Civil Nuclear Programs & Weapons Proliferation

fact sheet 09

Author: Jim Green energyscience.org.au

Civil nuclear facilities can and have been used in support of nuclear weapons programs.

International safeguards are inadequate for the task.

This paper discusses the numerous methods by which civil nuclear programs can – and do – contribute to the proliferation of nuclear weapons. According to Ian Hore-Lacy from the Uranium Information Centre[1]: "Happily, proliferation is only a fraction of what had been feared when the NPT was set up, and none of the problem arises from the civil nuclear cycle." Hore-Lacy's statement could hardly be further from the truth.

The majority of nuclear technologies and materials are dual–use capable: they can be used in either civil or military nuclear programs. That's why the Non-Proliferation Treaty (NPT) is seen as a deal – countries can access nuclear power technology, but they must forfeit the use of the materials to make nuclear weapons. This deal was engineered by the five 'declared' nuclear weapons states (China, France, Russia, UK and US) in 1970 as a means of allowing other countries to gain nuclear technology and materials, but not nuclear weapons.

The deal, however, has failed. The declared weapons states pay lip-service to their NPT disarmament obligations. Other states have developed nuclear weapons – India, Pakistan, Israel and North Korea (as well as South Africa, which has since disarmed). Nuclear power and research programs have increased the number of 'threshold' states capable of producing weapons in a short space of time – and the current push to expand nuclear power will inevitably increase the number of threshold states.

To make matters worse, the international safeguards system is increasingly vulnerable. The UN Secretary-General's High Level Panel on Threats, Challenges and Change noted:[2] "We are approaching a point at which the erosion of the non-proliferation regime could become irreversible and result in a cascade of proliferation." The International Atomic Energy Agency's Director-General, Mohamed El Baradei, has described the IAEA's basic inspection rights as "fairly limited", complained about "half-hearted" efforts to improve the system, and expressed concern that the safeguards system operates on a "shoestring budget ... comparable to a local police department".[3]

The anatomy of proliferation

Ostensibly civil nuclear materials and facilities can be used in support of nuclear weapons programs in many ways:

- Production of plutonium in reactors followed by separation of plutonium from irradiated material in reprocessing facilities (or smaller facilities, sometimes called hot cells).
- Production of radionuclides other than plutonium for use in weapons, e.g. tritium, used to initiate or boost nuclear weapons.
- Diversion of fresh highly enriched uranium (HEU) research reactor fuel or extraction of HEU from spent fuel.
- Nuclear weapons-related research.
- Development of expertise for parallel or later use in a weapons program.
- Justifying the acquisition of other facilities capable of being used in support of a nuclear weapons program, such as enrichment or reprocessing facilities.
- Establishment or strengthening of a political constituency for nuclear weapons production (a 'bomb lobby').

These are not just hypothetical risks. On the contrary, the use of civil facilities and materials in nuclear weapons research or systematic weapons programs has been commonplace.[4] It has occurred in the following countries: Algeria, Argentina, Australia, Brazil, Egypt, India, Iran, Iraq, Israel, Libya, North Korea, Norway, Pakistan, Poland, Romania, South Africa, South Korea, Sweden, Switzerland, Syria, Taiwan, and Yugoslavia.

Overall, civil nuclear facilities and materials have been used for weapons R&D in about one third of all the countries with a nuclear industry of any significance, i.e. with power and/or research reactors. The Institute for Science and International Security collates information on nuclear programs and concludes that about 30 countries have sought nuclear weapons and nine are known to have succeeded – a similar strike rate of about 30%.[5]

In a number of the countries in which civil materials and facilities have been used in support of military objectives, the weapons-related work was short-lived and fell short of the determined pursuit of nuclear weapons. However, civil programs provided the basis for the full-scale production of nuclear weapons in Israel, India, Pakistan, South Africa, and possibly North Korea. In other cases – with Iraq from the 1970s until 1991 being the most striking example – substantial progress had been made towards a weapons capability under cover of a civil program before the weapons program was terminated.

Civil and military nuclear programs also overlap to a greater or lesser degree in the five 'declared' weapons states – the US, the UK, Russia, China and France. Specific examples – such as the use of a power reactor to produce tritium for weapons in the US – are of less importance than the broad pattern of civil programs providing a large pool of nuclear expertise from which military programs can draw. The five declared nuclear weapons states all have nuclear power reactors and they account for 57% of global nuclear power output (203 out of 370 gigawatts as at September 2006).

Uranium enrichment

There are three methods of using the cover of a civil nuclear program for the acquisition of HEU for weapons production:

- Diversion of imported HEU. An example was the (abandoned) 'crash program' in Iraq in 1991 to build a nuclear weapon using imported HEU. The US alone has exported over 25 tonnes of HEU.
- Extraction of HEU from spent research reactor fuel. HEU has been used in many research reactors but power reactors use low enriched uranium or in some cases natural uranium.
- A civil nuclear program can be used to justify the development of enrichment facilities.

Some examples of the interconnections between enrichment and weapons proliferation include:

- All of the declared Nuclear Weapons States developed enrichment plants. The bomb dropped on Hiroshima was an enriched uranium bomb.
- The South African Apartheid regime acquired enrichment expertise under the guise of its civil nuclear program then built HEU weapons.
- Abdul Qadeer Khan stole enrichment technology from the European consortium URENCO which led to the production of HEU bombs in Pakistan.
- Khan and his black-market colleagues transferred enrichment know-how and/or facilities to North Korea, Iran and Libya and probably other countries. Centrifuges supplied by Khan were last seen in Dubai, and the claim that they were destroyed is widely disbelieved. Enrichment equipment was found at an 'outpost' of the Khan network in South Africa.
- Libya - the Khan network supplied centrifuge components and computer discs containing an entire plan for an enrichment program.
- North Korea has secretly pursued uranium enrichment research with the assistance of the Khan network.
- Iran has pursued enrichment with the assistance of the Khan network, and the secrecy of the enrichment research has aroused suspicion that it has been driven by a military agenda.
- The Iraqi regime was working on five different uranium enrichment methods from the 1970s to 1991 and pursued its 'crash program' to divert imported HEU for a short period in 1991.
- Secret uranium enrichment research began in the basement of a building at Lucas Heights in southern Sydney in 1965, and documents written by the then Chair of the Atomic Energy Commission reveal that there was a military agenda to this research.
- One of the many aspects of South Korea's secret nuclear weapons research program from 1979-2000 involved small-scale, undeclared uranium enrichment.
- Argentina and Brazil both pursued enrichment technology in the context of their virtual nuclear arms race in the 1970s and early 1980s ('virtual' in the sense that the arms race was pursued under the guise of civil nuclear development).
- India's small enrichment program is most likely connected to its military program, e.g. to support the development of thermonuclear weapons.
- The former Yugoslavia studied various enrichment methods in the context of its secret nuclear weapons program.
- Switzerland considered developing enrichment technology and HEU bombs from WWII until it signed NPT in 1969 (though little or no progress was actually made with enrichment technology).

An expansion of nuclear power would most likely result in the spread (horizontal proliferation) of enrichment technologies, justified by requirements and markets for low-enriched uranium (LEU) for power reactors but also capable of being used to produce HEU for weapons.

While concern about enriched uranium is justifiably focussed on HEU, LEU is also of concern. Lance Joseph, a member of the IAEA's International Expert Group on Multilateral Approaches to the Nuclear Fuel Cycle, and Australian Governor on the IAEA Board from 1997-2000, describes the proliferation risks arising from LEU production:[6]

> "This is not only because of the wider access now available to earlier centrifuge technology but also due to the ease of building small or even large-scale centrifuge facilities dedicated to production of highly enriched uranium (HEU), that is, weapons-grade material. In fact, production of a critical quantity of HEU does not actually require a large plant; a good-sized office conference room would accommodate the required number of centrifuges. The task is even simpler if LEU is at hand: at the enrichment level typically used in power reactors - 3.5 per cent uranium 235 - already six-tenths of the separative work has been done; at the 20 per cent U-235 level used in fuel for many research reactors, nine-tenths."

Technical developments in the field of enrichment technology – such as the development of laser enrichment technology by the Silex company at Lucas Heights in Australia – could worsen the situation. Silex will potentially provide proliferators with an ideal enrichment capability as it is expected to have relatively low capital cost and low power consumption, and it is based on relatively simple and practical separation modules.[7]

An Australian Strategic Policy Institute report released in August 2006 notes that an enrichment industry would give Australia "a potential 'break-out' capability whether that was our intention or not" and that this point is "unlikely to be missed by other countries, especially those in Australia's region".[8]

Plutonium and reactors

Israel and India both have arsenals of plutonium fission weapons, with the plutonium produced in ostensibly civil 'research' reactors.

Small volumes of plutonium have been produced in 'civil' reactors then separated from irradiated materials in a number of countries suspected of or known to be interested in the development of a nuclear weapons capability – including Iraq, Iran, South Korea, North Korea, Taiwan, Yugoslavia, and possibly Romania.[9] Pakistan announced in 1998 that a powerful 'research' reactor had begun operation at Khusab; if so, the reactor can produce unsafeguarded plutonium.

Sometimes it is claimed that plutonium from power reactors has never been used in weapons, or more generally that power reactors have not been used to support of weapons programs. These claims are false:

- India has long been suspected of using plutonium from power reactors for weapons.[10] India's recent refusal to subject numerous power reactors to IAEA safeguards, in the context of negotiations with the US over nuclear transfers, proves that the power reactors are used in support of nuclear weapons production.
- Pakistan may use power reactor/s in support of nuclear weapons production.
- North Korea's 'Experimental Power Reactor' has been an important component of the regime's weapons program and was probably the source of fissile material for the October 2006 weapons test.
- A test of sub-weapon-grade plutonium by the US in 1962 may have used plutonium from a power reactor.
- The US currently uses a power reactor to produce tritium for use in nuclear weapons.
- Then Australian Prime Minister John Gorton pushed for the construction of a power reactor at Jervis Bay in NSW in the late 1960s and later acknowledged that he wanted the reactor as a source of plutonium in the event that it was decided to pursue nuclear weapons. Cabinet submissions from the Australian Atomic Energy Commission (now the Australian Nuclear Science and Technology Organisation) repeatedly promoted nuclear power reactors on the grounds that they would produce not only electricity but also plutonium that could be used in weapons.

The (false) claim that power reactors have not become entangled in weapons programs also ignores the pool of expertise required to run a nuclear power program and the actual and potential use of that expertise in military programs. Claims made about power reactors also ignore the fact that 'research' reactors, ostensibly acquired in support of a power program or for other civil purposes, have been the plutonium source in India and Israel with 'research' reactors also involved in weapons programs or weapons research in numerous other countries.

The Uranium Information Centre states that: "Weapons-grade plutonium is not produced in commercial power reactors but in a "production" reactor operated with frequent fuel changes to produce low-burnup material with a high proportion of Pu-239".[11] However, the US government successfully tested a weapon using below-weapon-grade plutonium in 1962 (it is not publicly known whether it used reactor-grade plutonium or the intermediary category of fuel-grade plutonium). Further, the overwhelming weight of expert opinion holds that reactor-grade plutonium can be used in weapons, albeit the case that the process may be more dangerous and difficult, and the weapons may have a lower yield compared to weapon-grade plutonium. Two important points are not in dispute:

- Below-weapon-grade plutonium (reactor-grade or fuel-grade) can be and has been used in nuclear weapons.
- Using a power reactor to produce weapon-grade plutonium could hardly be simpler - all that needs to be done is to shorten the irradiation time, thereby maximising the production of plutonium-239 relative to other, unwanted plutonium isotopes. Indeed low burn-up, weapon-grade plutonium is produced in the normal course of operation of a power reactor, although in the normal course of operation it becomes fuel-grade then reactor-grade plutonium.

Power reactors have been responsible for the production of a vast quantity of weapons-useable plutonium. Adding to the proliferation risk is the growing stockpile of separated plutonium, as reprocessing outstrips the use of plutonium in MOX (mixed oxide fuel containing plutonium and uranium).

A typical power reactor (1000 MWe) produces about 300 kilograms of plutonium each year. Total global production of plutonium in power reactors is about 70 tonnes per year. As at the end of 2003, power reactors had produced an estimated 1,600 tonnes of plutonium.[12]

Using the above figures, and assuming that 10 kilograms of (reactor-grade) plutonium is required to produce a weapon with a destructive power comparable to that of the plutonium weapon dropped on Nagasaki in 1945:

- The plutonium produced in a single reactor each year is sufficient for 30 weapons.
- Total global plutonium production in power reactors each year is sufficient to produce 7,000 weapons.
- Total accumulated 'civil' plutonium is sufficient for 160,000 weapons.

The production of vast amounts of plutonium in power reactors is problem enough, but the problem is greatly exacerbated by the separation of plutonium in reprocessing plants. Whereas separation of plutonium from spent fuel requires a reprocessing capability and is potentially hazardous because of the radioactivity of spent fuel, the use of separated plutonium for weapons production is far less complicated.

The problem is further exacerbated by ongoing plutonium separation in excess of its limited re-use in MOX. According to the Uranium Information Centre, only about one third of separated plutonium has been used in MOX over the last 30 years.[13] Thus the stockpile of separated plutonium continues to grow – about 15-20 tonnes of plutonium are separated from spent fuel each year but only 10-15 tonnes are fabricated into MOX fuel.[14] (Albright and Kramer, 2004.)

Hence there is a growing stockpile of plutonium in unirradiated forms (separated or in MOX), currently amounting to about 270 tonnes – enough for about 27,000 nuclear weapons.

Alternative fuel cycles

The weapons proliferation problem cannot be satisfactorily resolved. Proliferation-resistant technologies are the subject of much discussion and some research (a number of examples are discussed in Australian Safeguards and Non-Proliferation Office.[15]).

However, there is little reason to believe that minimising proliferation risks will be a priority in the evolution of nuclear power technology. The growing stockpiles of unirradiated plutonium provide compelling evidence of the low priority given to non-proliferation initiatives compared to commercial and political (and sometime military) imperatives.

Further, a number of the ‘advanced’ reactor concepts being studied involve the large-scale use of plutonium and the operation of fast breeder reactors.[16]

Plutonium breeder reactors rely on plutonium as the primary fuel. There are various possible configurations of breeder systems. Most rely on irradiation of a natural or depleted uranium blanket that produces plutonium that can be separated and used as fuel. Breeder reactors can potentially produce more plutonium than they consume, and the use of uranium is only a tiny fraction of that consumed in conventional reactors.[17] Breeder technology is highly problematic in relation to proliferation because it involves the large-scale production and separation of plutonium (although separation is not required in some proposed configurations).[18] The proliferation of reprocessing capabilities is a likely outcome.

Like conventional reactors, proposed ‘Pebble Bed’ reactors are based on uranium fission. The nature of the fuel pebbles may make it somewhat more difficult to separate plutonium from irradiated fuel. However, uranium (or depleted uranium) targets could be inserted to produce weapon-grade plutonium for weapons. The enriched uranium fuel could be further enriched for HEU weapons - particularly since the proposed enrichment level of 9.6% Uranium-235 is about twice the level of conventional reactor fuel. The reliance on enriched uranium will encourage the use and perhaps proliferation of enrichment plants, which can be used to produce HEU for weapons.[19]

Fusion power systems remain a distant dream, and fusion also poses a number of weapons proliferation risks including the following:

- The production or supply of tritium which can be diverted for use in boosted nuclear weapons.
- Using neutron radiation to bombard a uranium blanket (leading to the production of fissile plutonium) or a thorium blanket (leading to the production of fissile Uranium-233).
- Research in support of a (thermonuclear) weapon program.[20]

The use of Thorium-232 as a reactor fuel is sometimes suggested as a long-term energy source, partly because of its relative abundance compared to uranium. No thorium-based power system would negate proliferation risks altogether.[21] Neutron bombardment of thorium (indirectly) produces Uranium-233, a fissile material which is subject to the similar safeguards requirements as plutonium and HEU. For Uranium-233, one Significant Quantity - the amount required to build a nuclear weapon - is 8 kgs. The possible use of HEU or plutonium to initiate a Thorium-232/Uranium-233 reaction is a further proliferation concern. Most proposed thorium fuel cycles require reprocessing with the attendant proliferation risks.

Further reading:

Institute for Science and International Security, n.d., “Nuclear Weapons Programs Worldwide: An Historical Overview”, www.isis-online.org/mapproject/introduction.html.

Nuclear Weapon Archive, n.d., “Nuclear Weapon Nations and Arsenals”, nuclearweaponarchive.org/Nwfaq/Nfaq7.html.

References

1 Hore-Lacy, Ian, 2000, “The Future of Nuclear Energy”, www.uic.com.au/opinion6.html.
2 UN Secretary-General’s High Level Panel on Threats, Challenges and Change, “A More Secure World: Our Shared Responsibility”, November 2004, www.un.org/secureworld.
3 El Baradei, Mohamed, n.d., various speeches and papers available at www.iaea.org/NewsCenter/Statements/index.html.
4 Nuclear Weapon Archive, n.d., “Nuclear Weapon Nations and Arsenals”, nuclearweaponarchive.org/Nwfaq/Nfaq7.html. Green, Jim, 2002, “Research Reactors and Nuclear Weapons”, paper prepared for the Medical Association for the Prevention of War, www.mapw.org.au/nuclear-reactors/02green.html. ISIS - Institute for Science and International Security, n.d., “Nuclear Weapons Programs Worldwide: An Historical Overview”, www.isis-online.org/mapproject/introduction.html.
5 ISIS - Institute for Science and International Security, 2004, “Civil Plutonium Produced in Power Reactors”, www.isis-online.org/global_stocks/civil_pu.html.
6 Joseph, Lance, 2005, “Multilateral Approaches to the Nuclear Fuel Cycle”, Lowy Institute for International Policy, www.lowyinstitute.org/Publication.asp?pid=293.

7 Greenpeace, 2004, “Secrets, Lies and Uranium Enrichment: The Classified Silex Project at Lucas Heights”, www.greenpeace.org.au/frontpage/pdf/silex_report.pdf, and Boureston, Jack, and Charles D. Ferguson, March/April 2005, “Laser enrichment: Separation anxiety”, Bulletin of the Atomic Scientists, Vol.61, No.2, pp.14-18, www.thebulletin.org/article.php?art_ofn=ma05boureston.
8 Davies, Andrew, 2006, Australian uranium exports and security: Preventing proliferation. Australian Strategic Policy Institute . www.aspi.org.au/publications.cfm?pubID=98.
9 Green, 2002.
10 Albright, David, and Mark Hibbs, September 1992, “India’s silent bomb”, Bulletin of the Atomic Scientists, Vol.48, No.07, pp.27-31, www.thebulletin.org/article.php?art_ofn=sep92albright.
11 Uranium Information Centre, October 2004, “Safeguards to Prevent Nuclear Proliferation”, Nuclear Issues Briefing Paper 5, www.uic.com.au/nip05.htm.
12 ISIS - Institute for Science and International Security, 2004.
13 Uranium Information Centre, 2002, “Plutonium”, Nuclear Issues Briefing Paper 18, www.uic.com.au/nip18.htm.
14 Albright, David, and Kimberly Kramer, November/December 2004, “Fissile material: Stockpiles still growing”, Bulletin of the Atomic Scientists, Vol.60, No.6, pp.14-16, www.thebulletin.org/article.php?art_ofn=nd04albright_016.
15 Australian Safeguards and Non-Proliferation Office, n.d., “The Nuclear Non-Proliferation Regime: An overview of Insttutional & Technical Issues”, www.asno.dfat.gov.au/nuclear_safeguards.html.
16 Burnie, Shaun, April 2005, “Proliferation Report: sensitive nuclear technology and plutonium technologies in the Republic of Korea and Japan”, Greenpeace report, www.greenpeace.org/international/press/reports/Proliferation-Korea-Japan>.
17 Hirsch, Helmut, Oda Becker, Mycle Schneider and Antony Froggatt, April 2005, “Nuclear Reactor Hazards: Ongoing Dangers of Operating Nuclear Technology in the 21st Century”, Report prepared for Greenpeace International, pp33-35. www.greenpeace.org/international/press/reports/nuclearreactorhazards; and von Hippel, Frank, and Suzanne Jones, 1997, “The slow death of the fast breeder”, Bulletin of the Atomic Scientists, Vol.53, No.5, September/October.
18 Feiveson, Harold, 2001, “The Search for Proliferation-Resistant Nuclear Power”, The Journal of the Federation of American Scientists, September/October 2001, Volume 54, Number 5, www.fas.org/faspir/2001/v54n5/nuclear.htm.
19 Harding, Jim, 2004, “Pebble Bed Modular Reactors—Status and Prospects “, www.rmi.org/sitepages/pid171php#E05-10
20 Gsponer, A., and J-P. Hurni, 2004 “ITER: The International Thermonuclear Experimental Reactor and the Nuclear Weapons Proliferation Implications of Thermonuclear-Fusion Energy Systems”, Independent Scientific Research Institute report number ISRI-04-01, http://arxiv.org/abs/physics/041110; WISE/NIRS, February 13, 2004, “The Proliferation Risks of ITER”, WISE/NIRS Nuclear Monitor, #603, www.antenna.nl/wise/603/index.php; and Hirsch et al., 2005.
21 Friedman, John S., 1997, “More power to thorium?”, Bulletin of the Atomic Scientists, Vol. 53, No.5, September/October; and Feiveson, 2001.

About the author:

Jim Green is the national nuclear campaigner with Friends of the Earth. He has an honours degree in public health and a PhD in science and technology studies for his doctoral thesis on the Lucas Heights research reactor debates. He is the author of the September 2005 report, ‘Nuclear Power: No Solution to Climate Change’, available at: www.melbourne.foe.org.au/documents.htm.

About our organisation:

energyscience.org.au is a co-operative production by a group of concerned scientists, engineers and policy experts that seek to promote a balanced and informed discussion on the future energy options for Australia.
With increasing concern over the looming impact of global climate change the community needs to be aware of the issues involved. energyscience aims to provide reliable and evidence based information to our whole community

Contact details:
via our website: **www.energyscience.org.au**
