D/3719

File No. D/91108

Director
[redacted]

NEW SCIENTIST ARTICLE OF 3.2.72 ON PNE

1 There were no letters to the editor on this article in the issues of 10 and 17 February.

2 I sent a copy of the article by airmail to [redacted], Head of LLL Plowshare Division, on 4 February. It remains to be seen whether there will be any Livermore comment.

3 [redacted]

4 I will keep you informed of any developments.

[redacted]

[redacted]
SSDM
[redacted]
Ext [redacted]
21 February 1972

cc [redacted], CPA

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[redacted] thinks AEC cannot ... appropriate.

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PNE - NEW SCIENTIST OF 3 FEBRUARY 1972

1. This issue contains articles on PNE ("Peaceful nuclear explosions - behind the brouhaha" by [redacted] - pps 256-8) and Cannikin ("After Cannikin" - New York view by [redacted] - pps 277-8) together with editorial comment ("Ploto's patience prevails" - by [redacted] - p 244). There follows a commentary together with a draft of a possible letter to the New Scientist.

2. <u>The [redacted] Article</u>

(a) The article makes a rather artificial connection between Cannikin and PNE. There is very much more than "one swallow" - namely the 22 specifically Plowshare projects involving nuclear explosions, [redacted] similar experiments in the Soviet Union and, of course the accumulated experience of several hundred weapon tests at the Nevada test site. Moreover at [redacted] Cannikin had a yield greater than any now suggested for PNE purposes and something like 25 to 100 times the [redacted] range appropriate to most contained underground nuclear explosions, particularly in petroleum industry applications.

(b) The name of [redacted] appears too frequently. A casual reader might think he was the only man in the field. Apart from [redacted] review there is also, I think, a balanced review by [redacted] in the November/December issue of the Journal of the Institution of Nuclear Engineers.

(c) Gas storage is <u>not</u> the most likely first use of PNE. partly because of the siting problems (near demand areas) but also because the costs of a scheme are likely to be only marginally better than those of alternative schemes. (this may not be true in the Soviet Union) - In any case there are two proved uses - extinguishment of gas fires and reservoirs - which he later mentions.

(d) The discussion of hydrocarbon stimulation is incomplete. Special explosives <u>have</u> been developed - Miniata-whilst the Russians have made considerable progress with oil stimulation. Nor is he aware, perhaps understandably, that Austral Oil has now applied for permission to use Rulison gas commercially.

(e) [redacted] approach is perhaps not the best but it is legitimate to emphasise the prima facie attractiveness of technological projects. Only then do people really look at the R & D which will be necessary.

(f) The Russian reservoir has a water volume of 7 million cubic metres; the remaining <u>10</u> million cubic meter capacity is behind the lip.

(g) I doubt whether the uncertainties in cost estimates are any more uncertain than in other large projects. However the full costs of Rulison are known. As far as nuclear explosives are concerned the position only parallels nuclear reactors and jet aircraft. Magnox reactors and the Boeing 707 derived from military projects. Given a large PNE programme these will be a sensible charge for nuclear explosives as for 707s.

CONTINUED

(h) The sentence on the cancer rate at Hiroshima is unfair Exposures of several tens of rem were involved.

(i) Not all the most attractive situations for PNE lie outside the United States. Gas stimulation is most likely and most needed in the United States.

(j) The NPT was agreed in 1968, not 1970. There is no mention of the IAEA role in PNE (except the reference to [redacted] paper)

(k) The Congressional vote for PNE is not small - smaller than it was perhaps but still likely to be $6.8 million for FY 1973 (Nuclear Industry, January 1972 p 46)

(l) As to the last clause of the last sentence this is precisely the present position. All firm experiments are presently in the USA and the USSR.

3. The [redacted] Article

No comment

4. The [redacted] Comment

The PNE reference is on the last paragraph. Again I think the connection between Cannikin and PNE is pretty tenuous.

[redacted]

[redacted]
SSDM
Building [redacted]
7 February 1972

Copy to Director

The Editor, New Scientist

Dear Sir,

It is wise for all of us who desire a balanced objective discussion of the potential of peaceful nuclear explosions to remember that for every evangelical advocate of their merits there are probably at least ten critics guilty of arguments which are partially or wholly emotive, irrational and unscientific. [redacted] is right to emphasise that much research and development work will be necessary before several of the suggested applications are shown to be feasible, safe and economic but surely this is well known to governments and interested organisations, particularly since the International Atomic Energy Agency's two Panels on PNE held in March 1970 and January 1971 and the publication of [redacted] paper. Moreover the presently planned experiments will take place within the United States and the Soviet Union. In the case of the former the interest in gas stimulation is well-founded; on present knowledge the need and the possibility is at a maximum within the United States although, given success, there is no reason why the technique should not be applied elsewhere. The relevant Government R and D expenditure of over 6½ million dollars a year enhanced by private funding is hardly "negligible".

As to safety, which is naturally uppermost in people's minds, most general discussions, such as that in the November/December issue of the Journal of the Institution of Nuclear Engineers, do give a balanced view within the limits of the space available. But if [redacted] wishes to refer unemotively to the cancer rate amongst those exposed at Hiroshima he should surely compare the radiation levels ingolved - tens or even hundreds of rems - with those involved in, say, domestic use of stimulated natural gas -

2 or 3 millirem per year - and with natural background radiation. (THIS SENTENCE TO BE CHECKED FOR ACCURACY). It is perhaps exceedingly difficult to present a completely balanced, unbiased view in this field but it is important that all concerned should try.

raise against any subsequent charges of hypocrisy.

In its gloss on the green paper, the government has already endorsed the customer-contractor principle. There seems no reason why it should abandon this position in its white paper. If it is argued that the scientific community as a whole is against Rothschild, the obvious retort will be that the scientific community as a whole has not expressed an opinion on the matter. As Rothschild said, four-fifths of the report has been ignored; it is not too great a logical jump from this to stating that probably those who have debated the report represent only one-fifth of the scientific community. A quick flick through the names and addresses at the bottoms of letters to The Times confirms that the public debate has been largely monopolised by a narrow section of the scientific community.

Consequently, it seems likely that the white paper will not only echo Rothschild's section of the green paper—with, perhaps, some juggling of the figures to prove that the debate has been attended to—but that it will meet with only token opposition in the House of Commons. Since there is probably no need to make statutory changes before implementing the proposals, the customer-contractor relationship will be fully operational by April 1973 at the latest. *Martin Sherwood*

Pluto's patience prevails

The US Atomic Energy Commission has plainly scored a moral victory over the business of Cannikin. As Peter Gwynne remarks in Forum this week (p 277), the just-issued report on the results shows that none of the terrible things the environmentalists predicted in fact happened. The Earth's crust did not shear when the 5-MT nuclear device exploded deep underground at Amchitka in the Aleutian Islands on 6 November—in accordance with the odds, nonetheless, fortunately. For, despite all the assurances to the contrary, earthquakes are notoriously unpredictable in their behaviour and the Aleutians are part of the world's greatest seismic belt. There must thus have remained a finite, if very small, chance that Cannikin would trigger off a catastrophe. Even if the shock alone were acceptable in that region of low population, the possibility of initiating a large Pacific tidal wave should have restrained President Nixon from proceeding with the test.

As Monitor pointed out recently (vol 53, p 131), new studies along the Aleutian arc have demonstrated that separate sections of the belt tend to disrupt in a confined manner when a major earthquake occurs. The shock and its string of aftershocks define an area within which another major earthquake seems not to take place for a period measured probably in tens of years. Amchitka lies in one such region where a big earthquake happened in 1965. Thus the likelihood is that the crustal stresses have not yet built up to the highly critical level where they could be released by a powerful nuclear explosion.

Justification for that sort of time scale comes from the theory of sea-floor spreading and the estimated rates at which the Pacific Ocean is thrusting under the Aleutian arc—so to speak: "winding up the catapult to have another go". However, there is no proof that a big earthquake, when it arrives, always releases all the pent-up stresses in the rocks. Nor is there any means of assessing with any degree of accuracy what the repeat times of big earthquakes in any given area may actually be. Again, although the USAEC argued that the area of the western Aleutians was not tsunami-prone, according to Dr Lynn Sykes of Columbia University writing in the Journal of Geophysical Research (vol 76, p 8021): "one of the largest and most widespread tsunamis of this century" occurred near the western end of the Aleutian peninsula on 1 April, 1946. He was unable to analyse why a rather small earthquake caused this tidal wave, while much larger ones failed to do so. He concluded: "Until the generating mechanism of the 1946 earthquake is understood, however, all shallow shocks larger than about magnitude 7 in the Aleutians and coastal Alaska should be regarded as possessing a tsunami risk."

As Peter Gwynne argues, the case against Cannikin may well have been ineptly conducted before the test. But that does not affect the principle involved, namely that mankind should not tamper with potentially dangerous, but ill-understood, natural processes without very sound reason. There have been misgivings about the military necessity of the Cannikin test and it is hard to avoid the conclusion that, in part at least, it was a show of strength by the USAEC to clear its name of the many slurs cast upon it by the environment lobby.

Unfortunately, since unscientifically trained mortals find probabilities harder to contend with than single accomplished facts, an AEC desperate to sell its wares will doubtless capitalise on the innocuousness of Cannikin. It will certainly add fuel, for instance, to Professor Edward Teller's campaign to promote the benefits of using nuclear explosions for peaceful purposes. As an antidote to possible nuclear euphoria, on p 256 we publish an article by Allan McKnight of Sussex University which spells out a story of the thorny road ahead for those anxious to enlist nuclear muscles to do their digging. *Peter Stubbs*

Lift ride to death

Lifts may carry passengers unknowing directly to a fire because certain electronic lift call buttons are triggered by flame. This is a particular danger in high rise buildings where a fire can be far advanced before all occupants of the building are aware of it.

In a fire at an office block in New York City two years ago, two lifts stopped at the blazing floor. One lift jammed there and two occupants were killed; the second lift returned to the ground floor. The incident triggered immediate controversy and an early report blamed the lift call button on the floor of the fire. The lift industry, particularly the Otis Elevator Co, which designed and patented the button, fought the suggestion bitterly. But a recent US National Bureau of Standards (NBS) study shows that because of the call button design, the lifts may in fact have been called to the floor by the fire itself. This danger is sufficiently serious that the NBS researcher, Thomas G. Lee, calls for the redesign of all such lift buttons.

The button in question is the type where the proximity of the finger triggers the switch and the button has no mechanical parts. Basically, the button is a cold cathode tube operating at a voltage close to its breakdown point. Touching the button with a finger adds the body's capacitance to the circuit, which alters the voltage of the circuit enough to discharge the tube and call the lift. The buttons are *not* heat sensitive and are *not* triggered by the "heat of the finger" as is commonly believed. The buttons have been in use in Britain since 1947.

Peaceful nuclear explosions - behind the brouhaha

The prospects of using peaceful nuclear explosions are often painted in alluring tones, but the uncertainties and unknowns are rarely discussed. It is time to appraise realities behind the salesmanship

Allan McKnight
is a research fellow with the Science Policy Research Unit, University of Sussex, and was formerly Inspector General of the International Atomic Energy Agency (IAEA)

The underground nuclear test in the Aleutians last November (the Cannikin test) saw environmentalists fighting the US Atomic Energy Commission in the Supreme Court until hours before the explosion. The environmentalists feared the shot would trigger a major earthquake and cause other widespread damage to the environment. No earthquake resulted, and other effects seem to be minimal so far. But one swallow does not make a summer and the apparent "safety" of Cannikin must not lead to a field day for the apostles of peaceful nuclear explosions. Their latter-day advocate, Dr Edward Teller, has twice (New Scientist, 19 February, 1970, and BBC2, 13 September, 1971) put his case to British audiences. Each presentation smacked of a Mid-West evangelist bringing light to the heathen, complete with rhetorical drama and lantern slides. It is time for a sober appraisal before the next missionary arrives.

It is 15 years since US scientists first discussed the possibility of using the immense energy of the thermonuclear weapon for constructive, beneficial purposes. The technical attraction is obvious: the potential ability in civil engineering works and mineral development of breaking and moving, quickly and cheaply, large quantities of rock and earth, particularly hard rock. But the accompanying effects are major and potentially deleterious: unpredictability, production of radioactivity and its release to the atmosphere and to aquifers, fall out of debris, air blast, ground motion, product contamination, and a whole range of environmental effects.

Teller has artistically drawn appealing prospects; he has ignored the hazards and difficulties. A balanced review, on behalf of the International Atomic Energy Agency, was given by A. R. W. Wilson of the Australian Atomic Energy Commission to the Fourth UN Geneva Conference in September 1971 (Paper no 762). While Wilson believes in the potential of peaceful nuclear explosions (PNE) and their necessity for future economic development, he does not disguise the difficulties yet could be reduced to acceptable levels by flushing out the initial gaseous content. This flushing-out technique has yet to be demonstrated as also has the long-term integrity of cavities under pressure. A closely related application of the nuclear explosive is oil storage in similar cavities. Gulf Oil finds the possibilities attractive for its North Sea wells.

Another possible application of contained explosions is the stimulation of hydrocarbon reservoirs where the permeability is too low for production by conventional techniques. Here the effective well diameter is increased as a result of the chimney formation and the associated fracturing of the medium. The product will be contaminated with tritium and krypton-85 and dilution with conventionally produced gas will be necessary. The need for dilution could be reduced by developing explosives designed to minimise tritium production but the possibility of this development is limited by a parallel need to produce minimum explosive diameter.

Another major development is also required to make this application feasible. A thick reservoir (which offers better economics) requires emplacement of several explosives in the one hole and the resulting chimneys must interconnect for the emplacement hole is needed for production, since it is impractical to drill back through the chimney. Wilson believes the potential for adding to world energy resources would justify the substantial research and development required which he estimates would take up to 10 or 15 years. As with storage, Teller put before his British audience the rosy prospect but skated over the need for extensive R & D.

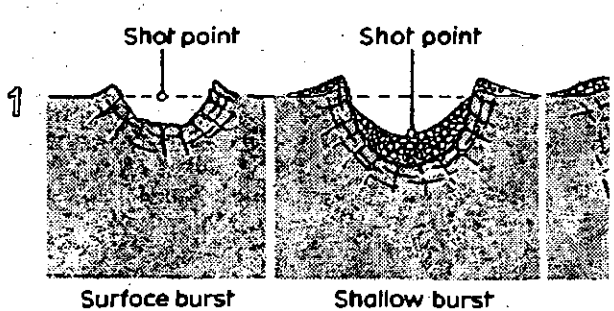
Ores for leaching

The application to mineral recovery most discussed is breaking ore for *in situ* leaching. Teller dwelt on the example of pure copper at great depth. By contrast, Wilson sees low-grade secondary copper deposits as the most favourable prospect. A major uncertainty is the efficiency of the leaching operation. More-

after boiling dry, the sealed; the waste woul round becoming absorb after decades, formin matrix. Presented glow application is still at The disposal of high-le looms as a major proble or so. Thus this appli attractive but the haza are huge and much R before even a protot mounted. The use of thermal power product early conceptual stage. tion has been develop Soviet Union—a contai the flow to an uncontro

Teller presented lyric excavating canals, harbo storage reservoirs. All in activity and contamina over, optimum contructi creation of a lip aroun example, to increase reservoir or to provide a

The Soviet Union ha with a crater volume



Subsic

The types of structures which can be created by nuclear explosions, both uncontained (1) and fully contained (2 and 3). (After the Annual Report of the Australian AEC 1967/1968).

each individual application depends on the idiosyncratic nature of the physical materials directly affected by the explosion. Much more needs to be known about air blast and ground motion; both can lead to damage claims at law for nuisance, and possible damage to buildings by ground motion is currently a serious inhibition in siting experiments.

Discussion of PNE often includes claims that a particular application would be "economic". At the heart of any financial assessment lies the cost of the explosive, which surely assumes a heavy subsidy from military votes, and the associated operational, transport and control services. Another element is allowance for nuclear damage claims for damage to persons and property, including loss caused by evacuation and cessation of income earning activities. Any estimate is shrouded in so much uncertainty as to make "economic" a misnomer.

Radiation hazard

Apart from the technical difficulties and uncertainties seen from within by the advocates of PNE, there are more general concerns felt from outside, particularly on grounds of public safety and environmental protection. First and foremost is the radiation hazard. Whatever the claims, experience with underground military tests creates scepticism that non-escape of the gas bubble can always be assured in contained explosions. Cratering explosions will release radioactivity to the atmosphere, although it is claimed that development of explosive design, emplacement techniques and shielding techniques can reduce radioactive release to practical limits. What are practical limits for public safety? The longer experience accumulates the lower the limits of exposure fall. The cancer rate among those exposed at Hiroshima is now rising alarmingly. We do not know what the safe limit is. Experience over a generation or two of human exposees is necessary. Even with full containment, a vast underground cavern of radioactivity is created, and on a balance of probabilities it will enter underground water systems whose dispersals and reappearances are simply not known. Even less is known about the effects on natural systems of making such violent changes.

A more general objection to PNE is its possible prejudicial effect on the quest for disarmament, which proceeds at the pace of a tortoise anyway. The chances of success in the SALT talks must not be jeopardised. The advocates of PNE want the partial Test Ban Treaty of 1963 amended. But it would be an appalling risk to throw open the treaty at a time when its extension is being negotiated in SALT as part of a wide package of measures for the cessation of the nuclear arms rce.

Why did Teller urge the case for PNE upon the British public in the way he did as a nuclear rainbow offering glittering prospects in the short term? Why did he dissemble the many uncertainties and gaps in knowledge and ignore the general objections of public safety, ecology and disarmament? Why is it that the most attractive situations cited for its use always lie outside the United States?

It may be a simple case of an old man with a young strange love being unable to see her shortcomings. After a life of protagonism for nuclear arms (he opposed both the Test Ban Treaty and the Non-Proliferation Treaty), perhaps he is bewitched by espousing a peaceful use of science. More probably Teller has dissolved into the genre of the US Atomic Energy Commission which has, since Eisenhower's atoms-for-peace speech to the UN General Assembly in December 1953, continuously and consistently oversold the peaceful uses of atomic energy.

Overselling has raised unfulfillable expectations in the developing countries and their disappointment is bitter. This has bred a particular problem. The overselling of PNE from 1960 onwards hindered negotiations for a halt in the spread of nuclear weapons. The developing countries argued that they could not sign away their rights to manufacture and acquire nuclear explosives because of their great development potential; they were mistrustful of the superpowers' argument that an explosive was indistinguishable from a weapon.

As a result, after years of haggling, the superpowers were forced to agree in the Non-Proliferation Treaty of 1970 that the potential benefits of PNE will be made available to non-nuclear-weapon parties to the treaty. As an indication of the strength of feeling on the part of the developing countries, the treaty even provides that the explosives should be available on a non-discriminatory basis and that the financial charge is to be "as low as possible and exclude any charge for research and development". There is to be appropriate international observation to ensure that the explosive device used remains at all times under the control of the weapon state which supplies it and that the explosion is not performed for other purposes.

While not as well publicised, the Soviet Union has a deep interest in PNE. As early as 1960, they were studying the possible use of PNE for tunnelling as part of a vast scheme to turn south into the interior the rivers flowing into the Arctic. It is rumoured that, at the Geneva Conference in 1964, they proposed a joint R & D programme to the USA. Their interest continues and several experiments are planned. By contrast, interest has waned in the US, most strongly evidenced by the refusal of Congress to vote anything but negligible amounts for the PNE programme.

This American dilemma probably explains Teller's missionary campaign in Britain. His programme needs finance if the USA is to meet any of the expectations (which it itself induced) of the developing countries. Perhaps funds may be wrung from Congress if there is sufficient support from other countries. There is an alternative for the US, namely to join in a cooperative programme with the Soviet Union. But whatever the ultimate American policy, could we please have the advocates presenting their pictures of PNE "warts and all" and planning their experiments in the vast land masses of the United States and the Soviet Union?

Forum

Westminster scene

Tam Dalyell MP

Side-effects of Rothschild—Dressing cereals

One important side-effect of the Rothschild controversy seems to have gone unremarked. Hitherto, it has been customary for those in the civil service or government institutions not to defend themselves in public against press criticism. Now that we have witnessed distinguished people, in the pay of the government, toppling over one another to send letters to The Times, and Lord Rothschild defending himself, ideas are being sewn in less famous heads. Why should the employees of an Industry Training Board, threatened with the axe, not leap to the defence of their own organisation? What's sauce for the scientific goose is sauce for numerous other ganders. A number of MPs to whom I've chatted rather welcome the change and think government employees, like the rest of us, should have the opportunity to leap into print.

☆ ☆ ☆

Miss Joan Quennell (Petersfield) is on the warpath against wild pigeon and wild mink. She wants them destroyed by the government. Tony Stodart, Under-Secretary at Agriculture, told her that it was for individual occupiers or local groups to protect crops which are exposed to damage by wood pigeons. He recommended scaring devices for this purpose, "because extensive research has established that no known techniques of destruction will lead to effective population control". (I understand a lot of work has been done on this really unfunny subject.)

Miss Quennell wanted Stodart to agree that one of the most efficient methods of securing population control would be for him, in his capacity as food minister, to popularise the excellent culinary qualities of these pests. Mr Stodart, who has a nice sense of humour, let us ultra-solemnly into the secret that he is an enthusiastic pigeon consumer. "I am fond of all birds", he added wryly—which, being prime fourth-form sense of humour, provoked a sympathetic hoot from us assembled legislators.

On the menace from wild mink, Stodart said they had been spotted in 41 counties in England and Wales, though they were nowhere numerous. Southern England, West Wales, and the Pennines are affected. He recommended humane trapping as a control. Miss Quennell can rest content.

☆ ☆ ☆

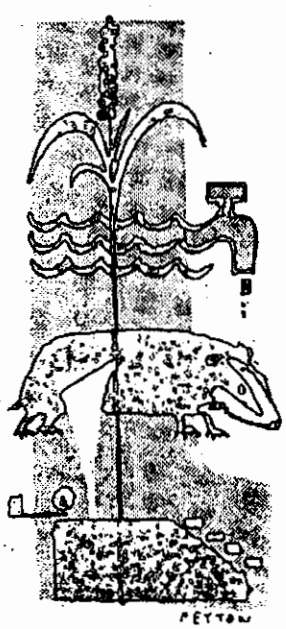
Peter Hardy (Rother Valley), a badger-watching headmaster representing a mining seat, is concerned about cereal-seed dressings. He wants MAFF to reconsider advice to farmers concerning the use of cereal seed dressed with aldrin, dieldrin, or heptachlor, with a view to limiting the use of such dressings, particularly on spring sown grain. MAFF says it has done so, except where there is a real risk from wheat bulb fly.

Hardy continues to be concerned about the small minority of farmers who act irresponsibly. The fact is that the Wilson Committee reviewed the use of organochlorines in 1969 and found that the restrictions had lowered the number of incidents with birds, which are chief sufferers. Wilson, however, also found that bulb fly was still too damaging to recommend a total withdrawal of dressings.

The damage done by bulb fly in a bad year can cost as much as £3 million. Again, this is one of the increasing number of cases which call for a sensible balance between the interests of production and those of conservation.

☆ ☆ ☆

Events in the freeze desalination affair, which surfaced recently in Technology Review (vol 52, p 24), have now moved one stage on. In March 1971, Peter Walker authorised the Water Resources Board to spend £1·5 million on a prototype freeze-process desalination plant on the Deben Estuary. The balance, about £750 000, was contributed by the AEA and Simon Engineering. Last November Simon Engineering decided to withdraw from financial participation in the project. As this company no longer considered the process commercially viable, and as the estimated cost of the project had risen by about £1 million, Mr Walker decided, together with DTI Secretary of State John Davies, that it would not be right to continue the project with the whole cost falling on public funds. (The amount actually spent on the project by the WRB was £60 000.)



However, Walker is supporting further work on the process in order to get the maximum value out of the development already done. He says that he would always be prepared to consider assistance to the development of other desalination processes that are "potentially efficient and economic", and is considering the possibility of working with European countries to obtain a breakthrough in desalination.

New York view

Peter Gwynne

After Cannikin

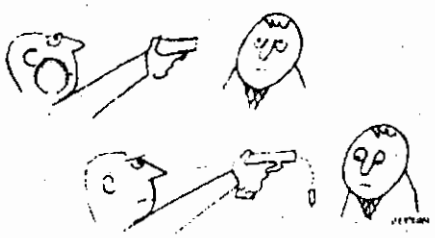
In their relatively few years as a cohesive political lobby, the environmentalists have stimulated a great deal of political and social action to make the US a better, cleaner place to inhabit, but they have also been guilty of a number of spectacular mistakes, in both the scientific and political arenas.

Frequently their protests have been shrill rather than scientific, and their predictions of doom have sounded more like environmental overkill than objective analysis. The spectres of vast numbers of skin cancers from the SST, and reduction of the planet's oxygen supply as a result of DDT attack on the world's oceans, for example, involved a number of spectacular, and unproven assertions. But perhaps the best recent example of the environmentalists' all or nothing approach to political issues was provided by the method they used to try to prevent the explosion of the Cannikin underground nuclear test beneath the Aleutian island of Amchitka last November.

A report issued recently by the National Oceanic and Atmospheric Administration (NOAA) on the scientific results of the test underscored a feeling among many scientists at the time of the test that the environmentalists had attacked it on entirely the wrong grounds. The blast was designed to test a warhead for the Spartan missile, the long-range part of the US Safeguard anti-ballistic missile system. In view of the history of the project there was undoubtedly a strong case to be made against the test on strategic grounds.

According to Jeremy J. Stone of the Federation of American Scientists, the warhead under examination at Amchitka had originally been designed as part of a system to defend US cities against Chinese missile attacks. However, the target of the nation's anti-ballistic missile defence was subsequently changed to Russian missiles and Stone charged that the Cannikin device had actually become obsolete by the time it was ready to test.

Other critics suggested that, since the Safeguard system was likely to become a casualty of the SALT talks, there would be little harm in delaying the Cannikin test a few months. These arguments.



however, featured hardly at all in the environmentalists' case against Cannikin. Instead, the critics took the prepare-to-meet-thy-doom route, claiming that the explosion would wreak environmental disaster in the Aleutians and, very possibly, around the whole Pacific. This line of attack, and the unnecessarily stubborn defence to it offered by the Atomic Energy Commission (AEC), which conducted the test, ensured that Cannikin took place in an atmosphere of maximum hysteria.

The focal point for the hysteria was a critical report on the blast prepared before the event by a number of government agencies, including the Office of Science and Technology and the President's Council on Environmental Quality (CEQ). Having kept the report secret for many months, the government was finally forced by court action to make it public.

The report included a memorandum by Russell Train, chairman of the CEQ, which suggested that, contrary to the AEC's contention, the Amchitka blast could trigger a major earthquake, which might in turn trigger a tsunami (or tidal wave) that could inundate ports throughout the Pacific. With that revelation, the environmentalists and the news media were off and running with forecasts of doom totally neglecting the facts that: 1. Train had subsequently toned down his prediction and 2. the AEC had produced an analysis that answered Train's contention rather convincingly. Acoustic profiling of the Aleutian trench and the Bering Sea near Amchitka showed that the area was not conducive to propagation of tsunamis, and moreover there was no historical record of a tsunami originating in the western Aleutians.

Instead of emphasising this analysis, the AEC chose to snub its nose at the environmentalists in spectacular fashion. Responding to a challenge by Alaska governor William Egan, AEC chairman James Schlesinger took his wife and two of his daughters to Amchitka to monitor the test from a station just 23 miles from ground zero. Inevitably the test proceeded without incident, and as the NOAA report makes clear, there was no hint that earthquakes or tsunamis had resulted from it. Apparently Cannikin did not interact with the large-scale processes which control the Aleutian region's major natural earthquake activity, reported the NOAA scientists, adding that, around the Pacific, no wave activity was observed on the tide gauges that could be distinguished from surf action.

In fact the only seismic activity that followed collapse of the cavity formed by the explosion was a series of barely detectable tremors in a small fault a dozen miles from ground zero, which lasted a month. In addition, Cannikin provided a number of scientific dividends. It was monitored by more seismological stations than have probably followed any single natural earthquake and, unlike earthquakes, it took place in a small, precisely known location at a fixed time. As a result geologists interested in the propagation of its shock waves through the Earth were able to separate effects caused by the explosion from those caused by the nature of the Earth's crust.

The data from Cannikin are expected to lead to better understanding of the geology of island arcs like the Aleutians, which are characteristic earthquake zones, and possibly to improved understanding of the genesis of natural earthquakes. Plainly these scientific bonuses do not represent justification for the detonation of Cannikin. Just as plainly the predictions of doom that preceded the blast were unjustified. There were political and strategic arguments to be made against Cannikin, but the debate that did unfold bad an Alice in Wonderland quality about it.

None of the parties involved in the debate—the Federal government, the AEC and the environmental critics—emerged with much credit. In retrospect the whole affair seems to be a classic example of how not to conduct a public argument on a scientific issue.

Ottawa notebook

David Hamilton

Canada's look at science policy

Canada's science and technology policy will be completely overhauled if Senator Maurice Lamontagne and his special Senate committee have their way. The second volume of their report on science policy in Canada—published in mid-January—calls for drastic revolutions in every segment of Canadian life so that Canada can catch up in the global technological race.

Broadly, the plan is this. The Canadian government and parliament should adopt an overall plan for the 1970s for science and technology, based on longer-term projections and overall national R & D targets. Planning, programming and budgeting techniques will be improved to provide a better assessment of the output of R & D activities and a better basis for determining how much to spend on them. By 1980 the science and technology plans will be built into a framework of formalised five-year plans.

National expenditure on R & D should reach 2·5 per cent of GNP by 1980, compared with 0·3 per cent in 1969, and the government's direct contribution will be restricted to support of worthwhile projects and programmes. The Ministry of State for Science and Technology is to be made responsible for keeping a national R & D inventory, and for a national audit of current R & D projects and programmes being supported by public funds.

To keep future needs continuously in sight the Economic Council will extend its activities and set up a special Committee on the Future—a "lookout institution" of experts that can examine economic and social matters, and questions raised by science and technology. It will have broad terms of reference, but is looking more specifically towards the years 1985 and 2000.

Spending on basic research is to be cut from 23 per cent of the national R & D effort—the level of the late 1960s—to 10 per cent by 1980. In absolute terms, however, spending will rise. Quality, not quantity, is to be the keynote in curiosity-oriented basic research.

The Minister of State for Science and Technology should initiate a thorough re-appraisal of all the Canadian government's scholarship and fellowship schemes in view of the surplus of PhDs and the new orientation of the nation's R & D effort.

Government departments and agencies with a practical mission are to get out of basic research. Their needs for mission-oriented basic research would be contracted out to three government institutes—for the physical sciences, the life sciences and the social sciences—working under the umbrella of a new National Research Academy. The institutes would also do contract research for industry.

It is industrial R & D which bears the brunt of the changes. The Lamontagne study points out that, since the early 1900s, Canada has adopted a passive strategy based on imported technology, responding mainly to the growing external demand for its abundant natural resources and primary products. But in the 1970s, says the committee, the country's growth strategy must rely on a high and sustained flow of technological innovations introduced by secondary manufacturing industry. For the first time in Canada's history, it is more or less being forced to become an innovative nation. The alternative will almost inevitably lead to an economic dead end that only annexation to the United States could delay.

To this end, the plan proposes that the R & D performed by industry should rise from 37 per cent of the national effort in 1969 to 60 per cent by 1980. This could considerably improve the return on expenditure by enabling a much greater number of Canadian firms to attain the critical size of research team required to obtain useful results.

Resource-based primary manufacturing and secondary manufacturing industries are asked by the Canadian government to carry out an exercise in self-criticism and self-improvement. Industry-wide task forces are organised and schemes prepared to raise efficiency, improve innovative capacity, and otherwise become more competitive. An Office of Industrial Reorganisation, mainly composed of the chairman and secretariat of these task forces, would be set up to assist a special Cabinet committee—itself created to examine, modify and approve the task force plans after talking to the interested provinces.

A special committee would be set up by the Minister of State for Science and Technology—with people from Canadian university schools of management and