# **Appendix 6C**. The illicit traffic in nuclear and radioactive materials

NICHOLAS ZARIMPAS

## I. Introduction

The theft and diversion of and unauthorized traffic in nuclear and radioactive materials may pose serious national and international security threats.[1] The number of confirmed cases of illicit trafficking has been increasing since the early 1990s, following the dissolution of the Soviet Union. International concerns heightened in mid-1994, when small quantities of smuggled plutonium-239 were discovered for the first time.

A very small number of countries which allegedly are interested in obtaining nuclear weapons, sub-state actors such as terrorists and religious extremists, and criminal groups may be attempting to acquire nuclear and radioactive materials. Apart from the obvious implications for nuclear proliferation, illicit trafficking in such materials could create a multitude of public health, safety and environmental risks. Not surprisingly and irrespective of their gravity, known incidents involving stolen nuclear and radioactive materials usually receive wide media coverage and attention from the authorities, the non-proliferation community and the general public.[2]

This appendix reviews the current situation regarding illicit trafficking by analysing publicly available information and developments over the past 10 years as well as the measures designed to combat this problem. The magnitude of the problem is discussed in section II. Section III outlines the prevention, detection and control mechanisms, and the measures and responses are described in section IV. Section V presents the conclusions.

[1] For the purposes of this appendix, nuclear material is defined as uranium, plutonium, thorium or a compound containing any of these elements, and irradiated nuclear reactor fuel. Uranium may contain the mixture of isotopes occurring in nature, be depleted in the isotope 235 (less than 0.7%), or be enriched in the isotopes 235 or 233. Highly enriched uranium (HEU) is uranium containing 20% or more of the isotope 235. Plutonium-239 (an isotope of the artificially produced plutonium element) and the uranium isotope 235 are common fissile materials (their nuclei fission when struck by slow—thermal—or fast neutrons). The term 'fissile materials' is often used to describe plutonium and HEU. The International Atomic Energy Agency (IAEA) classifies plutonium containing less than 80% of the isotope 238, HEU and uranium-233 as 'direct-use' materials (i.e., weapon-usable materials). Sophisticated nuclear weapons typically contain HEU enriched to over 90% in the isotope 235 or plutonium containing less than 7% of plutonium-240. Although nuclear material is radioactive, the term 'radioactive materials' refers primarily to ionizing radiation sources (e.g., those which are widely used in industrial, research and medical applications: americium, caesium, cobalt, strontium and radium). Radioactive material cannot be utilized in the construction of a nuclear explosive or weapon because it cannot sustain a nuclear chain reaction. The illegal acquisition of and trafficking in sensitive equipment, components and non-nuclear material that could be used either in the civilian or in the military sector are not addressed here.

[2] See, e.g., Henry L. Stimson Center, Committee on Nuclear Policy, URL <http://www.stimson.org/policy/nucleardangers.htm>; and entries in the subscription-only Newly Independent States (NIS) Nuclear Smuggling Database, Center for Nonproliferation Studies, Monterey Institute of International Studies, URL <http://www.cns.miis.edu>.

## II. The magnitude of the problem

Nuclear materials abound. Plutonium and highly enriched uranium (HEU) were first produced in the 1940s by the Soviet Union and the United States for their military needs. In the 1980s civilian nuclear power programmes matured worldwide, following the wide spread of technological know-how, services and related infrastructure.[3] Many countries operate fuel-cycle facilities, although the large, modern commercial reprocessing and mixed-oxide (MOX) fuel-fabrication plants are located principally in France and the United Kingdom.[4] There has been substantial and steady growth in the production, manufacture and international transport of nuclear fuels. Accordingly, the inventories of spent fuel have also been increasing.

Countries with nuclear weapon programmes have produced large quantities of plutonium and HEU for the manufacture of nuclear warheads.[5] HEU is also used to fuel naval-propulsion, research and tritium-production reactors.[6] As a result of the successful implementation of arms control agreements and unilateral initiatives, warheads are being dismantled and significant quantities of fissile material have become redundant.[7] Plans are under way to dispose of some of this material.[8] Concurrently, an imbalance between the supply of and the demand for plutonium in the civilian sector has resulted in the accumulation of large stocks of separated plutonium.[9] These massive and growing inventories of fissile materials pose challenges to accountancy and physical security systems and increase the risk of diversion.

Following the breakup of the Soviet Union, Russia and the other newly independent states (NIS) inherited vast quantities of HEU and plutonium in conditions that make them potentially attractive for theft.[10] Political instability, economic degrad-

[3] Some 30 countries operate a total of 438 nuclear power reactors with a net capacity of 351 gigawatts electric, which contribute a significant component of the world's energy supply. 'IAEA releases nuclear power statistics for 2000', IAEA Press Release PR 2001/7, 3 May 2001.

[4] Most of the civilian plutonium is not separated and is retained in spent reactor fuel. A number of countries (Belgium, France, Germany, Japan, Russia, Switzerland and the UK) reprocess spent reactor fuel. Some recycle recovered plutonium in MOX (mixed uranium–plutonium oxide) fuel.

[5] China, France, India, Israel, Pakistan, Russia, the UK and the USA possess a total of *c.* 32 000 operational or retired nuclear weapons; see appendix 6A in this volume for the operational strategic and non-strategic nuclear forces of these 8 countries. These countries possess a total of *c.* 260 tonnes of weapon-grade plutonium, either in operational or retired weapons, weapon pits, solutions, and scrap and waste material. Norris, R. S. and Arkin, W. M., 'National Resources Defense Council nuclear notebook: world plutonium inventories', *Bulletin of the Atomic Scientists*, vol. 55, no. 5 (Sep./Oct. 1999), p. 71. For a detailed discussion, see Albright, D., Berkhout, F. and Walker, W., SIPRI, *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities and Policies* (Oxford University Press: Oxford, 1997).

[6] The total military HEU inventory is *c.* 1750 tonnes (not including submarine fuel or waste). Some 20 tonnes of HEU are in research reactor fuel. The civilian use of HEU is steadily declining.

[7] The USA has designated 52.5 tonnes of plutonium and 174.3 tonnes of HEU as in excess of its military needs. Russia has also declared 50 tonnes of plutonium and 500 tonnes of HEU as excess. In Sep. 2000 the 2 countries formally agreed to dispose of 34 tonnes of weapon-grade plutonium each.

[8] Kokoski, R., 'Nuclear weapon destruction', *SIPRI Yearbook 1995: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 1995), appendix 16A, pp. 672–80; and MacLachlan, A., 'G-8 moving Pu disposition program into high gear', *Nuclear Fuel*, vol. 25, no. 25 (11 Dec. 2000), pp. 7–8. See also the subsection on 'Plutonium disposition' in chapter 6 in this volume.

[9] The 1999 worldwide separated plutonium stockpile in the civilian sector was *c.* 203.5 tonnes. Norris and Arkin (note 5).

[10] All Soviet nuclear weapons have been removed from Belarus, Ukraine and Kazakhstan to Russia. Weapon-usable nuclear materials in the former Soviet Union are believed to exist in nearly 400 buildings at nearly 60 sites; however, the bulk is concentrated in Russia. Bunn, M., Carnegie Non-Proliferation Project and Harvard Project on Managing the Atom, *The Next Wave: Urgently Needed New Steps to Control Warheads and Fissile Material* (Carnegie Endowment for International Peace and Harvard Uni-

ation, social unrest and, more importantly, the breakdown of the elaborate Soviet control and enforcement mechanisms have all contributed to making these stocks relatively easy to divert from the source and have created an acute illicit trafficking situation. Poor accountability of nuclear materials in the civilian fuel cycle in the majority of the NIS, owing to the lack of a safeguards culture, has also played a crucial role. Illicit trafficking in the NIS can be perceived as a component of a wider proliferation problem which also comprises sensitive equipment and underpaid scientists with specialized weapon design expertise and know-how.

There are no reliable, accurate and up-to-date statistics on the global illicit traffic in nuclear and radioactive materials, although numerous media reports, often grossly exaggerated, have addressed real or alleged incidents. However, the International Atomic Energy Agency (IAEA) maintains an extensive illicit trafficking database which provides useful insight into the main patterns.[11] As of 31 March 2001, this database recorded more than 550 incidents, of which about two-thirds have been confirmed by participating states.[12] Of these confirmed incidents, about one-half involved nuclear materials and the rest radiation sources.[13] One-third of the confirmed incidents with nuclear material involved low-enriched uranium, and 15 cases (9 per cent) involved plutonium or HEU. The majority of the seizures occurred in Europe and the NIS. The number of confirmed cases of illicit trafficking in weapon-usable or weapon-grade nuclear materials peaked in 1993–94 and then declined.[14] A steady drop in confirmed cases was also observed for all categories of nuclear and radioactive materials, although the number of diverted radiation sources rose considerably in the late 1990s. Following this relatively calm period, reports of cases involving

versity Belfer Center for Science and International Affairs, Apr. 2000), p. 18, available at URL <http://www.ceip.org/npp> and <http://www.ksg.harvard.edu/bcsia/atom>. According to Howard Baker and Lloyd Cutler, 'More than 1000 metric tons of HEU and at least 150 metric tons of weapons-grade plutonium exist in the Russian weapons complex'. Baker, H. and Cutler, L., Russian Task Force, *A Report Card on the Department of Energy's Nonproliferation Programs with Russia* (US Department of Energy: Washington, DC, 10 Jan. 2001), draft, p. 5.

[11] The IAEA is tasked with promoting the peaceful uses of atomic energy, and ensuring, by the application of international safeguards, that nuclear activities with which the IAEA is associated do not have military purposes.

[12] Anzelon, G., Hammond, W. and Nicholas, M., 'The IAEA's illicit trafficking database programme', International Conference on Security of Material: Measures to Prevent, Intercept and Respond to Illicit Uses of Nuclear Material and Radioactive Sources, Stockholm, Sweden, 7–11 May 2001. The IAEA database is limited to known and nationally reported cases registered since Jan. 1993 and is therefore only 1 indicator of the illicit trafficking problem. Various other sources provide different accounts. E.g., the German Federal Intelligence Service estimated that there were nearly 300 nuclear smuggling cases in 1994–95. Lee, R., 'Smuggling update', *Bulletin of the Atomic Scientists*, vol. 53, no. 3 (May/June 1997), p. 52. In the USA alone, *c*. 200 reports of lost, stolen or abandoned radiation sources are annually received by the US Nuclear Regulatory Commission. More cases go unreported. González, A. J., 'Strengthening the safety of radiation sources and the security of radioactive materials: timely action', *IAEA Bulletin*, vol. 41, no. 3 (1999), p. 4. According to Chief of the Russian State Customs Committee Nikolay Kravchenko, more than 500 incidents of illegal transport of nuclear and radioactive materials across the Russian state border were registered by the customs in 2000. The majority involved radioactive cargoes or sources. ITAR-TASS (Moscow), 2 Apr. 2001, in 'Russia: IAEA expresses concern over traffic in nuclear materials', Foreign Broadcast Information Service, *Daily Report–Central Eurasia* (FBIS-SOV), FBIS-SOV-2001-0402, 3 Apr. 2001.

[13] The majority of the cases involving radioactive material should be labelled 'unintentional trafficking'. Statens kärnkraftinspektion (SKI, Swedish Nuclear Power Inspectorate), Illicit Trafficking Combat Project Group, *Report on Combating of Illicit Trafficking*, SKI report 00:3 (Jan. 2000), pp. 20–21.

[14] Based on an evaluation of the entries in the NIS Nuclear Smuggling Database of the Center for Nonproliferation Studies at the Monterey Institute of International Studies, between Jan. 1995 and Dec. 1997 not a single confirmed case involving even minute quantities of weapon-grade material received coverage in the open literature. Ewell, E. S., 'NIS nuclear smuggling since 1995: a lull in significant cases?', *Nonproliferation Review*, vol. 5, no. 3 (spring/summer 1998), p. 119.

proliferation-sensitive material persisted after 1997,[15] although the number of reported thefts has been gradually declining.[16]

There has been no hard evidence of the theft or attempted theft of nuclear warheads or their components.[17] However, episodes of serious proliferation concern may have occurred that are unknown outside government, police or intelligence circles.

Analysis of the confirmed significant cases in 1992–94, although limited from a statistical viewpoint, shows a number of interesting correlations.[18]

1. The known, or the most likely, origins of diverted material were facilities located either in Russia or in the other NIS.
2. All seizures have taken place in Central Europe (the Czech Republic and Germany) or in Russia.
3. All intercepted quantities were small and insufficient for the manufacture of even one nuclear explosive. The material involved was predominantly HEU.
4. Reports in the open literature indicate that the stolen weapon-grade materials did not originate from actual weapon material stocks controlled by the Russian Ministry of Defence or Ministry of Atomic Energy but were produced to fuel naval or research reactors or to be used for scientific purposes.[19]
5. Two cases concerned HEU of identical levels of enrichment and were therefore linked.
6. No material was diverted while in transport.

In addition, circumstantial evidence does not support claims of the existence of a well-organized nuclear black market. Smugglers, in desperate search of potential buyers, have been easy targets for undercover law enforcement officers, and some of the recorded thefts were provoked by police 'sting' operations.

Since 1995 there has been a marked decline in confirmed cases involving trafficking in nuclear and radioactive materials. This could be interpreted in two ways.[20] The optimistic interpretation is that the decline is the result of international assistance to secure nuclear material and deter smuggling in the NIS with ensuing increased political, media and public awareness. The pessimistic analysis assumes that diversion and illicit trafficking continue undetected and points to the lack of information, poor intel-

[15] E.g., the Russian Federal Security Service announced that, in Dec. 1998, it foiled a theft of 18.5 kg of radioactive material suitable for 'the production of nuclear weapons components' from a facility in the Chelyabinsk region. If this material was really plutonium or HEU, as the report implied, this would be by far the largest theft of directly weapon-usable material on record. Henry L. Stimson Center (note 2). In Apr. 2000 almost 1 kg of HEU was seized (the location was not specified). Statement by the IAEA Director General to the 44th regular session of the IAEA General Conference 2000, Vienna, 18 Sep. 2000. About 3 grams of plutonium contained in hundreds of metal plates were discovered in a town outside Thessaloniki, Greece, in Jan. 2001. *Athens News*, 1 Feb. 2001, p. A04. Over 0.5 kg of HEU was found by Colombian authorities in Mar. 2001 in a suburb of Bogotá. 'Hot house', *Guardian Europe*, 25 Apr. 2001, pp. 2–3.

[16] 'Ministry notes drop in nuclear material theft', *Moscow Times*, 30 Sep. 2000, p. 4.

[17] Ek, P., SKI, Private communication with the author, 8 Sep. 2000. See also Bunn (note 10), p. 20.

[18] In this context, the term 'significant' means diverted weapon-grade or, at least, weapon-usable material, irrespective of weight. The IAEA defines a significant quantity of direct-use material as 8 kg of plutonium or uranium-233, or 25 kg of HEU.

[19] For a detailed discussion, see Potter, W. C., 'Before the deluge? Assessing the threat of nuclear leakage from the post-Soviet states', *Arms Control Today*, vol. 25 (Oct. 1995), pp. 9–11.

[20] Ewell (note 14), pp. 119–24.

ligence sharing between countries and discouraged Western intelligence officials.[21] It is also often claimed that smugglers have become more sophisticated.

It is not easy to properly characterize and address the threats posed by illicit trafficking. It can be argued that the only victims of illicit trafficking so far have been the opportunistic criminals and amateur gangs that divert and transport all kinds of radioactive scrap, such as abandoned radiation sources, in the hope of financial gain. These individuals usually do not appreciate the hazards involved and often suffer severe injuries or receive lethal doses of radiation.[22]

There is, however, cause for serious concern. First, the fact that amateurs were able to steal and remove sensitive material from nuclear installations is alarming. Second, existing drug smuggling routes, such as those in the volatile region of Central Asia, that are not as well policed or equipped with modern detection systems as the ones leading to Europe may offer alternatives to nuclear smugglers.[23] Third, insiders have clearly been involved in helping smugglers. Fourth, given the vast size and complexity of the former Soviet civilian and military nuclear complexes, remedies cannot be implemented easily or quickly. In short, the covert diversion of plutonium or HEU cannot be completely ruled out. The actual quantities involved may be much larger than reported or officially confirmed cases indicate.[24] Such diversions may have taken place in the early chaotic period after the fall of the Soviet Union.

The primary source of risk is the large stockpiles of fissile materials. It will take a long time to decrease their size or neutralize them. Irreversibly disposing of excess military plutonium and HEU, by recycling them, for example in the civilian nuclear fuel cycle, would be a step in the right direction. Another would be lowering the level of civilian stocks by adjusting spent fuel reprocessing rates to match the actual demand for plutonium. Strengthening physical protection, effective application of international safeguards in conjunction with comprehensive national accounting and control, and prevention mechanisms in general, together with a modern legal framework, are crucial. The most challenging question is whether there actually are ‘end-users’ for fissile materials and sophisticated criminal traffickers or supplier networks to serve them.

Terrorist acts such as the bombings of the New York World Trade Center in 1993 and the Murrah Federal Building in Oklahoma City in 1995 as well as the 1995 sarin nerve gas attack by the Aum Shinrikyo sect in the Tokyo underground have refocused attention on the potential for nuclear terrorism.[25] Acquiring fissile material is an

[21] Following the 1994 ‘Munich case’, a sting operation involving 363 grams of smuggled weapon-grade plutonium which was intercepted in Munich on a regular Lufthansa flight from Moscow, there was public outrage, which led to a parliamentary investigation resulting in intense scrutiny of the German intelligence service. Ewell (note 14), pp. 123–24.

[22] Although of no proliferation concern, health and environmental consequences from uncontrolled radiation sources could be significant. E.g., in 1987 a ruptured caesium-137 source, which was stolen in Goiâna, Brazil, resulted in 4 deaths, significant internal contamination of 129 people and external contamination of 249 people. It necessitated the decontamination of 85 houses and the evacuation of 200 people from 41 houses. The clean-up operations lasted 6 months, involved a staff of 575 and generated some 3500 cubic metres of radioactive waste. See SKI (note 13), annex 4, p. 4.

[23] Conrad, B., ‘Regional (non-) proliferation: the case of Central Asia’, Conflict Studies Research Centre, British Ministry of Defence, Apr. 2000, pp. 3–4, URL <http://www.ppc.pims.org/Projects/csrc/K29-BC.htm>. Commentators have observed an increase of incidents in the late 1990s in Central Asia and a decline in Russia and West Europe. E.g., Presentation by Williams, P., International Conference on Security of Material (note 12), 9 May 2001.

[24] SKI (note 13), p. 20.

[25] Advisory Panel to Assess Domestic Response Capabilities for Terrorism Involving Weapons of Mass Destruction, *First Annual Report to the President and the Congress, I. Assessing the Threat* (US Congress: Washington, DC, 15 Dec. 1999), pp. 6–12, available at URL <http://www.rand.org/

essential technical prerequisite to constructing a nuclear weapon.[26] Several kilograms of plutonium, or several times that amount of HEU, would suffice for this purpose.[27] Although there is active debate as to whether a sub-state group would be motivated or capable of assembling and detonating a nuclear weapon, there should be little doubt about the actions of a committed proliferating state.[28] The existing massive quantities of nuclear materials, some of which are still potentially vulnerable to theft, will inevitably continue to contribute to the threat of nuclear proliferation.

## III. Prevention, detection and control

Combating the illicit traffic in nuclear and radioactive materials is a difficult and complex problem for both states and international bodies. States have the sole responsibility for preventing and deterring the diversion and unauthorized transport, possession and use of these materials within their territory or across their borders. The first line of defence is prevention. The principal elements of a comprehensive national prevention scheme are: (*a*) complying with international treaties, conventions and agreements; (*b*) maintaining and implementing national legislation and regulations; and (*c*) operating systems for nuclear material accountancy, notification and authorization of radiation sources, physical protection of nuclear materials and facilities, export/import control, and law enforcement and border control.[29]

The 1968 Treaty on the Non-Proliferation of Nuclear Weapons (Non-Proliferation Treaty, NPT) and the IAEA-administered safeguards form the legal foundations of international systems of control and accounting of nuclear materials.[30] Although safe-

organization/nsrd/terrpanel>. See also the Middle Powers Initiative briefing book, Green, R. D., *Fast Track to Zero Nuclear Weapons*, 1999, p. 27, URL <http://www.napf.org/mpi/zero.html>; and Cirincione, J., 'Historical overview and introduction', ed. J. Cirincione, *Repairing the Regime: Preventing the Spread of Mass Destruction* (Routledge and Carnegie Endowment for International Peace: Washington, DC, 2000), p. 1.

[26] Radioactive material can nevertheless be employed relatively easily together with conventional explosives to construct a crude, but potentially dangerous, radiological bomb. Chechen rebels threatened to use such a 'dirty' explosive in 1995.

[27] National Academy of Sciences, *Management and Disposition of Excess Weapons Plutonium: Executive Summary* (National Academy of Sciences: Washington, DC, 1994), p. 1; and Maerli, M. B., 'Relearning the ABCs: terrorists and "weapons of mass destruction"', *Nonproliferation Review*, vol. 7, no. 2 (summer 2000), pp. 111–13. For a technical discussion, see Paine, C. E., Cochran, T. B. and Norris, R. S., 'Technical realities confronting transition to a nuclear weapon free world', Background papers, Canberra Commission on the Elimination of Nuclear Weapons, Aug. 1996, pp. 109–15.

[28] In Feb. 2000 Director of the US Central Intelligence Agency George J. Tenet noted that the intelligence community had no evidence that any fissile materials had actually been acquired by a terrorist organization. Ali, J., 'The radiological weapons threat: fact or fiction?', Presentation made at the Jane's Conference on Weapons of Mass Destruction: Reaction in the Face of Uncertainty, Washington, DC, 2–3 Oct. 2000. See also Baker and Cutler (note 10), p. 5.

[29] IAEA, Nuclear verification and security of material, (b) measures against illicit trafficking in nuclear materials and other radioactive sources, IAEA document GOV/1999/17, 26 Feb. 1999, p. 9; and Thorstensen, S., 'Safeguards and illicit nuclear trafficking: towards more effective control', *IAEA Bulletin*, vol. 38, no. 4 (1996), p. 31. See also chapter 9 in this volume.

[30] The application of IAEA safeguards is discussed in Zarimpas, N., 'Nuclear verification: the IAEA strengthened safeguards system', *SIPRI Yearbook 2000: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2000), pp. 496–508. For the list of states which have ratified, acceded to or succeeded to the NPT and the states which have safeguards agreements in force with the IAEA as of Jan. 2001, see annexe A in this volume. The nuclear weapon states recognized under the NPT (China, France, Russia, the UK and the USA) are not obliged to accept safeguards. However, they have entered into Voluntary Offer Agreements with the IAEA which allow it to apply selective safeguards on all or on certain facilities within their territories or under their jurisdiction or control. Civilian facilities in France and the UK are subject to safeguards administered by the European Atomic

guards can help detect the diversion of nuclear materials, they are not specifically designed to prevent it. This is predominantly the task of national physical protection systems which operate closely with a state's system of accounting and control of nuclear materials. The 1980 Convention on the Physical Protection of Nuclear Material and relevant consensus IAEA recommendations set the only internationally acceptable physical protection standards.[31] It should be noted, however, that the manner in which nuclear materials are protected varies widely from country to country.[32] This is also true, and of primary concern, for states possessing nuclear weapons which own facilities and material that are not under international safeguards. Although not legally binding, international standards also exist for the licensing, transport, safety and security of radioactive materials.[33]

The existence of a solid legal, regulatory, technical and administrative infrastructure is essential. Such frameworks are necessary to accommodate the obligations arising from international agreements and to ensure the effective implementation of national legislation regarding nuclear material accounting, radiation safety, security and export/import control measures. Combating illicit trafficking also requires the harmonious cooperation and continuous training of various state authorities such as law enforcement, intelligence, defence, customs, postal, regulatory and technical services. In order to detect illegally diverted material many countries have installed radiation detectors at airports, ports and border crossings.[34] Detailed analysis and evaluation of confiscated samples can be performed by radiological protection services and at safeguards laboratories. Modern communication networks and the availability of emergency teams form part of the national detection systems.

## IV. Continuing measures and responses

The illicit traffic in nuclear and radioactive materials is a problem with both national and international dimensions. While national measures are imperative, bilateral exchanges and a collective, well-coordinated global response would be beneficial in combating the problem. This was reiterated at the Moscow Nuclear Safety and Security Summit, held in April 1996, and at subsequent summit meetings.[35]

Energy Community (EAEC, Euratom). Safeguards are also not applied on the de facto nuclear weapon states: India, Israel and Pakistan.

[31] For a list of parties to the convention, see annexe A in this volume. IAEA, Convention on the Physical Protection of Nuclear Material, IAEA document INFCIRC/274/Rev.1, May 1980; and The physical protection of nuclear material and nuclear facilities, IAEA document INFCIRC/225/Rev.4 (corrected), June 1999. INFCIRC/274 measures principally address civilian nuclear material while in international transport. IAEA INFCIRC documents are available at URL <http://www.iaea.org/worldatom/infcircs>.

[32] For a discussion, see Harrington, K. J., *Physical Protection of Civilian Fissile Material: National Comparisons* (Sandia National Laboratories: Livermore, Calif., 1999); and Bunn, G., 'U.S. standards for protecting weapons-usable fissile material compared to international standards', *Nonproliferation Review*, fall 1998, pp. 137–43.

[33] E.g., guidance provided by the recommendations of the International Commission on Radiological Protection (ICRP).

[34] It is much easier to detect and identify radiation sources than plutonium and uranium using the simple and inexpensive passive systems usually employed for border controls.

[35] The summit meeting agreed on a programme for preventing and combating illicit trafficking in nuclear material to ensure increased cooperation among governments in all aspects of prevention, detection, exchange of information, investigation and prosecution in cases of illicit nuclear trafficking. IAEA, Text of the Moscow Nuclear Safety and Security Summit Declaration, Moscow, 19–20 Apr. 1996, IAEA document INFCIRC/509, 4 June 1996, p. 2.

The IAEA has been the focal point for promoting a much-needed global exchange of information.[36] Nearly 70 countries participate on a voluntary basis in the IAEA's illicit trafficking database programme, which was initiated in 1995. Other activities include performing analyses of confiscated samples, assisting states with border controls, and testing detection and monitoring equipment. Training courses have been provided for regulators, customs officials and border police, jointly with the World Customs Organization (WCO), the International Criminal Police Organization (Interpol) and the European Commission. More importantly, the IAEA Secretariat, together with national experts, is investigating the need to revise and enhance the Convention on the Physical Protection of Nuclear Material. Since 1995 missions have been conducted to review and suggest improvements to national physical protection systems and to offer relevant training. In addition, similar efforts are under way to reinforce the safety and security of radiation sources and other radioactive material.[37]

Different countries have different needs and, influenced by their capabilities and resources, do not respond in the same manner. The sharp increase in incidents of illicit traffic in the 1990s after the breakup of the Soviet Union demonstrated that national measures and preparedness were inadequate in many cases.

Since the early 1990s substantial progress has been made in applying comprehensive safeguards in the majority of the NIS. A fundamental step towards a more rigorous international nuclear verification regime would be the universal adoption and implementation of IAEA safeguards-strengthening measures that are specifically targeted at detecting clandestine nuclear activities. This would provide better assurance of the non-diversion of proliferation-sensitive material. In addition, since 1996 deliberations have been conducted between the IAEA, Russia and the USA (the Trilateral Initiative) to verify fissile material which is no longer needed for defence purposes.[38]

Russia, many of the other NIS and the USA have also actively cooperated since the early 1990s to make warheads and fissile materials in the former Soviet Union more secure.[39] These programmes are aimed at improving physical security for both warheads and materials at several nuclear sites, reducing the size of the former Soviet weapon complex, constructing a modern storage facility for excess fissile materials, establishing modern monitoring and accounting systems, setting up legal and regulatory frameworks for export control and equipping key border crossings with detection

[36] IAEA, 'Security of material', *IAEA Annual Report for 1999* (IAEA: Vienna, 1999), pp. 98–99, available at URL <http://www.iaea.or.at/worldatom/Documents/Anrep/Anrep99/01_over.pdf>; and Measures against illicit trafficking in nuclear materials and other radioactive sources, IAEA documents GC(43)/RES/18, 1 Oct. 1999, and GOV/2000/40-GC(44)/15, 17 Aug. 2000.

[37] González (note 12).

[38] Zarimpas (note 30), p. 501.

[39] Since the passage of the 1991 Soviet Nuclear Threat Reduction Act, sponsored by Senator Sam Nunn and Senator Richard Lugar, the US Government has established an array of threat reduction and non-proliferation programmes in the Department of Defense, the DOE, the State Department and other agencies to assist in dismantling Russian nuclear and other non-conventional weapons, improve the security of such weapons and materials, and prohibit illicit trafficking. Such programmes have expanded as bilateral cooperation has broadened and deepened. Through 1999 the US Congress authorized some $3 billion for these programmes. The Clinton Administration's Expanded Threat Reduction Initiative proposes spending an additional $4.5 billion in 2000–2004. For a detailed discussion, see Bunn (note 10); Baker and Cutler (note 10); Parrish, S. and Robinson, T., 'Efforts to strengthen export controls and combat illicit trafficking and brain drain', *Nonproliferation Review*, vol. 7, no. 1 (spring 2000), pp. 112–24; and Luongo, K. N., 'The uncertain future of U.S.–Russian cooperative nuclear security', *Arms Control Today*, Jan./Feb. 2001, pp. 3–10. The Nunn–Lugar legislation is discussed in Lockwood, D., 'Nuclear arms control', *SIPRI Yearbook 1993: World Armaments and Disarmament* (Oxford University Press: Oxford, 1993, pp. 566–67. Other countries, like Japan and Sweden, have also provided technical assistance to improve the security of materials in the NIS.

systems. In addition to efforts related to the conversion or the shutdown of the three remaining Russian plutonium production reactors and the unprecedented purchases by the USA of down-blended HEU from dismantled Russian warheads, such programmes have considerably helped to reduce illicit trafficking risks, although they have not completely eliminated them.[40]

## V. Conclusions

Despite the decline since 1995 in the number of reported cases of illicit trafficking involving fissile material and the fact that a major proliferation catastrophe has so far been averted, challenges will remain for a long time to come.

Illicit trafficking affects all countries to a certain degree because of the proliferation, public health and safety risks involved. There is an urgent need to: (*a*) reduce existing HEU and plutonium stockpiles; (*b*) raise global standards and uniformity for physical protection; (*c*) strengthen and extend the application of safeguards; (*d*) ensure the existence of modern prevention and detection infrastructures as well as the appropriate legal framework; (*e*) facilitate better cooperation and information sharing among countries and international bodies; and (*f*) continue to intensively assist Russia and the other NIS to contain proliferation. In addition, a better understanding of the problem of illicit trafficking that includes the motivation of traffickers, links to organized crime and the profile of potential end-users is necessary.

Undoubtedly, much has already been achieved by promoting international cooperation and raising awareness. Political determination, including the necessary funding, and focused responses will be crucial to overcome the remaining obstacles.

[40] According to the Director of the Snezhinsk Nuclear Weapon Laboratory, at the current pace of the US Department of Energy (DOE) programme it would take up to 60 years to improve the security of all the materials at risk in this facility. Baker and Cutler (note 10), p. 38. For a comprehensive account, see US General Accounting Office (GAO), Report to Congressional Requesters, *Nuclear Nonproliferation: Security of Russia's Nuclear Material Improving; Further Enhancements Needed*, GAO-01-312, Feb. 2001.