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Nuclear/Radiological Terrorism: Myth or Reality?

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Abstract

The nuclear/radiological terrorism ostensibly added the specter of nuclear attack by terrorist groups in our collective consciousness. The careful study of nuclear material acquisition and steps involved in manufacturing and exploding nuclear/radiological device manifest that nuclear terrorism is a cumbersome task. It becomes more difficult, if the terrorist organization manages to get a hold on nuclear weapon and try to use it, due to the inbuilt device code systems. Conversely, even if the terrorist's are unable to decode the device security codes, they would be able to create indescribable psychological fear among the people. In addition numerous methods are available to the terrorist groups for conducting radiological/nuclear terrorism. Though we have no precedent of nuclear terrorism, yet its possibility does not cease to exist.

Key Words: Myth, Nuclear, Radiology, Reality, Terrorism

The increasing reliance on the nuclear energy to decrease the dependence on the carbon fuels and steady deterioration of the twentieth century nuclear nonproliferation regime enhance the possibility of nuclear/radiological terrorism. The general perception is that the nuclear weapon states' enriched uranium, weapon grade plutonium and atomic devices could be misused by the terrorist group for nuclear/radiological terrorism. Nevertheless, the non-nuclear weapon states' nuclear programs built for peaceful application of nuclear technology are equally vulnerable to terrorist nefarious designs because many of these states nuclear facilities are not adequately guarded. In addition, the terrorist could purchase nuclear material from the global black market. (O'Neill, 1997: 1) The weak-security apparatus and nuclear non-proliferation regimes inability to prevent the illicit nuclear trade is in the advantage of transnational terrorist groups that are determined to use nuclear/radiological terrorism to accomplish their perilous design.

The nuclear radiological material's application in medicine, power generation industry and research laboratories make it an attractive commercial commodity. The commercialization of radioactive added an alarming variable in our lexicon because the commercial radioactive material is not considered a

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high security risk, despite the fact that it could be used in making radiological dispersal devices. Hence, the possibility persists that the radioactive material could be acquired from the nuclear facilities by concerned individuals or groups to provide terrorist groups for ideological or monitory gains. In this context, the nuclear infrastructure of non-nuclear weapon states is equally; and in some cases is more vulnerable as compare to nuclear weapon states nuclear infrastructure. This assertion merits on the hypothesis that nuclear weapon states are well equipped to guard their nuclear weapon facilities and sensitive to their personal reliability programs due to the lethality of nuclear weapons. Moreover, the states having a large nuclear infrastructure and target of transnational terrorists are also exposed to nuclear/radiological terrorist attacks.

In theory, nuclear/radiological terrorism seems too simplistic and thereby it has ostensibly added the specter of nuclear attack by terrorists in our collective consciousness. However, careful study of the nuclear material acquisition and steps involved in manufacturing and exploding a nuclear/radiological device manifest that nuclear terrorism is a cumbersome task. It becomes more difficult, if the terrorist organization manages to get a hold on a nuclear weapon and tries to use it, due to the inbuilt device code systems. Therefore, the nuclear/radiological terrorism could be a mere hype. The disturbing variable here is that despite the incapability of the terrorist to explode the nuclear device, the mere device in the possession of terrorist group would be having an immense psychological frightening impact on the people. Importantly, a mere announcement in the media that a terrorist group or a non-state entity possesses nuclear fissile material would generate psychological, economic and sociological devastating impacts. Nonetheless, it seems illogical to conclude that nuclear terrorism is a myth rather than reality. Though we have no precedent of nuclear terrorism, yet its possibility does not cease to exist. This necessitates an analytical examination of both theoretical and practical facets of nuclear/radiological terrorism. Thus, in the following discussion the hypothesis that 'despite the absence of precedent, nuclear/radiological terrorism is a practical threat' would be critically examined.

This study is structured into two sections. First section contains a debate on nuclear/radiological terrorism. It highlights the arguments which maintain that nuclear/radiological terrorism is a mere myth. Subsequent discussion underscores the possibility of nuclear/radiological terrorist attacks. The second section illustrates the forms and risks of nuclear/radiological terrorism.

Nuclear/Radiological Terrorism: **A Debate**

Nuclear/radiological terrorism was reckoned as an important security puzzle in 2009. Since then, it has been receiving a serious attention especially by the Obama Administration. Although, the nuclear/radiological terrorism has attracted immense attention in the UNSC Resolution 1887 (September 2009), yet some nations having nuclear material or vulnerable to nuclear/radiological terrorism seem to think that nuclear terrorism is not an acute danger and thereby there is no urgency to implement preventive measures. It seems that the nuclear non- proliferationists/abolitionists lacks serious supporting constituency, which could draw the nuclear capable states attention towards perilous nuclear/radiological terrorism and convince them to give up their nuclear arsenals. In realistic terms, the Nuclear Disarmament seems impossible because the nuclear weapon states are disinclined to compromise on their nuclear arsenals. Instead of capping their nuclear weapons modernization programs, the nuclear weapon states maintain 'long-term nuclear force modernization or up-gradation programs. (BASIC Trident Commission Discussion Paper 1, November 2011).

The Fukushima Daiichi (Japan) nuclear disaster March 2011 has not discredited the nuclear energy usage for power generation. The anti-nuclear energy lobby did its best to discredit the nuclear energy usage. But it failed to convince the states to suspend their nuclear energy projects. Importantly, at the 2012 Nuclear Security Summit the participating leaders not only defended the peaceful use nuclear technology but also promised to ensure the unconstrained advancement of nuclear technology for peaceful utilization. The Communiqué states: "We reaffirm that measures to strengthen nuclear security will not hamper the rights of States to develop and utilize nuclear energy for peaceful purposes (Seoul Communiqué, 2012)."

The trends in the terrorist groups' activities indicate that nuclear/radiological terrorism could not be deterred by a mere application of the deterrence strategy. It is because, the terrorist groups are non-state actors and a few of them have been employing an act of suicide as a modus operandi. These groups behavior is entirely different from the sovereign state. The factors, which oblige the ruling elite in a state to opt rational-decision-making model is very much missing in the terrorist group's decision making processes. Secondly, the terrorist groups have been opting asymmetrical war fighting strategies. Hence, the terrorist group(s) cannot be deterred by a mere threat of annihilation or inflicting an unacceptable damage upon it by massive retaliation.

The Washington Summit communiqué released in April 2010 revealed that 47 countries in attendance, stated that "nuclear terrorism is one of the most

challenging threats to international security, and strong nuclear security measures are the most effective means to prevent terrorists, criminals, or other unauthorized actors from acquiring nuclear materials" (Communiqué of Nuclear Security Summit, April 2010)." After the hiatus of two years, during the second Nuclear Security Summit heads of government/state of 53 nations on March 26-27, 2012, reiterated their political commitment "to work toward strengthening nuclear security, reducing the threat of nuclear terrorism, and preventing terrorists, criminals, or other unauthorized actors from acquiring nuclear materials." The Seoul Communiqué stated that: "Nuclear terrorism continues to be one of the most challenging threats to international security. Defeating this threat requires strong national measures and international cooperation given its potential global political, economic, social, and psychological consequences (Seoul Communiqué, 2012)." Hence, these developments have instigated a serious debate on the nuclear/radiological terrorism. The prevalent concern about the nuclear/radiological terrorism has obliged an international community to chalk out a collective approach to combat the menace of this new facet of terrorism.

Importantly, an alternative view on the nuclear/radiological terrorism does persist in the international security discourse. For instance, a few analysts categorically rejected or underplayed the possibility of nuclear/radiological terrorism in the near future on the basis of technological sophistication involved in uranium enrichment and plutonium separation from nuclear waste or fabrication of plutonium for nuclear explosive devices. They sound convincing because nuclear weapons are not easy to make. The engineering of fissile material such as Plutonium or Highly Enriched Uranium is beyond the capacity of a non-state actor, including the Taliban and al Qaeda.

It is a Myth

The nuclear fissile material producing infrastructure is very sophisticated and thereby it is impossible for a non-state actor, like terrorist group, to develop it. It is, therefore, almost impossible for a terrorist group to produce fissile materials. Nuclear history reveals that many countries renounced their nuclear weapons ambitions due to technological impediment. Nevertheless, the designing and assembling of a reliable nuclear device such as a gravity bomb or missile warhead is a cumbersome process. Many technologically less developed states joined Nuclear Non-Proliferation Treaty (NPT) of 1962 as a Non-Nuclear Weapon State (NNWS) to receive nuclear assistance under The International Atomic Energy Agency (IAEA) safeguards for the peaceful use of nuclear energy— power generation, medical treatment and augmenting agriculture productivity. Jonathan Tepperman pointed out that "Nuclear weapons are so controversial and expensive that only countries that deem them to be absolutely critical to their survival go through the extreme trouble of

acquiring them. That's why South Africa, Ukraine, Belarus, and Kazakhstan voluntarily gave them up in the early 1990s, and other countries like Brazil and Argentina abandoned their nascent programs (Tepperman, 2009, August 29)". Hence, if a sovereign state is incapable to develop its indigenous nuclear infrastructure or sustain its nuclear research and development program without the assistance of Nuclear Supplier Group (NSG); it is too erroneous to conclude that a terrorist group could carry out nuclear/radiological research and development by itself.

Many nuclear scientists have a consensus that due to the scientific difficulties, the construction of even a crude nuclear weapon seems impossible by the terrorist group. For manufacturing a nuclear device one needs to have technological expertise in high explosives, propellants, electronics, nuclear physics, chemistry, engineering, etc. (1997, August). If many sovereign states have failed to acquire proficiency in the nuclear know-how, it is difficult for non-state actor to produce nuclear or radiological device. Many analysts believe that a large amount of fissile materials (highly radioactive spent nuclear reactor fuel that has been discharged from commercial nuclear power reactors) is less-protected. But they fail to recognize the fact that these less-protected stocks of fissile materials cannot be used directly in nuclear weapons or radiological device. The terrorist group has to separate Plutonium from the spent fuel from the remaining uranium, cladding and fission products in a laboratory or reprocessing facility. It is highly unlikely that a terrorist group would be able to construct a nuclear reprocessing facility. Moreover, even if the 61terrorist group is able to acquire HEU or Plutonium, it is not capable to produce a nuclear weapon. Kevin O'Neill pointed out that: "in addition to sufficient fissile materials, a nuclear explosive device requires the assembly of several non-nuclear components. For instance, for an implosion system, these include high explosive lenses and high-speed switches; some form of a neutron generator; an iron or depleted uranium tamper; and perhaps natural uranium reflector. Assembling these components requires specialized knowledge and the ability to operate specialized machine tools (1997, August)." Charles D. Ferguson, Tahseen Kazi and Judith Perera wrote:

> To maximize harm to the targeted population, radiological terrorists would tend to seek very highly radioactive sources (containing tens of thousands or more curies) that pose external and internal health hazards. However, even suicidal terrorists might not live long enough to deliver an RDD because they might receive lethal acute doses of ionizing radiation from these sources in the absence of adequate shielding surrounding the radioactive material. But adding heavy protective shielding could substantially increase the difficulty in transporting an RDD and could dissuade terrorists from employing these types of sources (Ferguson; Kazi and Perera, 2003: 24).

The nuclear pessimists fear that states like Iran and North Korea could give or sell their nuclear material to terrorists groups. In reality, the pessimists' point of view lacks a convincing logic. First, the risk of giving out nuclear material to terrorist groups is overblown. It does not make sense that any state would give something it regards significant for its own security non-state actors like Al Qaeda. Second the concerned states would not give nuclear weapons to terrorist groups because Washington had 'made it very clear that it would regard any terrorist use of a WMD as an attack by the country that supplied it—and would respond accordingly'. In this context, the nuclear forensics technology could be employed by the investigators to trace the origin of the weapon.

Many nuclear alarmists have painted a worst case scenario about the nuclear weapon states collapse and the likely possibility of nuclear weapons falling in the hands of terrorists. In this context, the safety and security of Pakistan and North Korea's nuclear programs received a serious attention by the international nuclear security observers. However, the disintegration of former Soviet Union and Cultural Revolution in China in mid-1960s underlined that even during the chaos and turbulent times, the nuclear establishments in these states were able to keep their nuclear weapons and fissile material secure. Moreover, Islamabad always reiterates that it has institutionalized numerous precautionary measures to guarantee that these weapons would be remained out of the reach of the transnational terrorist groups during chaos or political crisis. For instance, it installed sophisticated firing mechanisms to prevent a launch by lone- wolf terrorist working within the nuclear establishment. Its Personal Reliability Program and Human Reliability Programs prevent its nuclear personnel from being infiltrated by extremists. Even if terrorists get hold of a Pakistani nuclear device, the nightmare scenario, would still be remote. They could not operate the device due to in-built protective code systems. The North Korea is a closed society and having an autocratic political system. Therefore, there is a dearth of information regarding its nuclear program safety and security apparatus.

It is a Reality

The misperception, miscalculation and above all ignorance of the ruling elite about security puzzles are perilous for the national security of a state. Indeed, in an age of transnational terrorism and unprecedented dissemination of dual-use nuclear technology, ignoring nuclear terrorism threat is an imprudent policy choice. The incapability of terrorist organizations to engineer fissile material does not eliminate completely the possibility of nuclear terrorism. At the same time, the absence of an example or precedent of a nuclear/ radiological terrorism does not qualify the assertion that the nuclear/radiological terrorism ought to be remained a myth.

Farsighted rationality obligates that one should not miscalculate transnational terrorist groups — whose behavior suggests that they have a death wish — of acquiring nuclear, radiological, chemical and biological material producing capabilities. In addition, one could be sensible about the published information that huge amount of nuclear material is spread around the globe. According to estimate it is enough to build more than 120,000 Hiroshima-sized nuclear bombs (Fissile Material Working Group, 2010, April 1). The alarming fact is that a few storage sites of nuclear/radiological materials are inadequately secured and continue to be accumulated in unstable regions (Sambaiew, 2010, February). Attempts at stealing fissile material had already been discovered (Din & Zhiwei, 2003: 18).

Numerous evidences confirm that terrorist groups had aspired to acquire fissile material for their terrorist acts. Late Osama bin Laden, the founder of al Qaeda stated that acquiring nuclear weapons was a"religious duty" (Yusufzai, 1999, January 11). The IAEA also reported that "al-Qaeda was actively seeking an atomic bomb." Jamal Ahmad al-Fadl, a dissenter of Al Qaeda, in his trial testimony had "revealed his extensive but unsuccessful efforts to acquire enriched uranium for al-Qaeda" (Allison, 2010, January: 11). On November 9, 2001, Osama bin Laden claimed that "we have chemical and nuclear weapons as a deterrent and if America used them against us we reserve the right to use them (Mir, 2001, November 10)." On May 28, 2010, Sultan Bashiruddin Mahmood, a Pakistani nuclear scientist confessed that he met Osama bin Laden. He claimed that "I met Osama bin Laden before 9/11 not to give him nuclear know-how, but to seek funds for establishing a technical college in Kabul (Syed, 2010, May 29)." He was arrested in 2003 and after extensive interrogation by American and Pakistani intelligence agencies he was released (Syed, 2010, May 29). Agreed, Mr. Mahmood did not share nuclear know-how with Al Qaeda, but his meeting with Osama establishes the fact that the terrorist organization was in contact with nuclear scientists. Second, the terrorist group has sympathizers in the nuclear scientific bureaucracies. It also authenticates bin Laden's Deputy Ayman Zawahiri's claim which he made in December 2001: "If you have $30 million, go to the black market in the central Asia, contact any disgruntled Soviet scientist and a lot of dozens of smart briefcase bombs are available (Allison, 2010, January: 2)."

The covert meetings between nuclear scientists and al Qaeda members could not be interpreted as idle threats and thereby the threat of nuclear/radiological terrorism is real. The 33Defense Secretary Robert Gates admitted in 2008 that "what keeps every senior government leader awake at night is the thought of a terrorist ending up with a weapon of mass destruction, especially nuclear (Mueller, 2011, August 2)." Indeed, the nuclear deterrence strategy cannot

deter the transnational terrorist syndicate from nuclear/radiological terrorist attacks. Daniel Whiteneck pointed out:

> "Evidence suggests, for example, that al Qaeda might not only use WMD simply to demonstrate the magnitude of its capability but that it might actually welcome the escalation of a strong U.S. response, especially if it included catalytic effects on governments and societies in the Muslim world. An adversary that prefers escalation regardless of the consequences cannot be deterred" (Whiteneck, 2005, Summer: 187)

Since taking office, President Obama has been reiterating that "nuclear weapons represent the 'gravest threat' to United States and international security." While realizing that the US could not prevent nuclear/radiological terrorist attacks singlehandedly, he launched 47an international campaign to convince the international community about the increasing threat of nuclear/ radiological terrorism. He stated on April 5, 2009: "Black market trade in nuclear secrets and nuclear materials abound. The technology to build a bomb has spread. Terrorists are determined to buy, build or steal one. Our efforts to contain these dangers are centered on a global non-proliferation regime, but as more people and nations break the rules, we could reach the point where the center cannot hold (Remarks by President Barack Obama, 2009, April 5)." He added: "One terrorist with one nuclear weapon could unleash massive destruction. Al Qaeda has said it seeks a bomb and that it would have no problem with using it. And we know that there is unsecured nuclear material across the globe" (Remarks by President Barack Obama, 2009, April 5). In July 2009, at the G-8 Summit, President Obama announced the convening of a Nuclear Security Summit in 2010 to deliberate on the mechanism to "secure nuclear materials, combat nuclear smuggling, and prevent nuclear terrorism" (Luongo, 2009, November 10). President Obama's nuclear/radiological threat perceptions were also accentuated by the United Nations Security Council (UNSC) Resolution 1887 (2009). The UNSC expressed its grave concern regarding 'the threat of nuclear terrorism." It also recognized the need for all States "to take effective measures to prevent nuclear material or technical assistance becoming available to terrorists." The UNSC Resolution called "for universal adherence to the Convention on Physical Protection of Nuclear Materials and its 2005 Amendment, and the Convention for the Suppression of Acts of Nuclear Terrorism." (UNSC Resolution, 2009)

The United States Nuclear Posture Review (NPR) document revealed on April 6, 2010 declared that "terrorism and proliferation are far greater threats to the United States and international stability." (Security of Defence, 2010, April 6: i). The United States declared that it reserved the right to"hold fully

accountable" any state or group "that supports or enables terrorist efforts to obtain or use weapons of mass destruction, whether by facilitating, financing, or providing expertise or safe haven for such efforts (Nuclear Posture Review Report, 2010, April: 12)". This declaration underscores the possibility that terrorist groups could acquire fissile material from the rogue states.

President Obama organized a Nuclear Security Summit on April 12-13, 2010, which manifested his belief that 'nuclear terrorism was the most immediate and extreme threat to global security'. The Communiqué of the Washington Nuclear Security Summit highlighted: "Nuclear terrorism is one of the most challenging threats to international security, and strong nuclear security measures are the most effective means to prevent terrorists, criminals, or other unauthorized actors from acquiring nuclear materials (Communiqué of the, 2010 April 13)." The representatives in Nuclear Security Summit unanimously declared the threat of nuclear/radiological terrorism as a reality. Again during second Nuclear Security Summit in March 2012, the 53 nations' leaders reiterated their commitment to prevent the nuclear/radiological terrorist attacks. Many states shared their national efforts to combat the menace of nuclear/radiological terrorism. For instance, the Prime Minister of Pakistan 4Yousaf Raza Gilani underscored in the Seoul Summit Islamabad's efforts to enhance the safety and security of Pakistani nuclear facilities. He also called "attention to Pakistani endeavors to cooperate with other states to improve their nuclear safety and security system." Notably, Pakistan had established Nuclear Security Training Centers to act as a regional and international hub to train the people. In addition Islamabad is ready to "deploy Special Nuclear Material Portals on key exit and entry points to counter the illicit trafficking of nuclear and radioactive materials."

The leaders of 53 States consensus on the 2012 Seoul Communiqué and their explicit commitment to enhance the safety and security of their respective nuclear infrastructure underscore that nuclear/radiological terrorism is not a myth and thereby this puzzle ought to be addressed vigilantly and collectively. The following discussion would assist us in understanding the different means of nuclear/radiological terrorist attacks.

Forms and Risks of Nuclear/Radiological Terrorism

Many nuclear security observers have a consensus that technically sophisticated terrorists could acquire nuclear material — Enriched Uranium and Plutonium — in several ways, even without the state support, and fabricate a dirty-bomb from enriched uranium or plutonium with the application of dual-use technology. The IAEA has categorized four potential nuclear security risks, i.e. "the theft of a nuclear weapon; the acquisition of nuclear materials for the construction of nuclear explosive devices; the malicious use

of radioactive sources—including so-called"dirty- bomb"; and the radiological hazards caused by an attack on, or sabotage of, a facility or a transport vehicle" (Japan's Disarmament and …, 2008, March: 86). Hence, nuclear terrorism could be in many forms. But every form is a disaster by any measure. The following are the predictable different categories of nuclear/radiological terrorism.

Dirty Bomb or Radiological Dispersal Device

The a radiological dispersal device (RDD) also known as dirty bomb spreads radioactive material that is highly toxic to humans and can cause mass death, injury and chaos. The security analysts have a consensus that "a much easier option for terrorist groups would be to make a dirty bomb, combining conventional explosives with radioactive materials like medical isotopes, which would generate nothing like the casualties of a fission or fusion bomb but have a psychological impact at least equal to 9/11" (Evan and Kawaguchi, 2009, November: 4). Importantly, the RDD effects would be substantial even if it does not cause an immediate, large-scale loss of life and physical destruction associated with nuclear explosives. It serves the terrorist's objectives, even though it would end up as a mere weapon of mass disruption or dislocation. It would be having a devastating psychological impact due to the fear of cancer and genetic effects on those exposed to the dispersed materials. For instance, "the accidental contamination of a village in Brazil in September 1987 with an industrial radiation source exemplifies the potential for a terrorist group to traumatize an unsuspecting population (1997, August)."

The radioactive material required to manufacture a dirty bomb is easily available from the radiation sources used in medicine or industry, to spent nuclear fuel from nuclear power plants (Blair, 2001, October 1). In addition there were many recorded "incidents of theft of nuclear radioactive material from Russian nuclear facilities" (Bhushan and Katyal, 2002: 137). Kevin O'Neill pointed out:

> "The manufacture of a radiological weapon is vastly less complicated than the assembly of a nuclear explosive device, and may be well within a terrorist group's capability, although the handling and dispersion of highly radioactive materials poses health and safety challenges that a terrorist group might not wish to risk for fear of incapacitation or discovery. The quantity of radioactive materials needed for a dispersal device is substantially less than the amount of plutonium needed to build an explosive device. Nor would the terrorist group be limited to plutonium or HEU for source materials; any highly radioactive substance could cause contamination and necessitate an expensive clean up if dispersed effectively" (1997, August).

The opinion about the reactor waste — plutonium — is divided on whether terrorists could make a dirty bomb using plutonium. Leonard S. Spector argued: "Though Plutonium is more difficult to use for a nuclear explosive than high enriched uranium, it is much more radioactive and can be easily fabricated into a very dangerous dirty bomb (Spector, 2009, May 8)." The fabricated plutonium could be used to cause radiation in densely populated city. Spector claimed "it (fabricated plutonium) would cause panic and great economic loss by contaminating the detonation site with one of the world's deadliest materials, one particle of which can cause lung cancer if inhaled (Spector, 2009, May 8)". Nadine Gurr, and Benjamin Cole wrote that: "Theoretically, a physics Ph.D. student could design a crude nuclear device that would satisfy terrorists' requirement for a radiological bomb, which is one in which radioactive materials are packed around a conventional bomb and flammable material. With this type of weapon the explosion leads to a fireball, shooting the radioactive material into the air, which then falls back on the earth over a wide area. The primary purpose of such weapons is to spread radioactive contamination rather than cause casualties through blast effects" (Gurr. And Cole, 2000: 44-45). In short, the radioactive contamination, serves the purpose of the terrorists' acts.

Facility vulnerability

The possibility persist that the terrorist group may target nuclear facilities, such as weapon-material production sites, nuclear power plants, plutonium separation facilities, and radioactive waste storage sites to cause the release of highly radioactive debris to create a radiological hazard. In this context, the older nuclear facilities are very much vulnerable because they were designed without keeping in mind the threat of terrorist attacks. Many analysts believe that even the designs of modern nuclear power stations and nuclear fuel plants does not withstand against terrorist attack. Hypothetically speaking, "a terrorist attack on a commercial nuclear power plant with a commercial jet or with heavy munitions could produce an effect similar to a radiological bomb and causes far greater casualties. If such an attack were to cause either a meltdown of the reactor core (as in the Chernobyl disaster), or a dispersal of the spent fuel waste on the site, extensive casualties could be expected. The power plant would be the source of radiological contamination, and the plane or the munitions would provide the explosive mechanism for spreading lethal radiation over large areas." The terrorist group could employ various methods to target nuclear facilities. For instance armed insurgents can forcibly enter and interfere with the plant safety systems. They could hit the facility with a truck or four-wheel drive vehicle loaded with explosive material. They could also reach the plant's secure area via a passive or an active insider employed within the plant itself to accomplish their objective.

Nuclear Device Theft

Admittedly, the nuclear weapon state maintains a sophisticated apparatus to guard their nuclear weapons. Despite it, one cannot rule out the possibility of theft of a nuclear device by a terrorist group. Importantly, the nuclear weapon states manufacture small nuclear devices, commonly known as "tactical nuclear weapons and miniaturized devices." These weapons are small and could be easily stolen. For instance, in 1986, the NCI\SUNY International Task Force on the Prevention of Nuclear Terrorism underscored the vulnerability of tactical nuclear weapons to non-state actors. In 1998, the Russian officials "announced foiling a plot by employees at a major nuclear facility in the Chelyabinsk region to steal 18.5 kilograms of weapons-grade uranium" (World at Risk, 2008:15).

Theft of Nuclear Material

The stealing of a fissile material from a highly-guarded nuclear facility is feasible. Numerous events, which prove the possibility of theft, were documented. These reported incidents are potent reminders that dedicated terrorist group could enter in the protected nuclear installation and steal a fissile material, especially in a non-nuclear weapon state. The following list recorded a few reported incidents in the first decade of the twenty-first century, which highlights the reach of non-state actors to the secured nuclear material and also underscores the possibility of nuclear material illicit trafficking:

- In March 2010, the Yemen law enforcement agency arrested a U.S. citizen, Sharif Mobley, who was an Al-Qaeda agent. He had worked for the U.S. nuclear power plant company PSEG Nuclear in New Jersey as a laborer between 2002 and 2008. The alarming fact in this reported case was that Mr. Mobley was employed by the company after passing the requisite federal security background checks necessary to work in the U.S. nuclear industry as recently as 2008 (New York (AFP) March 12, 2010)
- In February 2010, six anti-nuclear activists climb over a fence at the Kleine Brogel military base in Belgium, which is believed to store 10-20 US nuclear weapons. The protesters walk around for up to an hour before they are arrested.
- In November 2007, two to four armed men broke into South Africa's Pelindaba nuclear depository facility, which houses hundreds of kilograms of weapons-grade highly enriched uranium (HEU). They entered the facility's eastern block and headed for the control room. The problematic fact is that the intruders entered this facility despite a 10,000-volt security fence without setting off an alarm. It indicated that

they might have had help from the inside. The gunmen spent 45 minutes inside and shot an off-duty employee, and then escaped without stealing the uranium. Nevertheless, the intruders left the facility without making any effort to steal the nuclear material or sabotage the control room, the reactors, or anything else. (World at Risk, 2008: 13-14).

- In 2006, Alexander Litvinenko was poisoned with Polonium-210 in London (Evans and Kawaguchi, 2009: 39, 44).
- In January 2006, the Georgian authorities arrested a Russian who was carrying 100 grams of highly enriched uranium (Williams, 2007, August).
- The Russian nuclear black market analysis demonstrated that approximately 6183 cases that occurred between 2001 and 2006 in the former Soviet Union showed that traffickers transport their goods along various routes--an east-west route from Russia, Ukraine, and Belarus to Europe; a southwest corridor crossing Central Asia and the Caucasus toward Europe; and a southeast corridor, from Central Asia to neighboring Asian and Mideast countries--presuming the existence of a demand in countries along the way. These smugglers were usually intercepted before reaching their declared destinations, and were caught while transporting the goods, crossing a border, or during the sale of the material (often to an undercover agent) (Gormley, 2007, October 22).

Generate Electromagnetic Pulse

The possibility cannot be ruled out that the terrorist group may use nuclear material to generate an electromagnetic pulse (EMP) in the target area. Although, generating EMP is a difficult task, yet one cannot confidently rule out completely this kind of terrorist act. Nonetheless, if terrorist group succeeded in creating EMP, it would destroy or damage the electrical circuits and electrical items through electrical induction effects in the targeted area. In simple words, the EMP effect would knock out most of the computers, shut down electric power grids, communication gadgets such as telephone, television, radio, 1and water pumps along with almost everything that relies on electronics to operate. More precisely, by producing EMP the terrorist group would trigger mass panic or chaos.

Insiders Vulnerability

The terrorist organizations could obtain HEU from more than 130 research reactors located in different countries that use HEU as a reactor fuel with the assistance of an employee of a nuclear facility. Rolf Mowatt-Larssen pointed out: “Despite increases in the scope and sophistication of security measures…

the fact remains that missing weapons-usable material turns up regularly on the nuclear black market. The most worrisome aspect of these recurring incidents is that facilities from which the materials originated did not report them missing (Larssen, 2009, July/August)." The terrorist organization that seeks nuclear material can identify and approach individuals at a nuclear site who are willing to collaborate with them for the sake of ideology or monitory gains (Luongo and Salik, 2007, December). The insiders could assist the terrorist groups to obtain sensitive materials or facilitate armed takeovers of nuclear sites by deactivating alarms or sharing security plan vulnerabilities. Feroz Hassan Khan opined that: "Insiders in the program could have one of several motives. Some could be driven by economic incentives. Others may see an opportunity for political gain. Some may be driven by revenge, grudges, jealousies, psychiatric disorders, and so on. Also, moles or spies could reveal nuclear secrets to outside powers, help sabotage or destroy the program from within, or disclose a site's location to facilitate outside attacks (Khan, 2009, July-August)."

Clandestine Nuclear Cooperation

The Global underworld nuclear bazaar has been working since 1940s. The nuclear nonproliferation regime has failed to prevent the nuclear technology and material trafficking. Hence, the clandestine cooperation has been facilitating the nuclear buyers. According to Jermy Bernstein: " The representatives of potential proliferators scouted Europe without restraint to buy the elements needed to make the Zippe centrifuges. They accomplished their missions uninterrupted for the reason that many of the things they needed were dual use, so the real could be disguised." (Bernstein, 2008: 266)." On June 7, 1981, Iraqis decided to enrich their own uranium using Zippe-type centrifuges after the bombing of their reactor by Israel. They paid one million dollars to a German group for the design (Bernstein, 2008: 268). It was reported that Degussa, one of the largest chemical companies in Germany—which was involved in nuclear weapons material business— sold the Zippe centrifuges to Iranian. 11 Jeremy Bernstein argued "The Dagussa representatives made it clear that they did not care if the Iranians were going to use the material to make weapons. That was fine with them, as long as they paid their bills (Bernstein, 2008: 263)."

The illicit nuclear material trade or nuclear smuggling is an established phenomenon. According to IAEA record, there were 16 confirmed incidents involving trafficking in Highly Enriched Uranium (HEU) or plutonium between 1993 and 2005 (International Atomic Energy Agency, 2006). More explicitly, a "great deal of nuclear material, equipment, and components for nuclear weapons programs have been, and are being, smuggled from the United States and the former Soviet Union. An early example of the illicit acquisition

of nuclear material was the smuggling of enriched uranium to Israel between 1962 and 1965. About 100 kilograms of highly enriched uranium disappeared from a factory in Apollo, Pennsylvania, owned by the Nuclear Materials and Equipment Corporation" (Frank, 1992: 64). In summer 1993, three seizures of plutonium and one of HEU in Germany confirmed fears of a black market in nuclear materials which was smuggling out of the former Soviet Union (Bhushan and Katyal, 2002: 137).

Conclusion

Presently, the dual use of nuclear technology makes its trouble-free availability. The international nuclear black market is a viable source for terrorist groups to acquire small quantities of both fissile materials and highly radioactive materials. Even a small amount of radioactive material is sufficient to manufacture a RDD to contaminate a densely populated urban center. In addition, nuclear scientists, nuclear power plants operatives and nuclear facilities are also vulnerable to the terrorist groups. In such a risky situation underplaying the possibility of nuclear/radiological terrorism is an erroneous and perilous conclusion. Therefore, the international community has to take nuclear/radiological terrorism threat seriously and chalk out a comprehensive strategy to thwart this persistent danger.

The trends in the global terrorism underscore that the deterrence strategy would be of little use in deterring the nuclear/radiological terrorist attacks because the terrorists lack a return address and are ready to embrace death — suicide mission. Therefore, the challenge for devising countermeasures for the prevention of nuclear terrorism is to find the right balance, while "enhancing national implementation, developing self-governing mechanisms, and involving all stake-holders. The best strategy to combat both terrorists and terrorism is a comprehensive preventive multilayered-defensive-fence.

Notes

1. On March 23, 2010, the U.S. Secretary of Energy, Steven Chu pointed out that: "America is on the cusp of reviving its nuclear power industry. In February 2010 President Obama pledged more than $8 billion in conditional loan guarantees for what will be the first U.S. nuclear power plant to break ground in nearly three decades. And with the new authority granted by the president's 2011 budget request, the Department of Energy will be able to support between six and nine new reactors." Steven Chu, "America's New Nuclear Options," *Wall Street Journal,* March 23, 2010. http://www.energy.gov/news/8782.htm. Accessed on March 24, 2010.

2. The dual-use technology refers to technology that has both peaceful and military or proliferation uses in the following part of this study.
3. In September 1987 a 20 gram mass of cesium-137 chloride broke open in Goiana, Brazil, a city of about one million inhabitants. The 1,371 curie (Ci), lead-shielded source was initially found by scavengers at an abandoned cancer clinic and taken to a junkyard for sale as scrap. Workers broke open the shielding and discovered the shiny, white cesium chloride capsule inside. The cesium capsule was broken up and pieces were taken home by workers and dispersed as curiosities to friends. Soon after, thirteen people exposed to the cesium fell ill. Thirteen people checked into hospitals, and four eventually died. By the time authorities in Rio de Janeiro realized what had happened, 249 people were affected by radiation, some receiving doses as high as 1,000 rem, with thousands more rushing to emergency rooms fearing contamination. To decontaminate the area, 6,000 tonnes of clothing, furniture, dirt and other materials, filling, 3,460 cubic meters, were packed into steel drums and removed to away to an abandoned quarry. Kevin O'Neill, "The Nuclear Terrorist Threat," Op. cit., p. 7.
4. The nuclear industry defends its plants against natural and accidentally occurring hazards on a basis of 'as chance would have it', and it provides protection against human error by designing the systems and equipment to be tolerant and/or independent of human action (or inaction). John H. Large, "The implications of 11 September for the nuclear industry," *Disarmament Forum,* No 2, (Geneva: 2003), p. 30.
5. Some experts have suggested that the technical expertise of a Soviet scientist familiar with their construction would be required for detonation, and there is some question about whether such weapons would even work after decades without maintenance. But the unknowns about such mini-nukes, combined with their portability, are cause for deep concern. 'Nuclear Terrorism: a Briefing Paper', *International Physicians for the Prevention of Nuclear War*, http://www.ippnw.org/NukeTerrorism01.html, accessed on 13 October 2004.
6. Mobley is accused in Yemen of being a member of Al-Qaeda and shooting a guard while attempting to escape custody on March 7, 2010 in the capital Sanaa. He grabbed a firearm while being treated under guard at a hospital, killed one guard and badly wounded another before being subdued. Joseph Delmar, the spokesman of the PSEG Nuclear in New Jersey Company admitted that Mobley worked "mainly during refueling outages for several weeks at a time." He added: "While working here, he did routine labor work carrying supplies and assisting maintenance activities. He also worked at other nuclear

plants in the region." "Alleged Al-Qaeda man worked at US nuclear power plant," New York (AFP) March 12, 2010. http://www.spacewar.com/reports/Alleged_Al-Qaeda_man_worked_at_US_nuclear_power_plant_999.html, accessed on March 18, 2010.

7. Ibid
8. Syria denied the assertions that it had any nuclear weapon project or it dealt with North Korea. Similarly, Pyongyang maintained that it did not transfer nuclear technology to Syria.
9. These reported losses were in addition to the 70 kilograms of plutonium Japan previously conceded remained unaccounted for at a plutonium-based fuel fabrication plant it was operating. Sokolski, Henry, 'After Iran: Back to the Basics on "Peaceful" Nuclear Energy', *Arms Control Today,* April 2005.
10. Ibid
11. The Zippe centrifuge can produce as many as ninety thousand revolutions per minute. One of the innovations was to heat the bottom so as to produce countercurrents. The heavier uranium-238 is collected in a downward-moving current at the outside while the lighter uranium-235 moves on an upward current on the inside, where it can be collected. The original centrifuges used aluminum rotors, but aluminum has now been replaced by specialized steels. Jeremy Bernstein, *Nuclear Weapons: What you need to know,* Op. cit., p. 263.
12. The then President of Pakistan claimed in his news conference on February 7, 2004 and went on to say that Pakistan's civil and military bureaucracy was not a part of this illicit nuclear trafficking.
13. He later retracted his remarks.

End Notes

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