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NUCLEAR TERRORISM

Recent reports of alleged terrorist plans to build a 'dirty bomb' have heightened longstanding concerns about nuclear terrorism. This briefing outlines possible forms of attack, such as:

- **Detonation of a nuclear weapon.**
- **Attacks involving radioactive materials.**
- **Attacks on nuclear facilities.**

Legislation addressing these risks and the UK's strategy for coping with them are also considered.

Nuclear weapons

The detonation of a nuclear weapon (see box opposite), although extremely difficult for terrorists to accomplish, could have devastating consequences. Terrorists might attempt either to steal a nuclear weapon or construct their own device from illegally acquired nuclear material[1].

Acquisition of nuclear weapons by terrorists

There are over 30,000 nuclear weapons worldwide, more than 90% of which belong to the USA or Russia (see table on page 2). Nuclear weapons are held under high security, although standards vary internationally and the US National Intelligence Council (NIC) has voiced concerns about internal security at Russian weapons complexes (see box on page 2). Many groups, such as the Federation of American Scientists (FAS), consider it unlikely that terrorists could actually acquire a nuclear weapon. In addition, most[2] weapons are designed to prevent unauthorised use. Therefore, even with possession of a complete weapon, actual detonation could be very difficult.

Construction of nuclear weapons by terrorists

Obtaining the necessary nuclear material is the main obstacle facing terrorists seeking to *construct* nuclear weapons. Although much of the global stockpile of nuclear material is secure, some countries lack the resources to maintain reliable security systems. It is widely acknowledged (e.g. at the 2002 G8 summit) that the problem is most serious in Russia (see box on page 2) and the former Soviet states, which hold a large proportion of the global stockpile.

The International Atomic Energy Agency (IAEA)[3] reports 18 confirmed cases of illicit trafficking in highly enriched uranium or plutonium (see box below) since 1993. However, the quantities involved were not sufficient to make a weapon. There is no evidence to date that any terrorist group has acquired nuclear weapons or enough nuclear material to construct one – although there is evidence that both Aum Shinrikyo and Al Qaida have attempted to do so.

Nuclear weapons

Nuclear weapons use highly enriched uranium (HEU) or plutonium ('fissile materials') to generate a nuclear explosion.

- *Uranium* occurs naturally but can be used in nuclear weapons only if it has been artificially *enriched* to greatly increase the proportion of U-235 (a form of uranium that can generate a nuclear explosion).
- *Plutonium* does not occur naturally - it is a radioactive heavy metal generated in nuclear reactors. It is highly toxic and can cause cancer if particles are inhaled.

There are two possible techniques terrorists might use to construct a nuclear bomb:

- *Gun assembly devices* (e.g. the 'Little Boy' bomb, used against Hiroshima) are the simplest design - one piece of HEU is simply fired at another, causing a nuclear explosion. Plutonium cannot be used in this way.
- *Implosion devices* (e.g. the 'Fat Man' bomb, used against Nagasaki) are more complex, using conventional explosives to compress a sphere of plutonium or HEU, which triggers a nuclear explosion.

A nuclear device could be constructed with a minimum of 8kg of plutonium (a sphere the size of a tennis ball) or 25 kg of uranium (more for a gun assembly device).

Construction and deployment of a gun assembly type nuclear device, though difficult, is considered within the scope of a sophisticated terrorist organisation[4], given access to enough HEU. Opinions vary as to whether

terrorists could construct an implosion device – this would present far more technical challenges although less material would be needed and either HEU or plutonium could be used.

Security of nuclear facilities in Russia

Russia's nuclear security system has deteriorated since the break-up of the Soviet Union. Moreover there are concerns that poor living and working conditions might tempt staff to assist terrorists. A recent NIC[5] report observed the following:

- **Nuclear warheads**: Russia has maintained adequate security and control of its nuclear warheads but a decline in military funding has stressed the nuclear security system. Moreover, many security measures were designed in the Soviet era to protect against external threats rather than insiders. Officials have twice thwarted terrorist attempts to access nuclear weapons storage facilities.
- **Nuclear Materials (**civilian and military) are often inadequately protected - many buildings do not have cameras, detectors or trained personnel.

The exact amount of weapons grade fissile material in Russia is unknown[6] due to poor accounting procedures, although these have improved in recent years.

Global stocks of nuclear weapons and nuclear materials

Country	Total nuclear weapons[3] (including those in reserve)	HEU (metric tonnes)[4]	Separated plutonium (metric tonnes)	
		Military[4] (1994)	Military[4] (1994)	Civilian[5] (2000)
US	~9,000	580-710	85	0
Russia	~20,000	735-1365	100-165	34
UK	<200	6-10[2]	7.6	78.1
France	~350	20-30	3.5-6.5	82.7
China	410	15-25	2-6	0
India	30-35[1]	0	~0.3	0
Pakistan	30-52[1]	0.6-0.8	0.001-0.01 (end 1999)	0
Israel	60-100[1]	0	~0.4	0
South Africa	0	0.4	0	0
N.Korea	0	0	~0.03	0
Germany	0	0	0	7.2
Japan	0	0	0	5.2
Other European	0	0	0	4.5
Total	30, 085-30, 152	1360-2140 + ~ 20 (civilian)	200-270	~200

1 Estimates based on the amount of nuclear material these states are believed to possess.
2 21.9 tonnes as published in the Strategic Defence Review 1998
3 Carnegie Endowment for International Peace http://www.ceip.org/files/nonprolif/numbers/default.asp
4 Federation of American Scientists. Public Interest Report Vol.54, No. 6.
5 Based on national declarations to the International Atomic Energy Agency (Infcircs549 http://www.iaea.org/worldatom/Documents/Infcircs).

Effects of a nuclear explosion

The Hiroshima bomb had a 'yield' equivalent to 15,000 tonnes of TNT, killing ~100,000 people within the first few months. However the effects of a nuclear explosion depend on many factors such as weather conditions and the size and type of device. The yield of a nuclear weapon constructed or stolen by terrorists could range from only a few tonnes to many thousands of tonnes. However, even a low yield device could have significant consequences.

Attacks involving radioactive materials

Radiological attacks involve dispersal of radioactive material but not a nuclear explosion. They pose fewer technical difficulties than deploying a nuclear weapon. Many radioactive materials are easier to acquire than nuclear materials and are used extensively in many countries, in medicine, industry, agriculture and research. The activity of radioactive materials (i.e. the amount of radioactivity they emit) varies widely and security standards reflect this, but such standards also differ significantly between countries (discussed on page 4).

Methods of dispersal

The effects of an attack would depend on the material involved and how it was dispersed. One method is simply to leave radioactive material in a public place. In 1995, Chechen rebels planted four cases of radioactive caesium in a Moscow park as a warning of what they might do in the future. Although the material was in protective casing and posed no major hazard, the event generated widespread publicity.

Alternatively terrorists might set off a **dirty bomb,** using conventional explosives to disperse radioactive material over a wide area. To date, no terrorist group has detonated a dirty bomb. The effects are hard to predict, as they would depend on factors such as weather conditions and the type of material used. People could be exposed to radioactivity, not only from the initial dust cloud, but also from particles that settled on the ground and buildings or entered water or food supplies. Although such an attack may not necessarily result in large numbers of casualties, there could be significant psychological and social impact. According to the Federation of American Scientists, dirty bombs could contaminate large urban areas above recommended exposure limits, with potentially serious economic implications. The duration of any contamination would depend on the type of radioactive material used.

Attacks on nuclear facilities

Nuclear reactors

It is not physically possible to generate an uncontrolled nuclear explosion (as occurs with a nuclear weapon) at a reactor, but successful sabotage could cause a significant release of radioactive material. Western style nuclear reactors meet strict safety requirements but were not specifically designed to withstand the impact of large aircraft. Some reactors in the former Soviet Union do not meet Western safety standards (see page 4).

Although there have been no successful attacks on nuclear reactors, there have been threats and reports of suspected terrorists possessing sensitive documents. Under the UK Anti Terrorism, Crime and Security Act 2001 it is a criminal offence to disclose information that might compromise security of UK nuclear facilities.

Reprocessing plants

The reprocessing plants at Sellafield in the UK and Cap de la Hague in France have the largest inventories of radioactive material in Europe and so could be terrorist targets. Among the products stored at these sites, principal hazards include spent fuel, plutonium and high level liquid waste (HLLW). The Nuclear Installations Inspectorate (NII) report that "*there has been no specific design provision to protect [the HLLW storage tanks]*

against crashing aircraft" although they agree with BNFL's conclusion that the likelihood of such an impact is very remote. The consequences of breaching these tanks are hard to predict but it is notable that they contain more caesium-137 than was released into the environment following the Chernobyl accident.

Material in Transit
Nuclear electricity generation accounts for a large fraction of the total amount of radioactive material transported nationally and internationally each year. This ranges from low-level waste to highly radioactive material e.g. spent fuel. Under UK regulations (based on IAEA recommendations) highly radioactive material is transported in robust casks that would be difficult for terrorists to rupture.

Issues

Measures taken to address the risk of nuclear terrorism include:

- Reducing stockpiles and increasing security of nuclear weapons and materials
- Improving regulatory control of radioactive materials
- Improving the security of nuclear facilities
- Developing and maintaining contingency plans.

Nuclear Weapons
The Nuclear Weapons States are committed to multilateral disarmament under the Non-Proliferation Treaty (see box opposite). Several agreements exist between the US and Russia to reduce their stockpiles of nuclear weapons - although the 2002 Moscow Treaty allows warheads to be stored rather than dismantled. Russia acknowledges the need for security improvements at its nuclear weapons storage sites and upgrades are currently under way with financial assistance, primarily from the USA.

Nuclear Materials
Levels of protection of nuclear materials vary in different countries. Levels of physical protection for civilian nuclear material in *international* transit are set by the Convention for the Physical Protection of Nuclear Materials (see box opposite). However there are no binding international standards on *domestic* handling of nuclear materials, although the IAEA issues recommendations (which legislation in the UK follows closely). An amendment is currently under consideration to extend this convention to domestic use of civilian nuclear material. The Non-Proliferation Treaty (see box opposite) applies safeguards to civilian nuclear materials but these were designed to combat nuclear proliferation rather than terrorism.

In March 2002, the IAEA announced a programme of activities aimed at protection against nuclear terrorism, including measures to upgrade the physical protection of nuclear and radioactive materials worldwide. The IAEA will need an additional $34.5 million annually to bring this about. As of June 2002, IAEA member states had pledged an additional $7.5 million towards this project. This allows work to begin but is less than required to meet the programme needs.

International Agreements
The **Non-Proliferation Treaty (NPT)** entered into force in 1970 and has 187 signatories. Under the NPT, the Non Nuclear Weapons States undertake not to acquire nuclear weapons and to adhere to IAEA safeguards (i.e. to account for nuclear material and allow inspection of nuclear sites). The five 'Nuclear Weapons States' (US, UK, France, Russia and China) have agreed that these safeguards can be applied to some of their civilian nuclear facilities. Note that India, Pakistan and Israel – states known or thought to possess nuclear weapons – have not acceded to the NPT.
The **Convention for the Physical Protection of Nuclear Material** entered into force in 1987 and has 45 signatories. It relates to the physical protection of nuclear material used for peaceful purposes, in international transit.
The **Convention on Nuclear Safety** entered into force in 1996, has 65 signatories and relates to safety standards at nuclear installations.
The **Joint Convention on the Safety of Spent Fuel Management and Safety of Radioactive Waste Management** entered into force in 2001 and has 42 signatories.
The proposed **Fissile Material Cut Off Treaty** would end production of fissile materials for use in nuclear weapons. This could strengthen the non-proliferation regime but negotiations have stalled in recent years, partly due to concerns by some states over U.S. proposals for missile defence.

International effort is being dedicated to improve nuclear security in Russia and the former Soviet States. One of the key issues is reducing stockpiles of weapons-grade uranium and plutonium. The USA and Russia have a number of agreements in place and are considering increasing the amounts of material involved. With regard to uranium, Russia has an agreement with the USA to 'blend down' 500 tonnes of HEU from dismantled warheads (i.e. convert it into fuel which cannot be used in weapons) for use in US reactors. However, at the current blend-down rate of 30 tonnes a year, this target will not be met before 2013. With regard to plutonium, both countries have agreed to dispose of 34 tonnes of excess weapons-grade plutonium (the UK is contributing £70 million over 10 years to this project). Progress is hindered by lack of international consensus on whether to incorporate the plutonium into nuclear reactor fuel.

Initiatives are also underway to increase security of nuclear materials in Russia and the former Soviet states. Projects include upgrading security and accounting systems and finding work for ex-nuclear staff to limit the spread of expertise.

To date, the USA has made the largest contribution towards these activities (~$500 million in 2002 alone). The UK has allocated £84 million for 2001-2004. One of the UK's key areas of assistance is the de-fuelling and decommissioning of Russian nuclear submarines. At the 2002 summit the G8 leaders agreed to raise $20 billion (half from the US) over ten years to prevent the spread of weapons and materials of mass destruction. Priorities include employment of former weapons scientists and disposition of excess HEU and plutonium. However the amount pledged falls short of that recommended by the 2001 Baker-Cutler Task Force on Department of Energy Non-Proliferation Programs with Russia.

Radioactive materials

According to the IAEA, the majority of radioactive materials worldwide are under the control of competent regulatory authorities. However there are no internationally binding standards and the IAEA recently stated that regulation is inadequate in many countries – particularly in some of the former Soviet States. A large number of sources are abandoned, lost or stolen every year, although most of these would not pose a major risk if used in an attack. The IAEA is taking measures to strengthen regulatory control of radioactive materials. These include helping some states establish effective regulatory frameworks and securing lost or abandoned radioactive materials.

The use of radioactive materials in the UK is controlled under the Radioactive Substances Act 1993. Existing standards were designed to protect the public from radiation and not to combat terrorism. However the Environment Agency reviewed the security of radioactive materials they regulate following September 11th and carried out special inspections on the highest risk materials in England and Wales. Most arrangements were deemed satisfactory but some security issues were identified, such a need for improvements to prevent intruder access at some sites.

Nuclear Facilities

The IAEA is currently revising safety standards and increasing assistance aimed at improving the security of nuclear facilities. With Western aid some Soviet designed reactors are being decommissioned and safety systems and procedures at others improved. However, the US National Intelligence Council points out that inherent design flaws will prevent some of these reactors from meeting western safety standards.

In the UK, the Office of Civil Nuclear Security regulates security arrangements at civil nuclear sites. New regulations are currently under consideration to modernise the UK civil nuclear security regime . Security arrangements have been reviewed since September 11th. Measures have been taken to enable intervention by RAF interceptor aircraft in the event of an aircraft attack at a civil nuclear facility. In France, anti-aircraft missiles were installed around the Cap de la Hague facility - though these have since been removed.

UK Contingency Planning

The UK has contingency plans for responding to terrorist threats involving nuclear or other radioactive materials. The lead government department for co-ordinating emergency response depends on the mode of attack -

- Home Office: Any terrorist attack in the UK. Input from the DTI (attacks at civil nuclear sites) and DEFRA (other radiological attacks or an emergency overseas).
- FCO: Terrorist incidents affecting UK interests abroad.
- MOD: Attacks at military nuclear sites.

At local level, responsibility for emergency planning arrangements lies with the local authority. Plans require the support of public bodies such as the police, fire services and health authorities and would involve:

- Arrangements to protect the public from radiation, possibly involving evacuation.
- Treatment of casualties and monitoring of public exposed to radiation.
- Restriction of contaminated food and water supplies.

Exercises are carried out regularly at three levels – on site at nuclear facilities, at local level and at a national level. These exercises highlight the practical problems that would be faced in the event of an emergency. Detailed emergency plans exist for all areas within ~3 km of civil nuclear facilities although these plans can be extended to deal with larger events. Note that emergency zones in some countries (e.g. the US) are tens of kilometres wide.

The Civil Contingencies Secretariat (established as part of the Cabinet Office in 2001) is responsible for improving the UK's response to disasters, including acts of terrorism and is ensuring contingency plans are reviewed and renewed following September 11th.

Overview

- The most devastating form of nuclear terrorism would be the detonation of a nuclear weapon – although this would also be the most difficult form of attack. Terrorists may face fewer technical difficulties dispersing radioactive material in a radiological attack. This may not result in mass casualties but could have major psychological and economic impact.
- The IAEA is taking measures to strengthen international conventions and guidelines relating to the physical protection of nuclear and radioactive materials and nuclear facilities.
- Russia and the former Soviet states are receiving continued international assistance to maintain control over their nuclear materials and facilities.

Endnotes

1 A nuclear material is a radioactive material from which material for the core of a nuclear weapon can be obtained. Note that some nuclear materials (e.g. natural uranium) cannot be used directly in nuclear weapons without further processing.
2 According to a report presented to the US President and Congress in 1999, it is not certain whether protective mechanisms on some older and smaller Russian nuclear weapons are adequate.
3 The International Atomic Energy Agency (IAEA) was set up in 1957 as an independent body within the United Nations to promote the peaceful uses of nuclear technology.
4 For example, see 'The Nuclear Terrorist Threat', Institute for Science and International Security, August 1997.
5 Annual Report to Congress on the Safety and Security of Russian Nuclear Facilities and Military Forces. US National Intelligence Council, February 2002.
6 According to the Carnegie Endowment for International Peace.

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