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BLACK DAWN BRIEFING

Background Papers

AL QAEDA'S INTEREST IN WMD

Information

MOTIVATIONS AND THREATS

The leader of al Qaeda, Osama bin Laden, has stated that the terrorist group's principal goal is to free Mecca and the Arabian peninsula from both foreign unbelievers and the house of Al–Saud and to "re-establish" the Muslim state.[1]

Al Qaeda's ire is directed not only at America but at its allies. A fatwa issued by bin Laden on February 23, 1998, stated: "The ruling to kill Americans and their allies, civilian and military, is an individual duty for every Muslim who can do it in any country in which it is possible to do it, in order to liberate the holy mosque (Mecca) from their grip and in order for their armies to move out of all the lands of Islam, defeated and unable to threaten any Muslim."[2]

On May 26, 1998, al Qaeda distributed a statement on a card calling all Muslims to attack Jews and Christians: "Divide their nations, tear them to shreds, destroy their economy, burn their companies, ruin their welfare, sink their ships, and kill them on land, sea and air."[3]

The war in Afghanistan to dismantle al Qaeda and deny it sanctuary has resulted not only in the fracturing of the organization but also in the strengthening of sleeper cells and offshoots. Today, al Qaeda has transformed into a global network of like minded groups that share its radical Islamist ideology, beliefs, and principles. Recent attacks in Spain, Turkey, Indonesia, Saudi Arabia, Russia, and Iraq demonstrate the viability and lethality of these splinter groups worldwide.

EUROPEAN PRESENCE

A strong, persistent al Qaeda presence in Europe remains cause for concern. Evidence includes the Hamburg cell that provided logistical support and residency to several of the 9/11 hijackers, multiple foiled plots to bomb key targets in Europe, continued al Qaeda "chatter" that led to the cancellation of international flights during late 2003, the devastating attacks in Madrid in March 2004, and numerous arrests of senior al Qaeda members in Italy,

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[1] Rohan Gunaratna, *Inside Al Qaeda: Global Network of Terror* (The Berkley Publishing Group, 2002).
[2] Ibid.
[3] Ibid.

Germany, and Britain since 9/11. Al Qaeda is believed to have cells in virtually every country on the continent, UK, and Ireland.

The influx of Muslim immigrants into Europe could assist al Qaeda's recruiting efforts. More than 30,000 Muslims living in Germany could be classified as Islamic extremists, with 4,000 living in Berlin alone.[4] Sizeable Muslim populations in other countries also could provide fruitful recruiting grounds for al Qaeda and other Islamist extremist groups.

WEAPONS OF MASS DESTRUCTION

Bin Laden has stated that it is a "religious duty" to seek weapons of mass destruction, including chemical, biological, radiological, and nuclear technology and warheads.[5] Recently, well-known Saudi cleric Sheik Nasser bin Hamd al-Fahad issued a religious edict granting legal legitimacy to the use of weapons of mass destruction against the United States and Britain and against their citizens. Sheik Nasser bin Hamd al-Fahad is associated with bin Laden's al Qaeda organization.[6]

In a May 2003 report, CIA analysts assessed a high probability of a chemical, biological, radiological, or nuclear attack within the next two years. The assessment states that the attack would probably be small scale, "incorporating relatively crude delivery means and easily produced or obtained chemicals, toxins, or radiological substances."[7]

Although it is difficult to point to physical evidence of al Qaeda's chemical or biological weapons capability, several hints suggest that al Qaeda has produced small amounts of some type of agent. A 10-volume Encyclopedia of Afghanistan Resistance, found while coalition forces were inspecting a camp close to Jalalabad, contains precise formulas for manufacturing toxins, botullinum, and ricin. The document also instructs would-be perpetrators in methods of disseminating the deadly materials.[8]

In addition, an al Qaeda videotape discovered in 2002 documents experiments involving dogs exposed to vapors from a "white liquid." In the

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[4] The Berlin Office for the protection of the Constitution, Annual Report 2002.

[5] CIA Director George Tenet, Testimony before Senate Select Committee on Intelligence, February 6, 2002.

[6] "Saudi Cleric Issues Fatwah on the Use of Weapons of Mass Destruction," Yoni Fighel and Moshe Marzouk, International Policy Institute for Counter-Terrorism, 05 July 2003. http://www.ict.org.il/articles/articledet.cfm?articleid=491

[7] "Al Qaeda and the Bomb," *Jane's Intelligence Digest*, 03 July 2003.

[8] "Assessing Al Qaeda's WMD Capabilities," Jack Boureston, *Strategic Insights*, Volume I, Issue 7 (September 2002).

tape, the dogs struggle, vomit, have trouble breathing and finally die. Some experts speculate that the gas was a nerve agent such as sarin.[9]

Another hint of al Qaeda's chemical weapons capability comes from Ahmed Ressam, an Algerian man accused of planning to bomb the Los Angeles airport. Ressam testified that al Qaeda taught him to poison people by putting toxins on doorknobs, and that he engaged in experiments in which dogs were injected with a mixture containing cyanide and sulphuric acid.[10]

Jose Padilla, a U.S. citizen also known as Abdullah al Mujahir, was captured May 8, 2002, when he flew into Chicago's O'Hare International Airport from Pakistan. According to Deputy Secretary of Defense, Paul Wolfowitz, "Padilla met with senior al Qaeda members to discuss plans for exploding a radioactive dispersal device, what is commonly called a 'dirty bomb,'[11] in the United States. He researched nuclear weapons and received training on wiring explosives while in Pakistan. He was instructed to return to the United States to conduct reconnaissance operations for al Qaeda."[12]

Documents found in a safe house of an al Qaeda member arrested in Afghanistan indicated al Qaeda's interest in developing nuclear weapons. After analyzing some of the documents, an expert stated that in over 25 neatly hand-written pages, the author discusses various types of nuclear weapons, the physics of nuclear explosions, properties of nuclear materials needed to make them, and the effects of nuclear weapons.[13]

Al Qaeda's attempts to acquire nuclear devices and materials date back to 1994, when an operative testified going to a meeting to purchase what he thought was "enriched" uranium.[14] In 1998, an al Qaeda operative was captured in Germany while attempting to purchase what he also thought would be "enriched" uranium.[15] Between 1998 and 2001, Sultan Bashiruddin Mahmoud of Pakistan's Atomic Energy Agency met with bin Laden several times to discuss nuclear weapons and dirty bombs. In the late 1990s, there were unconfirmed reports that the Russian mafia was offering to sell weapons and material obtained from facilities in the former Soviet Union to al Qaeda members.[16] Although there is not yet evidence al Qaeda has

[9] "Al Qaeda Videos Seem to Show Chemical Tests," by Judith Miller, *The New York Times*, 19 August 2002.
[10] "Al Qaeda video tapes obtained by CNN," CNN, 19 August 2002.
[11] Federation of American Scientists
[12] http://www.defenselink.mil/news/Jun2002/n06102002_200206103.html
[13] David Albright, "Al Qaeda's Nuclear Program: Through the Window of Seized documents," Policy Forum Online, November 16, 2002
[14] Testimony of Prosecution Witness Jamal Ahmad Al-Fadl," U.S. District Court, United States v. Usama Bin Laden et. Al., Defendants, 7 February 2001.
[15] "U.S. Says Bin Laden Aide Tried to Get Nuclear Weapons," New York Times, 26 September 1998.
[16] Report Links Bin-Lanin, Nuclear Weapons," Al-Watan Al-Arabi, 13 November 1998

acquired nuclear materials, the possibility cannot be ruled out given the 500 illicit nuclear or radiological material trafficking incidents confirmed in over 40 countries since 1993.[17]

Assessment

Based on the fact that al Qaeda operatives have researched and written about WMD and have attempted to obtain related material, U.S. analysts believe "it is therefore theoretically possible that al Qaeda could develop a nuclear explosive device, provided it overcame important challenges. First, it must obtain the fissile material needed for the core of the device. After achieving this step, it must then gain access to the nuclear expertise needed to create a design compatible with the acquired fissile material. Finally, the group would need to find a way to test the device to ensure its success, although al Qaeda may determine that this final step is not necessary."[18] None of these challenges is insurmountable.

Al Qaeda's strong presence in Europe combined with multiple symbolic targets, such as U.S. military and NATO installations, close to major population centers renders plausible a WMD terrorist attack in Europe.

[17] Illicit Nuclear Trafficking Statistics, January 1993 – December 2003, http://www.iaea.org/NewsCenter/Features/RadSources/Fact_Figures.html

[18] Jack Boureston and Charles Mahaffey, "Al-Qaeda and Mass Casualty Terrorism: Assessing the Threat", Strategic Insights, Volume II, Issue 10 (October 2003)

HEU RESEARCH REACTORS WORLDWIDE

Information

SCOPE OF LOCATIONS AND MATERIALS

There are more than 140 HEU-fueled research reactors in more than 40 countries.[1] This translates into approximately 20 metric tons of weapons-grade equivalent HEU in the research reactor fuel cycle worldwide—enough to make hundreds of nuclear weapons. HEU research reactors are located at approximately 50 reactor sites throughout Western and Eastern Europe.[2] Even reactors that have been decommissioned or converted to low-enriched uranium fuel may have HEU in on-site storage.[3]

There are also many research reactors in the former Soviet Union. This includes operational HEU research reactors in Russia, Kazakhstan, and Uzbekistan, and HEU in storage at reactor sites in Ukraine and Belarus.[4] In Georgia, HEU was removed from two locations, in one case by theft of up to 2 kg of 90% enriched uranium and in the other by a U.S.-funded clean-out program.[5]

SUITABILITY OF HEU FOR TERRORIST PURPOSES

HEU is easier to make into an improvised nuclear device (IND) than plutonium. While a plutonium IND would require a technically complicated implosion design, HEU can be used in a "gun-type" design, the blueprints for which are widely published. Even if a gun-type IND was poorly designed or detonated, a fractional yield could still be as high as the equivalent of tens or

[1] "Research Reactors & Security: IAEA Promotes Research Reactor Safety," IAEA Staff Report, 8 March 2004, http://www.iaea.org/NewsCenter/Features/ResearchReactors/security20040308.html; Matt Bunn, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, Nuclear Threat Initiative, March 2003, http://www.nti.org/cnwm.

[2] "Foreign Research Reactors in the EIS, Aluminum-based and TRIGA Spent Nuclear Fuel Containing Enriched Uranium of United States Origin," RERTR Website, http://www.td.anl.gov/Programs/RERTR/FRRSNF/EISREACT.html.

[3] Pablo Adelfang and Iain G. Ritchie, "Overview of the Status of Research Reactors Worldwide," presented at the 2003 RERTR Meeting, Chicago, Illinois, USA, 5-10 October 2003, RERTR Website, http://www.td.anl.gov/Programs/RERTR/.

[4] "Russian Research Reactor Fuel Return," NNSA website, U.S. Department of Energy, http://www.nnsa.doe.gov/na-20/rrrfr.shtml; Matt Bunn, "Converting Research Reactors," in *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan*, Nuclear Threat Initiative, March 2003, http://www.nti.org/e_research/cnwm/securing/convert.asp.

[5] Matt Bunn, "Converting Research Reactors," *NTI Website*, http://www.nti.org/e_research/cnwm/securing/convert.asp

even hundreds of tons of TNT. In addition, while plutonium typically has a high radioactive signature, unirradiated uranium has a very small signature.

VULNERABILITY OF RESEARCH REACTORS

HEU research reactors are more vulnerable to theft or diversion than other nuclear facilities. Civilian research reactors are located at university and other research facilities, where security is often low and many people cycle through in a given day. This also causes a higher risk of insider threat, since there is less chance of the insider being caught.[6] In addition, personnel tend to be poorly paid in some countries, further raising the possibility of insiders diverting or stealing material for financial gain.

Fuel needs to be loaded into research reactors more often than power reactors. This means that weapons-usable fuel is loaded into the reactor and spent fuel taken out. Spent fuel from research reactors is still highly enriched. Since much spent fuel worldwide has been cooling for decades, there is a significant quantity now in storage at research reactor sites that is no longer radioactive enough to deter theft and often contains enough residual enrichment to make it usable in an IND.

In addition, fuel elements for research reactors are smaller than for power reactors. They are only about 1 meter long and weigh up to 20 kilograms. They can be disassembled and moved by one person if properly shielded.[7]

Some diversion vulnerabilities also arise during the process of converting to LEU or shutting down a research reactor. In the case of converting a research reactor to a lower-enriched fuel, the HEU is taken out of the reactor and continues to be stored at the site until such time as a fuel return arrangement is implemented. This is true in Swierk, Poland, one of the Eastern European reactors that has converted to 36% enriched uranium, but still houses significant spent fuel.

HEU remains on-site at many research reactors that already have ceased operating—for example, at the Sosny facility in Belarus.[8] These sites may be particularly susceptible to insider threat as future employment at the reactor

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[6] George Bunn, Chaim Braun, and Fritz Steinhausler, "Nuclear terrorism potential: Research reactors vs power reactors?" NUMAT proceedings, September 2002, Salzburg, Austria, http://www.numat.at/list%20of%20papers.htm.
[7] Ibid.
[8] Jon B. Wolfsthal, Christina Chuen, and Emily Ewell Daughtry, eds., *Nuclear Status Report: Nuclear Weapons, Materials, and Export Controls in the Former Soviet Union,* Carnegie Endowment for International Peace and Monterey Institute for International Studies, 2001, http://www.ceip.org/files/publications/StatusReport.asp?p=8&PublicationID=712

becomes uncertain, and personnel consider ways to provide for their families during the hard times ahead.

When HEU fuel is repatriated to the country of origin, strict material security must be provided. Particular concern arises over the secure transport and storage of returned Soviet-origin fuel to Russia.

Another threat is to the facilities themselves. If the research reactor facility was hit with a conventional explosive, the reactor itself could become in effect a radiological dispersal device for adjacent downwind areas.

INITIATIVES TO REDUCE RISK

International efforts are in place to minimize the risk from this proliferation threat. Research reactors are subject to IAEA safeguards. Monitoring and inspections by the IAEA keep track of amounts of material and verify that it has not been removed. Although IAEA and Nuclear Supplier Group recommendations are in place for physical protection at nuclear facilities, there are no binding international standards for research reactors, and security measures at these facilities vary around the world.[9]

Since most HEU research reactors are U.S. or Soviet in origin, the U.S. and Russian governments have led efforts to address this problem to date. The Global Threat Reduction Initiative (GTRI), launched in May 2004 by the U.S. Department of Energy, includes programs to convert HEU research reactors to low enriched uranium use and to repatriate U.S.- and Soviet-origin fuel.[19] However, implementation of both conversion and repatriation programs has been slow. Only one-third of countries with U.S.-origin HEU elements completely repatriated their fuel, and since 1978 only 39 of the 105 HEU reactors planned for conversion have begun or completed their transition.[20] No conversion of Soviet-designed reactors has taken place; the first is planned in Uzbekistan for 2005. Of the 17 countries with Soviet-origin HEU fuel, repatriation has taken place, both before and since the establishment of the GTRI, in Yugoslavia (Project Vinca), Romania, Bulgaria, Libya, Uzbekistan, and the Czech Republic.

Most experts agree that Soviet-origin reactor sites are most vulnerable to theft or diversion due to the difficult economic and political conditions in the

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[9] Ibid.

[19] Office of Global Threat Reduction, http://www.nnsa.doe.gov/na-20/na21_index.shtml.

[20] Government Accounting Office (GAO), “DOE Needs to Consider Options to Accelerate the Return of Weapons-Usable Uranium from Other Countries to the United States and Russia,” GAO-05-57, November 2004, and GAO, “DOE Needs to Take Action to Further Reduce the Use of Weapons-Usable Uranium in Civilian Research Reactors,” GAO-04-807, July 2004.

host countries. The GTRI is attempting to repatriate the most vulnerable material first and hopes to complete fresh fuel repatriation by 2005 and spent fuel by 2009. However, it may take until the end of the decade before reactors in places like Belarus, Kazakhstan, Ukraine, the Czech Republic, Poland, and Hungary are shut-down or converted and their HEU cleaned out.

Assessment

Compared to other sources of HEU, research reactors are the most accessible and vulnerable to theft or diversion. There are more than 140 HEU research reactors around the world (with varying amounts of weapons-usable uranium), most of which lack the security measures to prevent terrorist theft or diversion of weapons-grade nuclear materials.

Most of these sites have laid off parts of their workforce or will need to in the near future, and remaining staff are generally underpaid. This creates a possibility that disgruntled people with inside knowledge might be willing to sell critical security information or divert materials themselves for financial gain.

IMPROVED NUCLEAR DEVICES

Information

A "gun-type" Improvised Nuclear Device (IND) is the simplest nuclear weapon to produce.[1] Confidence was high enough in the simplicity of a gun-type weapon that this design was used in the Hiroshima bomb without undergoing previous testing.[2] There are many illustrations of gun-type INDs available in the open literature. Data on the exact quantities and qualities of HEU necessary to produce a critical mass, or assembly, also are available in the open literature.[3] Essentially, the nuclear physics associated with what is necessary to design a gun-type IND have been fully developed and are available in open sources.[4] Thus, the technical hurdles to creating such a weapon are in obtaining sufficient quantity and quality of HEU and actual processing/fabrication.[5]

A gun-type weapon consists of four basic parts: barrel, tamper, target, and bullet. The target and bullet, which make up the two sub-critical assemblies, would be of HEU, while the tamper could be made of tungsten or depleted/natural uranium. The barrel could be a section of an artillery/mortar barrel or a high tensile strength steel cylinder. A 1992 Los Alamos National Laboratory report stated, "Casting and machining of uranium can be accomplished in any modern foundry and machine shop. No part of these operations is beyond the capabilities of equipment and tools normally used in such a facility."[6] The fabrication/assembly of the non-nuclear components could be completed in a similarly equipped facility.

The amount of HEU needed for a nuclear weapon depends on several factors, including the amount, its enrichment level, and the use of reflectors. Reflectors reduce the amount of material needed for a weapon by reflecting

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[1] http://www.nti.org/e_research/cnwm/overview/technical2.asp (p. 1)

[2] Graham T. Allison, Owne Cote, Jr., Richard A. Falkenrath, Steven E. Miller. *Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material.* (CSIA Studies in International Security, John F. Kennedy School of Government, Harvard University, 1996) Appendix B: A Primer on Fissile Materials and Nuclear Weapon design. pp. 9-14.

[3] http://www.nti.org/e_research/cnwm/overview/technical2.asp; http://archive.greenpeace.org/comms/nukes/fig06.gif

[4] http://www.nuclearweaponarchive.org

[5] http://www.nti.org/e_research/cnwm/overview/technical2.asp p. 3; Carson Mark, Theodore Taylor, Eugene Eyster, William Maraman, Jacob Wechsler. *Can Terrorists Build Nuclear Weapons?*, A Paper prepared for the International Task Force on the prevention of nuclear terrorism, 1987), pp. 6-7; Michael May, *Nuclear Weapons Supply and Demand, American Scientist,* Vol. 82 (November-December 1994), pp. 527-530.

[6] Paternoster, Richard R. *Nuclear Weapons Proliferation Indicators and Observables,* Los Alamos National Laboratory Scientific report, (LA 12430-MS), Los Alamos, NM, (December 1992.) p. 10. To address the pyrophoric nature of uranium and plutonium, see U. S. Department of Energy Handbook HDBK-1081-94, *Primer on Spontaneous Heating and Pyrophoricity* (http://www.tis.eh.doe.gov/techstds/standard/ hdbk1081/hbk1081c.html)

neutrons back into the HEU. The amount of uranium required for a critical assembly is inversely proportional to the enrichment level. For example, it takes more than 200 kg of 36% enriched uranium to form a bare critical assembly, know as "bare crit." The "bare crit" amount of 90% enriched uranium is less than 60 kg. The use of reflectors around the fissile material can reduce the amount of HEU needed by up to one-half. For example, a few centimeters of readily available depleted uranium serves as an excellent reflector.[7]

One potential source of HEU could be research reactor fuel. Most research reactor fuel is made of aluminum and uranium alloy, although uranium oxide may be employed in some designs. To be useful in a weapon, the uranium must be extracted from the aluminum. Additionally, the uranium oxide would likely be reduced to uranium metal to allow for the smallest amount of HEU necessary for a weapon.

In the Plutonium Uranium Extraction (PUREX) process, widely practiced since the 1950s, the entire fuel element is dissolved in boiling nitric acid. It is then mixed with tributyl phosphate (TBP), which is diluted with kerosene. The TBP selectively extracts both uranium and plutonium, and is highly immiscible with the nitric acid solution. The TBP-Uranium-Plutonium mixture floats on the nitric acid solution, allowing the TBP to be tapped off, leaving behind the aluminum cladding and fission products.[8] This process has been widely practiced in the U.S., UK, France, Russia, and Japan.[9]

Some PUREX drawbacks include large waste streams, and the tendency of chemicals to breakdown due to high levels of radiation. This radiolytic damage is minimized in commercial processors by complex methods of ensuring complete and rapid mixing of chemicals. If, however, the fuel to be

[7] http://nuclearweaponarchive.org/Nwfaq/Nfaq4-1.html (Figure 4.1.7.1.1 Uranium Critical Masses for Various Enrichments and Reflectors); Carson Mark, et al., Can Terrorists Build Nuclear Weapons?, pp. 6-8; H.C. Paxton, N. L. Pruvost, Critical Dimensions of Systems Containing 235U, 239Pu and 233U (Los Alamos, NM: Los Alamos National Laboratory, 1986) table 28; Graham T. Allison, et al., Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material. p. 3.

[8] Stroller, S. M. and Richards, R. B., *Reactor Handbook*, New York: Interscience Publishers. Inc. 1961, ch. 4, pp. 208-225; Svantesson, I., Hagstrom, I., Persson, G., and Liljenzin, J. O., *Journal of Inorganic and Nuclear Chemistry* 41 (1979) pp. 383-389; Hesford, E., McKay, H.A.C. and Scargill, D., *Journal of Inorganic and Nuclear Chemistry* 4 (1957) pp. 321-325; Ishimori, T. and Watanabe, K., *Bulletin of the Chemical Society of Japan* 33 (1960) pp. 1443-1448. Additionally, there are numerous US Patents (http://www.uspto.gov/), which describe in technical detail processes of extracting uranium from fuel elements. Some examples include; US 5,961,679 (Recovery of fissile material from nuclear wastes) C. W. Forsberg; October 5, 1999; US 6,623,710 (Nuclear fuel reprocessing) E. Gaubert; September 23, 2003; US 2,811,415 (Extraction method for separating uranium, plutonium, and fission products from compositions containing same) G.T. Seaborg; October 29, 1957; US 4,486,392 (Process for the selective separation of uranium from accompanying metals) K. Heckmann; December 4, 1984; US 4,431,611 (Mixtures of organic phosphonates and anionic polymers to improve acid extraction of uranium) J. L. Gilron; February 14, 1984.

[9] Paternoster, Richard R. *Nuclear Weapons Proliferation Indicators and Observables*, p. 8.

processed had not undergone high levels of radiation, or had been allowed to cool for several months/years, radiation levels would be so low as to greatly minimize the concern for chemical degradation due to radiolysis. The PUREX process would likely be accomplished with equipment designed to withstand hot, highly corrosive solutions.[10]

Processing nuclear fuel produces discrete radioactive solid, liquid, and gaseous signatures.[11] Extensive efforts have been undertaken to detect these types of signatures in order to signal and stem proliferation of nuclear material. In the event an organization were to extract HEU from reactor fuel, the signature levels would be determined primarily by the amount of material processed, methods employed, and radioactivity of the fuel. The radiation level of the fuel would be determined by the amount of time it was irradiated, its power level, and the amount of time it was allowed to cool prior to processing.

Solid and liquid waste streams could be stored on-site for a short-term/one-time processing. Radioactive off-gassing is typically mitigated in commercial industry by absorbing noble gases on charcoal or removing them cryogenically. While detection techniques and equipment have become more sophisticated, certain commercial pollution control equipment, not subject to export control, can be effective in minimizing signatures.[12] If the health of workers were set aside, performing key operations in sealed areas where ventilation is not operated or only operated intermittently could mask gaseous signatures.

The IAEA Safeguards Glossary provides estimates of the amount of time it would take for a state to make a bomb from different types of nuclear material. These estimates assume that all other bomb making steps have already been completed. To extract and process HEU from irradiated fuel, it estimates 1-3 months of processing time.[13] Irradiated fuel is defined as fuel emitting more than 100 REM/hour. It is quite likely, however, that fuel which has cooled for several months, would be below 100 REM/hour. It should be noted that 100 REM/hour has been chosen because it represents a

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[10] *Nuclear Wastes: Technologies for Separations and Transmutation,* The National Academy of Sciences (1996). p. 37. It is estimated that 500-1000 gallons of solvents are required to start up laboratory-scale processing. See, Paternoster, Richard R. *Nuclear Weapons Proliferation Indicators and Observables,* p. 7.

[11] For example, the amount of solid and liquid radioactive wastes produced annually by the small reactor fuel reprocessing plant at Sellafield, UK. is 12 mg carbon-14, 125 g iodine-129, 15 g technetium-99, 2 mg strontium–90. *Environmental Monitoring for Nuclear Safeguard,* OTA-BP-ISS-168, U.S. Government Printing Office stock # 052-003-01441-4 (September 1995) p. 17.

[12] David A. Kay, *Denial and Deception Practices of WMD Proliferators: Iraq and Beyond, The Washington Quarterly,* 18:1, Winter 1995. p. 17.

[13] International Atomic Energy Agency (IAEA), *Safeguards Glossary*, 1987 edition, p. 24.

level of health risk to individuals processing fuel. An exposure to 500 REM (5 hours of exposure to a 100 REM source) will typically cause 50% mortality within 30 days of exposure.[14] A decision to disregard the health of workers would significantly simplify and expedite the process.

There are some disadvantages to a gun-type IND. Such a weapon would require a relatively large amount of highly-enriched uranium (e.g. 50 kilograms of 90% enrichment) and a long gun barrel, and would likely weigh a few hundred kilos, depending on the materials utilized.[15] The primary advantage of the weapon is its simplicity. All that must be accomplished is to quickly form a super critical mass. This is done by shooting one piece of HEU into another. Very basic propellants, vice high explosives, can be used to achieve sufficient velocities.[16]

All the above factors make it very plausible that an IND could be manufactured without the need for nuclear testing.[17] This would especially be true if the designers were not concerned about the weapon's reliability, predicted yield or safety. All the scientific data exists and has been disseminated already.[18]

Assessment

According to John Foster, Director, Lawrence Livermore National Laboratory (1961-1965), "The only difficult thing about making a fission bomb of some sort is the preparation of a supply of fissile material of adequate purity; the design of the bomb itself is relatively easy."[19] Numerous publication and websites contain sufficient technical information on gun-type designs, and the amount and enrichment quality of uranium necessary to create critical/super critical assemblies.[20] There are no significant scientific obstacles to overcome in making a gun-type IND.

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[14] REM stands for Radiation-Equivalent-Man. The REM measurement quantifies the amount of damage done to the body by ionizing radiation. 100 REM is commonly used as the "dividing line" between irradiated and unirradiated fuel. To be considered irradiated, a material must produce 100 REM/hour, at a distance of 1 meter, without any shielding.

[15] http://www.nti.org/e_research/cnwm/overview/technical2.asp p. 10.

[16] http://nuclearweaponarchive.org/Nwfaq/Nfaq4-1.html (Section 4.1.6.1); Graham T. Allison, et al., *Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material*. pp. 1, 15 16; http://nuclearweaponarchive.org/Nwfaq/Nfaq4-1.html (Section 4.2).

[17] Graham T. Allison, et al., *Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material.* p. 9.

[18] John Foster, *Nuclear Weapons, Encyclopedia Americana*, Vol 20 (New York, New York: Americana, 1973), pp. 520-522; Michael May, *Nuclear Weapons Supply and Demand*, pp. 527-530.

[19] John Foster, *Nuclear Weapons*, pp. 520-522.

[20] Graham T. Allison, et al., *Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material.* p. 9.

RADIOLOGICAL DISPERSAL DEVICES

Information

One possible form of nuclear terrorism involves the dispersal of radioactive materials in a radiological dispersal device (RDD) – one type of which is popularly known as a "dirty bomb." While radioactive materials can be spread with or without explosives, a dirty bomb is typically envisioned to use conventional explosives.[1] Unlike a nuclear weapon explosion, use of an RDD would cause few, if any, deaths soon after exposure to the RDD's ionizing radiation. Nonetheless, dirty bombs can prey on many people's fears of radiation and can potentially cause panic and massive contamination, resulting in substantial economic costs.

While almost any type of radioactive material, such as spent nuclear fuel from commercial nuclear power plants or research reactors, can, in principle, be used in an RDD, only certain types of radioactive substances present serious RDD threats. For instance, if terrorists obtained HEU from research reactor fuel (either fresh or irradiated), they would not be likely to use it to construct a dirty bomb. Dispersed in an RDD, HEU would cause very little actual damage because it is not very radioactive.

Other more accessible and ubiquitous radioactive materials have substantially greater amounts of radioactivity and, therefore, are more useful for RDDs. Unlike HEU, commercial radioactive sources are prevalent in practically every nation of the world. Every European country employs radioactive sources to provide beneficial services in medicine, industry, and research.[2] Fortunately, of the millions of sources in use or in storage worldwide, only a small fraction can fuel potent RDDs. Still, this small fraction represents tens of thousands of sources around the globe.[3] Within Europe, thousands of radioactive sources are considered high-risk, based on the IAEA's revised safety and security classification system. High-risk sources typically contain

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[1] Peter D. Zimmerman with Cheryl Loeb, "Dirty Bombs: The Threat Revisited,"*Defense Horizons* , No. 38, Publication of the U.S. National Defense University, January 2004.

[2] M. J. Angus, C. Crumpton, G. McHugh, A. D. Moreton, and P. T. Roberts, *Management and Disposal of Disused Sealed Radioactive Sources in the European Union*, Report for the European Commission, EUR 1886, 2000.

[3] Charles D. Ferguson, Tahseen Kazi, and Judith Perera, *Commercial Radioactive Sources: Surveying the Security Risks*, Occasional Paper No. 11, Center for Nonproliferation Studies, Monterey Institute of International Studies, January 2003.

relatively large amounts of americium-241, cesium-137, cobalt-60, iridium-192, or strontium-90.[4] Notably, HEU is not on this list.

Within the past few years, the European Union has commissioned two studies to determine the effectiveness of the existing regulatory controls over the lifecycle of radioactive sources. The first study examined the controls within the EU itself and found that radioactive materials management varied across the EU.[5] The report underscored the risk posed by some 30,000 disused sources that are in danger of becoming orphaned—that is, fall outside of regulatory controls due to theft, abandonment, or lax accounting.

Following on the heels of that study, the EU investigated the regulatory practices in the Czech Republic, Estonia, Hungary, Poland, and Slovenia because these states were being considered for early admission to the EU.[6] Although the EU report concluded that these states have regulatory controls that meet the general standards found throughout the EU, a major shortcoming of most states in both the EU and Central and Eastern Europe is the failure to plan for adequate disposal facilities. Disused sources that are not properly and promptly disposed of are more susceptible to becoming orphaned – and are more vulnerable to being seized by terrorists. It should be noted that these pre-September 11, 2001, EU reports focused on safety considerations and did not examine details of security procedures.

Assessment

Radioactive materials are prevalent throughout Europe and the rest of the world. Many commercially used radioactive sources are readily accessible and could end up in RDDs or dirty bombs. However, only certain types of radioactive materials can fuel potent RDDs. In particular, HEU is not a potent RDD material because even large samples of HEU contain relatively small amounts of radioactivity. If terrorists seized HEU, they would be inclined to build improvised nuclear devices, not dirty bombs.

[4] International Atomic Energy Agency, "Code of Conduct on the Safety and Security of Radioactive Sources" and "Categorization of Radiation Sources," TECDOC-1344," Revised Documents Approved by the IAEA Board of Governors, September 2003, and published in January 2004.
[5] Angus, Crumpton, McHugh, Moreton, and Roberts, op. cit.
[6] M. J. Angus, A. D. Moreton, and D. A. Wells, *Management of Spent Sealed Radioactive Sources in Central and Eastern Europe, Report for the European Commission*, EUR 19842, April 2001.

DETECTING AND INTERDICTING NUCLEAR SMUGGLING

Information

Approximately 700 illicit nuclear or radiological material trafficking incidents have occurred in more than 40 countries on six continents since 1991.[1] Most have occurred in and around Europe. The materials stolen range from weapons-grade HEU and plutonium to medical or industrial radiological source materials. In almost all cases, theft was carried out by insiders—guards or other facility personnel who knew ways around the safeguards in place and who were motivated by the hope of financial gain. Buyers of this material have not been confirmed in most cases, but likely end-users would be proliferant states, terrorist groups, separatist movements, or criminals.[2]

There have been 14 reported cases of weapons-grade HEU or plutonium smuggling from facilities in the former Soviet Union confirmed by open sources since 1991.[3] In most cases, the thief was an employee of the facility suffering economic hardship. The stolen material was recovered in 13 incidents, while in one instance approximately two kilograms of HEU were taken from a research institute in Sukhumi, Georgia between 1992 and 1997 and have never been recovered.

The challenge of detecting and interdicting nuclear smuggling into Europe could hardly be more daunting. Borders over which smugglers might travel stretch for thousands of kilometers, and include remote areas that are difficult to control, such as coastlines, mountain passes, and thick forests. Every year tens of millions of trucks, trains, ships, and airplanes in which nuclear material might be hidden cross international boundaries at legitimate border crossings. Customs officials and border guards at these crossing sites are often poorly paid, geographically isolated, and susceptible to corruption. Indeed, one need look no further than the vast, intractable international

[1] "Promoting Nuclear Security: What the IAEA is Doing," IAEA Factsheet, http://f40.iaea.org/worldatom/Periodicals/Factsheets/ English/nuclsecurity.pdf. Accessed Mar 11, 2004

[2] Lyudmila Zaitseva, Kevin Hand, "Nuclear Smuggling Chains: Suppliers, Intermediaries, and End-Users," American Behavioral Scientist, Vol. 46 No. 6, February 2003.

[3] Scott Parrish, "Illicit Nuclear Trafficking in the NIS," Nuclear Threat Initiative Issue Brief, March 2002, http://www.nti.org/e_research/e3_8b.html. Accessed Feb 10, 2005; and, International Atomic Energy Agency, "Illicit Trafficking Database (ITDB)," last updated December 2003, http://www.iaea.org/NewsCenter/Features/RadSources/PDF/itdb_31122003.pdf. Accessed Feb 10, 2005.

illegal drug trade to quickly understand the challenge of stopping nuclear smuggling.[4]

Once stolen, nuclear material would be very difficult to detect, especially if shielding was used to limit radiation emissions. The small amount of nuclear material required for a bomb makes the detection and interdiction of that material even more difficult. When processed, the HEU needed for a gun-type nuclear device is about the size of a two-liter liquid container, a relatively insignificant size when compared to the vast shipments of other illicit smuggling activities. Additionally, not all nuclear material is highly radioactive and susceptible to detection. HEU emits a low radiological signature, which can be easily and effectively shielded by a variety of readily available commercial radiation shielding materials.

In light of these challenges, there are numerous programs in place throughout Eastern Europe and the former Soviet Union to detect and interdict nuclear smuggling. An especially important measure adopted unanimously in April 2004 is United Nations Security Council Resolution 1540. It calls on all states to develop and maintain national controls on WMD materials and cooperate to prevent illicit trafficking in WMD.

- In 2003 the European Commission created the Agency for the Management of Operational Cooperation at the External Borders in order to optimize the implementation of Community policy in this field and to ensure that the rules are uniformly applied, thereby guaranteeing a high level of control and surveillance at all the external borders of the European Union. The agency will assist the Member States in implementing Community legislation by coordinating the operational aspects of cooperation at the external borders.[5]
- In 1995, the IAEA created a formal Illicit Trafficking Database to collect information from participating countries in a uniform, detailed fashion, and then to disseminate that collected information to member states. The goal of the database is to enhance the level of knowledge about how many incidents of illicit trafficking are detected each year and to search for trends in smuggling activities. The database contains information on incidents involving both nuclear material and radioactive sources. The IAEA counts a total of 75 states as participants in the database program.[6]
- The IAEA, in coordination with the World Customs Organization (WCO), the International Criminal Police Organization (Interpol), and

[4] Nuclear Threat Initiative website, URL: http://www.nti.org/e_research/cnwm/interdicting/index.asp#_ftn4. Accessed April 5, 2004

[5] European Commission, Bulletin of the European Union website, URL: http://europa.eu.int/abc/doc/off/bull/en/200311/p104003.htm. Accessed Mar 11, 2004

[6] International Atomic Energy Agency, “Illicit Trafficking Database (ITDB),” last updated December 2003, http://www.iaea.org/NewsCenter/Features/RadSources/PDF/itdb_31122003.pdf. Accessed Feb 10, 2005.

the European Commission, provides training to law enforcement and customs officials in member states on the detection and response to illicit trafficking in nuclear materials.[7]

- The IAEA Coordinated Research Project (CRP) was created in 2002 to oversee research and development on the detection capabilities and field performance of hand-held and portable radionuclide measurement devices.
- The IAEA also works with the WCO, the Universal Postal Union, Interpol, and EUROPOL to share information and to improve national capacities to control the flow of nuclear and radioactive materials, although resources for carrying out such operations are limited. A sign of such collaboration was the provision in 2003 of the unrestricted information in the Illicit Trafficking Database to Interpol, EUROPOL, and the WCO.[8]
- The Proliferation Security Initiative develops partnerships of states employing and exercising their national capabilities to develop a broad range of capabilities to interdict threatening shipments of WMD. Participating countries joining the U.S. are Australia, Britain, Canada, France, Germany, Italy, Japan, The Netherlands, Norway, Poland, Portugal, Russia, Singapore, and Spain.[9]
- The U.S. Department of Energy Second Line of Defense Program works to install radiation detection equipment to detect nuclear material passing through key ports and border crossings in Russia, other states of the former Soviet Union and Eastern Europe. In FY 2006, radiation detection equipment will be installed at an additional 12 foreign sites, increasing the number of sites with completed installations to 105.[10]
- The U.S. Department of State Export Control and Related Border Security Assistance Program is the U.S. government's premier initiative to help other countries improve their export control systems. With funds for programs in over 40 countries, the program has broadened to focus on potential smuggling routes including those in Eastern and Central Europe.[11]
- The U.S. Department of Defense International Counterproliferation (ICP) program provides equipment and training to customs and law enforcement counterparts in the National Intelligence Service (NIS) and

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[7] Nuclear Threat Initiative website, URL: http://www.nti.org/e_research/cnwm/interdicting/worldsmuggling.asp. Accessed February 20, 2004

[8] Ibid

[9] U.S. Department of State website, URL: http://www.state.gov/t/np/c10390.htm. Accessed February 10, 2005.

[10] Nuclear Threat Initiative website, URL: http://www.nti.org/e_research/cnwm/interdicting/second.asp. Accessed February 20, 2004; and, U.S. Department of Energy, FY 2006 Budget Request: Detailed Budget Justifications – Defense Nuclear Nonproliferation, p. 490.

[11] U.S. Department of State website, URL: http://www.state.gov/t/np/export/ecc/20779.htm. Accessed February 10, 2005.

in Southern and Eastern Europe. To date, the ICP has trained over 2,200 individuals in 22 countries.[12]

- Every Eastern European and former Soviet country has some form of national border security organization, each with varying degrees of detection and interdiction capabilities.

Assessment

Taken together, the challenges facing the detection and interdiction of nuclear smuggling seem overwhelming. The dimensions and characteristics of the vast EU borders, magnitude of legitimate commerce and existence of ongoing large-scale smuggling favor the nuclear smuggler. Although many programs exist throughout Europe to detect and interdict nuclear smuggling, these programs are far from comprehensive or foolproof. Detection equipment is in place at major border crossing sites, but not at many smaller crossing points. Border guards and officials in some countries lack adequate training and are susceptible to corruption.

Once nuclear material is obtained, smuggling it into EU territory is highly feasible. A determined and disciplined terrorist or criminal organization could either bypass known detection sites, effectively shield the nuclear cargo while disguising it as legitimate commerce, or simply include the material in one of the hundreds of smuggling shipments that cross EU borders every day.

[12] U. S. Department of Defense International Counterproliferation Program website, URL: http://www.dtra.mil/Toolbox/Directorates/OSI/Programs/icp/index.cfm. Accessed February 10, 2005

NUCLEAR EXPLOSION EFFECTS

Information

Our scenario postulates that al Qaeda has constructed a crude, improvised nuclear weapon with a 10 kiloton yield. This weapon is secreted in a storage facility near the target – NATO Headquarters on Boulevard Leopold III in Brussels – and then driven in a panel truck to NATO's front gate and detonated during morning rush hour. Such a detonation would have profound physical, economic, and psychological effects.

Physical Effects

The effects of the weapon can be broken down into two phases – prompt (those that occur within a few seconds of the explosion) and delayed. Prompt effects include blast, shock, ionizing radiation and non-ionizing radiation, including heat and electromagnetic pulse (EMP). Delayed effects include fallout, latent health effects, and economic, political, and social damage.

Prompt Effects

When the weapon detonates, everything within a radius of about 110 meters will be vaporized. A large crater will be created centered on the blast, and the material from this crater will be propelled upward by the blast along with a rising column of heat, creating the classic mushroom-shaped cloud. This cloud of radioactive material will rise on the order of 10 km in just a few minutes and begin drifting downwind (we postulate a prevailing northeasterly wind at 8 mph based on the last 30 years of recorded weather data for this time of year).

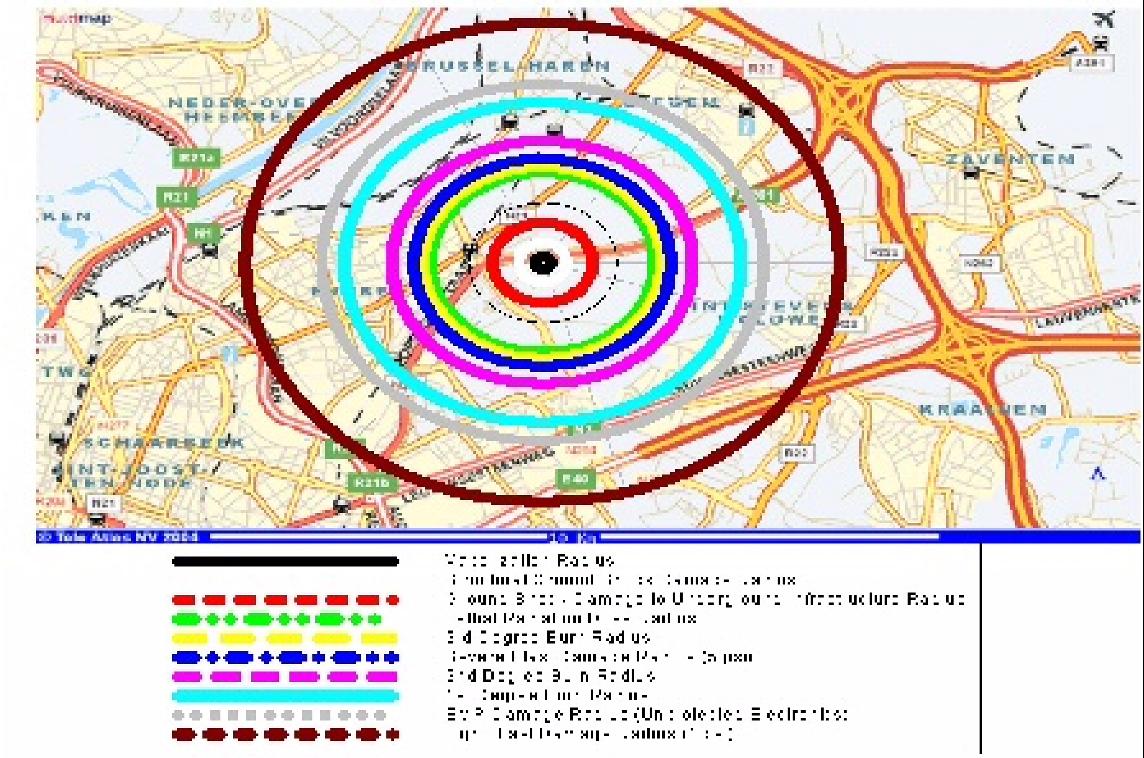
Structures within a radius of 350 meters will collapse from the ground shock and blast. The ground shock will shear or severely damage all underground electrical, gas, and water lines out to about 700 meters radius, and the resulting electromagnetic pulse will destroy or disrupt all unprotected electrical systems out to more than 3 kilometers in radius. The severe damage radius of the blast (5 psi overpressure) is 1860 meters; this will cause all but the most robust building structures to collapse while those that do not will suffer extraordinary damage.

A lethal radiation dose is defined as resulting in a 50 percent fatality rate within 30 days for the exposed population. All unshielded people within a 1620 meter radius will suffer such a dose. Beyond this immediate circle of lethality, unprotected people will suffer 3rd degree burns out to a radius of

1720 meters, 2nd degree burns out to 2180 meters and 1st degree burns out to 2870 meters. Note that 1st degree burns produce painful skin reddening, second degree burns produce blistering of the skin and can become infected if not treated. Third degree burns produce charred, destroyed tissue along with a high risk of infection if left untreated.

Unprotected electronics will suffer EMP damage out to at least 3200 meters. This does not include damage from energy coupled through antennae or wires, which will occur at considerably longer distances. Light blast damage (1 psi overpressure) will be experienced at a radius of 4300 meters from the explosion; essentially all exposed windows will be broken and poorly constructed buildings may be destroyed. Flying glass and debris will produce numerous secondary casualties. Also, note that fires within the prompt damage area will not be due to the thermal flash from the weapon, rather ruptured gas and electrical connections will ignite fires that are then fanned by the residual blast winds.

Recent Belgian census data suggests a population density of about 6000 people/km^2 in Brussels and the surrounding area. We can therefore estimate prompt casualties on the order of 40,000 killed outright, with another 300,000 injured. Major roads on the east side of Brussels will be damaged, as will the Haren Sud train stations, while the airport at Zaventem can be expected to suffer debris damage and significant radiation contamination. Further, the physical and EMP damage to electrical and electronically controlled systems (for example, SCADA systems controlling water or sewage flow, or electricity distribution) will cause cascading failures throughout the system, not unlike those experienced in the northeast quarter of the United States in 2003. This clearly has implications not only for Belgium, but surrounding countries as well.



Prompt effects radii of 10 kt nuclear weapon surface burst at NATO Headquarters

Delayed Effects

The northeasterly prevailing winds of Belgium dictate that the fallout cloud will ultimately grow to affect the Netherlands and northern Germany. Time, dispersion, and radioactive decay will mitigate downwind within a few months. Other delayed effects will nevertheless require aggressive management.

The first response challenges will be substantial. The immediate area of the blast will be highly radioactive and will pose absolutely no possibility of saving lives. The area surrounding the blast may have survivors, but their survival potential will be limited. Hard decisions will have to be made regarding the trade-off between the risk to rescuers and the benefit to the rescued. In general, response forces will only be able to work for a short period of time in a contaminated area, and they may or may not have reliable communications and appropriate equipment. Command and control will be difficult at best.

In the longer term, there will be serious implications for public health, not only in the immediate Brussels area but also throughout the region, as sewage, garbage, and corpses accumulate. Neighboring countries may confront significant influxes of refugees, and public health systems will be quickly overloaded with an unprecedented number of mass casualties.

All told, it is estimated that an additional 60,000 people will die from radiation exposure and individuals with whole body exposures greater than 100 Rads but less than 300 Rads will have some small increased chance of death from cancer depending on their pre-existing risk factors.

Economic Impact

Even as the instantaneous losses in infrastructure, real estate, and lives will be extraordinary, the medium- and long-term economic damage resulting from a nuclear explosion near NATO Headquarters will be far-reaching as well.

Belgium's per capita income in Belgium is € 21,973. Assuming 100,000 deaths from prompt and short-term effects, Belgium will face an economic loss of nearly € 2.2 billion income per year, a loss that will be compounded as consumption drops accordingly and businesses fail. Belgians contribute € 27,250 per capita towards productivity, and thus in terms of Gross Domestic Product, Belgium can expect to lose € 2.725 billion from human losses alone, a significant cost to an economy of only some € 282 billion GDP total.

Infrastructural losses also will be enormous. Although none of Brussels' major electricity-producing facilities are within what will be the worst affected blast area, severe electrical disruptions will occur. Furthermore, Belgium's grid is integrated with that of much of Western Europe. While in theory this would lend durability in the face of any localized power loss, in the past, major rerouting of electricity flows from abroad have threatened to overload grid capacity in Belgium, raising the specter of a country-wide blackout.

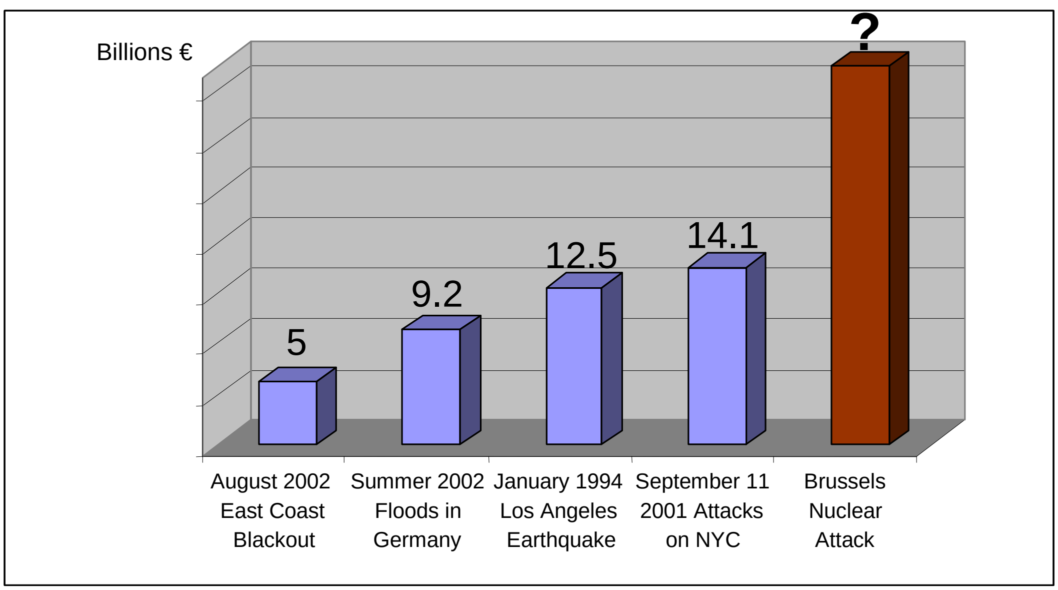
Three major highways will be badly damaged by the blast, prompt radiation and subsequent fallout, including the beltway and A3 E-40, a major East-West conduit. Much of Brussels rail travel passes through a major train yard just northwest of the effective blast radius and well within the irradiated area. Even more critically, fallout from the blast will drift to the northeast directly over the Brussels National Airport. This airport services 14.5 million passengers per year, and is the 29th busiest cargo transit point in the world; it will be rendered inoperable indefinitely.

Beyond the airport, the fallout will drift across northeast Belgium into the Netherlands and Germany, contaminating some of the greatest dairyproducing regions of Europe and causing widespread population dislocations. Food production in these areas will be precluded for a minimum of 60 days, the time required for the heavy doses of iodine deposited by the fallout plume to decay. Some areas will naturally be contaminated for much longer. Note that given public fears concerning radiation, this farmland may be commercially unavailable for years even after the region is technically safe for production.

In addition to infrastructure and electricity disruptions, the psychological impact of the attack will compound economic disorder. It can be assumed that virtually no economic activity will take place in Brussels for a number of days, if not weeks, following the incident. Although danger from radiation will be primarily directed away from Brussels under the northeasterly fallout plume, panic will likely overwhelm any government reassurances, and massive population movements will take place. A high percentage of Belgium's economy is concentrated around Brussels, and its loss will be devastating – the Brussels stock exchange alone turns over € 180 million in transactions per day.

Economic Cost of Recent Natural and Man-made Disasters:

Although the overall economic cost of a nuclear explosion in Brussels is difficult to predict, a comparison to other recent catastrophes provides some perspective. The scenario described above would combine the effects of a number of the disasters graphed below, such as widespread and prolonged electrical blackouts, massive human losses, and extensive infrastructure damage, and would dwarf the costs of its predecessors.



Sources: U.S. Department of Energy (East Coast Blackout), Munich Re German Insurance Group and German Federal Government (German Floods), ABS Consulting, retained by Californian state government (Los Angeles Earthquake), New York City Comptroller (September 11)

Psychological Impacts

The psychological impacts of the detonation will be significant and varied. First, there will be the impact on the immediate victims of the attack. Those that survive will need assistance for certainly months, if not years, to overcome the psychological devastation they will experience. Relatives of victims will suffer from the loss of loved ones and the frustrations associated with wondering whether and how the attack could have been prevented.

The trauma such an incident will inflict on rescuers should not be underestimated. Many of the first responders will die as they attempt to help survivors and ultimately become victims themselves due to overexposure to radiation. Because significant outside assistance may not arrive for hours – even days – the first responders will undoubtedly become exhausted. Leaders at all levels will more than likely suffer from a feeling of inadequacy to assist survivors and their own forces. Mental health workers will be overwhelmed – yet the task of assisting victims, rescuers, and residents will last for years.

Those outside the immediate impact area will certainly be affected as well. Panic will spread far beyond the targeted city: One week after the event, it is projected that fallout will have covered areas inhabited by half a million people in three different nations. Border crossings throughout Europe will tighten, not only in an attempt to control refugee flows, but also in belated efforts to prevent a follow-on attack. Cross-border commerce will obviously be badly hampered, but economic dampening will take place throughout a traumatized Europe as a whole. Moreover, there is also the risk of scapegoating and recrimination if a group accepts responsibility for the attack and the public perceives a particular religious or ethnic affiliation or cause. Innocent individuals may be blamed by association – damaging social cohesion in the wake of the attack.

In summary, citizens and their leaders will face a long, difficult recovery from such an incident. No matter what preparation may have occurred, such an attack will have a devastating impact on the affected community, the European Community and the community of nations.

OPTIONS FOR PREVENTING WMD TERRORISM

"The morning after a WMD terrorist attack,
what will we wish we had done to prevent it?
And why aren't we doing that now?"
Senator Sam Nunn, Strasbourg, France, November 2003

The most effective, least expensive way to prevent weapons of mass destruction (WMD) terrorism is to minimize the number of sites where dangerous weapons and materials are stored and to secure those sites as thoroughly as possible. Acquiring weapons and materials is the hardest and most crucial step for the terrorists to take, and the easiest step for governments to stop.

A global prevention effort—one involving all countries, not just the United States and Russia—is needed to secure, remove, and/or eliminate materials and weapons of mass destruction, wherever they may be. This effort should take advantage of and expand existing initiatives such as the G8 Global Partnership and the U.S. Global Threat Reduction Initiative. Although significant progress has been made in the last decade, tremendous work remains to be done, both in the arenas identified in this scenario-based exercise and elsewhere.

This document first outlines the spectrum of WMD threats and the inadequacy of current responses; it then offers a menu of global prevention measures that can be taken to meaningfully reduce the risk of WMD terrorism.

Current Efforts to Prevent WMD Terrorism

NUCLEAR MATERIALS

Terrorists cannot detonate a nuclear bomb without acquiring plutonium or highly enriched uranium (HEU). Experts estimate that over 600 metric tons of such weapons-usable nuclear material outside of warheads remains in Russia, a legacy of the Cold War. The material is scattered across scores of buildings in dozens of sites, some guarded only by simple padlocks and underpaid guards. The United States and Russia have cooperated since the early 1990s to improve the accounting, protection, and control of nuclear material in Russia to reduce the risk that such material might fall into terrorist hands. However, over half the material still has not received even basic security upgrades. Even the most optimistic projections estimate the job will not be complete until the end of 2008.

Impediments to speedier cooperation include the relatively modest level of funding devoted to this enormous task, as well as periodic disputes between donor governments and the Russian bureaucracy regarding access, transparency, taxes, travel visas, and liability. Unfortunately, additional nuclear material will add to the problem: Russia will continue to produce weapons-grade plutonium until at least 2008. Despite the magnitude of the threat, international funding for nuclear materials security efforts has not expanded significantly since the mid-1990s.

NUCLEAR RESEARCH REACTORS

In addition to the threat of loose nuclear material in Russia, there are more than 140 civilian nuclear research reactors in more than 40 countries around the world that have HEU—the key ingredient for a crude nuclear bomb like the one used in this hypothetical scenario. In the past, efforts to reduce the threat posed by these reactors have been slow and haphazard. Many of the 140 reactors still operate using HEU fuel, and even those that have been decommissioned or converted to low-enriched uranium still store caches of HEU. In addition, many HEU research reactors are located at high-traffic civilian sites such as universities and research institutes, where protections against outside attack or insider theft are often inadequate.

Since the end of the Cold War, the U.S., Russia, and International Atomic Energy Agency have cooperated to remove vulnerable HEU from sites in Kazakhstan, Georgia, Yugoslavia, Romania, Bulgaria, Libya, Uzbekistan, and the Czech Republic. In May 2004, the U.S. announced the launch of the Global Threat Reduction Initiative, consolidating its existing programs to address HEU and radiological materials at vulnerable sites worldwide. Even with these accelerated efforts, however, many sites, including some of the highest-risk, will likely not be cleaned out before the end of the decade. Moreover, other sites with HEU in and near Europe – many reactors with U.S.-origin spent fuel, some medical-related nuclear facilities, and sites with critical assemblies – will not be addressed by these programs.

NUCLEAR WEAPONS

Although all nuclear weapons were removed from Ukraine, Belarus, and Kazakhstan by 1996, Russia still possesses 18,000-25,000 nuclear warheads.

Not all of these are operational, and physical protection of warheads is believed to be significantly better than that for nuclear materials; they are stored at fewer, better secured sites, and access is restricted to a carefully selected cadre of officers. Additionally, strategic nuclear weapons have security and safety features that would prevent unauthorized use by terrorists. Nevertheless, progress toward consolidating the stockpile has been slow.

Russian tactical nuclear weapons remain a cause for even greater concern. Older tactical nuclear weapons do not have the security and safety features of strategic weapons. In addition, due to the lack of arms control agreements in this area and reported poor past accounting of warheads, it is unclear how many tactical weapons exist or in how many locations. Finally, because they are smaller, and easier to transport and conceal, tactical nuclear weapons are probably the most attractive target for terrorists seeking a ready-made bomb.

WMD EXPERTISE

Nuclear material is useless without the scientific knowledge needed to turn it into a weapon. Unfortunately, economic hardship or sympathy for extremist causes could potentially drive one of the thousands of former Soviet weapons scientists and personnel to sell his or her knowledge to terrorists. Since 1992, the United States, Russia, Japan and the European Union and others have supported the International Science and Technology Center (ISTC) to help employ ex-weapons scientists in the former Soviet Union via grants to engage in self-sustaining, peaceful research with potential commercial applications. The Science and Technology Center in Ukraine (STCU) provides similar grants to Ukrainian and other FSU scientists. In addition, the U.S., UK, and EU have funded similar bilateral projects in Russian closed nuclear cities. Nevertheless, funding for these programs has been relatively modest given the tens of thousands of scientists they are intended to help employ. Furthermore, as the primary nuclear threat shifts from nations seeking arsenals of sophisticated missile-deliverable weapons to terrorists seeking handfuls of crude but effective INDs, the most worrisome contribution of nuclear facility employees is no longer the risk of top scientists moving to proliferating states, but the risk of low-level employees offering inside assistance to material theft. This reality is not yet reflected in most of these efforts to address the human factor in nuclear proliferation.

CHEMICAL AGENTS, WEAPONS, AND EXPERTISE

The chemical agents, weapons, and expertise left over from the Cold War are also potentially attractive targets for terrorists. The Soviet Union produced roughly 40,000 metric tons of nerve and blister agents, more than any other country in the world. This stockpile of artillery shells, rocket and missile warheads, aerial bombs, spray tanks, and bulk containers remains scattered across seven different Russian sites. Thanks to assistance from international donors, including Germany, Italy, the Netherlands, the Czech Republic, Norway, Canada, France, Switzerland, Finland, the United States, the United Kingdom, and the European Union, physical security at some of these sites has improved and destruction of the chemical stockpile has begun. Some chemical weapons scientists have also transitioned to civilian work by availing themselves of ISTC assistance.

Still, the cost of destroying Russia's entire chemical stockpile is estimated at almost €7 billion, not to mention additional funds needed to employ former chemical weapons scientists. Donors have expended hundreds of millions of euros, but so far less than a thousand metric tons of chemical agent have been destroyed. At the current pace, Russia is unlikely to meet the extended destruction deadline set forth by the Chemical Weapons Convention in 2012.

BIOLOGICAL AGENTS, WEAPONS, AND EXPERTISE

Preventing WMD terrorism also requires securing dangerous pathogens and stopping scientific expertise developed under the Soviet biological weapons program from spreading to terrorist groups. Roughly 65,000 people depended on the vast Soviet biological warfare complex for their livelihoods, including 7,000-9,000 of whom pose a critical proliferation risk due to their role in Soviet-era research of military applications for dozens of dangerous agents, including anthrax, plague, smallpox, and Marburg. In secret and systematic violation of the Biological and Toxin Weapons Convention, the Soviets produced thousands of tons of these deadly agents, weaponizing many of them for delivery via ballistic missiles or other means. To this day, however, the true extent of the remaining Soviet biological stockpile remains a mystery, as Russia has never allowed full international access to its complex or provided a verifiable accounting of what that it includes.

The international community has attempted to engage Russia at several levels in order to reduce the danger of the Soviet biological legacy. The ISTC and other programs have provided opportunities for peaceful employment of some former bioweapons scientists. The United States and France have initiated modest biosecurity projects with Russia and other newly independent states to strengthen physical security and internal safety measures at facilities housing dangerous pathogens. The United States has also worked with former Soviet countries to eliminate the infrastructure once used to pursue biological warfare capabilities, such as excess pathogen repositories and dual-use technology. Although these efforts are promising, they have been relatively limited given the scope of the problem. There is still no definitive understanding of the scope and location of all bioweapons facilities. In addition, there remains no security cooperation at key military biological sites or with military biologists involved in the former Soviet weapons program.

DETECTION AND INTERDICTION

Stopping a terrorist network from transporting key material or weapons is essential if preventive measures have not been successful. This work is difficult and costly. Proper monitoring of border points and goods is both a technical and personnel issue. Training in how to install and use detection equipment as well as reduction in corruption are crucial. While efforts to address smuggling of WMD materials and equipment are underway, vast borders and poorly trained guards still favor the smuggler.

Options to Prevent WMD Terrorism

ACCELERATE THE GLOBAL CLEANOUT OF HEU RESEARCH REACTORS

As mentioned, more than 140 civilian nuclear research reactors use HEU fuel in more than 40 countries around the world. At least 50 research reactors are located in or on the periphery of Europe. Despite recent efforts by the United States, Russia, and the IAEA to accelerate progress, much of the HEU at research reactors will not be removed for the indefinite future unless additional action is taken.

A near term priority for European countries could be to inventory and provide immediate security upgrades to all sites in Europe using or storing HEU. If some European countries could not implement upgrades on their own, technical and other assistance could be provided through the European Union or a related mechanism.

European countries could also participate in efforts by the United States, Russia, and IAEA to address HEU sites worldwide. European countries with special relationships with countries possessing HEU could lead diplomatic efforts to repatriate the material and convert or shut-down any research reactors. European countries could also assist related activities, such as development of employment opportunities for former research reactor technicians, environmental remediation for decommissioned reactors, and removal of spent HEU fuel. France and the United Kingdom, who have reprocessing capabilities and infrastructure to dispose of nuclear materials, could consider establishing the legal basis for fuel acceptance, disposition, and waste storage.

ACCELERATE EFFORTS TO CONSOLIDATE AND SECURE DANGEROUS MATERIALS

European governments could expand funding for materials consolidation, protection, and destruction in Russia and other countries with vulnerable materials. The European community could direct additional funds to "sustainability" efforts, ensuring Russian government and security officials including at civilian facilities, have the training, incentives, and infrastructure needed to maintain security upgrades provided by foreign donors. European governments could help maintain the diplomatic priority of securing materials and encourage both the United States and Russia to resolve bureaucratic and political disagreements in implementation. European states could also consider increasing assistance to the IAEA's Nuclear Security Fund in support of these goals.

EXPAND EFFORTS TO EMPLOY FORMER WEAPONS SCIENTISTS AND PERSONNEL

International programs to engage former weapons scientists and personnel in peaceful commercial work are well established but have been under-funded, leaving long backlogs of approved projects without financing. European governments could help meet this shortfall by allocating additional funds to bilateral and multilateral programs to engage former weapons scientists. European and other governments could also shift emphasis of the projects away from short-term grants to projects with more potential for sustainable job creation and other techniques to reduce the number of employees at all levels with access to sensitive nuclear materials. To this end, the involvement of European private companies in this effort could be encouraged. European governments could also prioritize projects on the most sensitive technologies and urgent threats, prioritizing projects for joint research on biosecurity and counterterrorism.

INCREASE TRANSPARENCY AND SECURITY OF TACTICAL NUCLEAR WEAPONS

NATO plays a central role in the future of cooperative efforts to address tactical nuclear weapons. European governments could play a leadership role in prioritizing the threat by re-emphasizing the importance of confidence-building measures such as reciprocal data exchanges as recommended by the 2002 NATO report on confidence and security building measures. European governments and NATO could be prepared to welcome on-site visits and provide assistance for security upgrades at Russian storage sites should cooperation progress. Finally, European governments and NATO could encourage the United States and Russia to honor and codify their 1991 and 1992 declarations on tactical nuclear weapons transparency.

DRASTICALLY INCREASE FUNDING FOR CHEMICAL WEAPONS DEMILITARIZATION

In recent years, many European governments have expanded funding for chemical weapons destruction activities. However, despite these important efforts, it remains unlikely Russia will meet its CWC obligation for complete destruction in 2012. European governments could build on their experience by proposing to fund construction of an additional destruction facility at one of the four storage sites that does not currently receive international funding. The United Kingdom or Germany could offer to lead the European contribution, building on their experience at the facilities at Shchuch'ye, Gorny, and Kambarka. All countries could work to identify and amplify their roles in these projects by directly supporting the destruction of chemical munitions, supporting related infrastructure projects such as building roads or providing electricity, or funding supportive projects for communities near destruction facilities. In light of the recent discovery of aging chemical weapons munitions in Albania, European governments could lead and provide assistance for a regional initiative to identify, secure, and eventually destroy any additional orphan chemical weapons sources.

ENGAGE IN BIOSAFETY/BIOSECURITY CONFIDENCE-BUILDING MEASURES WITH RUSSIA

To build transparency and eventually redirect biological expertise and facilities to peaceful uses, the United States and Europe could initiate confidence-building measures with Russia in biosafety/biosecurity. Particular emphasis should be placed on the Russian Ministry of Defense, whose biological weapons experts do not currently participate in any threat reduction activities. The initial focus should be on common challenges presented by bioterrorism and could include: consultations between civil protection authorities; expansion of current joint projects on biodefense and laboratory exchanges; research into vaccines, medicine, and diagnostic tests;

and studies of anti-crop warfare and potential threat agents. Completing such measures may create the opportunity to pursue cooperation on security upgrades or shutdown of sites at Ministry of Defense complexes. European countries could also increase efforts to consolidate and secure nonmilitary collections of pathogens in Russia and the former Soviet Union.

ESTABLISH A GLOBAL PARTNERSHIP TO REDUCE THE RISK OF BIOTERRORISM

European governments could join with the United States, international community, and international organizations to form a global partnership to reduce the risk of bioterrorism. The partnership would engage governments, international organizations, non-governmental organizations and the private sector in a multiyear effort to significantly reduce the impact of terrorist use of biological pathogens.

Specifically, the global partnership would raise funds and coordinate a comprehensive effort to strengthen infectious disease surveillance and early warning systems across the globe. It would also provide assistance for the development of health care infrastructure necessary to deliver timely and vital public health measures and medical care in a crisis. The partnership could also help fund research to develop new vaccines, new drugs, and new rapid diagnostics tests. The international community could use the partnership as a venue to develop guidelines for implementing epidemic control measures, including difficult issues such as travel restrictions and quarantines. Finally, such a partnership could encourage the public and private international scientific community to design a system of self-policing, best security practices, and safety peer reviews to assure technological advancements cannot be used for deadly purposes. The global partnership would be an opportunity to simultaneously improve international security and public health.

BOLSTER INTERDICTION AND SMUGGLING DETECTION EFFORTS

To improve national and international capabilities for detecting and interdicting WMD smuggling, European governments need to increase dialogue between expert communities, e.g. nuclear and law enforcement. Efforts could also be carried out to make sure customs and border monitoring equipment is being used effectively, that training for customs officials particularly in Eastern Europe is regular and that information sharing between agencies is established before a crisis occurs.

STRENGTHENING THE GLOBAL PARTNERSHIP

Protecting Against the Spread of Nuclear, Biological and Chemical Weapons.

What is The Strengthening The Global Partnership Project?

The Strengthening the Global Partnership project is a CSIS-led consortium of 22 research institutes in 17 European, Asian, and North American countries working to build political and financial support for G8 efforts to reduce the dangers from nuclear, biological, and chemical weapons, beginning in the former Soviet Union. Although international cooperation has significantly reduced these dangers since the end of the Cold War, the task of eliminating them is far from complete. The risk that materials or weapons of mass destruction (WMD) will fall into terrorist hands remains alarmingly high.

In recognition of the magnitude of this threat, leaders of the Group of Eight Nations (G8) announced the Global Partnership Against the Spread of Weapons of Mass Destruction at their Kananaskis summit in June, 2002. Participants—the United States, the United Kingdom, Russia, Japan, France, Germany, Italy, and Canada—pledged to raise up to USD $20 billion over the next 10 years to combat the threat of WMD. Additionally, the G8 leaders agreed on a comprehensive set of nonproliferation principles and a specific set of guidelines designed to standardize and streamline the implementation of nonproliferation projects. The G8 also invited other non-G8 countries to join the Global Partnership and has added 13 additional countries.

Meeting the ambitious goals of the G8 Global Partnership requires a significant international commitment of political will and financial resources. The Strengthening the Global Partnership (SGP) project seeks to build that support by raising awareness of the WMD threat and creating a transnational coalition in support of increased and improved nonproliferation assistance. The SGP international consortium has published a four-volume report that identifies gaps in existing threat reduction programs, recommends future programmatic priorities, and proposes coordination mechanisms to improve the effectiveness of further efforts. This is the first time that experts from so many nations have reached consensus on specific steps to secure, account for, and safely dispose of nuclear, chemical, and biological weapons, agents, materials, and infrastructure in Russia and the former Soviet states.

Currently, the consortium is working to publicize the findings of this report and to encourage ministries and parliaments to adopt and implement the recommendations. Toward this end, organizational partners conduct outreach activities in their own country to inform decision makers and to foster further support for threat reduction. Project partners regularly meet and communicate in order to pool insights and experiences for the benefit of the project as a whole. The project's ultimate goal is to ensure sustained financial support for and effective implementation of the G8 Global Partnership.

The Nuclear Threat Initiative is the primary sponsor of the project, which began in late 2001.

STRENGTHENING THE GLOBAL PARTNERSHIP

Protecting Against the Spread of Nuclear, Biological and Chemical Weapons.

The Strengthening the Global Partnership is an international consortium of 22 think tanks in 17 countries. The Center for Strategic and International Studies acts as the coordinating organization for the consortium. More information can be found on our website, *http://www.sgpproject.org*.

Consortium Partners

Belgium	International Security Information Service, Europe
Canada	Centre for Security and Defence Studies, Carleton University
Denmark	Danish Institute for International Studies
European Union	EU Institute for Security Studies
Finland	Finnish Institute of International Affairs
France	Fondation pour la Recherche Stratégique
Germany	Stiftung Wissenschaft und Politik
International	International Institute For Strategic Studies
International	Stockholm International Peace Research Institute
Italy	Landau Network-Centro Volta/Union Scienziati Per Il Disarmo
Japan	Japan Institute for International Affairs
Korea	Institute of Foreign Affairs and National Security
Netherlands	Netherlands Institute of International Relations "Clingendael"
Norway	Norwegian Institute of International Affairs
Russia	Center for Policy Studies in Russia (PIR)
Russia	Institute of World Economy and International Relations (IMEMO)
Spain	Real Instituto Elcano de Estudios Internacionales y Estratégicos
Sweden	The Swedish Institute of International Affairs
Switzerland	Geneva Center for Security Policy
United Kingdom	Center for Defence Studies, King's College London
United States	Center for Strategic and International Studies
United States	Nuclear Threat Initiative