New Zealand After Nuclear War

THE BACKGROUND PAPERS

New Zealand Planning Council
PO Box 5066, Wellington

September 1987

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Background Paper 8

DISRUPTIONS TO TRANSPORT SYSTEMS IN NEW ZEALAND

by

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This is one of a set of background papers prepared, in consultation with the Nuclear Impact Study Team, from material provided by a wide range of contributors for a study of the impacts on New Zealand of a major nuclear war. Along with other sources the papers comprised the basis of the book ***New Zealand After Nuclear War****, by Wren Green, Tony Cairns and Judith Wright, published by the New Zealand Planning Council, 1987. The assumptions that the study was based on are explained in Background Paper 1, note particularly the assumption that New Zealand is not a target, and the variable assumption involving an electromagnetic pulse (EMP - for an explanation, see Background Paper 5).*

BACKGROUND INFORMATION

"Three things make a nation great and prosperous -- a fertile soil, busy workshops, and easy conveyance of people and goods from place to place." Anon.

Transport is integral to all aspects of our life. It supplies both the farmers and factories with raw materials and carries away processed food and manufactured goods for local use and the export market. Transport supplies the services by which we travel to and from our homes, and the services which make our homes and towns habitable (sewage and waste collection, emergency services). The transport industry provides employment for approximately fourteen percent of the labour force, including road carriers, bus operators, rental vehicle firms, taxi proprietors, freight forwarders, shipping and aircraft companies, vehicle assembers, vehicle maintenance, and those who service roads, ports, airports and railways.

This paper examines how transport in New Zealand would be affected by a Northern Hemisphere nuclear war and what some of the consequences would be for New Zealand and the people involved in transport. Road, rail, sea and air transport will be considered, as well as pipelines (one mode of transport often overlooked).

New Zealand's geographically remote position and dependence on overseas trade has made the country more reliant on transport facilities than many other countries. As a result, a technologically advanced transport system has been developed (Department of Statistics 1985, p. 9); one which has been very much shaped by the country's geographical features. New Zealand is long and narrow, with two main islands of more than 1600 kilometres in combined length, each with a backbone of rugged mountains, separated by a turbulent stretch of water. Despite its extended coastline, New Zealand has few natural harbours, although skilled engineering has ensured a network of useable harbours. The four finest natural harbours, Auckland, Wellington, Lyttleton and Otago are conveniently spaced down the length of the country.

Shipping was the mainstay of the country's transport system until the introduction of the railways, built in the 1860s with technology and expertise brought mainly from Britain. The railways opened up the country, and played the major role in New Zealand's transport, until surpassed by road transport in the 1950s. Since then air transport has increased in importance, particularly for long distance passenger haulage.

The situation today is one of a complex, interdependent system of road, rail, sea and air transport operated partly by private companies, and partly by government corporations, under restrictions and regulations set by government.

Road transport

Road transport is the most dispersed of the main transport modes in terms of structure and organisation, and is primarily operated by private companies.

There are over 1.5 million licensed motorcars, over 300,000 goods-service vehicles and over 5,000 buses and coaches. (Post Office vehicle registration records). With one car for every 2.2 people, New Zealand has the highest ratio of motor vehicle to population of any country other than North America.

There are 93,000 kilometres of formed, maintained roads. 50,900 km are sealed, and 11,555 km are designated as motorways or State Highways. Roading is the primary mode of transport over some of the country's main transport routes, e.g. those in the Nelson region, Napier to Taupo, and Gisborne to Rotorua.

Freight vehicles are predominantly fuelled by diesel. Cars use 49 percent of all transport fuels, petrol being the most commonly used, though just over 100,000 petrol-engined vehicles (6 percent of the car and light goods-service vehicle fleet) have been converted to CNG (compressed natural gas) while retaining dual-fuel capability, with the percentage highest among light commercial vehicles. CNG is only available in the North Island, within the range of the pipeline network. About 50,000 vehicles have been converted to LPG (liquified petroleum gas) which is available in both the North and South Islands.

Road is used in the farming sector far more than rail, as farms tend to be remote from existing railheads. Though much of that use is for the export market, transport is also used to get food to local markets. The food processing industry relies heavily on transport.

The New Zealand preference for private motor vehicles is reflected in a steady decline in public passenger transport. Census figures for 1981 show that 57 percent of the workforce commute to work in either their own vehicle, or as passengers in a car, while only 7 percent used public buses, and 1.7 percent used trains. Road is the most used mode of transport by private individual, except for long haul journeys, when air travel is preferred.

Rail transport

In contrast to the diversity of the road transport industry, rail transport is consolidated, being almost exclusively the province of one operator, the New Zealand Railway Corporation (NZRC).

In 1986 NZRC operated 271 diesel electric mainline locomotives, 181 shunting locomotives, 3 diesel electric railcars, 9 electric locomotives (scheduled to increase to 22 by 1988) and 83 electric multiple units.

The total length of rail open to all traffic has decreased from a peak in 1953 of 5,689 km to 4,266 km in 1986 (NZ Railways Corporation Annual Report). There has also been a rationalisation of stations and goods terminals which have decreased from 1,230 in 1952 to 610 in 1974 and 275 in 1987 (Ministry of Transport 1979, p. 97 and NZRC).

Diesel is the fuel used most by the railways, although electricity is beginning to gain importance. The North Island Main Trunk Electrification project is presently two-thirds complete and is on target for completion in mid-1988. There are over 100 steam engines in the country, fifteen of which are currently operating as historical interest vehicles (nine in the North Island, and six in the South Island).

Freight is the mainstay of rail operations, far outstripping passenger and commuter services. With recent deregulation of the transport industry, rail and road freight are in closer competition, though rail is a much more efficient user of fuel than road, and better suited to carrying bulk goods, i.e. coal, wheat and flour from the areas of production in the South Island to the areas of processing and consumption in the North Island, and salt from Lake Grasmere to all areas of the country.

Rail and sea transport are linked through the operation of the Cook Strait ferry service, operated by NZRC.

Sea transport

New Zealand's distance from its principal trading partners has resulted in a dependence on international shipping. Over ninety percent of the country's exports by value and a similar proportion of imports are carried by sea (Department of Statistics 1985, p. 11).

At 31 December 1985 the New Zealand register of ships exceeding 15 net tons listed 2,020 vessels. These included thirty-seven conventional cargo carriers, four container vessels, sixteen roll-on/roll-off carriers, four dry bulk carriers, five liquid bulk carriers, 204 fishing vessels, and 1,750 other vessels (including sailing vessels, barges, dredges, 1,641 of which were under 100 tonnes).

Coastal shipping currently uses 6.5% of the country's diesel supply. Diesel is used by the smaller ships and fishing boats, while the larger vessels use heavy and light fuel oils, and some diesel for better engine performance during tight maneuvers in and out of ports.

In 1986 thirty-eight international shipping lines carried trade to and from New Zealand, using over 110 vessels. For the year ending December 1985 there were 1,642 visits to New Zealand by ships involved with international trade - 204 visits by liquid bulk carriers, 304 dry bulk, 259 container ships, 724 conventional cargo carriers, and 151 roll-on/roll-off carriers. (Department of Statistics 1985, p. 36-37.)

In contrast, coastal shipping around New Zealand involved 16 vessels, of which

only four are all-purpose cargo-carrying - three New Zealand Rail ferries, and the privately owned *Spirit of Competiton* (1986/7 NZ Yearbook, p. 578). Coastal shipping concentrates on specialised bulk commodites, with carriers designed for specific trades. For example, there are four bulk oil tankers, and four cement carriers. In 1985 petroleum products accounted for 45 percent of coastal cargo loaded and unloaded, while the second largest commodity handled, cement, represented 15 percent of all coast cargo (Department of Statistics 1986, p. 8).

The ports handling the majority of New Zealand's coastal cargo in 1985 were Whangarei (1.6 million tonnes of coastal cargo loaded, mainly petroleum products), Port Taranaki (0.8 million tonnes), Westport (0.3 million tonnes) and the rail ferry ports of Wellington (0.8 million tonnes) and Picton (0.7 million tonnes). Wellington was the highest port of unloading with 1.0 million tonnes.

Air transport

New Zealand ranks amongst the leading nations of the world in terms of air transport per head of population (Department of Statistics 1985, p. 11). Commercial transport services in New Zealand are dominated, but not monopolised, by Air New Zealand. The industry is characterised by the involvement of the state at almost every level of aviation activity (Ministry of Transport 1979, p. 158).

The 1984 New Zealand register of aircraft included 1,873 land-based aircraft (34 owned by Air New Zealand), 18 amphibians, 12 balloons, 258 helicopters, 15 rotocraft, 286 gliders.

There are three international airports, Auckland, Wellington and Christchurch, four military bases, 26 national airports and approximately 150 private clubs and landing strips.

The primary use for air transport in New Zealand is for long-haul internal passenger movements. During 1984 internal passenger aircraft movements accounted for 88 percent of the total aircraft movements, while freight aircraft accounted for only 8 percent.

New Zealand's current supply of aviation fuel is believed to be 59,000 tonnes. This would be sufficient for 1,180 B747 flights between Auckland and Los Angeles, or 5,900 B747 Wellington to Sydney flights, or 14,750 B767 Wellington to Auckland flights, or 39,300 Friendship Wellington to Auckland flights.

Pipelines

Pipelines are used in New Zealand as a mode of transport for a limited range of products. The Natural Gas Corporation distributes natural gas by pipeline from the Kapuni field in Taranaki to nine undertakings between Auckland and Wellington, to the Otahuhu gas turbine station, and three major Taranaki dairy companies. Gas from the Maui field is transported by pipeline from Oaonui to Auckland. There are many miles of low-pressure gas piplines which are operated in urban areas by local authority gas boards. Oil companies operate pipelines from the waterfront to their storage depots.

Drinking water, storm water and sewage are also transported by pipe lines.

Transport fuels

The two main transport fuels are diesel and petrol. Diesel accounts for nearly 30 percent of present transport needs and petrol over 50 percent. The breakdown of users of transport fuels is as follows:

FUEL	%
Petrol	53
Diesel (road and off road)	19
Aviation fuels (internal)	10
Fuel oil (sea)	8
Diesel (sea)	7
Diesel (rail)	2
CNG and LPG	1

(Ministry of Energy, 1983)

New Zealand's self-sufficiency in transport fuels will peak in 1987/8 at 55 percent and decline thereafter to about 27 percent in 2004/5. (See Background Paper 6, "Impacts on Energy Systems in New Zealand".)

Stocks available at present: 160,000 tonnes premium gasoline (enough for approximately 30 days' use at present consumption levels), 20,000 tonnes regular gasoline and 135,000 tonnes diesel (25 days).

The New Zealand supply of oil products is manufactured and/or blended at the Marsden Point refinery and distributed by coastal tanker (fleet of four) to bulk storage at ports around the coast, from where it is distributed by road tanker. In addition 30-35 percent of all gasoline, 12-15 percent of diesel and 60-70 percent of aviation fuel is transported by pipeline from the refinery to Auckland.

LIKELY IMPACTS IF NO EMP

In the event of nuclear war in which there were no EMP, the major effect on transport would be the availability of fuel, lubricating oil, and imported spare parts.

Petrol could be produced in New Zealand at approximately 60 percent of the present consumption level, though the reliability of the Marsden Oil Refinery and the Synfuel plant could not be guaranteed after a few months (Energy Issue Paper). Diesel, which is more strategic in terms of freight carried by road and rail and coastal shipping, would be available to only 34-45 percent of present consumption levels.

There are two possible scenarios for disruption of the fuel supply. There would either be a gradual reduction in availability as some modules of the refinery or Synfuel plant ceased functioning, or there would be a sudden and catastrophic disruption if one of the major components in the system broke or became unavailable, for instance the catalysts used in the hydrocracker.

Lubricating oil for all engines would be in short supply, if available. At present almost all lubricating oil is imported. Stockpiles are sufficient for two to three months of current use. The New Zealand Refining Company advise they could be

made from local crudes, although they did not commit themselves to how long it would take to set up, or if all the necessary components are already in New Zealand.

This paper does not comment on how transport workers might react, other than to note that the workforce consists of a highly varied and diverse group. The independent owner-operator of a small truck might react entirely differently from the railway worker who is one link in a large organisation.

Impacts on road transport

There would be an immediate concern over fuel supplies. The public would not be slow to react to a real, or perceived shortage of petrol and panic buying could be expected, as occurred in November 1980 when the delivery of petrol to Auckland service stations was temporarily cut by an industrial dispute. The first two days of the stoppage saw thousands of motorists queuing to fill their petrol tanks, and many of the city's 230 service stations had little or no petrol left by the end of the second day (Fairgray 1981, p. 1).

There would be some reduced demand for freight transport, since there would be little point sending goods to ports or airports for export to the northern hemisphere. There might be an immediate increase in road usage as people tried to visit friends and relatives unreachable by telephone if the communications systems were overloaded. There would probably be serious overcrowding on public transport, as private users hoarded their supply of petrol.

Background Paper 6, "Impacts on Energy Systems in New Zealand", concludes that it should be possible to supply petrol and electricity in adequate quantitites for the changed economy for several months, though diesel would be in short supply.

The availability of liquid fuels would depend heavily on the depletion rates chosen for the Maui gas field and the various on-shore fields. Whatever decision were made on the allocation of resources to the refinery, petrol supply would be reduced to between 58-65 percent of 1987 levels, and diesel to between 34-45 percent of 1987 levels.

CNG and LPG are less vulnerable to breakdowns of the complex petrochemical plants and could be available at present levels.

Apart from fuel and replacement vehicles (bearing in mind that New Zealand does not manufacture vehicles) the critical components for road transport are spark plugs, tyres, and lubricating oil for the engines.

Tyres are made in New Zealand predominently from synthetic rubber, an oil-based product with a small amount of natural rubber added, both of which are imported. Under present driving conditions, tyres on cars last for 60-80,000 km (much less for heavy vehicles). In New Zealand 8,000 tyres are replaced every day. Due to deterioration by exposure to light, the few stocks already held in New Zealand have a shelf life of only two to three years.

Road maintenance would be effected as bitumen is currently made from imported heavy crude oil. Although bitumen could be produced at the Marsden refinery from local oil supplies (Background Paper 6) it is more probable that those limited resources would be allocated for other, higher priority uses.

Impacts on rail transport

Rail transport relies on one major operator, the NZRC. The effective running of the system would depend on the successful communication between the Corporation and the staff, and the co-operation of the staff.

As with road transport the demand for rail transport would be reduced without the need to transport goods for the export market. This would effect large numbers of the staff, who may not easily find alternative employment. The lack of imports would certainly effect the maintenance of rolling stock, track, signals and communication systems.

The supply of diesel would be a major problem, with a reduction in services envisaged. Electricity would not be an immediate problem, though supply could become erratic as months pass.

The availability of steel would affect the long-term running of the railways system, as it is required for the manufacture of spare parts and replacement of rolling stock.

Track maintenance would become labour-intensive if the fuel to run repair equipment became scarce. If the 2,600 bridges and viaducts were not maintained, the track would be rendered inoperable.

Impacts on sea transport

International shipping would be affected immediately. Vessels in New Zealand ports loading for departure to the northern hemisphere would probably stay in port, awaiting news, and money (which may never arrive) from the owning companies. On any one day in 1986 there were up to 32 merchant ships and 65 fishing vessels in New Zealand ports, with up to 2,600 crew. This number of vessels and their crew would cause severe congestion in the ports, especially if they were joined by any vessels in transit at the outbreak of nuclear war. The port facilities and the voluntary welfare organisations at the ports would have difficulty accommodating extra ships, crew members, and partly-loaded cargo. Perishable food stuffs could cause a problem if fuel was not available to run cool stores.

The major impact for coastal shipping would be the availability of fuel oils and diesel. Without access to supplies of overseas crude oils, it would become impossible to manufacture fuel oils once the remaining heavy crude oils had been used up, according to the Coastal Shipping Co-ordinating Committee. Diesel would also be in short supply, if available at all, after a few months. Coastal shipping currently uses 6.5 percent of the country's diesel supply.

The second major impact would be the availability of imported spare parts, mechanical and electronic. Most critical would be the spare parts for propulsion units, which are mostly made overseas from high quality steel, and for electronic equipment.

Impacts on air transport

As with shipping, international departures to the northern hemisphere would cease, causing a backlog of goods, passengers and aircraft at airports.

If aircraft in transit arrived, New Zealand airports would be faced with two major problems: parking space for additional aircraft, and a lack of facilities for decontamination of aircraft. (The Air Force has a bath in Whenuapai for washing down planes, but this is not large enough for commercial aircraft.)

The major impact on domestic flights would be the availability of aviation fuel (Avgas 100-130 and Avtur JE a-1) which, according to Air New Zealand, is currently imported with a minimum of 60 days' present usage in stock.

The other major impacts would be the lack of lubricating oil and spare parts, not many of which are kept in New Zealand. The maintenance of all communication and radio navigation facilities, and general aircraft maintenance, is dependent on the import of components from overseas. It is usual practice for an operator to hold a minimum of 30 days' supply of consumption items. In the absence of external trade, shelf items would be quickly used up and some aircraft would need to be cannibalised to keep other aircraft flying. New Zealand's fleet of civil aircraft would steadily decline in numbers.

LIKELY IMPACTS WITH AN EMP

The over-riding impacts of an EMP would be disruptions to the electricity supply and the malfunction of electronics equipment. The effect on transport would be the lack of production of liquid fuels and the failure of electronic control equipment, as well as an exaggeration of the impacts noted in the previous section. Even the fuel already available could be hard to use since "all movement of oil products within and between plants depends on electrically driven pumps, the loading of ships and the transfer of product would depend on restoration of power and possibly the repair to damaged motors" (Coastal Shipping Co-ordinating Committee).

Impacts on road transport

The concern over fuel availability would be justified. Petrol station stocks could last up to one week, depending on station size and location, at present consumption levels, though the petrol might have to be manually pumped out if the electronic pumping devices were damaged.

Petrol and diesel would not be produced again easily. The Ministry of Energy advise that "on the assumption that EMP destroys the control centre, the refinery would be inoperable in its existing form... Most of the more sophisticated equipment operation would be lost and only basic distillation equipment useable. This level of operation would only be likely after a considerable period of plant shut-down to carry out repairs and modifications."

The New Zealand Refinery Company note that some plant areas have turbine pumps that are steam-driven, so that production of fuel oils and bitumen might be managed on a limited scale, if enough steam could be produced.

Synthetic petrol would not be available as, according to the Ministry of Energy, "the Synfuels plant would stop suddenly under this scenario and would never start again."

However, CNG would become available if gas production were possible. Distribution

of CNG would depend only on the restoration of compression and filling machines, of which there are many throughout the North Island. Some could be cannibalised in order to repair others.

LPG would become available as soon as the surface production facilities were operating again, but this implies some restoration of reticulation in order to secure the gas. LPG supply to transport would depend on the continued operation of a designated coastal ship, electronic control systems at bulk storage depots, the operation of rail and/or tankers, pumps and filling equipment at service stations.

All vehicles with electronic ignition would stop suddenly at the time of an EMP. At present this is only about 5-10 percent of cars, mainly the newest ones, but if the event were to happen during rush hour, main arterial roads in cities could be blocked by the seized vehicles. Clearing the roadways would be complicated by lack of communications, street lighting and power. This would impede the movement of emergency personnel (especially if they were among the 10 percent with electronic ignition), fuels and equipment.

Impacts on rail transport

In addition to the problems caused by an acute shortage of diesel and lubricating oil, the impacts of an EMP would include:

- the failure of all electronic communications and signals;
- the failure of electrification due to damage to both NZRC facilities and the national grid;
- the failure of electric locomotives operating at the time of the EMP (electric locomotives not operating at the time are unlikely to be damaged);
- the failure of all computers;
- the failure of central train control;
- the failure of communciations with the Cook Strait ferries.

In all probability the diesel locomotives and ferry motors would not be immobilised by EMP, as sensitive electronic equipment, apart from communication antennae, are shielded by their outer shells.

If electric signals and telecommunications systems were damaged, a limited train service would be available using manual train control and no signals. This type of operation would be labour-intensive and would require skilled staff. It is possible to run trains without a signalling system by developing a train-ordering system. This would greatly reduce both the speed of trains and capacity of the rail system.

Impacts on sea transport

Although there would be very limited stocks of fuel oil to run coastal shipping, the Marine Division of the Ministry of Transport reports that the effect on the

actual ships would be minimal because:

- Ships of the merchant fleets of the world are built of steel, and floating in sea water are effectively earthed.

- Equipment controlling the most important machinery which could be affected by an EMP is below the main deck and is considered to be effectively shielded.

- Radio and radar have overload links in the aerial systems to guard equipment against electro magnetic pulses from lightning. These links may prove effective against a nuclear-induced EMP. Even if radio, radar and other navigation aids were knocked out, ships could still reach their destinations without them.

If, however, there was an EMP of sufficient strength and penetration to knock out shielded electronic circuits, the situation would become serious.

While it is accepted that an EMP could destroy electronic circuits, it is considered unlikely that the pulse could damage generators and pump motors operating at 220-240 volts.

Assuming all the above, the only ships which would be completely disabled would be the most up-to-date tonnage with the most sophisticated electronic control arrangements of which there are very few in this part of the world. Such ships would probably become derelicts and drift aimlessly with little hope of service, as without radio signals their position would be unknown. The crew would be unable to help themselves either, since there are now very few lifeboats with any sailing capability on board such ships.

If totally disabled ships were to drift onto the New Zealand coast there could be a problem with major oil pollution.The situation would become even more serious if a chemical tanker were to become grounded.

Lighthouses would be affected by an EMP. Their lack of operation would cause problems for any vessels still operational.

Impacts on air transport

Diminishing supplies of aviation fuel and disruptions to the communication system would seriously disrupt air travel. The commercial operation of aircraft is highly dependent on radio navigation aids for flight under Instrument Flight Rules, and on communication facilities for air traffic control and the co-ordination of payload. Aviation would have to be conducted according to Visual Flight Rules (VFR).

The National Search and Rescue services would also be effected by an EMP, since they rely on a communicaton network.

Impacts on the Meteorological Service

Shipping and aviation use information gathered by the New Zealand Meteorological Service when planning voyages and flights. The Service uses a continuous

international exchange of information - both data and derived products - and any disruption of this exchange would restrict weather forcasting services to about a 48-hour period.

If an EMP disrupted power supplies and communications the Service's activities would be reduced to making local forecasts for a few hours ahead.

Since most of the equipment used in meteorological observations is of overseas manufacture, there would eventually be a situation where the only observations possible would be rainfall (measured in locally-made rain gauges) and those made without instruments, such as those of cloud and visibility.

POST-WAR ADJUSTMENTS IF NO EMP

The adjustments that could be made by the users, suppliers and organisers of transport will be grouped under major option headings.

Rationing

A major adjustment of fuel use would be required. Unless the allocation of fuel oils, aviation fuel, diesel and petrol was controlled, these valuable resources might be squandered. If there was an effective governing body, some form of rationing would probably be introduced, though "there would be no point in rationing CNG and LPG to vehicles" (Background Paper 6) as there would be sufficient supply for all the vehicles that can run on these two fuels.

In order to ascertain available supplies and locations of goods essential to the transport industry, stock-taking exercises would be attempted. Resources in short supply (i.e. lubricating oil, tyres, batteries) could come under the scrutiny of controlling bodies and be subject to rationing.

Even without a central rationing system, voluntary rationing might occur, as it did during the 1980 Auckland petrol tankers strike when "some [service] stations imposed no limitations on the quantity [of petrol] they sold, some restricted customers to a certain amount, while others sold only to regular customers or account holders" (Fairgray, 1981, p. 1).

Regionalism vs centralisation

A resumption of regional importance might follow a reduced transport system, since "to some extent it was the limitations of transport that prompted the passing of the Constitution Act of 1852 which provided for the creation of six largely self-contained provinces" (Ministry of Transport 1979, p. 9).

Regional or provincial committees might organise the local distribution of resources better than central governing bodies, providing a mechanism for fair allocation between regions was possible.

Priority routes and goods

A reduced fuel supply would require adjustments to the patterns of transport movements. The most drastic adjustment would be the suspension of free market

operations, with government setting priorities for routes to be kept operational and goods to be transported.

For example, there could be restrictions on rail and air passenger movements; road blocks to keep roads clear of private traffic; priority could be given to the transport of fuel, food and certain manufactured goods.

Reduced transport services could mean high unemployment, or at the least high underemployment, particularly in railways and civil aviation, which would require adjustment on behalf of the unemployed and those responsible for finding employment.

Requisitioning

The government might adjust to shortages of "essential" goods by requisitioning them for priority uses. For example: stocks of fuel; light goods vehicles fueled by CNG and LPG; all the ships in ports, whether foreign-owned or New Zealand-owned; light aircraft.

Recycling

In the absence of imported goods, particularly spare parts, the recycling business would flourish. Vehicles could be reassembled; lubricating oil refined; lead (for batteries) collected. Employment prospects for the newly unemployed would develop.

A small amount of oil is re-refined presently in New Zealand, and though the usual additives would not be available post-nuclear war, their absence would be critical only for very high performance engines.

Alternatives

"Six months is a long time for a chemical engineer" (Jeanette Fitzsimons). Given a fairly stable society, and knowing their families were safe, chemical engineers should be able to develop alternative fuels, particularly where the technology is already known but not presently commercialised. For example, methanol could either be blended with petrol or used straight as a fuel. "Up to 15% blended with petrol would require no changes to vehicles or the distribution system" (Background Paper 6).

Methanol is also the key to making some agricultrual products useable as diesel substitutes. Tallow from meat works, butter, and rape seed oil can all be esterified with a small percentage of methanol to produce acceptable diesel substitutes, or to blend with diesel.

A South Island subtitute for CNG is biogas, produced from municipal waste, sewage, manures, agricultural wastes and especially crops. The technology is well established. Vehicle conversions and compression and filling equipment are as for CNG.

Wood gasifiers would be an option for some rural transport. They are built locally at present, though using them to run vehicles would involve some technical problems.

Some ships could adapt to using diesel instead of heavy and light fuel oils, if

they were not available from Marsden Point refinery.

The refinery would probably be able to adapt to produce aviation fuel though this might be a low priority. An alternative to aviation fuel might be found in locally-produced supplies of motor spirit which could be used in light aircraft adapted for the purpose. The refinery could also produce bitumen (presently made from imported crude oils) though it also would be a low priority. Road maintenance would probably revert to the earlier technology involving coal-tar, and the labour-intensive technique of filling holes with gravel. Any of the alternatives involving condensates at the Marsden refinery would be dependent on coastal shipping to transport the condensates from the Maui and Kapuni gas fields in Taranaki.

Whatever alternative fuels might be available, road transport in particular would be restricted by a lack of tyres, critical spare parts, and lubricating oil.

There are technologies already available for providing alternatives to lubricating oil: one involves anhydrous butter fat, the other fatty acids from tallow, though "the process technology to produce C-9 fatty acids [from tallow] is exclusively held by Emery Industries Inc., USA and thus would require its participation in any future development of synthetic lubricants in New Zealand." (Liquid Fuels 1983, p. 23.)

The steel mill at Glenbrook might be able to adapt to produce a limited output of high quality steels - this would have to be further researched.

There is always the option of reverting to "old fashioned" methods of transport, though these would not necessarily be adequate, even for a reduced post-nuclear war economy. It is comforting to know that the New Zealand Post Office still has a bicycle mechanic, and a fleet of bicycles. Although the mail would still be delivered, the local supply of bicycles would soon be depleted, and new parking problems would arise, as they did in 1941: "After the petrol cut-off on Saturday 13 December a Wellington dealer's home telephone rang incessantly and by Monday orders had been taken for every machine in his shop...There were new parking problems which some councils met by devising bicycle stands over the gutters; bicycle stealing increased." (Taylor, 1986.)

"Even horses re-appeared to some extent during the 1939-45 War, helped by the fact they had not totally vanished from the city streets, though any "back to the horse" movement faced severe limitations: it took four years to rear a working horse". (Taylor, 1986, p. 325.)

Rail enthusiasts suggest that steam engines in New Zealand would make a reappearance. Of the 100 steam engines in the country, 15 are currently in working order and 17 have "very good prospects" for restoration. This number could increase over the next ten years as the renaissance of steam engine restoration continues. Most of these engines would have the capacity to carry loads of between 500 and 1,500 tons, on the flat. A further 10 or so engines capable of smaller shunting jobs are available for restoration. It is possible that one region, close to a coal source, could be adequately serviced by steam engines. Steam engines used to be designed and built in New Zealand, the ability to do so may still exist.

There could be a resurgence of sailing vessels, though it would take a long time to develop the support industries necessary to operate sailing ships once the

stocks of imported raw materials were exhausted. Small wooden vessels could be built quite quickly, but they cannot be operated without sails and cordage.

The Marine Division of the Ministy of Transport suggests that "construction of the ships themselves would not be difficult provided size was kept down perhaps to the old scow size. However there would be a problem in securing material for sails. Synthetic materials are a hydrocarbon by-product so that need for a fabric could start another industry in Taranaki albeit on a small scale. On the other hand, the flax industry could find a considerable market for flax canvas, a long step back in time. Rope would pose similar difficulties, probably greater, since flax makes very poor rope." (Ministry of Transport).

POST-WAR ADJUSTMENTS WITH AN EMP

In addition to the adjustments discussed in the previous section, the country would have to adjust to the loss of some (if not all) electronic equipment, and the electricity supply. This would mean a loss of the refinery, and Motunui. The loss of electricity would have major impacts on engineering capacity.

Control and communications systems for railways, shipping and aviation (if it still existed) would have to revert to manual techniques. Radar and electronic aids for navigation would be replaced by a return to visual navigation aids.

An EMP would increase the need for adjustment at the same time as the country's ability to make the adjustments might be severely depleted.

Rationing would be all the more stringent, since there would be very limited fuels available.

PRE-WAR PLANNING OPTIONS

There are some areas where pre-war planning in New Zealand might soften the devastation caused by the indirect effects of a northern hemisphere nuclear war.

An advance fuel-rationing plan should make it possible to immediately conserve fuel stocks, and if perceived as equitable would do a lot to establish public trust in central authority (Background Paper 6).

A regularly updated inventory of "essential" stocks and their location would assist in post-war allocation, and stockpiling could be considered for certain of these essential items (particularly imported crude oil, diesel and catalysts for the Marsden Refinery and Synfuels plant).

Determining a priority of the routes (road and rail) to be maintained, the goods to be transported, and the ports to be serviced could prevent initial confusion and conflict of interests in the chaos expected after a nuclear war.

Recycling industries should be encouraged, and the public made aware of which materials it would be advantageous to save.

Pre-planning, including taking an inventory of the stocks of kit components, and the numbers and location of trained installers, could assist a mass conversion of vehicles from petrol to CNG.

Any planning now for research into alternative fuels would be invaluable, particularly as "even in the best scenario, transport fuels will be a major problem when local gas and oil fields run out round about the turn of the century" (Background Paper 6).

Knowing before a nuclear war how to adapt manufacturing industries to produce essential items could hasten recovery if such an event occurred.

Many of the older, more manual technologies and operating skills that have been abandoned in favour of high-tech innovations would be within New Zealand's post-nuclear war capability. The necessary return to these older technologies would be greatly facilitated if information was available on people who understood and could teach these older skills. For example, sail-making, boat-building, manual navigation skills, manual communication systems, horse-training for cart work.

Some planning for protection against EMP could prevent total chaos after a nuclear war. Four ways to protect against an EMP are:

1) Metal shielding of vulnerable equipment.
2) Stockpiling sufficient spares to replace damaged equipment.
3) Ensuring sufficient vulnerable equipment is disconnected, to hasten restoration of skeletal system after the event.
4) Build new equipment with EMP sensors installed which turn off the equipment before an EMP can cause damage.

FUTURE RESEARCH IDEAS

A major area of concern is the amount of manufactured parts that are imported. An analysis of, for example, engine components could be made to ascertain what would be essential after nuclear war, and what could be manufactured in New Zealand.

The New Zealand Dairy Research Unit and the Liquid Fuels Trust Board have done some preliminary work on substituting anhydrous butter fat and tallows for lubricating oil. More work could be done in this area.

Work could be done on the viability of making CNG conversion kits in New Zealand (prototypes are already available), and of converting diesel engines to CNG and LPG. (Kits do exist, but there are problems with them.)

If Australia could be persuaded to do a similar study, there would be information on what would be available from trade with Australia after a Northern Hemisphere nuclear war.

Research could be made into the viability of growing a rubber plant in New Zealand - not the Hevea tree which is native to equatorial rainforests, but the guayule shrub, native to upland plateaus in Mexico and Texas with subtropical-temperate climates. In 1910 it provided 10 percent of the world's natural rubber, and could become commercially viable (National Academy of Sciences 1977, p. 1). The Australian Department of Agriculture is investigating guayule as a potential crop for west New South Wales (Milthorpe 1982).

CONCLUSIONS

1. Transport is integral to all aspects of our life. Any disruptions to the system post-nuclear war would affect all aspects of society.

2. Demand for transport would reduce without imports, and the loss of export-related industries.

3. Under the assumption that there would not be an EMP all modes of transport could continue, though their level of operation would depend on the supply of fuel. "Even in the best scenario, transport fuels will be a major problem when local gas and oil fields run out round about the turn of the century" (Background Paper 6).

4. If there *was* an EMP, production of petrol and diesel could not be guaranteed, though CNG and LPG are more likely to be available.

5. There are two possible scenarios for disruption to the fuel supply. There would either be a gradual reduction in availability as some modules of the refinery or Synfuel plant ceased functioning, or there would be a sudden and catastrophic disruption if one of the major components in the system broke or became unavailable, for instance the catalysts used in the hydrocracker.

6. Electronic control equipment and communication systems would be seriously affected if there was an EMP, requiring a return to manual controls and navigation procedures, which may or may not still be available.

7. Road transport, which "is a less efficient fuel user than rail", would be vulnerable to fuel shortages, and lack of tyres, batteries and lubricating oil.

8. Diesel shortages would affect rail transport, though electricity should be available on the North Island Main Trunk Line (scheduled for completion in 1988) if there was no EMP. Between 10 and 30 steam engines could be available, possibly enough to service one region.

9. A lack of fuel would affect coastal shipping, preventing a resurgence of coastal shipping as a replacement for land transport.

10. Civil aviation would be affected by an acute shortage of fuel and spare parts, including tyres and lubricating oil.

11. Rationing of fuel, lubricating oil, vital spares and raw materials is likely to be the only option for conserving non-replaceable transport resources.

12. Traditional patterns of transport movements would alter. A strong, organised government might consider suspending free market forces and instead setting priorities of routes to be served and goods to be transported.

13. Regional or provincial committees might be better able to organise the local distribution of resources than central governing bodies, providing a mechanism for fair allocation between regions was possible.

14. In the absence of imported goods, particularly spare parts, the recycling business would flourish.

15. Many of the respondents to the study were strongly of the opinion that "Kiwi ingenuity" would win the day, and we could develop alternative fuels, or revert to older technologies. While some alternatives may be found, particularly if there is forward planning, the transport system would always be vulnerable to the lack of imports currently coming from Northern Hemisphere trading partners. It would be useful to identify vital spare parts and alternative sources for them.

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