The Secretary
Joint Standing Committee on Treaties

Inquiry into Nuclear Non-proliferation and Disarmament

Dear Sir/Madam,

I would like to submit the following submission to the Parliamentary Committee Inquiry into Nuclear Non-proliferation and Disarmament.

Yours sincerely,

Frank Barnaby.

A submission to the Parliamentary Committee Inquiry into Nuclear Non-proliferation and Disarmament.

Frank Barnaby

Nuclear reactors fuelled with uranium inevitably produce plutonium as a by-product. This plutonium can be used by countries and by nuclear terrorists to fabricate nuclear weapons. The operation of nuclear-power reactors, therefore, has consequences for national, regional and global security. The more nuclear reactors there are the greater the security risks.

Australia should recognise that these security risks outweigh the befits of producing electricity by nuclear power especially because the use of renewable sources of energy, combined with improvements in energy efficiency and the conservation of energy make the use of nuclear power unnecessary.

As the world's second largest exporter of uranium, Australia has a major responsibility to adopt policies to minimise the risks to security from nuclear proliferation and terrorism.

To this end, Australia should use its influence to bring the Comprehensive Nuclear Test Ban Treaty (CTBT) into effect. It should not supply uranium to countries, like the USA and China, which have not yet ratified the CTBT. Moreover, Australia should promote the negotiation of a Comprehensive Fissile Material Cut-Off Treaty to prohibit the further production of fissile material usable for the production of nuclear weapons, prohibit the reprocessing of spent nuclear-power reactor fuel that has been produced by Australian uranium and should not support or encourage the use of Mixed Oxide (MOX) nuclear fuel or the use of Generation IV reactors, particularly fast breeder reactors.

Reasons for the these recommendations. The plutonium recovered from spent civil nuclear-power reactor fuel elements (civil plutonium) can be used to fabricate nuclear weapons with significant explosive powers.

This question has been the subject of much discussion since the end of the Second World War. President Dwight Eisenhower's Atoms for Peace initiative, spread American nuclear knowledge and materials far and wide, apparently on the belief that civil plutonium from power reactors was unsuitable for use in nuclear weapons. The belief that civil and military plutonium could be safely separated was inherent in the negotiation of the Nuclear Non-Proliferation Treaty (NPT) in 1967.

The plutonium produced in nuclear-power reactors operated for the most efficient generation of electricity, called reactor-grade plutonium, contains a higher proportion of the isotope plutonium-240 than that preferred by nuclear-weapon designers. Typical reactor-grade plutonium contains 1.3 per cent plutonium-238, 56.6 per cent of plutonium-239, 23.2 per cent of plutonium-240, 13.9 per cent plutonium-241, and 4.9 per cent plutonium-242. Nuclear-weapon designers prefer plutonium containing, typically, 0.012 per cent of plutonium-238, 93.8 per cent of plutonium-239, 5.8 per cent of plutonium-240, 0.35 per cent of plutonium-241, and 0.022 per cent of plutonium-242, called weapon-grade plutonium. The major difference is that weapon-grade plutonium is richer in plutonium-239 and poorer in plutonium-240 than weapon-grade plutonium.

As J.Carson Mark explained there are two major problems with using reactor-grade plutonium in a nuclear weapon (1). Mark is undoubtedly an expert on the subject. He headed the Theoretical Division at the US Los Alamos National Laboratory for decades; was intimately involved in the design of both nuclear fission weapons and thermonuclear weapons.

The first problem is that plutonium-240 has a high rate of spontaneous fission so that the device will continually produce many neutrons. One of these background neutrons may set off the fission chain reaction prematurely, called pre-initiation, causing the device to have a relatively low explosive yield. The spontaneous emission rate of reactor-grade plutonium is about 360 neutrons/second/gram. The figure for weapon-grade plutonium is about 66 neutrons/second/gram. The probability of pre-initiation using reactor-grade plutonium is, therefore, much larger.

The second problem described by Mark is the heat produced by the alpha-particle decay of plutonium-238. The amount of plutonium-238 in reactor-grade plutonium is about one or two per cent. This contributes 10.5 watts of heat per kilogram of reactor-grade plutonium, compared with 2.3 watts per kilogram of weapons-grade plutonium. The design of a primitive nuclear explosive using reactor-grade plutonium would have to incorporate a method of dispersing the heat – such as the use of aluminium shunts. Otherwise, the plutonium would get very hot and become distorted or even melt.

Mark explained that, in spite of these problems, nuclear weapons could be fabricated using reactor-grade plutonium. “The difficulties of developing an effective design of the most straightforward type is not appreciably greater with reactor-grade plutonium than those that have to be met for the use of weapons-grade plutonium”.

More reactor-grade plutonium than weapon-grade plutonium would be required for a nuclear weapon. The bare sphere critical mass of reactor-grade plutonium is about 13 kilograms; that of weapons-grade plutonium is 10 kilograms.

Mark’s analysis was supported by Richard L. Garwin, another leading American nuclear-weapon expert, who also wrote that reactor-grade plutonium is usable in nuclear weapons, whether by unsophisticated proliferators or by advanced nuclear-weapon states (2). Garwin was a consultant for the Los Alamos National Laboratory from 1950 to 1993, mostly involved with nuclear weapon design, manufacture and testing.

He was an author of the report by the Committee on International Security and Arms Control of the US National Academy of Sciences that concluded: “In short, it would be quite possible for a potential proliferator to make a nuclear explosive from reactor-grade plutonium using a simple design that would be assured of having a yield in the range of one to few kilotons, and more using an advanced design”. (3).

At a conference at the International Atomic Energy Agency in June 1997, Matthew Bunn, of Harvard University, discussed the value of reactor-grade plutonium for the fabrication of nuclear weapons, stating that countries with advanced technologies "could, if they chose to do so, make bombs with reactor-grade plutonium with yield, weight, and reliability characteristics similar to those made from weapon-grade plutonium”. He went on to point out that “in some respects if would actually be easier to make a bomb from reactor-grade plutonium (as no neutron generator would be required)" (4).

A detailed description of the nuclear physics involved in the design of nuclear weapons was given by Amory B. Lovins in the British scientific journal Nature in 1980 (5). It gives the physical basis for understanding the scope for using reactor-grade plutonium in nuclear-fission weapons and shows that plutonium from nuclear-power reactors “can produce powerful and predictable nuclear explosions”.

In 1953, the British exploded a nuclear weapon at the nuclear test site in South Australia made from plutonium of a quality considerably below that of weapons-grade (6). In 1962, the United States conducted a similar nuclear-weapon test (7). The actual amount of Pu-239 in the plutonium used in these tests has not been made public but it was apparently about 19 per cent. The tests were made to prove that reactor-grade plutonium can be used in an effective nuclear weapon.

Given all this evidence, it is, to say the least, surprising that some people still deny that reactor-grade plutonium can be used to fabricate nuclear weapons with significant explosive powers.

The nuclear renaissance now underway will spread civil nuclear technology to more countries so that 40 or so countries will, in the foreseeable future, acquire the capability to produce fissile material that could be used in nuclear weapons, becoming latent or actual nuclear-weapon powers. The international community will then be faced with the threat of nuclear anarchy.

Despite statements to the contrary, there is no "proliferation-proof" nuclear fuel cycle. Proposals have been made to internationalize the enrichment and reprocessing elements of the cycle by putting them under the ownership and control of, for example, the International Atomic Energy Agency (IAEA) that would guarantee an assured supply of nuclear fuel to all countries while providing for safeguards of their nuclear facilities. Such a fuel bank would, however, be discriminatory and, therefore, unacceptable to many countries.

Some countries will not agree to put their nuclear fuel cycles into the hands of the IAEA when the nuclear-weapon states continue to operate and control their own nuclear technologies. These countries perceive a need to keep their civil nuclear technology up-to-date to support their nuclear-weapon programmes.

We will avoid global nuclear anarchy only if the Non-Proliferation Treaty (NPT) is strengthened at the 2010 NPT Review Conference the NPT. Australia should use its influence to this end.

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Frank Barnaby is a nuclear physicist by training. He worked at the Atomic Weapons Research Establishment, Aldermaston (1951-57) and was on the Senior Scientific Staff of the Medical Research Council at University College, London (1957-67). He was the Executive Secretary of the Pugwash Conferences on Science and World Affairs (1967-70) and Director of SIPRI, the Stockholm International Peace Research Institute (1971-81). He was Professor at the Free University, Amsterdam (1981-85), Visiting Professor, Stassen Chair, at the University of Minnesota (1985), and a consultant to the Oxford Research Group on the civil and military uses of nuclear energy and the terrorist use of weapons of mass destruction. He has honorary doctorates in Science from the Free University, Amsterdam, the University of Southampton and the University of Bradford.

He is the author of many books including: *Man and the Atom* (Thames and Hudson, 1971); *The Nuclear Age* (MIT Press, 1974); *The Automated Battlefield* (Sidgwik and Jackson, 1987); *How Nuclear Weapons Spread* (Routledge, 1993); *The Invisible Bomb* (Tauris, 1989); *Instruments of Terror* (Vision Books, 1996); *How to Make a Nuclear Weapon and other Weapons of Mass Destruction* (Granta, 2004), and editor of *Plutonium and Security* (MacMillan, 1992).

He has published a number of research reports on civil and military nuclear issues, including reprocessing and mixed-oxide fuel plants, and was a co-author of the *International Mixed-Oxide Fuel Assessment Report* (1997).