Physics 280: Session 11

Plan for This Session

Questions about the course

News and discussion

Module 4: Nuclear Terrorism

Next Thursday, video presentation :

"Last Best Chance"

Hannah Gelman will lead the discussion, I'll be at CERN.

Impact of the Department of Defense Spending Cuts on the Nuclear Triad

NationalJournal

GLOBAL SECURITY NEWSWIRE

Nuclear Triad to Survive Hagel Cuts in Pentagon Spending

A U.S. Air Force B-2 stealth bomber rehearses a flyover of
Monday said he would preserve funding to develop a new

By Elaine M. Grossman Follow on Twitter
February 24, 2014

U.S. Defense Secretary Chuck Hagel on Monday said the nation would keep its air-land-sea approach to the nuclear arsenal, despite new Pentagon spending cuts.

"We ... preserve all three legs of the nuclear triad," he said in a lengthy statement at a Defense Department press conference, mostly devoted to conventional-warfare preparedness. "We'll make important investments to preserve a safe, secure, reliable and effective nuclear force."

Speaking alongside Chairman of the Joint Chiefs of Staff Gen. Martin Dempsey, the defense secretary laid out a series of reductions he said were necessary for maintaining military readiness and rebalancing the force structure to address future threats.

US-Chinese Meeting on Nuclear Program in North Korea

The New York Times | http://nyti.ms/1fnmU99

ASIA PACIFIC

China Set to Press North Korea Further on Nuclear Aims, Kerry Says

By MICHAEL R. GORDON FEB. 14, 2014

BEIJING — After a day of meetings with senior Chinese officials, Secretary of State John Kerry asserted on Friday that China was prepared to step up the pressure on North Korea to abandon its nuclear weapons programs.

Mr. Kerry said he had urged President Xi Jinping and other senior Chinese officials to "use every tool at their disposal" to persuade North Korea to rethink its decision to be a nuclear power.

Chinese officials, Mr. Kerry added, had made it clear that they supported the denuclearization of the Korean Peninsula "over the long run" and were prepared to take "additional steps" if North Korea was not willing to stop its nuclear effort and begin serious negotiations.

But Mr. Kerry acknowledged that significant differences remained between the United States and China over the specifics of how to rein in North Korea's nuclear programs. And some experts noted that a similar appeal that Mr. Kerry made in April for China to use its leverage with Pyongyang did not appear to have much effect on North Korea's nuclear activities.

iClicker Question

If Soot is transported to the upper atmosphere by an explosion or eruption, what is the meantime for the soot to return to earth's surface?

(A) 1 year

(B) 3 years

(C) 5 years

(D) 10 years

iClicker

iClicker Answer

If Soot is transported to the upper atmosphere by an explosion or eruption, what is the meantime for the soot to return to earth's surface?

(A) 1 year

(B) 3 years

(C) 5 years

(D) 10 years

iClicker Question

What would be the impact of a U.S.-Russian (“SORT”) nuclear war with 2200 x 2 weapons of 100-kt each = 440 Mt total on the length of the growing season in the mid west of the United States of America?

(A) Reduction by 5-10% (little ice age)

(B) Reduction by 50-60% (last ice age)

(C) Reduction by 70-80% (no “recent” historic precedence)

iClicker

iClicker Question

What would be the impact of a U.S.-Russian ("SORT") nuclear war with 2200 x 2 weapons of 100-kt each = 440 Mt total on the length of the growing season in the mid west of the United States of Amercia

(A) Reduction by ~10% (little ice age)

(B) Reduction by 50-60% (last ice age)

(C) Reduction by 80-90% (no "recent" historic precedence)

Module 4: Nuclear Terrorism

Nuclear Terrorism

Topics covered in this module:

Part 1: Terrorism and how to counter it

Part 2: Reducing the threat of nuclear terrorism

Key sources:

What Terrorists Want, by Louise Richardson

Preventing Catastrophic Nuclear Terrorism, by Charles D. Ferguson

Articles on Reading Assignments Page

Terrorism and How to Counter It

The Importance of Understanding Terrorism

Endeavoring to understand or explain terrorism is not to sympathize with it.

Instead, understanding the appeal of terrorism is the best way to effective counterterrorism policies.

Example: Gaining an understanding the Shining Path Maoist movement in Peru was much more effective in countering it than attempting to smash it —

- It had 10,000 members in the 1980s and controlled a large area of Peru
- Thousands of armed military and paramilitary forces were deployed over 20 years
- Shining Path and military units killed ~ 70,000 people, but terrorism did not diminish
- Only when the government established a special 70-man intelligence unit to study the Shining Path was it successfully countered
- The intelligence unit discovered that the leadership of the movement was highly centralized and depended on the academic Abimael Guzmán
- They studied everything about him and discovered he had a particular skin condition
- By old-fashioned police work and good electronic intelligence, Guzmán was tracked down though his medical prescription and captured with several of his top lieutenants

The Shining Path never recovered

Terrorism and How to Counter It

Topics covered here and in the readings —

- What is terrorism?
- Where have terrorists come from?
- What causes terrorism?
- The three Rs of terrorism
  (Revenge, Renown, Reaction)
- Why do terrorists kill themselves?
- What changed on 9/11 and what did not
- What is to be done?

Categories of Violent Political Activity (Important)

Terrorism*: Deliberately* and *violently* targeting *civilians* for *political* purposes (all *4 criteria* must be met)

Insurgency: An organized movement aimed at the overthrow of a constituted government through use of subversion and armed conflict. Insurgents may or may not commit terrorist acts.

Guerilla warfare: A type irregular warfare and combat in which a small group of combatants use mobile military tactics in the form of ambushes and raids to combat a larger and less mobile formal army. Guerilla warfare is not terrorism.

Regular armed forces: Must satisfy the four Hague Convention (Hague IV) conditions (1899 and 1907): (1) be commanded by a person responsible to a party to the conflict, (2) have a fixed distinctive emblem recognizable at a distance, (3) carry arms openly, and (4) conduct operations in accordance with the laws and customs of war.

What is Terrorism?

Terrorism is **deliberately** and **violently** targeting **civilians** for **political** purposes.

Terrorism often (but not always) has *3 other characteristics* —

1. The point of terrorism is not to defeat the enemy but to send a message.
2. The act and the victim usually have symbolic significance.
3. The *victim* of the violence and the *audience* the terrorists are trying to reach *are not the same*.

Terrorism Carried Out by Governments – 1

Richardson argues that to have a clear understanding of the behavior of *terrorist groups*, we must understand them as sub-state actors. Although states and their leaders are not *terrorist groups,* states may engage in terrorism.

The terrorism committed by states can be divided into three categories:

1. State-sponsored terrorism: State sponsorship of terrorist acts against inhabitants of *other* countries as an instrument of foreign policy.

For example, to hurt other countries without risking the consequences of overtly attacking them (e.g., Libyan support of terrorist acts against U.S. interests during the 1980s, Iraqi support of Palestinian terrorist acts against Israel during the 1990s, Iranian support of terrorism against Israel by Hezbollah in Lebanon and Hamas in Gaza).

For example, as a way to engage in proxy warfare or covertly bring about internal change in another country without risking a direct confrontation (e.g., U.S. support of terrorist groups in Angola and Nicaragua).

Terrorism Carried Out by Governments – 2

2.State terrorism: Use of terrorism by a government against its own citizens, to coerce them into accepting the government's authority (examples: Germany in the 1930s, Argentina in the 1970s, Iraq in the 1980s and 1990s).

3.War terrorism: Use of terrorism by a government against the civilians of another country with which it is at war (examples: the German and Allied bombing campaigns in World War II, which damaged London and destroyed Coventry, Dresden, Hiroshima, and Nagasaki and were deliberate efforts to target civilian populations in order to force the hands of their governments).

Collective punishment of communities that produce partisans is another example of targeting civilians to achieve political ends and is therefore terrorism (example: collective punishment of villages of resistance fighters in the Ukraine, Italy and France through German troops in WWII).

Understanding Terrorists – 1

Richardson points out that:

- Terrorism, even religious terrorism, is neither new nor the primary preserve of Islam
- Terrorists have sometimes later become statesmen
- People strongly opposed to terrorism have been labeled terrorists

She argues that the causes of terrorism are not to be found in objective conditions of poverty or privation or in a ruthless quest for dominance, but rather in a "lethal triple cocktail" that combines —

1. a disaffected individual
2. an enabling community
3. a legitimizing ideology

Richardson argues that terrorists are neither crazy nor amoral but rather are rationally seeking to achieve a set of objectives within self-imposed limits.

Understanding Terrorists – 2

Richardson argues that —

- The behavior of terrorists can be understood in terms of
  - ***long-term political objectives***, which differ across groups
  - ***more immediate objectives***, which are shared by terrorists with very different long-term objectives
- Terrorists' generally have much more success achieving their immediate objectives than achieving fundamental change.
- When terrorists act, they are seeking 3 immediate objectives (the "3 Rs"):
  - to exact revenge
  - to achieve renown (glory)
  - to force their adversary to react

The 3 Standard Initial Reactions to Terrorism

There are 3 standard phases in an inexperienced society's reaction to terrorism —

Phase 1: Demonstrate resolve by adopting a draconian response that goes largely unchallenged by the public

Phase 2: Polarization of politics —

- The right demands tougher measures and denounces opponents as unpatriotic
- The left objects to many coercive measures

Phase 3: More reasoned reflection, when —

- Draconian measures have failed to produce the desired results
- The adversary has demonstrated his implacable commitment to harming the nation

Six Basic Rules for Containing Terrorism

Rule 1: Have a defensible and achievable goal

- If the goal of the U.S. is to defeat terrorism or eliminate terrorism, it can never be achieved
- By contrast the goal to capture those responsible for the 9/11 attacks, very well might be achievable
- *Containing* the threat of terrorism *is* achievable
- By keeping this more modest and concrete goal firmly in sight and planning accordingly, the U.S. can ensure that its short-term tactics do not undermine its long-term goals

Rule 2: Live by your principles

Six Basic Rules for Containing Terrorism (cont'd)

Rule 3: Know your enemy

Rule 4: Separate the terrorists from their communities

Rule 5: Engage others in countering terrorists with you

Rule 6: Have patience and keep your perspective

U.S. counterterrorism policy after 9/11 did not initially follow these six rules, but improved with time.

Example: US Reaction to 9/11

Richardson argues that the early response was marked by two significant mistakes and two major missed opportunities

Mistakes:

- declaration of a “global war on terror”
- conflation of the threat posed by al-Qaeda with the threat posed by Saddam Hussein

Missed opportunities:

- the opportunity to educate the American public to the realities of terrorism and the costs of U.S. sole superpower status
- the opportunity to mobilize the international community behind the U.S. in a transnational campaign against transnational terrorists

Impact of 9/11 in the United States

Richardson argues that the declaration of a “global war on terror” — has been a mistake and is likely to fail

She argues for a different approach —

- appreciate the factors driving the terrorists
- deprive them of what they need

Key Questions for Countering Terrorism

In thinking about counterterrorism policies, the question should *not* be

- Who's tough on terrorists?
- Who's soft on terrorists?

What matters is —

- *What actions are effective against terrorism?*
- *What are their costs?*

We are likely to experience terrorism in the future, just as we have in the past.

We are going to have to learn to live with and accept it as a price of living in a complex world in which communication is relatively easy.

The Relation of Democracy to Terrorism

Through improved security measures and enhanced intelligence, we can protect ourselves against the most dangerous weapons and the most sophisticated attacks.

It's important to remember that —

- Terrorists cannot derail our democracy by planting a bomb in our midst
- Our democracy can be derailed only if we conclude that it is inadequate to protect us
- Democratic principles are the strongest weapons against terrorists

Reducing the Threat of Terrorism

Richardson argues we should recognize that —

- Terrorism will continue to be employed as long as it is deemed effective
- Technological developments will make it easier for ever smaller groups to employ weapons of ever greater lethality against us
- Political, social, and economic developments will continue to produce disaffected individuals
- We will never be able to prevent every attack, but we can control our reaction to those attacks

If we keep terrorist attacks in perspective and recognize that the strongest weapons in our arsenal against terrorism are precisely the hallmarks of democracy that we value, then we can contain the terrorist threat.

iClicker Question

Which of the following is *not* a defining characteristic of terrorism?

A. The act must be violent or threaten violence

B. The violence must be against civilians

C. The individual victims must be randomly chosen

D. The violence must be deliberate

E. The violence must have a political purpose

iClicker

iClicker Answer

Which of the following is *not* a defining characteristic of terrorism?

A. The act must be violent or threaten violence

B. The violence must be against civilians

C. The individual victims must be randomly chosen

D. The violence must be deliberate

E. The violence must have a political purpose

iClicker Question

Terrorism

Which of the following is *not* one of the “lethal triple cocktail” of factors that Richardson argues leads to terrorism?

A. Extreme poverty

B. A disaffected individual

C. A legitimizing ideology

D. An enabling community

iClicker

iClicker Answer

Terrorism

Which of the following is *not* one of the “lethal triple cocktail” of factors that Richardson argues leads to terrorism?

A. **Extreme poverty**
B. A disaffected individual
C. A legitimizing ideology
D. An enabling community

Reducing the Threat of Nuclear Terrorism

Reducing the Threat of Nuclear Terrorism

Two Ongoing Parallel Approaches

1. Invasion and war (has led to insurgencies)
2. Cooperative efforts to secure or intercept nuclear explosive materials

Delivery Methods Other Than Long-Range Ballistic Missiles Pose Greater Threats

Several countries are capable of developing mechanisms to launch SRBMs, MRBMs, or land-attack cruise missiles from forward-based ships or other platforms. Some may develop such systems before 2015.

U.S. territory is more likely to be attacked with [nuclear weapons] using non-missile delivery means—*most likely from terrorists*—than by missiles, primarily because non-missile delivery means are —

- **less costly**
- **easier to acquire**
- **more reliable and accurate**

They also can be used without attribution.

— Unclassified summaries of past National Intelligence Estimates of Foreign Missile Developments and the Ballistic Missile Threat Through 2015

In Pictorial Form …

Physics 280: Session 12

Plan for This Session

- Last Best Chance
- Video Presentation
- Discussion

Reducing the Threat of Nuclear Terrorism

Video: “Last Best Chance”

2005, Nuclear Threat Initiative (NTI)

Discussion of “Last Best Chance”

Physics 280: Session 13

Plan for This Session

Questions about the course

News

The threat of nuclear terrorism

Is Ukraine Aiming for a Nuclear Program ?

Russia Today, March 1st

The ultra-right “Svoboda” (Liberty) party has remained unconvinced, with one of its representatives in the Ukrainian parliament warning that if Russia doesn’t tread carefully it will be dealing with a nuclear power.

"*We’ll regain our status as a nuclear power and that’ll change the conversation. Ukraine has all the technological means needed to create a nuclear arsenal – which would take us about three to six months*,” Svoboda party MP Mikhail Golovko said.

The rhetoric, which contradicts the international nuclear non-proliferation treaty Ukraine signed in 1994, is not new for the Svoboda party, one of the driving forces behind the Maidan uprising. Its leader, Oleg Tyagnibok, already promised that the country would go nuclear while he was running for the presidency in 2009.

Storage Tank Leaks at the Hanford Nuclear Reservation: New York Times, March 1st

WASHINGTON — Most of the youngest and sturdiest of the giant tanks that the Energy Department uses to store high-level radioactive waste at its Hanford nuclear reservation in Washington State show some of the same construction problems as a tank that began leaking in late 2012, according to documents released by Senator Ron Wyden of Oregon, whose state is across the Columbia River from the site.

The Energy Department is counting on the tanks, built in the 1960s and 1970s, to last for decades more, and has pumped into them thousands of gallons of radioactive liquids scavenged from older tanks that leaked or were at risk of leaking.

Mr. Wyden, a Democrat who is a member of t
sent Friday to Energy Secretary Ernest J. Moni
said, “It seems unlikely that the other double-
similarly affected.”

But now, Mr. Wyden said in the letter, it is evic
problems. “It is not merely that the design of t
it now appears that the physical integrity of th
Energy Department documents.

…

But at the Hanford site, Thomas W. Fletcher, t
affecting one tank did not necessarily mean th
tank had a particularly large amount of radioa
promoted problems, he said, and had less cor

Storage Tank Leaks at the Hanford Nuclear Reservation: New York Times, March 1st

WASHINGTON — Most of the youngest and sturdiest of the giant tanks that the Energy Department uses to store high-level radioactive waste at its Hanford nuclear reservation in Washington State show some of the same construction problems as a tank that began leaking in late 2012, according to documents released by Senator Ron Wyden of Oregon, whose state is across the Columbia River from the site.

The Energy Department is counting on the tanks, built in the 1960s and 1970s, to last for decades more, and has pumped into them thousands of gallons of radioactive liquids scavenged from older tanks that leaked or were at risk of leaking.

Mr. Wyden, a Democrat who is a member of the Senate Energy Committee, pointed out in a letter sent Friday to Energy Secretary Ernest J. Moniz that at the time of the 2012 leak, the department said, "It seems unlikely that the other double-shell tanks in similar circumstances would have been similarly affected."

But now, Mr. Wyden said in the letter, it is evident that most have at least some of the same problems. "It is not merely that the design of the tanks and internal components are a problem, but it now appears that the physical integrity of the tanks themselves is compromised," he wrote, citing Energy Department documents.

…

But at the Hanford site, Thomas W. Fletcher, the assistant manager for tank farms, said a leak affecting one tank did not necessarily mean that others would have similar problems. The leaking tank had a particularly large amount of radioactive material and thus a very high temperature, which promoted problems, he said, and had less corrosion-inhibiting chemicals than other tanks.

The Threat of Nuclear Terrorism

Terrorist pathways to a nuclear bomb —

- Stealing a bomb
- Buying a bomb
- Building a bomb

Stealing a Bomb

- About 25,000 nuclear weapons are in arsenals, with all but about 1,000 in Russia and the United States
- Stealing a bomb would be difficult but not impossible
- Activating a stolen bomb would be difficult —
  - The weapons of the United States, Britain, China, and France are protected by specialized security codes (permissive action links = “PALs”)
  - Most but not all Russian weapons have PALs
  - Whether the weapons of India, Israel, Pakistan, and North Korea use PALs is unknown

There are serious concerns about the security of Pakistani nuclear weapons and Russian tactical nuclear weapons.

Buying a Bomb – 1

- Nuclear-armed states are unlikely to sell a nuclear weapon because of the prospect of devastating retaliation
- But deterrence hinges on a credible retaliatory threat and credible evidence that a weapon transfer has occurred
- Gathering evidence that an explosion was produced by a transferred weapon is difficult
- Nuclear forensics and nuclear event attribution programs receive increased attention following the National Defense Authorization Act of 2010

  ➔ Nuclear Forensics and Attribution Act signed 2-16-2010 to establish the National Technical Nuclear Forensics Center within Homeland Securities Domestic Nuclear Defense Office (DNDO).

Buying a Bomb – 2

More likely routes for terrorists to buy or be given a nuclear weapon —

- Corruption among nuclear custodians
- Nuclear black markets
- A coup that brings to power officials sympathetic to terrorists

Pakistan is of particular concern —

- It has a relatively new nuclear command and control system
- Taliban and al-Qaeda forces have a formidable presence
- Elements in Pakistan's military intelligence agency sympathize with the Taliban
- Concerns with regards to stability: eg. Pakistani leaders have been frequent assassination targets
- The infamous (A.Q. Khan) black market originated in Pakistan

Building a Bomb – 1

Some problems that terrorist organizations wishing to construct a nuclear explosive would confront —

- Assembling a team of technical personnel
- Substantial financial costs
- Radiation and chemical hazards
- Possibility of detection
- Acquisition of nuclear-explosive material

Building a Bomb – 2

No terrorist organization currently has the ability to produce weapons-usable enriched uranium.

Hence terrorists would have to acquire already made HEU.

There is enough HEU in worldwide stockpiles to make ~ 30,000 bombs.

Most HEU is under military control, but 40 countries have civilian HEU, including in more than 120 research reactors and related facilities.

The HEU stockpiles most vulnerable to theft are in Pakistan, Russia, and may countries with civilian reactor facilities.

Building a Bomb – 3

No terrorist organization currently has the ability to make plutonium for a weapon. Nuclear reactors to produce plutonium and reprocessing plants to extract plutonium from spent reactor fuel require resources available only to States.

Hence terrorists would have to seize plutonium from existing stockpiles or receive aid from a State.

There is enough plutonium worldwide to make ~ 30,000 bombs.

Plutonium is under both military and civilian control.

Both pose a risk. The United States, Britain, France, and Russia have stopped producing plutonium for weapons. China may have stopped.

India, Israel, Pakistan and possibly North Korea are continuing to make plutonium for weapons.

Building a Bomb – 4

To make a Hiroshima-style gun-type bomb, terrorists would need about 50 kg (110 pounds) of weapons-grade HEU.

They could try to reduce the amount needed by using special techniques.

An implosion-type bomb can use either HEU or Pu, but the technical challenges are significant —

- Machining and assembling the parts
- Triggering the implosion

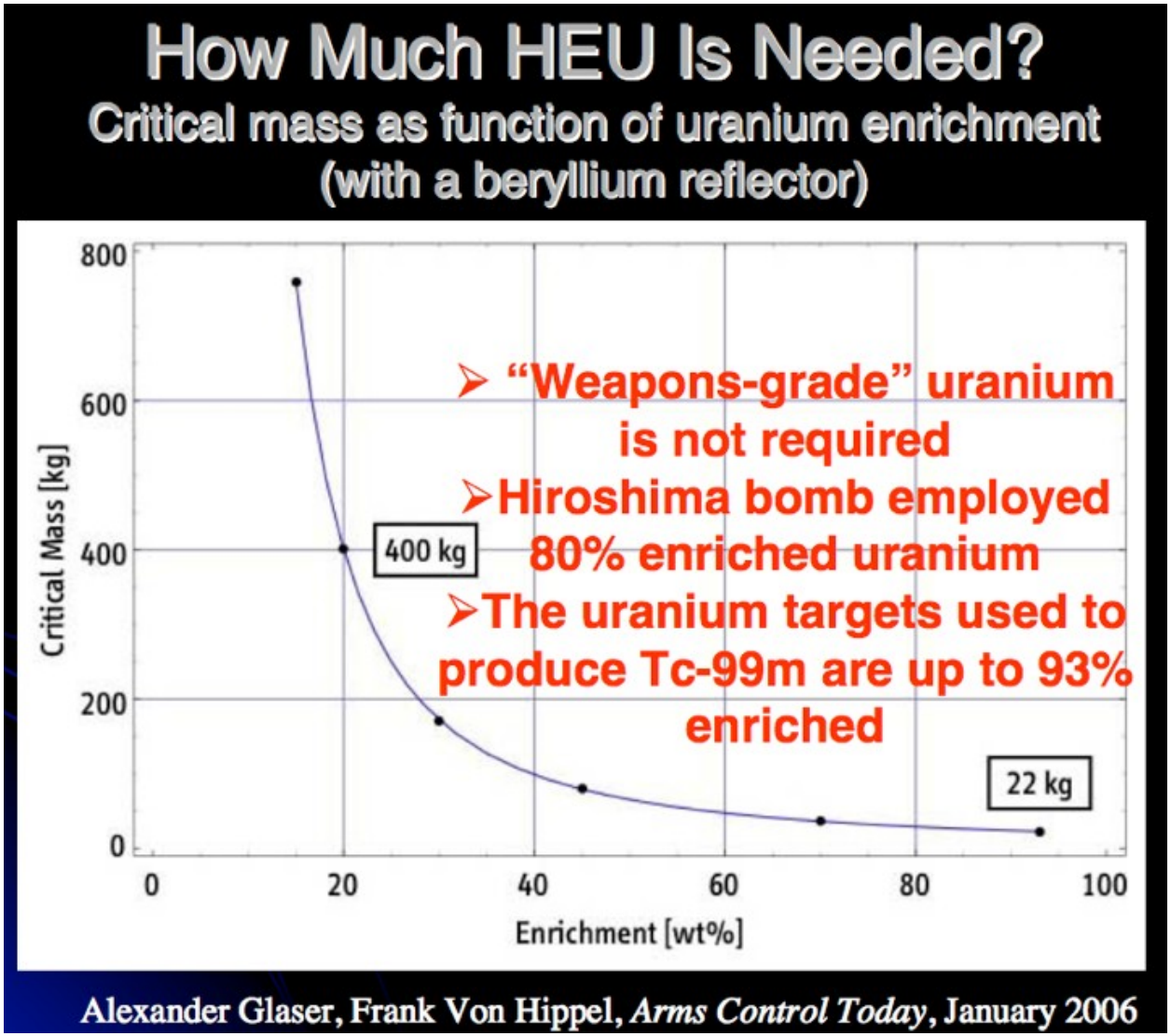
A simple implosion-type bomb would require only 25 kg (55 pounds) of HEU or 4 to 10 kg (9 to 22 pounds) of Pu

Terrorists would be aided by the fact that they would not need to meet military requirements.

The key barrier for terrorists is acquiring enough HEU.

Insecure Nuclear Explosive Materials

The Danger of Highly Enriched Uranium



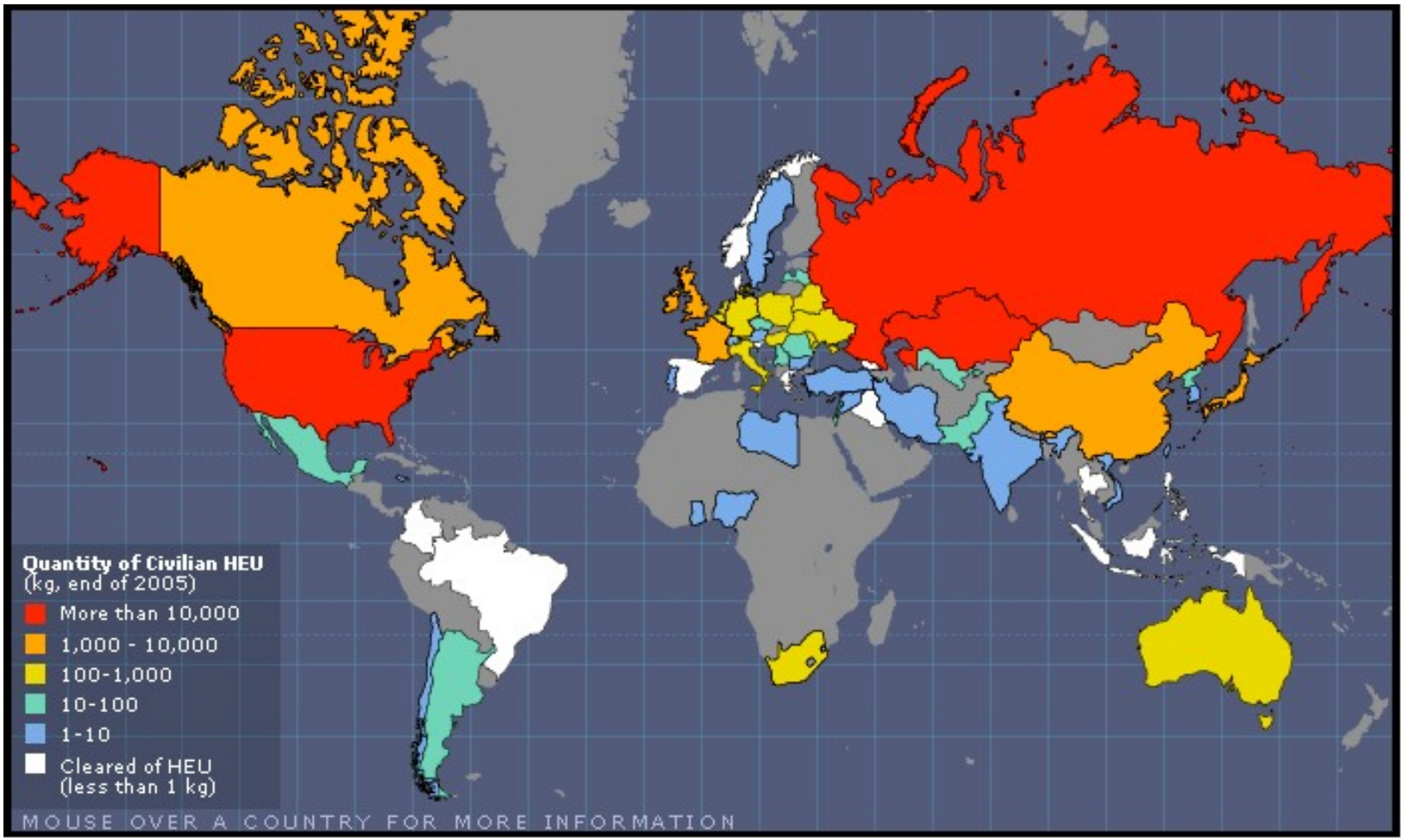
Availability of Uranium from “Atoms for Peace”

Atoms for Peace

- During the 1950s and 1960s, the U.S. Atoms for Peace program and the corresponding Soviet program constructed hundreds of research reactors, including reactors for export to more than 40 other countries.

- These reactors were originally supplied with low-enriched Uranium (LEU), which is not usable for nuclear weapons, but demands for better reactor performance and longer-lived fuel led to a switch to weapons-grade Highly Enriched Uranium (HEU).

Availability of Highly Enriched Uranium
Effect of "Atoms for Peace"

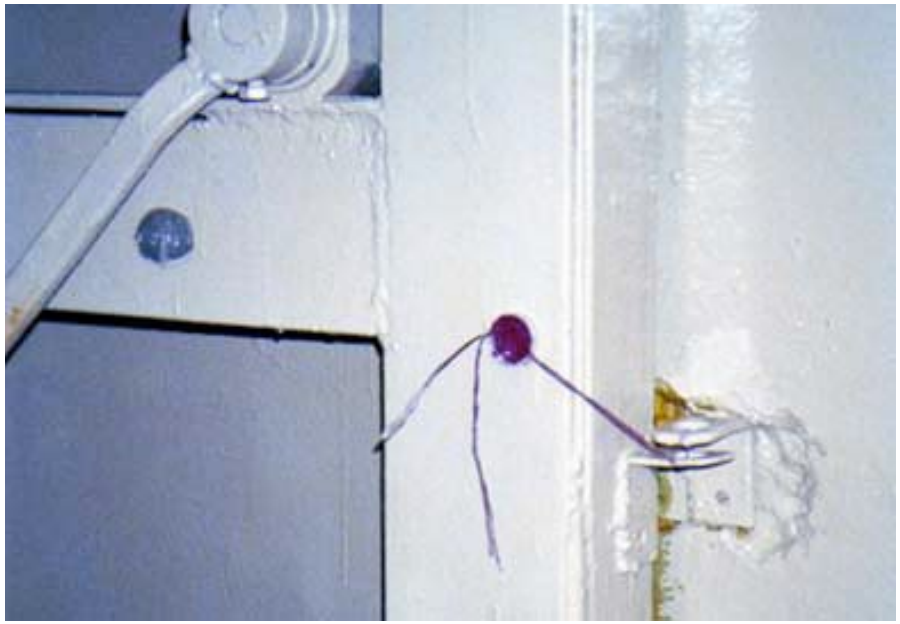


Availability of Nuclear Weapon Materials in the Former Soviet Union in the 1990s

In 1994, Building 116 at the Kurchatov Institute in Moscow had enough HEU for a bomb at its research reactor, but had an overgrown fence and no intrusion detectors or alarms, an example of the poor state of security at many nuclear facilities after the collapse of the Soviet Union.

Availability of Nuclear Weapon Materials in the Former Soviet Union in the 1990s

Left and below: Inadequate security measures at former Soviet nuclear facilities, such as the padlock and wax seal shown, would allow easy access to anyone wishing to steal materials.



The situation in Former Soviet Republics triggered intense efforts to collect and secure nuclear materials. Example, the Global Threat Reduction Initiative (GTRI), collect Pu, HEU and convert civilian HEU reactors to LEU.

Much progress has been made in securing nuclear materials in former SU states !

Reducing the Threat of Nuclear Terrorism

Programs to Intercept and Secure Nuclear Materials

Intercepting Nuclear Weapons and Materials

Terrorists organizations known to have sought nuclear weapons or weapon materials —

- Al-Qaeda
- Jemaah Islamiyah
- Chechnyan Separatists
- Hezbollah
- Aum Shinrikyo

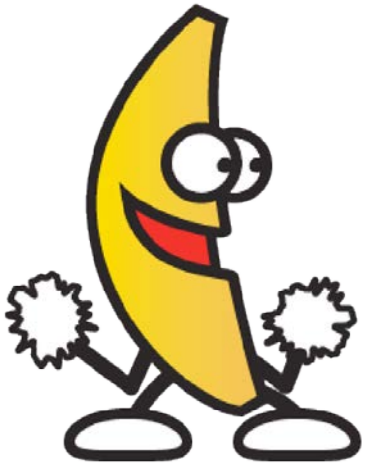
Border Security —

Seven million shipping containers enter the U.S. each year; only 6% are inspected carefully

A truck passes through a radiation portal monitor at the port of Newark, New Jersey.

Intercepting Nuclear Weapons and Materials

What do ceramics, bananas, and kitty litter have to do with border security?

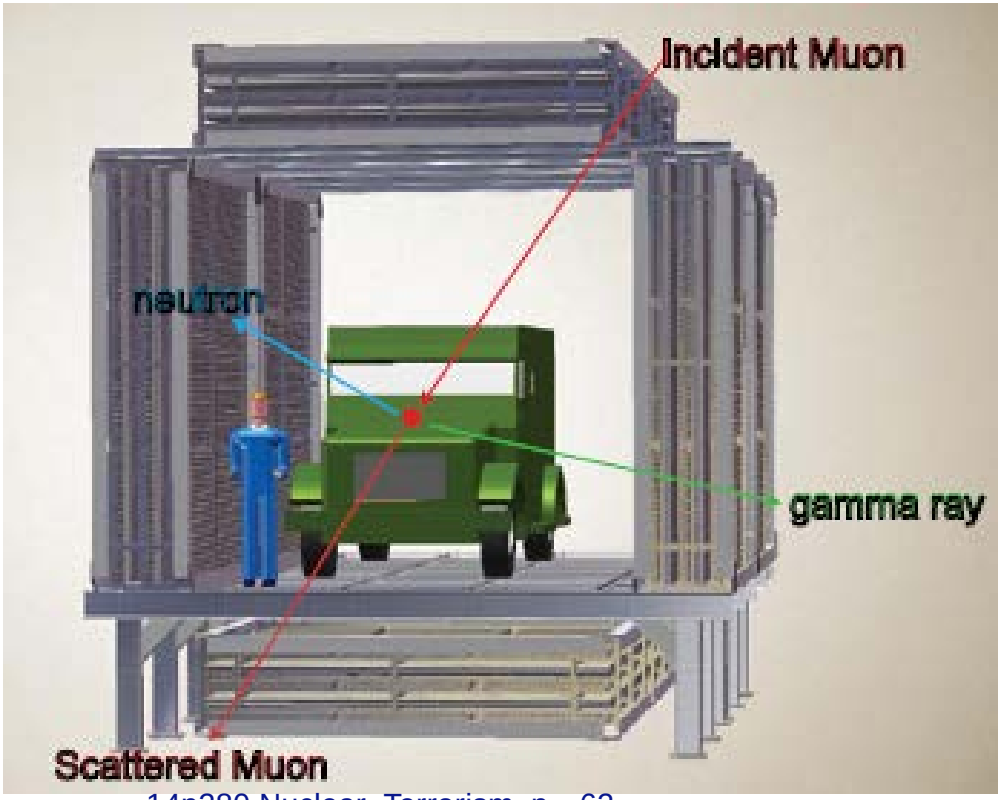


They accounted for 80 percent of the over 10,000 radiological false alarms made by portal monitors between May 2001 and March 2005.

Intercepting Nuclear Weapons and Materials

Port Scanners: Avoiding False Positive Alarms
Passive Muon Tomography

Solution: detect scattering of cosmic ray muons of high-z nuclei in nuclear explosive materials ! Very specific, low number of false positive alarms.



UIUC nuclear physics graduate Dr. Mike Sossong helped to develop this technology at Los Alamos National Laboratory and now is director of research at Decision Science Corporation in San Diego.

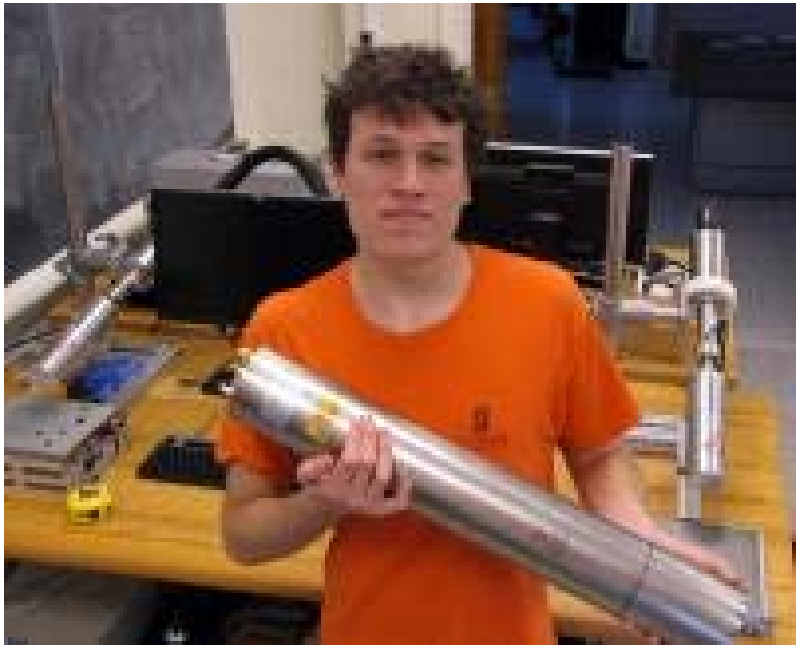
Dr. Sossong won the 2011 Columbus Scholar Award of the Homeland Security Department for commercializing this technology

Intercepting Nuclear Weapons and Materials

Research on active interrogation for NEM using neutrons

Example:

Brent Heuser, Ling Jian Meng at NPRE and MGP in physics
"Interrogation of Special Nuclear Material Using the UIUC Pulsed Neutron Facility"
funded by the UIUC Engineering College Strategic Research Initiative



Idea: neutrons get captured by nuclides
In the resulting decay gamma rays of characteristic energy are emitted.

NPRE Student (former 280 TA)
Rick Kustra with a gamma detector used

Identifying the Sources of Dangerous Nuclear Materials (Nuclear Forensics)

Nuclear Forensics Definitions

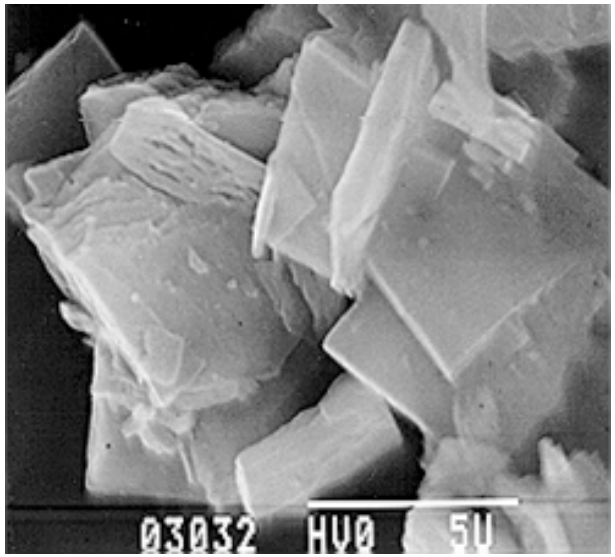
Nuclear Attribution is the process of identifying the source of nuclear or radioactive material used in illegal activities, to determine the point of origin and routes of transit involving such material, and ultimately to contribute to the prosecution of those responsible.

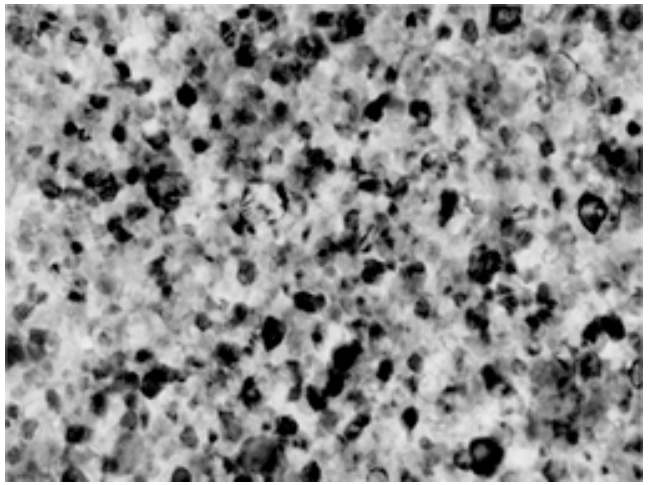
Nuclear Forensics is the analysis of intercepted illicit nuclear or radioactive material and any associated material to provide evidence for nuclear attribution.

Nuclear Forensic Techniques

Electron Microscopy and Spectroscopy

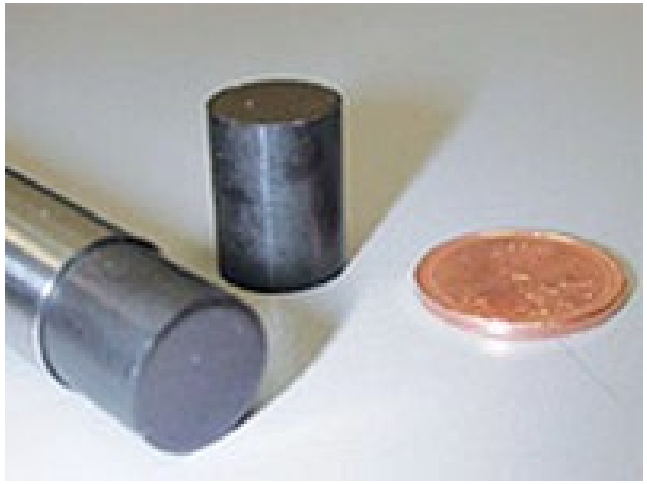
- Typography, morphology, elemental composition, and crystallographic structure
- Scanning Electron Microscopy (SEM) produces images of the surface at high magnification.
- Transmission Electron Microscopy (TEM) uses electrons that pass through the sample to produce images of the internal structure.





Source: Analyst, 2005: 130

Nuclear Forensic Techniques



http://www.nti.org/e_research/cnwm/threat/russia.asp

Analyst, 2005: 130

Profilometry —

- Measures the surface roughness of fuel pellets.
- **Production facilities use two types of grinding procedures** to reach the desired cylindrical shape: dry grinding and wet grinding. Wet grinding produces a smoother finish.

Size and features —

- The **dimensions of the fuel pellet**, including the height, radius, and the type of hole present (if any), **are specific to certain types of reactors**.

Nuclear Forensic Techniques: Spectroscopy

Isotopic composition reveals the enrichment process, intended use, and reactor type.

Impurity composition reveals the production process and previous geolocation.

Nuclear Forensic Techniques

Age —

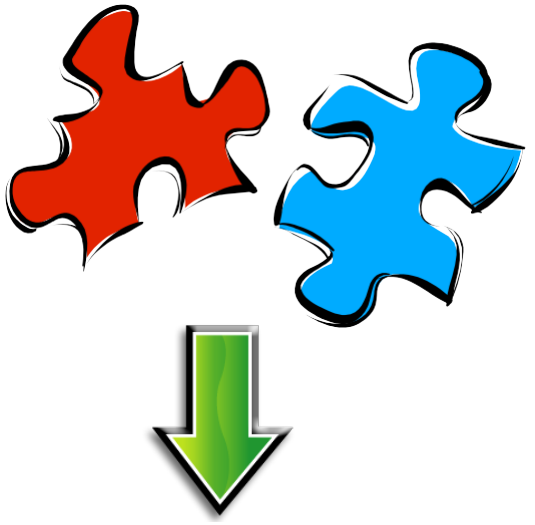
- As a radiological sample gets “older,” the parent isotope disintegrates and its daughter nuclides accumulate.
- Knowledge of the age helps an analyst identify when the material was produced.

$^{18}O/^{16}O$ Ratio —

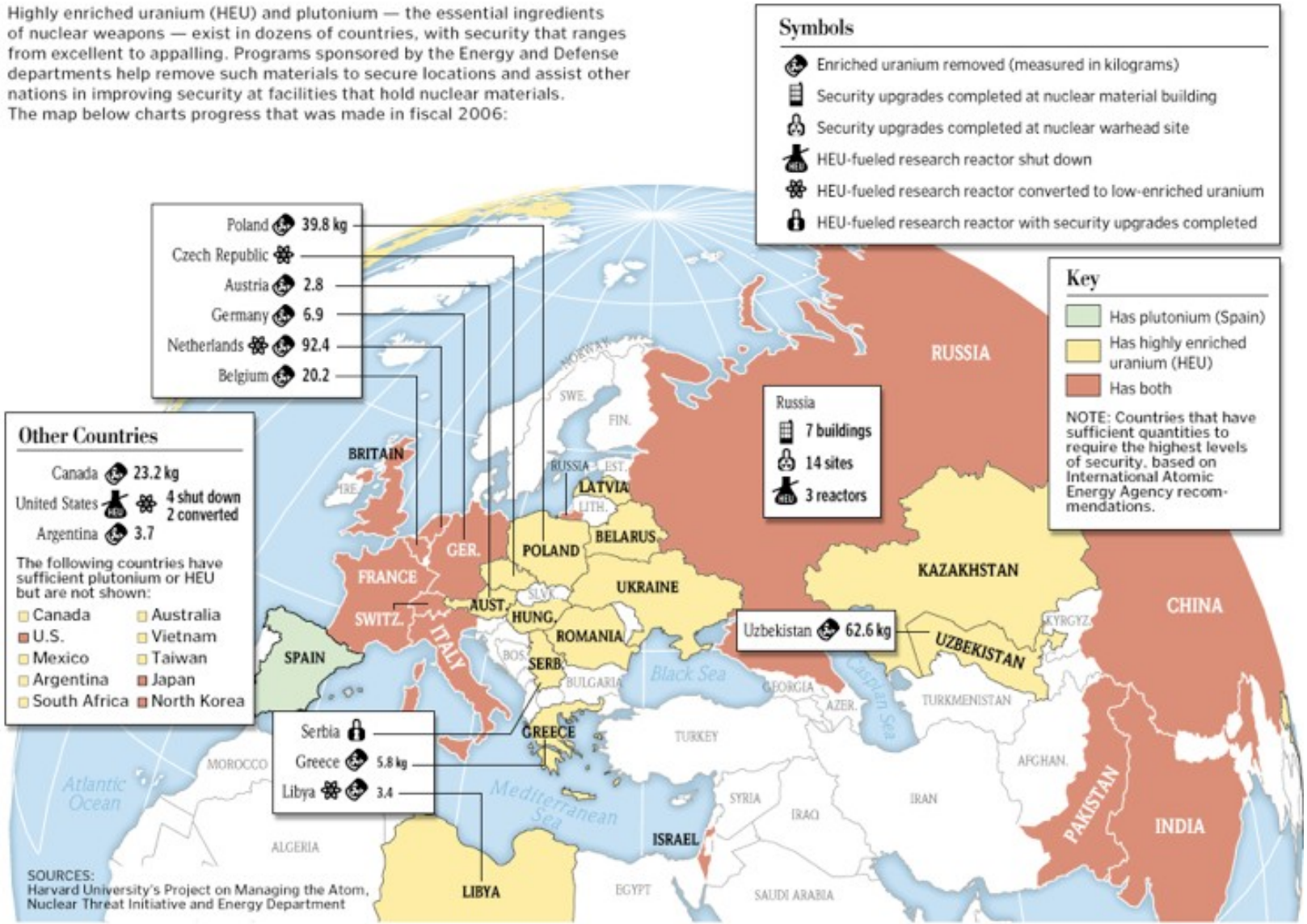
- Certain ratios are observed in rainwater, and these “variations up to 5 percent...depend upon average temperature, average distance from the ocean, and the latitude” (Mayer).
- By these means, an analyst can identify the former geolocation of the material.

Nuclear Forensic Techniques: Conclusion

- By using the techniques and analysis methods of nuclear forensics, one can create a “nuclear fingerprint” of the material.
- Information, such as material type, reactor type, production plant, production date, enrichment process, intended use, and geolocation, are pieces of the puzzle that must be solved to form a bigger picture of the radiological evidence’s history.



Securing Vulnerable Nuclear Materials



Securing Vulnerable Nuclear Materials

2010 Government Accountability Office Report on Status of the U.S. Nuclear Security Program

(see also *Arms Control Today*, Jan/Feb 2011)

The GAO reported that the National Security Council (NSC) has approved a document that serves as a government-wide strategy for achieving President Barack Obama's goal of securing all vulnerable nuclear materials within four years.

However, the GAO said that "this interagency strategy lacks specific details concerning how the initiative will be implemented."

Securing Vulnerable Nuclear Materials

Russia

The National Nuclear Security Agency (NNSA) received the highest marks for its Material Protection, Control, and Accounting (MPC&A) activities in Russia.

Through this program, which works to conduct security upgrades at nuclear facilities, the NNSA has improved security at 110 Russian nuclear warhead and material sites, the GAO said.

Securing Vulnerable Nuclear Materials

Other NNSA programs in Russia have achieved more limited success, the GAO said. The Materials Consolidation and Conversion (MCC) program was created in 1999 with the goal of moving highly enriched uranium (HEU) from 50 buildings and five sites by 2010; it "has achieved removal of all HEU from only 1 site and 25 buildings," the report said.

Likewise, the Global Threat Reduction Initiative (GTRI), which includes an effort to convert or shut down Russian HEU reactors, has made little progress toward that end, the GAO said.

According to the report, the GTRI plans to convert or shut down 71 HEU-fueled research reactors and related facilities in Russia by 2020. To date, Russia has shut down three HEU facilities and committed to shutting down five others, the GAO said.

Securing Vulnerable Nuclear Materials

Ukraine

Following Ukraine's commitment at the April 2010 nuclear security summit in Washington to get rid of all of its HEU by 2012. The last HEU, 128 kg, was removed on March 27th from two facilities in the Ukraine.

South Africa

NNSA has completed a contract with South Africa for the return of U.S.-origin spent HEU fuel to the United States. the contract, signed in August 2010, covers 5.8 kilograms of U.S.-origin HEU spent fuel. This will mark the final removal of all U.S.-origin HEU spent fuel from South Africa.

Securing Vulnerable Nuclear Materials

Belarus

Belarus has committed to give up its stockpile of highly enriched uranium (HEU) by the end of 2012.

Prior to the agreement, Belarus, Russia, the United States, and the International Atomic Energy Agency conducted two secret operations in which portions of Belarusian HEU were moved into secure facilities in Russia.

In these operations, a total of 85 kilograms of HEU were transported.

Belarus has suspended the agreement in August 2011 over US protests concerning human right violations in Belarus.

iClicker Question (Use Channel C-C)

Which country has given up all civilian HEU in 2012?

A. Belarus

B. Germany

C. Ukraine

D. Russia

E. France

iClicker

iClicker Question (Use Channel C-C)

Which country has given up all civilian HEU in 2012?

A. Belarus

B. Germany

c. Ukraine

D. Russia

E. France

What We Need To Do

What We Need to Do (Important)

The centerpiece of a strategy to prevent nuclear terrorism must be to deny terrorists access to nuclear weapons or materials

To accomplish this, nuclear terrorism experts argue that we must insist on “Three No’s” —

1. No loose nukes
2. No new nascent nukes
3. No new nuclear weapon states

What We Need to Do (Important)

1. No Loose Nukes

Insecure nuclear weapons or materials anywhere pose a grave threat to all nations everywhere.

The international community can therefore rightly insist that all weapons and materials—wherever they are—be protected to a standard sufficient to ensure the safety of citizens around the world.

Russia has been the principal focus of concern for the past decade, but other countries—such as Pakistan—are of growing concern.

What We Need to Do (Important)

2. No New Nascent Nukes

Construction of any national production facilities for enriching uranium or reprocessing plutonium must be prevented.

The former head of the IAEA, Mohamed ElBaradei, has said that the existing NPT system made a mistake in allowing non-nuclear weapon states to build uranium enrichment and plutonium production plants.

Closing this loophole will require deft diplomacy, imaginative inducements, and demonstrable readiness to employ sanctions to establish a bright line.

What We Need to Do (Important)

3. No New Nuclear Weapons States

This means drawing a line under the current eight nuclear powers (the United States, Russia, Great Britain, France, China, India, Pakistan, and Israel) and unambiguously declaring “no more”.

North Korea poses a decisive challenge to this policy. But if North Korea is accepted as a nuclear weapons state, South Korea and Japan are likely to follow within a decade, making Northeast Asia a far more dangerous place than it is today

The spread of nuclear weapons states makes it more likely that nuclear weapons or materials will be sold to others, including terrorists, or stolen by them.

End of Nuclear Terrorism Module