calculated by weight; and (iii) the increasing size of the submarine fleets of the Soviet Union and China which, if ever they are to be used, will find their principal targets in oil tankers. Since the combined Soviet Union-Eastern Europe-China group of countries have only a tiny tanker fleet,[24] around 4 per cent of the world total, and a small movement of crude oil internationally,[25] about 6.5 per cent, they have less to lose than most countries from wars which become general and extend into substantial naval conflicts.[26] In short, oil tankers are the most strategic as well as the most numerous targets available for submarine fleets.

Solutions

Individually examined, each of these emergency situations liable to interrupt crude oil supply can easily be interpreted as remote possibilities. However, looking at them in the aggregate and considering their incidence across the world over a ten-year period, one becomes less confident: it seems likely that one or more of the emergencies will appear to disconcert Australia. To reinforce uncertainty and fears, especially for the second half of this period, there is also our more definite knowledge of the growing U.S.S.R. submarine capacity in the Pacific; the development of mainland China's nuclear and submarine capacity; the rise of Japan to be the world's third industrial power and the most important trading nation of Asia and in the Pacific; and the phased withdrawal of British naval and air forces from South-East Asia and the Indian Ocean. With these thoughts in mind it would be foolish to discount the risk that there will be, on some occasion, interdiction of the crude oil supplies of Australian refineries.

To achieve security in oil supplies we can think in terms of two desirable objectives. Each could be pursued separately but in a complementary fashion. These are:

(a) A short term solution, or solutions, to meet a temporary scarcity of oil caused by political upsets, nationalisation of oil fields, interrup-

[24] Jacobs, *World Tanker Fleet Review.*

[25] British Petroleum, *Statistical Review of the World Oil Industry 1966.*

[26] The same is true for all ocean-going shipping. The U.S.S.R.-Eastern Europe-China group operates only 8 per cent of the non-tanker shipping of the world (Chamber of Shipping of the United Kingdom, *Annual Report 1966-67).*

tions of supply routes due to a regional disturbance or a shortage of tankers caused by wars elsewhere. (*In essence, what is required for emergencies of this duration is storage capacity of some kind.*)

(b) A long-term solution, or solutions, to offset in a more permanent manner Australia's dependence on oil sources in the potentially unstable areas of the Middle East and Indonesia and to remove our reliance on a specialised form of transport, oil tankers, over lengthy and undefended ocean routes. (*To be free of these kinds of uncertainty over the next ten years calls for the discovery and development of further alternative sources of supply in order to spread the risks of disruptions; a more adequate supply of tankers under Australian influence or control; or, best solution of all, adequate reserves of indigenous oil so placed that lengthy tanker hauls around the difficult-to-defend perimeter of Australia are unnecessary.*)

SHORT-TERM SOLUTIONS

SINCE short-term arrangements depend on additional storage it is as well to know the present background.

On mainland Australia and Tasmania, seaboard storage capacity totals 53 million barrels—mainly holdings of petroleum products for distribution. At a consumption of 400,000 barrels per stream day (roughly the 1967-8 figure) and assuming all tanks are full, this quantity would last for 132 days or four and a half months. If inland storage is added, one can safely assume that total storage is of the order of five months' normal consumption. However, it is impossible to maintain a 100 per cent capacity in all storage at all times. Stocks must be distributed; and refills must take place at intervals which ensure that economic loads are transported. Industry sources suggest that, allowing for these logistic factors, aggregate inventories of products and crude are about 60 per cent of total storage capacity, that is sufficient to carry industry and private consumption for about three months.

Some of this seaboard storage is in crude oil awaiting manufacture into products. Practice varies as between refinery companies; but most have available crude oil storage sufficient for between four to five and a half weeks depending on throughput. But only occasionally is this storage completely topped up. Depending on the size of tanker employed, tanker schedules, and current production rates, the crude-oil tanks at any one time may be carrying anything from five to thirty days throughput. Thus,

in an emergency affecting crude supplies, some refineries might easily be compelled to stop production within a week or so. On the other hand, industry and the community could continue to operate for so long as supplies of products remained available—for about three months. With rationing of the private consumer, perhaps stocks could be made to last four months or more (the private consumer absorbs only one-fifth of all refinery production—see p. 3).

The most efficient method of extending the period for which stocks can be made to last in an emergency would seem to be an increase in crude-oil storage capacity. Crude is a cheaper medium in which to hold inventories. It is less liable to contamination, to the hazards of fire or to deterioration in quality. And it has the advantage that a sufficient size of holding will avoid the necessity of closing down refinery operations too soon if and when crude supplies are cut off. There are several possible methods of storing crude in bulk which deserve consideration.

(a) *Steel Tanks* of the pattern conventional in the industry can be used to store crude. Remembering that the larger the vessel the lower the unit costs of providing the storage, then tanks as large as are technically and commercially available should be selected. For the oil industry this optimum size is now in the region of 500,000 barrels. Each tank of this size would cost around $1 million to fabricate and erect. To gain thirty days' additional throughput for Australia at a consumption rate of 400,000 BPSD (12 million barrels in all) then twenty-four such tanks would be required—at a capital cost of $24 million. To gain sixty days' additional throughput forty-eight tanks would be needed—a capital cost of $48 million. Ninety days' storage would require a capital outlay of $72 million. And so on. Then there is the cost of the stocks to be held. At an average landed cost of foreign crude of $2.10 per barrel,[27] each 500,000 barrel tank would cost $1.05 million to fill. To fill twenty-four such tanks—thirty days consumption—would cost $25.2 million. To fill forty-eight tanks—sixty days' supply—would cost $50.4 million. And to fill seventy-two tanks—ninety days' supply—would cost $75.6 million. To summarise, the cost of buying an additional thirty days' crude inventory for emergencies is $49.2 million in all; for sixty and ninety days it is, respectively, $98.4 and $147.6 million dollars.[28]

[27] Allowing for discounts on Middle East crudes and recent price reductions for Indonesian oil (mid 1968).

[28] These figures can be expressed as per annum operating costs (Australian currency). Counting in the costs of maintenance, depreciation of the tankage, interest on the investment, interest on the funds outlaid for purchasing the crude, insurance, etc., the per annum cost of financing one of these 500,000 barrel tanks

Storage in conventional tanks may seem expensive. But a $49.2 million outlay to gain one month, and $98.4 million to gain two months of uninterrupted operation of the refining industry (and for the remainder of the economy which depends so much on vital supplies of petroleum products) is not a very high price. Then, if and when the need to cover emergencies recedes, the tanks can, if not required by the Defence Departments, become part of the normal seaboard storage and be integrated into oil company assets. However, conventional tankage is admittedly not an ideal solution in all circumstances. In a military sense these installations are easily spotted and are most vulnerable to bombing, sabotage and fire dangers.

(b) *Old Tankers* can be used as storage containers. However, old tankers are smallish and not very freely available at present (1968), although this situation is likely to change rapidly after a year or so. If the average size of the oil tankers available could be taken as 35,000 DWT (i.e. holding 250,000 barrels each), then forty-eight would be needed to provide 30 days' storage; ninety-six for 60 days' storage; and 144 for 90 days' storage. At $1.5 million per ship, which if anything underprices a 10-year old 35,000 DWT tanker,[29] then the cost of storing crude oil by this method is three times as great as it would be using conventional steel tanks on land. There are other obvious disabilities. Maintenance costs to keep out marine deterioration would be greater. There is the risk of oil leaking into coastal waters. And such vessels would be stationary, conspicuous, and vulnerable to enemy submarine or aircraft attack.

(c) *Reinforced Rubber Bags* in the form of 'Dracone' containers (nylon reinforced bags) may also be used to store crude oil. These could be located in tidal waters, in bays and lagoons around the coast, and have the advantage that they are mobile, can be towed from one location to another as required, and eventually moved alongside a refinery or discharging port. But they also have some of the disadvantages—vulnerability, contamination of tidal waters, and fire hazards—of old tankers. These Dracone bags can also be used on land if suitably supported in a watery medium (large excavations partly filled with water, for example). These bags, towed by tugs, are used by some oil companies as a cheap form of transport for oil products where there is no back-loading (they can be folded up and carried back to the refinery in the

is around $250,000. For twenty-four such tanks, thirty day's supply, the per annum cost would be $6 million; for sixty days' supply, $12 million; and for ninety days $18 million.

[29] *Shipping World and World Shipbuilder*, vol. 16; *Annual Review* 1967.

tug). Certain variations of the idea also are used for military purposes by many armies including those of Australia and the United States—bulk storage of products near operational areas in large pillow-case-shaped rubber bags which do not require support in a watery medium. The cost of purchasing and maintaining Dracone bags large enough to hold substantial quantities of crude, say 200,000 barrels, is not known. The additional costs of preparing suitable sites and/or anchorages would require estimation also. However, it does seem certain that this method would be much less expensive than using tankers and may well be cheaper, at least in the short term, than storage in conventional steel tanks.

(d) *Underground Storage* possibly should be examined. In some countries natural gas is stored in porous rock formations under impermeable cover. It is more difficult to store crude in this way — mainly because it is not compressible. A special study of possible storage areas of this type perhaps could yield some knowledge of appropriate structures. But our present lack of detailed knowledge of the stratigraphy of Australia makes it unlikely that appropriate, and conveniently located, strata could be found without considerable expense and the diversion of scarce talent. Underground caverns excavated from hard rock are used in Sweden for storing oil and products—again an unusual and expensive method of securing underground storage and probably not too feasible in Australian conditions. A depleted oil field makes very suitable storage since the shafts, pumps, separation plant, oil gathering lines, and valve equipment would already be in place. Further, oil so stored is almost completely safe from sabotage, fire, and nuclear contamination. A corollary of this point is that the oil in existing, proved reservoirs is stored in very suitable and economic conditions.[30] All that is required—a point to which we will return later—is a decision to leave the crude in the ground to meet emergencies.

LONG-TERM SOLUTIONS

(a) *Diversification.* One long-term solution is to diversify oil-supply sources to take in areas other than the Middle East and Indonesia — or

[30] Natural gas and certain unwanted fractions of refined crude are, in some circumstances, 'recycled' back into petroleum reservoirs. This procedure is used partly to maintain working pressures and thus delay the time when secondary extraction processes, such as water injection or pumping, are necessary to extract the crude; but partly also to locate the recycled materials where they can be economically stored for recovery if required at a later date.

rather urge the international oil companies which dominate the Australian refining industry to do so.

This policy is scarcely practicable. The nearest oil-producing areas beyond the Middle East and Indonesia are Libya (8,500 miles away) and Venezuela (8,000 miles). Also, each of these supplying areas is on the wrong side of the Suez and Panama Canals. For normal, emergency-free, purposes these two centres are too distant and therefore expensive in transportation terms. And the canals themselves—because they each can be the subject of an international dispute—offer one more possible form of interruption to supplies. Further, crude oil from these areas is expensive. The f.o.b. price for Libyan oil of 36° gravity (in U.S. dollars) is $2.10 per barrel as against the Persian Gulf price of $1.65 for comparable quality (and allowing for discounts on Middle East supplies). That is, Libyan oil is around 45 cents more expensive at source. Venezuelan oil is priced at $2.80 per barrel at source as against comparable Indonesian crude from Sumatra, 35.5° gravity, which sells at $1.62. Thus Venezuelan crude costs $1.18 more. Then there is the extra tanker freight to be added—about 25 cents per barrel for each area. There is no reason why Australia should not regard Libya and Venezuela as supply sources in certain kinds of emergency. But it would be a most expensive adjustment to diversify supplies by employing them in normal times. It should always be borne in mind that the (mid-1968) Australian landed price for foreign crudes—$2.10 on average allowing for discounts—is one of the lowest landed prices in the world,[31] mainly because of our relatively favourable geographical proximity to these two inexpensive sources of oil.[32]

In any event one should handle the idea of diversification of sources with some care. To refer to the Middle East, from which comes 67 per cent of Australia's crude, as one single source of oil is misleading. In the Persian Gulf there are in fact four large suppliers: Saudi Arabia (7 per cent of world production); Kuwait (6.7 per cent); Iran (6.2 per cent) and Iraq (4 per cent). In addition there are a number of smaller producers—mainly coastal sheikdoms around the coast of the Gulf such

[31] Hunter, 'Investment in Petroleum Exploration in Australia', *Economic Record*, vol. 42, no. 99 (September 1966).

[32] From the Persian Gulf—the dominant export trade to which all other crudes adjust their price—the freight rates (1967 pre-Suez) to various centres are as follows: Ras Tanura (Arabia) to New York 69 cents per barrel; to Yokohama 64 cents; to Melbourne 59 cents; to Hamburg 58 cents; to London 56 cents (International Tanker Nominal Freight Scale Association, *Intascale*: rates—large tankers). These pre-Suez rates began to reassert themselves by mid-1968.

as Abu Dhabi, Bahrein, Qatar, the Kuwait Neutral Zone, and others. They produce between them, independently of the larger producing countries, 3.3 per cent of world production. To give some idea of the contribution offered by even these minor Gulf producers, this 3.3 per cent is more than twice the whole production of Indonesia (1.4 per cent of world production in 1966); and one-third the production of Venezuela (10.4 per cent in 1966), the major exporter of the Western Hemisphere.

The Persian Gulf group of producers cannot be expected to act together for very long. To take Iran alone. Although a Moslem country it is an outsider in the ethnic sense, a foreigner, almost an enemy, to the Arab group. It is a bitter commercial rival of the main Arab oil-producing countries. In 1950 before the abortive attempt to nationalise British Petroleum (then Anglo-Iranian), Iran was the leading Persian Gulf producer. While it was struggling through its oil-nationalisation crisis and the subsequent negotiations to restore the fields and refineries to commercial production during 1951-4, the oil companies in Kuwait and Saudi Arabia, including B.P. itself, increased production rapidly to take over many of the markets formerly supplied from Iran fields. Iran would now positively welcome a shutdown of any of the Arab producer countries in order to restore its leadership in crude production. At present, through the National Iranian Oil Company, which has 5 per cent of Iran oil production, and through pressure on the consortium of foreign producers, it is struggling hard to secure new customers in all parts of the world including some Soviet bloc countries and India. It is an opportunist producer which would supply any country and has reserves which would permit a doubling of its output. In offshore exploration NIOC is currently combining with French, Italian, and Japanese interests in order to expand its share of total Iranian output.

Among the four main producers, politically speaking, Iraq is furthest to the left. A republic run by a military junta, it is the most likely to nationalise its oil fields. (Syria, through which passes 70 per cent of Iraq oil in pipelines to Mediterranean ports, is constantly urging this course of action on its sister Arab country.) As already noted, Iraq unilaterally took over from the Iraq Petroleum Company (a British-French-American concern) a large part of its concession exploration area. It is intended that the Iraq National Oil Company will go into partnership with Soviet Union and possibly French companies to explore these areas. Because of its anti-imperialist-cum-socialist views this oil-producing country is strongly distrusted by Saudi-Arabia, an ultra-conservative, dynastic monarchy. Kuwait also has reason to fear Iraq. In 1963 Iraq

laid claim not only to the disputed Kuwait Neutral Zone but also to the whole of this tiny but incredibly oil-rich sheikdom, and would have succeeded had not Britain rapidly moved a military defence force into Kuwait to defend the country. Also Kuwait and Saudi Arabia are both wary of the motives of the United Arab Republic (Egypt). It is not merely that its mildly socialist domestic policies are distasteful. Kuwait and Saudi Arabia have sound reason to believe that Egypt is attempting, by means of the infiltration of Pan-Arab nationalist ideas, and in southern Arabia by direct military assistance, to acquire political hegemony over all the Arab oil economies of the Middle East.

A further factor which acts to break up the solidarity of Arab policy on oil is the enormous excess capacity in crude-oil production which persists in the area. The Middle East accounts for over 60 per cent of world oil reserves (including the U.S.S.R.) as against its 27 per cent share of world production. The whole area has reserves amounting to seventy-five years of production in the ground at present rates of extraction. Saudi Arabia alone has eighty-six years of production, Kuwait has eighty-eight years, Iraq sixty-two years, and Iran fifty-eight years.[33] Further, all Persian Gulf countries are very far from being fully explored and, undoubtedly, much more is waiting to be found. In this respect, the Middle East is only the extreme case of a world-wide phenomenon. In the world as a whole the intensity of recent oil exploration efforts has created reserves which give almost 100 per cent excess capacity at present production rates. That is to say, if the demand existed and the marine transportation and pipeline facilities could become available, world output could be doubled very rapidly.[34] Excess capacity conditions have their greatest impact on Middle East producers. Persian Gulf crudes, since 1959, have increasingly had to be sold to independent refiners (and subsidiary companies) at discounted prices (for example, 30 or more U.S. cents off a price of $US1.59 for 31° crude in the period 1966-8). The Arab countries are therefore very much aware that they are selling their crudes in a buyer's market. And to confound them further, new areas of oil production have been developed in Africa more advantageously placed to serve the Middle East's largest market area, Western Europe. Nigeria has been particularly competitive. By mid-1967 it supplied 10 per cent of the British market. And Libya and Algeria, although both Arab countries, have not hesitated to urge the international oil companies into developments which caused them to

[33] *World Oil*, August 1966 and 1967 issues.

[34] Hunter, 'Investment in Petroleum Exploration in Australia'.

acquire 25 per cent of Western Europe markets—a sector which otherwise would have remained mainly with Middle East countries. Four years ago Algeria and Libya had less than 17 per cent of this market. Seven years ago they had less than 6 per cent.

In sum, whatever occurs in the Middle East (and in North Africa), whether it be insurrection, nationalisation, revolution or war, the international oil companies can always count on a few dissident or commercially-opportunistic countries to supply. Although the efforts of the Organisation of Petroleum Exporters (OPEC) have succeeded in securing a fairly united front of all these countries against the oil companies in respect of exploration conditions, concession terms, taxation of profits, and f.o.b. prices, this agreement does not extend to a common policy on embargoes. Each country is too afraid of repeating Iran's mistake of 1951-4 thereby losing markets to competitors, lowering production, and therefore their income from oil. The possibility of embargoes on oil supplies from the Middle East to Australia is a defence cliché particularly favoured by politicians when discussing the need for self-sufficiency in oil production. It is at best only partially true; and the prospect of a total embargo is almost completely bogus. Indeed, our 22 per cent reliance on Indonesian crude from one field and one loading port (Dumai in Central Sumatra) probably is more vulnerable than the 67 per cent reliance on the Middle East for a range of crude oils.

(b) *Control over Tankers.* In order to protect against serious emergencies, rather than seek diversification of sources of oil supply—an expensive method under normal conditions and of uncertain value in an emergency—a more realistic solution would be to secure the lines of supply by obtaining some control over the disposition of tankers on the runs from the Middle East and Indonesia to Australia. Given access to tankers and assuming there remain some well-defended or sufficiently-isolated ocean routes to Australia, even if some of the normal supply sources are cut off, there may yet be oil available, at a high price and transportation cost from such exporting areas as the Caribbean, Canada, Mexico, Texas, Nigeria, Algeria, Libya, and the Soviet Union. To this list may soon be added Alaska, Portuguese West Africa, Thailand and possibly even Western Europe.

Control in this context would normally be taken to mean ownership by Australian companies or by an Australian government line.[35] Therefore

[35] There were (mid-1967 registration) twelve tankers licensed to operate in the Australian coastal trade carrying petroleum products inter- and intra-state. All are registered in Australia, although eight of them are in fact owned by subsidiaries of

one question must be asked—is it possible to enlarge the Australian-owned fleet?

If by Australian-owned is meant Australian-owned and Australian-registered tankers, the possibilities of expansion into this trade are not actually discouraging for would-be Australian tanker owners. Australian-registered tankers, operating on overseas as distinct from coastal transportation of crude oil and products, would be subject to Australian-flag manning scales and crew-accommodation conditions. These factors place them at a disadvantage vis-à-vis foreign-registered tankers.[36] On the other hand crew-cost elements become decreasingly important as bulk carriers become larger and larger. That is, the vessels become capital-intensive; the major costs are then for the servicing of capital, depreciation, repair and maintenance, insurance, and port charges. This change in ship-operating cost patterns is most true of tankers; they are not only very large in size (thus securing considerable economies of scale) but are highly specialised vehicles which more than most can be designed to reduce crew numbers by means of mechanical handling, remote control techniques, and automation. (Hatches and valves are operated hydraulically; engines, cargo pumps, and capstans by remote control; and the engine room watch operations are simplified by automatic temperature and fuel control, lubrication, and recording.) Thus, while it is not unusual for a 20,000-25,000 DWT products tanker on coastal operation to have a crew of thirty-one to thirty-five (possibly more on the Australian coast), the large ocean-going tanker specialised for crude oil carriage and in the size range 80,000 to 300,000 DWT is likely to have a crew of only twenty-nine to thirty-four members.[37]

Providing an Australian owner buys abroad in those low-price ship-

international oil companies. On overseas operations there were only two Australian-owned (AMPOL) vessels, one registered in London, engaged in carrying crude from Sumatra to Australia. Occasionally one or two of the four Australian-owned tankers licensed for coastal operations also goes to Sumatra (Department of Shipping and Transport, *Australian Shipping and Shipbuilding Statistics* (Melbourne, 30 June 1967)).

[36] For example, when R. W. Miller's shipping organisation claimed preferential loading for Australian-flag vessels over company vessels on the coastal petroleum trade, it raised the freight rates for petroleum products to above *plus* 180 per cent of Intascale (for tankers of 20-30,000 DWT) and thus more than doubled the per barrel cost of coastal freights. Formerly the coastal petroleum products trade was operated by foreign-registered vessels under licence for this purpose. Frequently they had Asian crews (Alex Hunter, 'Some Notes on National Shipping Lines: The Australian Case', *Economic Record*, vol. 43, no. 101 (March 1967)).

[37] Hunter, 'Some Notes on National Shipping Lines'.

building countries which normally offer eight-year purchase terms at reasonable rates of interest (for example Japan, Britain, Germany, Denmark, Sweden, and Holland)[38] he is not at a very great disadvantage against foreign-registered tankers if he buys large vessels.[39] A would-be Australian tanker owner, if he wishes to avoid the expenses associated with employing an Australian crew, also has these alternatives: He can register his ship in a British Commonwealth port (London, Bermuda, Hong Kong, or Singapore, for example), according to convenience and his taxation situation, and thus be in a position to have an all-British crew (British, Australian, Canadian, and New Zealand working in British conditions) or a British-Asian crew (British-Australian-New Zealand officers and Asian crew members). Or he can register under one of the flags of convenience, Panama, Honduras, or Liberia, with a cosmopolitan crew and again a favourable tax situation.

However, despite the feasibility, not many Australian companies other than oil companies will be tempted into becoming tanker owners engaged in overseas trade. Large quantities of capital, greater than is typical in Australian shipping trades, are required even if the ships are bought in the cheapest markets abroad. A single 50,000 DWT tanker costs about $3.7 million, a 100,000 DWT vessel $8.5 million, and a 200,000 DWT about $13.6 million. The profits can be great for the independent owner but so also are the risks.[40] Until the closure of the Suez canal in 1967 rescued owners from the situation, tanker rates were running very low: at *minus* 65 per cent Intascale for single-voyage contracts and *minus* 36 and 46 per cent respectively for medium and large tankers on charter. 'Prior to the Arab-Israeli conflict the outlook for [independent] owners was bleaker than at any previous point', stated one authority on tanker freight rates.[41] The 1967-8 Suez crisis probably will give relief to owners for about two to three years only, after which the long-term trend to substitute very large economic tankers (200,000 DWT and over) will help re-establish some excess capacity and push down rates once more. In sum, the tanker market normally is fiercely competitive and risky. Rapid technological changes at present liable to develop surplus capacity render

[38] Ibid.

[39] It is commonly assumed that there are limitations and possible heavy import duties to pay when a foreign ship is brought into Australia to be registered here. But, provided the ship is destined only for overseas operations—not coastal transportation—it does not appear under present legislation to require permission of the Australian government or to be liable for import duty (ibid.).

[40] *Shipping World and World Shipbuilding*, vol. 16; *Annual Review*, January 1967.

[41] Jacobs, *World Tanker Fleet Review*, June 1967.

it more so.[42] Only those owners who can secure guarantees of medium- and long-term charters from oil companies are safe; and for them the rate of return on their capital is not high.

Possibly these very substantial risks could be overcome by government action. The government could purchase abroad a small fleet of large commercial tankers, place their management in the hands of an experienced shipping company and arrange an understanding with the oil companies that they would be engaged, permanently, in the Australian trade on normal long-term charter terms. In this way a substantial Australian-owned fleet permanently engaged on the Australian run and operating at standard commercial rates could be established. Profits would not be high; but the trade offers greater stability and certainty of return than, for example, the dry-cargo, liner trade. Properly managed, such a fleet should not require any significant operational subsidy. The initial capital cost is of course considerable, but not staggering, and is recoverable through depreciation on standard long-term charter rates. Twelve modern, turbine engined, 16-knot tankers of 100,000 DWT, purchased in Japan, could cost just over $A100 million. Operating on an eight-round-trips per annum basis to the Persian Gulf they could deliver nine million tons of crude per annum (180,000 BPSD)—or 45 per cent of the present Australian throughput.[43]

However, control over tanker tonnage need not mean actual ownership. It can mean simply access to tankers. The structure of company ownership in the international oil industry, and in the Australian sector of the industry, may already offer this. Consider the following facts.

At present there are 97 million deadweight tons of tankers in the world's ocean-going fleet (tankers of 10,000 DWT and over excluding government and naval ships). Of this 36 per cent are directly owned by oil companies, about 55 per cent are engaged in medium- and long-term charter, mainly to oil companies, and the remainder, around 9-10 per cent are in operations at single-voyage or few-consecutive-voyage rates. For most purposes the bulk of the fleet operating on medium- and long-term charter is under the control of the international oil companies for the duration of their charters. Perhaps rather less than 15 per cent and certainly less than 20 per cent become available for rechartering in any

[42] Z. S. Zannetos, *The Theory of Oil Tankship Rates . . .* (Cambridge, Mass., 1966).

[43] Six tankers of 200,000 DWT would be cheaper, about $A82 million, and more economical to operate. But there are draft constraints at Australian refinery ports. And phasing deliveries, each of about 200,000 long tons of crude, into storage at refineries could be difficult, even if multi-port discharges are practised.

one year; and less than 10 per cent in any half year. Thus about 70 per cent or more of the world's tanker fleet is, at any given point in time, controlled by the oil companies. Of these, the classic 'big seven' of the oil companies dominate the situation both as owners and charterers: Standard Oil of New Jersey, The Royal Dutch-Shell Group, Mobil Oil, British Petroleum, the Gulf Oil Corporation, Texaco Ltd., and Standard Oil of California. (The eighth largest oil company, Compagnie Française des Pétroles (TOTAL) is not a large tanker owner but it is a significant charterer of vessels.) They own the largest individual fleets. And, because they also control around 75 per cent of world oil reserves,[44] 57 per cent of the world's oil production and nearly two-thirds of refinery runs (excluding the Sino-Soviet bloc), they are the major charterers of oil tankers.

These same seven companies dominate the Australian refinery industry. They own 85 per cent of refinery capacity. Along with one other international company, Standard Oil of Indiana (AMOCO), they own and control 88 per cent of refinery capacity. The remaining 12 per cent is owned by two Australian companies. But each of these has close ties with the California-Texaco group (Caltex): one in connection with supplies of crude (AMPOL); and the other in its disposal of refined products (BORAL).

Thus the major owners and charterers of the world tanker fleet are also the main refiners for Australia. Normally, it would seem to be in the interests of the international companies to find the tanker tonnage necessary to maintain the operation of their Australian assets if this is at all possible. But one can think of situations in which a scarcity of tankers would compel the companies to choose between supplying refineries in Australia as against larger and more valuable installations elsewhere. Further, the parent oil companies are liable to be under strong pressure from their own governments to give priority to United States, British, Dutch, and French interests. In such circumsances an Australian government fleet would be advantageous. But in an emergency directly affecting the security of the ocean routes to Australia rather than a general scarcity of tankers, it is not obvious that the government ship would be any more useful than the company ship. Both are sinkable.

(c) *Indigenous Supplies.* The best long-term solution for the oil-supply problem is, of course, to secure self-sufficiency from indigenous oil fields. What can be said of the prospects here?

At present (1968) only 8-9 per cent of crude oil requirements come

[44] J. E. Hartshorn, *Oil Companies and Governments* . . . (London, 1962).

from Australian fields—about 7-8,000 BPD from Moonie and Alton fields in Queensland and 25,000 BPD from Barrow Island in Western Australia. However, the ESSO-BHP group has made a confident announcement, designed to alert the refining companies in Australia, that it plans to produce 240,000 BPD from its three Gippsland fields by the beginning of 1971. (It is safe to infer, although the recoverable reserve figure is not published, that one field will be a major producer by world standards and yield at least 100,000 BPD.) Thus, together with the probable 1970-71 production of Moonie and Alton (10,000 BPD) and Barrow Island (35,000 BPD), indigenous production will be around 57 per cent of the expected refinery throughput (500,000 BPD) in that year. This proportion of self-sufficiency, so soon to be acquired, looks very promising indeed (see Table 5).

Moreover, if one examines the prospects beyond 1971 in the broadest possible way, with no precise time horizon in mind, it would seem that Australia will be assured of self-sufficiency in crude oil. Contrast Australia with the United States. That country has a land area close to that of Australia; and, more to the point, a sedimentary basin area (in which petroleum thicknesses are found) of the same size. The United States produces 9,610,000 BPD for its refinery industry (and imports the remaining 2,240,000 BPD from Venezuela, Canada, and the Middle East). Thus United States production is twenty-four times Australia's present needs. Even allowing for the fact that 30 per cent of the United States production is uneconomic,[45] and would disappear if imports were admitted freely, it seems more than reasonable to suppose that, in time, Australia will find at least a few major fields (100,000 BPD or more) and be in a position to meet all its requirements from indigenous resources. Quite probably, when some major oil provinces are discovered, it will become a substantial exporter.

However, at this point in time, despite recent successes, the picture is not all fair. Before 1966-7 exploration drilling in Australia was all onshore and mainly inland. And, although ample strikes of natural gas were made, the crude oil discoveries were disappointing and high-cost.[46] For example, the Surat basin, whence Moonie and Alton oil comes, has so far been revealed to contain a number of small pockets of crude oil (and gas) but no large reservoirs of commercial significance. Survey and geological work does not suggest any marked improvement for the future of this basin. This Moonie and Alton oil is protected by a formula which

[45] Hunter, 'Investment in Petroleum Exploration in Australia'.
[46] Ibid.

requires refiners to pay about $US1.15 per barrel more than the price for foreign crudes (see below); it clearly is marginal production which could not persist without some such support price scheme; and reports indicate that the field, after four years' production, has already passed its 'flush' period. At Mereenie, in the Northern Territory near the geographical centre of Australia, some large structures containing both oil and gas have been found. Unfortunately, although the porosity of the oil sediments is sufficiently good, the permeability (capacity of the oil to migrate through the rock) is low. In time, fracturing techniques, including the employment of underground nuclear explosions, may open up the structure and assist the permeability problem. Even so, it is unlikely that the construction of pipelines to the main refinery centres at Adelaide (850 miles away and using 45,000 BPD), Melbourne (1,300 miles away and using 165,000 BPD), and Sydney (1,400 miles away and using 180,000 BPD) can be justified.[47] To make economic the transport of oil over these distances, that is to make it competitive with landed foreign crudes, the fields must be capable of producing throughputs for the pipeline in the order of 150,000-200,000 BPD. This would place them on the scale of a 'giant' oil field with reserves of at least 1,000 million barrels. This seems not too likely. A trunk pipeline to carry oil to a marine terminal 650-700 miles away on the north-west coast, for export markets, probably will become the more feasible prospect for Mereenie. Even so, a minimum flow in the order of 80-100,000 BPD would need to be produced from the structure for such a project to be viable. Barrow Island, the third producing area developed in recent years, although larger than the Moonie field is not particularly fertile. Numerous shafts must be drilled to exploit the field and permeability is rather low. Without protection, which as noted, gives a bonus of $US1.15 over the landed price of foreign crudes, it could not have come into operation.

Thus, during what may be termed the inland phase of exploration for oil the results were disappointing. The reserves discovered, during the years 1961-5, for example, were sufficient to meet only 2 per cent of the Australian demand for crude oil (or about one-quarter of the annual rate of increase in consumption). This is a poor success ratio.[48]

With the discovery of the Marlin, Kingfish, and Halibut oil-producing fields in the Gippsland basins offshore of Victoria, during 1966-7, and then further development in 1968, the situation changed. These discoveries pushed the success ratio to 17 per cent per annum for the whole of Australia. If more reservoirs of significant size were to be discovered,

[47] O.E.C.D., *Pipelines and Tankers* (Paris, 1961).

[48] Hunter, 'Investment in Petroleum Exploration in Australia'.

along with the further development of the Gippsland fields by ESSO-BHP, the 17 per cent success ratio could be maintained in the coming years. Such a speed of development would secure self-sufficiency by 1975. However, although such an outcome is possible, there are too many imponderables in the general picture to provide any degree of certainty.

On shore, little is known of the stratigraphy of possible petroleum-bearing structures in Australia. Outside of the relatively intensively-explored Gippsland and Surat basins the areas of ignorance are great—almost total. There may or may not be major oil fields in any given basin. To discover and delineate them—if and where they exist—definitive exploration work must be undertaken in the appropriate areas. But there are many possible oil-bearing basins; most of them are very extensive in area; and the progressive elimination of the unrewarding areas to find the substantial oil reservoirs could take many years.

Subsequent to the Gippsland strikes, hopes now tend to be centred on discoveries yet to be made offshore on Australia's continental shelf. Broadly speaking the same remarks apply. The continental shelf which surrounds the 12,000-mile coastline of Australia is among the largest in the world—it is certainly the largest continental shelf possessed by one country. Consider in particular the north-west and northern arc where it stretches 250 miles into the Timor Sea, occupies the whole 500-mile width of the Arafura Sea to the coast of Indonesian West Irian, and fills the Torres Strait between Cape York and Papua. As well as being large, it is so far uncharted. But, although offshore operations are much more expensive than onshore at the drilling stage, the sediments are younger and there is a stronger probability of finding petroleum-bearing sands.[49]

[49] One authority, L. G. Weeks, a well known petroleum-geologist consultant has, in an interesting article ('World Offshore Petroleum Resources', *Bulletin of American Association of Petroleum Geologists*, vol. 49, pt ii (July-December 1965), pp. 1680-93), classified the sedimentary areas of all the world's continental shelf up to the water depth 1,000 feet. He points out 'the geologic fact that practically all of the world's offshore oil and gas accumulations will be found in young sediments, that is, sediments of Tertiary or Mesozoic-Tertiary age'. And most significant, 'These young sediments have a record of much greater yield than older sediments. About 87-90 per cent of the world's proved reserves are in sediments of these young ages' (p. 1686). Australia's inland sediments are mainly of an older era. Among other interesting data he offers the estimate that Australia and New Zealand have 8.7 per cent of the world's continental shelf acreage containing possible petroleum-bearing areas. This estimate was made before the discoveries of 1966-7, which undoubtedly would raise the proportion estimated. Mr Weeks is reputed to have advised the ESSO-BHP group to explore in the Gippsland-Bass Straits basins.

Further, seismic studies over the sea can be completed relatively easily and, by comparison with surveys on land, yield good-quality results. The possible drilling areas can then be defined with greater certainty and speed. Thus, although the initial capital outlay is greater, the prospects of economic strikes of crude oil are also greater.

During 1968 nine or ten offshore rigs will be in operation around Australia, and a substantial program of offshore drilling is scheduled over the next two years by experienced operating companies off Gippsland and in the Bass Strait, off Southern Victoria, at Barrow Island, on Ashmore Reef 250 miles off north-western Australia, in the Bonaparte Gulf near Wyndham, in the Gulf of Papua, and off Queensland 150 miles north-east of Gladstone. It seems as though the oil companies are confident about offshore prospects. Some of them are prepared to state, privately, that the 17 per cent success ratio for Australia will be maintained and bettered in the years immediately ahead. Thus, although it would be most unwise to base firm defence plans on the prospect—oil explorers are unrepentantly optimistic: it is part of their professional attitude—perhaps it would not be too unreasonable to look for self-sufficiency around the period 1975-80.

However, even supposing Australia is well on the way to self-sufficiency in crude oil—which, to repeat, is not certain—there are one or two major blemishes in the situation as it is developing.

The first deficiency concerns the economics of crude-oil production in Australia. It may turn out that we pay a quite unnecessarily high price in the attempt to secure self-sufficiency. At present, as well as offering subsidies of up to 40 per cent for seismic surveys, exploratory drilling, test wells, etc., the Commonwealth government protects all indigenously-produced oil. Subsequent to a Tariff Board Inquiry in 1965 it was arranged that all refining and importing companies must absorb all oil produced in Australia *pro rata* to the size of their respective markets. Payment for this oil is according to a formula which adds to the average landed price of foreign crudes a quality margin (27 cents for Moonie oil, though the refineries claim this is excessive) and an 'incentive' of 75 cents per barrel. Thus Moonie oil costs the refining companies $US3.50 per barrel delivered at Brisbane, the nearest refinery port; and Barrow Island oil costs $US3.58 per barrel delivered at Kwinana (Fremantle). In the industry it is generally agreed that, after making due allowance for the superior quality of Australian crude oils but also for the discounts given on foreign crudes, which more than cancel out that advantage, the protection element in the indigenous oil now (1968) is around $US1.15

per barrel over the average, landed price of foreign crudes.[50] The idea is that this $US1.15 is an 'exploration incentive' — to encourage more investigation and exploration of possible Australia oil-bearing sands.

If all exploration companies were Australian-owned and operated this could well be a useful, even necessary, device to encourage the development of the oil industry. But, although Australian companies once were the main holders of licences to explore Australian petroleum tenements most of them failed to raise the considerable capital necessary fully to explore and develop possible areas in their tenements. Inevitably they were compelled to 'farm out' a part of the tenements to foreign companies. Thus, by 1965 Australian-held tenements constituted only 16 per cent of the total; jointly-held tenements (with foreign and Australian companies as partners) made up 56 per cent; and tenements held solely by foreigners were 28 per cent of the total.[51] Since then the position has moved even further to favour foreign holding of petroleum tenements.

Most active exploitation of oil areas is now undertaken by foreign companies or by companies which are a mixture of Australian and foreign ownership but with the foreign company usually finding the initial working capital and acting as the operator-explorer. This is a not-too-surprising phenomenon. The foreign-international companies are not only more experienced—they are economically viable. Instead of relying on the rather small Australian market for risk capital (and oil exploration is an extremely risky enterprise), they are in a position to obtain funds already generated by successful exploration and production overseas. Over two-thirds of the capital found by private enterprise for oil exploration in Australia is provided by foreign companies (see Table 7 for figures and comment). Consequently, the 'exploration incentive' is money largely wasted so far as the large international oil company is concerned. There is plenty of evidence to show that these companies, which, as well as being active are the most successful in discovering oil, are prepared to prospect offshore and onshore without any such incentive. There was extensive exploration in Australia before the Tariff Board was given its reference at the end of 1964 to consider protection for crude-oil production. Since then there has been no increase in the number of feet or wells drilled: indeed some decline occurred although seismic survey work has since intensified. And to give one significant example of

[50] The landed price of foreign crudes, discounted, ranges from $US2.05 to $2.10. Allowing a 27 cents advantage off the $US3.50 protected price, for its higher quality, the protective margin is then $US1.13 to $1.18.

[51] L. W. Williams, 'Exploration Outlook for 1966' *Australasian Oil and Gas Journal*, April 1966.

the irrelevance of incentives, the decision to survey and explore the Gippsland and Bass basins by ESSO-BHP was taken before the Tariff Board inquiry began—and would have continued regardless of any 'exploration incentive'.

TABLE 7 Oil Exploration Funds: Australia 1966

	$	%
Australian Private Enterprise Funds *	15,934,000	27
Australian Private Enterprise Reinvestment	3,618,000	6
Overseas Funds—North America	31,836,000	54
Overseas Funds—Other	7,432,000	13
	58,820,000	100
Plus Australian Government Subsidy	10,154,000	
TOTAL	$68,974,000	

* The Australian private enterprise figure contains some funds contributed by foreign companies investing in Australian registered companies.

Source: Bureau of Mineral Resources, Canberra, quoted in Petroleum Information Bureau, *Oil and Australia 1967*.

COMMENT: Of oil fields presently operating Union-Kern (U.S.A.) and Australian Oil and Gas Corp. share *Moonie* respectively 80 per cent and 20 per cent. Union-Kern is the operator. *Barrow Island* is owned by WAPET (Western Australian Petroleum Pty Ltd) and ownership of WAPET is in the proportion Shell Development (U.K.-Holland) 28.57 per cent, California Asiatic (U.S.A.) 28.57 per cent, Texaco Corp. (U.S.A.) 28.57 per cent, and AMPOL has 14.29 per cent. The *Gippsland* fields, two oil, one oil and gas, and two gas, are owned by ESSO Exploration and Production (U.S.A.) and Broken Hill Pty on the basis 50-50 per cent. ESSO is the operator. Lawrence G. Weeks (U.S.A.) has a 2½ per cent overriding royalty interest (see note 44).

Of the more important current and planned exploration for oil in 1968 consider the following: (1) the Alliance Group plans to drill offshore in Bonaparte Gulf. The operator is ARCO Ltd (U.S.A.) which with Canadian Superior and Australian Superior (Canada) have 52 per cent of the interest holding. Alliance Petroleum Australia N.L. has 12 per cent and Alliance Oil Drilling 36 per cent. (2) Australian Oil and Gas Corp. has an offshore drilling program 140 miles east of Rockhampton. The operator, Australian Gulf Oil Corp. (U.S.A.) will earn an interest so far unknown. (3) The Exoil-Transoil group is drilling onshore in the Nullarbor plain area. Continental Oil of Australia (U.S.A.) is the operator with a 25 per cent interest; Australian Sun Oil (U.S.A.) has a 25 per cent interest. Exoil Pty has 35 per cent and Transoil Pty 15 per cent. (4) Phillips Australian Oil (U.S.A.) is drilling in the Gulf of Papua 200 miles north-west of Port Moresby. Phillips is operator with 25 per cent interest; Canadian Superior Oil has 30 per cent; Sunray DX Oil (U.S.A.) has 25 per cent; and Anacapa Corp. (U.S.A.) has 20 per cent. (5) Burmah Oil Co. of Australia (U.K.) is drilling on Ashmore Reef offshore Western Australia. Burmah the operator has a 16.66 per cent share; Woodside Oil Co. a 25 per cent interest; Mid-East (U.S.A.) a 3·33 per cent share; and British Petroleum has 16·66 per cent. (6) Planet Exploration is drilling in

Bowen basin in south-central Queensland for oil or gas. It has a 100 per cent interest. (7) Delhi Australia (U.S.A.) and Santos Ltd are drilling in South Australia probably with gas in mind rather than oil to add to the already discovered Gidgealpa-Moomba fields. They share on a 50-50 per cent basis. The north-west corner of their tenement is being explored by the French Petroleum Company (France) to earn a 20 per cent interest. (8) WAPET is drilling offshore Barrow Island at the eastern and western ends of Exmouth Gulf in W. Australia and plans further drilling in the Perth, Canning, and Carnarvon basins in W. Australia. (WAPET ownership is noted above.) (9) Ampol and Japex (Japan) plan to drill offshore Proserpine in Queensland. On completion of the present program Japex will have earned a 50 per cent interest.

The large oil companies, because they are international, have their own special outlook. They come to Australia to explore because: (i) there are many miles of unexplored basins and continental shelf which offer the possibility of discovering a large commercial field (they are not interested in discovering small marginal reservoirs which require subsidy); (ii) Australia, although a small market, is growing steadily; (iii) any large field discovered on, or reasonably near, the coast is well placed to supply Japan, an already large market growing at more than 20 per cent per annum; (iv) it is oil company policy to divert cash flows to those parts of the world where they will yield the highest return (i.e. will find the largest reservoirs of oil) consistent with security; (v) Australia is a stable and secure country; and (vi) investment in Australia, although less likely to be as rewarding in yields of oil, is an insurance against political instability in areas such as the Middle East, Africa, and Venezuela, where their main reserves are placed. In short, the exploration incentive is an unnecessary inducement.

Meanwhile it has some unfortunate effects. It brings into operation high-cost fields, such as Barrow Island and Moonie, which otherwise could not meet the prices of landed foreign crudes. Once established, there will be an obligation to buy the crude of such fields for probably, ten to fifteen years of operation. This is not good economics. It is not particularly good defence policy either. If certain fields are strategically useful but when discovered are found to be non-economic, then a decision, on the merits of each case, should be made on whether it is worth while supporting their operation and exploitation by means of bounty payments on production. Such a selective policy is superior, financially and in its defence effects, to one which gives a support price regardless of location, defence effectiveness, and the economic burden thrown on the community. It is ironic too that the support price for Moonie oil and Barrow Island oil increases the cash flow of two companies which are predominantly foreign-owned—four-fifths and six-sevenths respec-

tively.[52] And if continued beyond 1970 will apply to around 60 per cent of Australian throughput which is 50 per cent owned abroad.

As more fields are discovered which are economic (that is, can meet the prices of foreign landed crudes), the production from these sub-marginal fields will begin to appear more and more anomalous. But there is an obvious solution to the problem. The Tariff Board is due to review the pricing arrangements and protection of indigenous crude oil in 1970. If it is clear that by that date, or before then, there are reservoirs additional to the ESSO-BHP Gippsland fields which will also produce oil competitive with foreign-landed crudes, then a recommendation to cease protection of indigenous oil would be in order. The advantages would be substantial. Automatically, high-cost fields will be excluded from commercial production and the efficiency of the industry will be determined by its capacity to meet foreign competition—which is as it should be. In time the indigenous crude-oil industry would be in a position to export. Sub-marginal fields would not be without their uses. If conveniently located they could be supported in production, as suggested, by a bounty applied on the understanding that the rate of extraction be low in order to conserve the main content of the reservoir for defence emergencies.

The Moonie-Alton and Barrow Island fields come into this class of sub-marginal producers which might merit bounties. Moonie-Alton, 190 miles inland from Brisbane has a naturally protected position. Barrow Island, 800 miles north of Fremantle on an exposed, unprotected coast-line, appears less desirable from the defence point of view.

Alternatively, the government could buy out these sub-marginal fields and maintain them on a caretaker basis for a defence emergency or until such time as sufficient commercial oil is discovered to make their protection redundant. Such a shut down, or partial production, would create

[52] A little arithmetic helps illustrate this point. (1) When it started operations from the Moonie field the AOG-Union Kern group originally offered its crude, delivered in Brisbane, to AMPOL (Refineries) for $US2.85 per barrel (Hunter, 'Investment in Petroleum Exploration in Australia'). It was refused. Presumably at this price the group expected at least to break even on the Moonie operation. The decision of the Commonwealth to give both quality *and* exploration incentive to make up the price of Moonie oil to $US3.50 therefore should give at least a pre-tax profit of 65 cents per barrel. This support is equivalent, assuming a production of 7,000 BPD, to a bonus of $US1.92 millions per annum—four-fifths of which goes to the American partner, Union-Kern. (2) If we assume the ESSO-BHP Gippsland fields, recently discovered and of considerable size, do not need a support price to make them competitive with foreign produced crudes, then every barrel produced under the support price will earn $1 or more for ESSO-BHP. After 1970-1 this promises to give a bonus income of $240,000 per day or $87.6 million per annum.

some material advantages for the economy. Assuming that by 1970 they are producing between them 40,000 BPD, then the economies to the refining companies (and to consumers of petroleum products) of *not* using these expensive crudes would be (on the basis of a $1.00 per barrel saving) around $US14.6 million per annum. Also, the refining industry would become more profitable and the public would obtain the revenues of a 42.5 per cent of net profit on company taxation.

The second major blemish on the prospective self-sufficiency of Australia turns on the remoteness of many of the potential oil fields of Australia. It may well occur that our largest petroleum resources are located along the north-west and northern arc of the continental shelf. In one sense these are convenient enough locations. Certainly they are better than most inland locations. Except for large flows of oil through a pipeline, 80,000 BPD or better, tanker transportation, where it can be used, is by far the most economical and flexible method available for bringing crude throughput to main refinery centres.[53]

But, in other respects, there are serious drawbacks. Although perhaps not a primary consideration in matters of defence, there is the relative cost of Australian-flag tanker operations from distant coastal or continental shelf fields. If the journey to the refinery is over 1,300 miles, a not unlikely event, then transportation of indigenous crude on Australian-flag tankers would be more expensive than to bring foreign crude 4,500 miles from Indonesia or 6,500 miles from the Persian Gulf. To take an extreme example. Carriage of crude on Australian tankers from Darwin to Melbourne (4,500 miles) would cost in the order of 95 US cents per barrel; carriage of crude from Kuwait to Melbourne (6,500 miles) on foreign tankers would cost 51 US cents per barrel on large-sized tankers or 58 cents on medium-sized tankers.[54]

In addition, remoteness along the Australian coastline creates a defence problem of considerable importance. Oil, where supplied to Australian refineries by onshore pipelines, is fairly secure. Supplied from the underwater collecting lines of an offshore field it is less secure but at least is contained within a circumscribed area easily monitored by anti-

[53] O.E.C.D., *Pipelines and Tankers.*

[54] Of course, under normal peace-time circumstances, substantial discoveries of oil on the north and north-west arc of Australia is of the greatest economic and balance of payment advantage. The most rational economic disposal of such crudes would be in exports to Japan, for which the freight on (foreign-flag) large tankers would be only about 45-50 US cents per barrel. Given the high cost of Australian-flag tankers, it would make sound sense to export Australian crudes to Japan while continuing to import foreign crudes from the Persian Gulf and Indonesia.

submarine listening devices and patrolled by anti-submarine vessels. But where the crude travels some 3,500 miles along the coast by tanker from, say, Bonaparte Gulf to Melbourne, it is altogether more vulnerable to enemy action assuming that Australia is involved in war with a foreign power which possesses ocean-going submarines. Anti-submarine monitoring devices and aircraft patrols would of course assist enormously in the protection of these vulnerable vessels. But a twenty-four hour vigil on each convoy along 3,500 miles of coastline would probably be an impossible drain on defence resources. If the coast were only partially defended, the ocean-going tanker bringing crude from the Persian Gulf, because it has more room to manoeuvre, could well have a better chance of survival than the Australian tanker embarking from a specified point and travelling a largely predetermined route around the continent.

SUMMARY AND CONCLUSIONS

ALL developed countries are heavily dependent on crude-oil supplies. Australia is no exception. Indeed, until such times as this country develops a significant degree of self-sufficiency it is more vulnerable than most, since over 90 per cent (1968) of the crude throughput of the refinery industry travels long voyages over exposed, virtually undefended (and difficult to defend) ocean waters. A variety of political, revolutionary, or war-like episodes—occurring in many parts of the world—can threaten and seriously interfere with Australia's crude-oil supply sources or, more likely, diminish effectively the size of the tanker fleet which links foreign oil fields with this country. Going beyond the generalities of defence hazards it is possible to be rather more specific and state that South-East Asia and the south-west Pacific will, in particular, generate military and quasi-military episodes which could have a profound and direct effect on Australia's defence. But one can also be reasonably certain that, for five years anyway, most problems in these areas to the north can be contained. They will most probably consist of nationalist and religious insurrectionist activity or communist-inspired uprisings against established régimes. Experience shows that (with one conspicuous exception, Vietnam) such episodes can be localised and kept down to minor dimensions by the national government concerned alone or sometimes with the assistance of the forces of friendly allies. Britain has played a significant role in these terms for the last twenty-odd years in South-East Asia and the countries bordering on the Indian

Ocean; and the United States presence in the Pacific and its involvement in Korea and Vietnam has likewise engendered stability or prevented the 'brush fire' wars developing into major conflagrations. Consequently, even in the most disturbed areas, normal international commercial intercourse, including that of the vulnerable oil trade, has continued with only minor interruption.

Beyond the next five years greater difficulties are discernible. As noted, three factors significant for defence in this part of the world, now developing, will reach their maturity by 1971-2: First there is the forecast departure of British forces from South-East Asia and the Indian Ocean. Second, the proliferation of nuclear weapons, to include such countries as China, India, Pakistan, Japan, and perhaps Indonesia, must be envisaged. Third, one must mark carefully the growth of Soviet, Chinese, and possibly Japanese long-range submarine fleets capable of carrying out interdiction operations on commercial vessels or attacks on mainland centres, by means of short- or medium-range missiles carrying conventional or nuclear warheads or by means of long-range Polaris-type missiles.

Australia could be a tempting target by reason of her close relationship with the United States (from which it is not easy to retire); and because the continental mass, and its ocean approaches, are not easy to defend. If ever hostilities go beyond the careful containment of pro-communist forces on the Asian mainland, or the dampening down of *confrontasi* and similar adventures, it seems inevitable that large naval forces will be the determining factor in a war of any dimension or duration.

Oil tankers, therefore, will be a primary target: their cargoes are vitally necessary for effective defence; and they are most vulnerable to submarine operations. Refineries, equally, are strategically most attractive targets. In Australia they provide admirable practice for short- or medium-range missiles. Nuclear warheads would make more certain, but they are not really necessary for, refinery destruction.

It would be difficult to assert that any one of the emergencies of the next five years of so, whether in distant Europe and the western hemisphere or in nearby Asia, will interfere seriously with the sources of crude oil, its transportation or its refining. At all stages the international oil industry is far-seeing, flexible, and adaptive, normally considerate of national interests and prepared to co-operate fully. Nevertheless, the array of possible episodes affecting oil supply surveyed earlier makes it appear wise to accept the probability that one or two such events will occur to create serious deficiencies or some short-term interruptions to supply.

The point was made in Part III that storage is the key to short-term emergency situations. Military and naval authorities should be prepared to investigate the possibilities of storing crude, or certain vital defence fuels, in nylon reinforced rubber containers. It is probably a cheap solution; and if active service for the armed forces in Asia is prolonged, or enlarged, there may be some useful practical applications of the idea for one or other of the services. There may be some advantage in using oil tankers for storage of crude—they can be moved around according to convenience. But they appear to be expensive containers and costly in maintenance. Underground storage is an interesting idea but probably requires an expensive deployment of scarce geological talent which would be better applied to the long-run stratigraphic problems of oil exploration. Consequently, conventional large steel tanks would seem to be the most satisfactory method of providing two-, three-, or four-month emergency storage for crude; especially since the construction of such vessels only anticipates what the oil industry itself must build eventually.

There is, however, one form of storage considerably more satisfactory than any of those mentioned. Moreover, it is available here and now if the government can nerve itself to a rather radical interference into the affairs of the oil industry. The most secure, most convenient and probably (in Australia anyway) the cheapest form of storage is the conservation of existing oil fields. Moonie-Alton and Barrow Island are the obvious candidates here since, if their production were halted (by withdrawal of protection), this action would not only provide emergency storage; it would relieve the industry and the economy, of a burden of high-cost oil production and pave the way for more realistic development of what promises to be an export industry of some significance.

Although the relevant emergencies are further off in time, the need for long-term solutions is the more important. One can forget any plan to arrange for a diversification of crude oil sources from the Middle East and Indonesia. It is an expensive solution which merely provides another set of risks equally great and uncertain in their incidence.

The provision of a tanker fleet is different. Since transportation will always be a weak link so long as a significant proportion of the crude throughput of the industry continues to come from overseas, there is a sound argument for creating a government-owned fleet of tankers. Providing the Commonwealth selects an efficient commercial company for management, and refuses to be dragooned into constructing the tankers in Australia, the operation of large (100,000 DWT) tankers on long-term charter to international companies is a relatively uncomplicated

business in which, though there may be little profit, there need not, on the other hand, be losses and therefore any need for operational subsidies. As the need for the tankers disappears they can be disposed of in a well-organised, world-wide, second-hand market. An alternative to organising an Australian tanker fleet is evolving a workable *modus operandi* between government and the international oil companies as to how tankers would be deployed in defence emergencies. But it may be that, because oil companies are international and must usually defer to the wishes of United States, British, Dutch, and French governments, such a solution cannot offer sufficient guarantees for Australia.

In any event, the discovery of indigenous oil resources to provide self-sufficiency is, by far, the most desirable solution. Australia has reason for self-congratulation when one looks at the long-run prospects. There are very large areas of sedimentary basins inland which, even if they do not provide high yields of oil, will at least give more than a sufficiency of natural gas.[55] The continental shelf is extraordinarily long and spacious, with younger sediments probably containing many productive thickness of oil sands. And, since most of the capital for discovery is found by international oil and exploration companies, self-sufficiency is likely to be provided at a small initial cost to this country (see Table 7). It is fortunate too that the first large sustained effort to find oil in Australia should have occurred at a time when the geophysical sciences of seismic, gravity, and magnetic survey of petroleum-bearing structures and the techniques of offshore drilling (all fostered by the international oil industry) have reached a peak of development which permits a wide range of oil prospecting to take place within a relatively brief time, thus shortening the preliminary period of trial and error.

Nevertheless complacency should be avoided. If self-sufficiency is obtained quickly, it is possible (unless protection policies alter) that it will be secured only at the price of sustaining considerable uneconomic production. Also, as noted earlier, self-sufficiency may be formal only. If most of the additional indigenous crude discovered in the next decade should be found on the continental shelves of the Arafura and Timor Seas then, in the defence sense, it is not much better placed than our present 23 per cent of supplies from central Sumatra. Further, it is most important to realise that additional substantial discoveries may not come for some years. In the recent history of oil exploration there are examples —in Egypt, Nigeria, and Canada—in which exploration went on continuously for twenty years or more in areas where oil men were virtually

[55] Hunter, 'Natural Gas in Australia'.

certain oil existed, before the substantive discoveries were made and became commercially significant. Good luck apart, oil exploration is a technique in which only scrupulous attention to geological detail and the systematic collation of large quantities of stratigraphic data will yield results. All of this requires time.

At the time of writing, Australia appears to be reasonably assured of a 57 per cent self-sufficiency of crude oil by 1971—with around 50 per cent well placed to feed into the two largest refining centres (containing 62 per cent of capacity) in Melbourne and Sydney. But 40 per cent or more of foreign-supplied crude still leaves a large gap to be filled if we are thinking in defence terms. If emergencies come on us rapidly in the next five years, circumstances could force on the authorities the distinctly unpleasant choice between making available supplies of petrol, kerosenes, and fuel oils to industry and agriculture or diverting it to the stocks of the defence services. Alternatively, there may be the equally agonising decision whether to run down defence stocks in favour of sustaining the maximum level of output of the economy.

It is for such reasons that policy should be formulated now to take account of the necessity to provide two, three, or four months extra storage of crude oil in Australia; and to consider whether it would not be wise to conserve some of the indigenous supplies we already have in sub-marginal fields such as Moonie and Barrow Island.

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