

# **Science in the Public Interest:**

*The American Association for the Advancement of Science  
Science and Engineering Fellowships*

*Dr. Jerry Gilfoyle*

*Physics Department, University of Richmond, Virginia*

*Defense Policy Fellow, 1999-2000*

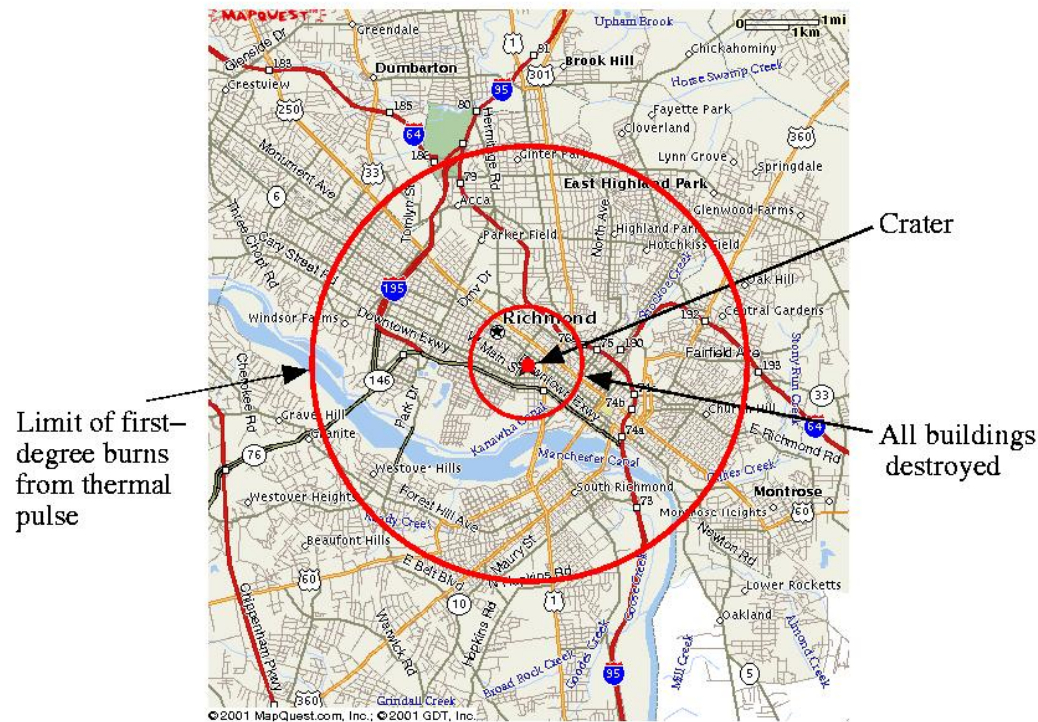
- Outline:
1. The AAAS Fellowship program
  2. How did I get here and what am I doing?
  3. Enhancing nuclear weapons material security in Russia.
  4. The Comprehensive Test Ban Treaty.
  5. Other projects and conclusions.

## How did I get here and what am I doing?

- Science and Engineering Fellowships of the American Association for the Advancement of Science (AAAS).
  - Applied to seven Fellowship programs.
  - Interviewed for a Defense Policy Fellowship and then ‘matched’ to an office in the Department of Defense (DOD).
- Defense Policy Fellowship
  - Worked in DOD in the Advanced Systems and Concepts Office (ASCO), a small think tank within the Defense Threat Reduction Agency (DTRA).
  - Performed an internal study to enhance fissile material (*i.e.* nuclear-weapons-grade materials) security in Russia.
  - Provided oversight for a net assessment of the Comprehensive Test Ban Treaty.
  - Managed other studies of the successes, failures, and the future of international efforts at threat reduction.

# Nuclear Weapons 101

- A nuclear explosion releases huge amounts of energy. The picture below illustrates the effect of a 20 kiloton blast (about the size of the bomb used at Nagasaki) dropped at 907 Floyd Avenue.



- The energy is emitted as heat, radiation, and blast. The dot in the center is the size of the crater. The first circle is the limit where essentially all buildings will be destroyed. The outer circle is the limit where the heat and radiation can cause first-degree burns.

## Fissile Material Security in Russia Declines

- The economic situation in Russia left few funds for maintaining the security of now-unused nuclear materials.
- Reports by the National Research Council (1994, 1997, 1999) and a DOE Russia Task Force (January, 2001) revealed the extent of the decline of security.
- There have been numerous instances of smugglers apprehended with nuclear materials.
  - In late 1998 the Russian FSB (successor to the KGB) reports stopping an attempt to steal 18.5 kg of weapons-usable material.
  - In January, 2000 four Russian sailors are arrested by the FSB with radioactive materials stolen from the armored safe of a nuclear submarine.



Building at the Kurchatov Institute housing HEU with no motion sensors, detectors, or portal monitors.

## Why should you care?

- The US and most other nations have a long-standing policy of nuclear nonproliferation.
- A nuclear blast would have devastating consequences; loss of life, property, and security.
- Even acquisition of a nuclear weapon by an adversary could have a devastating influence on US security and non-proliferation.
- **One of the highest hurdles to obtaining a nuclear weapon is acquiring enough weapons-grade, fissile material to produce a nuclear bomb.** Iraq spent \$5-\$10 billion in the 1980's to produce a few grams of plutonium.
- Smuggling fissile material is a 'short-cut' to acquiring nuclear weapons; it lowers the acquisition hurdle.
- Prevention (*i.e.*, security) is critical especially against an 'insider' threat.

## What are the technical challenges (and possible solutions)?

- The US is spending about \$700 million a year to improve security, accounting, export controls, re-training weapons scientists, and destroying missiles and submarines.
- Challenge #1: Highly-enriched uranium (HEU) is not very radioactive (*i.e.*, it's easy to hide and smuggle).

*Add a detection tag ( $^{232}\text{U}$ ) to the HEU which will emit penetrating gamma-ray radiation and set off portal monitors.*

- Challenge#2: If stolen material is recovered, it is difficult to identify the source.

*Add an attribution tag to HEU (use  $^{233}\text{U}$ ) and to plutonium ( $^{244}\text{Pu}$ ).  
The proportion of the tag will identify a particular storage site.*

- Creating the tags would be hugely expensive. WE ALREADY HAVE THEM!! - leftovers from nuclear engineering and weapons research.
- Processing Russian fissile material would also cost billions. WE'VE ALREADY STARTED!! - the HEU Purchase Agreement and the Fissile Material Storage Facility.

## **A Net Assessment of the Comprehensive Test Ban Treaty (CTBT)**

- The CTBT is an international treaty signed by 160 nations and ratified by 76 forbidding any nuclear explosion for peaceful or military use.
  - It is a major component of the Non-Proliferation Treaty (NPT) which has the goal of eliminating nuclear weapons.
  - An international network of seismic, acoustic, hydro-acoustic, and radionuclide detectors scans for evidence of nuclear explosions.
  - On-site inspections can be made of suspicious locations.
- The treaty was submitted to the US Senate in fall, 1999 and rejected in a vote along largely party lines.
- The following spring President Clinton commissioned General John Shalikashvili (ret.), former head of the Joint Chiefs of Staff to evaluate the treaty.

## **A Net Assessment of the Comprehensive Test Ban Treaty (CTBT)**

- ASCO performed a net assessment (with contractor help) of the CTBT to address the following questions.
  - What types of weapons could be produced without testing?
  - How sensitive is the detection network?
  - How could nuclear explosions be hidden?
  - What knowledge could be obtained from surreptitious tests?
- Final report was sent to President Clinton in January, 2001 and featured in a front-page article in the New York Times on January 5, 2001.
- The impact of the report remains to be seen. President Bush has voiced his opposition to the treaty, but it retains support among our allies, many in Congress, and others.



## Other Projects and Conclusions

- Investigating the future of cooperative threat reduction.
- Assessing preventive threat reduction.
- Science and technology review of DTRA R&D.
- Conclusions
  - Government is in dire need of technical and scientific expertise.
  - The research tends to be broader than traditional physics research, but is not as ‘deep’ (don’t take this to mean it’s lower quality, easier, less important, *etc*).
  - The work and the issues you confront are important societal ones.
  - Uses your scientific training to contribute to improving society.
  - The AAAS Fellowships open many doors.