RADIOLOGICAL TERRORISM – A GLOBAL POLICY CHALLENGE IN NEED OF URGENT ACTION

BY DR BAHRAM GHIASSEE, ASSOCIATE FELLOW

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CENTRE ON RADICALISATION & TERRORISM

July 2022

Published in 2022 by The Henry Jackson Society

The Henry Jackson Society
Millbank Tower
21-24 Millbank
London SW1P 4QP

Registered charity no. 1140489
Tel: +44 (0)20 7340 4520

www.henryjacksonsociety.org

Title: "RADIOLOGICAL TERRORISM – A GLOBAL POLICY CHALLENGE IN NEED OF URGENT ACTION"
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ISBN: 978-1-909035-78-2

£9.95 where sold

Cover image: White dust particle explosion by piyaphong at Shutterstock (https://www.shutterstock.com/image-photo/white-dust-particle-explosion-resembling-snow-514337542).

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Developments in the nuclear sphere in the Middle East and North Africa (MENA) are of particular interest to Bahram, and he comments for a number of media organisations, including the *BBC* and *Voice of America*.

Bahram is a member of the International Nuclear Law Association (Brussels), and the World Institute for Nuclear Security (Vienna). He is also a chartered member of the UK Nuclear Institute, and a recipient of the Institute's prestigious Pinkerton Prize (2011). Bahram holds dual qualifications in Public International Law (University College London, UCL), and Nuclear Science & Technology (Imperial College London). (b.ghiassee73@alumni.imperial.ac.uk).

Acknowledgements

I am grateful to the Senior Management Team at HJS for their unanimous approval of the research proposal, and for their continuing support. I am also grateful to the internal and external reviewers for their valuable and constructive comments and suggestions. I would like to take this opportunity to further extend my gratitude to the staff at HJS for their generous support.

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The Centre on Radicalisation and Terrorism (CRT) at the Henry Jackson Society is unique in addressing violent and non-violent extremism. By coupling high-quality, in-depth research with targeted and impactful policy recommendations, we aim to combat the threat of radicalisation and terrorism in our society.

Executive Summary

This report addresses radiological terrorism, and the threat it poses to the public, the economy, the environment, and the ecological systems across the globe. It also assesses the illicit transnational trafficking in radioactive sources used in medical, industrial, agricultural and research applications in more than 150 countries.

A review of the Incidents and Trafficking Database of the International Atomic Energy Agency (IAEA) and other global databases is provided in this report, indicating the continuing trend in reporting of radioactive substances out of regulatory control, and the malicious use and trafficking in such substances.

A brief description of relevant cases is also given, demonstrating the ease with which non-State actors may illicitly acquire such materials, and use them in Radiological Dispersal Devices (RDDs), including the so-called 'Dirty Bombs'.

The report highlights the multiplicity and fragmented nature of the global initiatives, entities, and organisations concerned with radiological security and radiological terrorism, notwithstanding the positive contributions they are making. It also underlines the inadequacy of the international legal framework, which is primarily based on non-binding 'Soft Law' instruments.

A number of policy recommendations are further advocated in the report, *inter alia*:

(i) The international community to mandate and fund the establishment of an 'International Centre for Radiological Security', within the IAEA, as a single overreaching entity, to oversee and co-ordinate all activities related to radioactive sources, on a long-life basis, including disused sources, and orphan sources (those abandoned, lost, misplaced, or stolen).

(ii) The relevant IAEA Codes and Supplementary Guidance be consolidated, and, under the IAEA auspices, be elevated to a binding international legal instrument. There is precedent in relation to the IAEA Convention on the Physical Protection of Nuclear Material (CPPNM).

(iii) The United Nations Security Council (UNSC) to adopt a binding resolution, to prohibit non-State actors from acquiring radiological devices and weapons, thus complementing resolutions on 'chemical, biological, and nuclear weapons', and their illicit trafficking.

In addressing the global policy challenges which radiological terrorism is posing, the international community would be in a strong position to pre-empt the adverse humanitarian, economic, environmental, and ecological harms which could otherwise ensue.

Glossary

9/11	11 September 2001 terrorist attacks in the US
CBRN	Chemical, Biological, Radiological, and Nuclear
Co-60	Radioactive Cobalt, with atomic mass 60
CPPNM	Convention on the Physical Protection of Nuclear Material
Cs-137	Radioactive Caesium, with atomic mass 137
GTD	Global Terrorism Database
GTRI	Global Threat Reduction Initiative
HASS	High Activity Sealed Radioactive Sources
IAEA	International Atomic Energy Agency
ITDB	Incident and Trafficking Database
INTERPOL	The International Police Organization, with 195 member countries
Ir-192	Radioactive Iridium, with atomic mass 192
NNSA	US National Nuclear Security Administration
NRC	US Nuclear Regulatory Commission
OECD	Organisation for Economic Co-operation and Development
ONR	Office for Nuclear Regulation (UK)
POST	Parliamentary Office of Science and Technology (UK)
RDD	Radiological Dispersal Device
RED	Radiological Exposure Device, or Simple Exposure Device (SED)
WINS	World Institute for Nuclear Security
WMD	Weapons of Mass Destruction
UAV	Unmanned Aerial Vehicle, commonly known as a drone
UNGA	United Nations General Assembly
UNSC	United Nations Security Council

Chapter 1. Introduction

This report assesses the global radiological security concerns associated with the illicit acquisition of radioactive substances by non-State actors, in particular terrorist groups, for malicious purposes. The report also examines the risks posed by radioactive materials out of regulatory control, which may be used in illicit transnational trafficking.

The report highlights the inadequacy of the international legal framework, and the fragmented nature of the international institutions governing radiological security. These shortcomings constitute major global policy challenges which the international community needs to urgently address, in order to effectively counter radiological terrorism, and to combat illicit trafficking in radioactive materials.

The need for global action was acknowledged by the Ministers of the Member States of the International Atomic Energy Agency (IAEA) at the 2020 International Conference on Nuclear Security, where they reiterated their commitment to strengthening the security of nuclear and other radioactive materials and facilities. They also expressed their resolve to combat illicit trafficking in such materials, to ensure they are not used by non-State actors for malicious purposes. [1] The IAEA, in its latest 'Nuclear Security Plan 2022–2025', has, indeed, outlined the measures it could provide to its Member States to enhance the security of radioactive materials and associated facilities. [2]

Non-State actors, including terrorists, may illicitly acquire small quantities of radioactive waste, or a radioactive source, that is commonly used for medical and industrial applications, for malicious purposes. The break-up of the Soviet Union in 1991, which resulted in the inadequate protection and security of significant quantities of nuclear and other radioactive materials, posed a major threat to the global security of such materials, and heightened the likelihood of illicit transnational trafficking in them. Indeed, in 1993, the IAEA started collating information on illicit trafficking, and in 1995 formally established the Trafficking Database, which was later renamed the Incident and Trafficking Database (ITDB). [3]

Moreover, the terrorist attacks of 11 September 2001 (9/11) in New York and Washington DC demonstrated the immense capabilities of terrorist groups, thus bringing to the fore the stark realisation that chemical, biological, and radiological terrorism are no longer abstract notions, but constitute actual threats to the public, the environment, and the economic prosperity of nations across the globe. [4] The events of 9/11 also elicited the recognition that not only States, but also extremist groups were pursuing the acquisition of radioactive materials. [5]

The growth of global terrorist networks attempting to acquire radioactive materials, and the escalation of the global radiological threat, prompted the international community, in March 2002, to adopt the first 'IAEA Plan of Action to Protect Against Nuclear Terrorism', and to establish the Nuclear Security Fund to support the implementation of the Plan. [6]

1 "Ministerial Declaration", IAEA International Conference on Nuclear Security: Sustaining and Strengthening Efforts, 10-14 February 2020, paras. 1 & 14, https://www.iaea.org/sites/default/files/20/02/cn-278-ministerial-declaration.pdf.

2 "Nuclear Security Plan 2022–2025", IAEA, *GC(65)/24*, 15 September 2021: 12, https://www.iaea.org/sites/default/files/gc/gc65-24.pdf.

3 Charlotte East and Kendall Siewert, "IAEA Incident and Trafficking Database – Combating illicit trafficking of radioactive materials for 25 years", *IAEA Bulletin*, February 2020: 24-25, https://www.iaea.org/sites/default/files/6112425.pdf.

4 See, "The Post-9/11 Context: Governments Crank Up The Dirty Bomb Threat", in Andy Oppenheimer, "A Sickening Episode: Nuclear Looting in Iraq and the Global Threat From Radiological Weapons", *Disarmament Diplomacy*, no. 73 (October-November 2003), http://www.acronym.org.uk/old/archive/dd/dd73/73op03.htm.

5 Mohamed ElBaradei, *The Age of Deception – Nuclear Diplomacy in Treacherous Times* (London: Bloomsbury, 2011), 164.

6 "Nuclear Security – Measures to Protect Against Nuclear Terrorism", IAEA, *GOV/2002/10*, March 2002, https://www.iaea.org/sites/default/files/gc/gc48-6-att1_en.pdf.

Over the past three decades, non-State actors, in particular terrorists, have been attempting to illicitly acquire small quantities of radioactive material for malicious purposes, including the construction of 'Radiological Dispersal Devices' (RDDs), and the so-called 'Dirty Bombs', [7, 8] which use conventional explosives to disperse radioactive particles, as noted below.

In 1996, Chechen extremists planted a radiological device containing radioactive caesium (Cs-137) packed with explosives (dynamite) in Izmailovsky Park, in Russia. [9, 10] Following a tip-off to the press, the bomb was located and defused, and no one was hurt. [11]

In 2002, an American al-Qaeda associate, Jose Padilla, was arrested in the US for plotting to assemble and detonate a 'Dirty Bomb' in the US. [12, 13]

In 2004, five people were arrested in the UK for planning to detonate RDDs in the vicinity of a gas network, a nightclub, and a shopping centre. They were intercepted, arrested, and subsequently sentenced to life imprisonment in 2007. In a separate case in 2004, the UK security services arrested Dhiren Barot, a Muslim convert who had planned to assemble and use 'Dirty Bombs' in the UK and the US to kill members of the public. He was sentenced to 30 years imprisonment in 2007. [14, 15]

In 2006, radioactive polonium (Po-210) was used in the assassination of Alexander Litvinenko, a former Russian spy, in London. Around 700 people were tested for exposure to radiation, and numerous places were found to be contaminated. Po-210 is one of the most lethal substances known to man, as ingestion or inhalation of microgram quantities will lead to death within a few days. Two Russian agents had brought the Po-210 to London on board a commercial flight. [16, 17]

The accidental contamination of the Brazilian city of Goiânia exemplifies the potential impact of a radiological terrorism attack in an urban setting. In 1987, a medical device housing highly radioactive Cs-137 source was stolen from an abandoned cancer clinic, and sold to a scrapyard. Workers had removed the shiny 93-gram source, cut it up, and distributed the fragments amongst friends and family across the city. The fragments were attractive, as they glowed in the dark. Subsequently, four people died, and 112,000 people had to be monitored. As part of the decontamination exercise, many residents had to be evacuated; 12,500 drums and 1470 boxes filled with contaminated clothing, furniture, etc, had to be disposed of; and a number of properties had to be demolished. [18]

7 "Radiological Dispersal Devices (RDDs)", Radiation Emergency Medical Management (REMM), U.S. Department of Health & Human Services, updated 18 February 2022, https://remm.hhs.gov/rdd.htm.

8 "Dirty Bombs, FACT SHEET", US Nuclear Regulatory Commission (NRC), December 2012, p.4, https://www.neha.org/sites/default/files/Rad%20health%20fs-dirty-bombs.pdf.

9 Graham Allison, "Nuclear Terrorism: How Serious a Threat to Russia?", Belfer Center for Science and International Affairs, Harvard Kennedy School, September/October 2004, https://www.belfercenter.org/publication/nuclear-terrorism-how-serious-threat-russia.

10 Nick Paton Walsh, "Russian nuclear theft alarms US", *The Guardian*, 19 July 2002, https://amp.theguardian.com/world/2002/jul/19/chechnya.nickpatonwalsh.

11 "Security of High Activity Radioactive Sources in Use and Storage", World Institute for Nuclear Security (WINS), April 2019, p.9.

12 Amanda Ripely, "The Case of the Dirty Bomber", *Time*, 16 June 2002, http://content.time.com/time/nation/article/0,8599,262917,00.html.

13 Rolf Mowatt-Larssen, "Al Qaeda weapons of mass destruction threat: hype or reality?", Belfer Center for Science and International Affairs, Harvard Kennedy School, January 2010, p.21, https://www.belfercenter.org/sites/default/files/files/publication/al-qaeda-wmd-threat.pdf.

14 "Security of High Activity", WINS, p.9.

15 "Dirty Bombs, FACT SHEET", NRC, p.4.

16 Marcus MacGill, "Polonium-210: Why is Po-210 so dangerous?", *MedicalNewsToday*, 28 July 2017, https://www.medicalnewstoday.com/articles/58088.

17 "Alexander Litvinenko: Profile of murdered Russian spy", *BBC News*, 21 January 2016, https://www.bbc.co.uk/news/uk-19647226.

18 "The Radiological Accident in Goiânia", IAEA, *STI/PUB/815* (September 1988): 1-5 & 22, https://www-pub.iaea.org/mtcd/publications/pdf/pub815_web.pdf.

The radiological accident in Brazil highlights the extent of harm which the detonation of a single 'Dirty Bomb' in London's Parliament Square could cause. A radiological device containing 50 grams of Cs-137, the size of a standard chocolate bar, and half the amount involved in the Goiânia incident, would have significant social, economic, environmental and psychological impact. Regarded as 'Weapons of Mass Disruption', and not 'Weapons of Mass Destruction' (WMDs), radiological devices, nonetheless, have the potential to cause considerable harm. [19]

Based on similar studies in relation to possible attacks in Washington DC, Los Angeles, the port of Long Beach (USA), Vancouver BC (Canada), and London, the detonation of a 'Dirty Bomb' in Parliament Square would lead to the dispersal of fine radioactive particles, and could contaminate an area up to $10km^2$, encompassing the Supreme Court, the Houses of Parliament, and Downing Street. It would result in a limited number of immediate casualties from the explosion itself, and also delayed (long-term) casualties and illnesses from exposure to radiation and inhalation of radioactive dust. [20, 21, 22] Moreover, areas in the vicinity of the Square, including the underground stations, would need to be sealed off. [23] Such an incident would cause extensive disruption to civic and commercial activities, would require decontamination of large areas, and disposal of large quantities of radioactive soil, tarmac, cars, etc, at a cost of billions of pounds. [24] The potential threat posed would be severe.

In 2021, according to the IAEA, 120 incidents were reported to its ITDB by 32 States, indicating that unauthorised activities, including illicit trafficking and malicious use, continue to occur. Since 1993, the ITDB has recorded 3928 incidents, of which 320 related to trafficking or malicious use (IAEA Category 1 classification). [25] Exposure for just a few minutes to an unshielded Category 1 source would be fatal. [26]

Furthermore, the availability of commercial Unmanned Aerial Vehicles (UAVs), commonly known as drones, which may be purchased off the shelf, has added a new dimension to the threat posed by radiological terrorism. Drones may be used to disperse radioactive particles over public spaces and public gatherings, causing extensive harm to the public, the environment, and the economy. Drones may also be used for the illicit trafficking across national borders of radioactive material weighing just a few grams without shielding. Illicitly purchased, disused, abandoned, or stolen radioactive sources could, therefore, be easily trafficked.

The methodology adopted in the preparation of this research report was based on a detailed review of the open literature in the public domain, and open-source databases, encompassing the following: (i) Radioactive sources used globally in medical, industrial, and research-related applications; (ii) RDDs, including radiological 'Dirty Bombs'; (iii) Incidents and trafficking databases relating to nuclear and other radioactive materials; (iv) Cases of incidents, unauthorised use, and trafficking involving radioactive sources used in the medical

19 "Nuclear Security, POSTNOTE", no. 540, October 2016, p.2, UK Parliamentary Office of Science & Technology, https://researchbriefings.files.parliament.uk/documents/POST-PN-0540/POST-PN-0540.pdf.

20 Jonathan Medalia, "'Dirty Bombs': Technical Background, Attack Prevention and Response, Issues for Congress", Congressional Research Service, 24 June 2011, p.7-10, https://sgp.fas.org/crs/nuke/R41890.pdf.

21 Ibid, p.15-17.

22 Leonard W. Connell, "Dirty Bomb Risk And Impact", Sandia National Laboratories, US Department of Energy, 2017, p.5, https://www.osti.gov/servlets/purl/1378173.

23 Beyza Unal and Sasan Aghlani, "Use of Chemical, Biological, Radiological and Nuclear Weapons by Non-State Actors: Emerging trends and risk factors", Lloyd's Emerging Risk Report, Chatham House, 2016, p.23, https://assets.lloyds.com/assets/pdf-risk-reports-cbrn/1/pdf-risk-reports-CBRN.pdf.

24 Connell, "Dirty Bomb Risk", p.6-9.

25 "IAEA Incident and Trafficking Database (ITDB) – 2022 Factsheet", IAEA, December 2021, p.2-4, https://www.iaea.org/sites/default/files/22/01/itdb-factsheet.pdf.

26 "Categorization of Radioactive Sources", IAEA Safety Standards Series No. RS-G-1.9, 2005, p.32, https://www-pub.iaea.org/MTCD/publications/PDF/Pub1227_web.pdf.

and industrial fields; and (v) The international legal and institutional frameworks governing radioactive sources. A critical assessment of the global threat posed by radiological terrorism was then carried out.

In addressing and assessing the global threats posed by radiological terrorism, [27] this report is structured into seven chapters. Following this introduction, Chapter 2 assesses the global radiological threat, and the illicit transboundary trafficking of radioactive material. Chapter 3 reviews the 'Incidents and Trafficking Databases' which collate information on incidents and events involving nuclear and other radioactive material. Chapter 4 provides a selection of cases involving radioactive substances, including radioactive sources. Chapter 5 offers a review of the existing international legal framework governing radioactive sources, and assesses the efficacy of the relevant non-binding legal instruments. Chapter 6 examines the global initiatives and international institutions which are concerned with nuclear and other radioactive substances, and the fragmented nature of these entities. Finally, Chapter 7 presents the concluding remarks and policy recommendations.

[27] B Ghiassee, "Nuclear Terrorism and the Environment", *UK Environmental Law Association e-Journal*, no. 8 (March 2002): 15-18.

Chapter 2. Radiological Terrorism – The Global Threat

According to the UN Office of Counter-Terrorism, which aims to counter chemical, biological, radiological, and nuclear terrorism, "The prospect of non-State actors, including terrorist groups and their supporters, gaining access to and using weapons and materials of mass destruction is a serious threat to international peace and security." [28] Moreover, it is now considered as technically feasible for non-State actors, in particular terrorist groups, to construct a radiological device for malicious purposes. [29]

To construct a radiological device, or to simply disperse radioactive particles in crowded areas, terrorists may illicitly acquire radioactive waste, or "sealed radioactive sources", [30] used extensively in medical and industrial applications.

Large quantities of radioactive waste and spent (used) fuel rods originating in military and civil nuclear programmes are stored in temporary storage facilities and waste repositories in a number of countries around the world. They contain highly radioactive elements, including plutonium (Pu), caesium (Cs), and strontium (Sr). However, in view of nuclear proliferation concerns, these materials are generally well secured, [31] and unlikely to be accessed by intruders. Also, because of their high activity, close proximity to such wastes for even a few minutes would be fatal, thus denying terrorists the chance to use it in an RDD.

Radioactive waste is also generated by non-nuclear industries, including the production of radioactive sources used in hospitals and in industry, and from the accumulation of disused radioactive sources. This category of waste is not generally well secured and, therefore, may be accessed by terrorists. It thus poses a global radiological security threat, as it may be illicitly trafficked across borders.

It is most likely that terrorists would illicitly acquire radioactive sources in order to construct an RED, to intentionally expose members of the public to radiation, or an RDD to spread radioactive material in public areas. [32]

Terrorists may also construct a so-called 'Dirty Bomb, mixing one or more radioactive source with conventional explosives, and detonate them in crowded areas, thus causing extensive disruption, psychological harm, and environmental damage, and requiring enormous expenditure to decontaminate the affected areas. [33, 34, 35, 36, 37]

[28] "Chemical, biological, radiological and nuclear terrorism", UN Office of Counter-Terrorism, https://www.un.org/counterterrorism/chemical-biological-radiological-nuclear-terrorism.

[29] Christoph Wirz and Emmanuel Egger, "Use of nuclear and radiological weapons by terrorists?", *International Review of the Red Cross* 87, no. 859 (September 2005): 497-510, https://www.icrc.org/en/doc/assets/files/other/irrc_859_egger_wirz.pdf.

[30] Defined as "radioactive material that is permanently sealed in a capsule or closely bonded, in a solid form", 'IAEA Code of Conduct on the Safety and Security of Radioactive Sources', *IAEA/CODEOC/2004*, IAEA, January 2004, p.3, https://www-pub.iaea.org/MTCD/Publications/PDF/Code-2004_web.pdf.

[31] Nuclear security is defined as "The prevention and detection of and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities." 'IAEA Nuclear Security Series Glossary, Version 1.3', IAEA November 2015, p.18, https://www-ns.iaea.org/downloads/security/nuclear-security-series-glossary-v1-3.pdf.

[32] Ibid., p.10.

[33] Medalia, "Dirty Bombs", p.1-3.

[34] "Dirty Bombs: Backgrounder", US Nuclear Regulatory Commission, February 2020, https://www.nrc.gov/docs/ML1814/ML18143B254.pdf.

[35] "Radiological Dispersal Devices (RDDs): Dirty Bomb, Other Dispersal Methods", REMM.

[36] "Preventing a Dirty Bomb", Nuclear Threat Initiative (NTI), 2022, https://www.nti.org/about/programs-projects/project/preventing-dirty-bomb/.

[37] "Dirty Bomb", *Radiation Glossary*, US Environmental Protection Agency, updated 29 March 2022, https://sor.epa.gov/sor_internet/registry/termreg/searchandretrieve/termsandacronyms/search.do?search=&term=Dirty%20Bomb&matchCriteria=Contains&checkedAcronym=true&checkedTerm=true&hasDefinitions=false.

Radioactive sources are used extensively in medical, industrial, agricultural, and research-related applications, at a few thousand sites in more than 150 countries. They are generally poorly secured, and poorly managed, as most countries do not have the national regulatory framework in place to prevent their theft or unauthorised use, and to combat illicit movement across their national boundaries. [38]

Radioactive sources have a number of characteristics which render them attractive to terrorists and other non-State actors. As noted previously, they are highly accessible, as they are transported on a daily basis, and used routinely in hospitals and industrial sites with varying degrees of security provisions. They are, thus, vulnerable to theft, loss, and insider threat. Some of the sources are highly dispersible.

Caesium (Cs-137), primarily used in hospitals and clinics, is supplied as caesium chloride in sealed capsules. It is a fine, water-soluble powder, similar to table salt. It binds itself to concrete and other surfaces, making decontamination and clean up highly costly. Cobalt (Co-60), another commonly used radioactive element, is manufactured in small metallic pellets with a two-millimetre diameter. If used in a 'Dirty Bomb', or simply dispersed in a crowded area, overground or underground, it would cause extensive physical and psychological harm. Some of these sources are highly portable, and small enough to be carried in a rucksack, or pocket, to the detriment of the carrier. Of course, the risk posed would not deter a suicide bomber. Some of the sources also remain radioactive for many years, as they have long half-lives.

Finally, there is extensive information on the internet regarding their lethal properties, dispersibility, handling, and, most alarmingly, their geographical locations. [39]

Equally concerning is the poor security afforded to disused radioactive sources, and the so-called "orphan" sources – those which have been abandoned, lost, misplaced, stolen, or transferred without proper authorisation. [40] These sources may be found, and sold to scrap metal yards, exposing people to radiation without their knowledge. They may also be acquired and illicitly trafficked into other countries for malicious purposes. A number of incidents involving disused and orphan sources have been reported worldwide, [41] the most significant of which are reviewed in Chapter 4 of this report.

As noted previously, illicit transnational trafficking of nuclear and other radioactive material constitutes a major global threat. A joint report by the EU Law Enforcement Agency (EUROPOL), IAEA, INTERPOL, and the World Customs Organization (WCO) has highlighted the importance of combatting the illicit trafficking in nuclear and other radioactive material.

The joint report has also expressed concern regarding orphan sources which "could be appropriated by traffickers", as they are not under regulatory control. The joint report, in its Appendix I, provides "Statistics on Illicit Trafficking Incidents and Selected Cases", and gives a brief description for each case. [42]

It is noteworthy that alternative non-radioactive technologies are being developed to replace 'High Activity Sealed Radioactive Sources' (HASS). Though a positive step in addressing

38 "Radioactive Source Security Assessment Excerpt: Losing Focus in a Disordered World", *NTI Nuclear Security Index*, 5th edn, July 2020, p.8-10, https://www.ntiindex.org/wp-content/uploads/2021/01/2020_NTI-Index_Rad-Excerpt_FINAL.pdf.

39 "Security of High Activity Radioactive Sources in Use and Storage", WINS, April 2019, p.6-7, https://www.wins.org/document/5-1-security-of-high-activity-radioactive-sources/.

40 "IAEA Code of Conduct", *IAEA/CODEOC/2004*, p.3.

41 Eugenio Gil, "Orphan Sources. Extending Radiological Protection outside the Regulatory Framework", Second European IRPA Congress on Radiation Protection, Paris, May 2006, p.7, https://www.osti.gov/etdeweb/servlets/purl/20854828.

42 "Combating Illicit Trafficking in Nuclear and other Radioactive Material", *IAEA Nuclear Security Series No.6*, EUROPOL, IAEA, INTERPOL, and WCO, December 2007, p.127, https://www-pub.iaea.org/MTCD/Publications/PDF/pub1309_web.pdf.

radiological security, and mitigating the risks posed by radiological terrorism, in the short- and medium term, it is most unlikely that such technologies will be available to replace the majority of HASS. Co-60, which is used in most developing countries, across the globe, is a prime example of a HASS which will be in use for many years to come.

Other challenges associated with non-radioactive technologies include the fact that many developing countries have neither the requisite infrastructure, in particular uninterrupted power supply, nor the funding to utilise alternative technologies. Moreover, a few decades will need to elapse for such initiatives to make a significant impact at a global level, and a legacy of disused and orphan sources will persist.[43, 44]

In the meantime, efforts at international and national levels need to be instituted to mitigate the risks, counter the global threats posed, and prevent incidents involving radioactive material and trafficking in such substances, as compiled by the databases reviewed below.

43 "Considerations for the Adoption of Alternative Technologies to Replace High Activity Radioactive Sources", WINS, 22 January 2021, https://www.wins.org/document/considerations-for-the-adoption-of-alternative-technologies-to-replace-high-activity-radioactive-sources-2/.

44 "Security of Radioactive Material in Use and Storage and of Associated Facilities", IAEA, December 2019, p.32, https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1840_web.pdf.

Chapter 3. Incidents and Trafficking Databases

A number of international organisations and private entities maintain databases on incidents involving nuclear and other radioactive substances, and transnational trafficking of such material. A selection of the databases is reviewed here. The databases promote the exchange of information and international co-operation, thus contributing to the enhancement of global efforts in countering nuclear and radiological terrorism. The existence of such databases, and the statistics they contain, illustrate the threat posed by radiological terrorism, and the illicit transnational trafficking in radioactive substances.

The IAEA, as noted previously, maintains an Incident and Trafficking Database (ITDB). It was originally established in 1995 to exclusively record incidents of illicit trafficking. However, its remit was subsequently expanded to include all incidents involving nuclear and other radioactive materials which are not under regulatory control. The database collates voluntary information from its 142 participating States in relation to, *inter alia*, loss, theft, and illicit trafficking of nuclear and other radioactive material. More than 3900 incidents have been voluntarily reported by the participating States since 1993, of which 320 were connected with trafficking or malicious use. In the past decade, over 250 incidents of theft of radioactive sources were reported to the ITDB. In 2021, 120 incidents were reported by 32 States, which indicates that unauthorised activities, including incidents of trafficking and malicious use, are continuing to occur. Details of the reported incidents are shared with INTERPOL, INTERPOL's Geiger database, and a number of other international organisations. [45, 46]

INTERPOL's Geiger database collates law enforcement data on incidents involving radiological or nuclear material. The database provides member countries with information related to their investigation of terrorist and criminal acts involving radiological and nuclear materials. It contains over 4,200 incidents, dating back to 2002, and ranging from contaminated scrap metal to attempted sales of nuclear material. [47]

The Global Terrorism Database (GTD) is an open-source database that contains information on over 200,000 cases of domestic and international terrorist attacks, dating back to 1970. It includes information on bombings, assassinations, kidnappings, and hostage taking. It is maintained by the National Consortium for the Study of Terrorism and Responses to Terrorism (START), at the University of Maryland. The database contains information on terrorist attacks involving, *inter alia*, Chemical, Biological, Radiological, and Nuclear (CBRN) materials, and defines a radiological weapon as "A weapon whose components are produced from radioactive materials that emit ionizing radiation and can take many forms." [48] The UK Foreign, Commonwealth, and Development Office (UK FCDO) provides funding for the GTD to collect, maintain, and improve its database. [49] The GDT contains 13 incidents involving radioactive material: one in Austria; one in France; one in the US (New York); and ten in Japan. [50]

45 "IAEA ITDB – 2022 Factsheet", IAEA.

46 East & Siewert, "IAEA Incident", 2020.

47 "Our response to radiological and nuclear terrorism", INTERPOL, 2022, https://www.interpol.int/en/Crimes/Terrorism/Radiological-and-Nuclear-terrorism/Our-response-to-radiological-and-nuclear-terrorism#.

48 "Codebook: Methodology, inclusion criteria, and variables", Global Terrorism Database (GTD), National Consortium for the Study of Terrorism and Responses to Terrorism, University of Maryland, August 2021, p.28, https://www.start.umd.edu/gtd/downloads/Codebook.pdf.

49 Ibid, p.5.

50 GDT search for "Radiological", accessed 10 April 2022, https://www.start.umd.edu/gtd/search/Results.aspx?expanded=yes&casualties_type=b&casualties_max=&dtp2=all&success=yes&weapon=3&ob=GTDID&od=desc&page=1&count=100#results-table.

The Monterey WMD Terrorism Database, according to its website, "is the largest open-source catalogue of worldwide incidents involving the acquisition, possession, threat and use of weapons of mass destruction (WMD) by sub-state actors." The database is maintained by the WMD Terrorism Research Program of the Center for Nonproliferation Studies. It contains over 1100 incidents, dating back to 1900, including those involving the use of CBRN materials as possible weapons since 2013. [51]

The 'Database of Radiological Incidents and Related Events' compiles general data on severe radiological accidents/incidents and other occurrences which have given rise to radiation-related casualties. It also includes accidents involving stolen radioactive sources, and orphan sources. The data covers 399 incidents in 55 countries. The database, moreover, contains a listing of criminal acts resulting in acute radiation casualties, and a dossier of "Nuclear terrorism incidents involving radioactive materials, assaults on nuclear facilities, and thefts of nuclear warheads".

According to the database, the commonly used radioactive elements iridium (Ir-192), cobalt (Co-60) and caesium (Cs-137) were involved in the highest number of incidents at 84, 56, and 26, respectively. Ir-192 had caused 16 fatalities and 200 injuries; Co-60 had caused 44 fatalities and 277 injuries; and Cs-137 had caused 17 fatalities and 70 injuries. [52]

51 "Monterey WMD Terrorism Database", Center for Nonproliferation Studies (CNS), http://wmddb.miis.edu.

52 "Database of Radiological Incidents and Related Events", compiled by Wm. Robert Johnston, last modified 24 August 2019, https://www.johnstonsarchive.net/nuclear/radevents/index.html.

Chapter 4. Cases Involving Radioactive Substances

The cases noted below demonstrate the ease with which radioactive substances, including radiological sources, may be illicitly acquired, and trafficked by terrorists and other non-State actors for malicious purposes. The cases also illustrate the degree of harm which minute quantities of radioactive material – a fraction of a small sachet of sugar – could cause to the public, the economy, and the environment.

As noted previously, in 1987, an abandoned and unsecured medical device containing highly radioactive Cs-137 source was stolen in Goiânia, Brazil. The radioactive source, weighing around 93 grams, was removed from its casing and broken up, contaminating a wide area, exposing many people to radiation, costing millions of dollars to clean up, and causing extensive psychological harm. 112,000 people were monitored for exposure to radiation, 249 people were contaminated, and four died due to overexposure to radiation. [53]

The first reported case of the malicious use of a RED was in Moscow, in 1993. A Cs-137 source was intentionally placed in the chair of the Director of the Kartonara Packing company, who after a few weeks fell ill, and subsequently died of radiation overexposure. [54]

Another incident involving a Cs-137 source occurred in Tammiku, Estonia, in October 1994, when three men illegally entered a radioactive waste repository. One of the men put the radioactive source in his pocket, and took it home. He subsequently died from radiation exposure, along with the family's pet dog. Many others were injured due to exposure to radiation. The source, which was subsequently recovered from the kitchen, was a small cylinder, approximately 1.5cm in diameter and 3cm long. [55]

As noted previously, Chechen rebels had placed a radiological device containing Cs-137 in Izmailovsky Park in Moscow in 1995. The press was tipped off, and the authorities removed the radioactive device before any harm was done. [56]

In 1998, in North Carolina, 19 small Cs-137 sources went missing from a locked safe in a hospital in Greensboro. The sources, each 3mm by 20mm, were used in the treatment of cervical cancer. Despite an extensive search by the authorities using radiation detectors, the sources were never recovered. [57]

In Istanbul, Turkey, two metal packages containing radioactive cobalt (Co-60) radiotherapy sources were sold as scrap metal in 1999. The shielded metal containers were subsequently opened in a residential area, exposing 18 people who were admitted to hospital. One source was recovered; the other was never found. [58]

In 1999, burglars attempted to steal a container housing 200g of radioactive material from a chemical factory in Grozny, Chechnya. They were exposed to radiation for a few minutes. One died half an hour later, and the other was hospitalised in a critical condition. [59]

53 "The Radiological Accident in Goiânia", IAEA, p.1-2.

54 "Security of High Activity Radioactive Sources", WINS, p.9.

55 "The Radiological Accident in Tammiku", IAEA, October 1998, p.9-12, https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1053_web.pdf.

56 Medalia, "Dirty Bombs", p.13.

57 "Considerations for the Adoption of Alternative Technologies", WINS, p.4.

58 "The Radiological Accident in Istanbul", IAEA, September 2000, p.1-2, https://www-pub.iaea.org/MTCD/publications/PDF/Pub1102_web.pdf.

59 Medalia, "Dirty Bomb", p.13.

In December 2001, three men found two hot metal cylinders (8–10kg, 10cm × 15cm) in a forest while collecting firewood in the village of Lia, Georgia. They used the cylinders as heaters, and all fell ill the following day. Two recovered after two years of treatment, and the third died in 2003. The cylinders contained highly radioactive strontium (Sr-90) sources, used by the former Soviet army as radioisotope thermoelectric generators, some of which were misplaced or lost. [60]

Since the 9/11 attacks in the US, in 2001, terrorist arrests and prosecutions have revealed that individuals associated with al-Qaeda have been planning to acquire radioactive materials for RDDs and, in particular, for 'Dirty Bombs'. In 2002, Jose Padilla, an American associate of al-Qaeda, was arrested in the US for plotting to assemble and detonate a 'Dirty Bomb' in the US. [61, 62]

As noted previously, in 2004, British authorities arrested a British national and Muslim convert, Dhiren Barot, and his associates, who were planning to make Dirty Bombs to 'cause injury, fear, terror, and chaos'. [63]

In a separate case, in 2004, British authorities arrested a British National and his accomplices who allegedly had links to al-Qaeda. They were making inquiries about buying a "radioisotope bomb" from the Russian mafia in Belgium. [64]

In 2003, an Americium-Beryllium (Am-Be) source, which was being used in a well logging operation, went missing in Nigeria. Despite extensive efforts, the authorities could not find the source. A few months later, it was located in Germany, without a clear trail. [65]

In 2003, the Thai police arrested a schoolteacher in Bangkok after he attempted to sell a container housing a Cs-137 source for US$240,000. [66]

Also in 2003, evidence was uncovered in Herat, Afghanistan, which led British weapons experts to conclude that al-Qaeda may have succeeded in constructing a small 'Dirty Bomb'. The device was, however, not found. [67]

In the context of a RED, in 2003, a scientist in Guangzhou, China, intentionally exposed a colleague to a radioactive iridium (Ir-192) source by placing it above a ceiling panel in his office. The colleague and 74 other staff members subsequently developed radiation-related sickness. [68]

As noted previously, the former Russian agent Alexander Litvinenko was assassinated in London on 1 November 2006. Microgram quantities of Po-210 were said to have been mixed in his tea. He died of multiple organ failure 23 days after the poisoning, which highlights the potency of minute quantities of radioactive substances. [69]

In 2009, a Cs-137 source was stolen from its secure vault in Argentina by an ex-employee for extortion purposes. The man was arrested, and the police concluded that he probably had insider help. [70]

60 "The Radiological Accident in Lia, Georgia", IAEA, December 2014, p.1-9, https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1660web-81061875.pdf.

61 Ripely, "The Case of the Dirty Bomber".

62 Mowatt-Larssen, "Al Qaeda Weapons".

63 "Dirty Bombs, FACT SHEET", U.S. NRC, December 2012, p.4.

64 Ibid.

65 "Consideration for the Adoption", WINS, April 2017, p.5.

66 Medalia, "Dirty Bomb", p.13.

67 Ibid.

68 "Considerations for the Adoption of Alternative Technologies", WINS, p.5.

69 "Security of High Activity Radioactive Sources", WINS, p.10.

70 "Considerations for the Adoption of Alternative Technologies", WINS, p.5.

In 2013, a vehicle carrying a disused Co-60 teletherapy medical source was stolen in Mexico. The highly active (Category 1) source was removed from its protective shielding and left in a field. According to the Mexican authorities, the surrounding area was not contaminated.[71]

The cases highlighted above, and numerous other cases recorded in the databases mentioned in the preceding chapter, demonstrate the ease of access to radioactive material and radioactive sources, and its use for malicious activities.

The UK authorities have, indeed, acknowledged that "it is possible that terrorist groups may seek to use chemical, biological or radiological material against the West in the future."[72, 73] The UK National Counter Terrorism Security Office has, also, asserted that "The UK faces a real threat from terrorism and crowded places remain an attractive target."[74, 75]

Terrorists intending to cause maximum disruption to daily activities, and inflict significant social, economic, and psychological harm, may target critical infrastructure using multiple RDDs. Busy rail and underground stations are attractive targets, as they are usually crowded, and also serve as nationally critical transport hubs.[76, 77]

One may, indeed, envisage a scenario whereby terrorist groups, using 'Dirty Bombs', simultaneously attack the overground and underground transport systems at Euston, King's Cross, and Waterloo stations in London. A 'Dirty Bomb', containing 10kg of explosives and less than one gram of unshielded radioactive Caesium Chloride salt (Cs-137), could be easily carried in a rucksack. As discussed previously in relation to the Parliament Square scenario, it is most likely that such an attack would cause a number of immediate casualties and injuries due to the explosions and could also result in delayed illnesses from exposure to radiation and inhalation of radioactive particles. The stations, and surrounding areas up to a few square kilometres away, depending on the circumstances, would need to be evacuated and cordoned off for many months following the attacks.[78, 79] Moreover, all transport activities would have to be halted for prolonged periods, and the required decontamination and clean-up operations would cost several billion pounds for each station.

The extent of the likely radioactive contamination, and the need for extensive decontamination, were demonstrated in a US study modelled on an RDD attack, involving a pea-sized source of Cs-137 dispersed by ten pounds of TNT at Union Station in Washington, DC. The source in the scenario was similar to that discovered in February 2002 in a discarded piece of industrial equipment at a North Carolina scrap metal processing plant.[80]

71 "Mexico Says Stolen Radioactive Source Found in Field", IAEA, 5 December 2013 (updated 27 July 2017), https://www.iaea.org/newscenter/news/mexico-says-stolen-radioactive-source-found-field.

72 "Chemical, Biological and Radiological (CBR) attacks", UK National Counter Terrorism Security Office, 2 November 2020, https://www.gov.uk/government/publications/crowded-places-guidance/chemical-biological-and-radiological-cbr-attacks.

73 "Chemical, Biological and Radiological (CBR) attacks", UK National Counter Terrorism Security Office, 1 March 2022, https://www.protectuk.police.uk/chemical-biological-and-radiological-cbr-attacks.

74 "Crowded places guidance – Guidance on increasing the protection of crowded places from a terrorist attack", UK National Counter Terrorism Security Office, 2 November 2020, https://www.gov.uk/government/publications/crowded-places-guidance.

75 "Threat Level Update", *ProtectUK Bulletin*, 9 February 2022, https://www.protectuk.police.uk/news-views/bulletin-threat-level-update.

76 "Critical National Infrastructure", Centre for the Protection of National Infrastructure (CPNI), updated 20 April 2021, https://www.cpni.gov.uk/critical-national-infrastructure-0.

77 "Chemical, Biological, Radiological and Nuclear (CBRN) Threats", CPNI, updated 31 March 2021, https://www.cpni.gov.uk/chemical-biological-radiological-and-nuclear-cbrn-threats.

78 "Dirty Bombs, FACT SHEET," NRC, p.8.

79 Connell, "Dirty Bomb Risk And Impact", p.2-5.

80 Arl Van Moore, "Radiological and Nuclear Terrorism: Are You Prepared?", *Journal of American College of Radiology*, 1 no. 1 (January 2004): 54-58, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7129295/pdf/main.pdf.

The clean-up operations following the Chernobyl nuclear accident in 1986, and the Goiânia radiological incident in Brazil in 1987, have demonstrated the necessity, the complexity, and the challenging nature of removing radioactive Cs-137, with a half-life of 30 years, from contaminated areas. [81]

In the context of the scenario involving radiological attacks on the three stations in London, the economic, environmental, and psychological harm done would be highly significant, noting the urban settings of such a malevolent attack. [82]

[81] S. Biancotto, et al., "Analysis of a dirty bomb attack in a large metropolitan area: simulate the dispersion of radioactive materials", *Journal of Instrumentation*, 15 (February 2020): 1-20, https://iopscience.iop.org/article/10.1088/1748-0221/15/02/P02019/pdf.

[82] "Nuclear Security POSTNOTE", UK POST, p.2.

Chapter 5. The Existing International Legal Framework [83]

Radioactive sources and associated facilities are excluded from the scope of key international nuclear law instruments which govern Nuclear Safety, Nuclear Security, and Nuclear Civil Liability. The global radiological safety and security of radioactive sources and associated facilities is, thus, governed primarily by a number of legally non-binding 'Soft Law' instruments, including the IAEA *Code of Conduct on the Safety and Security of Radioactive Sources* ('the Code').

The general objective of the Code, adopted in 2004, is to achieve a high level of safety and security of radioactive sources that may pose a significant risk to individuals, society, and the environment. It applies to all the sources listed in annex I of the Code (categories 1–3), but excludes sources used in defence and military programmes. The specific provisions of the Code relating to the security of radioactive sources were strengthened, following the 9/11 terrorist attacks in the US. [84]

The Code's supplementary *Guidance on the Import and Export of Radioactive Sources* was adopted in 2005. It expands on the import and export provisions of the Code, outlined in paragraphs 23–29 of the Code, and assists member countries in the implementation of the import and export provisions set out in the Code. [85]

The IAEA supplementary *Guidance on the Management of Disused Radioactive Sources*, adopted in 2017, provides a general framework for the management of disused sources. It is designed to support those States which intend to establish, or strengthen, their national policies, strategies, legislation, and regulatory bodies. The Guidance also offers advice on a number of options, including reuse, recycling, long-term storage and disposal, and return to supplier. [86]

It is noteworthy that disused radioactive sources used in medical, industrial, research, and other applications are included in the scope of the 'Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management' (article 3(2)), provided the sources are declared as 'disused' by the regulatory body in a given State. The Convention, however, lacks universal adherence, as it currently has just 88 States Parties. [87]

As 'Soft Law' instruments, the Code and its Guidance are not legally binding. Moreover, their provisions have not been consistently and universally implemented. The IAEA's list of the UN Member States that have expressed a political commitment, updated in September 2021, makes uncomfortable reading: 140 countries have made a political commitment to the Code; 123 to the Guidance on Import and Export; and a mere 44 to the Guidance on Disused Sources. [88]

The IAEA *Code of Conduct on the Safety of Research Reactors*, adopted in 2006, provides guidance on the development of policies at national level, and harmonisation of laws on

83 Bahram Ghiassee, "Nuclear Terrorism and Environmental Protection Under International Law", *International Journal of Nuclear Governance, Economy and Ecology* 4, no. 2 (2014): 83-99, https://www.inderscience.com/info/inarticle.php?artid=65931.

84 "Code of Conduct on the Safety and Security of Radioactive Sources", IAEA.

85 "Code of Conduct on the Safety and Security of Radioactive Sources: Guidance on the Import and Export of Radioactive Sources", IAEA, *IAEA/CODEOC/IMP-EXP/2005*, 2005, https://www-pub.iaea.org/MTCD/publications/PDF/Imp-Exp_web.pdf.

86 "Code of Conduct on the Safety and Security of Radioactive Sources: Guidance on the Management of Disused Radioactive Sources", IAEA, *IAEA/CODEOC/MGT-DRS/2018*, April 2018, https://www-pub.iaea.org/MTCD/Publications/PDF/Guidance_on_the_Management_web.pdf.

87 "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management", IAEA, *INFCIRC/546*, 24 December 1997, https://www.iaea.org/topics/nuclear-safety-conventions/joint-convention-safety-spent-fuel-management-and-safety-radioactive-waste.

88 "List of States Expressing a Political Commitment", IAEA, 15 September 2021, https://nucleus.iaea.org/sites/ns/code-of-conduct-radioactive-sources/Documents/Status_list%2015%20September%20%202021.pdf.

the safety of research reactors. As a legally non-binding instrument, it merely encourages the Member States to use the Code. [89] There are a number of research reactors in operation worldwide, many of which generate medical and other radioisotopes. [90]

Accidents, terrorist attacks, cyberattacks, and sabotage involving research reactors may result in extensive release of radioactivity, with significant transboundary impact. Notwithstanding, research reactors are excluded from the provisions of the IAEA Convention on Nuclear Safety (1994), the scope of which applies to land-based civil nuclear reactors. The same exclusions apply in relation to the 1996 IAEA 'Joint Convention on the Safe Management of Spent Fuel and Safe Management of Radioactive Waste', which complements the 1994 Nuclear Safety Convention, as regards commercial (civil) nuclear reactors.

Radioactive sources and associated facilities are also excluded from the scope of the Vienna and Paris Civil Nuclear Liability regimes, developed under the auspices of the IAEA and the Organisation for Economic Co-operation and Development (OECD), respectively. They are specifically concerned with compensation for the transboundary impact of accidents involving nuclear installations. As noted previously, radioactive sources may be illicitly acquired and trafficked across borders, to be used in radiological dispersal devices, including 'Dirty Bombs', or to contaminate the marine environment. Also, research reactors generating radioisotopes may be the target of attacks and sabotage by non-State actors, resulting in the release of radioactivity, and extensive transboundary damage.

Key international legal instruments on Nuclear Security, namely the 1995 Convention on the Physical Protection of Nuclear Material (CPPNM), and the 2005 Amendment to the CPPNM, also exclude radioactive sources and associated facilities from their remit.

The provisions of the UN International Convention for the Suppression of Acts of Nuclear Terrorism (ICSANT, 2005), however, apply to all radioactive substances, including radioactive sources. The Convention criminalises acts involving the illicit use of "radioactive material". It also criminalises planning, threatening, or perpetrating acts of nuclear and radiological terrorism. It further requires States to adopt national legislation to criminalise such offences, and to establish penalties, accordingly. Currently, there are 118 States Parties to the Convention, and universal adherence is needed to mitigate illicit transboundary movement of radioactive substances. [91] According to the established maxim, "Global security is only as strong as the weakest link".

The UNSC resolution 1373 (2001), adopted on 28 September 2001, condemned the 9/11 terrorist attacks, and expressed its deep concern with the worldwide increase in acts of terrorism, motivated by intolerance or extremism. Adopted under Chapter VII of the UN Charter, it imposes legally binding obligations on all UN Member States to, *inter alia*, counter international terrorism; fully implement international legal instruments relating to terrorism; and criminalise various acts of terrorism. It makes specific reference to the "illegal movement of nuclear, chemical, biological and other potentially deadly materials" (Operating Paragraph 4), but omits reference to radiological materials. [92]

89 "Code of Conduct on the Safety and Security of Research Reactors", IAEA, September 2006, https://www-pub.iaea.org/MTCD/Publications/PDF/CODEOC-RR_web.pdf.

90 L.J. Evitts, et al., "The future of medical radioisotope production in the UK", *Nuclear Future*, 17, no. 4 (2021): 18-29.

91 "International Convention for the Suppression of Acts of Nuclear Terrorism", United Nations Treaty Collection, *A/RES/59/290*, vol. 2445, updated 2021, p.89, https://treaties.un.org/pages/ViewDetailsIII.aspx?src=TREATY&mtdsg_no=XVIII-15&chapter=18&Temp=mtdsg3&clang=_en.

92 "UN Security Council Resolution 1373 (2001)", *S/RES/1373 (2001)*, 28 September 2001, https://www.unodc.org/pdf/crime/terrorism/res_1373_english.pdf.

The UNSC resolution 1540 was adopted under Chapter VII of the UN Charter, in 2004, to prevent non-State actors from acquiring WMDs (chemical, biological and nuclear weapons) and to prevent illicit trafficking of WMDs, and related materials. It prohibits all States from providing support to non-State actors in acquiring WMDs; requires all States to adopt laws criminalising acquisition and possession of WMDs by non-State actors; and obliges all States to put control mechanisms in place to prevent proliferation of WMDs, their means of delivery, and related materials. The resolution has created ambiguity amongst UN Member States, as it makes no specific reference to radiological terrorism, radiological weapons, radiological dispersal devices, or 'Dirty Bombs'. [93]

It may be discerned from the foregoing review of international legal instruments that the international community has been primarily concerned with the security of nuclear material and nuclear facilities. The international legal framework governing radioactive sources and associated facilities has thus been addressed as an adjunct, and afforded secondary importance. This secondary focus is also reflected at the national level, where most countries lack the requisite regulatory regime to secure, monitor, and track the movement of radioactive sources, and, hence, are not in a position to prevent the loss, theft, or illicit transnational trafficking in such sources. [94]

5.1 The UK Legal and Regulatory Frameworks

In the 2021 'Integrated Review of Security, Defence, Development and Foreign Policy', the UK Government has affirmed that "In strengthening our homeland security, we will build on firm foundations in counter-terrorism, intelligence, cyber security and countering the proliferation of chemical, biological, radiological, and nuclear (CBRN) weapons." [95] Alarmingly, the UK has also acknowledged that "It is likely that a terrorist group will launch a successful CBRN attack by 2030." [96]

The UK's fundamental policy objective in relation to radiological and civil nuclear safety is "to ensure an efficient and effective safety framework which protects the public and the environment from the harmful risks of ionising radiation." [97]

The UK policy is built upon the safety standards developed by the international community, including the IAEA's Fundamental Safety Objectives and Fundamental Safety Principles,[98] and the relevant provisions of international conventions relating to nuclear and radiological safety and security, to which the UK is a party.

These international legal instruments include the Convention on Nuclear Safety; the Convention on Early Notification of a Nuclear Accident; the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency; the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management; the International

93 "UN Security Council Resolution 1540 (2004)", *S/RES/1540 (2004)*, 28 April 2004, http://unscr.com/en/resolutions/doc/1540.

94 B Ghiassee, "The Need to Enhance the International Legal and Institutional Frameworks Governing Radioactive Sources and Radiological Facilities", *Proceedings of the First IAEA International Conference on Nuclear Law – The Global Debate*, IAEA, Vienna, 26-29 April 2022.

95 "Global Britain in a competitive age – The Integrated Review of Security, Defence, Development and Foreign Policy", UK Government, March 2021, p.11, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/975077/Global_Britain_in_a_Competitive_Age-_the_Integrated_Review_of_Security__Defence__Development_and_Foreign_Policy.pdf.

96 Ibid., p.32.

97 "How we regulate radiological and civil nuclear safety in the UK, Chapter 2: Summary of UK policies on radiological and civil nuclear safety", Department for Business, Energy & Industrial Strategy, 20 April 2021, https://www.gov.uk/government/publications/how-we-regulate-radiological-and-civil-nuclear-safety-in-the-uk/how-we-regulate-radiological-and-civil-nuclear-safety-in-the-uk-webpage.

98 "Fundamental Safety Principles", *STI/PUB/1273*, IAEA, November 2006, https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1273_web.pdf.

Convention for the Suppression of Acts of Nuclear Terrorism; and the Convention on the Physical Protection of Nuclear Material, as amended.

Furthermore, the UK plays an active role in relevant international fora and organisations, including the IAEA, the International Commission on Radiological Protection (ICRP), the OECD's Nuclear Energy Agency (OECD-NEA), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). The UK is one of the main contributors to the IAEA, both financially and through expert support, and has been a major contributor to the IAEA Nuclear Security Fund since its inception.

The UK has well-established legal and regulatory frameworks in relation to radioactive substances which are used extensively in hospitals, universities, and industry, as well as in the nuclear power and defence industries. It, thus, ensures that activities involving radioactive substances are effectively regulated, and that people and the environment are protected from the harmful effects of ionising radiation. The key safety and security objectives are enshrined in, *inter alia*, the 1974 Health and Safety at Work Act, the Ionising Radiations Regulations 2017, the Ionising Radiation (Medical Exposure) Regulations 2017, and the Environmental Permitting Regulations (England and Wales) 2016, as amended. [99]

The UK regulatory framework for radiological and civil nuclear safety comprises regulatory bodies across England, Northern Ireland, Scotland, and Wales. In England, the Environment Agency regulates activities involving radioactive material, including radioactive sources, aiming to protect people and the environment from the harmful effects of radioactive substances. It also regulates the security of sealed radioactive sources used in hospitals, universities, industry, and other non-nuclear sites. The security requirements for sealed radioactive sources are based on IAEA standards, and are incorporated into UK requirements set by the UK National Counter Terrorism Security Office. [100]

Moreover, in relation to orphan sources, the Environment Agency has a legal (statutory) duty to provide advice and technical assistance, in cases when an orphan source is found, and to dispose of it where required. [101]

The Agency's radioactive substances regulation is based upon 10 principles. Principle 6 is concerned with security of radioactive substances and radioactive waste, excluding materials on nuclear licensed sites, or when in transit. Principle 7 is concerned with lifetime planning for radioactive substances, thus regulating radioactive substances from the earliest stage of their use through to the point where they can no longer cause harm to people or the environment. [102, 103]

The Environment Agency is also the enforcing authority in England in relation to HASS, and receives records on HASS through its permitting (authorisation) regime. [104, 105]

99 See, generally, "How we regulate radiological and civil nuclear safety in the UK", Dept for Business, Energy and Industrial Strategy, https://www.gov.uk/government/publications/how-we-regulate-radiological-and-civil-nuclear-safety-in-the-uk/how-we-regulate-radiological-and-civil-nuclear-safety-in-the-uk-webpage#medical-and-non-medical-exposures.

100 National Counter Terrorism Security Office, https://www.gov.uk/government/organisations/national-counter-terrorism-security-office.

101 See, "How we regulate radiological and civil nuclear safety in the UK, Chapter 8. Public exposures and protection of the environment".

102 "Radioactive substances regulation (RSR): objective and principles", Environment Agency, 1 December 2021, https://www.gov.uk/government/publications/radioactive-substances-regulation-rsr-objective-and-principles/radioactive-substances-regulation-rsr-objective-and-principles.

103 "Non-nuclear radioactive substances regulation: technical guidance – Technical guidance for operators with non-nuclear radioactive substances regulation (RSR) environmental permits", Environment Agency, 2 December 2021, https://www.gov.uk/government/collections/non-nuclear-radioactive-substances-regulation-technical-guidance.

104 "Non-nuclear RSR: environmental permits", Environment Agency, 2 December 2021, https://www.gov.uk/guidance/non-nuclear-rsr-environmental-permits.

105 "RSR-EPR10: HASS record", Environment Agency, updated 8 May 2018, https://www.gov.uk/government/publications/rsr-epr10-hass-record.

The Office for Nuclear Regulation (ONR) is the independent regulator for nuclear safety, security, and conventional health and safety, at the 30 licensed nuclear sites in the UK. It regulates the existing fleet of operating reactors, fuel cycle facilities, and the nuclear installations which are undergoing decommissioning. ONR also regulates nuclear waste, and HASS on licensed nuclear sites, both of which could be maliciously used in RDD attacks by non-State actors, including terrorists.[106]

Transnational security and national security are inextricably linked, a notion which the UK has acknowledged in its '2021 Integrated Review', noting that "we cannot disrupt or deter every threat in our more interconnected world in which the distinction between domestic and international security is increasingly blurred." The UK has also affirmed that collective and concerted action is required to reduce vulnerabilities and improve resilience to threats from State and non-State actors.[107]

In this context, and in preventing the illicit trafficking of radioactive substances into the UK, enhancing the scope of the UK Border Strategy would enable border-monitoring for the detection of radioactive material to be extended beyond airports and established maritime crossings.[108] It is equally imperative that the institutional and legal frameworks at international level are strengthened, and that the UK, as a global player and a major global economic power, is in a strong position to provide political, financial, and technical support in this respect.

106 "About ONR", Office for Nuclear Regulation, Updated 8 April 2022, https://www.onr.org.uk/about.htm.

107 "Integrated Review", p.69.

108 Robert Downes, Christopher Hobbs and Daniel Salisbury, "Combating nuclear smuggling? Exploring drivers and challenges to detecting nuclear and radiological materials at maritime facilities", *The Nonproliferation Review*, 26 no. 1-2 (2019): 83-104, https://www.tandfonline.com/doi/full/10.1080/10736700.2019.1610256.

Chapter 6. Global Initiatives and International Institutions

A number of UN bodies, international institutions, and global initiatives contribute to the global nuclear and radiological security regime, albeit in a fragmented manner, and not acting in unison.

The IAEA Division of Nuclear Security, within the IAEA Department of Nuclear Safety and Security, promotes, coordinates, and leads the global efforts in preventing, detecting, and responding to threats and acts of nuclear terrorism. However, there is no 'Division' or 'Centre' specifically overseeing and coordinating all the relevant activities related to the safety and security of radioactive sources and associated facilities. Notwithstanding, and as noted previously, the IAEA provides extensive assistance to policymakers and experts, across the globe, on how to improve the management of radioactive sources on a life-cycle (lifelong) basis, and counter radiological terrorism. The Division also maintains the IAEA Incident and Trafficking Database, recording incidents of malicious use, and trafficking of nuclear and other radioactive material out of regulatory control.

The UN Office of Counter-Terrorism (UNOCT) was established in June 2017, with the aim of strengthening the capability of the UN system to assist the Member States with the implementation of the UN's Global Counter-Terrorism Strategy. [109, 110] It incorporates the UN Global Counter-Terrorism Coordination Compact and the UN Counter-Terrorism Centre. The Office works closely with UN Member States, UN entities, civil society, and international and regional organisations to prevent and to counter terrorism. [111]

As regards radiological security, the UNOCT, through its Counter-Terrorism Centre, provides support to Member States in countering the threat of radiological terrorism, and the illicit transnational trafficking in nuclear and other radioactive substances. In relation to WMD and CBRN terrorism, the Centre collaborates with the Global Initiative to Combat Nuclear Terrorism (GICNT) and Global Partnership Against the Spread of Weapons and Materials of Mass Destruction (Global Partnership), as discussed below. [112]

The UN Global Counter-Terrorism Strategy encourages, *inter alia*, the IAEA and the Organisation for the Prohibition of Chemical Weapons (OPCW) to support Member States in preventing terrorists accessing nuclear, chemical or radiological materials, to ensure security at facilities, and to respond accordingly, in the event of an attack. [113]

The UN Office on Drugs and Crime (UNODC), as part of its counter-terrorism activities, provides support to the UN Member States to prevent and counter the threat posed by CBRN weapons, or related materials, and their use by non-State actors for terrorist activities, or other criminal purposes. It, *inter alia*, promotes international co-operation in criminal matters related to CBRN terrorism; raises awareness of the importance and benefits of adhering to international legal instruments against CBRN terrorism; and assists national policy makers and legislators in drafting model penal codes, and other relevant legislation. [114]

109 "UN General Assembly resolution A/RES/71/291", UNGA (19 June 2017), https://documents-dds-ny.un.org/doc/UNDOC/GEN/N17/172/58/PDF/N1717258.pdf?OpenElement.

110 UN Global Counter-Terrorism Strategy, UN Office of Counter-Terrorism, undated, https://www.un.org/counterterrorism/un-global-counter-terrorism-strategy.

111 "About us", UN Office of Counter-Terrorism, https://www.un.org/counterterrorism/about.

112 "Chemical, biological, radiological and nuclear terrorism", UN Counter-Terrorism Centre, https://www.un.org/counterterrorism/cct/chemical-biological-radiological-and-nuclear-terrorism.

113 "The United Nations Global Counter-Terrorism Strategy", UN General Assembly Resolution *A/RES/60/288*, 20 September 2006, p.8, para.9, https://documents-dds-ny.un.org/doc/UNDOC/GEN/N05/504/88/PDF/N0550488.pdf?OpenElement.

114 "Countering chemical, biological, radiological and nuclear terrorism", UN Office on Drugs and Crime (UNODC), updated December 2021, https://www.unodc.org/unodc/en/terrorism/expertise/countering-chemical-biological-radiological-and-nuclear-terrorism.html.

A number of voluntary organisations and global initiatives are also involved in the global effort to counter nuclear terrorism, and more recently radiological terrorism.

The Nuclear Threat Initiative (NTI), a non-profit global security organisation, was founded in 2001 with the aim of reducing nuclear and biological threats. It publishes the Nuclear Security Index (NTI Index), which assesses the security of highly enriched uranium (HEU) and plutonium (Pu) against theft, and the security of nuclear facilities against sabotage. [115] Stolen HEU or Pu could be used for the construction of improvised nuclear devices, and sabotage of nuclear facilities could lead to extensive harm to the public and the environment.

For the first time in its 20-year history, the 2020 NTI Index was accompanied by a separate Radioactive Source Security Assessment which evaluated the national policies, practices, and commitments to secure radioactive sources in 175 countries. It noted, with concern, that thousands of radiological sources are held across the globe which are generally poorly secured and easily accessible, as they are housed in public places such as hospitals and universities. It also noted that, in the hands of extremists, a radioactive source may be used in a 'Dirty Bomb', which could be detonated in the centre of a city. [116]

The World Institute for Nuclear Security (WINS) was founded in 2010 and granted the legal status of a Non-Governmental International Organisation by the Australian government. Its primary aim is to improve the capabilities of those involved in nuclear security and ensure that nuclear and other radioactive materials are not used for terrorist or other criminal activities. In this context, it collaborates closely with the IAEA on security-related issues. [117]

The WINS 'Knowledge Centre' offers an extensive archive of information on nuclear and radiological security, including International Best Practice Guides, WINS Academy Brochures, Special Reports, Peer Review Guidelines, and Webinars. Its publications on the 'Adoption of Alternative Technologies to Replace High Activity Radioactive Sources' are a major contribution to mitigating the risks posed by radioactive sources. [118]

'The Global Partnership Against the Spread of Weapons and Materials of Mass Destruction' (GP) is an international initiative aimed at preventing the proliferation of CBRN weapons and related materials, and their use by non-State actors. Established in 2002, it is a G7-led partnership of 31 members, and aims to address and mitigate the significant threats which WMDs pose to international peace and security. It notes with concern the continuing challenges which the international community is facing from CBRN weapons and related materials, at regional and global levels, and that the capacity to prevent trafficking of radioactive and nuclear materials remains inadequate. [119]

Radiological source security, and prevention of illicit trafficking, are two thematic areas which the Global Partnership's Nuclear and Radiological Security Working Group is engaged in, as it believes that "A single act of nuclear or radiological terrorism would have catastrophic humanitarian, political, environmental and economic consequences on a global scale." [120]

115 "About the NTI Index and the Radioactive Source Security Assessment", NTI, updated 2022, https://www.ntiindex.org/about-the-nti-index/.

116 "Losing Focus in a Disordered World", p.6.

117 "Governing Statue of the World Institute for Nuclear Security", WINS, 3 May 2018, https://www.wins.org/wp-content/uploads/2018/09/2018-05-03-Governing-Statute-of-the-World-Insitute-for-Nuclear-Security-FINAL.pdf.

118 "Considerations for the Adoption of Alternative Technologies".

119 "Why We Work", Global Partnership Against the Spread of Weapons and Materials of Mass Destruction, updated 2017, https://www.gpwmd.com/why-we-work.

120 "The Global Partnership Nuclear & Radiological Security Working Group", updated 2017, https://www.gpwmd.com/nrswg.

The Global Initiative to Combat Nuclear Terrorism (GICNT), launched in 2006, is a voluntary international partnership of 89 nations and six international organisations, and is co-chaired by Russia and the US. One of the principles noted in its 'Statement of Principles' is a commitment to improving the ability to prevent, detect, and respond to nuclear terrorism, and to prevent illicit trafficking in nuclear and other radioactive materials. [121, 122]

The Nuclear Security Contact Group (NSCG) was instituted in 2016, at the culmination of the fourth and final Nuclear Security Summit. It was tasked with the goal of sustaining and strengthening the global nuclear security architecture. [123]

The Contact Group convenes annually on the margins of the General Conference of the IAEA, to discuss nuclear security-related issues, and to identify emerging trends that may require early attention. It is primarily concerned with HEU and Pu, both of which are of nuclear proliferation concern. [124]

The Ad Hoc Group of Supplier States, which meets informally on the margins of the IAEA meetings on the *Code of Conduct on Safety and Security of Radiological Sources*, has been active in promoting best practice, and improving the complete life-cycle (lifelong) management of HASS. [125]

Notwithstanding the significant contributions which the initiatives, entities, and organisations noted above are making to the security of radioactive materials, and in preventing radiological terrorism, their multiplicity is a manifestation of the fragmentation of the institutional framework at international level.

The international community has yet to mandate and fund a single overreaching entity to oversee and co-ordinate the activities of all the stakeholders involved in the manufacturing, distribution, transport, finance, insurance, use, regulation, and management of disused radioactive sources used in medical, industrial, agricultural, and research-related applications across the globe. [126]

121 "The Global Initiative to Combat Nuclear Terrorism (GICNT)", updated 2022, https://www.gicnt.org.

122 "Global Initiative to Combat Nuclear Terrorism", NTI, 2022, https://www.nti.org/education-center/treaties-and-regimes/global-initiative-combat-nuclear-terrorism-gicnt/.

123 "Global Initiative to Combat Nuclear Terrorism", GICNT, undated, https://www.state.gov/wp-content/uploads/2018/11/Global-Initiative-To-Combat-Nuclear-Terrorism.pdf.

124 "Joint Statement on Sustaining Action to Strengthen Global Nuclear Security Architecture", Nuclear Security Contact Group, 5 April 2016, https://www.nscontactgroup.org/joint-statement.php.

125 IAEA, "Joint Statement on Strengthening the Security of High Activity Sealed Radioactive Sources", *INFCIRC/910*, 20 January 2017, p.2, https://www.iaea.org/sites/default/files/publications/documents/infcircs/2017/infcirc910.pdf.

126 "Losing Focus in a Disordered World", NTI, p.7-10.

Chapter 7. Concluding Remarks and Policy Recommendations

The legal and institutional frameworks which the international community has adopted, to date, may be regarded as most inadequate in securing radioactive materials, countering radiological terrorism, preventing illicit trafficking, and fully protecting the public, the environment, and ecological systems.

The heightened state of instability and insecurity in many parts of the globe, and the new threats which emerging technologies, in particular drones, are posing to radiological security, make it imperative for the international community to enhance and strengthen the existing global institutional and legal frameworks, and to promote implementation at a national level.

Based on the foregoing discussions and findings of this report, a number of policy recommendations may be advocated, the implementation of which would strengthen the current regime in countering radiological terrorism, and protecting the public and the environment.

The UNSC could adopt a legally binding resolution, under Chapter VII of the UN Charter, specifically addressing radiological terrorism, radiological devices, and radiological weapons. As noted previously, the text of resolution 1540 (2004) has created ambiguity amongst the Member States regarding its application to radiological matters. The legally binding provisions of such a resolution would oblige all UN Member States to act accordingly, in establishing the requisite legal and institutional frameworks at national level; to secure and protect radioactive substances, sources, and associated facilities; and to prevent illicit transnational trafficking in radioactive material.

The international community needs to promote universal adherence to the UN International Convention for the Suppression of Acts Nuclear Terrorism (ICSANT), to counter radiological terrorism, and to mitigate illicit transboundary trafficking in radioactive substances and sources. To date, there are 118 States Parties to the Convention – the only binding international legal instrument, the scope of which includes radioactive substances. [127]

Under the auspices of the UNGA, an international Convention or a Treaty on the Physical Protection of Radioactive Sources and Associated Facilities could be adopted, to create legally binding obligations at international level, and to facilitate the establishment of legal and regulatory frameworks at national level by the States Parties. It is noteworthy that, in 2017, the UNGA adopted the Treaty on the Prohibition of Nuclear Weapons, regarded as a major development in the nuclear disarmament arena, [128] and it could do the same in relation to radiological weapons and radiological terrorism. The proposed Convention/Treaty would, thus, ban all radiological weapons-related activities by State and non-State actors.

As an interim measure, the international community needs to promote the universalisation and implementation of the *Code of Conduct on the Safety and Security of Radioactive Sources*, and also the IAEA *Guidance on the Management of Disused Radioactive Sources*, to which 140 and 44 states, respectively, have made political commitments to date.

The relevant IAEA Codes of Conduct and IAEA Guidance need to be consolidated and, subsequently, under the auspices of the IAEA, elevated to a binding international legal instrument. It is noteworthy that the IAEA's Convention on the Physical Protection of Nuclear

[127] "International Convention for the Suppression of Acts Nuclear Terrorism", United Nations Treaty Series.

[128] Bahram Ghiassee, "Treaty on the prohibition of nuclear weapons: an assessment of the environmental provisions", *International Journal of Nuclear Governance, Economy and Ecology* 4, no. 4 (2019): 238-255, https://www.inderscience.com/info/inarticle.php?artid=106019.

Material (CPPNM), as amended, is based on the IAEA's *Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities* and was subsequently elevated to legally binding instrument. The IAEA's *Nuclear Security Recommendations on Radioactive Material and Associated Facilities* [129] would serve as a valuable document in this respect.

Elevation of the IAEA *Code of Conduct on the Safety of Research Reactors* to a binding international legal instrument also needs to be considered at a later stage.

The international community needs to promote the establishment of an 'International Centre for Radiological Security', within the IAEA. Alternatively, a new Division of Nuclear Security and Radiological Security could be instituted at the IAEA. Initially, the proposed Centre/Division could be funded by the G20, or the member countries of the OECD-NEA.

The Centre/Division should be mandated to oversee and co-ordinate the activities of all stakeholders involved in the life-cycle of radioactive sources, *inter alia*, manufacturers; suppliers; distributors; agents; aviation, shipping and transport companies; funding institutions; insurers; end users; regulatory bodies at regional and national levels; and entities involved in the end-of-use management of radioactive sources and associated facilities. The Centre/Division would also need to be mandated and funded to collate and share information on disused sources, and orphan sources – those which have been abandoned, lost, misplaced, or stolen.

International collaboration on promoting the replacement of existing 'High Activity Radioactive Sources' (HASS) with alternative technologies needs to be strengthened, with focus initially on Co-60, Cs-37, and Ir-192, which are the most commonly used sources across the globe. The provision of funding and capacity building would be essential in enabling 'Low and Middle-Income Countries' to participate, accordingly.

The 'Ad Hoc Group of Supplier States' – an informal group which convenes in Vienna on an annual basis, on the margins of the IAEA meeting on the Code of Conduct – needs to be formalised into a 'Radiological Suppliers Group', similar to the existing 'Nuclear Suppliers Group', to oversee and co-ordinate the export of radioactive sources and associated facilities. The suppliers need to incorporate the 'return-to-a-supplier' principle in their transactions, where HASS are involved. [130]

The 'Supplier States' need to put in place export control procedures to ensure that exports are made to recipient countries that have the requisite legal and regulatory frameworks in place for effective life-cycle (lifelong) management of radioactive sources and associated facilities.

By instituting and implementing the course of action noted above, the international community would be in a strong position to pre-empt the adverse humanitarian, economic, environmental, and ecological harms which could otherwise ensue.

Enhancing the existing international frameworks would be equally effective in countering radiological terrorism and other malicious activities perpetrated by non-State actors, and preventing illicit transboundary trafficking in radioactive materials.

As regards the UK, to effectively counter radiological terrorism, and to prevent the illicit trafficking of radioactive substances, the UK Border Strategy needs to institute measures to extend and expand its border-monitoring systems for radiation detection beyond airports and established maritime crossings.

[129] "Nuclear Security Recommendations on Radioactive Material and Associated Facilities", *STI/PUB/1487*, IAEA, January 2011, https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1487_web.pdf.

[130] "Joint Statement on Strengthening the Security of High Activity Sealed Radioactive Sources", p.2.

The theft and accidental loss of radioactive material, and, also, the poor management of disused sources are global issues of long-standing concern, noting that gram quantities of radioactive material are all that is needed for RDDs, or ‘Dirty Bombs’. These could be smuggled into the UK by illegal immigrants, criminals, or small commercial drones, as cigarettes, drugs, people, and weapons enter the UK illegally. Also, the security of radioactive sources and associated facilities used in hospitals, clinics, universities, and research centres needs to be strengthened, to deny access to terrorists and other non-State actors, and prevent malicious activities.

Finally, the UK, as a permanent member of the UNSC, an active member of the OECD-NEA, a member of the G7 and G20, and a major contributor to the IAEA Nuclear Security Fund, stands in a strong position to provide political, technical, legal, and financial support. The UK could, thus, play a significant role in enabling the international community to address the global policy challenges posed by radiological terrorism.

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July 2022