Illicit trafficking in nuclear and radioactive materials and nuclear terrorism

Elena K. Sokova
James Martin Center for Nonproliferation Studies
Middlebury Institute of International Studies at Monterey

Nagasaki
January 8, 2016

Four Scenarios of Nuclear Terrorism

- Theft and detonation (or threat of detonation) of an existing nuclear weapon/bomb from one of the nuclear weapons possessor states
  - Incredibly catastrophic
  - Difficult for terrorists to accomplish
- Theft or purchase of fissile material leading to the fabrication of an improvised nuclear device (crude bomb)
  - Incredibly catastrophic
  - For constructing a crude bomb, the most difficult task is to obtain nuclear materials
- Attack against and/or sabotage of a nuclear facility causing the release of large amount of radioactivity
  - From very catastrophic to limited impact
  - Difficult to accomplish yet not impossible
- Fabrication and detonation of a radiological dispersion device (RDD or dirty bomb) or radiation emission device (RED)
  - Limited physical impact (similar to regular explosives) but potentially billions of dollars in disruption, medical screening, and cleaning costs
  - Easy to accomplish

Radiological incident/attack impact

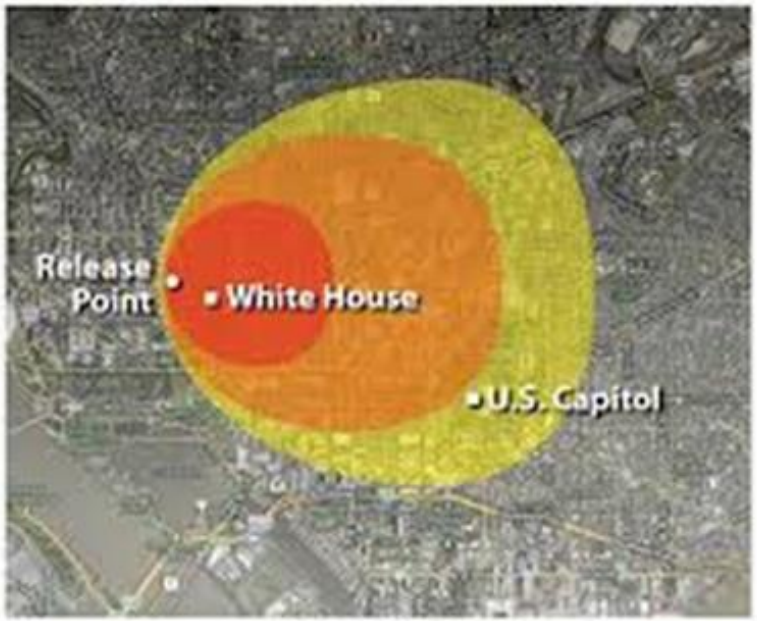
Goiania, Brazil, 1987

Accidental dispersal of Cs-137 from a radiotherapy unit, 1,375 Ci

4 deaths; 1 amputation; 28 people with radiation burns; over 112,000 monitored; 3,500 cubic meters of contaminated soil and other materials; over $20 million in clean-up costs; 5 years to return to the level of economic output prior to the accident

Hypothetical Cs-137 "dirty bomb" impact modeling

(Congressional Research Service, Modeling by Sandia National Laboratories, 2010)

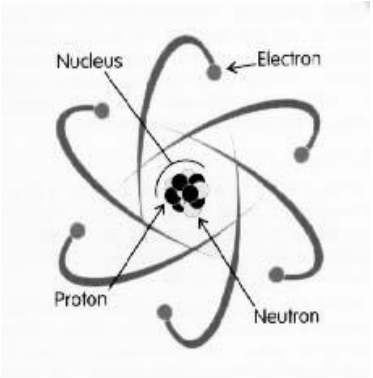


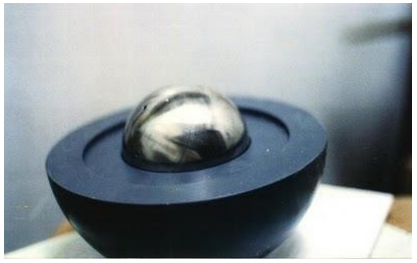
Effects and Actions					
Area	Equivalent Dose (rem)	Exceeds relocation PAG for which year	Population	All Cancers	Fatal Cancers
3.10 0.81	>2.00	First year only	35,000	233	159
7.60 2.93	>0.500	Any subsequent year	94,700	270	189
13.2 5.10	>4.00	50 years (cumulative)	125,000	461	314

Areas and counts are cumulative. PDD determined at 38.9 N, 77.0 W. PAG: Protective Action Guide

Nuclear and radioactive materials

- **Radioactive Materials**
  - Materials with isotopes with unstable atoms that seek to become stable by breaking and thus emit energy as radiation
- **Nuclear Materials**
  - Materials or isotopes of materials that can sustain a chain reaction of fission of neutrons
    - Uranium (U)
    - Plutonium (Pu)
    - Thorium (Th)
- **Special Fissionable or Special Nuclear Materials – materials for nuclear explosive devices**
  - Highly enriched uranium (HEU) – contains more than 20% of U235 isotope
  - Plutonium (Pu239 and
  - Plutonium "dual use": can have weapons and peaceful application





Radioactive material uses

(over 8 million worldwide)

- Medicine: diagnosis, sterilization, radiotherapy, research in nuclear medicine
- Industry and research
- Agriculture: irradiators

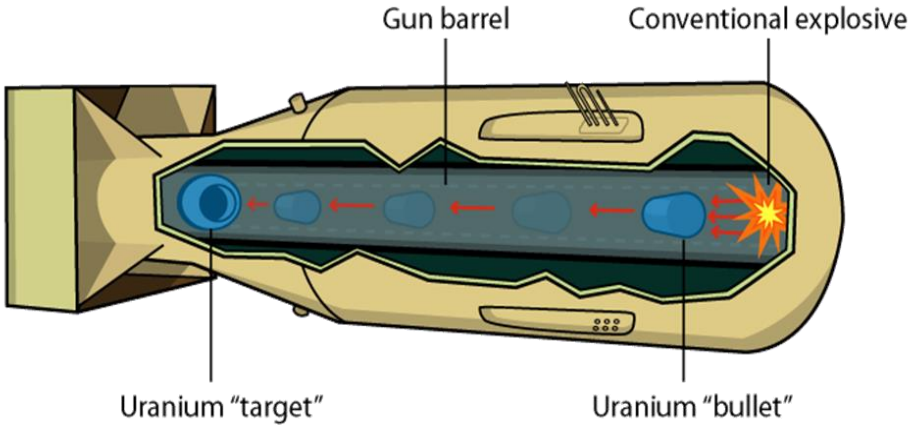
- Long-term energy sources

Civilian and non-weapon uses of nuclear materials

- Nuclear power generation (over 437 reactors in 31 countries)
- Research and testing (about 670 research reactors in 69 countries)
- Propulsion (nuclear icebreakers and nuclear submarines)
- Medical and other isotopes production

Concerns over HEU

- HEU-based bomb is relatively easier to pursue than a Pu-based
- High level of confidence in “workability” of device – could skip testing
- Crude or improvised nuclear device based on HEU is considered to be within the reach of “sophisticated” terrorist groups
- HEU is available in the civilian nuclear fuel cycle
- As little as 50 kg of HEU is needed for a crude gun-type device
- Majority of known illicit trafficking cases of weapons-useable materials involves HEU
- HEU is easy to shield and thus hard to detect



Concerns over Pu

- Over 240 MT of separated military Pu and over 260 MT of separated civilian Pu accumulated worldwide
- Non-military Pu can be weapon-useable (North Korea used plutonium recovered from spent reactor fuel for its nuclear devices)
- France, India, Japan, Russia, and the United Kingdom carry out large-scale reprocessing and recovery of Pu from civilian spent nuclear fuel
- Use of Pu in the civilian cycle may further increase availability of separated Pu stocks (fast neutron reactors, spent fuel reprocessing, MOX fuel cycle, etc.)
- While Pu-based bomb is technically more challenging than HEU, one can not rule out that a technically sophisticated non-state actors could construct a working device using Pu
- Only 6 kg of Pu is required for a 1st generation implosion bomb

Availability of nuclear and radioactive materials

- ~ 16,500 assembled nuclear weapons stored at over 100 sites globally
- ~1,884,000 kg of weapons-useable material (HEU and separated plutonium) in 24 countries (down from 32 in 2012 and down from over 50 countries in 1992) – equivalent of roughly 100,000 or more nuclear bombs worth
- Of this amount only 4.5% of weapons grade and weapons useable material is in countries without nuclear weapons programs
- Over 95% of HEU and Pu (both in weapons programs and in civilian applications) is in the five nuclear weapons states (China, France, Russia, United Kingdom, United States) and four nuclear possessor states (India, Pakistan, Israel, DPRK) and are not subject to international oversight
- The United States and Russia account for ~85% of stocks of all nuclear weapons useable materials
- Nuclear materials are present in over 1130 facilities and sites in ~70 countries
- Radioactive sources and materials are used virtually by every country in the world (8 million rad. sources worldwide)
- Aum Shinrikyo, Al Qaeda, Chechen groups, and other extremists sought nuclear weapons, as well as nuclear and radioactive materials

Illicit Trafficking in Nuclear and Radioactive Materials

- Any unauthorized transactions involving Nuclear and Radioactive materials
- Acquisition, provision, possession, use, transfer or disposal, loss of control – any transaction/action outside of the legitimate realm, including thefts, losses, illegal trade
- Criminal or not
- Intentional or unintentional
- With or without crossing borders
- Attempted transactions/actions
- Scams

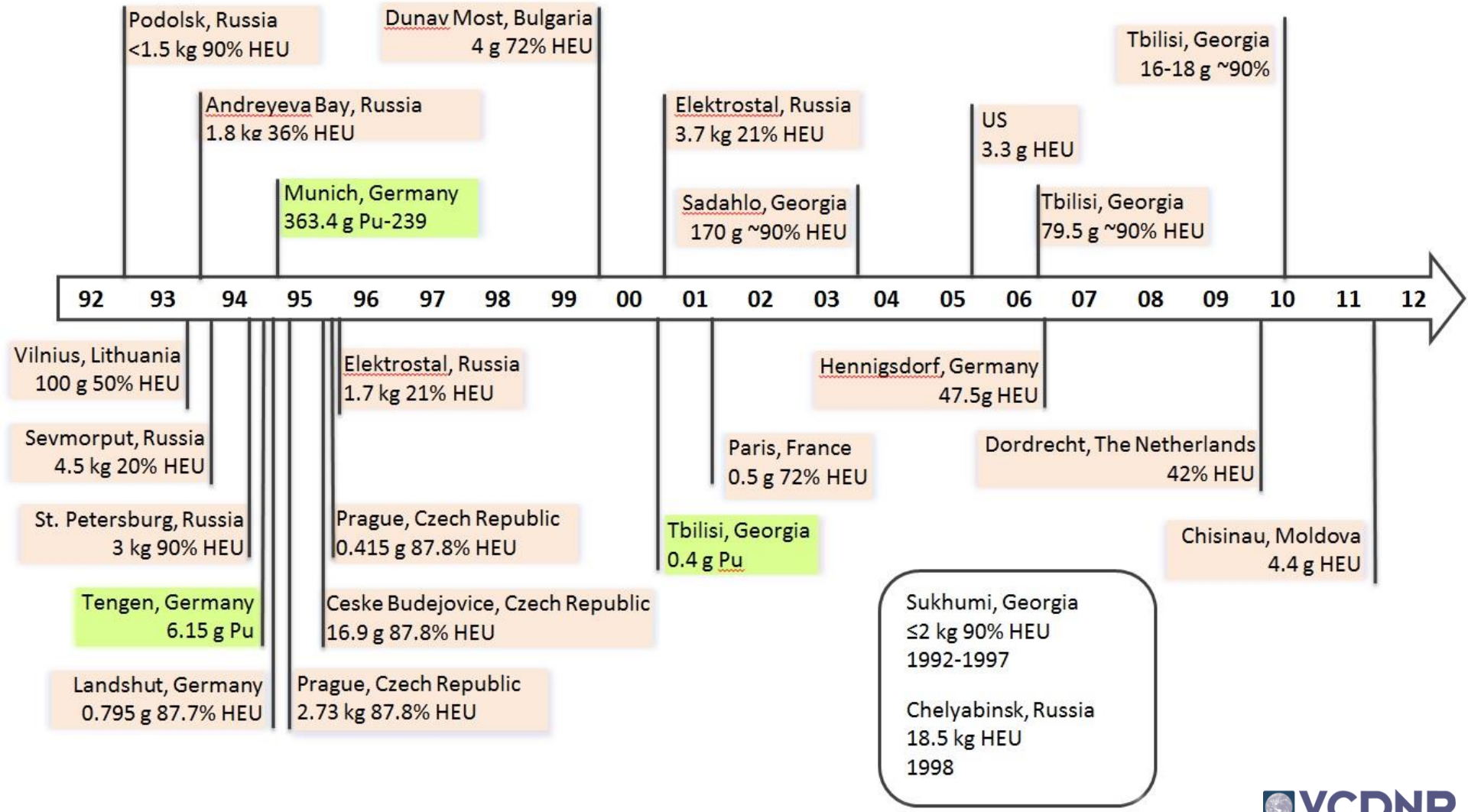
Statistics

IAEA Illicit Trafficking Database (1993-2014) – 131 countries reporting

- Over 2700 confirmed incidents
- Less than 1/3 involve nuclear materials (all forms, including natural and depleted uranium)
- Number of cases involving nuclear materials, particularly LEU, gradually goes down (in the past couple of years – less than 10%)
- Majority of incidents involve radioactive materials and contaminated materials
- Reported thefts and losses primarily involve radioactive sources, such as Cs-137, Am-241, Sr-90, Co-60, Ir-192
- Geographical distribution of smuggling incidents (2007 data)

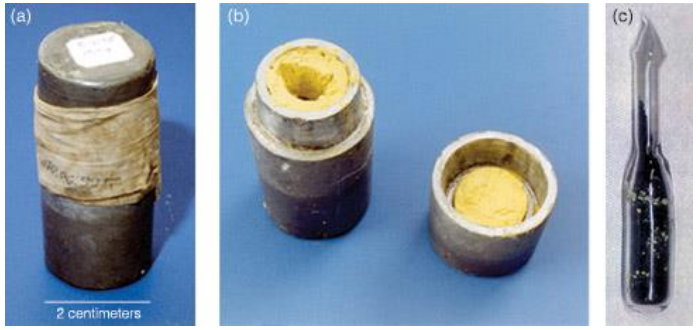
  Russia – 24%
  United States – 20%
  Ukraine – 5%
  Kazakhstan – 5%
  Other FSU – 7%
  Canada – 3%
  South Africa, India, Germany, Poland, Iraq – 2% each

HEU and Pu Trafficking



VCDNP

June 2011 HEU Seizure in Moldova



- Sting operation
- 4.4 grams HEU
- Enrichment level – 72% U235
- Origin – reportedly Russian uranium enrichment or reprocessing facility
- Six individuals arrested; three prosecuted
- Reportedly at least 1 kg of HEU was available in addition to the sample (up to 10 kg per some reports)
- Reportedly a buyer from North Africa (questionable)
- Packaging and enrichment – similar to the 1999 and 2001 HEU incidents (!)

HEU and Pu Trafficking

(incidents with similarities are highlighted)

Incident	Date	Location	Material	Amount, g
Seizure	24 May 1993	Vilnius, Lithuania	HEU (50%)	150
Seizure	March 1994	St. Petersburg, Russian Federation	HEU (90%)	2972
Seizure	10 May 1994	Tengen-Wiechs, Germany	Pu	6.2
Seizure	13 Jun 1994	Landshut, Germany	HEU (87.7%)	0.795
Seizure	25 Jul 1994	Munich, Germany	Pu	0.24
Seizure	8 Aug 1994	Munich Airport, Germany	Pu	363.4
Seizure	14 Dec 1994	Prague, Czech Republic	HEU (87.7%)	2730
Seizure	Jun 1995	Moscow, Russian Federation	HEU (21%)	1700
Seizure	6 Jun 1995	Prague, Czech Republic	HEU (87.7%)	0.415
Seizure	8 Jun 1995	Ceske Budejovice, Czech Rep.	HEU (87.7%)	16.9
Seizure	29 May 1999	Rousse, Bulgaria	HEU (~72%)	4-10
Seizure	Dec 2000	Tbilisi, Georgia	Pu	0.4
Seizure	16 Jul 2001	Paris, France	HEU (~72%)	0.5
Seizure	26 Jun 2003	Sadahlo, Georgia	HEU (~89%)	~170
Seizure	1 Feb 2006	Tbilisi, Georgia	HEU (~89%)	79.5
Discovery	30 Mar 2006	Henningsdorf, Germany	HEU	47.5
Discovery	5 Oct 2009	Dordrecht, Netherlands	HEU (42%)	Unknown
Seizure	11 Mar 2010	Tbilisi, Georgia	HEU (~89%)	16-18
Seizure	27 Jun 2011	Chisinau, Moldova	HEU (~72% ?)	4.4

VCDNP

Current Patterns and Issues in Illicit Nuclear Trafficking

- Fewer cases involving nuclear materials, including LEU & HEU (1991-2000 – 110/year vs. 2001-2010 – 19/year, 2013-2014 – 10-12 incidents/year)
- However, HEU seizures (2003, 2006, 2010, 2011) indicate continued nuclear security vulnerabilities; persistent offers of HEU; disturbing similarities between different incidents
- In each HEU seizure case, larger amounts of HEU were promised
- Mostly “intermediaries” or “middlemen” are arrested in HEU or other significant cases. Thieves or buyers/end users are not captured or known
- Radioactive sources, including “orphan” sources, materials out of control, constitute the bulk of incidents
- ~10% of all incidents with radioactive sources and materials involve category I and II sources
- Cs-137 continues to lead the charts among radioactive sources
- Contamination in the metal recycling industry continues (even HEU is found in scrap metal)
- Persistent and repeating incidents in certain regions (Georgia, Moldova, Chernobyl area)

Current Patterns and Issues in Illicit Nuclear Trafficking (continued)

- No visible nexus between traffickers and terrorists… yet
  - However, announced interest to nuclear and radioactive materials by terrorists is evident
  - Past cases of demonstration of capabilities (Chechen groups in the mid-1990s)
  - Willingness of smugglers to sell to terrorists is also confirmed
- Possibility that nuclear smuggling goes undetected
  - We only learn about thefts and materials out of control by accident or when transactions are unsuccessful and lead to arrest and seizure
  - Do smuggling operations go undetected? If so, what is the scope?
- Reporting of incidents involving nuclear and radioactive materials if very uneven
  - Some countries do not report or underreport
  - Reporting is inaccurate and incomplete
- Low nuclear security culture in many countries
  - Nuclear safety is understood better than nuclear security
  - No legally binding international standards in the area of nuclear security or monitoring mechanism