Nuclear Terror:

The Essentials, Threats, Effects and Resilience

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LIST OF ABBREVIATIONS

CBRN – Chemical, Biological, Radiological and Nuclear

CDC – Center for Disease Control and Prevention

CNS – Center for Non-proliferation Studies

CRCPD – The Conference of Radiation Control Program Directors

DOD – Department of Defense

FAS – Federation of American Scientists

GICNT – Global Initiative to Combat Nuclear Terrorism

IAEA – International Atomic Energy Agency

ICRP – International Committee for Radiation Protection

ISIS – Islamic State of Iraq and Syria

NCRP – National Council on Radiation Protection and Measurements

OECD – Organization for Economic Cooperation and Development

SADM – Special Atomic Demolition Munition

UNDOC – United Nations Office on Drugs and Crime

WMD – Weapon of Mass Destruction

1. INTRODUCTION

Chemical, Biological, Radiological and Nuclear (CBRN) means of destruction used to be called "Non-conventional" and were rarely used in the last decades following World War II[1] . In the last few years, with ISIS activities in Iraq and Syria, the world has witnessed frequent usage of chemical gas by both the Syrian army and their counterparts, along with brutal means of mass executions. It is evident now that the concept of "Non-conventional weapons" is no longer entirely valid, and that the world has crossed all legal and moral thresholds regarding the use of CBRN and any "non-conventional" means. Terrorist groups seek to engage any means that may serve their goals. Our research concentrates on Nuclear and Radiation terrorism.

Islamic terrorist groups are motivated by religious rulings – "Fatwas" – that provide them with the justification and legitimacy for their deeds. In chapter 2 we cite several fatwas that provide the impetus for the use of weapons of mass destruction (WMD).

Nuclear terrorism can manifest itself in several forms: nuclear explosion, release of radio-active radiation and dispersion of radioactive materials. In chapter 3 we survey the details of all these forms and conduct a quantitative assessment to show that the most probable form is the dispersion of nuclear materials through a Radiological Dispersion Device (RDD), usually involving the detonation of explosives augmented with radioactive materials, known also as a "dirty bomb".

The detonation of a dirty bomb may have many severe implications. Alongside with the bomb casualties, it may have medical, economical and socio-psychological effects. Chapter 4 deals with the socio-psychological effects related to a dirty bomb. An incident in the city of Goiania, Brazil, in which radioactive material was unintentionally spread in the city is referred to as a test case for the socio-psychological impacts of a dirty bomb.

Since the dirty-bomb is considered a real threat, chapter 5 deals with ways to communicate the risk to the public and extends its scope to deal with ways to build

[1] Recall Egypt's use of gas in its fight in Yemen, in the 1960's, Saddam Hussein's gas attack on Kurdish villages in northern Iraq in the 1990's, and several occasions of chemical and biological terrorist acts conducted by terrorist groups, for example Aun-Shinrikyo in Japan and Rajneeshe in Portland, Oregon (USA).

resilience to the RDD and its possible consequences. Resilience is treated in this chapter in the broad sense that includes both the activities carried out so as to prevent terrorists from detonating a dirty bomb, and the preparedness to deal with its medical, economical, sociological and psychological impact in both the short term and long term effects.

The nuclear terror threat has been recognized as the global main threat by world leaders including President Obama, Prime Minister Merkel of Germany, the Secretary General of the United Nations and many others. The International Atomic Energy Agency (IAEA) affiliated with the United Nations, which used to lead the global efforts on Nuclear Safety, took upon itself the same role regarding Nuclear Security as of 2002. Chapter 6 provides a detailed description of the global anti nuclear terror activities conducted by the IAEA, including a survey of all the guidelines published by the organization dealing with the many different aspects regarding nuclear terrorism. The Global Initiative to Combat Nuclear Terrorism (GICNT) is also described in this chapter, as well as a mention of the legal issues related to anti-terrorism activities.

Chapter 7 provides a list of very recent global incidents and trafficking of nuclear materials that can be used for nuclear terrorism acts. In the framework of this research, we conducted a survey of open sources related to the topic of incidents and trafficking of nuclear materials in the last three years. We refrained from dealing with nuclear reported issues related to states, i.e. Iran, Turkey, Pakistan, North-Korea and Syria. This survey is by no means a complete account of these incidents, yet, it provides the assurance that the field of nuclear materials theft and trafficking is alive and dynamic.

In chapter 8 we summarize the main findings of this work and draw several conclusions and recommendations so as to decrease the probability of a nuclear terror act on the one hand, and building resilience to such an act on the other hand. One of the recommendations is to carefully follow the guides published by IAEA, yet we point out several flaws in the IAEA that need to be taken care of given the geopolitical circumstances in the region.

We recognize that the readers of this document may have no scientific background, yet they are interested in the issue of nuclear terrorism. For those readers we wrote an

original annex, which provides the very elementary basics of nuclear radiation and nuclear phenomena and the biological effects of the nuclear radiation.

2. Religious Rulings Regarding the Legitimate Use of WMD in Terror Activities

Terrorist groups are often motivated by religious impetus and drive. All the known religious ruling in the last two decades regarding the use of weapons of mass destruction came through Muslim clerks in several Fatwas. This chapter describes what a Fatwa is and cites several Fatwas that relate to the use of weapons of mass destruction (WMD).

What is a Fatwa[2]?

A fatwa is an Islamic religious ruling, a scholarly opinion on a matter of Islamic Law. A fatwa is issued by a recognized religious authority in Islam. Since there is no hierarchical priesthood in Islam, a fatwa is not necessarily "binding" on the faithful. The people who pronounce these rulings are supposed to be knowledgeable, and base their rulings in knowledge and wisdom. They need to supply the evidence from Islamic sources for their opinions, and it is not uncommon for scholars to come to different conclusions regarding the same issue.

Fatwas regarding WMD

Several fatwas have been issued regarding WMDs and in particular, nuclear bombs. A comprehensive review of those fatwas was recently published[3] and some mention of those fatwas is provided below. All operational Jihadic activities regarding WMDs must be authorized and supported through fatwas. Since we deal with nuclear terror we cite those fatwas that support Jihadic nuclear terror, yet there are several fatwas that express different rulings.

[2] This section is based upon "Islamic Glossary", http://islam.about.com/od/law/g/fatwa.htm

[3] Rolf Mowatt-Larssen, "Islam and the Bomb - Religious Justification for and against Nuclear Weapons", Harvard Kennedy School, Belfer Center for Science and International Affairs, January 2011

Osama Bin Laden 1998 FATWA

"All these crimes and sins committed by the Americans are a clear declaration of war on God, his messenger, and Muslims, And ulema have throughout Islamic history unanimously agreed that the jihad is an individual duty if the enemy destroys the Muslim countries. This was revealed by Imam Bin-Qadamah in "AL-Mughni", Imam al-Kisa'I in "Al-Bada'i", al-Qurtubi in his interception, and the shaykh of al-Islam in his books, where he said: "As for the fighting to repulse [an enemy], it is aimed at defending sanctity and religion, and it is a duty as agreed [by the ulema]. Nothing is more sacred than belief except repulsing an enemy who is attacking religion and life".

On that basis, and in compliance with God's order, we issue the following fatwa to all Muslims: The ruling to kill the Americans and their allies – civilians 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 al-Aqsa Mosque and 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. This is in accordance with the words of Almighty God, "and fight the pagans all together as they fight you all together", and "fight them until there is no more tumult or oppression, and there prevail justice and faith in God"

This fatwa declares an all-out war against America and its allies and provides the justification for such a war, calling for a Jihad that uses all possible measures in this war. A specific mention to WMD was provided by Zawahiri, his deputy and successor, in what is called "The Zawahiri Project".

Some experts from Zawahiri's Fatwa of 2008:

"If a bomb were dropped on them, destroying 10 million of them and burning as much of their land as they have burned of Muslim land that would be permissible without any need to mention any other proof. We might need other proofs if we wanted to destroy more than this number of them"

Zawahiri cites other related fatwas published by other Islamic Clerks and the main conclusions can be summarized as follows:

- All Americans (and their allies) are a legitimate target, including women and children
- The first stage, which needs no further authorization, should cause the death of millions of Americans (and their allies)
- The best of Al-Qaeda (following 9/11) is yet to come
- WMD is a proper manner to achieve those goals
- Al-Qaeda is constantly improving its capabilities

One should bear in mind that this chapter here is by no means a detailed account of the fatwas related to this issue, yet it provides an insight to the religious impetus to acquire and use Weapons of Mass Destruction.

3. The Different Forms of Nuclear Terrorism

Nuclear Terrorism can manifest itself in several different forms:

Nuclear Explosion – This form of nuclear terrorism is the gravest in terms of the number of casualties, the immediate vast destruction and the lethal long-term effects on human health and the environment.

Determined-terrorist groups can acquire and detonate a nuclear bomb through the following possible paths:

- Seizing a bomb through theft, diversion or taking over nuclear devices in states that are politically unstable
- Obtaining a bomb from a supportive state
- Buying a bomb either from a supportive state or individuals with access to a nuclear device
- Acquiring fissile materials and detonating an improvised nuclear device

Releasing Radioactive Radiation – This can be significantly accomplished through damaging nuclear power stations and consequently creating a wide spread of radioactive materials with similar effects as accidently experienced in Chernobyl and Fukoshima. The deliberate release of radiation can be accomplished through several means:

- Airplane-crash into the nuclear core of the power station
- Stand-Off missile attack
- Commando-type penetration of terrorists into the power station destroying the nuclear core from within
- Sabotage by insiders recruited by the terrorist organization
- Sabotage through remote cyber terrorism by taking over the control systems and creating the conditions for a melt-down of the nuclear fuel, thus allowing for wide-spread dispersion

Other facilities that may release significant amounts of radiation are spent-fuel storage facilities, reprocessing plants and high-level radioactive waste-storage sites.

Dispersing Radiation – This means of nuclear terrorism can be accomplished in several paths:

- A Dirty Bomb – A conventional TNT bomb augmented radioactive materials. While being detonated the bomb has its conventional explosive effect along with the spread of radioactive particles and aerosols. This device, referred to as a "dirty bomb", is not regarded as a weapon of mass destruction, but as a "weapon of mass disruption" because of the fear imposed upon the people from the non-sensible radiation.
- Spread of radioactive materials, such as those widely used in medical diagnoses, medical treatments and industrial radiography, so as to expose people to the radiation and cause radiation-sickness. A relatively large area that may be contaminated should be evacuated and subjected to clean-up procedures. The closure of the area for a considerable duration of time bears economical, ecological and complicated socio-psychological impacts. The Guiania incident, to be discussed later, in which an orphan abandoned radioactive source spread in the city is an actual demonstration of the consequences of such an event.
- Local radioactive poisoning through insertion of radioactive sources in food and water supplies or hiding a nuclear radiation source at a site where people are externally exposed to the radiation.

The following Table[4] provides a scaling of the complications involved in each of the nuclear terrorism paths mentioned above. The features in the table include:
"Motivation" – how much motivation should a terrorist group have in order to conduct the specified nuclear terrorism act (Extreme – 4, Very High – 3, Moderate – 2, Low – 1). "Organizational Skills" – what level of organizational skills is required to conduct the terrorist act. The additional features are: "Geographic Reach Needed", "Financial Resources", "Technical Skills", "Difficulties to meet all the necessary demands".
The table is listed below:

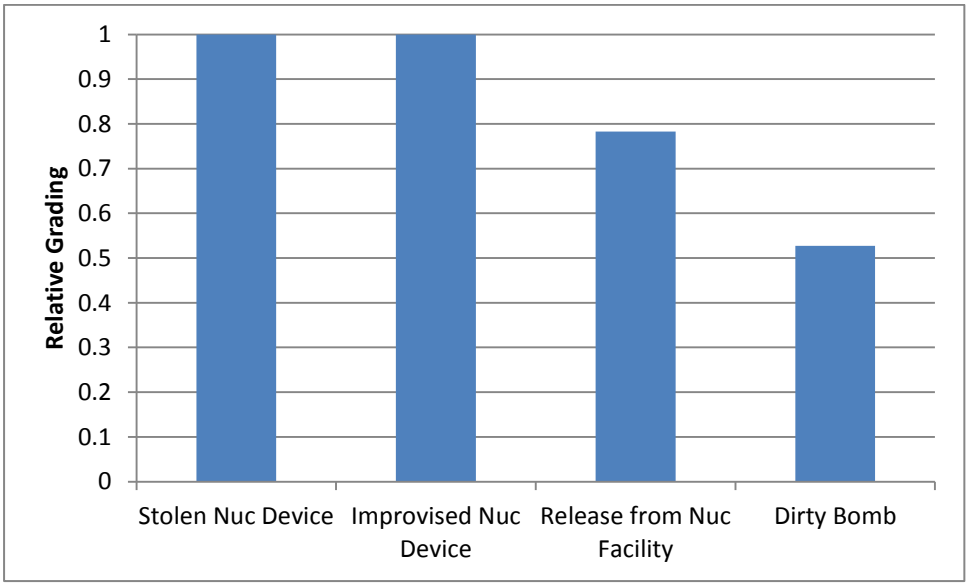
[44] The Four Faces of Nuclear Terrorism. C.D.Ferguson and W.C.Potter, CNC – Center for Non-Proliferation Studies, Monterey, California, 2004

A Scaling of the Complications Involved in the Various Nuclear Terrorism Paths

The feature	Stolen Nuclear Device	Improvised Nuclear Device	Radioactive release from a nuclear facility	Dirty Bomb
Motivation	Extreme - 4	Extreme - 4	Very High - 3	Very High - 3
Organizational skills	Very High - 3	Very High - 3	Very High - 3	Moderate - 2
Geographic reach	Multi-country capacity - 4	Multi-country capacity - 4	Single country - 3	Single country - 2
Financial resources	High - 4	High - 4	Moderate-High - 3.5	Modest - 2
Technical Skills	High - 4	High - 4	Moderate-High - 3.5	Modest - 2
Difficulty to meet all demands	High - 4	High - 4	Moderate - 2	Low-Modest - 1
Total Grading Score	23	23	18	12

We introduce the following picture to provide a graphic presentation of the relative normalized grading:

Relative Complications to Carry Qut a Nuclear Terror Attack



It is evident that the most convenient and easy-to-accomplish means to implement a nuclear terrorism act is through a "Dirty Bomb".

Thus, it would be reasonable to assume, that the RDD means, though the lowest in its consequences, has the most likelihood to actually take place. In this document we shall put emphasis on this means and elaborate on its major disruptive effect, which is what terrorism is about.

All in all, the different forms of nuclear terrorism all impose two major challenges: the huge effort to prevent the very happening of a nuclear terrorism act, and the task of being prepared to respond to such an event, in the event that it occurs, and to mitigate its possible disastrous consequences.

4. Socio-Psychological Impacts of Nuclear Terrorism: The Goiania Incident as a Test Case for the "Dirty Bomb" and Other Sources

Radiological terrorism is the deployment of a Radiological Dispersal Device (RDD) that results in radiation exposure of a targeted population. The main purpose is to mass panic rather than mass destruction as in most cases, the amount of radiation exposure is not enough to cause critical radiation detriment. Nevertheless, the social and psychological effects can be severe (and more widespread than the actual physical harm caused by an RDD), particularly in a metropolitan area where a large number of people may either be actually contaminated or, perceive to be contaminated, and this can have far-reaching economic and social consequences.

An explosive-based RDD, commonly known as a “dirty bomb”, though comparatively lowest in its consequences from all other means of nuclear terrorism, has the most likelihood to actually take place, as demonstrated earlier. This is due to its relative ease in being carried out and because of its major disruptive effect, which is what terrorism is essentially about. A dirty bomb seems to be the easiest way to produce panic on a mass scale through the usage of nuclear materials, and therefore it has been estimated that an RDD attack somewhere in the world is overdue.[5]

In the aftermath of the accidental radiological incident contaminating the Brazilian city of Goiania in 1987, there is a wealth of valuable experience gained from which lessons can be learned and practical solutions to future potentially similar scenarios applied. The incident highlights the reaction by the uncontaminated residents of Goiania, as well as the panicked reaction of outsiders towards the city’s residents. Alongside emerging issues such as "panicky" news reports, social stigma, economic losses and legal problems, as well as questions of state and federal responsibility, more specifically, the socio-psychological effects of a radiation terrorism event can provide an understanding of the dirty bomb outcome, and lessons can be derived so as to plan a proper response in the event that a dirty bomb is detonated.

[5] Allison, Graham. Nuclear Terrorism: The Ultimate Preventable Catastrophe, 2004. P8.

In December of 1987, two months after a major radiation accident shocked the Brazilian city of Goiania, when a cancer treatment machine was opened in a junkyard, The New York Times reported, "the threat of contamination, like an intangible plague, still reaches deep into the psyche of its [the city's] inhabitants."[6] Time Magazine has identified the accident as one of the world's "worst nuclear disasters"[7] and the International Atomic Energy Agency called it "one of the world's worst radiological incidents".[8]

After an old radiotherapy machine was stolen (for its scrap metal value) from an abandoned hospital site in the city, and subsequently handled by many people, four people died and many others were injured, leading to the radioactive contamination of parts of the city – a city with an approximate population of one million. However, it was "radiophobia," referring to the fear of radiation, which itself radiated across the city of Goiania as well as the rest of Brazil in the months following the accident, which caused the most harm.

Radiophobia is what caused businesses to cancel orders from this farming state and incited people in other cities to stone cars and cancel hotel reservations of travelers from Goiania. Two airline pilots were dismissed after they refused to pick up passengers from Goiania. Mailmen and repairmen refused to come to the city's inhabitants and it was even reported that relatives and colleagues avoided the city's inhabitants, to the point where families boycotted their relatives who were part of the medical personnel that agreed to treat the radiation casualties. Some doctors and nurses had to stay at the hospital or find alternative housing. Several shops and bars lost their clients and employees and closed down. People were forced off buses headed for other cities. Several buses from Goiania had been stopped altogether and some hotels refused to accept travelers from here. An international trade fair in Rio de

[6] "Radiation Fears Infect Brazil After Accident", SIMONS, MARLISE. The New York Times, December 2 1987.
[7] "The Worst Nuclear Disasters", TIME Magazine http://content.time.com/time/photogallery/0,29307,1887705_1862268,00.html, Accessed January 4, 2016.
[8] "Time to better secure radioactive materials", Amano, Yukiya. The Washington Post, March 25, 2012.

Janeiro went so far as to ban products from the state of Goias.[9] What began as a relatively minor accident cascaded into turmoil for an entire state's internal and external economy and this was mainly due to people's perception of danger rather than the actual risks. For this reason, one cannot underestimate the importance of the role of a healthy socio-psychological state of a population.

Panic and hysteria among a targeted population is actually a terrorism act per-se. In the case of Goiania, panic led way to anger and violent clashes broke out between citizens and technical decontamination staff, who were deployed to manage the procedures. Citizens were furious to see and did not understand why the technical staff, unlike themselves, were given protective outfits.[10]

In addition, the Brazilian National Nuclear Energy Commission (CNEN) staff, who were called in to manage urgent decontamination procedures, although having extensive theoretical knowledge, had no practical experience with real radiation victims.[11] Excessive and emotional stress combined with shock was experienced by overworked experts having to cope with patients screaming and in despair, leading to psycho-somatic disturbances among staff. The staff, therefore, had to be replaced after 2-3 weeks.

In the aftermath of the incident, huge numbers of people—about 112,000—streamed into special facilities asking to be monitored for signs of radiation. Some came from locations far removed from the site of the accident, even from other states.

Even after discharge from the hospital, residents who had been contaminated often faced discrimination and had difficulties in finding jobs as a result of stigmatization.

Since this chapter deals with RDD specifically, the Chernobyl and Fukushima accidents present much more far reaching damage and consequences. However, it is worth mentioning here that these examples also entail the provoked feelings of

[9] "Radiation Fears Infect Brazil After Accident", SIMONS, MARLISE. The New York Times, December 2 1987.
[10] The Radiological Accident in Goiânia - IAEA Publications, September 1988
[11] "Countering Radiological Terrorism: Consequences of the Radiation Exposure Incident in Goiania (Brazil)", F. Steinhäusler, in : Social and Psychological Effects of, Radiological Terrorism, Volume 29 NATO Science for Peace and Security Series: Human and Societal Dynamics, Editors: I. Khripunov, L. Bolshov and D., Nikonov, November 2007, 176 pp., hardcover, ISBN: 978-1-58603-787-1.

mistrust in the minds of the public, reinforced by the fact that radiation cannot be perceived by humans. The prospect of, for example, contaminated food, aggravated by ambiguous, even contradictory recommendations by national authorities gave rise to a variety of reactions and, perhaps more importantly, overreactions. An important consequence of both Chernobyl and Fukushima, which has a bearing on health, is the appearance of a widespread status of psychological stress in the populations affected.

Public skepticism towards authority was reinforced not only by the difficulty in understanding radiation and its effects, but also the inability of perceived experts to present the issues in a way that was comprehensible. This induced anxiety and stress in people not only in contaminated areas, but also to a lesser extent, all over the world.[12]

[12] "CHERNOBYL Ten Years On – Radiological and Health Impact" – An Appraisal by the NEA Committee on Radiation Protection and Public Health, OECD, Paris, November 1995.

5. Communicating the Nuclear Terror Risk to the Public and Ways to Build Resilience

The impacts of a nuclear attack will vary. Many of those who were or believe they were exposed will likely worry about delayed radiation health effects. Depending on how the attack evolves and its aftermath is handled, there may be loss of confidence in societal institutions. If severe damage to the communications network disrupts communication from authorities, public anxiety and fear could be heightened.

There are several definitions for resilience, originally stemming from the technological world. A common definition is "the physical property of a material that can return to its original shape or position after deformation that does not exceed its elastic limit." (Collins English 2012 Digital Edition). Also: "the ability of something to return to its original shape after it has been pulled, stretched, pressed, bent, etc." (Webster) and similar definitions from Oxford and Cambridge dictionaries. The Webster dictionary broadens the definition to the societal field: "the ability to become strong, healthy, or successful again after something bad happens" and "the capacity to recover quickly from difficulties; toughness" (Oxford).

In the technological field there has been some evolution in the perception of the term resilience. From a traditional definition stating that "resilience is the ability of a system (or organization) to keep, or recover quickly to a stable state, allowing it to continue operations during and after a major mishap or in the presence of continuous significant stresses", resilience takes a more general definition that includes "prevention of upsets"[13].

Building resilience in its broadened sense includes several stages that are interconnected and inter-dependent:

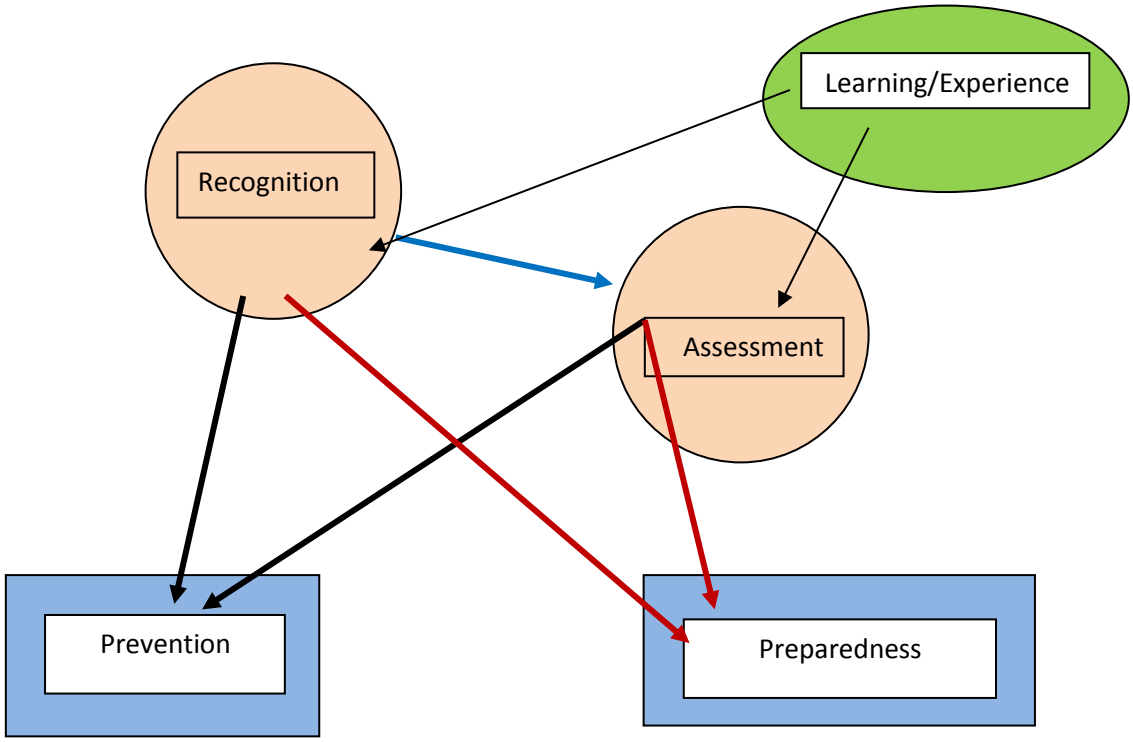
- RECOGNITION - Recognize the threat
- ASSESSMENT - Assess the potential outcomes if the threat is being carried into effect

[13] "Resilience Engineering: Concepts and Precepts", E. Hollangel, D. Woods and N. Leveson (Eds.), Ashgate Pub., USA, 2012.

- PREVENTION - Build a capability to prevent or minimize the probability of the threat to be realized
- PREPAREDNESS - Build the ability to recover quickly or continue operations during and after the threat was realized
- MODIFICATIONS - Periodical examination and modifications due to new data, new technology or experience

We can show these stages in the diagram below:

A diagram of the building blocks of resilience



Resilience to RDD

In the previous chapters, we have shown how an RDD attack has been recognized as a real threat. The issue of building resilience to the effect of an RDD attack has been addressed by several international and professional organizations. Assessment of the outcomes of an RDD terrorist attack has been generically carried out, and computer models have been developed to take into account different parameters such as the characteristics of the radioactive materials, weather conditions and the environment where the event takes place (i.e. rural or urban nature).

Prevention is based upon intelligence work, homeland security authorities and international cooperation and is usually conducted secretly. The preparedness stage includes several aspects, such as:

- Establishment of a recognized management team responsible to deal with the event
- Preparation of teams and equipment that can decipher that an event did spread radioactive materials
- Preparation of a scientific team and equipment to carry out calculations as to the extent and consequences of the event
- Preparation of technical teams to carry out decontamination operations
- Preparation of plans and resources to evacuate people from infected areas
- Preparation of medical and public health staff to deal with radiation related injuries both on the scene and in hospitals
- Preparation of law-enforcement teams to deal with possible chaos situations
- Preparation of alternative housing for evacuated people
- Training fire fighters to deal with potential fires in infected areas
- Preparing the logistics needed to supply the working teams for a considerable time
- Preparing professional teams to deal with the socio-psychological aspects of an RDD
- Preparing reliable teams to communicate with the public regarding the nature of an RDD and the operations conducted by the authorities during the event and following the event.

There exist several publications regarding the methodology to be used to comply with all these issues. Recently, in November 2015, the IAEA published yet another volume in its Safety Standard Series, providing an up-to-date guidance to emergency preparedness and response to nuclear or radiological emergency for protecting people and the environment[14].

The NCRP had also published its own guide entitled: Responding to a radiological or Nuclear Terrorism Incident: A guide for Decision Makers[15]. This report provides a

[14] IAEA Safety Standards, GSR Part 7, November 2015
[15] NCRP Report #165, 2010

comprehensive summary of recommendations and key decision points for planners preparing response to radiological or nuclear terrorism incidents.

The CRCPD Task force HS-5 for responding to radiological dispersal device RDD published a Handbook for responding to RDD – First Responders Guide – The First 12 Hours[16].

There are also some dedicated guides published by international organizations, for example, a publication by the Center for Disease Control and Prevention (CDC), which provides a tool-kit for public health officials and also maintains an updated site online with information on responding to nuclear emergencies.

Of all the issues addressed in those guidelines, it seems that while most of them are of professional and technological characteristics, the issue of communication with the public cannot be put into frames and it poses several complications to be considered, as described in the section below.

Communicating the RDD to the public

Precautions notwithstanding, if an accident does occur, there should be a well understood chain of information and command which needs to be clearly communicated. The issue of reliable communication to the public before an event takes place, during its occurrence and following an event is addressed in all the handbooks and guidelines. For example, requirements 10 and 13 in the IAEA Safety Standard state: "The government shall ensure that arrangements are in place for communication with the public throughout a nuclear or radiological emergency" and "The government shall ensure that arrangements are in place to provide the public who are affected or are potentially affected by a nuclear or radiological emergency with information that is necessary for their protection, to warn them promptly and to instruct them on actions to be taken".

In preparing an effective and reliable means of communication with the public there are some considerations to take into account, which make the communication with the

[16] CRCPD Task Force HS-5, 2006

public some-what complicated. Several articles address these considerations. A publication by the Stinton Institute[17] mentions that:

> "The American mass media's coverage of the rising threat of radiological terrorism has focused on the potential for catastrophic effects. Stories about an RDD incident often describe mass casualties, plumes of radioactive clouds over urban areas, and mass relocation of those living or working adjacent to the incident sites. This sensational coverage has misrepresented the radiological threat by overstating the physical effects of an attack. Worse still, some have equated radiological terrorism with nuclear detonations. The media has delivered this conflicting and incorrect information to a public that already has a deep fear and misunderstanding of radiation".

It is also evident in a time of crisis that the media is keen to interview whoever is considered to be an expert, or whoever introduces himself as one, among which, are academic professors, former members of the security forces etc. These self-declared experts may not be updated and thus may provide incorrect, outdated or inaccurate information, arise unnecessary panic and interrupt with the communication efforts made by the authorized personnel.

Public education is a critical component of radiological terrorism response planning. Jurisdictions must educate the public about the effects and dangers of a radiological incident. National and local government officials should receive sufficient training so they are prepared to provide effective strategic communications during an incident. A well-tailored public education campaign must overcome misinformation about the nature of the RDD threats, speak to a range of audiences, and build confidence in emergency response organizations.

The communication aspect of resilience preparedness should count on:

- Establishing a team of experts who can provide accurate and reliable information. The team members must not only be experts and knowledgeable but also be trained how to effectively broadcast information to the public and work with the media.

[17] "Radiological Terrorism: The Dangers of Public Misperception", C, Galastri, Stinton Inst., 2007

- Clear, accurate information about radiological threats is fundamental to avert mass panic and save lives. This information should be routinely available to the public, i.e. through the internet, radio broadcast, tv and print media.
- Effective pre-tested and pre-drafted messages prepared in due time can facilitate the communication to the public in real-time when an event takes place.

Information about RDD can be found online in official sites open to the public, including the official site of the Israel Defense Forces (IDF)'s Homeland Command.

It is important to communicate that the radioactive part of the dirty bomb is not capable of causing an immediate death, such as is caused by the conventional explosives, but may increase, under very certain circumstances, the likelihood of latent cancer. This likelihood depends on several factors, such as the type of radioactive source, the level of exposure to the radiation, the rate of exposure, the modes of exposure, i.e. external exposure, annihilation or penetration through the breathing system.

Radioactive materials are used in many civilian utilities and play an important role in medical diagnosis and medical therapy. People are prone to react as if radiation is a type of transmissible disease, or virus. It is important to communicate, as did the IAEA, Vienna, in its September 1988 report of The Radiological Accident of Goiania, that the applications of nuclear energy and nuclear materials in industry, medicine, agriculture and scientific research can be of great help in raising productivity, diagnosing and treating disease and improving agriculture. Such activities cannot ever be entirely free of the risk of accidents: "Any human endeavour entails a certain degree of risk, while refraining from endeavour carries risks of its own."[18]

The public must feel confident that the responsible authorities and individuals do all in their power to minimize these risks; a process which includes learning from any accident that may occur despite all the precautions taken. It is worth mentioning that an accident should be documented as soon as possible, since the facts tend to become blurred with the passage of time.

[18] The Radiological Accident in Goiânia - IAEA Publications, September 1988.

Good communication is required between all concerned in implementing and enforcing radiological protection requirements. Recognition by the general public of the potential danger of radiation sources is an important factor in lessening the likelihood of radiological accidents.

It is crucial to develop a communication approach that is informed by an awareness of people's fear and concerns and that effectively conveys the information needed to protect health and safety.

Recognizing that information and communication are crucial in the prevention and mitigation of social behavioral consequences, it is vital that accurate and complete information be conveyed as early as possible. The overarching communication policy must be one that recognizes that public health and safety are paramount. Not paying sufficient attention to critical psychosocial and communication issues could result in failed efforts to manage an incident.

6. Global Anti-Nuclear Terrorism Activities: The International Atomic Energy Agency (IAEA)

The IAEA Perception of the Nuclear Terror Threat[19]

The IAEA considers the nuclear terror threat to be real and grave:

- Not only is the threat of nuclear terrorism real, but it is the number one threat the international community faces. There are reports that confirm Al-Qaeda is continuing its pursuit of weapons of mass destruction. With enough materials available worldwide to build 120,000 nuclear bombs, the possibility that a terrorist network could buy or steal such material is far too high. Failure to recognize the gravity of this threat could have devastating consequences.
- There are still unsecure nuclear materials around the world, including in the developed world, which terrorists and other non-state actors could potentially gain access to. This underscores the importance for states to secure, reduce, and/or eliminate their stockpiles of weapons and sources of radiological materials, in order to prevent materials/technology from falling into the wrong hands.
- Ungoverned or poorly-governed areas around the world potentially pose an increased risk of nuclear theft.

The Former Director General of the IAEA, Mohamed El Baradei, declared on February 1st, 2009, that: "Nuclear terrorism is the most serious danger the world is facing". Many other leaders, not of the IAEA, such as President Obama expressed the same observation in 2009: "Nuclear terrorism is the most immediate and extreme threat to global security." Indeed, one should recall Osama Bin Laden's declaration in 1998 on "The Nuclear Bomb of Islam," stating that "It is the duty of Muslims to prepare as much force as possible to terrorize the enemies of God." However, Al Qaeda is not the only terrorist group that is most considered by the IAEA. A research conducted on behalf of the IAEA [20] details that four terrorist groups have demonstrated interest in acquiring a nuclear weapon: Al Qaeda, Chechnya-based

[19] The official website of the International Atomic Energy Association

[20] Nuclear Security Summit Background Material, Harvard Kennedy School, Belfer Center for Science and International Affairs, April 2010.

separatists, Lashkar-e-Taiba, and Aum Shinrikyo. To this list the research adds the Taliban and Hezbollah, as groups that may be capable of acquiring and using nuclear weapons. Aum Shinrikyo and Al Qaeda have already made attempts to buy nuclear material on the black markets. Al Qaeda is reported to have been trying to acquire or make nuclear weapons for at least 15 years, and continues to pursue its strategic goal of obtaining a nuclear capability.

The legal framework of IAEA

The legal framework and mandate of the IAEA to deal with issues related to nuclear terror stems from international treaties and conventions under the United Nations authority, from regional treaties recognized by the UN, and from resolutions obtained by the UN Security Council. The main sources are listed below:

International Conventions

- Treaty on the Non-Proliferation of Nuclear Weapons
- International Convention for the Suppression of Terrorist Bombings[21]
- International Convention for the Suppression of Acts of Nuclear Terrorism[22]

Regional agreements

- Regional Non-Proliferation and Nuclear Weapons Free Zone Treaties

United Nations Security Council Resolutions

United Nations Security Council resolutions 1373 (2001) and 1540 (2004) address, among other things, the threat of nuclear terrorism and nuclear proliferation and call for national, regional and international cooperation to strengthen the global response to these challenges to international security. The IAEA provides, on request, assistance to the UN Committees established in relation to Security Council resolutions 1373 and 1540 and assists member states in meeting their obligations under these resolutions. A brief summary of these resolutions is listed below:

Security Council Resolution 1373 which was adopted in 2001, notes with concern the close connection between international terrorism and the illegal movement of nuclear

[21] United Nations General Assembly (UNGA) Resolution 52/164 Annex, 1997

[22] UNGA Resolution 59/290, 2005

materials. The resolution emphasizes the need to enhance coordination of national, regional and international efforts in order to strengthen a global response to this serious challenge and threat to international security. The resolution obliges all states to criminalize assistance for terrorist activities, deny financial support and safe haven to terrorists and exchange information for the prevention and prosecution of criminal acts.

Security Council Resolution 1540 which was adopted in 2004 obliges all states to adopt and enforce appropriate effective laws which prohibit non-state actors to manufacture, acquire, possess, develop, transport, transfer or use nuclear weapons, in particular for terrorist purposes, and to establish domestic controls to prevent the proliferation of nuclear weapons, including the establishment of appropriate controls over related material. To this end, states are obliged to implement a variety of accountancy and control measures. These include: physical protection measures; border controls; measures to detect, deter, prevent and combat illicit trafficking; and import and export control measures.

To this list of basic security related fundamental documents one should also refer to:

- Convention on the Physical Protection of Nuclear Material (A convention on Safety, but has also Security implications)
- Code of Conduct on Safety and Security of Radioactive Sources (A non-binding publication by the IAEA that provides the framework as to how to implement the treaties and UN resolutions listed above)
- Safeguards agreements and their additional protocols (The safeguards agreements signed between the IAEA and member states, which define the protocols for the IAEA inspections in nuclear installations (The Israeli Soreq Nuclear Research Center is inspected by IAEA under such an agreement).
- Physical Protection Objectives and Fundamental Principles (IAEA document)
- Nuclear Security - Measures to Protect Against Nuclear Terrorism, 2006 GC(50)/13 (A summary prepared by the IAEA Director General on behalf of the General Council of the IAEA).

Several conventions and treaties have been dedicated to the issue of *Safety* of nuclear materials and nuclear facilities. Though there is a strong linkage between the Safety and Security issues, it is beyond the scope of this paper to detail the

many publications of the IAEA on Safety related subjects. It should be emphasized, though, that the Safety publications are concerned mainly in the well being of the people and the environment, when handling nuclear materials and facilities under nominal work conditions, in peaceful operations such as medical diagnosis and therapy, non-destructive radiography, food and medical equipment sterilization and energy production.

Publications of the IAEA on Nuclear Security

Publications in the IAEA Nuclear Security Guidelines series are issued in the following categories:

- ***Nuclear Security Fundamentals*** contain objectives, concepts and principles of nuclear security and provide the basis for security recommendations.
- ***Recommendations*** present best practices that should be adopted by Member States in the application of the Nuclear Security Fundamentals.
- ***Implementing Guides*** provide further elaboration of the Recommendations in broad areas and suggest measures for their implementation.
- ***Technical Guidance*** publications comprise:
    - *Reference Manuals*, with detailed measures and/or guidance on how to apply the Implementing Guides in specific fields or activities;
    - *Training Guides*, covering the syllabus and/or manuals for IAEA training courses in the area of nuclear security; and
    - *Service Guides*, which provide guidance on the conduct and scope of IAEA nuclear security advisory missions.

It is important to pay attention to the wording: The recommendations *SHOULD* be adopted by member states, while the guides *SUGGEST* measures of implementation.
International experts assist the IAEA Secretariat in drafting these publications. For Nuclear Security Fundamentals, Recommendations and Implementing Guides, open-end technical meetings are held by the Secretariat to provide interested Member States and relevant international organizations with an appropriate opportunity to review the draft text. In addition, to ensure a high level of international review and consensus, the Secretariat submits the draft texts to all Member States for a period of 120 days for formal review. This allows Member States an opportunity to express their views before the text is published.

Nuclear Security Guidelines of the IAEA

The IAEA Nuclear Security Guidelines series was launched in 2006. Twelve guides in the series have been published to date:

1. **Technical and Functional Specifications for Border Monitoring Equipment**[23]

   Provides Member States and equipment manufacturers with guidance on design, testing, qualifying and purchasing of radiation monitoring equipment for use at borders. The system parameters can serve as state-of-the-art conceptual specifications for the deployment of equipment as well as for procedures for testing and confirming the performance parameters for border radiation monitoring equipment.

2. **Nuclear Forensics Support**[24]

   Describes the tools and procedures for nuclear forensic investigations. The guidelines incorporate experience in dealing with illicit trafficking events accumulated by law enforcement agencies and nuclear forensics laboratories.

3. **Monitoring for Radioactive Material in International Mail Transported by Public Postal Operators**[25]

   Describes the techniques and equipment available to detect radioactive material being carried in mail processed by public postal operators. These guidelines were developed in cooperation with the Universal Postal Union.

4. **Engineering Safety Aspects of the Protection of Nuclear Power Plants against Sabotage**[26]

   Provides guidelines for evaluating the engineering safety aspects of the protection of nuclear power plants against sabotage, including standoff attacks. The guidance takes into account the existing robustness of structures, systems and components, and emphasizes those aspects of sabotage protection that work synergistically with the protection against extreme external

[23] Combating Illicit Trafficking in Nuclear and other Radioactive Material, IAEA NSS No.6, 2007

[24] Nuclear Forensics Support, IAEA NSS No.2, 2006

[25] Monitoring for Radioactive Material in International Mail Transported by Public Postal Operators, IAEA NSS No.3, 2006

[26] Engineering Safety Aspects of the Protection of Nuclear Power Plants against Sabotage, IAEA NSS No.4, 2007

occurrences of accidental origin, such as earthquakes, tornadoes and human induced events.

5. **Identification of Radioactive Sources and Devices**[27]

   Aids non-specialist individuals and organizations in initial identification of radioactive sources, devices and packages that they may come into contact with by accident or in the normal course of their work.

6. **Combating Illicit Trafficking in Nuclear and other Radioactive Material**[28]

   Focuses on unauthorized acts involving nuclear and other radioactive material. It was developed as an information and training resource for law enforcement personnel who may be called upon to deal with detection of and response to the illicit trafficking incidents.

7. **Nuclear Security Culture**[29]

   Explains the basic concepts and elements of a nuclear security culture and how they relate to arrangements and policies for other aspect of nuclear security. It provides an overview of the attributes of nuclear security culture, emphasizing that nuclear security is ultimately dependent on individuals: policy makers, regulators, managers, individual employees and, to a certain extent, members of the general public.

8. **Preventive and Protective Measures against Insider Threats**[30]

   Provides general guidance to the competent authorities and operators on prevention of and protection against insider threats. Threats to nuclear facilities can involve outsiders, insiders or both together in collusion.

9. **Security in the Transport of Radioactive Material**[31]

   Provides States with guidance in implementing, maintaining or enhancing a nuclear security regime to protect radioactive material (including nuclear material) while in transport against theft, sabotage or other malicious acts that could, if successful, have unacceptable radiological consequences.

10. **Development, Use and Maintenance of the Design Basis Threat**[32]

[27] Identification of Radioactive Sources and Devices, IAEA NSS No. 5, 2007

[28] Combating Illicit Trafficking in Nuclear and other Radioactive Material, IAEA NSS No.6, 2007

[29] Nuclear Security Culture, IAEA NSS No.7. 2008

[30] Preventive and Protective Measures against Insider Threats, IAEA NSS No.8, 2008

[31] Security in the Transport of Radioactive Material, IAEA NSS No.9, 2008

[32] Development, Use and Maintenance of the Design Basis Threat, IAEA NSS No. 10, 2009

Provides guidance on how to develop, use and maintain a design basis threat, which is defined as a description of the attributes and characteristics of potential insider and/or external adversaries who might attempt a malicious act, such as unauthorized removal or sabotage against which a physical protection system for nuclear or other radioactive material or associated facilities is designed and evaluated.

11. Security of Radioactive Sources[33]

Provides guidance and recommended measures for implementing security measures on radioactive sources, including for the prevention of, detection of, and response to malicious acts involving radioactive sources. It recommends that security measures be applied to radioactive sources in manufacture, use and short term or long term storage. This publication is intended for use by States in formulating security policy for radioactive sources and by regulatory bodies in developing regulatory requirements that are consistent with the Code of Conduct on the Safety and Security of Radioactive Sources.

12. Educational Program in Nuclear Security[34]

Ensures the availability of experts able to provide the necessary competencies for the effective national nuclear security oversight of nuclear and other radioactive material and to establish and maintain an appropriate nuclear regime in a State. This guide provides both the theoretical knowledge and the practical skills necessary to meet the requirements described in the international framework for nuclear security. Emphasis is placed on the implementation of these requirements and recommendations in States. On the basis of this guide, each university should be able to develop its own academic program tailored to suit the State's educational needs in the area of nuclear security and to meet national requirements.

Further documents are in various stages of development and will be eventually published as part of the Nuclear Security Guidelines. One that is in a very advanced stage is Nuclear Security Glossary, Revision 3A Draft 17 March 2010, to be published soon as additional publication of the IAEA Nuclear Security Series.

[33] Security of Radioactive Sources, IAEA NSS No. 11, 2009

[34] Educational Program in Nuclear Security, IAEA NSS No. 12, 2010

Statements of the IAEA regarding Nuclear Terror Concerns

The IAEA publishes particular statements regarding nuclear terror, nuclear threats and violations of international conventions and treaties. For example, in the last two years IAEA published several statements of concern regarding the nuclear plans of Iran[35].

Conclusions on the IAEA activity

The International Atomic Energy Association recognizes the threat of nuclear terror as realistic and grave. Under the legal framework defined by the United Nations the IAEA has been promoting nuclear security through the preparation of professional recommendations and guides, providing training and equipment to state members, conducting inspections in safeguarded installations and the publication of statements regarding possible threats.

The guides published so far on the issue of nuclear security relate to both specific threats and to general concepts. The specific guides include the following issues:

- Technical and Functional Specifications for Border Monitoring Equipment
- Nuclear Forensics Support
- Monitoring for Radioactive Material in International Mail Transported by Public Postal Operators
- Engineering Safety Aspects of the Protection of Nuclear Power Plants against Sabotage
- Identification of Radioactive Sources and Devices
- Combating Illicit Trafficking in Nuclear and other Radioactive Material
- Preventive and Protective Measures against Insider Threats
- Security in the Transport of Radioactive Material
- Security of Radioactive Sources

[35] For example, IAEA Statement on Iranian Enrichment Announcement, Press Release 2010/02. Also The UN Nuclear Watchdog Statement that IAEA fears Iran is working now on nuclear warheads, September 2010.

The general guides include the following issues:

- Nuclear Security Culture
- Development, Use and Maintenance of the Design Basis Threat
- Educational Program in Nuclear Security
- Nuclear Security Glossary

Preparation of additional guides is under way.

The guides provide a comprehensive guidance to the implementation of security measures needed to combat nuclear terror and are usually prepared by a group of experts from all over the world. Before being finalized and approved, the guides are sent to all member states to be subjected to remarks and modifications. This later procedure ensures that upon approval, the guides have already gained global consensus.

Discussion and Recommendations Regarding the IAEA Nuclear Security Guidelines and Standards

The IAEA is aware of the threat of nuclear terror and is working towards the enhancement of nuclear security, which is perceived as the major global threat. The IAEA activities on this matter include the preparation of professional recommendations and guides, providing training and equipment to state members, conducting inspections in safeguarded installations and the publication of statements regarding possible threats. All this activity in security started as of 1998, and was enhanced significantly following the 9/11 terror attack.

The set of guides prepared and published by the IAEA on security issues, follows many years of similar work conducted on safety issues. The safety guides published during the many years of IAEA activity proved to be very useful, and were adopted by the member states. In Israel, the implementation of the safety guides is mandatory by default[36] and any deviation should be explained and approved. No doubt that the safety authorities can impose more severe demands and requirements as part of nuclear installation and facility licensing.

[36] A directive delivered by the Israel Atomic Energy Commission (IAEC), the Licensing and Safety Division, 1994

Following the excellent experience gained with the IAEA guides on safety, it is recommended that the IAEA guides on security will also be adopted as the cornerstone for the nuclear security policy and implementation in every state. Stricter measures should be imposed, if necessary, taking into account the particular state's reality and its geopolitical situation. Recommendations of other world professional organizations such as the International Committee for Radiation Protection (ICRP) should also be considered[37].

One also should bear in mind that the IAEA is a UN affiliated institute, which, like the UN itself, is not free from non-professional considerations. Also, the IAEA assumes that every state is responsible for the nuclear security in its territory, but does not relate to the possibility of nuclear terror supported and encouraged by the states themselves. Under these remarks, though it is warmly recommended to adopt the security guidelines of the IAEA as a mandatory baseline, each state should exercise logical, critical and independent thinking in dealing with the threat of nuclear terror.

The Global Initiative to Combat Nuclear Terrorism - GICNT[38]

Overview

The Global Initiative to Combat Nuclear Terrorism (GICNT) is a voluntary international partnership of 86 nations and five international organizations that are committed to strengthening global capacity to prevent, detect, and respond to nuclear terrorism. The GICNT works toward this goal by conducting multilateral activities that strengthen the plans, policies, procedures, and interoperability of partner nations.

The GICNT Statement of Principles (SOP) states a set of broad nuclear security goals encompassing a range of deterrence, prevention, detection, and response objectives. The eight principles contained within the SOP aim to develop partnership capacity to combat nuclear terrorism, consistent with national legal authorities and obligations as well as relevant international legal frameworks such as the Convention for the

[37] Protecting People Against Radiation Exposure in the Event of Radiological Attack, ICRP Publication 96, Annals of the ICRP Vol. 35 No. 1, Elsevier 2005.

[38] This chapter is based upon the home page of the GICNT's website http://www.gicnt.org/index.html

Suppression of Acts of Nuclear Terrorism, the Convention on the Physical Protection of Nuclear Material, and United Nations Security Council Resolutions 1373 and 1540.

The GICNT structure

The United States and Russia serve as Co-Chairs of the GICNT, while the Netherlands leads the Implementation and Assessment Group (IAG) under the guidance of the Co-Chairs. To date, the GICNT has conducted over 70 multilateral activities and nine senior-level meetings.

Official Objectives of CIGNT

- Integrate collective capabilities and resources to strengthen the overall global architecture to combat nuclear terrorism
- Bring together experience and expertise from the nonproliferation, counter-proliferation and counter-terrorism disciplines
- Provide the opportunity for nations to share information and expertise in a voluntary, non-binding framework

Non-State Organizations that are Partners of GICNT

Along with the 86 partner states, Israel included, the non-state organizations that are partners of the GICNT include:

- International Atomic Energy Agency (IAEA)
- European Union (EU)
- International Criminal Police Organization (INTERPOL)
- United Nations Office on Drugs and Crime (UNODC)
- United Nations Interregional Crime and Justice Research Institute (UNICRI)

It should be emphasized that while the IAEA provides the guidelines for nuclear security to be implemented by each member state of the IAEA, the GICNT initiative provides the frame for inter-state global cooperation to combat nuclear terrorism.

Legal Aspects and Laws Related to Nuclear Terrorism

Nuclear incidents and nuclear terrorism introduce some legal issues, for example:

- The proliferation of international nuclear law's actors: Resolution 1540 and the security council's (legal) fight against weapons of mass destruction falling into terrorists' hands.[39]
- The nuclear weapon non-proliferation treaty and terrorism: The (legal) consequences of 9/11 on the treaty review process[40]
- Inspection for clandestine nuclear activities: Does the nuclear non-proliferation treaty provide legal authority for the IAEA's proposals for reform?[41]

It is emphasized that the combat against the un-lawful nuclear terrorism is officially being carried out in the frame of the international law, and that this combat introduces legal issues to be discussed and resolved.

[39] B. Demegere, Nuclear Law Bulletin, No.75, Vol. 2005/1

[40] G.A.du Repaire, Nuclear Law Bulletin, No.71, Vol. 2003/1

[41] G. Bunn, Nuclear Law Bulletin, No.57, Vol. 1996/1

7. Recent Global Incidents and Trafficking of Nuclear Materials Database; Missing Bombs and the Case of the Missing SADM's

A report published recently[42] referring to the year 2014, provides information about 325 reported incidents across 38 different countries in which nuclear or other radioactive material was lost, stolen, or otherwise outside of regulatory control. About 5% of the incidents involved material that was directly weapons-usable or high-risk radioactive sources.

The report states that "The dearth of truly high-risk incidents, however, does not necessarily indicate that weapons-usable materials are adequately secure. Indeed, most incidents were caused by careless, not criminal, individuals; and even among cases linked to criminal activity, many often involved the unintentional or opportunistic theft of radioactive material. If petty criminals can exploit weak security controls or careless human behavior, then certainly an organized and determined terrorist group can as well."

Although the data does not indicate a convergence between illicit trafficking, organized crime, and terrorism, such a nexus may one day emerge. Just because a terrorist nuclear or radiological attack has not yet occurred does not mean one is not possible. Traffickers operating in some parts of the world remain attracted to the perceived value of illicitly acquiring and selling radioactive material. A wide variety of actors, from petty smugglers to organized criminal groups, are involved in the illicit transfer and sale of these materials, particularly in Eastern Europe and Eurasia.
One should also bear in mind that not all the incidents have necessarily been reported, that the database refers to 2013 and 2014 only, and that deliberate (rather than theft) trafficking of nuclear materials to either criminal or terrorist groups are not included in the database.

[42] CNS Global Incidents and Trafficking Database, April 2015, The James Martin Center for Non-Proliferation Studies

A SAMPLE OF A CONCISE LITERATURE REVIEW OF OPEN SOURCES REGARDING RECENT INCIDENTS AND TRAFFICKING OF NUCLEAR MATERIALS

In the frame of this document, we conducted a survey of open sources related to the topic of incidents and trafficking of nuclear materials in the last three years. We refrained from dealing with nuclear reported issues related to states, i.e. Iran, Turkey, Pakistan, North-Korea and Syria. This survey is by no means a complete account of these incidents, yet, it provides the assurance that the field of nuclear materials theft and trafficking is alive and dynamic.

- *The Independent, England, reported that the Australian Intelligence Agency claims that ISIS have been gathering and accumulating nuclear materials from the cities they conquered in Iraq and that ISIS is capable of producing a mass-destruction bomb. Most of the materials were gathered from hospitals and research institutes. The Australian Foreign Affairs Minister expressed her deep concern under the circumstances*[43]

- *Moldova: Seven people were arrested while smuggling 200g of Uranium from Russia (June 2015). A similar incident was reported in Moldova on 2010.*

- *The Lebanese authorities seized a transport of 30 packages of women underwear in which radioactive materials were hidden. The transport came in from Dubai (March 2015). Another report from Lebanon tells that radioactive materials were also found in February 2015, hidden within cell phones transported from China.*[44]

- *In Romania, the amount of 73.5 Kilograms of Uranium was stolen from a government site in the city of Stei. The Romanians are digging Uranium for use in their nuclear power stations. The report claims that the quality of the stolen Uranium allows for its upgrading for the purpose of Nuclear Bombs.* [45]

[43] http://mobile.mako.co.il/news-world/arab-q2_2015/Article-45371c7ec8ddd41004.htm
[44] http://www.upi.com/ Odd_News/2015/03/20/Lebanese-customs-agents-seize-radioactive-maxi-pads/8431426870991/?spt=mps&or=5
[45] http://www.libertatea.ro/detalii/articol/alerta-nucleara-362731.html

MISSING NUCLEAR BOMBS

It is estimated that as many as 50 nuclear bombs have been reported lost by either the United States (11 bombs) and Russia (Soviet Union) (39 bombs)[46]. Most of the American bombs were lost in the ocean when released from aircrafts having technical problems. Most of the Russian bombs were lost when several submarines sank due to technical problems or accidents. None of the missing bombs were recovered, but there is evidence that at least one Russian submarine (k-129) was broken into and its nuclear bombs disappeared. Although those incidents happened tens of years ago, most of the missing bombs are still in the ocean and with the twenty-first century's technology; it might be feasible to dig them out. Under certain circumstances their fissile materials may be of use.

THE CASE OF THE MISSING SADMs

In the early 1980's both U.S.A and U.S.S.R developed Special Atomic Demolition Munitions (SADM). These were small scale nuclear explosion devices, the size of a suitcase, of which the nuclear explosion effect was about 5-30% of the bomb dropped at Hiroshima.

Two types of SADM are shown in the figure below:

[46] Broken-Arrow Nuclear Weapon Accidents, J. Scott, AerospaceWeb, 2006. Broken-Arrow is a code for an incident involving loss, theft, erratic detonation and any non-operational mishap related to nuclear warheads. There are numerous sites in the internet which provide details regarding the loss of nuclear weapons, mostly sunk at the sea and never recovered.

In 1997, General Lebed, the Chief Security Advisor to the President of Russia announced, while interviewed on the "60 Minutes" program, and again at a meeting with several senators, that apparently 100 SADMs are missing. This declaration was fiercely denied by Russia, and its credibility was doubted by the American Intelligence authorities[47].

However, if terrorists managed to acquire SADMs, they could be smuggled to any part of the world and after a certain treatment become operational. Indeed, Wikileaks documents published in 2011 cited Halid Scheich Muchamed (who planned the 9/11 attacks) saying that at least one nuclear bomb had already been hidden somewhere in Europe, and that Al-Qaeda has been planning a massive nuclear attack on America, called "Nuclear Storms", combined with other Biological and Chemical Weapons of Mass Destruction.

[47] A detailed account of this issue was provided by B.M. Jenkins in "Will Terrorists Go Nuclear?", Prometheus Books, New York, 2008.

8. Summary and Conclusions

The threat of nuclear terrorism is real, attempts to build capabilities to carry out a nuclear terror act are constantly made, religious authorizations to carry out such an act had already been issued, and it is generally accepted by intelligence agencies that the question is not "if" but "when" nuclear terrorism would manifest itself.

Of all the different forms of nuclear terrorism, we showed quantitatively that the most probable one is the dispersion of radioactive materials through the detonation of conventional explosives augmented with radioactive sources, usually denoted as a "dirty bomb".

By referring to the erratic and unintentional dispersion of radioactive material in the incident that took place in the city of Goiania, Brazil, an essential effort must be carried out to deal with the immediate as well as the long-term sociological and psychological aspects of a terror act. The later aspects must be included inherently in a national task of building resilience to a dirty bomb, besides the obvious technical, economical and medical issues.

The resilience, in its broader sense, should concentrate on both minimizing the probability of the occurrence of a nuclear terror event and the preparedness to deal with all the aspects and consequences in the case that such an event takes place.

Being considered as a global threat, the principal in providing guidance and leading the efforts to mitigate nuclear terrorism is the United Nation's affiliated organization, the International Atomic Energy Agency. However, after providing a detailed survey of the IAEA's valuable guidebooks on different aspects of nuclear security, we pointed out that according to its mandate, the IAEA assumes that all member states share the same motivation to fight nuclear terrorism. The IAEA does not refer, then, to any possibility that a state would carry out a nuclear terror act, neither that a state would support terrorist groups that wish to carry such an act. Taking this into account, it is recommended to closely follow the IAEA's recommendations and guidelines, but, in addition, to give the proper considerations to those elements of nuclear security not dealt with by the IAEA, taking into account the geopolitical circumstances in the region.

Appendix:

Basics of Nuclear Radiation and Biological Effects

One cannot deal with nuclear terrorism without having at least a very basic understanding of the atomic and nuclear structures. This chapter provides a very basic simplified insight into these topics[48].

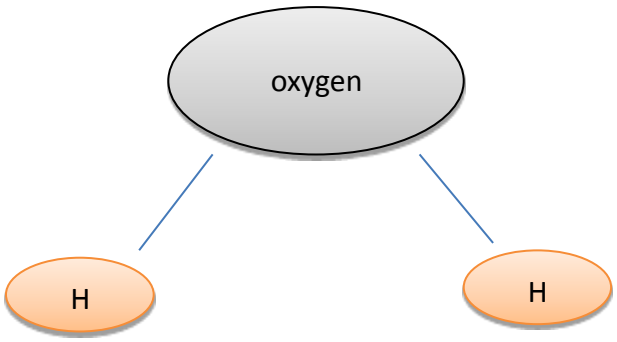
Basic Terms and Concepts

All materials are built of different combinations of about 100 "basic elements". Each element has its own characteristics, i.e. weight, size, melting point, chemical reactivity and many more.

An **ATOM** is the smallest "piece" of matter that preserves those characteristics. The atoms are tiny. For example, 1 gram of Hydrogen contains about 600,000,000,000,000,000,000,000 atoms (the Avogadro number).

A **MOLECULE** is the smallest "piece" of matter that preserves the characteristics of a compound

Figure A.1: A molecule of water is comprised of a single atom of Oxygen and two atoms of Hydrogen

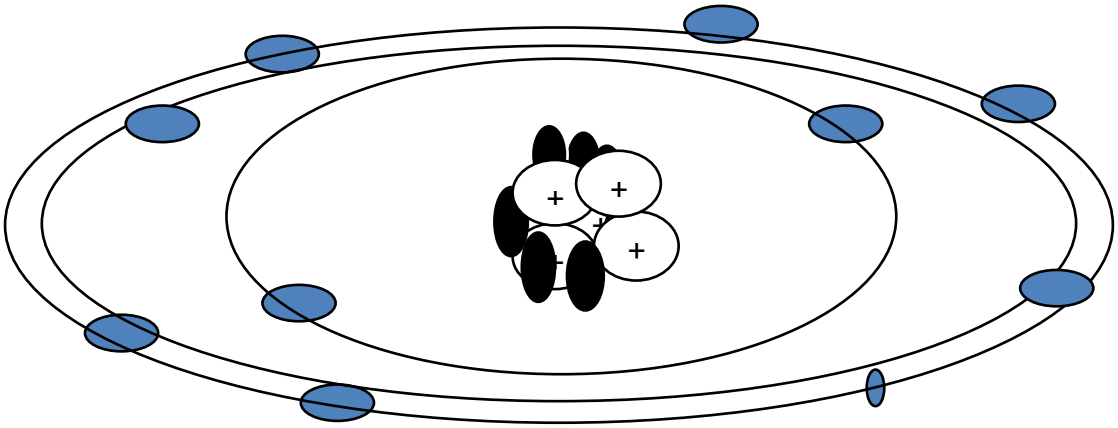


The **ATOM** is constructed of a **NUCLEUS**, where actually almost all the Mass is concentrated, and **ELECTRONS** orbiting around it.

[48] This chapter along with its original figures was prepared and written by the authors of this document. More information regarding nuclear structures and nuclear phenomena can be found in numerous elementary text-books

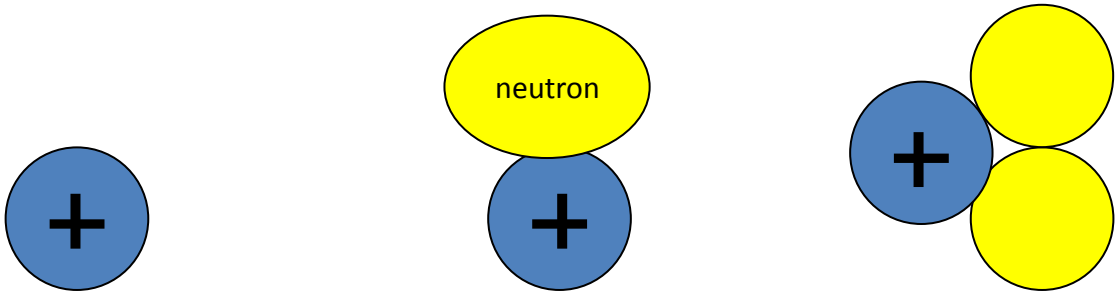
The Nucleus is essentially built of **NUCLEONS**. Those who possess a positive electric charge are the **PROTONS**. Those which are electrically neutral are called **NEUTRONS**.

Figure A.2: A schematic (not to scale) view of an atom



ISOTOPES of an element are atoms that have the same number of protons in the nucleus, but different number of neutrons. For example, in nature an atom of Hydrogen may have a single proton in its nucleus, or a pair of one proton and one neutron, or a pair of two neutrons along with one proton.

Figure A.3: The nuclei of the three isotopes of Hydrogen



The isotope which possesses a single proton is the most common in nature. The isotope which possesses one proton and one neutron is also known as Deuterium. The isotope which possesses two neutrons and one proton is also known as Tritium.

HEAVY WATER is a molecule of water in which at least one of the Hydrogen atoms is either the Deuterium or the Tritium Isotopes.

Stable and Radioactive Isotopes

Within a nucleus there is a permanent "struggle" between several forces (e.g. electric rejection between the positively charged protons). Some of the forces wish to maintain the integrity of the nucleus, and some wish not.

As long as the "integrity" forces are on the upper hand, the Nucleus remains stable (no change in its structure and energy). Otherwise, the nucleus will try to become more stable through emission of energy and/or particles - **RADIATION** (Radiation – the transfer of energy from one point to another).

The release of energy can be manifested through the emission of electromagnetic energy and/or the release of particles which carry kinetic energy. There are mainly three types of radiation emitted by the nucleus which are of interest in regard to biological effects: the Alpha, Beta and Gamma particles. The released energy, i.e. the nuclear radiation, may, under certain circumstances, interact with the body and cause biological damages.

We must stress the point, though, that exposure to radiation is part of our very existence in this planet, and we are constantly exposed to a certain amount of radiation through inhalation of isotopes in the air that we breathe, food consumption and external exposure from the very walls of the buildings and the soil we dwell upon. We are also exposed to cosmic rays from outer space.

In regard to Nuclear Terrorism, radioactive materials can be utilized to cause biological damage through deliberate exposure of people to levels of radiation which are considerably larger than the low-level radiation people are exposed to in their everyday lives.

Biological effects of nuclear radiation

The energy emitted by unstable nuclei interacts with the body and may inflict bio-physiological damages, some of which, are:

- Breaking essential molecules in a manner that affects the function of the organ
- Breaking/damaging the genetic strands
- Affecting the nervous system, of which the communication within the body is conducted through electric charges

- Heating organs in a manner that causes severe burns

The level of damage depends on the characteristics of both the radiation and the body. Those of the radiation are:

- The strength of the source (how many particles are released)
- The duration of exposure (how much time the body is exposed)
- The pace at which the energy is absorbed by the body
- The type of particles that constitute the radiation

Those of the target-body are:

- The organ exposed (different effect on the eyes and on the feet)
- The gender of the target – There seems to be a difference between the susceptibility to radiation by women and men
- The distance between the target body and the radiation source – increasing the distance can significantly reduce the exposure
- The species of the target body (there are certain species that are notably less sensitive to radiation, like certain type of mice and cucarachas).
- The age of the target body: Young kids are more sensitive to radiation than adults

So far we were dealing with Nuclear Radiation. However, in terms of Nuclear Terror the main concern is Nuclear Explosion (a Nuclear Bomb engaged by terrorists). The next section provides some basic understanding of the physical phenomena involved in Nuclear Explosion.

Nuclear Fission and a Nuclear Bomb

It is essential that we recall the famous Einstein's formula which provides the connection between a mass m (the amount of material) and the energy E that can be obtained if all this mass is transferred into energy:

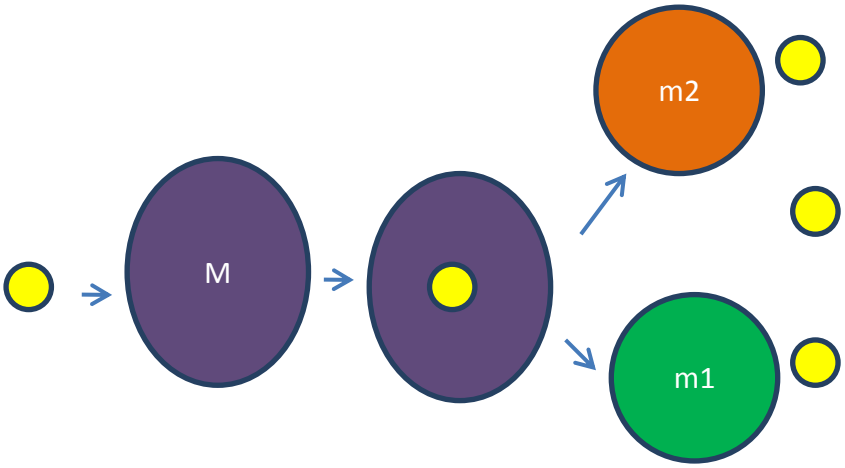
$$E = m * C^2$$

C is the speed of light in vacuum (about 300,000 kilometer per second).

There are certain heavy materials (such as plutonium, uranium) that when their nucleus is hit by neutrons, the compound of both the nucleus and the neutron becomes

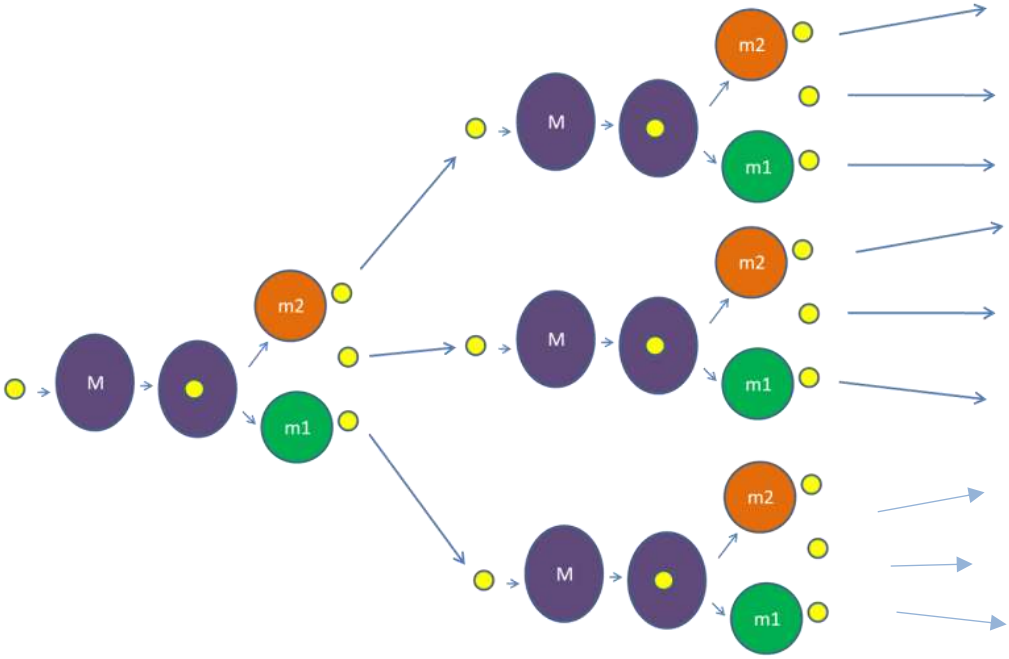
so unstable that the heavy nucleus splits into two lighter nuclei – **FISSION** – emitting a few neutrons as well. It turns out that the total mass (and energy) before the split, is somewhat larger than the total mass (and energy) of the fission products. This means that a certain amount of mass "vanished". But actually, this mass deficiency turned into energy according to Einstein's famous formula.

Figure A.4: The Fission process



The fission produces also several neutrons (usually 2-3 neutrons). These neutrons hit other heavy nuclei of uranium or plutonium causing additional mass-deficiencies that transfer into energy – **A CHAIN REACTION**.

Figure A.5: The chain reaction



This released energy can be controlled and utilized in Nuclear Power Stations to provide electricity, or the energy can be released in a manner that creates a **NUCLEAR EXPLOSION** (BOMB).

Bear in mind that the first NUCLEAR BOMB at Hiroshima, considered to be a very small bomb, was, in term of destructiveness, the equivalent of 20,000 (twenty thousands) tons of TNT.

The main phenomena associated with a Nuclear Explosion are[49]:

- Blast – About 50% of the explosion's energy is an extremely strong air blast that can smash buildings and of course humans. The duration of the lethal blast is about 1000 times longer than the duration of the blast from a conventional bomb
- Heat – About 35% of the explosion's energy is thermal radiation whose temperature can reach tens of millions of Celsius grades. This thermal radiation cause immediate fires and of course lethal burns
- Immediate Nuclear Radiation – About 10% of the explosion's energy is transferred through Gamma Radiation and Neutrons for about one minute.
- Fallout – The radioactive products of fission can be deposited on the ground at large distances away from the detonation site. As such they may present a radiation hazard long after the explosion

In terms of Nuclear Terror, the only manner to prevent terrorists from producing a nuclear bomb is keeping fissile materials out of their hands. We should mention that nuclear release of energy can also be obtained through Nuclear Fusion, but it is believed that this route, which is both much more complicated technically and by far more energetic than fission, is currently beyond the scope of this document.

[49] Detailed descriptions of the phenomena and their consequences can be found in: "Nuclear War – The Aftermath", A special AMBIO (A journal of the Human Environment) publication, Pergamon Press, 1983.

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