

Nuclear Terrorism

Topics covered in this module:

Part 1: Terrorism and how to counter it

Part 2: Reducing the threat of nuclear terrorism

Sources:

What Terrorists Want, by Louise Richardson

Preventing Catastrophic Nuclear Terrorism, by
Charles D. Ferguson

Articles on Reading Assignments Page

Physics/Global Studies 280

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.

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Plan for This Session

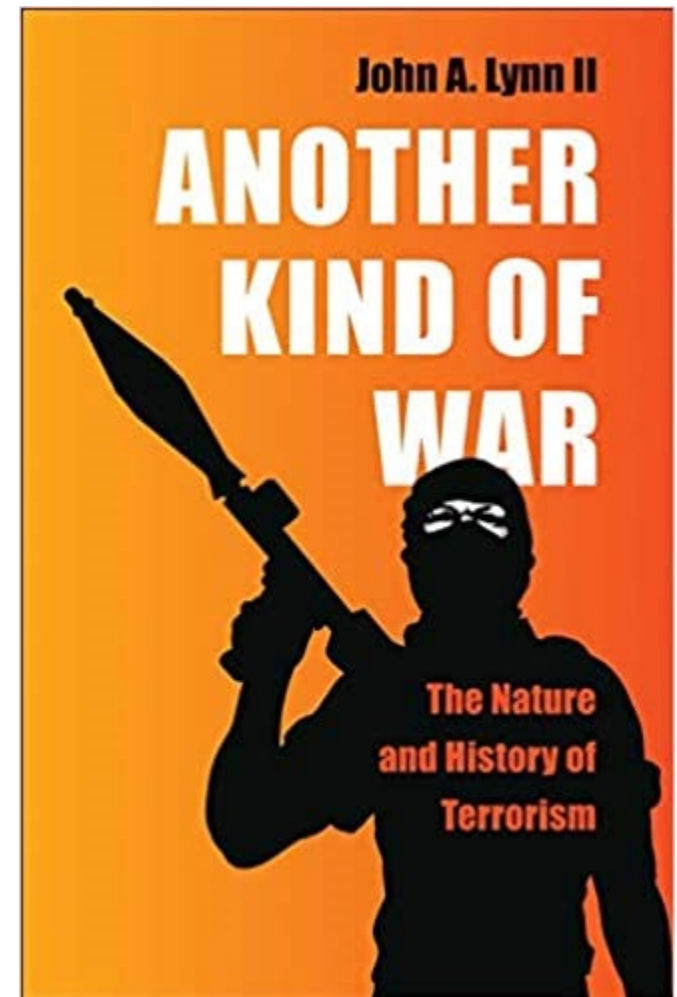
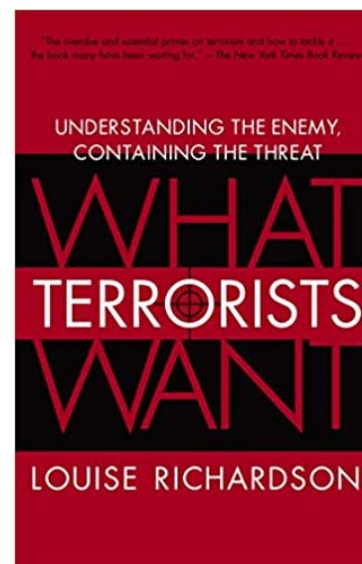
News and discussion

Module 4: Nuclear Terrorism

For additional studies:

UIUC Emeritus, John Lynn, History

Required reading



Updated Feb. 21, 2022 11:25 am ET

WORLD

U.S. Nears Return to Iran Nuclear Deal

Agreement could be completed as early as the next couple of days, officials say, but some differences remain

Iran, the U.S. and other world powers are nearing a deal to revive the 2015 nuclear accord, although negotiators are still wrangling over significant final demands from Tehran, including the scope of sanctions relief.

An agreement could be finalized in Vienna within the next couple of days, said officials involved in the talks. President Biden has made restoring the agreement a top foreign-policy goal. The White House views an agreement restraining Iran's nuclear program as key to Middle East stability, allowing the U.S. to [focus on China and Russia](#).

An agreement would set out the steps Iran and the U.S. must take to return to compliance with the 2015 deal, which imposed tight but temporary limits on Iran's nuclear program in exchange for suspending international sanctions. [The U.S. pulled out of the deal in May 2018](#) and reimposed sweeping sanctions on Iran, which brought most international trade with Iran to a standstill.

While the terms of a restored deal would be almost identical to the 2015 pact, Iran's "breakout time"—the duration needed to amass enough nuclear fuel for a bomb—could fall to as low as six months, down from about a year in the original deal, U.S. officials say. That is because of expertise that Iran has gained through its nuclear work since the U.S. exited the agreement.

U.S. Nears Return to Iran Nuclear Deal

Agreement could be completed as early as the next couple of days, officials say, but some differences remain

Any deal would likely need final signoff by the leaders of the countries involved: the U.S., the U.K., France, Germany, Russia, China and Iran. Among the most important unresolved issues is how many U.S. sanctions will be lifted, including those on the office of Iranian Supreme Leader Ayatollah Ali Khamenei and Iran's Revolutionary Guard Corps.

"The U.S. must prove its will to lift major sanctions," Iran's President Ebrahim Raisi said Monday.

U.S. and European officials have indicated that they want a deal by the end of February, because of advances in Iran's nuclear work. Western diplomats have warned they could leave the negotiating table in coming days if an agreement isn't within reach.

"The Iranian leadership now has a choice. This is the moment of truth," German Chancellor Olaf Scholz said Saturday at the Munich Security Conference.

....

U.S. Nears Return to Iran Nuclear Deal

Agreement could be completed as early as the next couple of days, officials say, but some differences remain

...

Iran has accrued nuclear expertise over the past two years, including its deployment of advanced centrifuges that can produce nuclear fuel more quickly, reducing its breakout time. That window could shrink further after 2026, when some of the nuclear deal's restrictions expire. Strict limits on the size of Iran's stockpile of nuclear fuel remain until 2031, and broad monitoring of its nuclear work will continue well beyond then.

Since the U.S. exit, Iran has massively expanded its nuclear work, including producing highly enriched uranium. It is currently within a few weeks of being able to amass enough nuclear fuel for a bomb, officials say.

The original pact wasn't put forward for congressional approval as a treaty. However, Republicans are pressing for an in-depth congressional review of any agreement that restores the deal. That could lead to a vote in the Senate, but it would require a two-thirds majority to override a presidential veto of a resolution of disapproval.

...

Iran would also have to downgrade several tons of enriched uranium, or send it abroad, and uninstall hundreds of advanced centrifuges from its nuclear sites. The United Nations atomic agency would have to parse through footage and other material from its nuclear-monitoring activities that Tehran hasn't given the agency access to over the last 12 months.

U.S. oil sanctions are likely to be fully lifted only once Iran has taken the steps needed to scale back its nuclear work, people close to the talks say. ... Iran has at least \$30 billion in oil revenue trapped overseas by sanctions, and receiving some of the trapped funds could trigger an exchange of Western and Iranian prisoners.

Reducing the Threat of Nuclear Terrorism

Video Presentation: Ground Zero

(from CBS Reports on The Defense of the United States, aired June-14-1981)

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, Nagasaki, Rotterdam 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).

Physics/Global Studies 280: Session 12

Plan for This Session

Questions about the course

News

The threat of nuclear terrorism

Video: Last Best Chance

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

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, has been 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.

Physics/Global Studies 280: Session 13

Plan for This Session

News

Nuclear Terrorism continued

PBS video on port scanner from Decision Sciences

Discussion

U.N. agency sees sharp increase in Iran's uranium stockpile, potentially reducing time needed to build nuclear bomb

By Joby Warrick

March 3, 2020 at 11:57 a.m. CST

Iran is dramatically ramping up production of enriched uranium in the wake of the Trump administration's decision to abandon the 2015 nuclear deal, the U.N. nuclear watchdog confirmed Tuesday in a report that also criticized Tehran for blocking access to suspected nuclear sites.

Inspectors from the International Atomic Energy Agency reported a near-tripling of Iran's stockpile of low-enriched uranium just since November, with total holdings more than three times the 300-kilogram limit set by the nuclear accord. Iran also substantially increased the number of machines it is using to enrich uranium, the agency said, allowing it to make more of the nuclear fuel faster.

The report is the first since Iran announced it would no longer adhere to any of the nuclear pact's restrictions on uranium fuel production, in a protest of the Trump administration's decision to walk away from the deal. Iran has declined to formally pull out of the agreement, known as the Joint Comprehensive Plan of Action, in which it agreed to sharply curtail its nuclear activities and submit to intrusive inspections in exchange for relief from economic sanctions.

U.N. agency sees sharp increase in Iran's uranium stockpile, potentially reducing time needed to build nuclear bomb

Inspectors confirmed that Iran now possesses more than 1,020 kilograms of low-enriched uranium — up from 372 kilograms in the fall. The additions to the stockpile theoretically could allow Iran to build a nuclear weapon more quickly if it decided to do so, although the IAEA found no evidence that Iran is taking specific steps toward nuclear weapons production. Iran's low-enriched uranium, the kind typically used in nuclear power plants, would have to undergo further processing to be converted to the highly enriched uranium needed for nuclear bombs.

In a rare step, the watchdog agency criticized Iran in a separate report for blocking its efforts to investigate claims of undisclosed nuclear activity at three sites in Iran. The agency sent letters demanding access to the sites, where Iran is suspected of storing equipment and other material used in past nuclear research.

After a 2019 visit to one of the sites, IAEA officials reported finding unexplained traces of enriched uranium. Inspectors have since observed Iran carrying out activities “consistent with efforts to sanitize” one of the locations, the agency said in the report.

U.N. agency sees sharp increase in Iran's uranium stockpile, potentially reducing time needed to build nuclear bomb

The facilities came to light after the release of a trove of stolen nuclear documents taken from inside Iran by Israeli operatives in 2018. The stolen records offered new insight into Iran's well-documented efforts to build nuclear weapons early in the last decade. Iranian scientists conducted extensive research on weapons components as part of a secret initiative dubbed Project 119 but shelved the effort after Iran's leaders ordered the program halted in 2003, U.S. officials say. Afterward, Iran focused instead on making nuclear fuel, building two large factories for making enriched uranium.

The 2015 Iran agreement was signed by the United States and five other world powers: Russia, China, Britain, France and Germany. In it, Iran agreed to sweeping restrictions on its nuclear activities, including limits on its uranium stockpile and curbs on the number of centrifuges — machines used to enrich uranium — that it could operate. Iran also agreed to remove and disable a nuclear reactor that U.S. officials feared could be used to make plutonium for nuclear bombs. Some of the restrictions were set to expire after 15 years.

Donald Trump ridiculed the Obama-era deal during his presidential campaign, calling it a “disaster” and the “worst deal ever.” Although Trump administration officials confirmed that Iran was honoring the terms of the agreement, the White House in 2018 said it was quitting the accord and re-imposing economic sanctions in an effort to force Iran to agree to even tougher limits. The other signatories have continued to honor the agreement, although Iran's recent defiance has spurred concerns that the deal will collapse, freeing Iran to further accelerate its nuclear program.

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.

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 2022*

A possible Scenario

- I) Select high profile symbolic target eg NATO summit (Chicago in May of 2012 with all NATO heads of state present)
- II) Smuggle fissile material and other weapon components illegally into the country.
- III) Rent nearby shop or house to setup nuclear device.

chicagotribune.com

Trial to begin of three charged with planning attacks at NATO summit

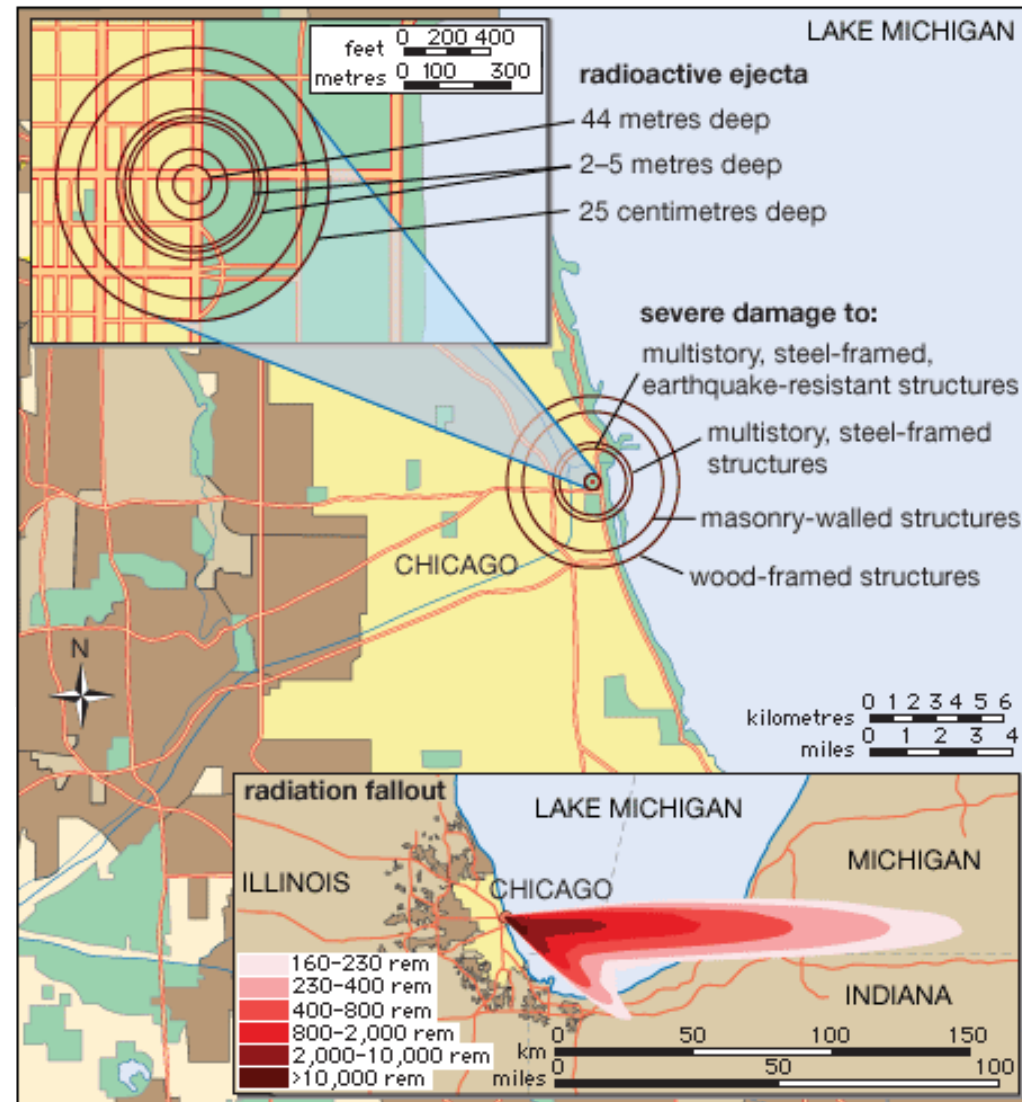
Mary Wisniewski

Reuters

7:31 AM CST, January 21, 2014

CHICAGO (Reuters) - Opening statements are due to begin on Tuesday in the trial of three men accused of plotting to attack high-profile targets, including President Barack Obama's re-election campaign headquarters, during the 2012 NATO summit in Chicago.

Brent Betterly, 25, Brian Church, 25, and Jared Chase, 29, are being prosecuted under an Illinois anti-terrorism law adopted after the September 11, 2001 al Qaeda attacks.



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In Pictorial Form ...



Physics/Global Studies 280: Session 13

Plan for This Session

Questions about the course

News

The threat of nuclear terrorism

Deadlines: RPPv2 – Tomorrow at 10pm

Putin Declares a Nuclear Alert, and Biden Seeks De-escalation

When the Russian leader ordered his nuclear forces into “special combat readiness,” the U.S. could have gone on high alert. Instead, the administration tried not to inflame him.

By David E. Sanger and William J. Broad

Feb. 27, 2022 Updated 9:02 p.m. ET

WASHINGTON — When Vladimir V. Putin declared Sunday that he was putting his nuclear forces into “special combat readiness” — a heightened alert status reminiscent of some of the most dangerous moments of the Cold War — President Biden and his aides had a choice.

They could match the move and put American forces on Defcon 3 — known to moviegoers as that moment when the Air Force rolls out bombers, and nuclear silos and submarines are put on high alert. Or the president could largely ignore it, sending out aides to portray Mr. Putin as once again manufacturing a menace, threatening Armageddon for a war he started without provocation.

For now, at least, Mr. Biden chose to de-escalate. The American ambassador to the United Nations reminded the Security Council on Sunday afternoon that Russia was “under no threat” and chided Mr. Putin for “another escalatory and unnecessary step that threatens us all.” The White House made it clear that America’s own alert status had not changed.

But to many in the administration, who spoke on Sunday on the condition of anonymity, it was a stark reminder of how quickly the Ukraine crisis could spin into a direct superpower confrontation — and how it may yet do so, as Mr. Putin tests how far he can go and threatens to use the ultimate weapon to get there.

Matthew Kroenig, a professor of government and foreign service at Georgetown University who specializes in atomic strategy, said history bristled with cases in which nuclear powers had threatened to unleash their arsenals on one another. He pointed to the Berlin crisis of the late 1950s, the Cuban missile crisis of 1962, a border war between the Soviet Union and China in 1969, the Arab-Israeli war of 1973, and a war between India and Pakistan in 1999.

Mr. Putin's outburst reminded many nuclear experts of one of Mr. Trump's tweets, in which he noted: "North Korean Leader Kim Jong Un just stated that the 'Nuclear Button is on his desk at all times.' Will someone from his depleted and food starved regime please inform him that I too have a Nuclear Button, but it is a much bigger & more powerful one than his, and my Button works!"

Mr. Trump later insisted that the threat was calculated, and that it had brought Mr. Kim to the negotiating table for a series of three high-profile meetings between the two leaders. But the talks collapsed, and Mr. Kim's nuclear stockpile is now significantly larger, by most unclassified estimates, than it was before Mr. Trump issued the threat.

"Nuclear-armed states can't fight nuclear wars because it would risk their extinction, but they can and do threaten it," Dr. Kroenig noted on Sunday. "They play games of nuclear chicken, of raising the risk of war in hopes that the other side will back down and say, 'Geez, this isn't worth fighting a nuclear war over.'"

Mr. Kristensen of the Federation of American Scientists said the threats could be empty unless matched with evidence that nuclear weapons are being removed from storage and prepared for action.

"Unless we see that kind of thing," Mr. Kristensen said, "it's rhetoric — it's madman brinkmanship."

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 Security's 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 many 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 —

- Designing high explosive lenses
- Machining and assembling precision 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

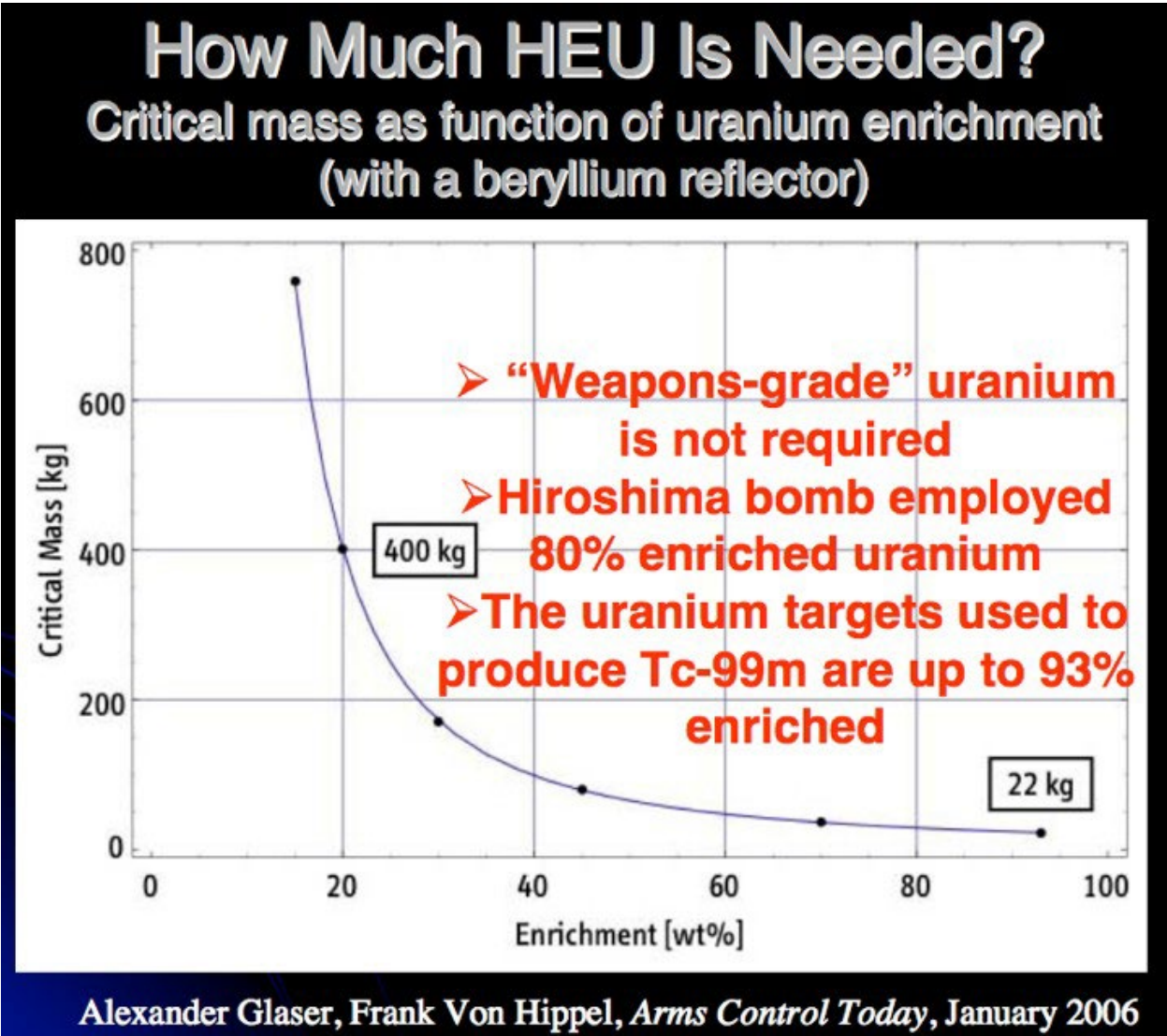
Terrorists would be aided by the fact that they would not need to meet military requirements.

The key barrier for terrorists is acquiring enough HEU.

The Threat of Nuclear Terrorism

Insecure Nuclear Explosive Materials

The Problem of Dual Use of Highly Enriched Uranium



HEU is also used in civilian applications: research reactors, medical isotope production.

It is challenging to protect HEU in civilian facilities from theft or from secret transfer of HEU to a clandestine weapons program.

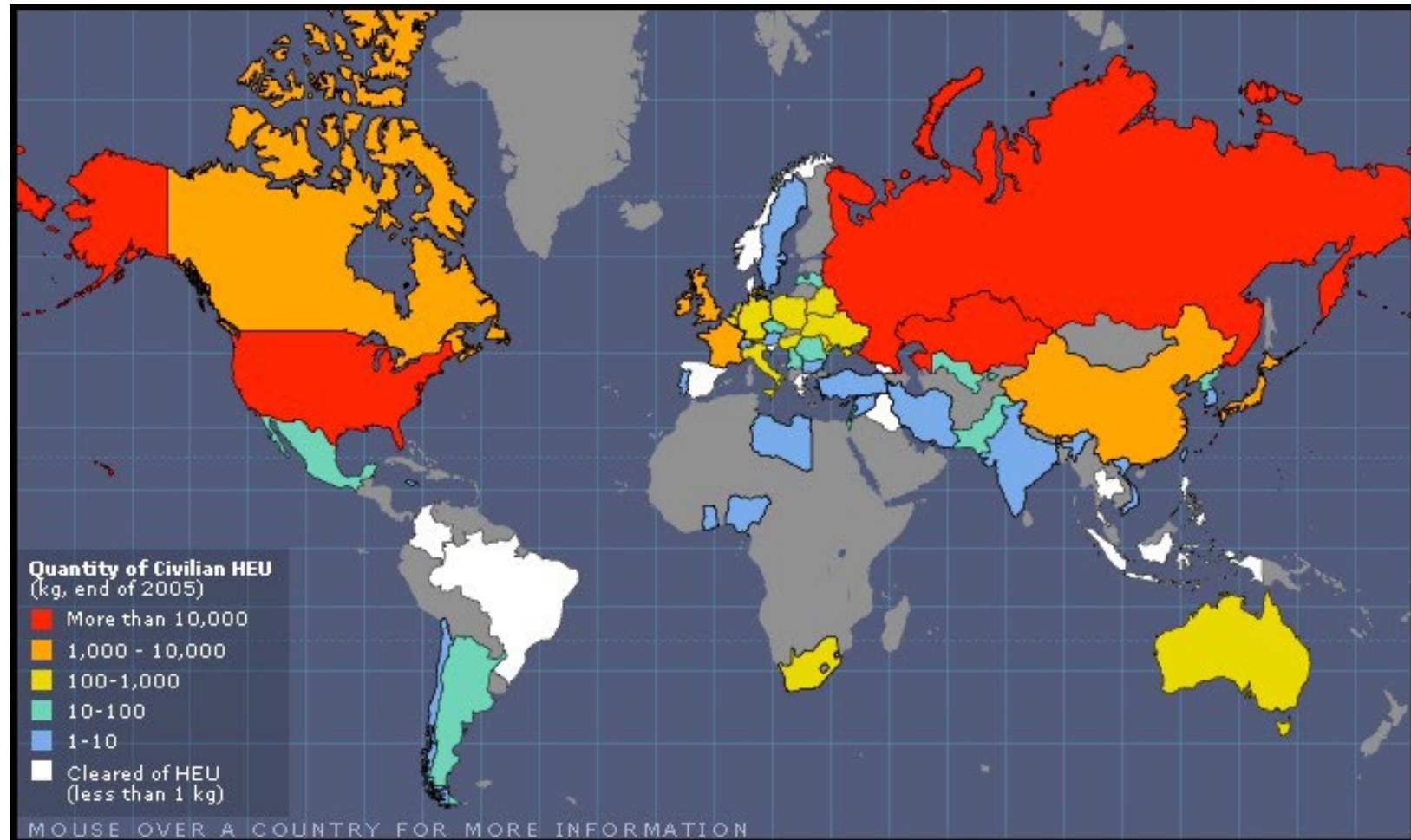
Availability of Uranium from “Atoms for Peace”

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).
- In addition there are important medical applications for isotopes that require HEU for their production.

Availability of Highly Enriched Uranium

Effect of “Atoms for Peace”



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

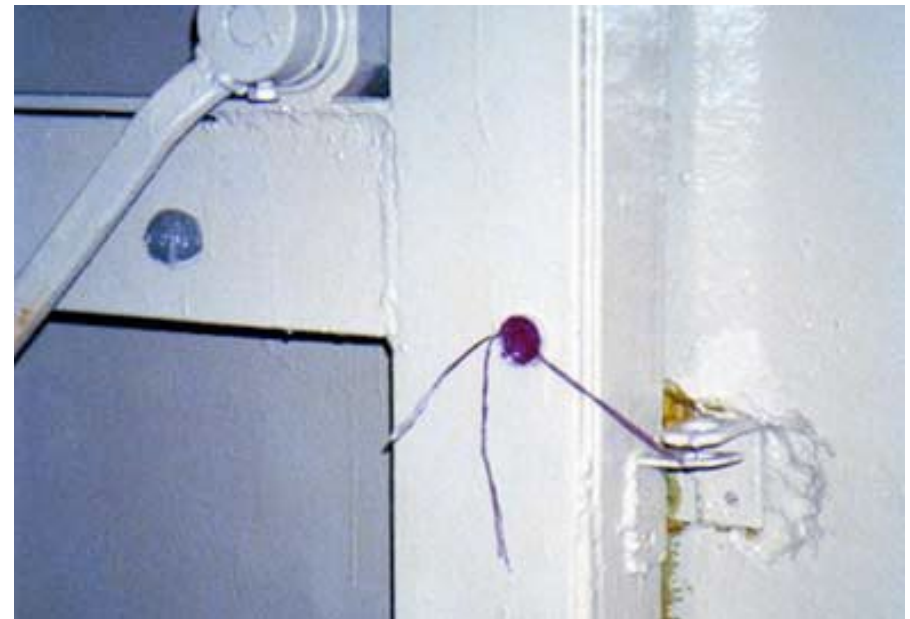


In 1994, Building 116 at the Kurchatov Institute in Moscow had enough HEU for a bomb at its research reactor, but had an overgrown fence and no intrusion detectors or alarms, an example of the poor state of security at many nuclear facilities after the collapse of the Soviet Union.

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), collects Pu, HEU and converts 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 —

About 15 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 naturally contain radioactive isotopes and 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

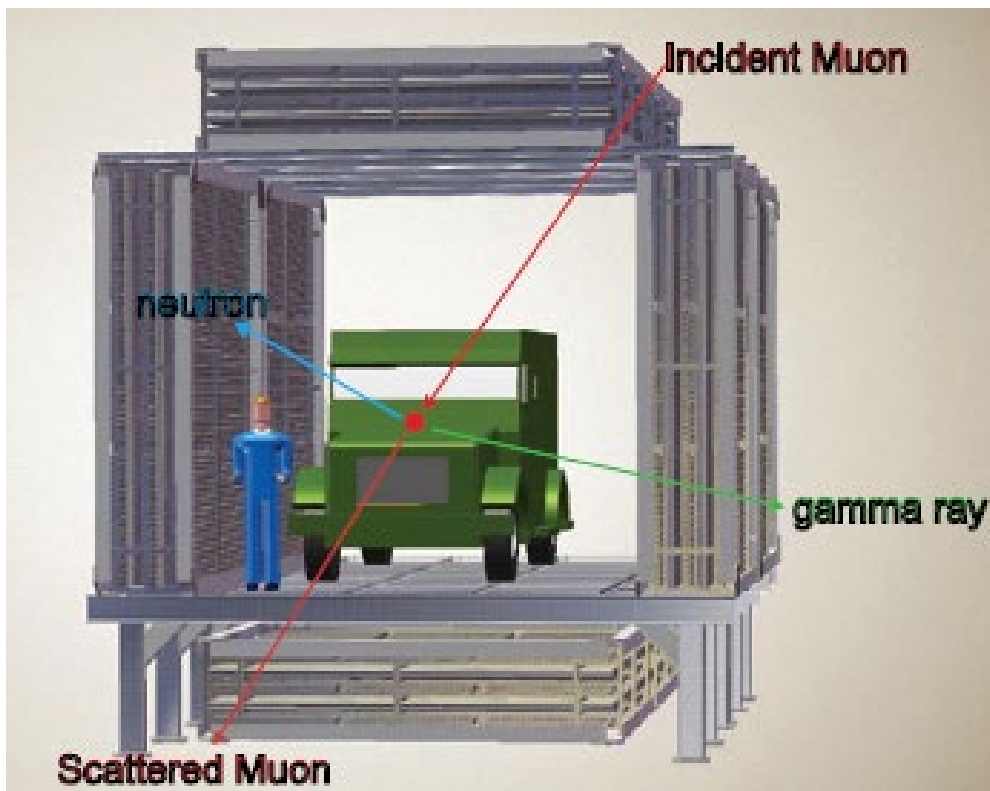
Port Scanners: Avoiding False Positive Alarms Passive Muon Tomography

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

UIUC NPRE graduate student Aric Tate has started thesis project related to Port scanners based on cosmic rays!



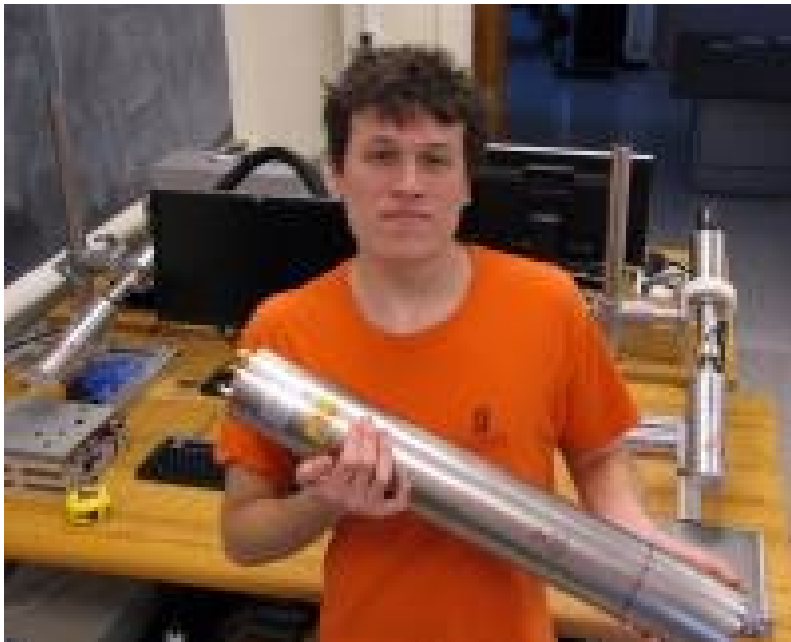
Intercepting Nuclear Weapons and Materials

Research on active interrogation for NEM using neutrons

Example:

Brent Heuser, Ling Jian Meng at NPRE

**“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

Reducing the Threat of Nuclear Terrorism

Identifying the Sources of Dangerous Nuclear Materials (Nuclear Forensics)

Nuclear Forensics Definitions

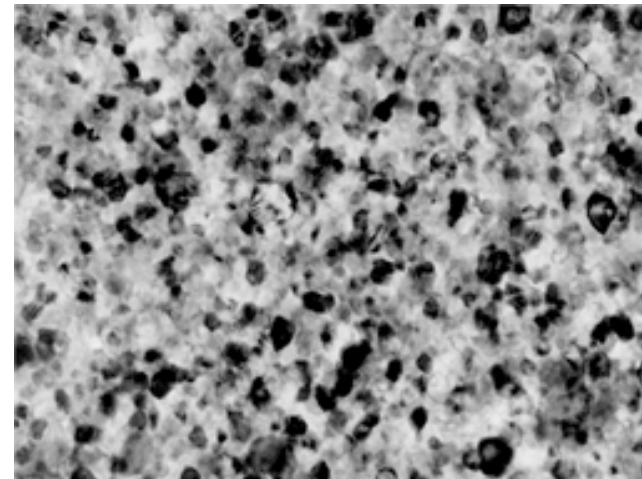
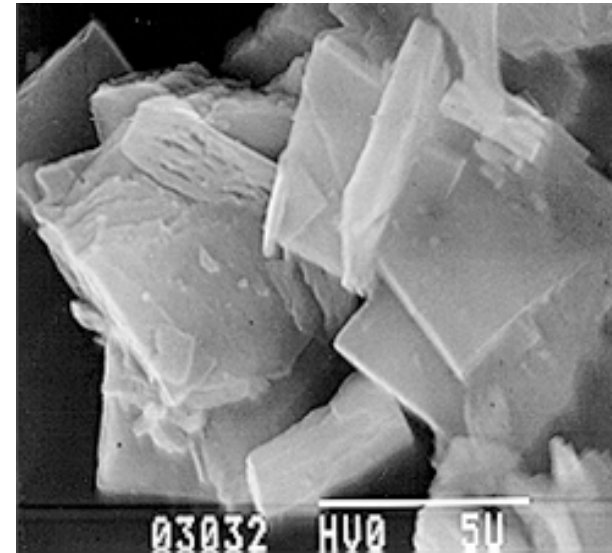
Nuclear Attribution is the process of identifying the source of nuclear or radioactive material used in illegal activities, to determine the point of origin and routes of transit involving such material, and ultimately to contribute to the prosecution of those responsible.

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

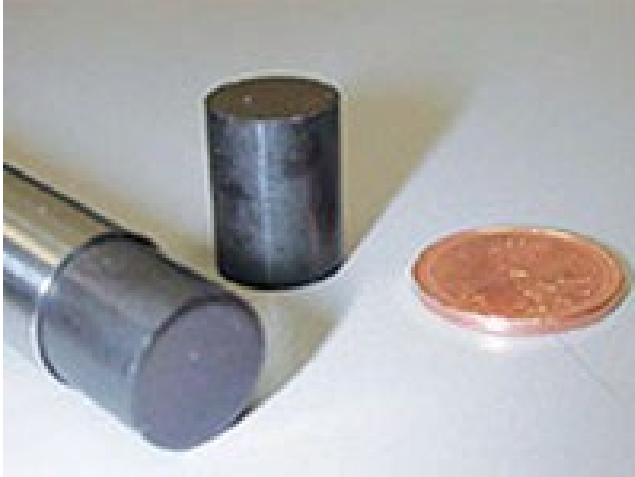
Electron Microscopy and Spectroscopy

- 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

22p280 Nuclear Terrorism, p. 63

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 —

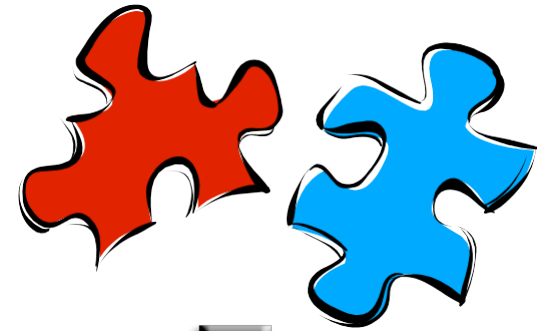
- As a radiological sample gets “older,” the parent isotope disintegrates and its daughter nuclides accumulate.
- Knowledge of the age helps an analyst identify when the material was produced.

$^{18}\text{O}/^{16}\text{O}$ Ratio —

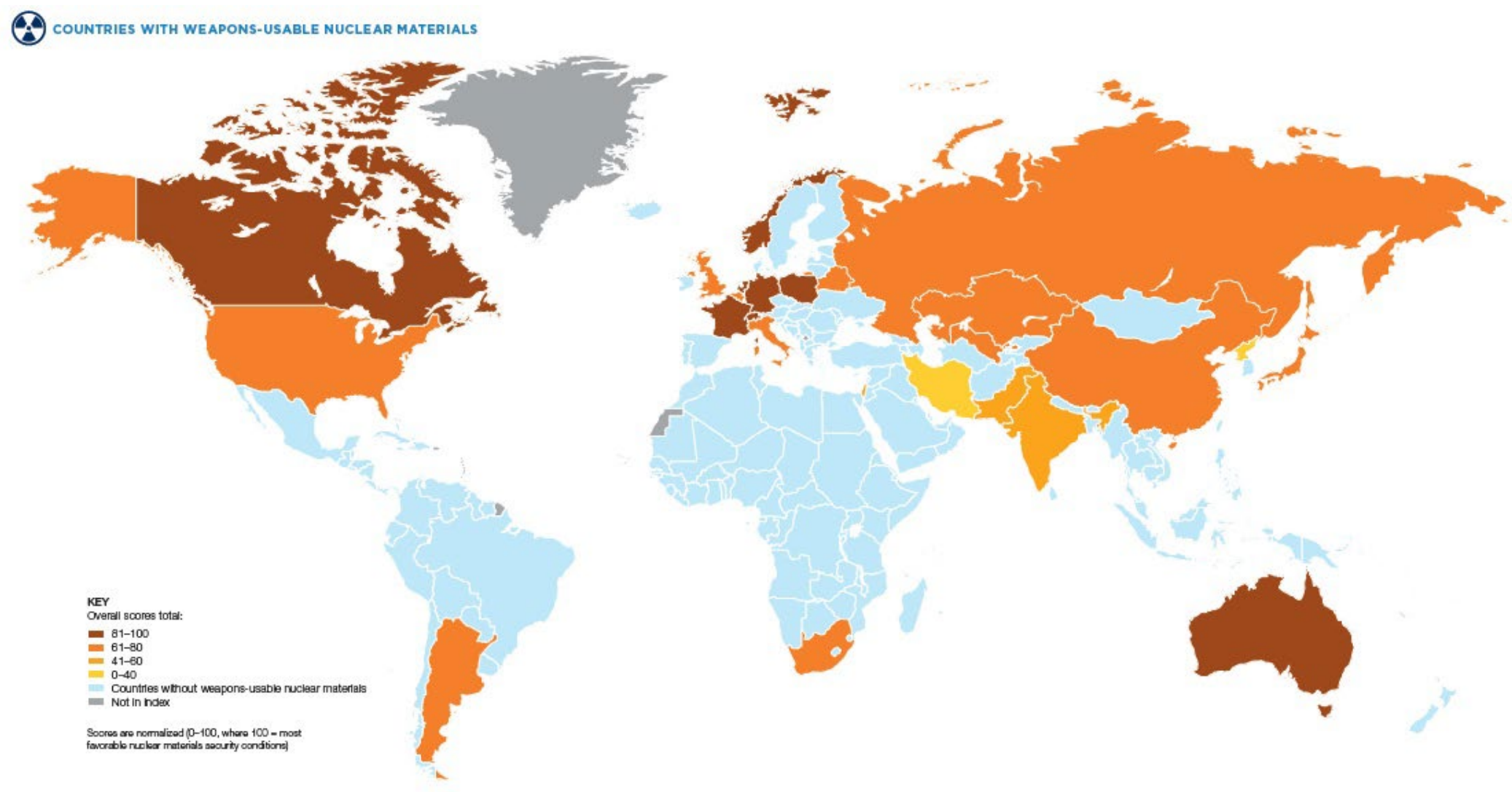
- Certain ratios are observed in rainwater, and these “variations up to 5 percent...depend upon average temperature, average distance from the ocean, and the latitude” (Mayer).
- By these means, an analyst can identify the former geolocation of the material.

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



(Old) News: A Grand Uranium Bargain

By Thomas L. Neff

The Soviet Government is struggling to transform itself economically and politically while maintaining control of more than 24,000 nuclear weapons in the newly independent republics. Mikhail Gorbachev has pledged to dismantle thousands of them, but the bankrupt Government may not be able to pay for doing so in ways that prevent misuse or wider proliferation. There is, however, a way to pay for disarmament that also provides economic motivation to the republics and the central Government.

The warheads contain substantial amounts of valuable material that can be processed for use in commercial nuclear power plants. It may be advantageous for the U.S. to buy or barter for such materials and turn them safely to commercial use. This can be done in ways that protect Western and Soviet commercial and security interests.

Dr. Thomas Neff from the Center of International Studies at Harvard proposed for the US to buy Soviet area weapons material diluted from HEU to LEU at market prices for use in US nuclear power reactors. See Neff's Op-Ed in the NY-Times of 10-24-1991.

- o funds Soviet effort to control > 24,000 nuclear weapons in the newly independent republics.
- o stabilizes western market for LEU reactor fuel.
- o prevents HEU from Soviet stocks to be deviated into black market channels.
- o addresses demands from non-nuclear weapons states in the NPT that superpowers reduce arsenals!
- o commercial value of 500 tons of HEU in 1991 is about \$5 Billion.

The Highly Enriched Uranium Purchase Agreement → the Megatons to Megawatts Program !

- o October-24 1991 Neff's proposal as Op-Ed in the NY-Times
- o August-28 1992 US-Russian negotiations in Moscow start
- o August-31 1992 President George W. Bush announces agreement
- o February-18 1993 20 year US-Russian agreement signed by President Bill Clinton
- o January-14 1994 Commercial contract between United States Enrichment Corporation (USEC) and Technabexport (TENEX) a commercial subsidiary Russia's Ministry for Atomic Energy signed: HEU-LEU contract.
- o 1994 to 2013 500 tons of former Soviet weapons HEU diluted to LEU and used as fuel in US civilian nuclear reactors produced up to 10% of US electricity needs.

The Highly Enriched Uranium Purchase Agreement → the Megatons to Megawatts Program !

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HEU-LEU fuel storage containers



- o largest scale non-proliferation effort to date.
- o prevented HEU from Soviet stocks to be deviated into black market channels.
- o partially addressed demands from non-nuclear weapons states in the NPT that superpowers reduce arsenals.
- o bi-partisan support in the US across Bush-Clinton-Bush-Obama administrations.

Securing Vulnerable Nuclear Materials

2004 National Nuclear Security Administration (NNSA) establishes Global Threat Reduction Initiative (GTRI)

→ identify, secure, remove and/or facilitate the **disposition of high risk vulnerable nuclear and radiological materials** around the world that pose a threat to the United States and the international community.

Three initiatives are:

Convert: **Convert or shutdown research reactors and isotope production facilities** from the use of highly enriched uranium (**HEU**) to low enriched uranium (**LEU**).

Remove: Remove or confirm the **disposition of excess nuclear and radiological materials**.

Protect: Protect high priority nuclear and radiological materials from theft.

GTRI Conversions 2004 – 2014

- (1) Successfully **converted to LEU fuel or verified the shutdown of 49 HEU research reactors in 25 countries**: Argentina, Australia, Bulgaria, Canada, Chile, China, the Czech Republic, France, Germany, Hungary, India, Japan, Kazakhstan, Libya, the Netherlands, Portugal, Poland, Russia, Ukraine, the United Kingdom, United States, Uzbekistan, and Vietnam.
- (2) Verified the **cessation of the use of HEU targets for isotope production in Indonesia**.
- (3) Accelerated the **establishment of a reliable supply of the medical isotope molybdenum-99 (Mo-99) produced without HEU** by establishing partnerships with South Africa, Belgium, and the Netherlands to convert Mo-99 production from HEU targets to LEU targets, and with four domestic commercial entities to produce Mo-99 in the United States with non-HEU technologies.

GTRI Removal Since 2004 - 2014

- (1) Removed or confirmed the disposition of more than 4,100 kilograms of HEU and plutonium (more than enough material for 165 nuclear weapons).**
- (2) Removed all weapons-usable HEU from 16 countries and Taiwan, including: Greece (December 2005), South Korea (September 2007), Latvia (May 2008), Bulgaria (August 2008), Portugal (August 2008), Romania (June 2009), Taiwan (September 2009), Libya (December 2009), Turkey (January 2010), Chile (March 2010), Serbia (December 2010), Mexico (March 2012), Ukraine (March 2012), Austria (December 2012), and Czech Republic (April 2013).**
- (3) Removed more than 36,000 disused and unwanted radiological sources from sites across the United States.**

GTRI Protection 2004 - 2014

- (1) **Completed physical protection upgrades at more than 1,700 buildings in the United States and internationally** with high-activity radiological sources;
- (2) Provided **Alarm Response Training to more than 3,000 site security, local law enforcement officers and other first responders** from across the country on responding to a potential incident involving radiological material.

Countries that have given up all HEU

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 6.3 kilograms of U.S.-origin HEU spent fuel. HEU was returned August 2011.

This Remains a Challenging Process

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.

Reducing the Threat of Nuclear Terrorism

What We Need To Do

What We Need to Do (Important)

In the September/October 2006 issue of the Bulletin of the Atomic Scientists, Harvard University professor **Graham Allison** discusses a “**nuclear 9/11**” and concludes that “**a nuclear terrorist attack on the United States is more likely than not in the decade ahead.**”

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

To accomplish this, he formulates the doctrine of “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 two decades, but other countries—such as Pakistan, North Korea and India — 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

Reducing the Threat of Nuclear Terrorism

Video: “Last Best Chance”

2005, Nuclear Threat Initiative (NTI)

Reducing the Threat of Nuclear Terrorism

Discussion of “Last Best Chance”