Giants Can Fade:
Hazards of Nuclear-powered Shipping

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"You have to be ready for what can *happen, not what you think is* going to *happen".*
— Capt. James Ellis jr, USS *Abraham Lincoln* (nuclear-powered aircraft carrier).
NZ Herald 9 Nov 1991 [our emphasis]

The Nuclear Nightmare – Incredible?

A nuclear-propelled vessel in Wellington or Auckland harbour suffers a reactor meltdown: the pressure vessel of the reactor bursts, such minor containment structures as ships have are promptly breached, and the radioactive contents are spewed into the environment. It's like Chernobyl [1]. Although the reactor power is about 80MW, not 3200MW, and the likely accumulated inventory of radioactive materials roughly in proportion, the close proximity to a city compensates: dilution and spreading-out of airborne radioactive materials before they reach a large population are far less, as is warning time for evacuation. Indeed, evacuation is essentially impossible.

The government admits that such a mishap is conceivable, but they promise it won't happen; it's too incredible.

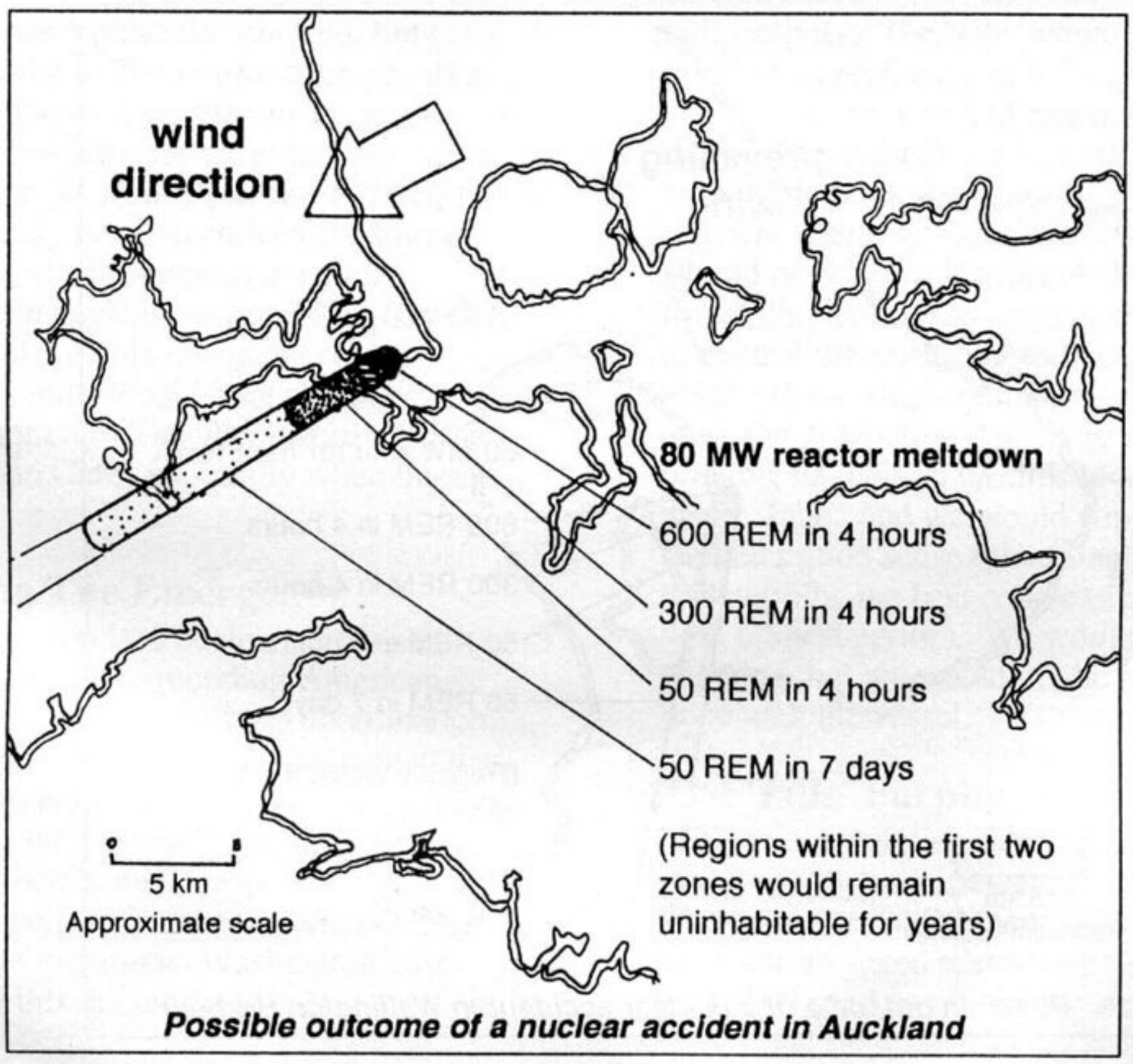
Some Think Of It

In the Soviet Union, the 1986 Chernobyl reactor explosion was the stimulant for some planning about nuclear ship reactor mishaps. Authorities at the northern port of Murmansk on the Kola peninsula decided they had better prepare for the worst. They drew up a contingency plan [2] based on the assumption that a ship's reactor blew itself apart while in port. They calculated 65,000 casualties among the half-million inhabitants of Murmansk. Of these, 26,000 would be exposed to serious doses of radiation, and about 8,000 of these people would probably die from the effects within the short or medium term. Health hazards would extend 1,000 km downwind from the accident site.

In contrast, New Zealand government officials have never described publicly the consequences of a major nuclear accident.

The whole issue is a political hot potato – so much so that a key US Navy document dealing with nuclear accidents is labelled "For official use only. Special handling required – Not releasable to foreign nationals". We have obtained a copy of this secret document [3] from sources in the USA.

Scientists at Auckland University have calculated radiation doses which could arise from a severe nuclear reactor accident in a New Zealand harbour: several years ago one of us (RM) and colleagues in the Department of Planning computed simulations of radioactive dispersion from such an event. Calculations like these cannot be very accurate, but they give a good idea of how serious the consequences of an accident could be. Expected radiation doses at different distances from the accident site depend on many factors such as how the radioactive material is apportioned between air and water, the weather pattern at the time, and the local terrain. One possible pattern of fallout is shown in the diagram.



Possible outcome of a nuclear accident in Auckland

Radiation Doses

- 600 rem kills most people within weeks from radiation sickness.
- 300 rem produces promptly (and acutely in both senses of the term) radiation sickness in all, killing about 10%.
- 50 rem produces no prompt radiation sickness but increases the number of malformations, cancers, and genetic defects later.

The USA Environmental Protection Agency has recommended evacuation of districts where fallout is enough to commit people who stayed there to an extra dose of 5 rem over the rest of their lifetime.

{A new unit of radiation dose is used lately:
1 sievert (Sv) = 100 rem.}

This scientific report was unofficial, but was sent for comment to the government's experts at the DSIR Institute for Nuclear Sciences, who offered no substantive corrections. The Auckland Regional Authority therefore adopted this hazard estimate for its most detailed report on planning for hazardous activities [4]. The Auckland map shown here is from that report; the Wellington map is simply a transposition of that, to the same scale.

The actual pattern of doses after a reactor melts itself depends on many influences, most of which are obvious e.g. wind speed & direction, atmospheric layering if any, terrain, trees, buildings etc. The particular case displayed is for a slow steady wind but not an extreme temperature-inversion.

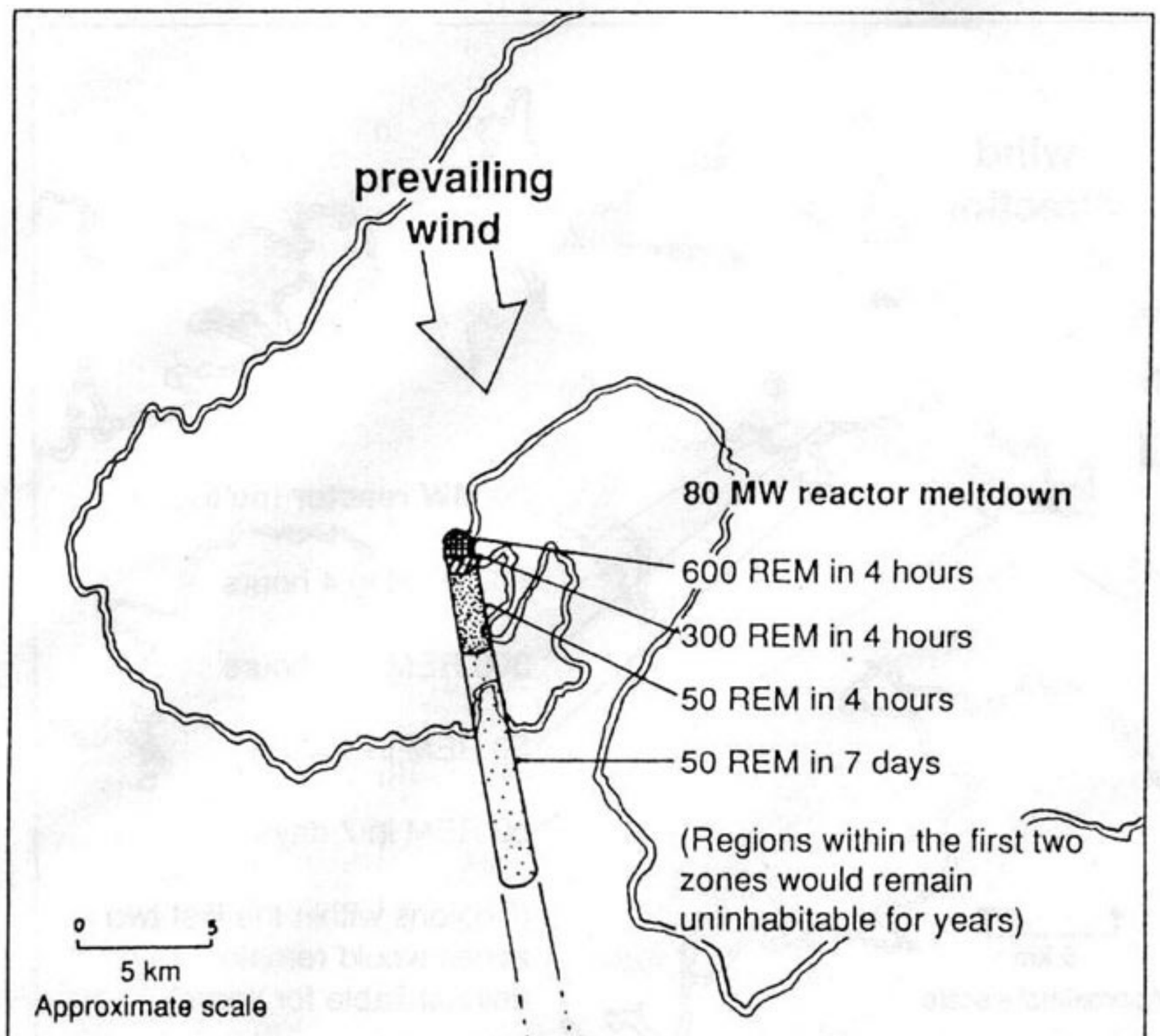
In the past, conditions for nuclear-powered ships' visits to New Zealand ports were laid down in an official document known as AEC 500 – the so-called NZ Code for Nuclear-powered Shipping [5]. The chief of the Ministry of Transport for the northern part of the country, who is an experienced mariner, has stated at a public seminar on hazards in the Auckland region that AEC 500 does not deserve the title 'code' and is of very little use.

Much of the document was concerned with visits by hypothetical nuclear-powered merchant ships. The real visits of nuclear-powered warships circumvented most of the code's requirements under a let-out clause which allowed the government to authorize military visits at will. The document assures readers that nuclear-powered vessels from the U.S. and Royal navies are subject to detailed safety assessments by highly qualified independent safety review authorities, but no substantiation of the adequacy of these assessments is available because the New Zealand government is not privy to any certification information.

Official contingency planning has been restricted to AEC 500's case of a "reference accident" in which only a very tiny fraction of the reactor's radioactive inventory is released into the atmosphere. Even so, planning to cope with the consequences of such a "reference accident" involves at least 10 central and local authorities, ranging from the Ministries of Health, Transport and Civil Defence to the harbour authorities, Police, St John's Ambulance and Fire Service. Evacuation within 0·6 km is envisaged in this old contingency plan, whereas the independent calculations indicate the need to consider evacuation for distances of 20 km or more. This would be very difficult to accomplish in the time available, especially for Wellington.

No scientific basis for the 0·6 km limit has ever been revealed; some have inferred that it had none but was instead based on a desire to fit nuclear vessels into the Devonport (Auckland) naval base, and downtown Auckland piers, without conceding the fact that this would introduce a serious hazard to many hospitals, schools, etc. The denial is closely analogous to that of the designers and administrators of the Chernobyl-type (RBMK) reactors – only a tiny minority of the core was postulated to be released in the "worst credible" mishap [1].

When a nuclear-powered vessel of the U.S. or Royal Navy visits a foreign port, the US or UK government



Possible outcome of a nuclear accident in Wellington Harbour

normally sends what is known as the "Standard Statement" certifying safety aspects of the design, crew training and operating procedures of its nuclear propulsion plants. The US government refuses to make its Standard Statement public; however we have obtained a copy and found that it is virtually identical to the British statement. The Standard Statement makes certain guarantees, but it states categorically that no technical information on the design or operation of nuclear reactors will be made available to the government hosting the visit.

Compensation ?

The settlement of any claims arising from a nuclear accident is consigned to be dealt with through diplomatic channels. During the multiple protests in 1976 following the Muldoon government's announcement that they intended to welcome nuclear-propelled vessels into our harbours, much was made of the US congressional policy declaration [6] that in the event of damage from such a vessel the US would accept "absolute liability". This legal term, systematically used with intent to mislead, actually means only that the requirement to prove negligence would be waived. The declaration's essential statements are merely "it is the **policy** of the United States that it will pay claims ... **proven to have resulted from** a nuclear accident involving the nuclear reactor of a United States warship ... the President **may** authorise, under such terms and conditions as he may direct ... payment ..." [emphasis added]

This makes very little difference to any prospects for collecting compensation, because the vast majority of the potential damage is in the delayed categories, at least 6 months and mostly many years or even generations later, and cannot, in general, be "proven to have resulted from" any one cause. Waiver of the requirement to prove negligence is thus practically irrelevant. But the term "absolute liability" misled many in 1976–77 into thinking that the US would pay unlimited damages – very far from the truth. The notorious Price-Anderson Act (1957), which the US congress has repeatedly renewed, limits to a few cents in the dollar the total compensation payable by that government even to its own citizens in the event of a very severe nuclear mishap; are we to believe that the US government would be far more generous to 'foreign nationals'? One can readily understand why the Port of London authorities refused admission to the (since decommissioned) German nuclear-powered freighter *Otto Hahn* , stipulating lack of suitable insurance cover.

In any case, of course, money could not compensate us for devastation of a major city. The watchword must be 'Prevention Is Better Than Cure', especially when there is no cure.

Information During The Emergency

An Australian investigation into nuclear ship visits concluded [7] that the secrecy surrounding American contingency plans could cause problems in coordination, should an accident occur. The Australian parliament was informed by its Department of Defence that there was no detailed information available on what the U.S. Navy would do if they had a nuclear mishap in an Australian port. Some details are spelt out in Instruction 3040.5B from the Chief of Naval Operations, Washington. We have obtained a copy of this document [3]. It acknowledges the possibility of a serious accident occurring while a vessel is in port, contaminating the environment and requiring some evacuation of the public. The U.S. Navy is concerned that "because of public reaction, even a minor accident could have a serious impact on the Navy and on the operation of its nuclear-powered warships throughout the world". The Commander in Chief of the United States Pacific Fleet has issued special instructions [8] on how to handle the media when an accident occurs. Situations aboard ship are divided into seven categories, one of which is "Media embarked. Media not aware of circumstances as yet, will acknowledge basic facts as appropriate". Priority is given to establishing security in order to protect classified information.

When the detectable level of radioactivity is relatively low, local authorities are eventually informed through the Chief of Naval Information in Washington. The ship's captain himself has no instruction to inform the harbourmaster or anyone else outside his chain of command. No specific protective action is recommended for the public, but personnel are dispatched to monitor radioactivity levels around the ship.

In more serious situations, civil authorities would be notified immediately, but the captain of the ship would consult with his superiors in Hawaii on the best course of action. Local port authorities would simply have to cope with whatever decision US authorities made. A special emergency PINNACLE / FADED GIANT message would be sent to Washington with FLASH priority, indicating that there had been a nuclear reactor mishap.

Aboard ship, efforts would be made to protect the reactor core, impede the release of radioactivity, survey and assess the radiation hazard, minimise exposure to personnel, and request assistance from special teams in Guam, the Philippines or Hawaii. Some of these actions could be impossible until the situation was brought under control, and there is no knowing how long that might take. Smoke bombs obtained from shore facilities are supposed to be released to track the path of airborne radioactivity. The hope would be to tow the vessel out of port within an hour (but NZ tug crewmen made very clear in 1976 that they would refuse to do this). Enquiries from the media would be fobbed off to the "area commander" who might be in Australia or at some other U.S. base.

There are many factors involved in determining what should be done with a disabled vessel, e.g. the potential for further damage to the reactor core, the ability (if any) to control the release of radioactivity, the radiation levels involved, the ship's remaining propulsion capability (if any), the population density in surrounding areas, and possible navigation hazards along any projected towing route. In the end we would simply have to rely on the captain's good sense (assuming s/he was still functional) to determine the best course of action, in consultation with USN superiors. We would be given warnings to shipping, but we would not be asked what we wanted done with the vessel.

The 'Pills' Furphy

Nuclear apologists have made much, from time to time, of the prophylactic powers of thyroid-protecting pills. The nuclear establishment spoke of sodium iodide pills; later, for no stated reason, they changed to sodium iodate. AEC 500 tried to convey the impression that these can

An example of Garrick Tremain's brilliant cartoons.

largely mitigate the prospective harm from airborne radioactivity. But in any case, the scope for protection by pills is extremely limited. At best, if eaten in time, they can inhibit absorption into the thyroid gland of radioactive iodine. Thyroid cancers are the biggest category calculated for the delayed damages in the exposed generation of people. However, the possibility of distributing any pills during a nuclear emergency is exceedingly limited. How many officials in radiation-protection suits and masks would walk along the miles of traffic-jam on the Hutt Road (Wellington) or Lake Road (out of Devonport) knocking on drivers' windows in attempt to get them to open up to let in some pills along with some more radioactive air? And even if they would, for many the pills would be too late. A non-radioactive 'chaser' is useless, or nearly so; what is needed is prior 'filling-up' of the thyroid with non-radioactive iodide, shutting down biochemically the normal uptake mechanisms of iodide from the blood. The government has shown few signs of pre-distributing the pills (to do so would clash with the "it can't happen" image). Indeed, there is doubt how many pills exist, at how many depots. A further complication is that illness can be induced in some individuals by such pills.

Neglected in all the 'pills' talk are the many other types of cancer – in all body organs – which cannot, even in principle, be prevented. Also of concern are the malformed babies expected from embryos exposed during the first three months of pregnancy (one could confidently anticipate unprecedented demand for abortions, which the overloaded medical services and even the 'free market' might not fully meet). Similarly not mentioned by nuclear enthusiasts are the 10 – 20 generations of extra genetic defects expected.

After a year or so, the main public health hazard is envisaged to be 'groundshine' from strontium-90 and caesium-137 fallout. All parts of the body are steadily irradiated from these external radiation sources, which have radioactive half-lives of 3 decades. These radionuclides would also get incorporated into food, as would many others.

The 'pills' image is thus rather misleading. Even if we could largely inhibit absorption of radioiodine into the thyroid within the hours immediately after the mishap – which cannot be done to any substantial extent in a panicking population attempting evacuation – that would decrease only a little of the total harm to public health.

Marine Pollution

The distribution of damage from the reactor debris depends to an important extent on the apportionment of radioactive materials between air and water. Given a catastrophic reactor rupture (which becomes increasingly probable throughout the years of operation as high neutron fluxes tend to embrittle metals), the fragments of the pressure-vessel will become missiles puncturing all man-made structures and committing most of the reactor contents to release upwards into the air. On the other hand, if the crucial initiating event is a loss of reactor coolant, without pressure-vessel rupture, the core can melt itself (in a matter of hours at most), after which a white-hot mass of intensely radioactive materials will proceed to melt its way through the hull. The 10% of the radioactive inventory which is gaseous or very volatile, including iodine, will in this case still become mainly airborne; but enormous amounts of water-soluble radioactivity will end up in the sea.

Another possibility, known from several spectacular accidents at metal smelters, is a steam explosion: when the white-hot metal contacts bulk seawater, it might not merely fizzle into the water but could instead provoke a powerful bang (audible many miles away), blowing up into the air an intensely radioactive hot fog which would then wander off downwind.

It is clear that the division of radioactivity between air and water is a major uncertainty in calculating how marine propulsion reactors can affect the environment. Nevertheless, we can be sure that a substantial amount of radioactivity, in some cases perhaps as much as half of it, will remain in the water. No thorough modelling has been done on how this would affect marine ecology; indeed, an accurate model is infeasible because of incomplete knowledge of tidal flushing and, especially, concentration of radionuclides along marine food chains (and connected aerial and land-based predators). A preliminary investigation by one of us (RM) suggests at least one year of gross disruption in the harbour's ecology. At what later time fish and shellfish might become again acceptable to eat is unclear.

The New Review

Whether or not New Zealanders start planning to deal with this contingency will depend on the outcome of the enquiry recently announced by the Prime Minister Mr

Bolger to be conducted by himself, the Minister of Health (Mr Simon Upton) and the new Minister 'for' the Environment Mr Rob Storey. In the end the decision will be purely political, but it is very important that the technical committee advising the ministers be competent. To that end, the country's main environmental groups have written to the ministers pointing out several independent scientists with special knowledge on nuclear reactors and effects of radioactivity, and demanding that at least two of them augment the government scientists (presumably much the same men as produced AEC 500) who are otherwise likely to conduct a biased whitewash. Their activities were already evident when Mr Bolger stated on Radio NZ [9] that nuclear propulsion had, so far, caused no loss of life and no radioactivity released. These falsehoods are breathtaking in their inaccuracy.

Our Present Context

There is, after all, no hurry. At present, all nuclear-propelled US warships carry a remarkable variety of nuclear weapons. Our government says it does not want to re-admit nuclear *weapons*, and Pres. Bush's welcome announcement did mention a period of two years to get them off the US ships. Similarly, unless the RN will drop its 'neither confirm nor deny' policy, it will have to wait until its vessels (nuclear- or oil-powered) actually carry no nukes before we will let them into our waters.

There are no nuclear-powered surface ships in the Royal Navy, nor are there any nuclear-powered merchant ships operating in the Pacific or elsewhere. (Nuclear merchantmen have proven costly flops.) The only nuclear-powered vessels likely ever to visit New Zealand are those of the US Pacific Fleet. Between 1976 and 1984, New Zealand ports were visited by 7 different nuclear-powered vessels from the fleet, 4 of them submarines. The US Pacific Fleet currently includes 88 major ships of which only 5 cruisers and 3 aircraft carriers have nuclear propulsion. The Fleet also includes 44 nuclear-powered submarines; of these, 8 are ballistic-missile submarines which do not normally visit foreign ports.

The U.S.S.R. does have half a dozen nuclear-powered icebreakers, which are not warships but operate under naval command. One of these, the proud turbo-electric *Lenin* , has been reported [1,10] to have suffered a severe reactor mishap, probably a meltdown, which is difficult to reconcile with the soothing "one in a million" PR slogans of nuclear promoters. For this category of vehicle as for the warships, we see no reasonable justification to put New Zealanders at risk.

We have here sketched the hazard, i.e. the scope for harm, entailed in marine reactors. To discuss the risk (i.e. the probability that a serious mishap will occur) is simpler, because nobody knows much about these probabilities.

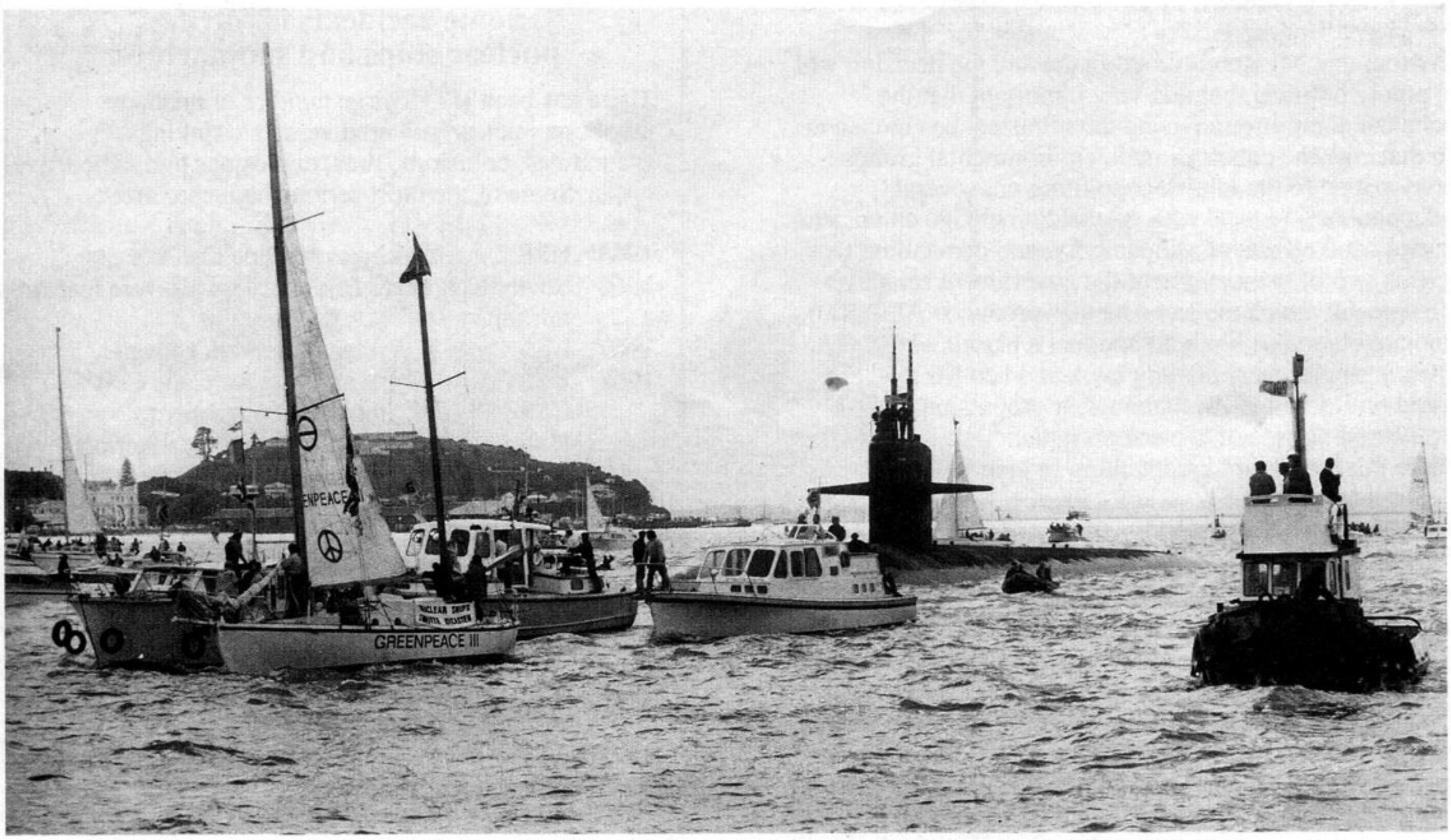
Meanwhile, we point out that in 1976 the then largest petition ever to the NZ Parliament, one-third of a million signatures, requested exclusion from NZ of not only nuclear power stations but also nuclear-propelled vessels. Anyone who thinks the public is less, rather than more, informed and adamant these days is misinformed or deluded. Any politician who pretends to think so is trying to create a distraction from his/her main political failures, and we do not intend to dignify this decoy with much more discussion.

Some accidents involving nuclear ships and submarines

There has been [11] a large number of mishaps involving nuclear-powered vessels – sinkings, groundings, collisions, fires, explosions and radioactive leaks. Some of the most serious on record are:

1963 USS *Thresher* sinks off Cape Cod †
1966 Soviet icebreaker *Lenin* suffers a severe reactor mishap*†
1967 USS *Guardfish* runs aground in Hawaii
1968 USS *Seawolf* runs aground off Cape Cod
USS *Scorpion* sinks off the Azores †
USS *von Steuben* collides with a tanker off Spain
A Soviet submarine sinks off the Kola Peninsula †
1970 A Soviet November-class submarine is abandoned and sinks off Spain
A Polaris submarine rams a freighter off Virginia
1971 USS *Dace* loses 500 gallons of cooling water in the Thames, Connecticut *
1972 A disabled Soviet Hotel II class submarine is towed across the Atlantic †
A Soviet submarine is towed to base after a nuclear torpedo accident*
1973 USS *Guardfish* leaks primary coolant *
1974 USS *Pintado* is rammed and damaged by a Soviet submarine off Kamchatka
1979 USS *Hawkbill* leaks primary coolant near Hawaii *
USS *Truxtun* spills radioactive water into San Diego Bay
USS *Nimitz* leaks primary reactor coolant off Virginia
1980 Fire disables a Soviet Echo-class submarine off Okinawa †
1981 USS *George Washington* collides with and sinks a freighter off Japan †
Explosion disables a Soviet submarine *†
Soviet submarine crew exhibit terminal radiation sickness after a severe nuclear mishap (CIA report)*†
1983 A Soviet Charlie-class submarine sinks off Petropavlovsk †
USS *Texas* (nuclear-powered cruiser) hits a quay in Brisbane and is holed, above the waterline
1985 A Soviet submarine reactor explodes in Shkotovo *†
USS *Enterprise* (8-reactor carrier) grounds near San Diego
1986 A Soviet Yankee I class missile submarine sinks off Bermuda †
1987 Celtic League (Isle of Man) documents sinkings of fishing vessels by submarines †
1989 The Mike-class Soviet submarine *Komsomolets* sinks off the Norwegian coast †*
A Soviet Echo II class submarine is disabled by fire and leaks coolant off Norway *

* Nuclear or radioactivity accidents
† Loss of life



Action on Auckland Harbour against a visit by a U. S. nuclear submarine, 1984 *Photo supplied by Greenpeace*

Conclusion

We do not perceive any benefit to justify the hazard of allowing nuclear-powered warships into New Zealand waters.

References

1. Zh. A. Medvedev, *The Legacy of Chernobyl*, Norton 1990.
2. Anon., 'Plan for medical protection measures for the populations of the towns of Murmansk and Kola in the event of nuclear accidents on vessels with nuclear power plants', ca. 1988; trans., with analysis by J Large, Greenpeace International, 1991.
3. Chief of Naval Operations US Navy, 'Nuclear Reactor and Radiological Accidents, Procedures & Reporting Requirements for' (OPNAV Instruction 3040.5B) 1981.
4. Auckland Regional Authority, *Planning for Hazardous Activities in the Auckland Region*, 1984.
5. Anon. (Gerry Symmans [Muldoon's chief propagandist at the time] *et al.*), *NZ Code for Nuclear Powered Shipping*, NZAtomic Energy Committee (since abolished) 1976; see also draft version 1974.
6. Public Law 93-413, Congressional Joint Resolution Dec 6 1974.
7. Parliament of the Commonwealth of Australiq, 'Visits to Australia by nuclear powered or armed vessels – contingency planning for the accidental release of ionizing radiation', report of the Senate standing committee on foreign affairs, defence & trade, 1989.
8. US Navy CINCPACFLINST [Commander in Chief Pacific etc.] 3100.7E 'Special Incident Reporting OPREP-3' 1986.
9. Radio NZ Morning Report, 5 Nov 1991.
10. D E Kaplan, the leading US investigative writer about naval nuclear reactors (& weapons), sued for Central Intelligence Agency excerpts: 'CIA Releases Soviet Meltdown Record' *NZ Times*, 11-5-86; ref. 1 is less specific but gives strong circumstantial evidence that the ship suffered a severe reactor mishap.
11. J Handler, W Arkin, *The Neptune Papers*, Greenpeace USA 1988, 1989.

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Procuring and editing material is only a small part of the total work needed to produce a magazine. Numerous other tasks must be done, in timely and competent fashion; they add up to most of the work.

This number of NZE is the 20th and, unfortunately, last in which Hayden Willey has been involved as a member of the team of volunteers. Hayden has kept the magazine together in recent years, with great skill and devotion — introducing desk-top publishing, stepping into the role of subscriptions secretary, and most recently putting all the subscription records on Macintosh computer to generate the current form of mailing labels.

His plans for 1992 include learning Swedish, to better pursue his love of Scandinavian design and to prepare for research overseas, in both Scandinavian architecture and environmental aspects of architectural design.

As editor I am acutely aware of how much we are losing, and it is with great regret that Hayden's reluctant resignation is accepted. Our warm thanks and best wishes go with him.

Robert Mann