5

Fuel cycle multilateralisation

Introduction

5.1 While treaty-based commitments, notably the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and its associated verification measures, form the key institutional elements of the nuclear non-proliferation regime, these are complimented by a number of other institutional and technical measures aimed at providing assurance that the peaceful use of nuclear energy does not contribute to the proliferation of nuclear weapons.

5.2 A set of institutional proposals which would multilateralise sensitive stages of the nuclear fuel cycle are among the complimentary initiatives now receiving considerable attention by governments. These institutional proposals are examined in this chapter.

5.3 While proposals to multilateralise the fuel cycle have been advocated on several occasions since the 1940s, the principal concern driving renewed interest in these concepts is whether the expected expansion of nuclear energy programs world wide—the so-called nuclear renaissance—will lead to a much wider spread of proliferation-sensitive nuclear technologies, which are capable of producing fissile materials suitable for use in weapons.

5.4 For Dr Yuri Yudin, Senior Researcher at the United Nations Institute for Disarmament Research (UNIDR):

> The revival of interest in nuclear power could result in the worldwide dissemination of uranium enrichment and spent fuel reprocessing technologies, which present obvious risks of

> proliferation as these technologies can produce fissile materials that are directly usable in nuclear weapons—high enriched uranium and separated plutonium.[1]

5.5 The Nuclear Threat Initiative (NTI), among a range of submitters, concurred with this view:

> The growing distribution and quantities of nuclear bomb making material—plutonium and highly enriched uranium—around the globe, dramatically increases the risk that these materials will be illicitly acquired … for use in a crude nuclear weapon. The challenge of securing weapons useable nuclear materials will continue to grow with the anticipated expansion of nuclear power and related fuel cycle facilities.[2]

5.6 Dr Hans Blix submitted that:

> If reliance on nuclear power increases, as is expected, the need for a greater production of low-enriched uranium fuel and for the disposal of spent fuel can be anticipated. This must occur in a manner that does not increase the risks of proliferation and the diversion of nuclear materials.[3]

5.7 For the Department of Foreign Affairs and Trade and Australian Safeguards and Non-Proliferation Office, the potential for the spread of proliferation-sensitive nuclear technologies requires an international response to address issues including:

- how to reduce the availability of sensitive nuclear technology for misuse now or in the future; and
- how to ensure that states with nuclear power programs have a secure and reliable supply of fuel, so they have a viable alternative to developing national enrichment or reprocessing capabilities.[4]

Proliferation implications of the global expansion of nuclear power

5.8 According to the International Atomic Energy Agency (IAEA), as at August 2009 there were 436 nuclear power reactors operating in 30

1 Y Yudin, *Multilateralization of the Nuclear Fuel Cycle: Assessing the Existing Proposals*, UNIDR, Switzerland, 2009, p. xi.

2 NTI, *Submission No. 87*, p. 1; Mr John Carlson, *Introduction to the Concept of Proliferation Resistance*, 23 January 2009, p. 1, *Exhibit No. 80*.

3 Dr Hans Blix, *Submission No. 78*, p. 3.

4 Department of Foreign Affairs and Trade and Australian Safeguards and Non-Proliferation Office, *Submission No. 29*, p. 12.

countries, with 52 reactors under construction world wide.[5] The Australian Bureau of Agricultural and Resources Economics states that 64 reactors will be commissioned over the next six years, with growth concentrated in China, the Russian Federation and India.[6]

5.9 On the other hand, a report commissioned by the German Government paints a more conservative picture, stating that after 2015 old reactors will be decommissioned at a greater rate than new projects will be coming online.[7]

5.10 In a research paper commissioned by the International Commission on Nuclear Non-proliferation and Disarmament (ICNND), Ms Martine Letts and Ms Fiona Cunningham argued that the proliferation risk of the expansion in civil nuclear energy is determined by three factors:

- whether the expansion takes place in existing nuclear power states or new nuclear power states;
- the geostrategic contexts of the countries acquiring nuclear technology for the first time; and
- the nature of the technologies acquired.[8]

5.11 While 80 per cent of the growth in nuclear capacity is forecast to occur in countries that already operate reactors, evidence suggested that over the decades ahead numerous countries propose to introduce nuclear power:

- The OECD Nuclear Energy Agency (OECD-NEA) states that 25 countries that do not currently use nuclear energy have either announced plans or are considering building nuclear power plants. Of these, six countries have firm plans to build a total of some 16 reactors: Vietnam, Turkey, Iran, Indonesia, Belarus and the United Arab

5 IAEA, *Power Reactor Information System*, viewed 1 September 2009, <http://www.iaea.or.at/programmes/a2/>; IAEA, *Nuclear Power Reactors in the World*, 2009 Edition, IAEA, Vienna, 2009, p. 11, viewed 1 September 2009, <http://www-pub.iaea.org/MTCD/publications/PDF/RDS2-29_web.pdf>. In 2008, nuclear reactors generated 2,598 terawatt-hours of electricity and supplied 17.7 per cent of the global total. One gigawatt electric equals one billion watts of electrical capacity.

6 M Lampard, 'Uranium', *Australian Commodities*, Vol 16, No. 1, Australian Bureau of Agricultural and Resource Economics, Canberra, March 2009, viewed 1 September 2009, <http://www.abareconomics.com/interactive/09ac_mar/htm/uranium.htm>.

7 M Schneider et. al., *The World Nuclear Industry Status Report 2009*, German Department of the Environment, Nature Conservation and Reactor Safety, viewed 15 September 2009, <http://www.bmu.de/english/nuclear_safety/downloads/doc/44832.php >.

8 M Letts and F Cunningham, 'The role of the civil nuclear industry in preventing proliferation and in managing the second nuclear age', *Paper prepared for the Second Meeting of the International Commission on Nuclear Non-proliferation and Disarmament, Washington, 13–15 February 2009*, p. 12.

Emirates. The other countries are: Thailand, Bangladesh, Bahrain, Egypt, Ghana, Georgia, Israel, Jordan, Kazakhstan, Kuwait, Libya, Malaysia, Namibia, Nigeria, Oman, the Philippines, Qatar, Saudi Arabia, Uganda, Venezuela and Yemen.[9]

- The IAEA reported in 2008 that 51 countries had expressed interest in the possible introduction of nuclear power over the previous two years, with 12 countries actively preparing for nuclear power.[10] In July 2009, the Agency reported that 60 countries are now considering nuclear power and 20 countries may introduce by 2030.

5.12 Former Senator Bob Graham, Chair of the US Congressional Commission on Weapons of Mass Destruction Proliferation and Terrorism, argued that:

> Today, there are some 20 or 25 countries that are considering either expanding existing civilian nuclear or starting a civilian nuclear plant. We are concerned that if that is not accompanied by some appropriate security steps that that becomes another vulnerability for the leakage of nuclear material into the hands of terrorists.[11]

5.13 The Commission's report, *World at Risk*, warned that:

> Concern about the spread of nuclear weapons intensifies with the possibility of a large increase in nuclear power production to meet growing energy demands—a nuclear renaissance. As additional countries acquire nuclear facilities—particularly if they build uranium enrichment or reprocessing facilities … the number of states possessing the knowledge and capability to 'break out' and produce nuclear weapons will increase significantly. This also increases the risk that such materials could be diverted to, or stolen by, terrorist groups.[12]

---

9 OECD-NEA, *Nuclear Energy Outlook 2008*, OECD-NEA, Paris, 2008, pp. 75–76, *Exhibit No. 14*. See also: International Security Advisory Board, *Report on Proliferation Implications of the Global Expansion of Civil Nuclear Power*, US Department of State, 7 April 2008, p. 3. The report notes that 12 countries have plans to introduce nuclear power within ten years: Azerbaijan, Norway, Turkey, Belarus, Poland, Vietnam, Egypt, Indonesia, Kazakhstan, Lithuania, Estonia and Latvia.

10 IAEA, *International Status and Prospects for Nuclear Power*, IAEA, Vienna, 2008, p. 21.

11 Senator Bob Graham, *Transcript of Evidence*, 26 March 2009, p. 2.

12 Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism, *World At Risk: The Report of the Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism*, Vintage Books, New York, 2008, pp. 14–15.

5.14 Senator Graham also observed that as the nuclear renaissance progresses and more nuclear facilities are built, the resources of the IAEA will be placed under greater strain than they currently are.[13]

5.15 Similarly, the Hon Gareth Evans AO QC remarked that:

> An expansion of civil nuclear energy—a dramatic expansion—even if oil prices stay as low as they are now, is a significant reality for the future. It is very important that we do not multiply proliferation risks associated with that expansion …[14]

Proliferation-sensitive nuclear technologies

5.16 As noted in the preceding section and in the discussion of the Fissile Material Cut-off Treaty, production of nuclear weapons requires a sufficient quantity of fissile material with a suitable isotopic composition, combined with the necessary technical capability. The fissile material required to construct nuclear weapons would need to be either highly enriched uranium or plutonium.

5.17 The two technologies currently utilised in the civil nuclear fuel cycle which have the potential to produce weapons-usable material, and are thus considered proliferation-sensitive nuclear technologies (SNT), are uranium enrichment and the separation of plutonium as part of the reprocessing of used nuclear fuel. The place of these technologies in the nuclear fuel cycle is illustrated in figure 5.1.

5.18 The civil nuclear fuel cycle refers collectively to the industrial activities associated with the generation of power from nuclear reactions. The main stages in the fuel cycle are:

- mining and milling of uranium ore;
- uranium conversion;
- uranium enrichment;
- fuel fabrication;
- fission of the fuel in a reactor for the generation of power, or production of radioisotopes (for medical, industrial or research purposes);
- interim storage of used fuel;

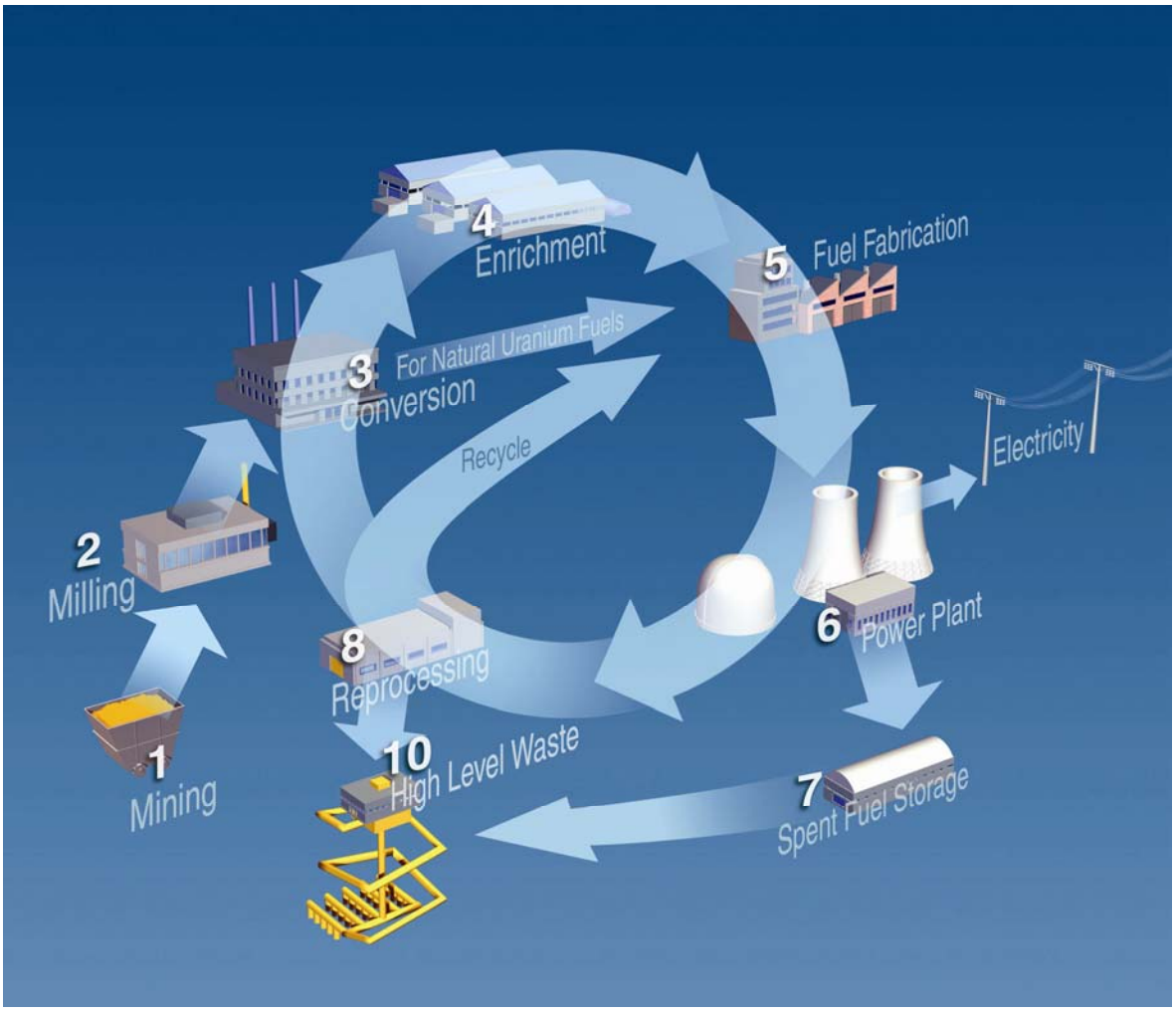
13 Senator Bob Graham, *Transcript of Evidence*, 26 March 2009, p. 13

14 Hon Gareth Evans AO QC, *Transcript of Evidence*, 26 February 2009, p. 5.

- reprocessing of the used fuel; and
- management and disposal of wastes.[15]

5.19 The 'front end' of the fuel cycle refers to those stages involved in the preparation of the fuel, while the 'back end' refers to those stages concerning the management, storage, and either reprocessing or long-term disposal of used fuel.

Figure 5.1 The civil nuclear fuel cycle



Source International Atomic Energy Agency

15 Y Yudin, *Multilateralization of the Nuclear Fuel Cycle: Assessing the Existing Proposals*, UNIDR, Switzerland, 2009, p. 65.

Uranium enrichment

5.20 As noted in chapter three, uranium enrichment is achieved through the implementation of complex processes of nuclear physics to increase the proportion of the fissile isotope uranium-235 (U-235) in a given quantity of uranium and decreasing that of the far more abundant U-238 isotope. Enriched uranium is uranium in which the proportion of U-235 has been concentrated above the 0.71 per cent found in nature. This process requires a uranium enrichment facility and enriched uranium is a critical component for both civil nuclear power generation and nuclear weapons.

5.21 For the operation of the most common type of power reactor—the light water reactor—the proportion of U-235 must be increased typically to between three and five per cent U-235. This is described as low enriched uranium (LEU), with the upper limit of the LEU category set at approximately 20 per cent U-235. Uranium in which the U-235 content is above 20 per cent is referred to as highly enriched uranium (HEU).

5.22 While nuclear weapons have been made from HEU at approximately 80 per cent enrichment, 'weapons-grade' uranium is defined as having an enrichment level of 90 per cent and above.[16] Importantly, there is no technological barrier between the production of LEU and HEU—weapon grade material can be produced with the same enrichment equipment that otherwise is used to produce LEU for civilian power generation.[17]

5.23 The IAEA defines HEU as a 'direct use material'; that is, 'nuclear material that can be used for the manufacture of nuclear explosive devices without transmutation or further enrichment.' The Agency also defines the approximate amount of HEU for which the possibility of manufacturing a nuclear explosive device cannot be excluded—the 'significant quantity'—as being 25 kilograms.[18]

5.24 Two enrichment processes are in large scale commercial use at present—gaseous diffusion and gas centrifuge technologies. There are four principal enrichment suppliers in the world (Areva, Tenex, Urenco and USEC), with commercial enrichment facilities in six countries—France, Germany, the Netherlands, the Russian Federation, the UK and the US. In addition, China and Japan have large enrichment facilities, which are used to satisfy

16 Mr John Carlson, *Introduction to the Concept of Proliferation Resistance*, 23 January 2009, p. 29, *Exhibit No. 80*.

17 Y Yudin, *Multilateralization of the Nuclear Fuel Cycle: Assessing the Existing Proposals*, UNIDR, Switzerland, 2009, p. 69.

18 IAEA, *IAEA Safeguards Glossary, 2001 Edition*, IAEA, Vienna, 2002, pp. 33, 23.

domestic demand; Brazil is currently commissioning a commercial-scale facility; Pakistan operates a plant for military purposes and is planning a new civil enrichment facility; and Argentina operates a pilot plant. Including Iran, a total of 13 countries operate enrichment facilities and 15 commercial-scale enrichment plants are in operation worldwide today.[19]

5.25 The safeguards status of all commercial-scale enrichment facilities that are currently in operation, being commissioned, under construction or planned are listed in appendix F.

5.26 Two centrifuge plants are currently under construction in the US (Urenco Eunice, New Mexico and USEC Piketon, Ohio). In addition, Areva recently applied for a license to build a third US centrifuge plant (Eagle Rock, Idaho). Areva is also replacing the existing gaseous diffusion plant in France with a new centrifuge plant (George Besse II). All these new plants will be offered for IAEA safeguards.[20]

5.27 Nevertheless, very few if any of these new large-scale plants in the weapon states will apparently be selected for safeguards due to IAEA budget constraints. The IAEA is also not officially involved in discussions with the future operators of these plants, which could facilitate implementation of safeguards at a later stage.[21]

5.28 The potential for enrichment facilities to be misused to produce uranium sufficiently enriched so that it could be used for weapons is of great concern:

> Even a relatively small enrichment plant with the capacity to enrich uranium to fuel a single standard nuclear power reactor provides the capability to produce annually enough highly enriched uranium for a significant number of weapons. In the case of centrifuge facilities, and in contrast to other enrichment processes, conversion to military use can be done rather quickly. The fact that such plants are also easy to conceal, and thus could

19 M ElBaradei, *Possible New Framework for the Utilization of Nuclear Energy: Options for Assurance of Supply of Nuclear Fuel*, GOV/INF/2007/11, IAEA, Vienna, 13 June 2007, Annex 2, p. 1.

20 A Glaser, 'Internationalization of the Nuclear Fuel Cycle', *Research paper commissioned by the ICCND*, February 2009, p. 17, viewed 31 August 2009, <http://www.icnnd.org/latest/research/index.html>.

21 A Glaser, 'Internationalization of the Nuclear Fuel Cycle', *Research paper commissioned by the ICCND*, February 2009, p. 17, viewed 31 August 2009, <http://www.icnnd.org/latest/research/index.html>.

> be built clandestinely, adds to the concern. This prospect is seen as a challenge to the non-proliferation regime …[22]

5.29 While the outlook for enrichment capacity and the economic justification for new enrichment facilities is unclear, some evidence suggested that '[n]ot very many new enrichment plants will be needed in the next two decades' and that:

> A very significant fraction (at least 75%, and up to 100%) of the future demand of enrichment services will be covered by enrichment plants that *already* exist today, are currently being expanded, and under construction or planned.[23]

5.30 The IAEA and the WNA report that total world enrichment capacity currently exceeds demand by a significant margin.[24] However, the Australian Safeguards and Non-Proliferation Office noted that '[a]n increase in global enrichment capacity will be needed from as early as the coming decade.'[25]

5.31 Other than those countries noted above, which have plants under construction or planned, no additional states currently have plans to construct commercial enrichment plants, although Argentina, Brazil and South Africa 'have the capacity and so far insist on the right to do so in future.'[26]

Plutonium separation (reprocessing of used fuel)

5.32 Plutonium is produced in the fuel of all uranium-fuelled reactors, but is retained within used fuel unless separated through a chemical process known as reprocessing. To obtain separated plutonium requires both a reactor and a reprocessing (or plutonium extraction) facility.

---

22 A Glaser, 'Internationalization of the Nuclear Fuel Cycle', *Research paper commissioned by the ICCND*, February 2009, p. 26, viewed 31 August 2009, <http://www.icnnd.org/latest/research/index.html>.

23 A Glaser, *Internationalization of the Nuclear Fuel Cycle*, February 2009, p. 13, viewed 30 August 2009, <http://www.icnnd.org/latest/research/index.html>. Emphasis in original.

24 M ElBaradei, *Possible New Framework for the Utilization of Nuclear Energy: Options for Assurance of Supply of Nuclear Fuel*, GOV/INF/2007/11, IAEA, Vienna, 13 June 2007, Annex 2, p. 1; WNA, 'Uranium Enrichment', *Information Paper*, viewed 2 September 2009, <http://www.world-nuclear.org/info/inf28.html>.

25 Mr John Carlson, *Introduction to the Concept of Proliferation Resistance*, 23 January 2009, p. 26, *Exhibit No. 80*.

26 M Letts and F Cunningham, 'The role of the civil nuclear industry in preventing proliferation and in managing the second nuclear age', *Paper prepared for the Second Meeting of the International Commission on Nuclear Non-proliferation and Disarmament, Washington, 13–15 February 2009*, p. 13.

5.33 Reprocessing is undertaken in the civil fuel cycle in order to recycle uranium and plutonium into fresh reactor fuel.

5.34 The predominant uranium isotope U-238 is described as 'fertile'; that is, when irradiated in a reactor it can capture a neutron and transform into a new element, plutonium (Pu). The initial plutonium isotope formed is Pu-239, which is fissile. Higher irradiation levels, usually equating to longer periods in the reactor, result in additional neutron capture, producing higher plutonium isotopes, e.g. Pu-240. Increased irradiation also produces quantities of a lower plutonium isotope, Pu-238.

5.35 Plutonium-239 is the plutonium isotope of primary interest for nuclear weapons. Plutonium-238 and the plutonium isotopes higher than Pu-239 have properties which present technical difficulties for weapons use (high spontaneous fission rate, radiation and heat levels). 'Weapons grade' plutonium is defined as comprising no more than seven per cent of the isotope Pu-240; that is, around 93 per cent Pu-239.

5.36 The IAEA defines all plutonium, except for plutonium containing 80 per cent or more of Pu-238, as direct use material and identifies the significant quantity as being eight kilograms.[27] This effectively defines any plutonium discharged from commercial nuclear reactors as direct use material.

5.37 According to the International Panel on Fissile Materials, the global stockpile of separated plutonium is currently about 500 tonnes, divided almost equally between civilian and military stocks.[28]

5.38 Dr Richard L Garwin, a long-term consultant on nuclear weapon design and testing for the US Los Alamos National Laboratory and the author of the design used in the first hydrogen bomb, submitted that while there are impediments to using reactor grade Pu for weapons and no nation is likely to prefer reactor grade Pu for its weapons, it is possible nonetheless:

> Virtually any combination of plutonium isotopes … can be used to make a nuclear weapon. Not all combinations, however, are equally convenient or efficient.
>
> … it would be quite possible for a potential proliferator to make a nuclear explosive device from reactor-grade plutonium using a

27 IAEA, *IAEA Safeguards Glossary, 2001 Edition*, IAEA, Vienna, 2002, p. 23. Dr Frank Barnaby states that the critical mass of weapons grade Pu required for a nuclear weapon is 10 kilograms, and approximately 13 kilograms of reactor grade Pu. See: Dr Frank Barnaby, *Submission No. 19*, p. 3.

28 International Panel on Fissile Materials, *Nuclear Weapon and Fissile Material Stockpiles and Production*, viewed 2 September 2009, <http://www.fissilematerials.org/ipfm/pages_us_en/fissile/inventories/inventories.php>.

> simple design that would be assured of a yield in the range of one to a few kilotons, and more using an advanced design. Theft of separated plutonium whether weapons-grade or reactor-grade, would pose a grave security risk.[29]

5.39 The currently established reprocessing technology is known as PUREX (Plutonium and Uranium Recovery by Extraction). Spent fuel is dissolved and the resulting solution is separated into three streams—unused uranium, plutonium and fission products (waste).[30]

5.40 Reprocessing plants for civilian used fuel operate at present in France, the UK, India, the Russian Federation and Japan, with other commercial-scale facilities also operating in Israel and Pakistan.[31]

5.41 The safeguards status of commercial-scale reprocessing facilities that are in operation, under construction, on standby or deferred and their type (military, civilian or dual use) is listed in appendix G.

5.42 In addition to the commercial-scale facilities, smaller scale reprocessing facilities (e.g. laboratories or pilot plants) are located in Argentina, Belgium, Brazil, China, Democratic People's Republic of Korea (DPRK), Germany, India, Italy and Norway. However, according to the IAEA, only the pilot plant in India is currently operational and China's pilot plant is commissioning.[32]

5.43 Other than the Japanese Rokkasho plant, no state currently has firm plans to construct a commercial reprocessing facility. However, the anticipation of growth in nuclear energy has revived interest in reprocessing. For instance, renewed US support for reprocessing as a method of disposing of waste has led to cooperation with South Korea on new reprocessing techniques.[33]

---

29 Dr Richard L Garwin, *Submission No. 85*, pp. 3–4. See also: Dr Frank Barnaby, *Submission No. 19*, p. 3.

30 Mr John Carlson, *Introduction to the Concept of Proliferation Resistance*, 23 January 2009, p. 22, *Exhibit No. 80*.

31 International Panel on Fissile Materials, *Production and Disposition of Fissile Materials*, viewed 2 September 2009, <http://www.fissilematerials.org/ipfm/pages_us_en/fissile/production/production.php>.

32 IAEA, *Nuclear Fuel Cycle Information System*, 2009, viewed 1 September 2009, <http://www-nfcis.iaea.org/NFCIS/NFCISMAin.asp>. The facilities located in the other countries are variously decommissioning, decommissioned, shutdown, deferred or, in the case of the DPRK, on standby.

33 M Letts and F Cunningham, 'The role of the civil nuclear industry in preventing proliferation and in managing the second nuclear age', *Paper prepared for the Second Meeting of the International Commission on Nuclear Non-proliferation and Disarmament, Washington, 13–15 February 2009*, p. 14.

5.44 Used fuel reprocessing has been deployed by few countries to date, and mainly for military purposes. With the exception of Pakistan, all official, de facto and suspected nuclear-weapon states used reprocessing technology to produce plutonium for their nuclear weapons. Only India, Pakistan, possibly Israel (and now also possibly the DPRK) are believed to be producing fissile materials (Pu or HEU) for nuclear weapons.[34]

5.45 While the Committee's evidence did not contain forecasts for the reprocessing capacity that may be needed to meet the requirements of an expansion in nuclear energy use, an independent Commission appointed by the Director General of the IAEA, to examine the role of the Agency to 2020 and beyond, came to the following conclusion on this question in its report *Reinforcing the Global Nuclear Order for Peace and Prosperity*:

> The economics of complex and sensitive nuclear fuel-cycle facilities (for uranium enrichment or spent fuel reprocessing) do *not* warrant a multiplication of these facilities. They rather call for establishing large-scale multinational facilities in a limited number of locations that are optimized to respond to worldwide needs.[35]

5.46 The Commission went on to conclude that:

> Countries that choose to develop nuclear energy without investing in such facilities must be assured at all times they will be able to obtain the necessary supplies to operate their reactors over the long term.[36]

Proposals to limit the spread of sensitive technologies

5.47 To limit the spread of SNT, institutional impediments to proliferation have been proposed which include multilateralising sensitive stages of the fuel cycle and nuclear fuel supply assurances. While these proposals are the subject of this chapter, other institutional impediments to nuclear proliferation include:

---

34 Y Yudin, *Multilateralization of the Nuclear Fuel Cycle: Assessing the Existing Proposals*, UNIDR, Switzerland, 2009, p. 73.

35 Report prepared by an independent Commission at the request of the Director General of the IAEA, *Reinforcing the Global Nuclear Order for Peace and Prosperity: The Role of the IAEA to 2020 and Beyond*, IAEA, Vienna, 2008, p. 7. Emphasis added.

36 Report prepared by an independent Commission at the request of the Director General of the IAEA, *Reinforcing the Global Nuclear Order for Peace and Prosperity: The Role of the IAEA to 2020 and Beyond*, IAEA, Vienna, 2008, p. 7.

- the IAEA's safeguards measures, which have been considered in the previous chapter;
- interdiction activities of the Proliferation Security Initiative; and
- national controls on the supply of nuclear materials, equipment and technology, including through the export guidelines developed by the Nuclear Suppliers Group.

5.48 In addition, technical measures for proliferation resistance—the development of proliferation-resistant fuel cycle technologies—are also being developed, notably by the two major international programs working in this area—the IAEA's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) and the Generation IV International Forum (GIF).[37]

5.49 The Hon Gareth Evans AO QC stated that development of proliferation-resistant technologies and nuclear industry codes of conduct were important elements, alongside the various institutional impediments, to ensuring that expansion of civil nuclear energy does not multiply proliferation dangers. These other factors will be examined by the ICNND.[38]

Sensitive technology export controls — the role of the Nuclear Suppliers Group

5.50 Since 1978 the international system to regulate nuclear trade has been managed by the Nuclear Suppliers Group (NSG). These states have agreed to rules for the export of critical nuclear material, equipment and technology, including the requirement for full-scope IAEA safeguards.

5.51 In February 2004 US President George Bush proposed that the NSG should refuse transfers of SNT to any state not already possessing full-scale enrichment or reprocessing facilities. To date, this proposal has not been taken up by the NSG. However, the NSG guidelines do encourage a move away from transfers of new national enrichment and reprocessing facilities, stating that:

> Suppliers should exercise restraint in the transfer of sensitive facilities, technology and material usable for nuclear weapons or other nuclear explosive devices. If enrichment or reprocessing

37 Mr John Carlson, *Introduction to the Concept of Proliferation Resistance*, 23 January 2009, p. 4, *Exhibit No. 80*. See also the web sites for the GIF <http://www.gen-4.org/> and INPRO <http://www.iaea.org/INPRO/ >, viewed 1 September 2009.

38 Hon Gareth Evans AO QC, *Transcript of Evidence*, 26 February 2009, p. 5.

> facilities, equipment or technology are to be transferred, suppliers should encourage recipients to accept, as an alternative to national plants, supplier involvement and/or other appropriate multinational participation in resulting facilities. Suppliers should also promote international (including IAEA) activities concerned with multinational regional fuel cycle centres.[39]

5.52 Successive G-8 Summits have agreed that SNT will not be supplied to states that may seek to use them for weapons purposes, or allow them to fall into terrorist hands. The G-8 agreed that the export of such items should occur only pursuant to criteria consistent with global non-proliferation norms and to those states rigorously committed to these norms. These criteria are now being developed in the NSG.

5.53 The NSG has been discussing possible criteria for supply of SNT but has not yet reached agreement. Details are kept confidential, but the Australian Safeguards and Non-Proliferation Office suggests that possible criteria could include:

- the state's non-proliferation and safeguards record, including whether it has an Additional Protocol in place;
- whether there is a clear rationale for the proposed project in terms of energy requirements and economics;
- whether the project will be wholly national or involves others, e.g. through multination/regional arrangements; and
- whether the project has any implications for international/regional security and stability.[40]

5.54 Several submitters recommended tighter controls on the export of SNT.[41]

5.55 Senator Bob Graham expressed concern about the export of nuclear technologies to countries which do not have the experience or regulatory structures in place to manage the facilities, and thus increasing the potential for proliferation.[42]

---

39 IAEA, INFCIRC/254/Rev.9/Part 1a, 7 November 2007, p. 2, viewed 30 August 2009, <http://www.iaea.org/Publications/Documents/Infcircs/2007/infcirc254r9p1.pdf>.

40 Mr John Carlson, *Challenges to the Nuclear Non-Proliferation Regime: Can the Regime Survive? An Australian Perspective*, Paper presented to the Carnegie Moscow Center, 29 May 2007, p. 9, *Exhibit No. 1*.

41 Citizens' Nuclear Information Centre, *Submission No. 8.1*, p. 2.

42 Senator Bob Graham, *Transcript of Evidence*, 26 March 2009, p. 13.

The rationale for fuel cycle multilateralisation

5.56 The multilateralisation concepts proposed to date fall broadly into one of two categories—fuel supply assurances, or approaches where sensitive facilities are placed under some form of multinational control.

5.57 The rationale for these various approaches is as follows:

> Multilateral arrangements are generally aimed at denationalizing sensitive fuel cycle activities by placing decisions on the operation of nuclear facilities, as well as on the disposition of their products, in the hands of a number of nations or international organizations rather than individual states. If appropriately arranged, these arrangements appear to meet energy security concerns by providing participants with a legal and economic stake in the supply system, and to meet non-proliferation concerns by limiting the spread and the number of sensitive facilities, thus reducing the likelihood of break-out, diversion or theft.[43]

5.58 Of the second group of proposals, Dr Alexander Glaser notes that:

> Advocates of multinational approaches envisioning fuel cycle facilities that are not under purely national control—and possibly located outside the countries of the current supplier states—hope that such arrangements would make an important contribution to re-establishing confidence in the NPT and be sufficient to discourage additional states to develop enrichment and reprocessing technologies. Some proposals even envision a fuel cycle, in which the existence of facilities under national control has been abandoned altogether.[44]

5.59 The key benefits claimed for the multilateral approaches are that they:

> … could ensure that the benefits of nuclear energy are made available to all states that seek them, while strengthening the non-proliferation regime and ensuring safe and secure management of the fuel cycle.[45]

---

43 Y Yudin, *Multilateralization of the Nuclear Fuel Cycle: Assessing the Existing Proposals*, United Nations Institute for Disarmament Research, Switzerland, 2009, p. 9.

44 A Glaser, 'Internationalization of the Nuclear Fuel Cycle', February 2009, *Research paper commissioned by the ICNND*, p. 10, viewed 30 August 2009, <http://www.icnnd.org/latest/research/index.html>.

45 Y Yudin, *Multilateralization of the Nuclear Fuel Cycle: Assessing the Existing Proposals*, United Nations Institute for Disarmament Research, Switzerland, 2009, p. xi.

5.60 The OECD-NEA contends that:

> The fundamental non-proliferation benefit of such approaches is that a multilateral undertaking carried out by staff from many countries will place all participants under greater scrutiny from their partners and peers.[46]

5.61 The independent Commission appointed by the IAEA Director General concluded that increasing the multilateral or international ownership and control of enrichment and reprocessing would:

> … significantly contribute to international non-proliferation efforts and allow more countries to take part in owning and profiting from such facilities without spreading sensitive dual-use technologies.[47]

The historical context to multilateral proposals

5.62 Initiatives to limit national control over SNT and to place these technologies under the control of multinational bodies, or similar arrangements, have been proposed on three separate occasions over the past 60 years.

5.63 The first such initiative was the Baruch Plan, which was proposed by the US Government to the UN Atomic Energy Commission in June 1946. The Plan proposed that states transfer national ownership and control over dangerous civilian nuclear activities and nuclear materials to an 'International Atomic Development Authority'. The Baruch Plan was largely based on the *Report on the International Control of Atomic Energy*—the so-called 'Acheson-Lilienthal' report—which was authored by US scientists associated with the Manhattan Project and published in March 1946.[48] However, this first proposal foundered on the efforts by states to obtain national control over nuclear technology which accompanied the advent of the Cold War.[49]

---

46 OECD-NEA, *Nuclear Energy Outlook 2008*, OECD-NEA, Paris, 2008, pp. 281–282, *Exhibit No. 14*

47 Report prepared by an independent Commission at the request of the Director General of the IAEA, *Reinforcing the Global Nuclear Order for Peace and Prosperity: The Role of the IAEA to 2020 and Beyond*, IAEA, Vienna, 2008, p. 10.

48 A Glaser, 'Internationalization of the Nuclear Fuel Cycle', February 2009, *Research paper commissioned by the ICNND*, p. 6, viewed 30 August 2009, <http://www.icnnd.org/latest/research/index.html>.

49 For a full chronology see: IAEA, *Multinational Approaches to Nuclear Fuel-Cycle in Historical Context*, viewed 3 September 2009, <http://www.iaea.org/NewsCenter/Focus/FuelCycle/key_events.shtml>

5.64 With India having conducted a nuclear test in 1974, multilateral approaches received renewed attention when their evaluation was mandated by the first NPT Review Conference in 1975. This led to the establishment by the IAEA of the International Nuclear Fuel Cycle Evaluation (INFCE) project, a three-year study launched in 1977, and a Regional Nuclear Fuel Cycle Centres study. Among other issues, the INFCE addressed the possibility of regional fuel cycle facilities and prospects for multilateral cooperation on plutonium storage. However, consensus on the various initiatives that were proposed during this period could not be reached because states were unwilling to renounce sovereign control over nuclear technology and fuel.[50]

5.65 The discovery of Iraq's secret weapons program in 1991, the exposure of the AQ Khan network trading in uranium enrichment technology, and the weaknesses in a non-proliferation regime relying on technical safeguards and export controls that these incidents exposed, stimulated renewed interest in fuel cycle multilateralisation.

5.66 Arguing that nuclear-weapons technologies are now far more difficult to control than in the past, the Director General of the IAEA warned in an article which appeared in the *The Economist* in October 2003 that:

> Should a state with a fully developed fuel-cycle capability decide, for whatever reason, to break away from its non-proliferation commitments, most experts believe it could produce a nuclear weapon within a matter of months.
>
> In 1970, it was assumed that relatively few countries knew how to acquire nuclear weapons. Now, with 35-40 countries in the know by some estimates, the margin of security under the current non-proliferation regime is becoming too slim for comfort. We need a new approach.[51]

5.67 To address the challenge, Dr ElBaradei reintroduced the concept of fuel cycle multilateralisation, proposing that:

> … it is time to limit the processing of weapon-usable material (separated plutonium and high-enriched uranium) in civilian nuclear programmes, as well as the production of new material through reprocessing and enrichment, by agreeing to restrict these operations exclusively to facilities under multinational control. These limitations would need to be accompanied by proper rules

50 OECD-NEA, *Nuclear Energy Outlook 2008*, OECD-NEA, Paris, 2008, p. 281, *Exhibit No. 14*

51 M ElBaradei, 'Towards a safer world', *The Economist*, 16 October 2003, viewed 30 August 2009, <http://www.iaea.org/NewsCenter/Statements/2003/ebTE20031016.html>.

of transparency and, above all, by an assurance that legitimate would-be users could get their supplies.[52]

5.68 Then, in June 2004, Dr ElBaradei appointed an international Expert Group to consider 'possible multilateral approaches to the civilian nuclear fuel cycle'. The Expert Group's report, released in February 2005, discussed three broad types of multilateral options:

- assurances of services not involving ownership of facilities;
- conversion of existing national facilities to multinational facilities; and
- construction of new joint facilities.[53]

5.69 Based on these broad options, the report suggested five different 'multilateral nuclear approaches' (MNA) that could be gradually introduced over time:

1. Reinforcing *existing commercial market mechanisms* on a case-by-case basis through long-term contracts and transparent suppliers' arrangements with government backing. Examples would be: fuel leasing and fuel take-back offers, commercial offers to store and dispose of spent fuel, as well as commercial fuel banks.
2. Developing and implementing *international supply guarantees* with IAEA participation. Different models should be investigated, notably with the *IAEA as guarantor* of service supplies, e.g. as administrator of a fuel bank.
3. Promoting voluntary conversion of *existing facilities to MNAs*, and pursuing them as *confidence-building measures*, with the participation of NPT non-nuclear weapon states and nuclear-weapon states, and non-NPT states.
4. Creating, through voluntary agreements and contracts, *multinational, and in particular regional, MNAs for new facilities* based on joint ownership, drawing rights or co-management for front-end and back-end nuclear facilities, such as uranium enrichment; fuel reprocessing; disposal and storage of spent fuel (and combinations thereof). Integrated nuclear power parks would also serve this objective.

---

52 M ElBaradei, 'Towards a safer world', *The Economist*, 16 October 2003, viewed 30 August 2009, <http://www.iaea.org/NewsCenter/Statements/2003/ebTE20031016.html>.

53 IAEA, *Multilateral Approaches to the Nuclear Fuel Cycle: Expert Group Report submitted to the Director General of the International Atomic Energy Agency*, INFCIRC/640, IAEA, Vienna, 22 February 2005, viewed 30 August 2009, p. 6, <http://www.iaea.org/Publications/Documents/Infcircs/2005/infcirc640.pdf>.

5. The development of a *nuclear fuel cycle with stronger multilateral arrangements*—by region or by continent—*and for broader cooperation*, involving the IAEA and the international community.[54]

The Twelve Proposals

5.70 Since the release of the Expert Group's report in 2005, 12 concepts for fuel cycle multilateralisation have been proposed by various governments, industry groups and non-government organisations. Most of the proposals can be categorised under one of the five suggested MNA approaches identified by the Expert Group.

5.71 Listed in chronological order below are brief summaries of the 12 proposals.[55] The proposals are also summarised in appendix H, which identifies to which of the five multilateral approaches, proposed by the Expert Group described above, each of the concepts broadly corresponds.

1. Reserve of Nuclear Fuel

Proposed by the United States of America, September 2005. The US announced at the 49th regular session of the General Conference of the IAEA in September 2005 that it would commit up to 17 tonnes of HEU to be down-blended to LEU 'to support assurance of reliable fuel supplies for states that forego enrichment and reprocessing'.[56]

2. Global Nuclear Power Infrastructure

Proposed by the Russian Federation, January 2006. Vladimir Putin, then President of the Russian Federation, outlined a proposal to create 'a global infrastructure that will give all interested countries equal access to nuclear energy, while stressing reliable compliance with the requirements of the non-proliferation regime', including the 'creation of a system of international centres providing nuclear fuel cycle services, including

54 IAEA, *Multilateral Approaches to the Nuclear Fuel Cycle: Expert Group Report submitted to the Director General of the International Atomic Energy Agency*, INFCIRC/640, IAEA, Vienna, 22 February 2005, viewed 30 August 2009, p. 15, <http://www.iaea.org/Publications/Documents/Infcircs/2005/infcirc640.pdf>. Emphasis in original.

55 The summaries reproduce those contained in: T Rauf and Z Vovcjok, 'Fuel for Thought', *IAEA Bulletin*, Vol. 49, No. 2, March 2008, pp. 62–63, viewed 1 September 2009, <http://www.iaea.org/Publications/Magazines/Bulletin/Bull492/art13-subart1.pdf>; and Y Yudin, *Multilateralization of the Nuclear Fuel Cycle: Assessing the Existing Proposals*, UNIDR, Switzerland, 2009, pp. 15–18.

56 IAEA, *Communication dated 28 September 2005 from the Permanent Mission of the United States of America to the Agency*, INFCIRC/659, 29 September 2005, p. 1, viewed 1 September 2009, <http://www.iaea.org/Publications/Documents/Infcircs/2005/infcirc659.pdf>.

enrichment, on a non-discriminatory basis and under the control of the IAEA' as a key element in developing this new infrastructure.[57]

3. Global Nuclear Energy Partnership

Proposed by the United States of America, February 2006. The US announced the Global Nuclear Energy Partnership (GNEP) as 'a comprehensive strategy to increase US and global energy security, encourage clean development around the world, reduce the risk of nuclear proliferation, and improve the environment'. One of the elements of GNEP is a proposed 'Fuel Services program to enable nations to acquire nuclear energy economically while limiting proliferation risks. Under GNEP, a consortium of nations with advanced nuclear technologies would ensure that countries who agree to forgo their own investments in enrichment and reprocessing technologies will have reliable access to nuclear fuel'.[58]

4. Ensuring Security of Supply in the International Nuclear Fuel Cycle

Proposed by the World Nuclear Association, May 2006. A World Nuclear Association (WNA) Working Group on Security of the International Nuclear Fuel Cycle, including representatives of the four principal commercial enrichment companies, proposed a three level mechanism to assure uranium enrichment services: (a) basic supply security provided by the existing world market, (b) collective guarantees by enrichment companies supported by governmental and IAEA commitments, and (c) government stocks of enriched uranium product.[59]

5. Multilateral Mechanism for Reliable Access to Nuclear Fuel

Proposed by France, Germany, the Netherlands, the Russian Federation, the United Kingdom and the United States of America, June 2006. The six enrichment service supplier states proposed essentially two levels of enrichment assurance beyond the normally operating market. At the 'basic assurances' level, suppliers of enriched uranium would agree to substitute for each other in the case of certain supply interruptions to customer states that have 'chosen to obtain suppliers on the international market and not

57 IAEA, *Communication received from the Resident Representative of the Russian Federation to the Agency transmitting the text of the Statement of the President of the Russian Federation on the Peaceful Use of Nuclear Energy*, INFCIRC/667, 8 February 2006, p. 3, viewed 1 September 2009, <http://www.iaea.org/Publications/Documents/Infcircs/2006/infcirc667.pdf>.

58 United States Mission to International Organizations in Vienna, *Fact Sheet on the Global Nuclear Energy Partnership*, viewed 1 September 2009, <http://vienna.usmission.gov/sp_global_nuclear.html>. Further information on GNEP is available at <http://www.gneppartnership.org/>.

59 WNA, *Ensuring Security of Supply in the International Nuclear Fuel Cycle*, 12 May 2006, p. 3, viewed 1 September 2009, <http://www.world-nuclear.org/reference/pdf/security.pdf>.

to pursue sensitive fuel cycle activities'. At the 'reserves' level, participating governments could provide physical or virtual reserves of LEU that would be made available if the 'basic assurances' were to fail.[60]

6. IAEA Standby Arrangements System

Proposed by Japan, September 2006. Japan proposed an information system to help prevent interruptions in nuclear fuel supplies. The system, to be managed by the IAEA, would disseminate information contributed voluntarily by IAEA member states on their national capacities for uranium ore, uranium reserves, uranium conversion, uranium enrichment and fuel fabrication. The proposal is described by Japan as complementary to the concept for reliable access to nuclear fuel (proposal number five, above).[61]

7. IAEA Nuclear Fuel Reserve ('Nuclear Fuel Bank' Proposal)

Proposed by the Nuclear Threat Initiative, September 2006. The Nuclear Threat Initiative (NTI) offered to contribute $50 million to the IAEA to help create an LEU stockpile controlled by the Agency that could be made accessible should other supply arrangements be disrupted. The offer was contingent on the following two conditions being met within two years from when the offer was made: (a) that the IAEA takes the necessary actions to approve the establishment of the reserve; and (b) that one or more IAEA member states contribute an additional $100 million in funding or an equivalent value of LEU. The NTI stated that: 'Every other element of the arrangement—its structure, its location, the condition for access—would be up to the IAEA and its member states to decide'.[62]

In December 2007 the US Congress authorised a $50 million contribution, in February 2008 Norway pledged $5 million, in August 2008 the United Arab Emirates pledged $10 million, in December 2008 the EU pledged €25 million, and in March 2009 Kuwait offered US$10 million. The monetary

60 IAEA, *Communication dated 31 May 2006 received from the Permanent Missions of France, Germany, the Netherlands, the Russian Federation, the United Kingdom of Great Britain and Northern Ireland and the United States of America*, GOV/INF/2006/10, 1 June 2006, viewed 1 September 2009, <http://www.state.gov/documents/organization/98987.pdf>.

61 IAEA, *Communication received on 12 September 2006 from the Permanent Mission of Japan to the Agency concerning arrangements for the assurance of nuclear fuel supply*, INFCIRC/683, 15 September 2006, viewed 1 September 2009, <http://www.iaea.org/Publications/Documents/Infcircs/2006/infcirc683.pdf>.

62 NTI, 'Nuclear Threat Initiative Commits $50 Million to Create IAEA Nuclear Fuel Bank', *NTI press release*, 19 September 2006, viewed 1 September 2009, <www.nti.org/c_press/release_IAEA_fuelbank_091906.pdf>.

condition set by the NTI has now been met.[63] At the request of the IAEA, the deadline for the offer has been extended to September 2009.[64]

8. Enrichment Bonds

Proposed by the United Kingdom, September 2006. The UK proposed a 'bonding' principle that would, in the event that the IAEA determines that specified conditions have been met: (a) guarantee that national enrichment providers would not be prevented from supplying enrichment services; and (b) provide prior consent for export assurances.[65]

Germany and the Netherlands are cooperating with the UK in the development of the enrichment bonds concept. Recently the name of the proposal was changed to the 'Nuclear Fuel Assurance' proposal.

9. International Uranium Enrichment Centre

Proposed by the Russian Federation, January and May 2007. As an element in the creation of a global nuclear power infrastructure, proposed by then President Vladimir Putin in January 2006 (proposal one, above), the Russian Federation proposed the establishment of an International Uranium Enrichment Centre (IUEC) at the Angarsk Electrolysis Chemical Complex to provide participating countries guaranteed access to uranium enrichment capabilities. On 10 May 2007 the first agreement in the framework of the IUEC was signed by the Russian Federation and the Republic of Kazakhstan. A mechanism is being developed to set aside a stockpile of LEU that might contribute to a broader assurance of supply mechanism, and 'a regulatory basis will be developed in the sphere of export control such that the shipment of material out of the country at the request of the [IAEA] is guaranteed'.[66] In June 2007, Russia offered to set up an LEU reserve of 120 tonnes under IAEA auspices, and stored under safeguards at Angarsk, for use by IAEA member states.

---

63 NTI, 'NTI/IAEA Fuel Bank Hits $100 Million Milestone; Kuwaiti Contribution Fulfils Buffett Monetary Condition', *Press Release*, 5 March 2009, viewed 1 September 2009, <http://www.nti.org/c_press/release_Kuwait_Fuel_Bank_030509.pdf>.

64 IAEA, 'Multinational Fuel Bank Proposal Reaches Key Milestone', 6 March 2009, viewed 1 September 2009, <http://www.iaea.org/NewsCenter/News/2009/fbankmilestone.html>.

65 IAEA, *Communication dated 30 May 2007 from the Permanent Mission of the United Kingdom of Great Britain and Northern Ireland to the IAEA concerning Enrichment Bonds – A Voluntary Scheme for Reliable Access to Nuclear Fuel*, INFCIRC/707, 4 June 2007, p. 3, viewed 1 September 2009, <http://www.iaea.org/Publications/Documents/Infcircs/2007/infcirc707.pdf>.

66 IAEA, *Communication received from the Resident Representative of the Russian Federation to the IAEA on the Establishment, Structure and Operation of the International Uranium Enrichment Centre*, INFCIRC/708, 8 June 2007, p. 3, viewed 1 September 2009, <http://www.iaea.org/Publications/Documents/Infcircs/2007/infcirc708.pdf>.

10. Multilateral Enrichment Sanctuary Project

Proposed by Germany, May 2007. Germany proposed the creation of a multilateral uranium enrichment centre with extra-territorial status, operating under IAEA control on a commercial basis as a new supplier in the market. From there, potential users could then obtain nuclear fuel for civilian use under strict supervision.[67] Germany has further developed this proposal into a Multilateral Enrichment Sanctuary Project (MESP) for a multilateral enrichment facility established by a group of interested states on an extra-territorial basis in a host state, supervised by the IAEA, owned and operated by a multinational commercial consortium.[68]

11. Multilateralisation of the Nuclear Fuel Cycle

Proposed by Austria, May 2007. Austria proposed a two-track multilateral mechanism. The first track would 'optimiz[e] international transparency going beyond current IAEA safeguards obligations'. The second track would place all nuclear fuel transactions under the auspices of a 'Nuclear Fuel Bank' to 'enable equal access to and control of most sensitive nuclear technologies, particularly enrichment and reprocessing'.[69]

12. Nuclear Fuel Cycle

Proposed by the European Union, June 2007. The EU noted that flexibility would be appropriate in considering an approach to fuel supply options and proposed criteria for assessment of a multilateral mechanism for reliability of fuel supply. These criteria included, inter alia: (a) *proliferation resistance*—minimization of the risk of unintended transfer of sensitive nuclear technology; (b) *assurance of supply*—reliability of long-term supply arrangements; (c) *consistency with equal rights and obligations*—obligations of private companies, supplier states, consumer states and the IAEA; and

67 IAEA, *Communication received from the Resident Representative of Germany to the IAEA with regard to the German proposal on the Multilateralization of the Nuclear Fuel Cycle*, INFCIRC/704, 4 May 2007, viewed 1 September 2009, <http://www.iaea.org/Publications/Documents/Infcircs/2007/infcirc704.pdf>.

68 IAEA, *Communication dated 30 May 2008 received from the Permanent Mission of the Federal Republic of Germany to the Agency with regard to the German proposal for a Multilateral Enrichment Sanctuary Project*, INFCIRC/727, 30 May 2008, viewed 1 September 2009 <http://www.iaea.org/Publications/Documents/Infcircs/2008/infcirc727.pdf>; IAEA, *Communication dated 22 September 2008 received from the Permanent Mission of Germany to the Agency regarding the German proposal on a Multilateral Enrichment Sanctuary Project*, INFCIRC/735, 25 September 2008, viewed 1 September 2009 <http://www.iaea.org/Publications/Documents/Infcircs/2008/infcirc735.pdf>.

69 IAEA, *Communication received from the Federal Minister for European and International Affairs of Austria with regard to the Austrian proposal on the Multilateralization of the Nuclear Fuel Cycle*, INFCIRC/706, 31 May 2007, p. 2 , viewed 1 September 2009, <http://www.iaea.org/Publications/Documents/Infcircs/2007/infcirc706.pdf>.

(d) *market neutrality*—avoiding any unnecessary disturbance or interference in the functioning of the existing market.[70]

5.72 In April 2008 Dr ElBaradei outlined his vision for a three-step approach to create a global non-discriminatory framework for the fuel cycle:

> The *first* step would be to establish a system for assuring supply of fuel for nuclear power reactors—and, if necessary, supply of the actual reactors. The *second* step would be to have all *new* enrichment and reprocessing activities in future put exclusively under multilateral control. And the *third* step would be to convert all *existing* enrichment and reprocessing facilities from national to multilateral operations.[71]

5.73 Dr ElBaradei outlined what he saw as four key requirements for such an assurance of supply mechanism to work, and for it to receive widespread support:

> *First*, I believe, it must be unambiguously under some form of multinational control, not just managed by the leading nuclear powers or a few suppliers. Consumers and suppliers should be equal participants. Otherwise, the mechanism would fail to win the confidence of countries considering a nuclear energy programme.
>
> *Second*, an assurance of supply mechanism would be available to *all* States, based on equal rights and obligations for all participants. Equality is key to the success of the mechanism.
>
> *Third*, the release of nuclear material to a consumer State should be determined by non-political criteria established in advance and applied in an objective and consistent manner.
>
> *Fourth*, assurance of fuel supply must be part of an over-arching multilateral nuclear framework.[72]

---

70 T Rauf and Z Vovcjok, 'Fuel for Thought', *IAEA Bulletin*, Vol. 49, No. 2, March 2008, p. 63, viewed 1 September 2009, <http://www.iaea.org/Publications/Magazines/Bulletin/Bull492/art13-subart1.pdf>.

71 M ElBaradei, *Statement of the IAEA Director General to the International Conference on Nuclear Fuel Supply: Challenges and Opportunities, Germany, 17 April 2008*, viewed 3 September 2009, <http://www.iaea.org/NewsCenter/Statements/2008/ebsp2008n004.html>. Emphasis in original.

72 M ElBaradei, *Statement of the IAEA Director General to the International Conference on Nuclear Fuel Supply: Challenges and Opportunities, Germany, 17 April 2008*, viewed 3 September 2009, <http://www.iaea.org/NewsCenter/Statements/2008/ebsp2008n004.html>. Emphasis in original.

5.74 In May 2008 the independent Commission appointed by the IAEA Director General concluded that:

> Such mechanisms would help countries have access to nuclear power while reducing the need to construct proliferation-sensitive facilities themselves. Countries should not be asked, however, to give up their legal right to develop such facilities.[73]

5.75 In June 2009 Dr ElBaradei formally proposed to the Board of the Agency the establishment of the IAEA bank of LEU to guarantee supplies to countries that need nuclear fuel:

> My proposal is to create a physical stockpile of LEU at the disposal of the IAEA as a last-resort reserve for countries with nuclear power programs that face a supply disruption for non-commercial reasons. This would give countries confidence that they can count on reliable supplies of fuel to run their nuclear power plants, and therefore do not need to develop their own uranium-enrichment or plutonium-reprocessing capability.
>
> …
>
> The money needed to launch an LEU bank is in place, thanks primarily to a non-governmental organization - the Nuclear Threat Initiative - and initial funding from Warren Buffett. But this can only be a first step. It should be followed by an agreement that all new enrichment and reprocessing activities will be placed exclusively under multinational control, and that all existing such facilities will be converted from national to multinational control.[74]

Support for fuel cycle multilateralisation proposals

5.76 Evidence to the Committee was generally supportive of fuel cycle multilateralisation proposals. For instance, Ms Joan Rohlfing of the NTI stated that:

> … we need to work long term on some kind of multinational or international ownership of a facility, and that is absolutely essential because, unless and until we get to the point where all

73 Report prepared by an independent Commission at the request of the Director General of the IAEA, *Reinforcing the Global Nuclear Order for Peace and Prosperity: The Role of the IAEA to 2020 and Beyond*, IAEA, Vienna, 2008, p. 7.

74 M ElBaradei, 'A New Start for Non-Proliferation', *Daily News Egypt*, 15 July 2009, viewed 30 August 2009, <http://www.iaea.org/NewsCenter/Transcripts/2009/dnegypt150709.html>.

> states are agreed that it is in no-one's interest for new facilities to be created and the only way to stem that proliferation in a non-discriminatory way is to create some limited number of facilities that are under international control, we will only be taking incremental steps. So I think it is time for the international community to really begin to address these gap areas.[75]

5.77 The Australian Uranium Association submitted that multilateralisation concepts have merit:

> … the development of internationally-controlled facilities is an option … that recognises the permanence and growth of nuclear power and of the Australian uranium industry supplying it, as well as the concerns of those opposed to those industries.[76]

5.78 The Australian Nuclear Science and Technology Organisation was supportive, arguing that it would be desirable if:

> … we could get agreements with countries that their fuel would be supplied from another country, and there would be unhindered access to that process—so it would be under some sort of international control—there is no need for countries to develop enrichment. If we can get a nuclear non-proliferation regime that restricts the enrichment facilities to those that are fully open to safeguards and under international control, I think that sort of process can happen.[77]

5.79 Some submitters advocated support for specific multilateralisation concepts and approaches. Former US Senator Bob Graham endorsed the regional fuel cycle centre concept and recommended that it be promoted at the 2010 NPT Review Conference:

> … it should be under the auspices of the IAEA. That is yet another item to add to [the] 2010 agenda for non-proliferation reform. There would be clusters of countries having responsibility for specific [fuel] banks. There might be a group of countries in the Asia-Pacific area which, collectively working through the IAEA, would have the actual technical responsibility for maintaining the fuel bank for the countries in that region. There would be similar banks in Africa and Latin America.[78]

---

75 Ms Joan Rohlfing, *Transcript of Evidence*, 14 May 2009, p. 13.

76 Australian Uranium Association, *Submission No. 45.1*, p. 3.

77 Dr Ron Cameron, *Transcript of Evidence*, 26 March 2009, p. 21.

78 Senator Bob Graham, *Transcript of Evidence*, 26 March 2009, p. 11.

5.80 The Australian Nuclear Science and Technology Organisation argued that, of the multilateralisation concepts proposed to date, those that address the back end of the cycle, rather than simply fuel supply assurances, are most attractive to other countries:

> … proposals that address the back end of the fuel cycle, that is, waste and spent fuel would be of far more interest to potential recipient states than proposals restricted only to fuel supply. That was the basis for the development of the Global Nuclear Energy Partnership which we believe still provides the most advanced opportunity for controlling proliferation issues across the fuel cycle.[79]

5.81 Dr Marko Beljac argued that Australia should support multilateral or international control of enrichment and urged that Australia amend its safeguards policy to expressly forbid the enrichment of uranium in anything other than a multilateral facility, should international control of enrichment become a reality.[80]

5.82 Professor Joseph Camilleri urged that support be given for:

> … one single fuel bank in the world under the control of the International Atomic Energy Agency and it monitors every transaction; no-one has uranium enrichment—not just not Iran but nobody. If you need uranium enrichment you have to enter into a transaction with the IAEA and enter into all the safeguards that they might ask of you, which presumably would need to be much stricter than they are now.[81]

5.83 Dr Hans Blix submitted that, under the auspices of the IAEA, 'possibilities should be explored for international arrangements to ensure the availability of nuclear fuel for civilian reactors while minimizing the risk of weapon proliferation'.[82] In regions of tension, such as the Korean peninsula and the Middle East, Dr Blix also advocated 'a verified suspension of the production of enriched uranium and plutonium for a prolonged period of time, while obtaining international assurances of the supply of fuel for civilian nuclear power.'[83]

5.84 World leaders have this year expressed support for fuel supply assurance and fuel cycle multilateralisation proposals. For example, during US

79 Dr Ron Cameron, *Transcript of Evidence*, 26 March 2009, p. 13.

80 Dr Marko Beljac, *Submission No. 18*, p. 6.

81 Professor Joseph Camilleri, *Transcript of Evidence*, 25 March 2009, p. 3.

82 Dr Hans Blix, *Submission No. 78*, p. 3.

83 Dr Hans Blix, *Submission No. 78*, p. 3.

President Obama's 5 April speech in Prague on nuclear non-proliferation and disarmament, he stated:

> ... we should build a new framework for civil nuclear cooperation, including an international fuel bank, so that countries can access peaceful power without increasing the risks of proliferation. That must be the right of every nation that renounces nuclear weapons, especially developing countries embarking on peaceful programs. And no approach will succeed it it's based on the denial of rights to nations that play by the rules. We must harness the power of nuclear energy on behalf of our efforts to combat climate change, and to advance opportunity for all people.[84]

Issues and challenges for multilateralisation proposals

5.85 While submitters to the inquiry were generally supportive of multilateralisation proposals as a means of limiting the spread of SNT, a number of issues were raised in relation to specific proposals (especially fuel supply assurance concepts) and to multilateralisation more generally. In summary, these arguments included the:

- risk of further entrenching perceptions of discrimination and dependency on the part of recipient or 'client' states by further restricting national-fuel cycles, while other states retain enrichment and reprocessing capacity;
- potential for multilateral proposals to spur some countries into rapidly developing national capabilities, before opportunities to do so become more restricted;
- risk that nations which host multilateral facilities could always decide to 'break out';
- risk that SNT deployed in a new state and provided on a 'black box' basis could be leaked;
- risk of technical skills gained by personnel in multilaterally-controlled facilities spreading;

84 President Barack Obama, *Address to the people of Prague*, delivered 5 April 2009, viewed 14 July 2009, <http://www.whitehouse.gov/the_press_office/Remarks-By-President-Barack-Obama-In-Prague-As-Delivered/>.

- likely opposition from countries which currently operate sensitive technologies to give up their right to retain exclusive national control over those facilities and technologies;
- lack of interest and incentive, particularly in the recipient states, to participate in fuel assurance proposals because of the effective and competitive operation of the current enrichment (and other fuel cycle services) markets;
- lack of appeal to countries with larger nuclear capacities (e.g. South Korea or Ukraine) of the fuel bank proposal, because the limited size of the fuel bank might be a serious constraint;
- controversy over the definition of the 'political purpose' caveat in fuel supply assurance proposals;
- risks of increased international transport of fissile materials and high level radioactive waste; and
- likely opposition from countries nominated for multinational high level radioactive waste dumps.

5.86 In opposing multilateralisation altogether, Professor Richard Broinowski emphasised the potential of these proposals to exacerbate perceptions of a 'double standard' between countries; for example, that establishment of international enrichment facilities in certain countries would be viewed as entrenching a divide between the nuclear 'haves' and nuclear 'have nots':

> I think it is reinforcing a double standard … Certain countries in this world have the capacity, the trust and the good citizenship to enrich uranium. We are the main country but there are a few others. We are the nuclear haves: 'Trust us, you non-nuclear countries. We do not want you to have nuclear weapons but we will enrich your uranium. We will bring it back after it has been used and we will reprocess it and give you back the plutonium mixed oxide and you can use that again.' First, the technique does not work—it has been proven not to work—and, second, it is reinforcing the haves and the have nots in the nuclear debate. The nuclear proliferation system will not work while you have a double standard.[85]

85 Professor Richard Broinowski, *Transcript of Evidence*, 26 March 2009, p. 63.

5.87 Dr Frank Barnaby and Professor Camilleri also warned of the 'need to avoid the risk of a "two-tier" discriminatory system of fuel producers and users.'[86]

5.88 More generally, Dr Ben Saul emphasised the need to avoid the unequal treatment of countries in the international legal system:

> From the point of view of global governance of nuclear issues, a central problem … has been the development of unequal ways of dealing with different groups of states. In particular, unequal treatment seriously undermines perceptions of fairness and legitimacy in the international legal systems and also undermines—I think sometimes fatally—the likelihood of compliance with that legal regime that exists.[87]

5.89 In relation to fuel supply assurance proposals specifically, Dr George Perkovich and Ms Joan Rohlfing noted that a key problem with existing fuel assurance strategies is that:

> ... they have not addressed the really thorny issue of who decides whether someone is in compliance or not with the use conditions for these mechanisms.[88]

5.90 Dr Perkovich also noted that, based on his discussions with South American and other colleagues, if there is a move to full multilateralisation of the fuel cycle, it would need to be done equitably and all at once:

> … if we are going to move to that model it has to be done for everyone at the same time—in other words, no phasing, which is what people here in the US and others envision as we move incrementally to that model of multinational facilities. And the sense I get is that it has to be totally equitable and done all at once everywhere as a political condition and perhaps also as an economic condition for a 'level playing field'.[89]

5.91 A more fundamental challenge to widespread acceptance of fuel supply assurances has been pointed out by Dr Glaser, who argues that for many countries 'fuel supply assurances are largely a solution to a problem they do not face', because for most states without enrichment capacity the

---

86 Professor Joseph Camilleri, *Transcript of Evidence*, 25 March 2009, p. 8. See also: Dr Frank Barnaby, *Submission No. 19*, p. 5.

87 Dr Ben Saul, *Transcript of Evidence*, 26 March 2009, p. 45.

88 Ms Joan Rohlfing, *Transcript of Evidence*, 14 May 2009, p. 13.

89 Dr George Perkovich, *Transcript of Evidence*, 14 May 2009, p. 13.

current market works well and is 'characterised by several independent and reliable suppliers.'[90] Moreover, existing or planned enrichment capacity is argued to be sufficient to supply reactors for at least another two decades, even if total nuclear capacity almost doubles by 2030.

5.92 New fuel assurance mechanisms, it is argued, would be potentially relevant only to countries that begin to lose trust in the current market system or are newcomers to the market.

5.93 Dr Glaser concludes that:

> … fuel assurances and banks, have a good chance to go forward. … however, they may prove to be largely irrelevant because most of the main buyers of enriched uranium are satisfied with the current supplier market, or have their own supply, and are therefore unlikely to ever use the services now being developed.[91]

5.94 Dr Yudin also pointed to the danger of multilateral proposals being perceived as denying states their right to acquire sensitive technologies and recommended that countries be provided with a real 'entitlement' motivation to participate:

> The existing ideas for multilateralization of the nuclear fuel cycle have all come from suppliers of front-end fuel cycle services, while the prospective customers have generally been lukewarm because they often, yet not always fairly, consider these ideas as technology denial approaches.[92]

5.95 The Australian Uranium Association also commented on the challenges that lie ahead for these proposals in encouraging countries to forego their rights:

> The Association does not underestimate the difficulty of convincing sovereign nations in good standing under the Nuclear Non-Proliferation Treaty to forego their rights under the Treaty to develop the full civil nuclear fuel cycle; and we anticipate that

90 A Glaser, 'Internationalization of the Nuclear Fuel Cycle', *Research paper commissioned by the ICNND*, February 2009, p. 2, viewed 30 August 2009, <http://www.icnnd.org/latest/research/index.html>.

91 A Glaser, 'Internationalization of the Nuclear Fuel Cycle', *Research paper commissioned by the ICNND*, February 2009, p. 27–28, viewed 30 August 2009, <http://www.icnnd.org/latest/research/index.html>.

92 Y Yudin, *Multilateralization of the Nuclear Fuel Cycle: Assessing the Existing Proposals*, UNIDR, Switzerland, 2009, p. xv.

> some nations will proceed in that direction notwithstanding a global partnership to develop internationally-controlled facilities.[93]

5.96 Reinforcing Dr Glaser's conclusion, Ms Martine Letts also argued that multilateralisation proposals in general could cause an acceleration of some countries' efforts to develop an indigenous enrichment capability:

> One of the claims is that the mere talk of multilateralisation of the nuclear fuel cycle is going to accelerate efforts by some to develop an indigenous capacity before the door is shut and that this might cause countries to want to develop their own capacity quickly so that when the multilateral fuel cycle finally comes online they do not have to worry about forgoing their national rights.[94]

5.97 In light of the challenges to fuel supply assurance proposals and the fact that few new enrichment plants will be required in coming decades, Dr Glaser recommends that attention be given instead to the conversion of *existing* facilities to multinational control and management:

> Given that it is unlikely for many large new uranium enrichment plants to be required, and that proposals for fuel banks and fuel assurances do not address basic issues of the supplier/client dependency and of prevailing insecurity about the international system, the debate over multilateral approaches to the fuel cycle could more usefully focus on the conversion of existing national enrichment plants to multinational control and management.[95]

5.98 Dr Glaser makes the further point that most proposals for multinationally owned and operated plants depend on a 'black box' approach, in which the sensitive technology (e.g. centrifuge equipment) is supplied to a country or project on a pre-fabricated basis, and the operators—or even the owners of the plant—do not have access to any proprietary or proliferation-sensitive information. However, he notes that there are different types of proprietary or proliferation-sensitive information that could be involuntarily disseminated through poorly implemented black-box approaches. Dr Glaser also argues that, at present, it is unclear if the available technology providers would support any black-box approach involving partners with whom they do not already have strong business

93 Australian Uranium Association, *Submission No. 45.1*, p. 3.

94 Ms Martine Letts, *Transcript of Evidence*, 11 May 2009, p. 18; A Glaser, 'Internationalization of the Nuclear Fuel Cycle', *Research paper commissioned by the ICNND*, February 2009, p. 28, viewed 30 August 2009, <http://www.icnnd.org/latest/research/index.html>.

95 A Glaser, 'Internationalization of the Nuclear Fuel Cycle', *Research paper commissioned by the ICNND*, February 2009, p. 3, viewed 30 August 2009, <http://www.icnnd.org/latest/research/index.html>.

relations, given that a significant fraction of their intellectual property would be at risk of being compromised. He also observes that the existing commercial suppliers of enrichment services would, if they saw a need for new enrichment capacities, probably prefer to expand their own operations, rather than provide the technology for a 'black box' project.[96]

5.99 The Citizens' Nuclear Information Centre (CNIC) argued that multilateral proposals will not eliminate the possibility of the 'break-out' scenario occurring—where a country hosting an international facility withdraws the facility from multilateral control and then uses it to produce weapons material. The CNIC also cautioned that the technical skills gained within multilaterally controlled civil programs could be transferred to weapons programs:

> In the quest for solutions to intractable proliferation problems, internationalization must not be seen as a panacea. Proposals to implement multilateral approaches to solve problems associated with the nuclear fuel cycle should be rigorously scrutinized, in order to ensure that they will not exacerbate the problems they purport to solve.[97]

5.100 The CNIC, Australian Conservation Foundation and Dr Marko Beljac expressed opposition to GNEP. In particular, Dr Beljac argued that GNEP proposes to reprocess plutonium using new techniques which he claims are not as proliferation resistant as they are claimed to be.[98]

5.101 While acknowledging the merits of multilateral proposals and urging that they be further explored, Ms Letts cautioned that:

> … some countries fear that, if it really comes down to it and there is a political reason why they are being refused fuel, other countries will be able to exercise influence on the multilateral facility, on the management or on the governance of the multilateral facility to stop the supply from happening.[99]

---

96 A Glaser, 'Internationalization of the Nuclear Fuel Cycle', *Research paper commissioned by the ICNND*, February 2009, pp. 16–17, viewed 30 August 2009, <http://www.icnnd.org/latest/research/index.html>.

97 Citizens' Nuclear Information Centre, 'Background Paper for Submission to the International Commission on Nuclear Non-proliferation and Disarmament Concerning the Civilian Use of Nuclear Energy', p. 8, *Exhibit No. 7.*

98 Citizens' Nuclear Information Centre, 'Background Paper for Submission to the International Commission on Nuclear Non-proliferation and Disarmament Concerning the Civilian Use of Nuclear Energy', p. 8, *Exhibit No. 7*; Australian Conservation Foundation, *Submission No. 55*, p. 10; Dr Marko Beljac, *Submission No. 18*, p. 12.

99 Ms Martine Letts, *Transcript of Evidence*, 11 May 2009, p. 18.

Conclusion

5.102 The new challenges to the nuclear non-proliferation regime presented by an expansion in nuclear energy use—including deployment in many countries for the first time—and the growing risk of nuclear terrorism, demands a new and vigorous response.

5.103 The 12 proposals differ considerably in their scope, targets and time required for implementation. However, the proposals generally agree that:

- any multilateral mechanism should not disturb the international market for nuclear fuel cycle services, especially for front end services, such as enrichment and nuclear fuel;
- establishment of multilateral arrangement should occur step by step, with most proposals focussed on the front end and addressing assurances of supply and provision of LEU fuel; and
- there is not likely to be a uniform approach that would be satisfactory for all technologies and countries and that successful implementation of multilateralisation will require flexibility.[100]

5.104 Notwithstanding the merits of fuel cycle multilateralisation as a means of limiting the spread of SNT, and the manifest need to progress these initiatives in the face of the nuclear renaissance, the Committee notes the cautionary point emphasised in evidence that such proposals cannot be tied to demands on customer countries to forgo their rights. The Committee accepts that such demands are likely to be perceived as 'technology denial' and be resisted. Instead, giving multilateralisation proposals the greatest chance of success will depend on providing countries with political and economic incentives, and an 'entitlement' motivation to participate.

5.105 The Committee notes that the challenges raised in evidence will need to be overcome in order to realise the more visionary concepts that have been proposed. However, the Committee urges that these not be permitted to delay progress on the more short-term proposals, which deal primarily with the front end of the cycle and involve:

- providing backup assurances of supply in addition to the existing commercial uranium market (WNA proposal, Six-Country Concept, UK Enrichment Bonds and Japanese IAEA Standby Arrangements);

100 Y Yudin, *Multilateralization of the Nuclear Fuel Cycle: Assessing the Existing Proposals*, United Nations Institute for Disarmament Research, Switzerland, 2009, p. 51.

- establishing nationally controlled (US reserve of nuclear fuel, WNA proposal, Six-Country Concept) or IAEA-controlled LEU reserves (Russian IUEC, NTI Fuel Bank); and
- placing enrichment facilities under some form of international control, including the establishment of an IAEA-controlled uranium enrichment facility (Russian IUEC, German MESP proposal).[101]

5.106 The Committee is conscious of the fact that:

> … numerous stumbling blocks lie ahead. Among these are the lack of trust, national self interest, and various political, financial, and legal hurdles. Nonetheless, the world has no choice but to protect itself from the misuse of sensitive nuclear technologies. To be successful, multilateral nuclear fuel-cycle arrangements will inevitably require broad political consensus on how the international community can limit access to these technologies, while protecting states' rights to develop nuclear energy for peaceful purposes.[102]

5.107 The Committee believes that the Australian Government must be actively involved in international discussion and consideration of multilateralisation proposals including within the Nuclear Suppliers Group.

101 Y Yudin, *Multilateralization of the Nuclear Fuel Cycle: Assessing the Existing Proposals*, United Nations Institute for Disarmament Research, Switzerland, 2009, p. 52.

102 Y Yudin, *Multilateralization of the Nuclear Fuel Cycle: Assessing the Existing Proposals*, United Nations Institute for Disarmament Research, Switzerland, 2009, pp. xi–xii.

Recommendation 7

The Committee recommends that the Australian Government investigate further the potential merits and risks of fuel cycle multilateralisation proposals, including through:

- **discussion of such proposals at the 2010 Non-Proliferation Treaty Review Conference;**
- **advocating within the Nuclear Suppliers Group for the development of restrictive criteria for the supply of sensitive nuclear technologies; and**
- **engaging in dialogue with those countries in South-East Asia proposing to develop a nuclear energy industry.**