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Terrorism and WMD
The Link with the War in Afghanistan

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Introduction

• It is generally understood that when we talk about Weapons of Mass Destruction (WMD) we imply nuclear, biological, and chemical (NBC) weapons. More recently, other means of mass destruction or mass disruption effects entered the lexicon. Radiological weapons, often called radiological dispersal devices (RDD), add to a grouping of weapon capabilities as chemical, biological, radiological, and nuclear (CBRN). High yield explosives can be considered, in some cases, a weapon of mass destruction. This characteristic is incorporated in a contemporary acronym of CBRNE. Cyber Terrorism can in part cause severe disruption and physical damages, one example could be a cyber attack on nations air traffic control system.

• The devastating impacts of WMD include chemical, biological, radiological, nuclear, and enhanced high explosive weapons as well cyber attacks. WMD may, at times, rely more on disruptive impacts than on destructive effects.

• The devastation of 9/11 raised the bar in terms of the kind of carnage that a future terrorist act must produce to capture similar news coverage. That, in turn, induces the terrorists to innovate in order to find a new means to cause greater destruction.

• Terrorist groups that acquire WMD pose a critical danger. Terrorists armed with these weapons can gain leverage for their demands by threatening use of WMD to influence political or military actions, or to achieve a specific economic or financial objective. Likewise, some groups simply want to employ WMD to create large numbers of casualties, both military and civilian, and capitalize on the effects of these events.

Terrorist Acts with Mass Casualties

23 Oct 1983	**: truck bombings of U.S. Marine and French barracks, Beirut, Lebanon (301) fatalities.**
21 Dec 1988	**: mid-air bombing of Pan-Am flight over Lockerbie, Scotland (270) fatalities.**
26 Feb 1993	**: truck bombing in garage of World Trade Center, NYC, USA. (6) fatalities, (1,000) injuries.**
20 Mar 1995	**: sarin nerve gas attack in subway in Tokyo, Japan. (12) fatalities, (5,511) injuries. (Chemical Terrorism)**
19 Apr 1995	**truck bombing of Federal Building, Oklahoma City, Oklahoma, USA (169) fatalities.**
26 Jun 1996	**: truck bombing at U.S. military housing complex in Dhahran, Saudi Arabia. (19) fatalities, (513) injuries.**
8 Aug 1998	**: truck bombings of U.S. Embassies in Nairobi, Kenya, and Dar as Saalam, Tanzania (303) fatalities.**
31 Oct 1999	**: intentional crash of Egypt Air flight over Massachusetts USA by pilot, (217) fatalities .**
11 Sep 2001	**: crashing of hijacked planes into World Trade Center, NYC, Pentagon in Alexandria, and site in Pennsylvania USA (2,993) fatalities.**
18 Sep 2001	**: anthrax-laced letters mailed to Florida and NYC, (1) fatalities, (10) injuries. (Bio-Terrorism)**
9 Oct 2001	**: anthrax-laced letters mailed to Washington DC, USA. (4) fatalities (Bio-Terrorism)**
11 Mar 2004	**: bombings of four trains in Madrid, Spain, (191) fatalities, (7) injuries.**
7 July 2005	**: bombings of three subway trains and one bus in London, UK (54) fatalities, (700) injuries.**

(Reference: Worst Terrorist Attacks Worldwide. Compiled by Wm. Robert Johnston. December 2009)

• One important aim of the U.S. invasion of Afghanistan was to destroy and eliminate the main bases of al-Qaida and its central command structure. The 9/11 attacks demonstrated that transnational terrorism is becoming more lethal, and that it can produce a fundamental political and strategic impact. The threat of terrorist use of WMD is still possible and perhaps inevitable given the goals of al-Qaida.

• The threat of terrorist use of weapons of mass destruction (WMD), is a real one that represents a very serious threat to the U.S. and other nations that are potential targets of sub-national terrorist groups or networks. Transnational terrorism and the potential acquisition by terrorists of weapons of mass destruction are part of the 'asymmetric' dynamics of the new threats that have emerged and have thrust the international community into a new era of warfare.

• As far as is presently known, terrorist groups do not have in their possession nuclear weapons. However they could have the capability sometime soon given that knowledge about these kinds of weapons are available worldwide. Recent terrorist attacks have shown a rise in the tendency towards the use of mass-causality weapons for which WMD could be very well suited.

• The attempted terrorist attacks to simultaneously bomb locations in Jordan, in April 2004, using conventional explosives to disperse toxic chemical material, clearly demonstrates the deliberate planning for use of toxic chemical material in terrorism. Jordanian security forces foiled the attack on Jordanian and U.S. targets with a preemptive raid on the facilities used by the terrorists. Reports estimate that approximately 20 tons of chemicals were confiscated, which could have caused tens of thousands of casualties. The intent for the indiscriminate nature of the terrorist attacks was clear and projected how fast and how large a future attack using mass destruction bombs would occur.

• For radiological attacks a study was conducted by the Federation of American Scientists in which the destructive effects of various types of radiological bombs were analyzed. The case studies consisted of Cobalt, Cesium and Americium bombs. The conclusion was that "While radiological attacks would result in some deaths, they would not result in the hundreds of thousands of fatalities that could be caused by a crude nuclear weapon. Attacks could contaminate large urban areas with radiation levels that exceed the Environment Protection Agency (EPA) health and toxic material guidelines".

Possible Terrorist Groups that Might Resort to the Use of WMD against the U.S.

Group	Description	Possible Reason
Non-State Sponsored Terrorists	**These are groups that operate autonomously, receiving no significant support from any government. These groups may be transnational, they don't see themselves as citizens of any one country, and thereby transnational terrorism is carried out by groups that operate without regard for national boundaries.** **Typical: Al-Qaida Terrorist Organization**	**Terrorist organization backed in a corner, loosing ground and support internationally.** **Terrorist organization trying to recapture public attention by resorting to higher levels of terrorism resulting in mass casualties.**
State-Sponsored Terrorists	**International terrorist group that generally operates independently but is supported and controlled by one or more nation-states as part of waging asymmetric surrogate war against their enemies.**	**To undermine U.S. policy and influence, and for the U.S. to change its policy.**

• Due to a number of global developments over the past decade, the threat that terrorists might resort to weapons of mass destruction has received increased attention from political leaders and the news media. These developments include: the proliferation of WMD-related technologies, materials, and know-how; trends in transnational terrorist incidents suggesting a growing tendency toward mass-casualty attacks for which WMD are well suited; and the interest in WMD that has been expressed by Osama bin Laden and al Qaida.

• The likelihood of terrorist groups acquiring WMDs is probably low in the short run but could be high in the long run. There is no way to demonstrate that terrorists will acquire and use such weapons, but, conversely, there is no way to demonstrate that they will not do so.

• When addressing the "supply and demand" sides for WMD, the technical hurdles to produce such weapons should be taken into consideration. Due to the complexity and expense of the processes needed to develop nuclear weapons, the "supply" side has to be addressed for such weapons. While few states are known to have nuclear weapons capability, those that have nuclear reactors should be addressed. With tight security measures at these plants and export controls, as well as all material under IAEA safeguards, no nuclear material would theoretically fall into the hands of terrorist organizations.

• By contrast, due to the relative ease in which biological, chemical, and radiological weapons can be produced in a vast number of open laboratories and facilities that are designated as purely civilian, the "demand" side should be addressed for such weapons. This implies the need to identify and to destroy terrorist organizations that are pursuing the production or possession of these weapons.

Technical Hurdles for Nuclear, Biological, and Chemical Weapon Programs

	Nuclear	Biological	Chemical
Feed materials	Uranium ore, oxide widely available; plutonium and partly enriched uranium dispersed through nuclear programs, mostly under international safeguards.	Potential biological warfare agents are readily available locally or internationally from natural sources or commercial suppliers.	Many basic chemicals available for commercial purposes; only some nerve gas precursors available for purchase, but ability to manufacture them is spreading.
Scientific and technical personnel	Requires wide variety of expertise and skilful systems integration.	Sophisticated research and development unnecessary to produce commonly known agents. Industrial microbiological personnel widely available.	Organic chemists and chemical engineers widely available.
Plant construction and operation	Costly and challenging. Research reactors or electric power reactors might be converted to plutonium production.	With advent of biotechnology, small-scale facilities now capable of large-scale production.	Dedicated plant not difficult. Conversion of existing commercial chemical plants feasible but not trivial
Comments	Black-market purchase of ready-to-use fissile materials or of complete weapons very possible.	Biological organisms are less expensive and easier to produce than nuclear material or many of the chemical warfare agents.	Legitimate commercial chemical plants and facilities can produce the required warfare agents.

• The United States has published two National Strategies, one on Combating Terrorism and the other to Combat Weapons of Mass Destruction. The National Strategy on Combating Terrorism is based on a 4D strategy: Defeat; Deny; Diminish and Defend. This entails offensive military operations in destroying terrorist and their organizations, and to strengthen and sustain the international effort to fight terrorism by diplomatic, political and economic means. The National Strategy to Combat WMD also involves offensive military operations to interdict and destroy any deployment for possible use of WMD; in addition, it includes active non-proliferation diplomacy and engagement in multilateral agreements and treaties as well as the control on WMD material. Both strategies will require the strengthening and sharing of intelligence gathering and analysis, research and development, and more international cooperation and commitment.

• If governments aim at curbing terrorism they must not focus on just one type of attack mode, they must target simultaneously a wide range of terrorist attack modes. This implies that governments must use not only deterrence but also preemption. Therefore, governments have to invest not only in defensive and proactive counter-terrorist measures, but also in intelligence in order to face terrorist innovations. Counter terrorism polices consist of proactive and passive policies.

➢ Proactive Polices:
Aim at preventing attacks by disabling terrorists and include: preemptive strikes, retaliatory strikes against a state sponsor, infiltrating terrorist groups, gathering intelligence, or freezing terrorist assets.

➢ Passive Policies:
Aim is to create obstacles in order to reduce the probability of success of terrorist attacks and include: erecting technological barriers such as metal detectors or bomb-sniffing equipment at airports, hardening potential targets, and securing borders.

These passive/defensive policies are intended to deter an attack by either reducing the level of success or increasing the negative consequences to the terrorist.

U.S. Goals and Objectives in Combating Terrorism
4D Strategy: Defeat, Deny, Diminish and Defend

Goal: **Defeat terrorist and Their Organization**	Goal: **Deny Sponsorship, Support, and Sanctuary to Terrorists**	Goal: **Diminish the Underlying Conditions that Terrorists Seek to Exploit**	Goal: **Defend U.S. Citizens and Interests at Home and Abroad**
Objectives:	Objectives:	Objectives:	Objectives:
Identify terrorists and terrorist organizations.	**End the state sponsorship of terrorism.**	**Partner with the international community to strengthen weak states and prevent the (re)emergence of terrorism.**	**Implement the National Strategy for Homeland Security.**
Locate terrorist and their organizations.	**Establish and maintain an international standard of accountability with regard to combating terrorism.**	**Win the War of Ideas**	**Attain domain awareness.**
Destroy terrorists and their organizations.	**Strengthen and sustain the international effort to fight terrorism.** **-Working with Willing and Able States** **-Enabling Weak States** **-Persuading Reluctant States** **-Compelling Unwilling States**		**Enhance measures to ensure the integrity, reliability, and availability of critical physical and information-based infrastructures at home and abroad.**
	Interdict and disrupt material support for terrorists.		**Integrate measures to protect U.S. citizens abroad.**
	Eliminate terrorist sanctuaries and havens		**Ensure an integrated incident management capability.**

• Terror intends to cause a psychological impact on a target population that diminishes morale, dispenses doubt, and degrades the resolve to resist a terrorist's objective. Recruitment is the life-blood of a terrorist organization, and they use multiple methods to entice new members.

• We can safely assume that al-Qaida and other terrorist groups have the capability and intent to develop and employ a radiological dispersal device, as well as obtaining biological agents such as anthrax, and chemical weapons such as Sarin. Presently, it is doubtful that al-Qaida has the capability to produce or even possesses nuclear weapons, although acquisition remains a goal.

• Terrorists will seek to acquire and use weapons of mass destruction for spectacular attacks with catastrophic disruption, damage, or destruction. In addition to mass casualties and panic, the terrorist will seek a U.S. Government response perceived to be advantageous to the terrorist's objectives. Therefore, there should be an ample cause of concern for a WMD terrorist attack on the United States or on a European country.

• The terrorist threat and intended use of WMD is real. If this type of attack occurs, warning times will be very short, and the number of people involved can be comparatively small.

• The danger in any WMD threat is not limited only to the human fatalities and causalities, but includes the very wide psychological impact and socio-economic disruption that could be high, especially if an effective national emergency response preparation system has not been developed. Even a somewhat low level WMD attack could cause considerable damage to a civil society, it could take the inhabitants of the area under attack considerable time to get back to a somewhat normal level of life.

• Countries that recognize their own deficiencies in conventional military capabilities are demonstrating an increasing interest in "asymmetric strategies" that include terrorism with WMD. Therefore, state-sponsored/supported terrorists will have all the resources that will help them assemble and conduct successful attacks producing mass causalities. The level of terrorist destruction and disruption has emerged in recent years as a significant asymmetric form of conflict.

• The United States Government assesses that al-Qaida and its affiliated network of transnational terrorists is the most serious international threat to it. Economic targets such as commercial aviation, energy sector, or mass transportation and other "soft" targets such as public gatherings will most probably continue to be the focus as the main targets .

The Comparative Effects of Biological, Chemical and Nuclear Weapons.

	Area Covered (sq. km.)	Estimated Fatalities					
		Washington DC	NYC	Paris	London	Berlin	Karachi
Chemical: **300 kg of Sarin nerve gas with a density of 70 milligrams per cubic meter**	**0.22**	**110**	**720**	**780**	**1,120**	**840**	**4,160**
Biological: **30 kg of Anthrax Spores with a density of 0.1 milligrams per cubic meter**	**10**	**4,930**	**32,680**	**35,500**	**51,000**	**38,300**	**189,000**
Nuclear: **One 12.5 kiloton nuclear devise achieving an over pressure of 5psi**	**7.8**	**3,840**	**25,490**	**27,690**	**39,780**	**29,870**	**147,420**
1.0 megaton hydrogen bomb	**190**	**93,670**	**620,920**	**674,500**	**969,000**	**727,700**	**3,591,000**
Using one aircraft dispensing 1,000 kg of Sarin nerve gas or 100 kg of Anthrax spores.							
Clear sunny day, light breeze:							
Sarin Nerve Gas	**0.74**	**360**	**2,420**	**2,630**	**3,770**	**2,830**	**13,990**
Anthrax Spores	**46**	**22,680**	**150,330**	**163,300**	**234,600**	**176,180**	**870,000**
Overcast day/night, moderate wind:							
Sarin Nerve Gas	**0.8**	**390**	**2,610**	**2,840**	**4,080**	**3,060**	**15,120**
Anthrax Spores	**140**	**69,020**	**457,520**	**497,000**	**714,000**	**536,200**	**2,646,000**
Clear Calm Night:							
Sarin Nerve Gas	**7.8**	**3,840**	**25,490**	**27,690**	**39,780**	**29,870**	**147,420**
Anthrax Spores	**300**	**147,900**	**980,400**	**1,065,000**	**1,530,000**	**1,149,000**	**5,670,000**

Afghanistan, Insurgency and Terrorism

U.S. General Counter-Terrorism Objectives in Afghanistan:

• Disrupting and destroying terrorist networks in Afghanistan and especially Pakistan to degrade any ability they have to plan and launch International Terrorist attacks. Securing Afghanistan's South and East against a return of al-Qaida and its allies in order to provide a space for the Afghan government to establish effective government control

• Developing increasingly self-reliant Afghan security forces that can lead the Counterinsurgency and Counterterrorism fight with reduced U.S. assistance. Training and partnering with the Afghan National Security Forces (ANSF) so that these forces are able to expand rapidly, take the lead in effective counterinsurgency operations, and allow the United States and other International forces to decrease their role in combat operations.

• Defeating the Insurgency not only in tactical term, but by diminishing its control and influence over the Afghan population.

• The U.S. is implementing a comprehensive strategy to defeat and remove insurgency control and influence over a geographic area, which is coupled with territorial control.

• The strategy is based upon general lessons of the last eight years that have emerged in both Afghanistan and Iraq: "Shape", "Clear", "Hold" and "Build".

(Source: Anthony Cordesman CSIS)

Defining the Concept of Shape, Clear, Hold, and Build

• Clear the military conditions necessary to secure key population centers; limit the flow of insurgents;

• Remove insurgent and anti-government elements from a given area or region, thereby creating space between the insurgents and population;

• Maintain security, denying the insurgents access and freedom of movement within the given space; and,

• Exploit the security space to deliver humanitarian relief and implement reconstruction and development initiatives that will connect the Afghan population to its government and build and sustain the Afghanistan envisioned in the strategic goals.

Shape

• In the Shape phase, the United States and its Allies and partners conduct reconnaissance to identify the key leaders, key infrastructure, tribal dynamics and the tribes relationship with the Government of the Islamic Republic of Afghanistan (GIRoA), and the economic status of a given area.

- Develop mix of US, NATO/ISAF, and host country deployments needed to create conditions where the force can credibly clear the insurgents.

- Limit insurgents ability to reinforce and disperse.

(Source: Anthony Cordesman CSIS)

Clear

• In the Clear phase, military operations create an initial secure environment in which a stable and prosperous Afghanistan can begin to grow.

• Carefully coordinated international forces and host country security forces eliminate, detain, or expel insurgents and anti-government entities from a given area or region, separating these elements from the general Afghan population.

Hold

• In the Hold phase, the U.S., its Allies and partners, and the GIRoA seek to maintain the secure environment and take advantage of the separation created between the insurgents and the population to connect the population to the government in Kabul.

• International and Afghan military and police forces need to maintain a strong presence, denying anti-government elements the opportunity to return.

• Afghan national Police (ANP) must enforce the law according to the Afghan Constitution, including counternarcotics laws and gain the confidence and trust of the local population.

• Meanwhile, the military and civilian agencies should work with local and tribal leaders, deliver humanitarian relief, and provide initial government services.

(Source: Anthony Cordesman CSIS)

Build

• In the Build phase, the U.S., members of the international community, and Afghans take advantage of the security and stability established in the clear and hold phases to build the human capital, institutions, and infrastructure necessary to achieve a stable, secure, and prosperous Afghanistan.

• The U.S. and other members of the international community provide advisory services and training to the leaders and lawmakers who govern the country. International trainers and mentors help build the capacity of the Afghan National Police (ANP) and Afghan National Army (ANA).

• The Afghan citizen who will staff the courtrooms, government offices, the private enterprise of the country receive aid, education, and training. The international community works to build schools, clinics, roads, bridges, and other infrastructure.

(Source: Anthony Cordesman CSIS)

Insurgency Force Variation and Attacks

- Insurgency Force Variation at any time is dependent on the following:

  - Insurgency forces crossing the borders in our case Pakistan into Afghanistan, and the efficiency of the Border Control and Security Systems in detecting and interdicting them before they can successfully infiltrate deep into Afghanistan.

  - In-country security components and counter-insurgency capabilities. Insurgency recruitment from the population and the attrition rate inflicted by the ISAF/NATO and Afghanistan Forces.

- Factors that reduce the number of Insurgents in-country at any specific time depend on:

  - Maximizing Border Control & Interdiction Efficiency Levels. By increasing the probability of detecting and interdicting attempted infiltration. Due to the long borders between Pakistan and Afghanistan this is achievable through political and military coordination between the U.S., Pakistan and Afghanistan in Military and Technology means.

  - Minimizing the Rate of Insurgency Recruitment Rate from within the Afghan population in the territory that is under insurgent control. This can be accomplished through economic assistance, civilian projects, political and COIN support, to Afghanistan.

  - Maximizing combat attrition levels inflicted by ISAF/NATO forces against the Insurgents.

• Wherever there is a strong Taliban presence, there is an al-Qaida presence. Al-Qaida will then re-establish itself in Afghanistan with recruitment and training of international terrorists.

• High border Infiltration rate (from Pakistan into Afghanistan) implies a strong support for Taliban insurgents and therefore, al-Qaida members in Pakistan and Afghanistan.

• Recruitment implies territorial influence and control by the Taliban as well as Afghan support, and the possible presence of al-Qaida terrorist cells and even camps.

• Attrition of insurgents related to size of the ISAF forces.

• If the presence and the number of attacks by Insurgency is increasing, it follows that, Infiltrators and recruitment is higher than attrition.

• If we assume zero infiltrators and still the number of Taliban initiated attacks is increasing, it follows that the recruitment rate in Afghanistan is larger than the attrition rate of the Insurgency.

• The fundamental question becomes:
  - will an increase in U.S. and coalition size curb and deter terrorist organizations in Afghanistan?

Or put differently,

• For each of the following cases in terms of Insurgency Attacks and Coalition Size:

  - **Insurgency Forces and Attacks Decrease; Coalition Forces Decrease in Size;**
  - **Insurgency Forces and Attacks Decrease, Coalition Forces Increase in Size;**
  - **Insurgency Forces and Attacks Increase; Coalition Forces Increase in Size;**
  - **Insurgency Forces and Attacks Increase, Coalition Forces Decrease in Size;**

What would the probability be of a terrorist attack, by al-Qaida or other terrorist groups, on the U.S. and Europe using WMDs?

Insurgency Forces and Attacks Decrease; Coalition Forces Decrease in Size:

• This would be the ideal case, whereby both parties decrease their presence and fighting units through a peace reconciliation program as Taliban fighters hand over weapons, similar to the October 14, 2009 instance in Heart province. A move that implies a big reduction in Insurgency attacks and infiltrators from Pakistan into Afghanistan and no large areas in Afghanistan under Taliban influence and control.

• The U.S. and coalition forces start handing over security to the Afghan government and gradually withdraw their forces. As a result, recruitment by the insurgency will be low as both sides will be disengaging their forces & the attrition rate on both sides will also be low.

• As a result al-Qaida will not find any insurgency support in Afghanistan to re-open terrorist training camps and establish any command centers for international terrorism. The probability that al-Qaida launch terrorist attacks using WMD weapons will be low.

Insurgency Forces and Attacks Decrease; Coalition Forces Increase in Size:

• In this case, extra coalition forces are needed to further reduce the number of Insurgency attacks and to increase insurgency attrition/loss rate, in addition to implementing the strategy of "Shape, Clear, Hold and Build". The increase of coalition forces could also be deployed to further enhance Border Security, and to pursue Al-Qaida terrorist and continue training the Afghan Security and Military Forces.

• An increase in coalition forces in Afghanistan can also reduce the Taliban control and influence in strategic geographical areas such that insurgency and terrorist recruitment are substantially reduced.

• The probability of al-Qaida re-establishing itself in Afghanistan and to launch terrorist attacks using WMD weapons will be low.

Insurgency Forces and Attacks Increase; Coalition Forces Increase in Size:

• Here the combat forces of both sides increase. The US sends more troops to Afghanistan while the Taliban also increases in size to launch more attacks in both Pakistan and Afghanistan .

• The size of Taliban infiltrators from Pakistan into Afghanistan increases as well as the control and influence of geographic regions in Afghanistan by the insurgency. This would result in more recruitment into the insurgency and terrorist organizations.

• As both sides increase in size the number and intensity of military encounters will rise thereby increasing the attrition rates on both sides.

• As insurgency recruitment and attacks are on the rise, most probably the number of terrorists in both Pakistan and Afghanistan will increase, and al-Qaida could re-establish training camps and command centers in Afghanistan. The probability of a terrorist attack against the U.S. and Europe, using WMD weapons, will be high.

Insurgency Forces and Attacks Increase; Coalition Forces Decrease in Size:

• Here the U.S. and coalition start handing over security and other functions to the Afghan military and government, and start withdrawing their forces.

• The Taliban start increasing their force size and attacks. Cross-Border infiltrations from Pakistan increase, and the control and influence of territories in Afghanistan will be on the rise, resulting in high recruitment into the Taliban insurgency and al-Qaida as well as other terrorist groups.

• As the coalition forces decrease and the Taliban increase, military encounters will decrease resulting in a lower attrition rate to the insurgency.

• This increases the probability that Al-Qaida would return to Afghanistan, re-establish its training camps and an international terrorist command center as pre-9/11. The probability of terrorist attacks against the U.S. and Europe, using WMD weapons will be high.

Probability of al-Qaida and other Terrorists Groups re-establishing Training Camps/Central Command Structure in Afghanistan & Launching a Terrorist Attack using WMD on the U.S. and Europe.

Insurgency Forces and Attacks	Coalition Forces Size	Insurgency			Probability of Terrorists using WMD against the U.S. and Europe
		Border Infiltration	Recruitment	Attrition due to ISAF Forces Combat Effectiveness	
Decrease	**Decrease**	**Low**	**Low**	**Low**	**Low (Ideal Situation for both sides decreasing attacks & size)**
Decrease	**Increase**	**Low**	**Low**	**High**	**Low**
Increase	**Increase**	**High**	**High**	**High**	**High**
Increase	**Decrease**	**High**	**High**	**Low**	**High**

Brief Overview of the Insurgency Status in Afghanistan

(Source all Charts: Anthony Cordesman CSIS; Various Reports)

Analysis of the available charts and briefings, show the following regarding the insurgency status in Afghanistan:

Insurgency Attack Activities in Afghanistan:

1. A 60% increase of cross-border insurgency raids from Pakistan to Eastern Afghanistan in the first six months of 2007 vs 2008.

   The border detection and interdiction efficiency between Pakistan and Afghanistan is very low.

2. Insurgent initiated attacks were up 59% overall (Jan – May 2009 vs Jan-May 2008)

3. Trend in Afghanistan IED's and Roadside Bombs between 2002 – 2008 in terms of incidents per year has risen from 307 to 3,276 over 5 years.

Attrition to ISAF/NATO Forces:

4. Comparing Jan – May 2009, to the same time period in 2008, the total military deaths to ANSF and ISAF are up by 37%. ISAF deaths were up by 62% while that of ANSF up by 33%.

5. Comparing Jan – May 2009, to the same time period in 2008, the total casualties from IED's were up only 6% despite a 64% increase in IED events. IED's remain the leading cause of total casualties.

   - 58% of all casualties results from IED's during the period Jan – May 2009.
   - 66% of all civilian casualties resulted from IED's during the period Jan – May 2009.

Attrition to the Afghan Civilian Population:

6. Total civilian deaths are down 9% when comparing Feb 2009 to the previous three months period (Nov 08 – Jan 09) Since Jan 2007, insurgents have caused 79% of civilian deaths in Afghanistan.

(See various publications by Anthony Cordesman CSIS).

7. Cause of civilian deaths in Afghanistan between 2007 vs 2008 were 35% by Government Forces and 68% by Insurgent forces.

8. Total civilian deaths in Afghanistan is down 27% when comparing Jan – May 2009 to the same period time in 2008. Since Jan 2007 to May 2009 insurgents have caused 80% of civilian deaths known by ISAF.

ISAF Air Warfare against the Insurgency:

8. ISAF Close Air Support Sorties against insurgent forces has risen from 11,528 in 2006 to 13,962 in 2007, to 19,092 in 2008 and to 14,897 by August of 2009. Whereas Close Air Support strikes by ISAF in 2007 were 1090, in 2008 were 1,170, and by August 2009 the number of strikes were 786.

9. The U.S. has carried out about 40 drone air strikes since the beginning of 2008, most since September, killing more than 330 people, including many foreign militants, according to a tally of reports from Pakistani intelligence agents, district government officials and residents. There have been 18 attacks this year (June 2009).

Relationship between Insurgency Activities and Popular Support in Afghanistan. Results of Polls:

10. Nationwide support for the Taliban in Afghanistan was 22% by February 2009, compared to 20% in 2007.

11. Afghan view favorable of the U.S. between 2005 up to Feb 2009 fell from 83% down to 52%.

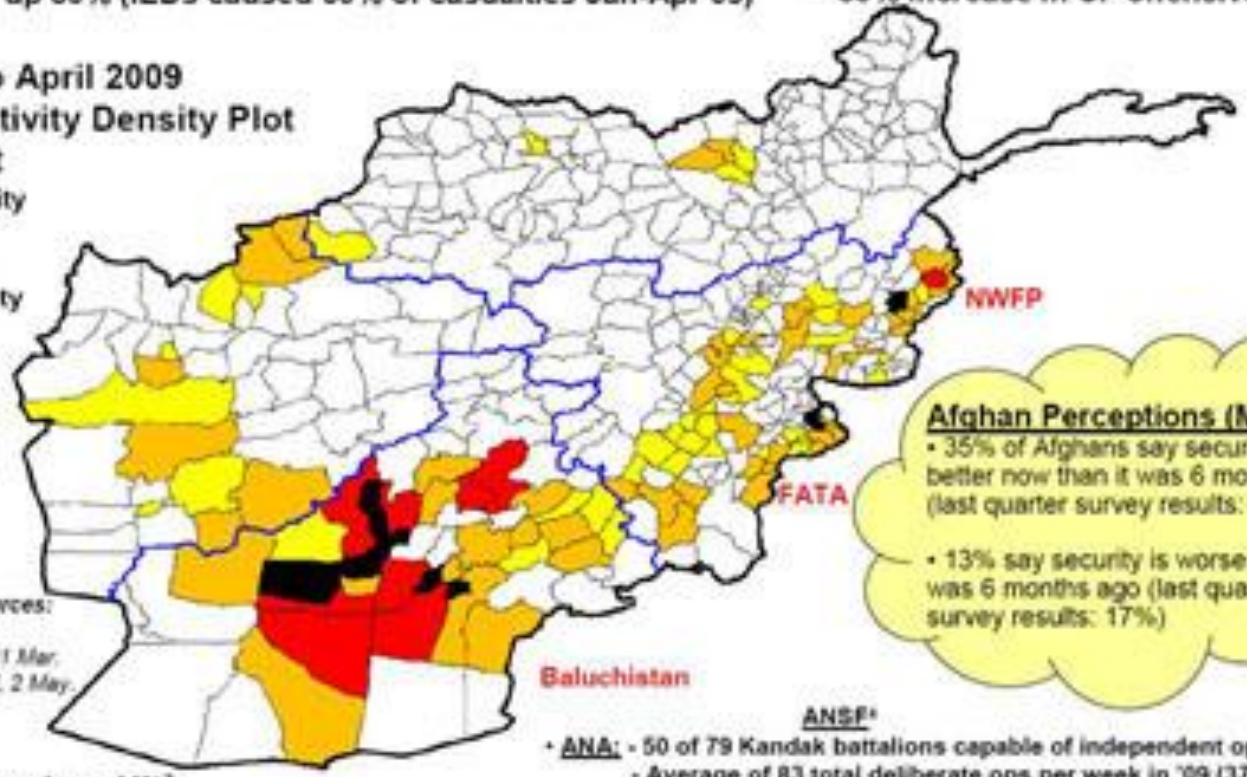
12. 26% of Afghans blame the U.S., ISAF and Government Forces for the violence and rose to 36% by Feb 2009. In comparison 36% blaming the Taliban in 2007 falling down to 27% by Feb 2009.

(See various publications by Anthony Cordesman CSIS).

Security Summary (April 2009)

- 64% increase in Insurgent Initiated Attacks[1]
- 80% of attacks occurred in 13% of the districts (Jan-Apr 09)[1]
- IED events up 80% (IEDs caused 60% of casualties Jan-Apr 09)[1]

- 28% increase in CF force strength[5]
- 38% increase in ANA force strength[4]
- 59% increase in CF offensive events[1]



Afghan Perceptions (Mar 09)[2]

- 35% of Afghans say security is better now than it was 6 months ago (last quarter survey results: 28%)
- 13% say security is worse than it was 6 months ago (last quarter survey results: 17%)

Footnotes on Sources:
[1]JOIIS, 4 May.
[2]ANQAR Survey, 31 Mar.
[3]CJOC CivCas cell, 2 May.
[4]CSTC-A, 4 May.
[5]CJ1, 3 May.

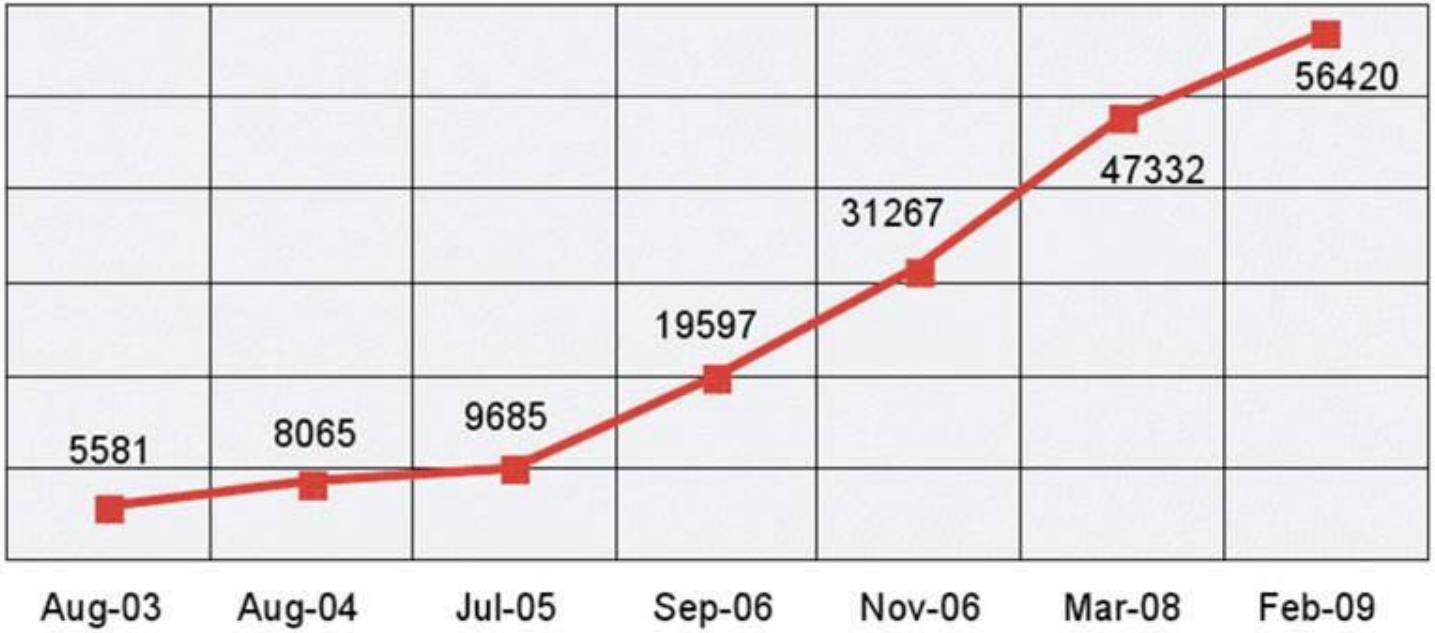
- Civilian Deaths: down 44%[3]
- ISAF/OEF Deaths: up 55%[1]
- ANSF Deaths: up 25%[1]
  (Since Jan 07, ANPs suffered 1.8x more deaths than ANA+ISAF)
- Attacks on GIRoA officials & district centers: up 90%[1]
- Kidnappings/Assassinations: down 17%[1]

ANSF[4]

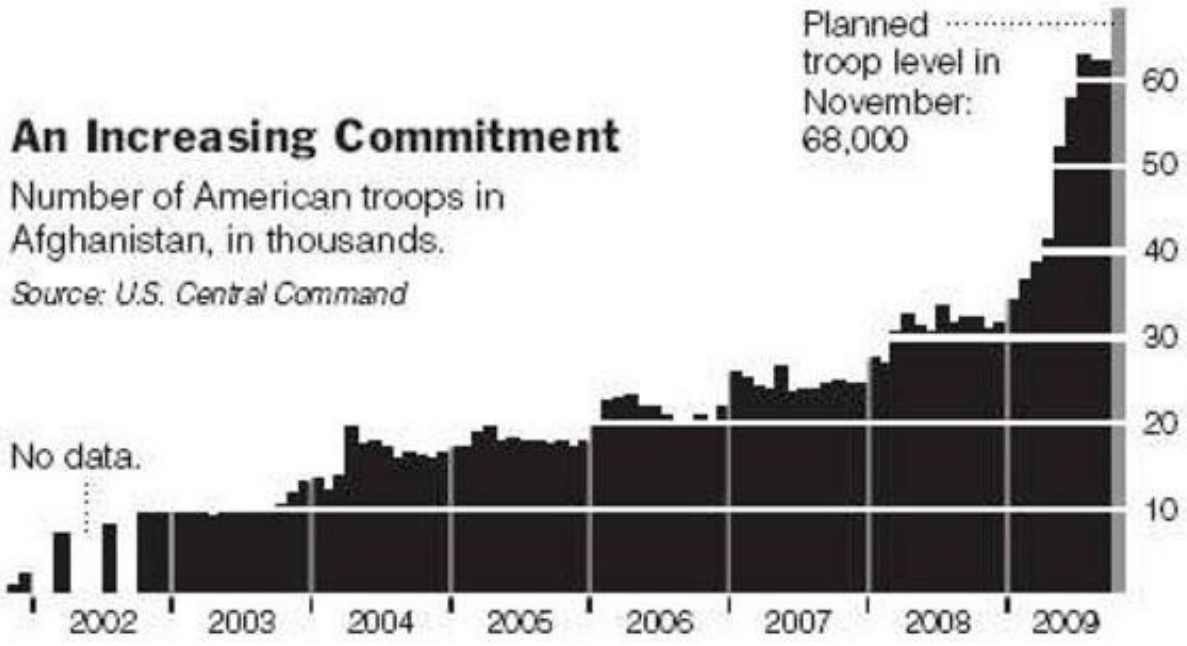
- ANA: - 50 of 79 Kandak battalions capable of independent ops
  - Average of 83 total deliberate ops per week in '09 (37 in '08)
- ANP: - Focused District Development: 52 districts completed training
  - 14 of 20 Civil Order Police Battalions fielded
- ABP: - Focused Border Development: 2 cycles complete (20 companies)
  - 3rd and 4th Cycles underway (14 companies programmed)

HQ ISAF Strategic Advisory Group "Unclassified Metrics" April 2009.

Increase in ISAF troop levels



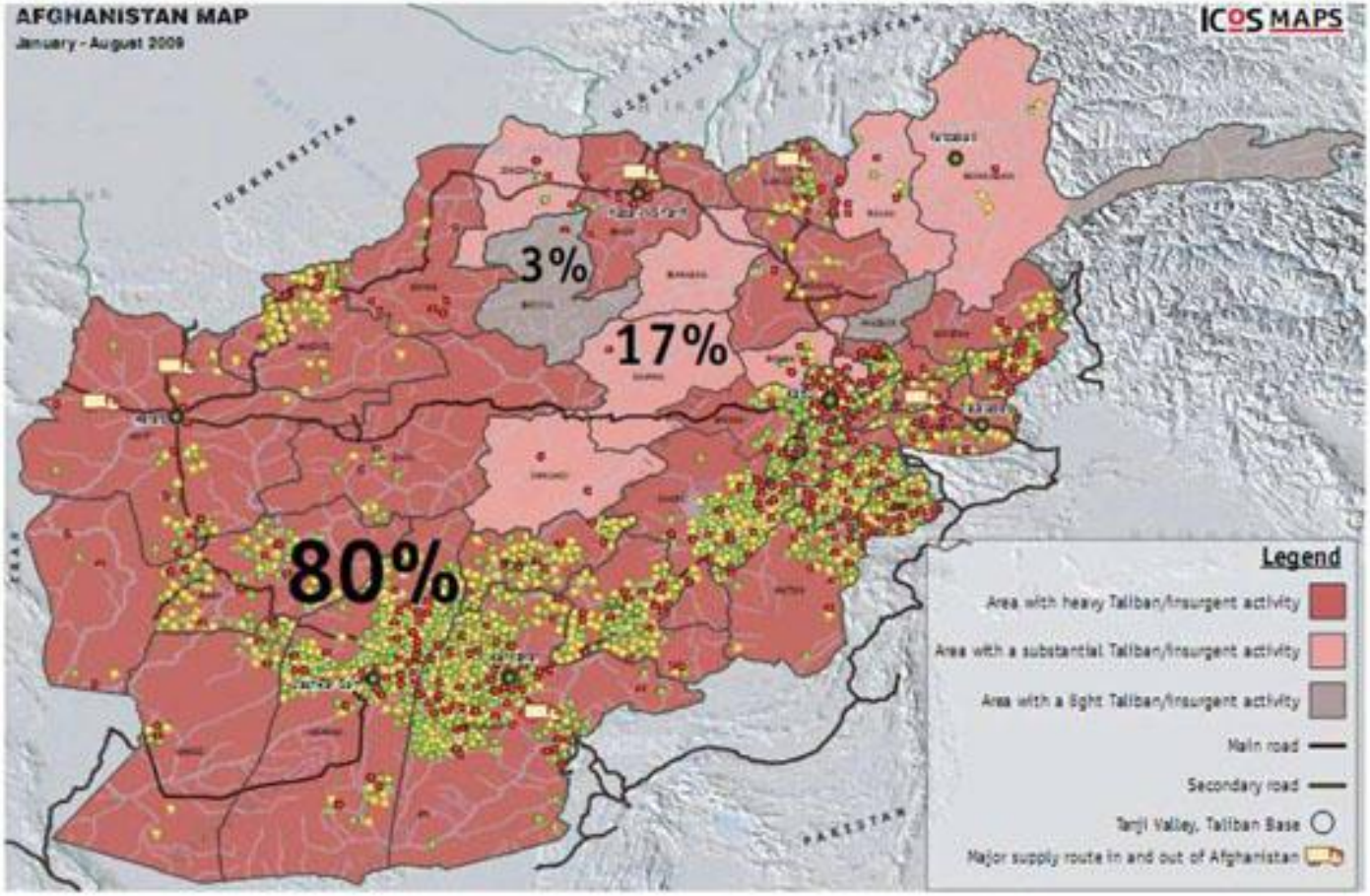
US Troop Levels: Reacting and Losing



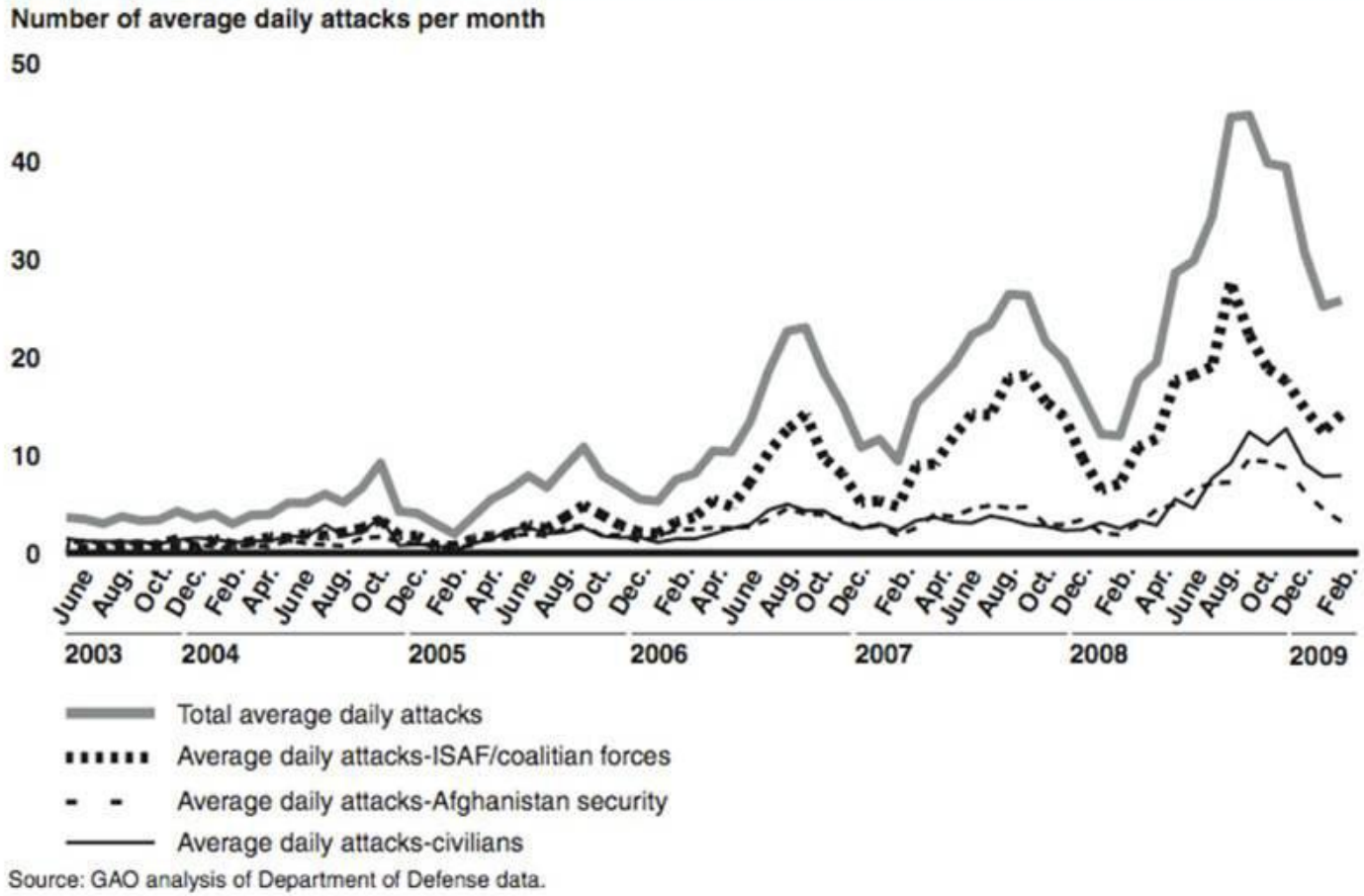
Insurgency Attack Activities In Afghanistan

(Source all Charts: Anthony Cordesman CSIS; Various Reports)

ICOS Threat Estimate: Fall 2009



Enemy Initiated Attacks in Afghanistan May 2003 to March 2009

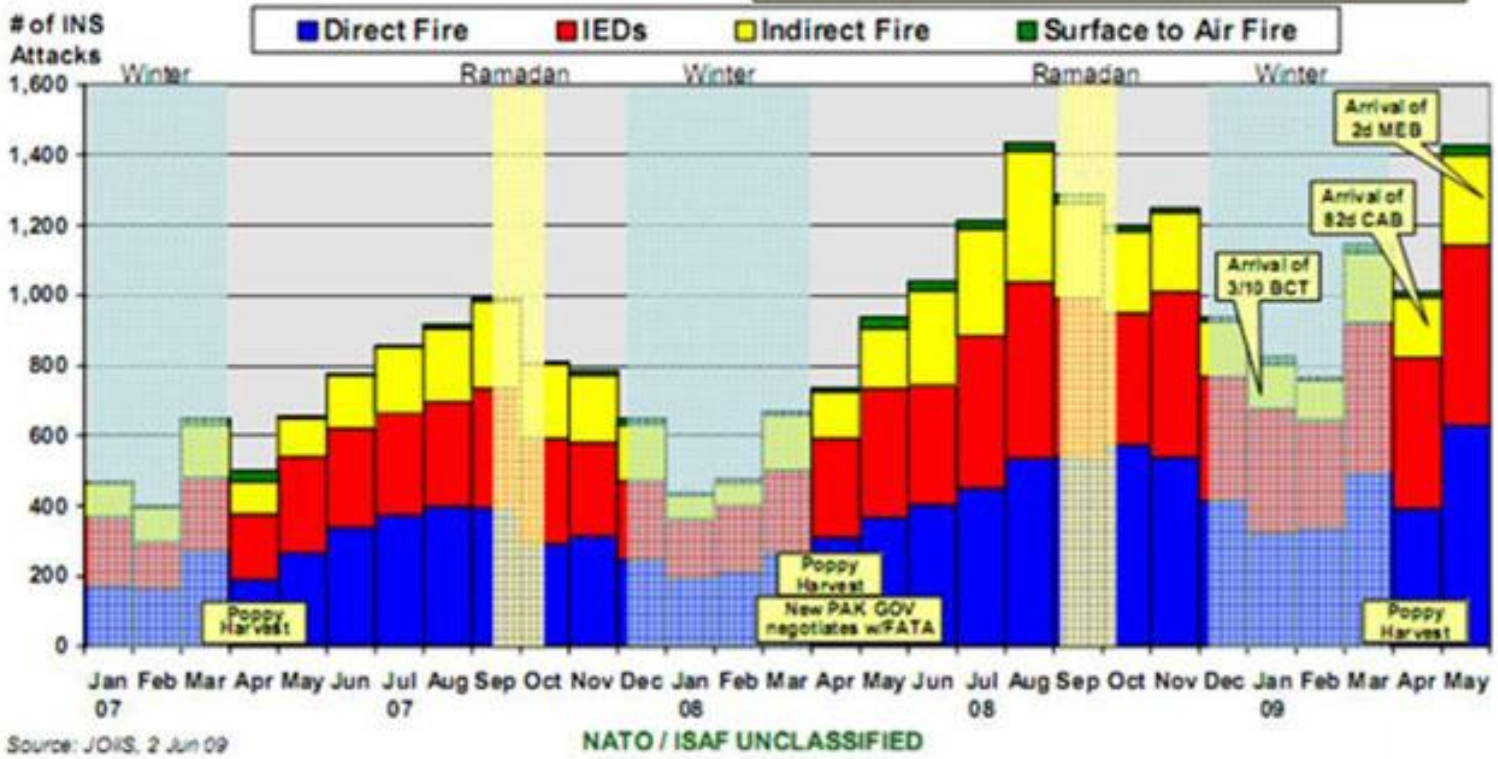


GAO: "Iraq and Afghanistan, March 2009, GAO-09-476T, p.11.

Insurgent Attacks

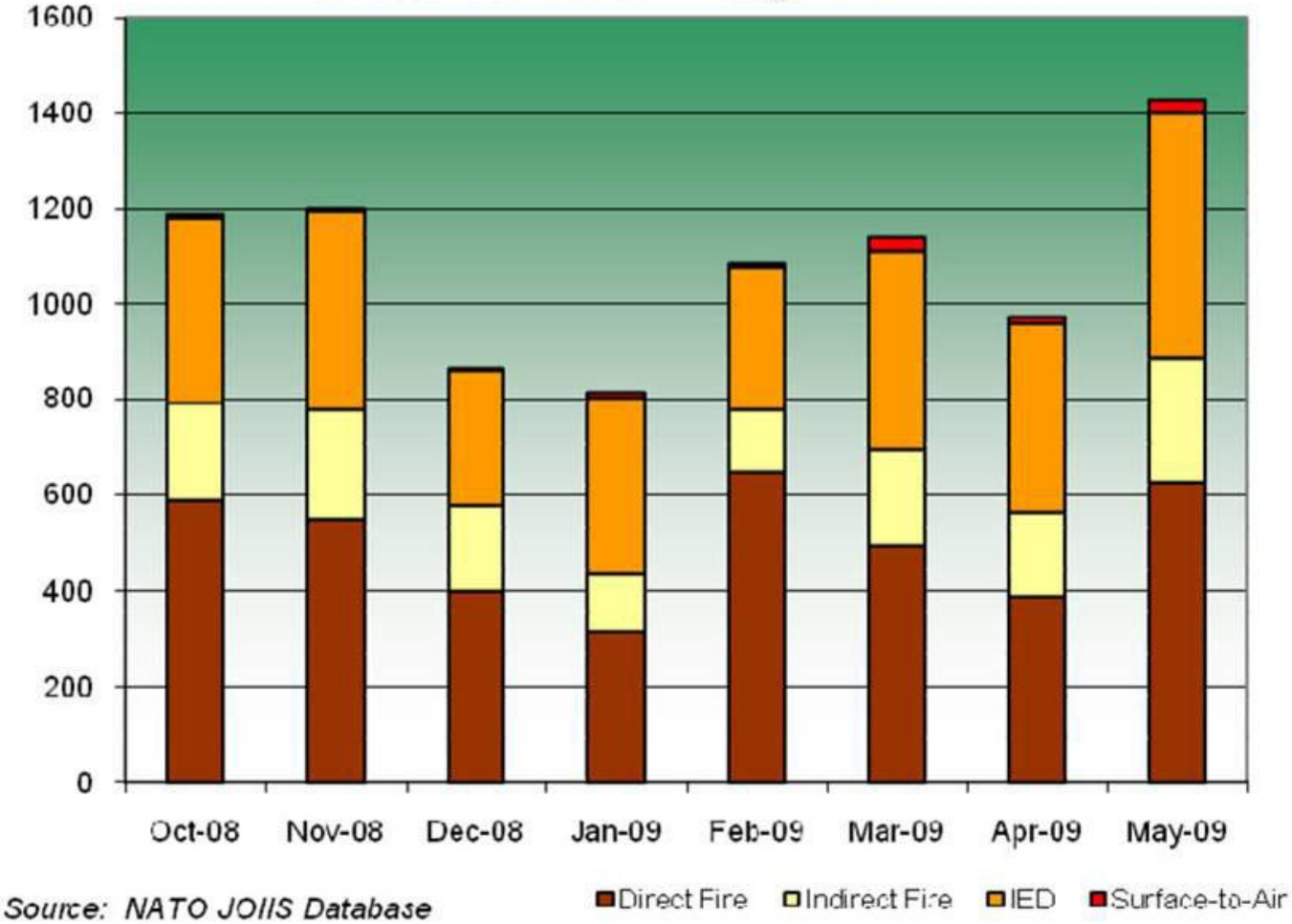
- Insurgent initiated attacks were up 59% overall (Jan-May '09 v. Jan-May '08):
  - Direct Fire attacks were up 61%
  - Indirect Fire attacks were up 46%
  - IEDs were up 64%
  - Surface to Air Fire was up 48%
  - Coalition Force offensive actions were up 34%

- Kinetic events increased substantially this year relative to the same period last year
  - Deliberate increase in operational tempo by ANSF and ISAF
  - Milder winter
  - Continued freedom of action for insurgents from sanctuaries across the border



HQ ISAF Strategic Advisory Group "Unclassified Metrics" May 2009.

Insurgent initiated Attacks October 2008-May 2009

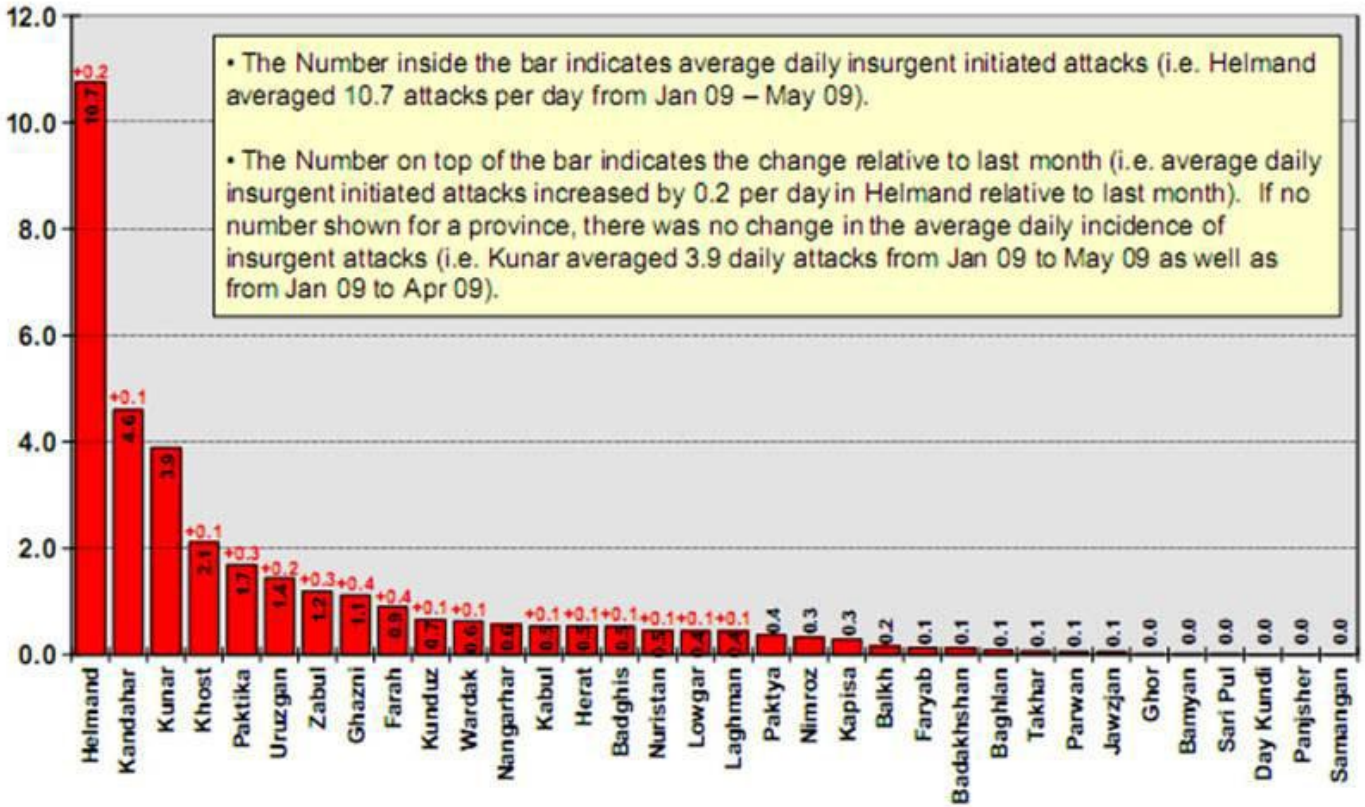


Source: NATO JOIIS Database

"Progress toward Security and Stability in Security and Stability in Afghanistan", Department of Defense, June 2009, Page 22

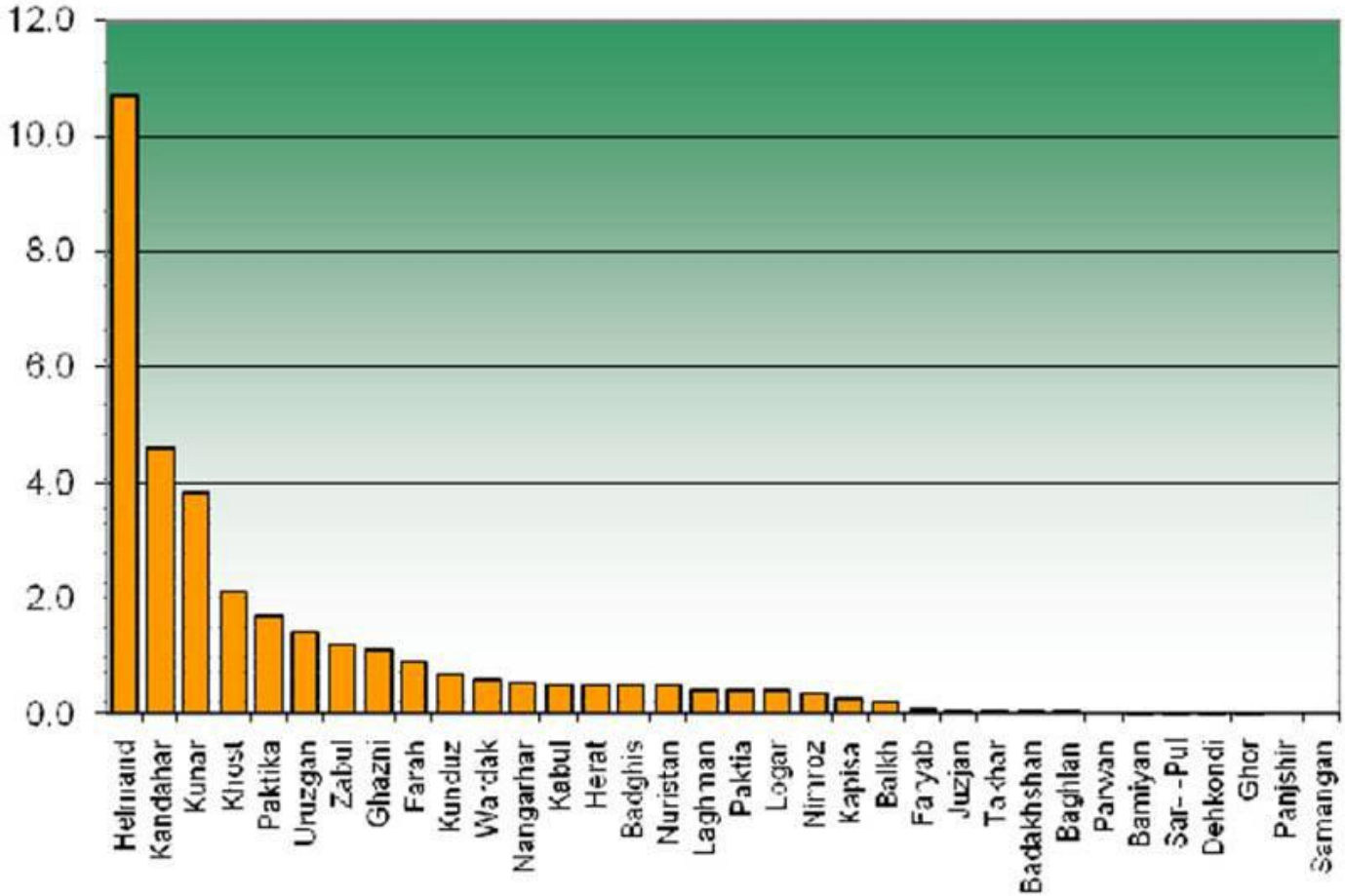
Average Daily Insurgent Initiated Attacks

By Province, January 1, 2009 – May 31, 2009



HQ ISAF Strategic Advisory Group "Unclassified Metrics" May 2009.

Average Daily Insurgent Attacks by Province January 2007-May 2009



"Progress toward Security and Stability in Security and Stability in Afghanistan", Department of Defense, June 2009, Page 23

Terrorist Incidents in Iraq and Afghanistan: 2005-2008:

Incidents of Terrorism in Iraq and Afghanistan*

	2005	2006	2007	2008
Terrorist attacks in Iraq	3,467	6,631	6,210	3,258
Attacks resulting in at least 1 death, injury, or kidnapping	2,837	6,028	5,573	2,902
People killed, injured, or kidnapped as a result of terrorism	20,722	38,878	44,012	19,083

Terrorist attacks in Afghanistan	494	968	1,125	1,220
Attacks resulting in at least 1 death, injury, or kidnapping	369	694	890	948
People killed, injured, or kidnapped as a result of terrorism	1,551	3,556	4,662	5,423

Office of the Coordinator for Counterterrorism, *Country Reports on Terrorism 2008 April 2009*, United States Department of State, Released April 2009, p. 348 .

US Drone Attacks in Pakistan (Jan 2008-Jan 2009)

The US has carried out about 40 drone air strikes since the beginning of 2008, most since September, killing more than 330 people, including many foreign militants, according to a tally of reports from Pakistani intelligence agents, district government officials and residents. There have been 18 attacks this year.

MILITANTS REPORTED KILLED IN STRIKES SINCE JANUARY 2008

January 28, 2008 - A senior al Qaeda member, Abu Laith al-Libi, was killed in a strike in North Waziristan.

July 28, 2008 - An al Qaeda chemical and biological weapons expert, Abu Khabab al-Masri, was killed in South Waziristan.

October 31, 2008 - A mid-level al Qaeda leader, Abu Akash, was killed in an attack in North Waziristan.

November 19, 2008 - An Arab al Qaeda operative identified as Abdullah Azam al-Saudi was killed in Bannu district.

November 22, 2008 - Rashid Rauf, a Briton with al Qaeda links and the suspected ringleader of a 2006 plot to blow up airliners over the Atlantic, was killed in an attack in North Waziristan. An Egyptian named as Abu Zubair al-Masri was said to be among the dead in the same attack.

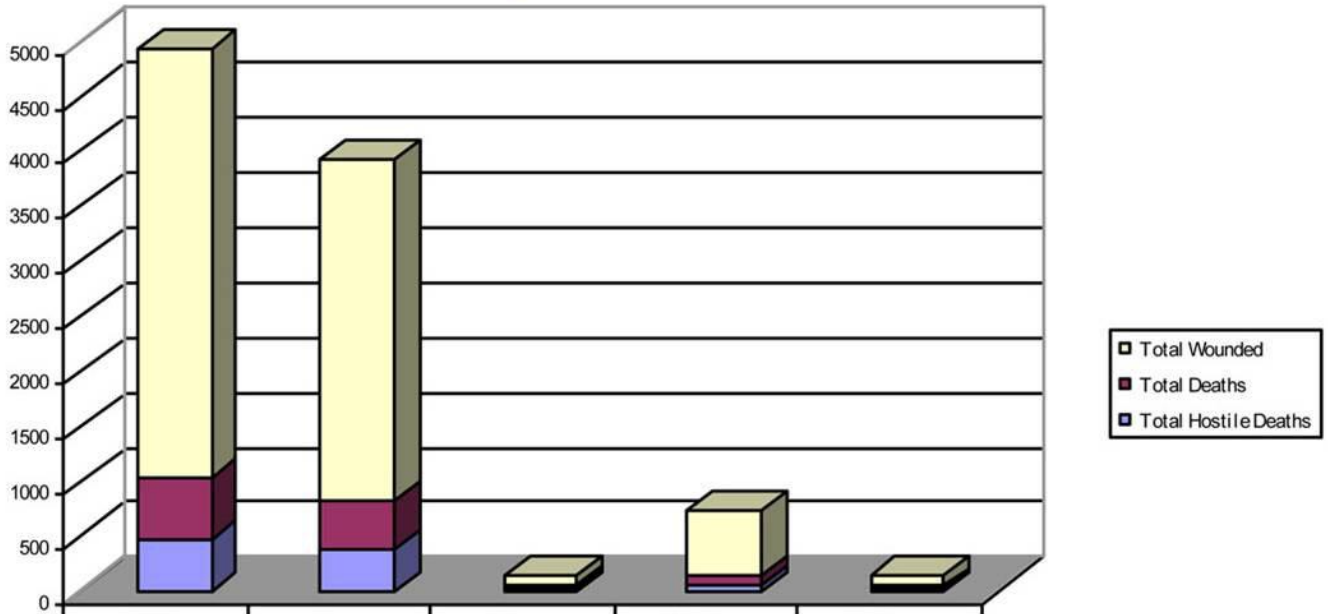
January 1, 2009 - A U.S. drone killed three foreign fighters in South Waziristan, Pakistani agents said. A week later, a U.S. counterterrorism official said al Qaeda's operational chief Usama al-Kini and an aide had been killed in South Waziristan.

Source: Reuters, "FACTBOX: U.S. Drone Attacks in Pakistan," June 14, 2009.

Attrition to ISAF/NATO Forces by the Insurgency

(Source all Charts: Anthony Cordesman CSIS; Various Reports)

US Deaths and Casualties in Afghanistan
As of September 5, 2009

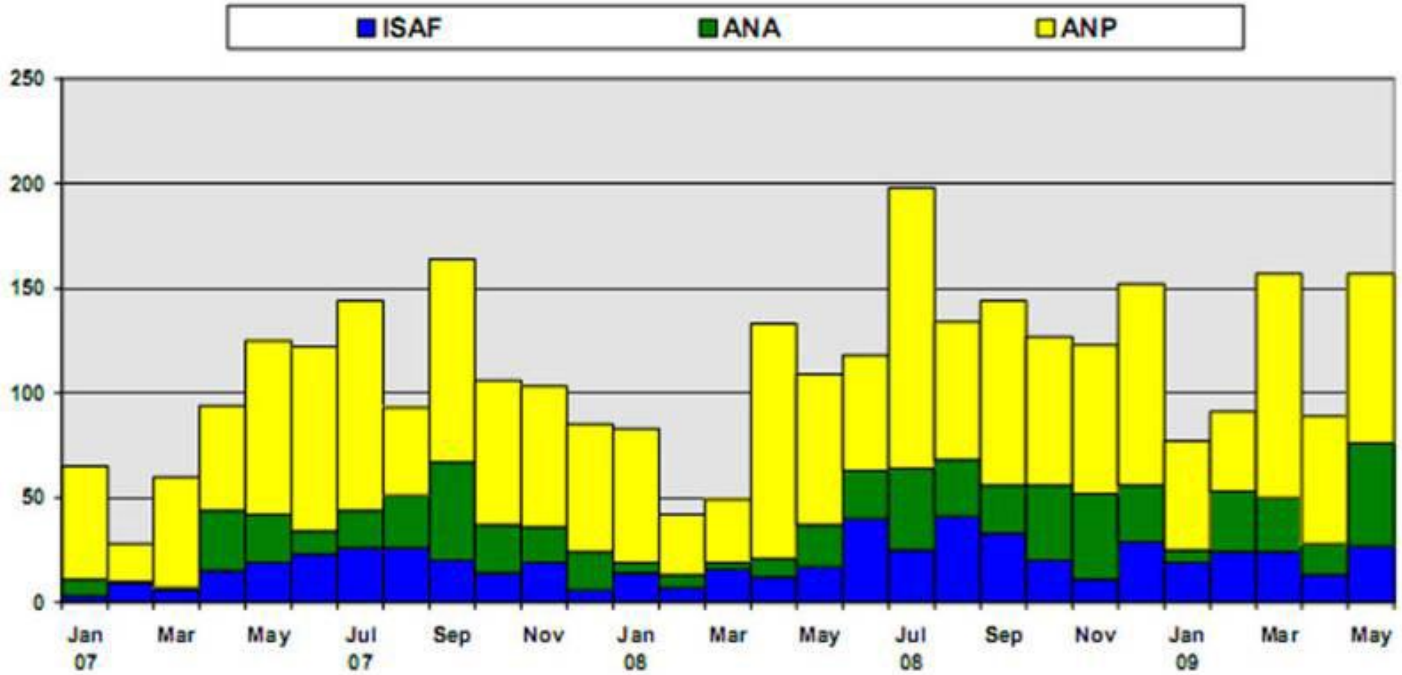


	Total	Army	Navy	Marines	Air Force
Total Wounded	3896	3120	72	596	108
Total Deaths	569	439	31	80	19
Total Hostile Deaths	464	367	28	53	16

http://siadapp.dmdc.osd.mil/personnel/CASUALTY/wotsum.pdf

Military Deaths

- Comparing Jan-May '09 to the same time period in 2008:
  - Total military deaths were up 37%
  - ANSF deaths were up 33%
  - ISAF deaths were up 62%



*Attributed to insurgent initiated attacks (direct fire, indirect fire, IEDs, and surface-to-air fire)

Source: JOIIS, 2 Jun 09

NATO / ISAF UNCLASSIFIED

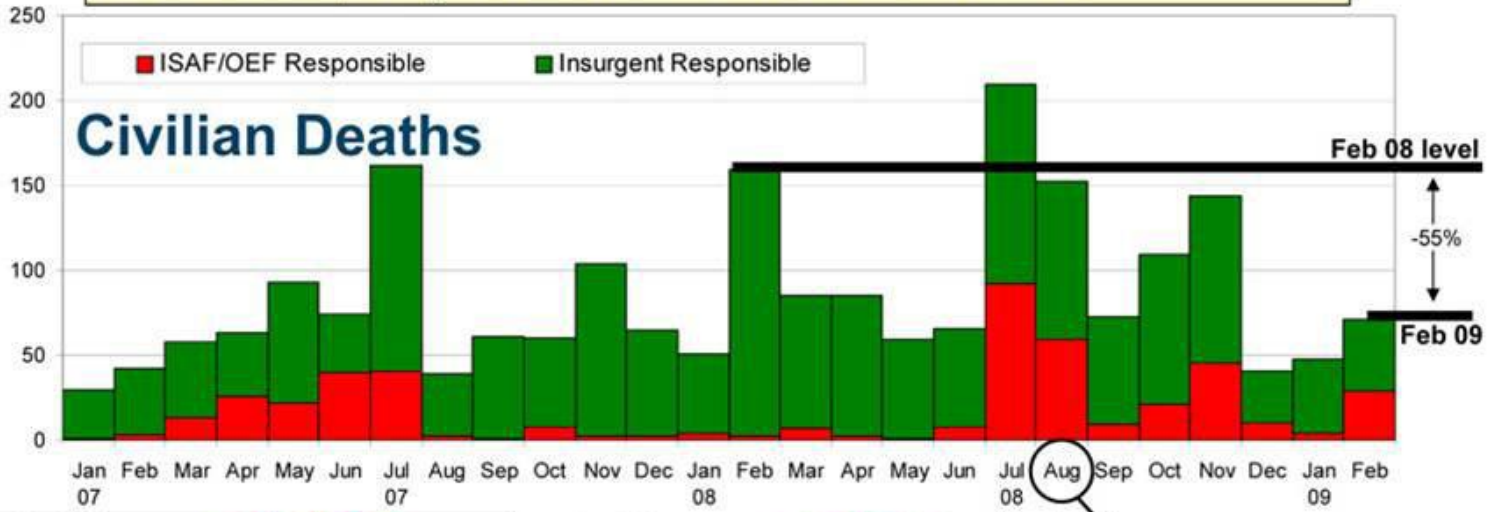
HQ ISAF Strategic Advisory Group "Unclassified Metrics" May 2009.

Attrition to the Civilian Population of Afghanistan

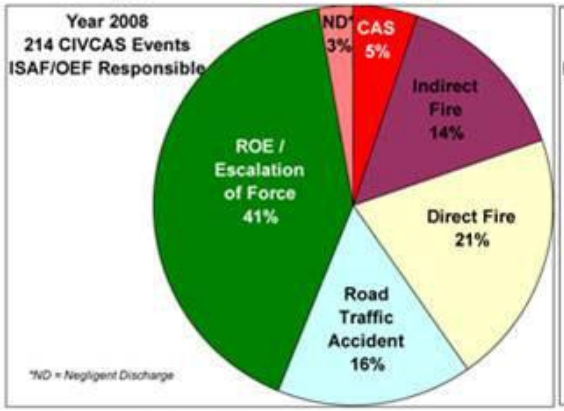
(Source all Charts: Anthony Cordesman CSIS; Various Reports)

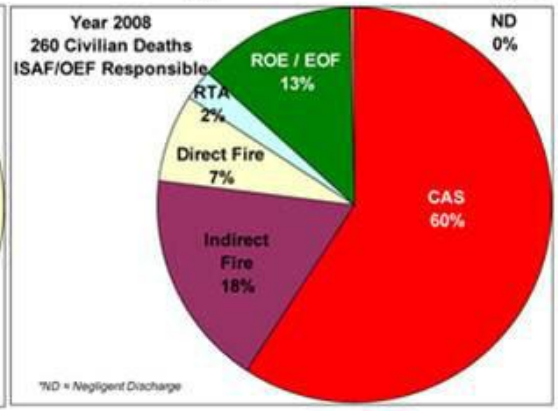
Civilian Deaths

- Comparing Feb 09 to the previous three month period (Nov 08 – Jan 09), civilian deaths are down 9%
- Since Jan 07, insurgents have caused 79% of civilian deaths



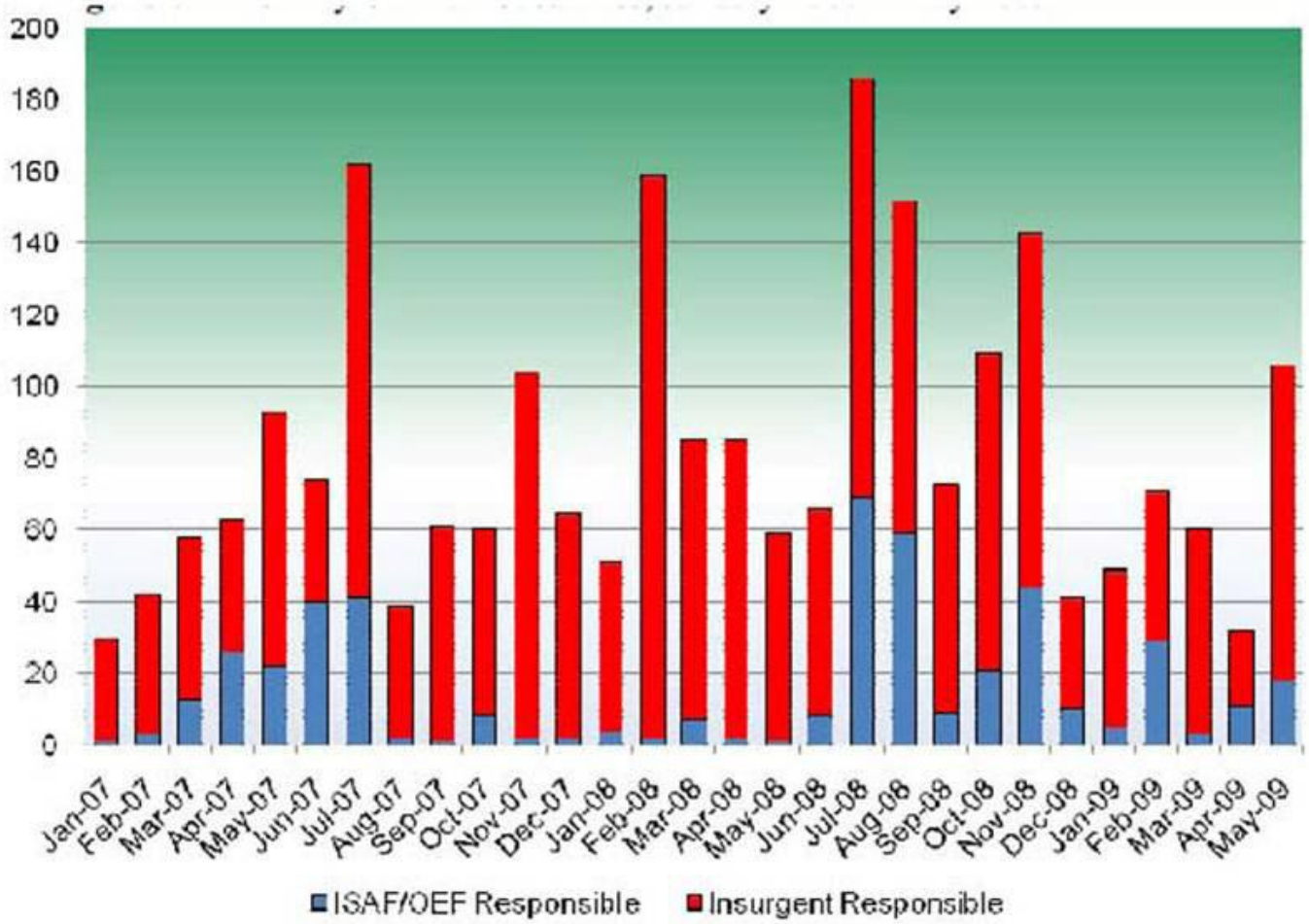
Civilian Casualty Tracking Cell Formed in CJOC
Standardizes process to investigate incidents of reported civilian casualties





Source: CJOC, CIVCAS Cell

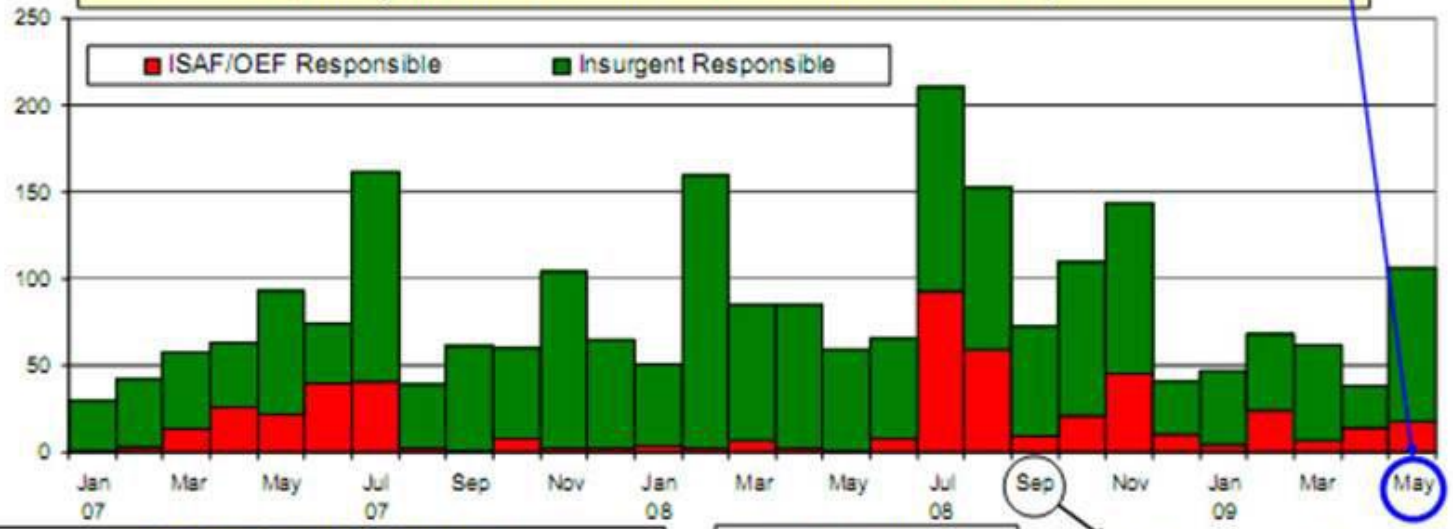
Monthly Civilian Casualties
January 2007-May 2009

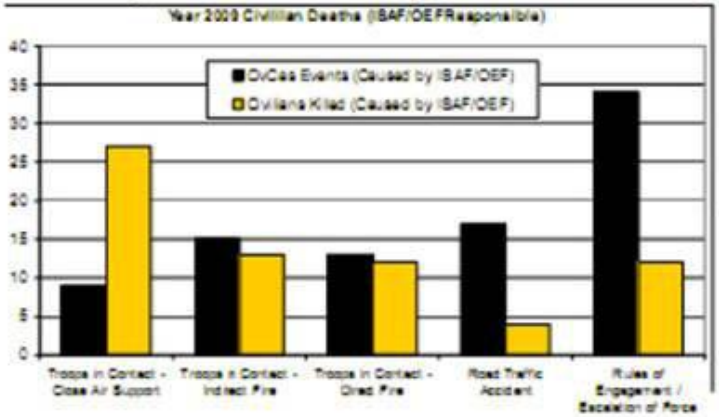


"Progress toward Security and Stability in Security and Stability in Afghanistan", Department of Defense, June 2009, Page 25

Civilian Deaths in Afghanistan

- Note: Data from 4 May Farah incident not included (final report not yet released as of 8 Jun)
- Comparing Jan-May '09 to the same time period in 2008, civilian deaths were down 27%
- Since Jan 07, insurgents have caused 80% of civilian deaths known by ISAF





ISAF Responsible	
Jan 07 - May 09	20%
Jan 07 - Dec 07	19%
Jan 08 - Dec 08	21%
Jul 08 - May 09	29%
Sep 08 - May 09	22%
Jan 09 - May 09	21%

Civilian Casualty Tracking Cell Formed in CJOC

Standardized process to investigate incidents of reported civilian casualties

- Among events that have caused civilian casualties attributed to ISAF/OEF Forces, Escalation of Force incidents have been the most frequent cause of civilian casualties, but Close Air Support events have caused the greatest proportion of civilian deaths.

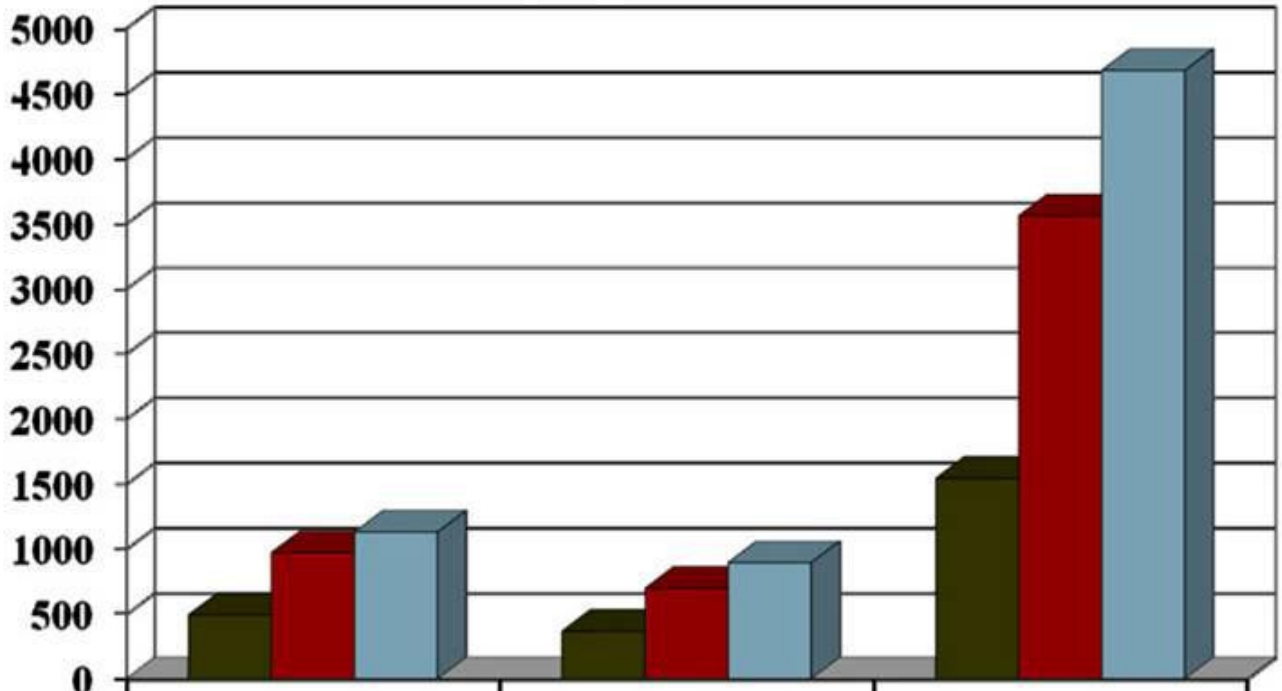
NATO / ISAF UNCLASSIFIED

Source: ISAF CJOC, CIVCAS Tracking Cell, As of 1 Jun 09

HQ ISAF Strategic Advisory Group "Unclassified Metrics" May 2009.

Rise in Afghan Terrorism: 2005-2007

Attacks Targeting Non-Combatants



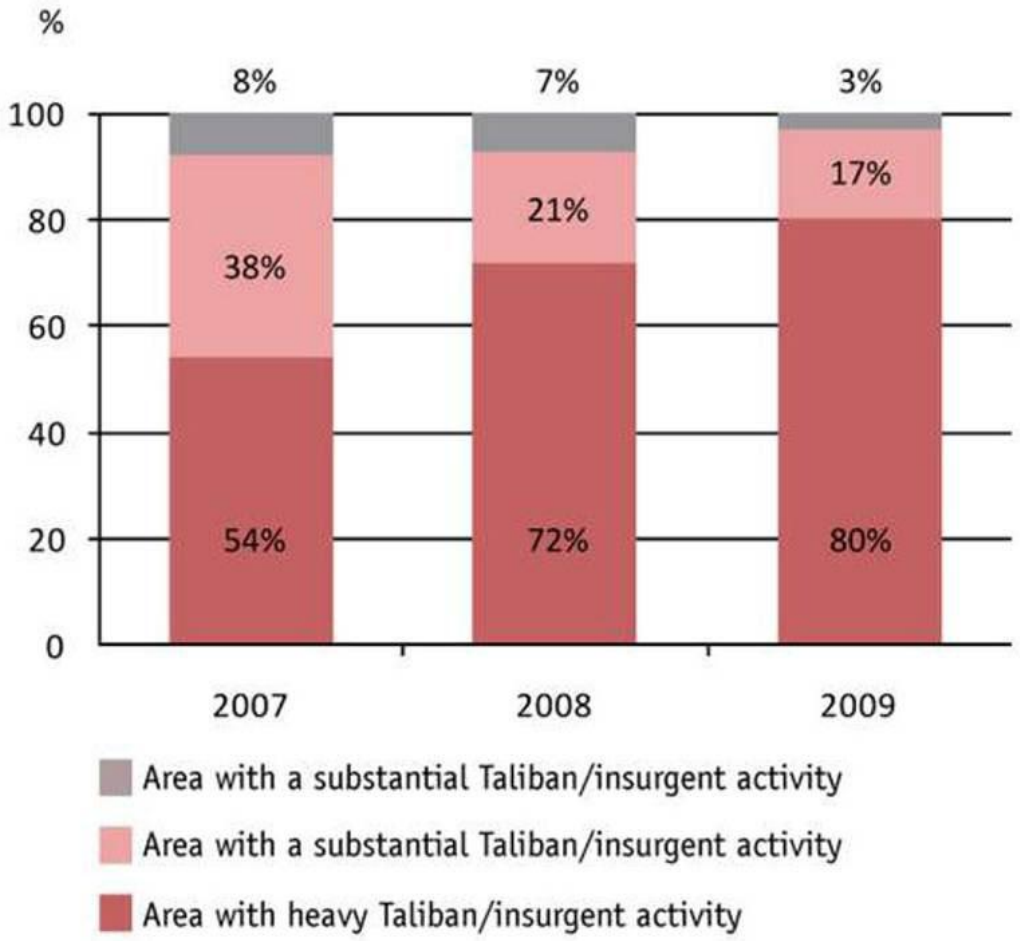
	Terror attacks	Attacks causing at least one death, inury, or kidnapping	People killed, injured, or kidnapped
2005	491	366	1540
2006	969	695	3557
2007	1127	892	4673

Adapted from US State Department, Country Reports on Terrorism. April 30,2008, and www.nctc.gov

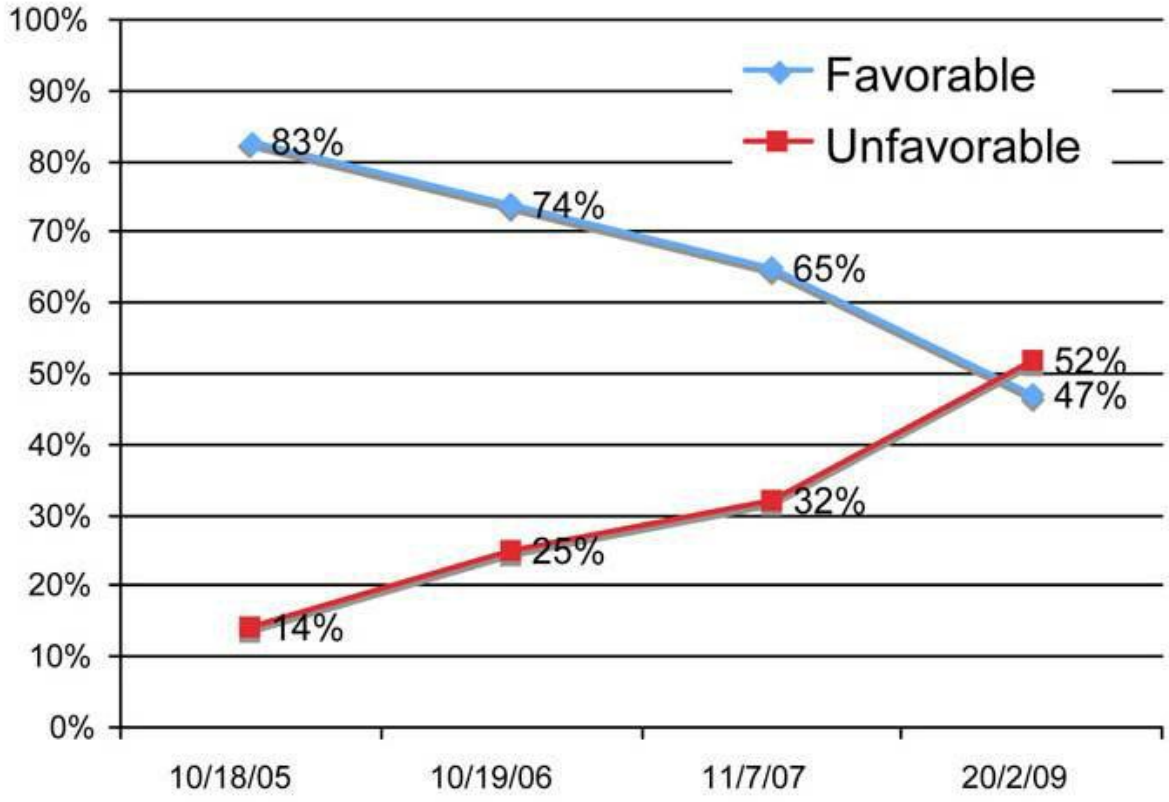
Relationship between Insurgency Activities and Popular Support

(Source all Charts: Anthony Cordesman CSIS; Various Reports)

ICOS Estimate of Growth of Taliban Influence: 2007-2009



ABC/BBC/ARD Poll: Afghan Views of the US: 2005-2009-2



Source: *Gary Langer, Director of Polling, ABC News, "Afghanistan: Where Things Stand,"* Public Opinion Trends in Afghanistan, CSIS – Feb. 11, 2009

Chemical Terrorism

Chemical Weapons

Chemicals can be used to kill or incapacitate personnel and to deny use of areas, materiel, or facilities. Agents can be both lethal and non-lethal, and can be either persistent or non-persistent in effects. Terrorists have already used chemical weapons and although examples often display a basic use of chemicals, a tendency exists to demonstrate ever increasing death, damage, and psychological stress on a target.

Categories of Chemical Warfare Agents

Chemical agents can be categorized by the effects they have on the target population. Effects may include death, temporary incapacitation, or permanent health damage. Categories of chemical warfare agents are: nerve, blood, blister, and choking agents.

Nerve agents are fast-acting chemical agents. Practically odorless and colorless, they attack the body's nervous system causing convulsions and eventually death. The body muscles and glands become over stimulated to a point where breathing stops. Nerve agents are classified as either G or V agents, and further classified such as such as Sarin (GB), Tabun (GA), Soman (GD), or VX. At low concentrations, the GB series incapacitates; GB can kill if inhaled or absorbed through the skin. The rate of action is very rapid if inhaled, but slower if absorbed through the skin. The V-agents are quicker acting and more persistent than the G-agents.

Blood agents are absorbed by breathing and block the oxygen transfer mechanisms in the body, leading to death by suffocation. A common blood agent is hydrogen cyanide (AC). Other blood agents include Cyanogen Chloride (CK) or Arsine (SA). Each agent may have a different type of effect, but cause symptoms such as respiratory or cardiovascular collapse or myocardial failure.

Blister agents, such as mustard (H) or lewisite (L), and combinations of the two compounds redden and blister skin. Contact can produce very large blisters. They also cause damage to the eyes, blood cells, and lungs. Eye exposure will cause reddening or temporary blindness, and may have permanent eye effects. These agents are especially harmful when inhaled.

(Reference: US Army TRADOC Handbooks. A Military Guide to Terrorism in the 21st Century. 2007)

Choking agents, such as phosgene (CG) and diphosgene (DP), attack the respiratory system and make the membranes swell so the lungs fill with fluid. The pulmonary edema that results has been informally called "dry-land drowning." As with blood agents, poisoning from choking agents comes through inhalation. Signs and symptoms of toxicity may be delayed up to 24 hours and can be fatal. Chemical agents are also classified according to their persistency. Persistency is the length of time an agent remains effective on the battlefield or other target area after dissemination. The two basic classifications are persistent or non-persistent.

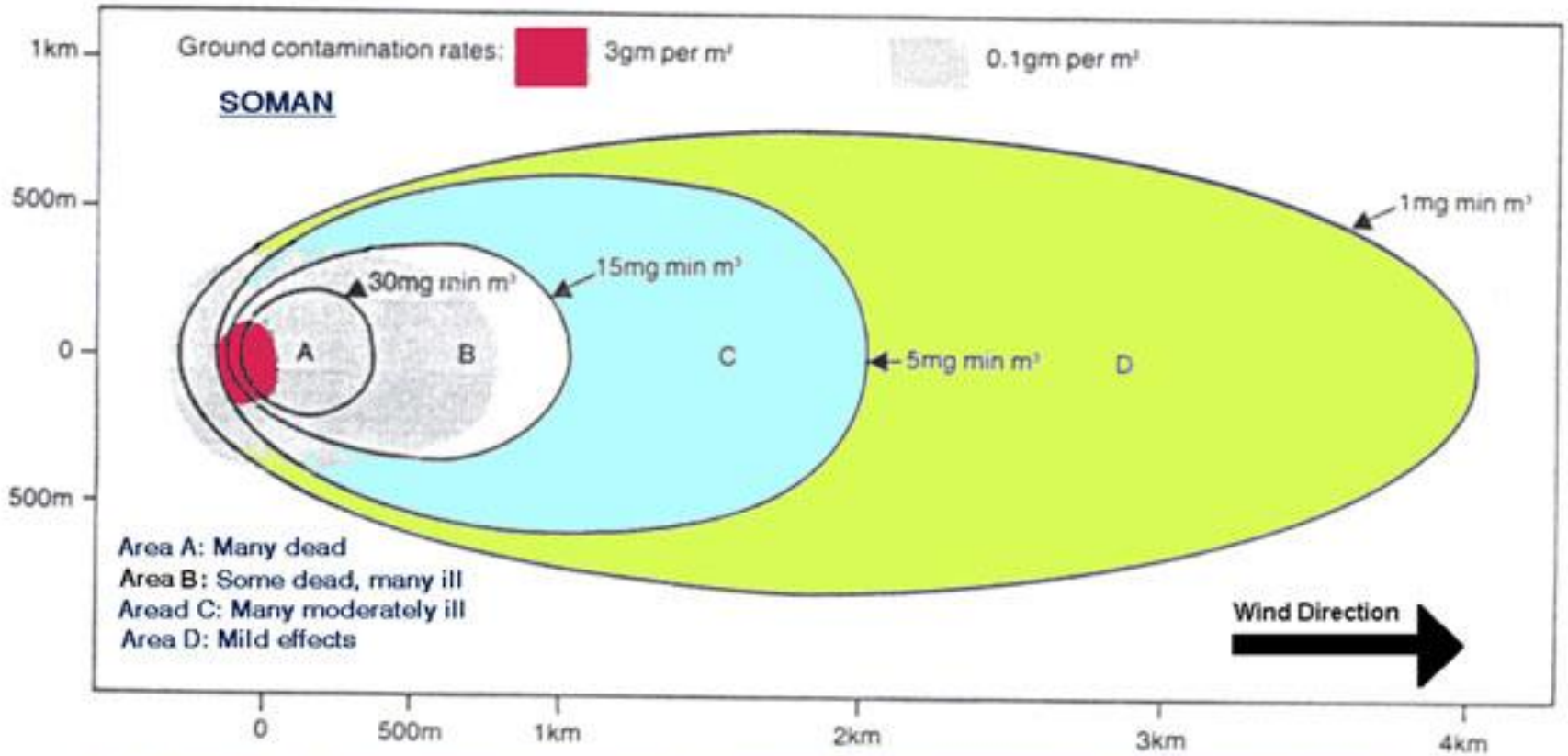
Persistent and Non-persistent Agents

Persistent nerve agents, such as V-agents, thickened G-agents, and the blister agent mustard, can retain their disabling or lethal characteristics for days to weeks (depending on environmental conditions). Persistent agents produce either immediate or delayed casualties. Immediate casualties occur when an individual inhales a chemical vapor. Delayed casualties occur when the chemical agent is absorbed through the skin.

Non-persistent agents generally last a shorter period of time depending on the weather conditions. For example, the nerve agent sarin (GB) dissipates within minutes after dissemination. However, some liquid GB could remain for periods of time varying from hours to days, depending on the weather conditions and method of delivery

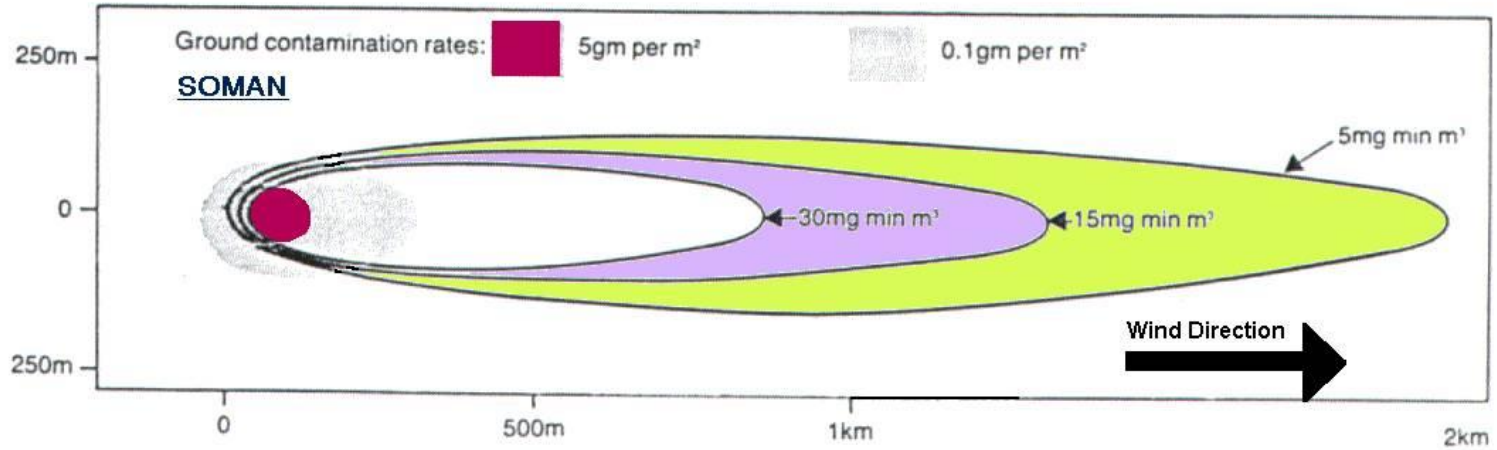
Chemical Weapons

Agent	Known As	Route of Entry	Rate of Action	Persistency
Choking	**Phosgene (CG)** **Chlorine (C)**	**Respiratory**	**Immediate**	**Minutes to Hours**
Blood	**Hydrogen Cyanide (HC)** **Cyanogen Chloride (CK)**	**Respiratory**	**Rapid (seconds)**	**Minutes to Hours**
Blister	**Mustard (H)** **Lewisite (L)** **Phosgene Oxime (CX)**	**- Skin** **- Inhalation** **- Eyes**	**Rapid**	**Hours to Days**
Nerve	**Tabun (GA)** **Sarin (GB)** **Soman (GD)** **VX**	**- Skin** **- Inhalation** **- Eyes**	**- Inhalation: Rapid** **- Skin: Seconds to minutes**	**Tabun: Minutes to Hours** **Sarin: Minutes to Hours** **Soman: Hours** **VX: Hours to Days**



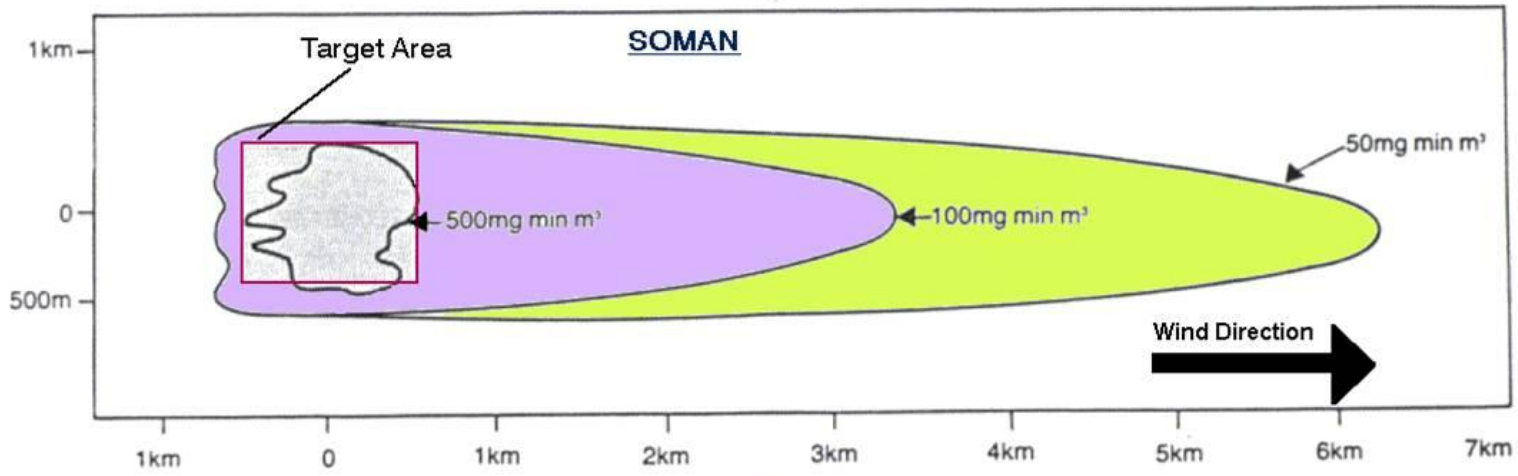
SCUD MISSILE ATTACK: One missile fired (CEP:900m); wind speed 5 m/sec; neutral atmospheric conditions.

SSM	Single Warhead (kg)	Range (km)
SS-1C (SCUD B)	**985**	**300**
SS-1D (SCUD C)	**500**	**500**



FROG Missile Attack: One missile fired (CEP: 400 m); windspeed 5 m/sec; neutral atmospheric conditions.

SSM	Single Warhead (kg)	Range (km)
Frog 7b	**200 to 457**	**68**



BM-21 MRL Attack: One battalion of 18 launchers (each 40 rockets) fired at target area 1 x 1 km; wind speed 3 m/sec; neutral atmospheric conditions.

Biological Terrorism

Biological Weapons

• Biological Weapons are easier and cheaper to produce than either chemical or nuclear weapons, and the technology is readily available in open literature and on the Internet. Biological agents can be very lethal in comparison with other WMD agents or material. As one example assuming optimum conditions, about 1,800 pounds of chemical agent Sarin is required to inflict a large number of casualties over a square mile area, while only a quarter ounce of anthrax spores is required to achieve the same effect over the same area under ideal distribution conditions.

• Biological warfare agents include three basic categories: pathogens, toxins, and bioregulators. Pathogens are disease producing microorganisms such as bacteria, rickettsia, or viruses. Pathogens can occur naturally or can be altered with biotechnology. Toxins are poisons formed by a vegetable or animal, but can be produced synthetically also. Bioregulators affect cell processes in the body. Used as a bioweapon, they can cause severe adverse effects or death.

• Biological agents can be isolated from sources in nature, acquired from laboratories or bioweapons stockpiles, or synthesized or genetically manipulated in a laboratory.

Biological Weapons

Type	Agent	Incubation Period
Bacteria	**Anthrax** **Tularemia** **Plaque**	**Typically 1-6 days, but up to 42 days** **1-21 days (average 3-6 days)** **1-7 days (usually 2-3 days)**
Toxins	**Botulism** **Ricin**	**12 hours to 5 days** **18-24 hours**
Viruses	**Smallpox** **Ebola**	**7-17 days (average 12)** **4-21 days**
Rickettsia	**Q fever**	**7-41 days**

(Reference: US Army TRADOC Handbooks. A Military Guide to Terrorism in the 21st Century. 2007)

Dissemination of Effects

• Biological dissemination through aerosols, either as droplets from liquid or as particles from powders, is usually the most efficient method. This method does create a challenge since aerosol sprayers or other devices need to be properly designed for the agent used, and proper meteorological conditions must exist to conduct an effective attack. The objective of biological weapon delivery is to expose humans to an agent in the form of a suspended cloud of fine agent particles. Airborne particles, once inhaled, tend to lodge deep in the lungs and vulnerable body tissues and bloodstream. The agent must be cultured and processed to achieve an appropriate minuscule size in order to gain entry into the intended human body organs.

• Pathogens such as anthrax, plague, smallpox, tularemia, cholera, or various types of pathogens could be used against targets such as population centers, water and food supplies, and economic or infrastructure sites. Anthrax invades in one of three ways: the skin (cutaneous), the digestive system (gastrointestinal), or the lungs (inhalation). Inhalation is the most serious vector of attack.

• Terrorists can deliver biological weapons by unconventional dissemination means. These include commercially available or specially designed sprayers or other forms of aerosol generators mounted in automobiles, trucks, or ships. Smaller, more portable devices could be used to effectively disseminate biological agent aerosols. Such devices could be used to introduce an agent into heating, ventilating, and air conditioning systems. Drinking water can be contaminated by high-pressure agent injectors attached to plumbing system components.

• Under appropriate meteorological conditions and with an aerosol generator delivering 1–5 micron particle-size droplets, a single aircraft can disperse 100 kg of anthrax over a 300 km2 area and theoretically cause 3 million deaths in a population density of 10,000 people per km2. The mean lethal inhalator dosage is 10 nanograms.

(Reference: US Army TRADOC Handbooks. A Military Guide to Terrorism in the 21st Century. 2007)

Biological Weapons Estimated Casualties Using Aerosol Delivery Mechanism

	Amount Released	Estimated Damage/Lethality
Anthrax	100 kg spores released over a city the size of Washington DC	130,000 – 3 million deaths
Plague	50 kg Y. pestis released over city of 5 million people	150,000 infected 36,000 deaths
Tularemia	50 kg F. tularensis released over city of 5 million people	250,000 incapacitated 19,000 deaths

Basis of Dose Calculations:

Wind Speed 5 meter/sec at 10 meters height
Release Height = 10 meters
Source Strength = 1 gram = 10 ^(12) spores
Breathing Rate = 30 L/min (as for a man engaged in light work)

Atmospheric Stability "Neutral" : Briggs "D"
Atmospheric Stability "Slightly Stable" : Briggs "E"

ID50 (Dose in spores to cause effect in 50% of a population) = 8,000

Briggs "D" ID50 Downwind Distance = 1,190 meters
Briggs "E" ID50 Downwind Distance = 1,900 meters

(Reference: Applied Science and Analysis Inc. The ASA Newsletter. 2001: "Note Regarding Source Strength" Matthew Meselson.)

Anthrax Centerline Dose (Spores)

Downwind Distance (km)	Briggs "D" (Atmospheric Stability - Neutral)	Briggs "E" (Atmospheric Stability – Slightly Stable)
0.5	**32,610**	**62,100**
1	**10,620**	**21,940**
2	**3,580**	**7,470**
3	**1,950**	**4,160**
4	**1,290**	**2,830**
5	**940**	**2,140**
6	**730**	**1,720**
7	**600**	**1,440**
8	**500**	**1,250**
9	**430**	**1,100**
10	**375**	**990**
20	**160**	**530**
30	**100**	**390**
40	**72**	**320**
50	**57**	**270**

Radiological Bombs
Radiological Dispersal Device RDD

Radiological Weapons

• Radiological terrorism, a relatively new aspect of WMD and terrorism, is usually conceived as the use of a radiological device or an attack on a nuclear facility such as a nuclear power plant. The aim is to release radioactive contamination into the atmosphere.

• Although physical destruction with a radiological device will be much less than a nuclear detonation, structure contamination, or the fear of radiation and long-term health issues, may be key physical and psychological impacts. Trauma of a radiological threat can have significant negative effects on the economic, financial, and political programs of a region and nation.

Categories of Radiological Dissemination

• Radiological contamination caused by terrorists can occur in multiple ways. One of the more well-known dissemination descriptions is a radiological dispersal device (RDD). This capability uses any number of mechanical means to spread radiation throughout a designated area. Another common term, the "dirty bomb," is an example of using conventional explosives to disperse radioactive material. Other forms of RDD could distribute radioactive material in the atmosphere or in confined areas such as an office complex ventilation system. An aircraft might be used to disperse powdered or aerosolized forms of radioactive material. The many industrial, scientific, agricultural, and public uses of radiation make access to certain radiological equipment and materiel a distinct probability for a dedicated individual or terrorist group.

• Although radiation type devices may not necessarily cause mass casualties, they could present a significant radiation contamination effect on the target area. Radiation casualties could be low initially, but would potentially increase over time. The U.S. Environmental Protection Agency (EPA) guidelines recommend that if a cancer risk due to remaining radiation cannot be reduced to less than one person per 10,000 people, the area should be abandoned. Disaster response and recovery issues of decontamination would include medical treatment of people in the affected area, possible evacuation or relocation of populations, and multiple actions to make physical property and materiel useable with no fear of radiation.

(Reference: US Army TRADOC Handbooks. A Military Guide to Terrorism in the 21st Century. 2007)

"Dirty Bomb" Danger

• To date, the U.S. has not been attacked with a radiological weapon by terrorists. Nonetheless, theoretical case study examples illustrate the potential impacts of a radiological "dirty bomb." Most injuries would probably occur from the heat, debris, radiological dust and force of the conventional explosion. A "dirty bomb" cannot create an atomic blast. Nonetheless, assumptions may appear too simple or too critical in stating the damage of a radiological event.

• Attack on a nuclear facility is another means to cause radiological contamination. Even with the redundant safeguards and security measures at nuclear facility locations, the possibility of terrorist assault and breach of these measures is not impossible. Considerable precautions and security measures are, in effect, to preclude successful attacks by vehicle borne explosive devices or aerial borne means.

• The simplest and the most primitive terrorist nuclear device would be a radiological weapon or radiological dispersal device, commonly called a "dirty bomb". It is not strictly speaking a nuclear weapon, as it does not involve a nuclear explosion. A dirty bomb would consist of a conventional high explosive—for example, Semtex, dynamite or TNT—and a quantity of a radioactive material.

Effects of a radiological weapon

• The detonation of a dirty bomb is unlikely to cause a large number of casualties. Generally, any immediate deaths or serious injuries would most likely be caused by the detonation of the conventional explosive. The radioactive material in the bomb would be dispersed into the air but would soon be diluted to relatively low concentrations.

• If the bomb were exploded in a city, as it most likely would be, some people would probably be exposed to a dose of radiation. However, in most cases the dose would probably be relatively small. A low-level exposure to radiation would slightly increase the long term risk of cancer. The main potential impact of a dirty bomb is psychological—it would cause considerable fear, panic, and social disruption, exactly the effects' terrorists wish to achieve.

(Reference: US Army TRADOC Handbooks. A Military Guide to Terrorism in the 21st Century. 2007)

• The radioactive area would have to be evacuated as quickly as possible, to prevent people becoming contaminated, and would then have to be decontaminated. The degree of contamination would depend on the amounts of high explosive and incendiary material used, the amount and type of radioisotope in the bomb, whether it was exploded inside a building or outside, and the weather conditions. Decontamination is likely to be very costly (costing millions of dollars) and take weeks or, most likely, many months to complete. Radioactive contamination is the most threatening aspect of a dirty bomb.

• However, certain other radioactive materials, dispersed in the air, could contaminate up to several city blocks, creating fear and possibly panic and requiring potentially costly cleanup. A second type of RDD might involve a powerful radioactive source hidden in a public place, such as a rubbish receptacle in a busy train or underground station, where people passing close to the source might get a significant dose of radiation.

• A dirty bomb is in no way similar to a nuclear weapon. The presumed purpose of its use would be therefore, not as a Weapon of Mass Destruction but rather as a Weapon of Mass Disruption.

Radiological and Nuclear Devices

Device	Type of Weapon
Radiological Dispersal Device (RDD)	**This is a conventional weapon designed to disperse radioactive material causing destruction and contamination as well as injury.**
Improvised Nuclear Device (IND)	**This is intended to cause a yield-producing nuclear explosion. Built from a modified nuclear weapon or components.**

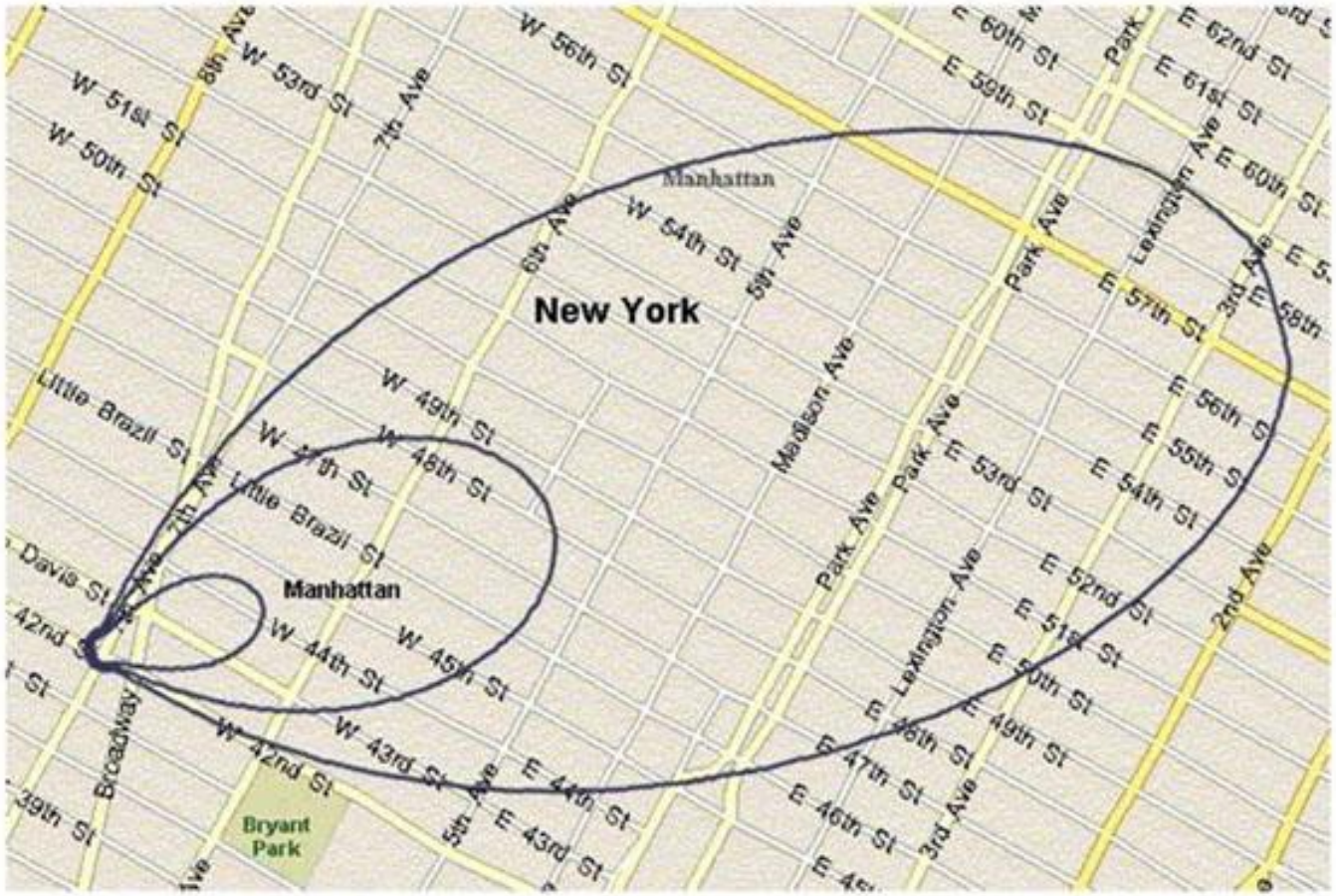
(Reference: US Army TRADOC Handbooks. A Military Guide to Terrorism in the 21st Century. 2007)

A Radiological Dispersal Device (RDD) is a conventional weapon designed to disperse radioactive material causing destruction and contamination as well as injury.

A Selected Sample of Radioactive Materials

Radioactive Material	Used In
Cobat-60 (Co-60)	**• Cancer Therapy • Industrial Radiography • Industrial Gauges • Food Irradiation**
Cesium – 137 (Cs-137)	**• (Same uses as Cobalt – 60) • Well Logging**
Iridium – 192 (Ir – 192)	**• Industrial Radiography • Implants Cancer Therapy**
Strontium – 90 (Sr – 90)	**• Radioisotope • Thermoelectric Generators**
Plutonium – 238 (Pu – 238)	**• Research • Well Logging • Thermoelectric Generators**
Americium – 241 (AM – 241)	**• Industrial Gauges • Well Logging**

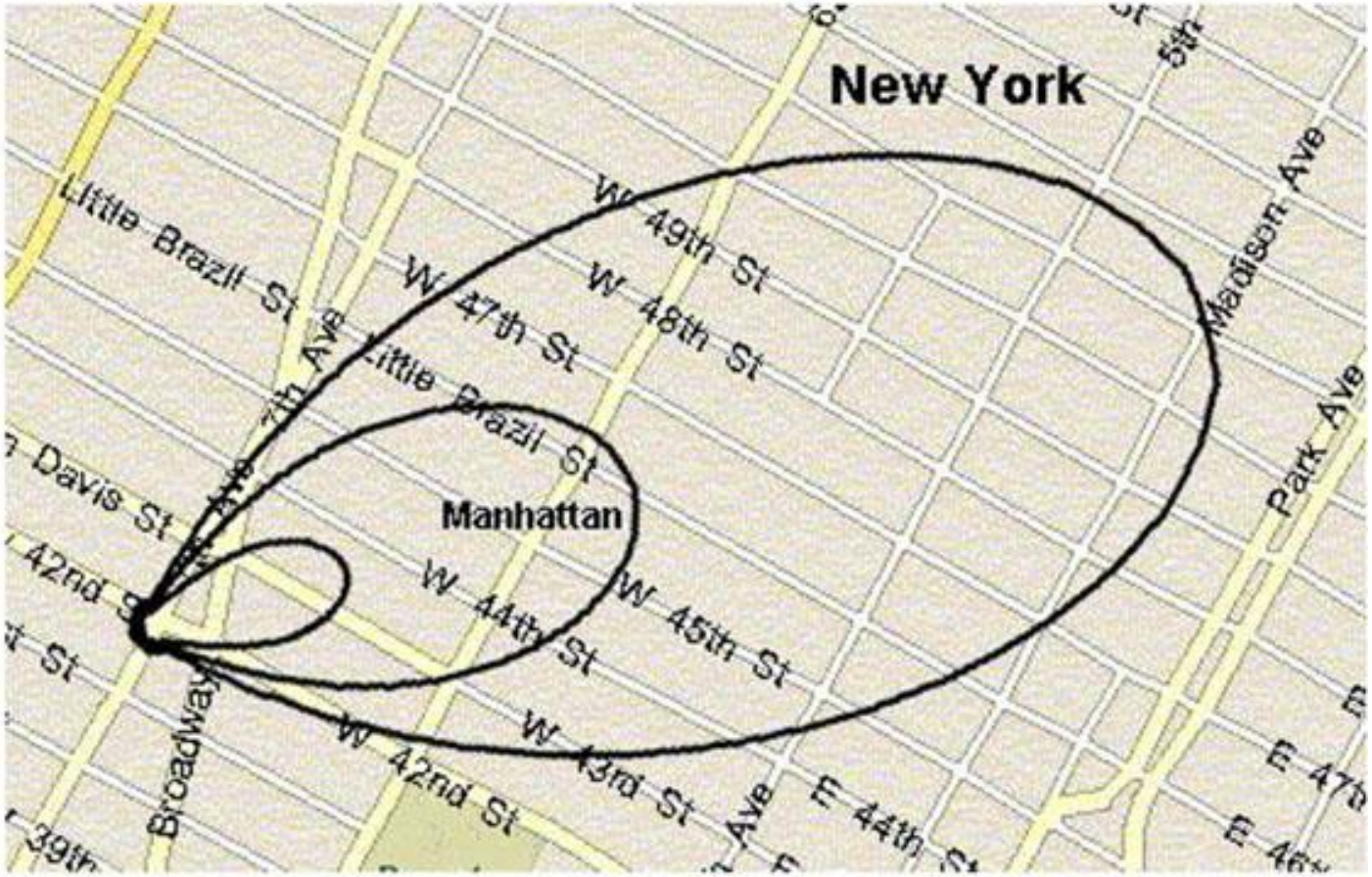
Figure 5: Contamination Due to Americium Bomb in New York City



Inner Ring:	One cancer death per 100 people due to remaining radiation
Middle Ring:	One cancer death per 1,000 people due to remaining radiation
Outer Ring:	One cancer death per 10,000 people due to remaining radiation
	EPA recommends decontamination or destruction

(Reference: Testimony of Dr. Henry Kelly, President Federation of American Scientists before the Senate Committee on Foreign Relations. March 6, 2002)

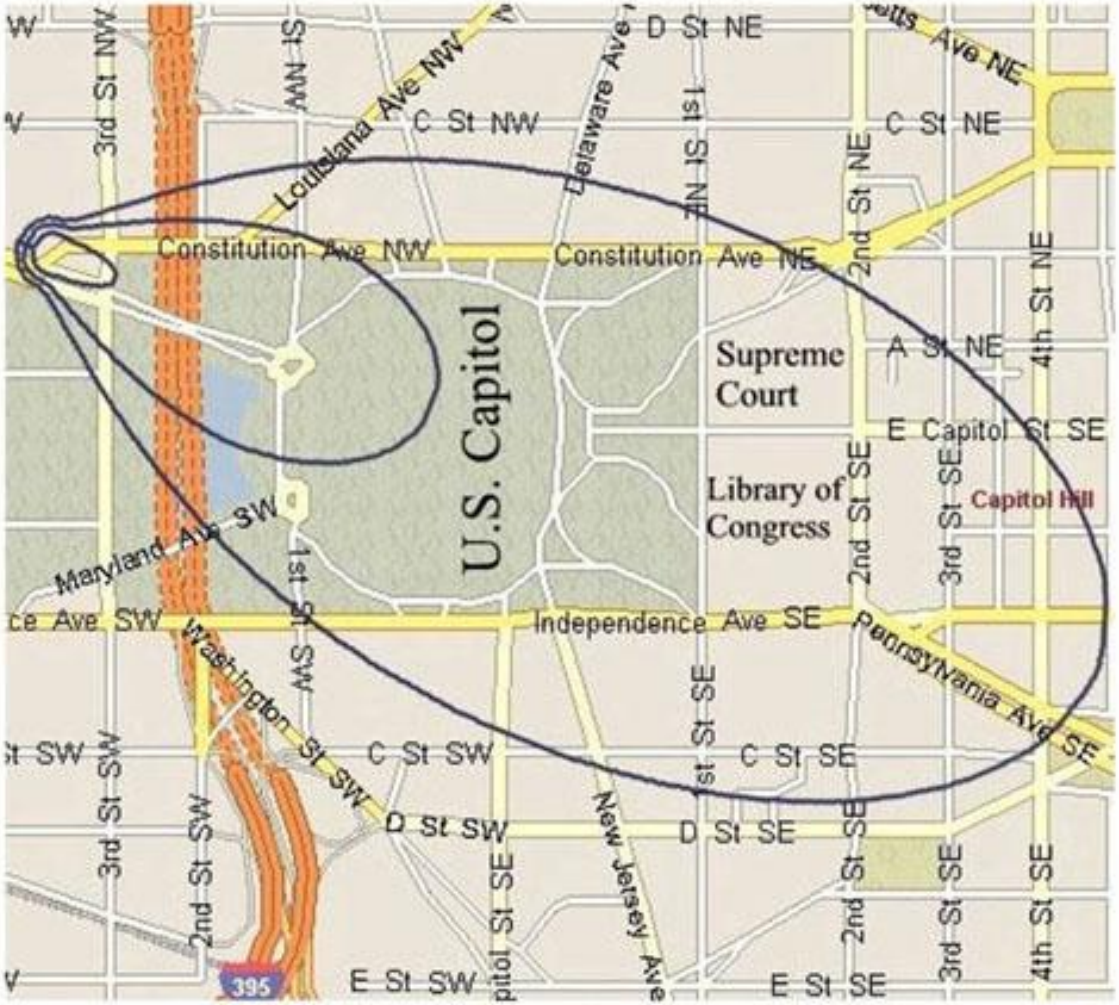
Figure 4: Immediate Effects Due to Americium Bomb in New York City



Inner Ring:	All people must receive medical supervision
Middle Ring:	Maximum annual dose for radiation workers exceeded
Outer Ring:	Area should be evacuated before radiation cloud passes

(Reference: Testimony of Dr. Henry Kelly, President Federation of American Scientists before the Senate Committee on Foreign Relations. March 6, 2002)

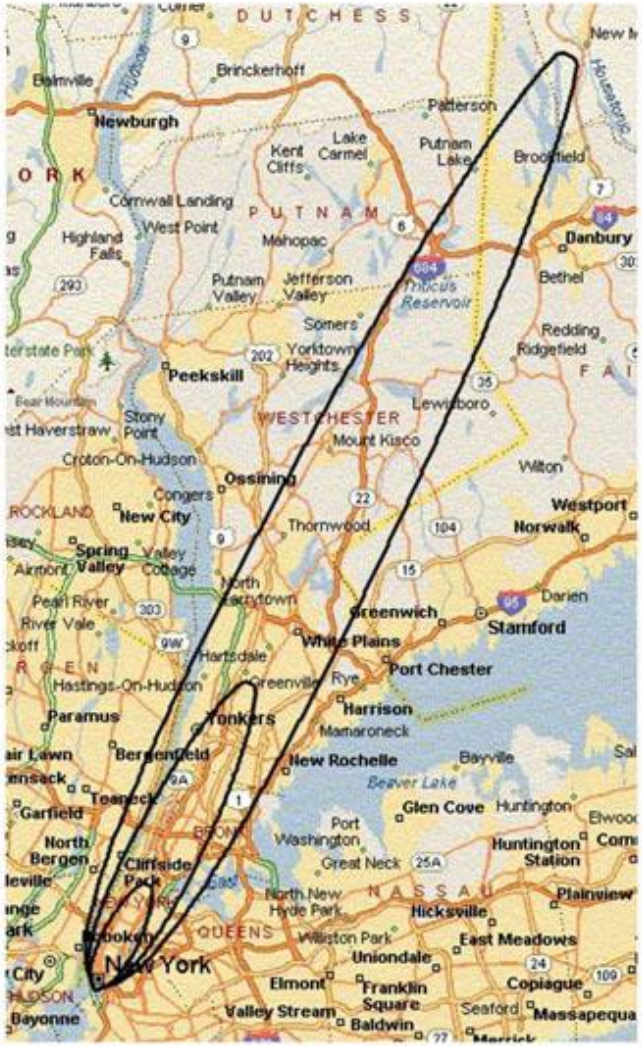
Figure 1: Long-term Contamination Due to Cesium Bomb in Washington, DC



Inner Ring:	One cancer death per 100 people due to remaining radiation
Middle Ring:	One cancer death per 1,000 people due to remaining radiation
Outer Ring:	One cancer death per 10,000 people due to remaining radiation
	EPA recommends decontamination or destruction

(Reference: Testimony of Dr. Henry Kelly, President Federation of American Scientists before the Senate Committee on Foreign Relations. March 6, 2002)

Figure 2: Long-term Contamination Due to Cobalt Bomb in NYC – EPA Standards



Inner Ring:	One cancer death per 100 people due to remaining radiation
Middle Ring:	One cancer death per 1,000 people due to remaining radiation
Outer Ring:	One cancer death per 10,000 people due to remaining radiation EPA recommends decontamination or destruction

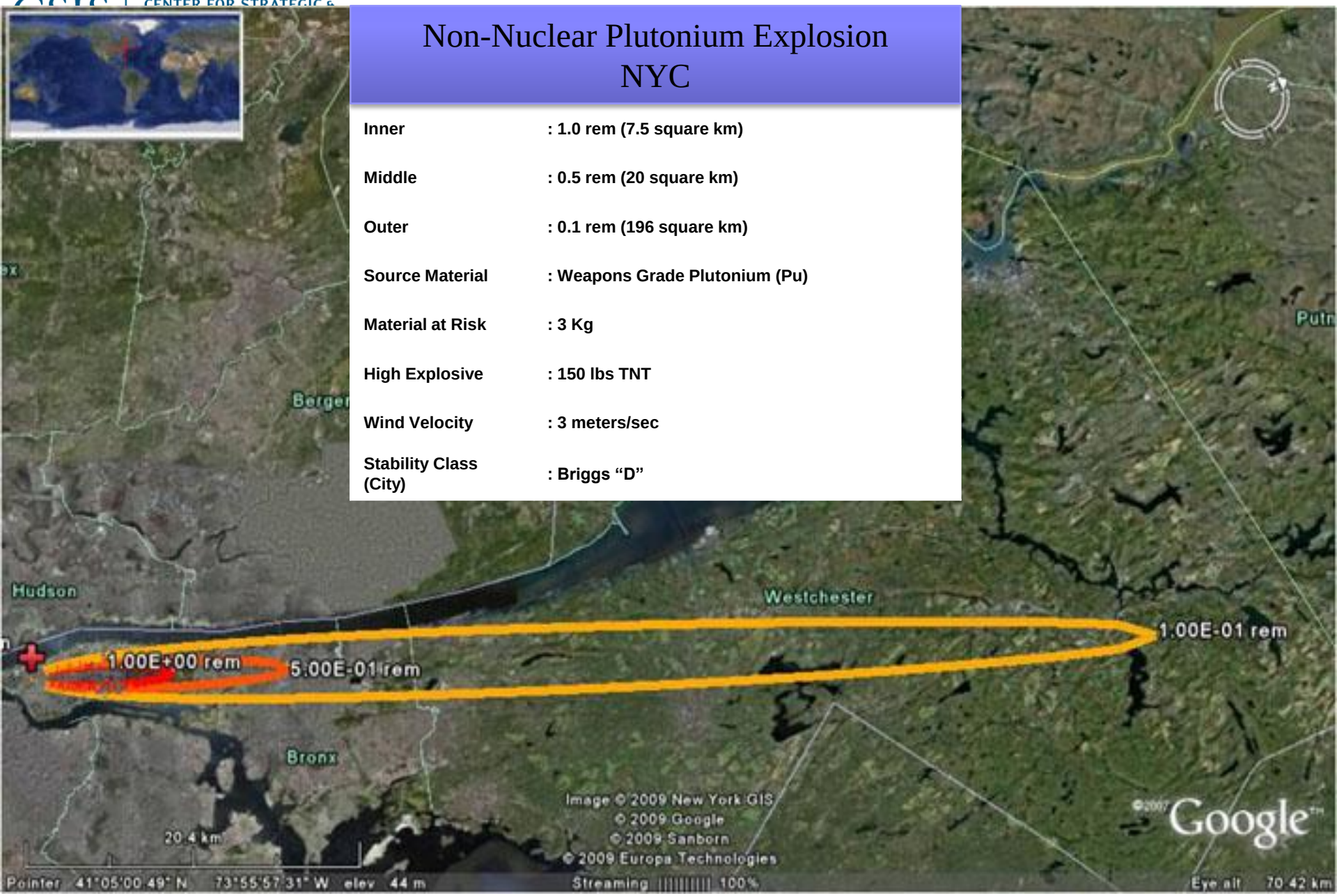
Figure 3: Contamination Due to Cobalt Bomb in NYC – Chernobyl Comparison

Inner Ring:	Same radiation level as *permanently closed* zone around Chernobyl
Middle Ring:	Same radiation level as *permanently controlled* zone around Chernobyl
Outer Ring:	Same radiation level as *periodically controlled* zone around Chernobyl

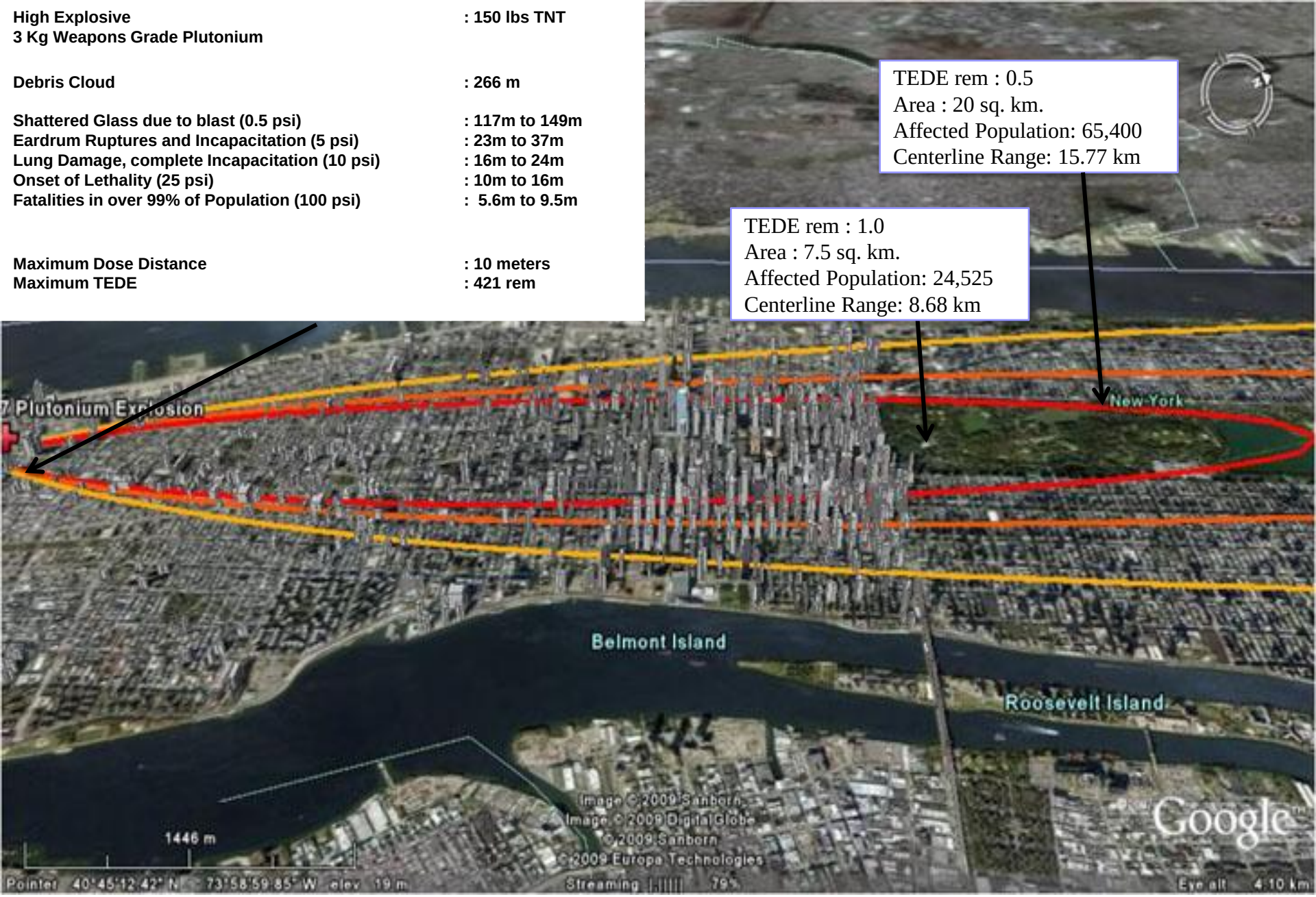
(Reference: Testimony of Dr. Henry Kelly, President Federation of American Scientists before the Senate Committee on Foreign Relations. March 6, 2002)

Non-Nuclear Plutonium Explosion NYC

Inner	**: 1.0 rem (7.5 square km)**
Middle	**: 0.5 rem (20 square km)**
Outer	**: 0.1 rem (196 square km)**
Source Material	**: Weapons Grade Plutonium (Pu)**
Material at Risk	**: 3 Kg**
High Explosive	**: 150 lbs TNT**
Wind Velocity	**: 3 meters/sec**
Stability Class (City)	**: Briggs "D"**

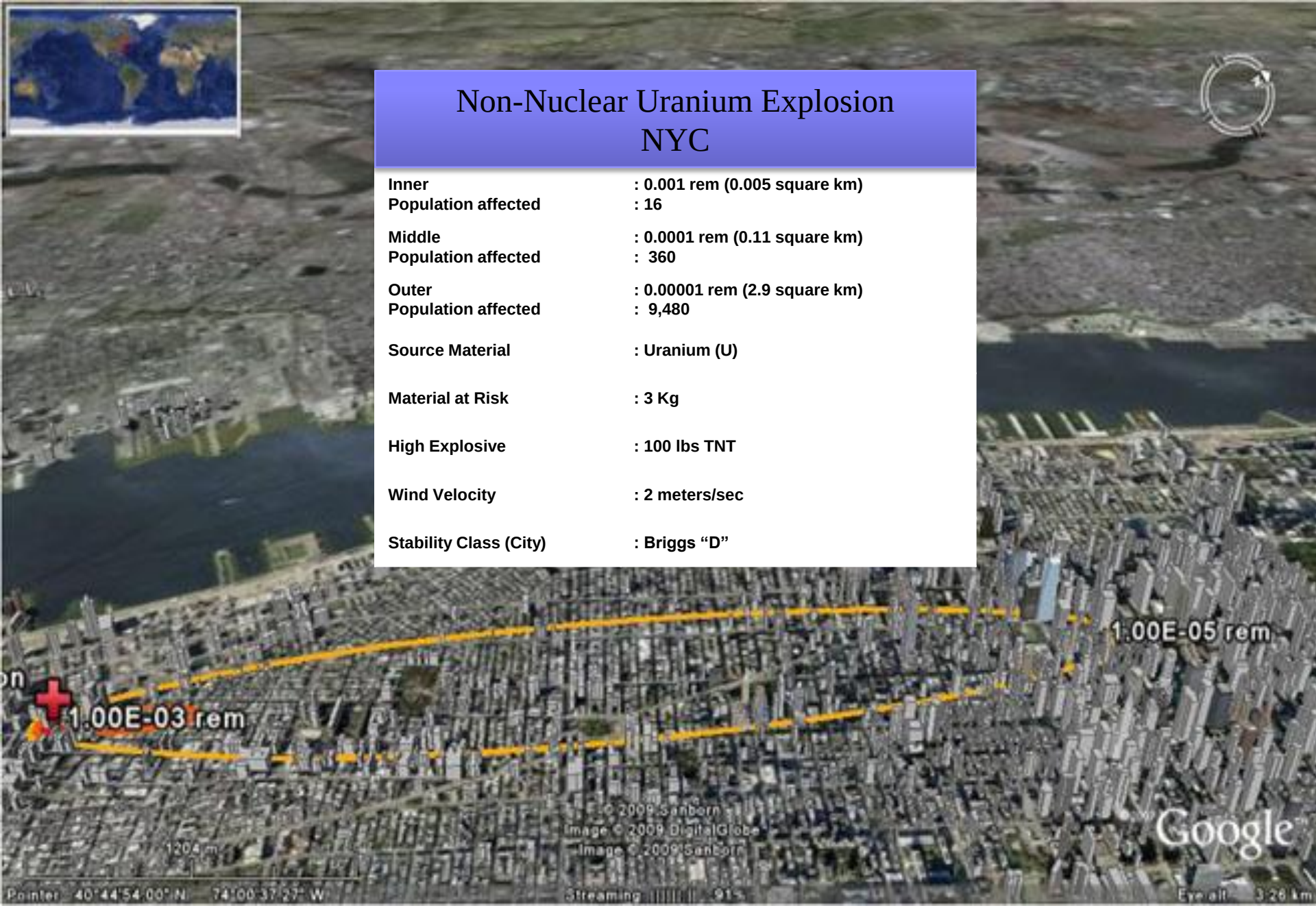


High Explosive	**: 150 lbs TNT**
3 Kg Weapons Grade Plutonium	
Debris Cloud	**: 266 m**
Shattered Glass due to blast (0.5 psi)	**: 117m to 149m**
Eardrum Ruptures and Incapacitation (5 psi)	**: 23m to 37m**
Lung Damage, complete Incapacitation (10 psi)	**: 16m to 24m**
Onset of Lethality (25 psi)	**: 10m to 16m**
Fatalities in over 99% of Population (100 psi)	**: 5.6m to 9.5m**
Maximum Dose Distance	**: 10 meters**
Maximum TEDE	**: 421 rem**



Non-Nuclear Uranium Explosion
NYC

Inner	**: 0.001 rem (0.005 square km)**
Population affected	**: 16**
Middle	**: 0.0001 rem (0.11 square km)**
Population affected	**: 360**
Outer	**: 0.00001 rem (2.9 square km)**
Population affected	**: 9,480**
Source Material	**: Uranium (U)**
Material at Risk	**: 3 Kg**
High Explosive	**: 100 lbs TNT**
Wind Velocity	**: 2 meters/sec**
Stability Class (City)	**: Briggs "D"**



Terrorist attack on a nuclear-power station

• Instead of fabricating and exploding a nuclear weapon, a terrorist group may decide to attack a nuclear facility. A group with significant resources could attack and damage nuclear-power plants. However, there is disagreement about how much damage would be done and how many people harmed by such an attack. It is probably true that attacks on nuclear-power plants that could do a great deal of damage and cause many fatalities have a relatively small chance of success. However, the damage caused and the number of people killed by a successful terrorist attack on a nuclear-power plant could be so catastrophic that even a small risk of such an attack is not acceptable.

• In a nuclear-power station, there are two potential targets for a terrorist attack: the reactor itself and the ponds storing the highly radioactive reactor fuel. An attack on the reactor could cause the core to melt down, as happened during the 1986 accident at the Chernobyl reactor, or cause a loss of the coolant, usually water, that removes heat from the core of the reactor, as happened during the accident at Three Mile Island in 1979.

• Terrorists could target a reactor or spent fuel pond by: using a truck carrying high explosives and detonating it near a critical part of the target; exploding high explosives carried in a light aircraft near a critical part of the target; crashing a hijacked commercial airliner into the reactor building or spent-fuel pond; attacking the power station with small arms, artillery, or missiles and occupying it; or attacking the power lines carrying electricity into the plant. Alternatively, a terrorist group may infiltrate the plant so that some of its members, or sympathizers, can sabotage it from inside.

(Reference: US Army TRADOC Handbooks. A Military Guide to Terrorism in the 21st Century. 2007)

Improvised Nuclear Device
"IND"

Nuclear Weapons

• The use of a sophisticated nuclear weapon is a possible attack scenario but would require extraordinary terrorist financial and technical resources. More likely scenario deals with nuclear material and sabotage or a siege-hostage situation at a nuclear facility. This type scenario aligns more correctly with a radiological incident. The potential effects would be catastrophic to a surrounding area and population. Depending on the degree of radioactive fallout related to wind patterns, contaminated area could be an ecological disaster for decades.

• Some groups may have State sponsors that possess or can obtain nuclear weapons, but there is no credible evidence at this time of terrorists successfully acquiring nuclear weapons or sufficient material to make them.

•An Improvised Nuclear Device (IND) is intended to cause a yield-producing nuclear explosion. Built from a modified nuclear weapon or components.

Amount of fissile material needed to build an atomic bomb.

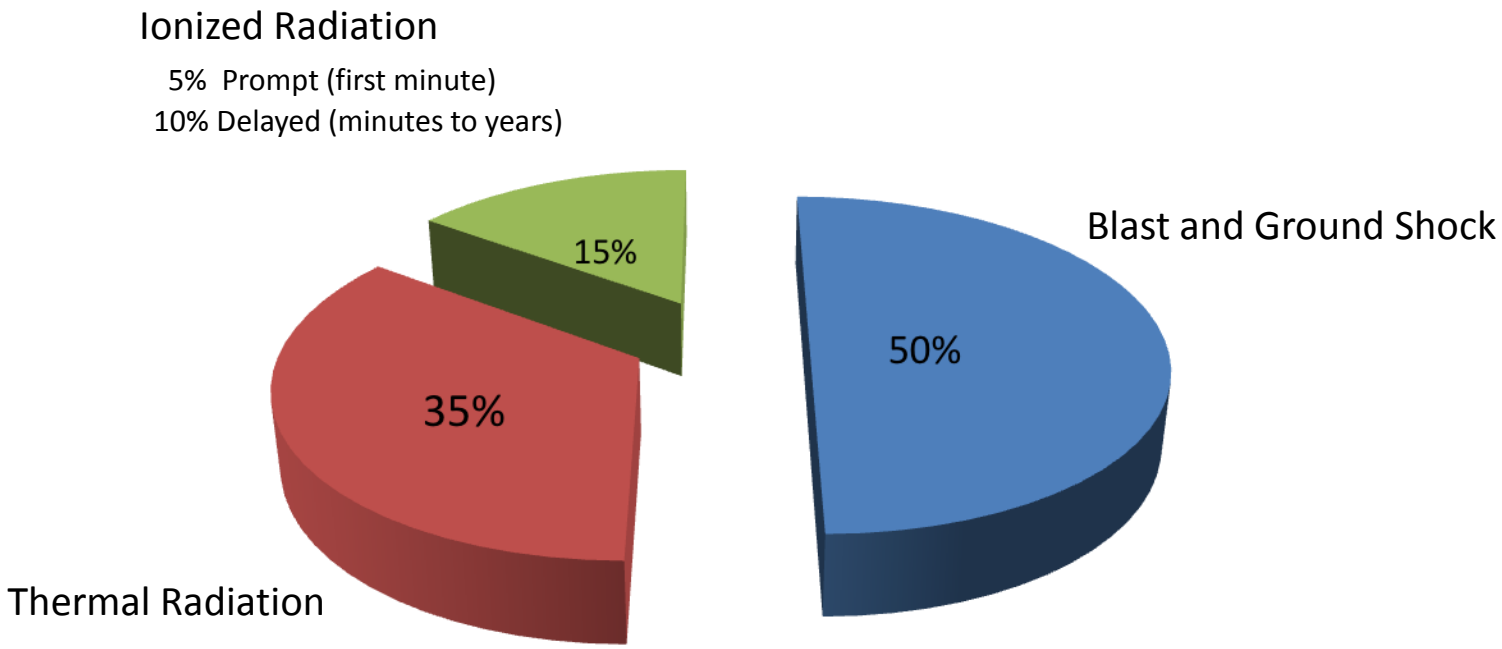
Highly Enriched Uranium (HEU enriched to 90% of U-235)	Simple gun-type nuclear weapon	9-110 lbs (40 to 50kg)
	Simple implosion weapon	33 lbs (15 kg)
	Sophisticated implosion weapon	20-26 lbs (9 to 12 kg)
Plutonium	Simple implosion weapon	14 lbs (6 kg)
	Sophisticated implosion weapon	4.5 – 9 lbs (2 to 4 kg)

(Source: Union of Concerned Scientists. “Preventing Nuclear Terrorism Fact Sheet” April 2004)

The Energy of a Nuclear Explosion

Personnel exposed to a nuclear explosion may be killed or suffer injuries of various types. Casualties are primarily caused by blast, thermal radiation, and ionizing radiation. The distribution and severity of these injuries depends on device yield, height of burst, atmospheric conditions, body orientation, protection afforded by shelter, and the general nature of the terrain.

The energy of a nuclear explosion is partitioned as follows:



		20 KT	100 KT	500 KT
Fireball	**Elapsed time to reach maximum diameter**	**1 sec**	**1 sec**	**1 sec**
	Maximum diameter	**580 m**	**1,100 m**	**2,100 m**
Thermal Radiation	**Temporarily flash blindness from scattered light out to a distance of distance of :**	**23 km 14 miles**	**26 km 16 miles**	**29 km 18 miles**
	Individuals who directly view the initial fireball could experience retinal burns to a distance of:	**25 km 16 miles**	**30 km 19 miles**	**35 km 22 miles**
	Unprotected individuals could receive in excess of the thermal radiation dose required for third degree burns, out to a distance of:	**1.9 km 1.2 miles**	**3.9 km 2.4 miles**	**7.8 km 4.8 miles**
Ionizing Radiation	**Unprotected individuals could receive in excess of the prompt ionization radiation dose required for 50% lethality (within weeks), out to a distance of:**	**1.6 km 0.98 miles**	**2.0 km 1.24 miles**	**2.5 km 1.58 miles**
	Unprotected individuals remaining in the contamination zone for the first hour following the nuclear explosion could receive in excess of the fallout dose required for 50% lethality (within weeks), out to a distance of about:	**9 km 6 miles**	**13 km 8 miles**	**15 km 9 miles**
	The idealized maximum width of the fallout footprint is about:	**0.47 km 0.29 miles**	**0.78 km 0.49 miles**	**6.5 km 4.1 miles**
	For individuals remaining in the contamination for the first 24 hours, the downwind extent of the 50% lethality contour increases to approximately:	**20 km 12 miles**	**33 km 21 miles**	**55 km 34 miles**
	The 50% lethality contour width increases to about:	**1.2 km 0.80 miles**	**3.1 km 1.9 miles**	**8.1 km 5.0 miles**
Electromagnetic Pulse (EMP)	**The EMP range (is the outer extent that any EMP effects are expected to occur) for the detonation is approximately:**	**5 km 3 miles**	**6 km 4 miles**	**7 km 4 miles**

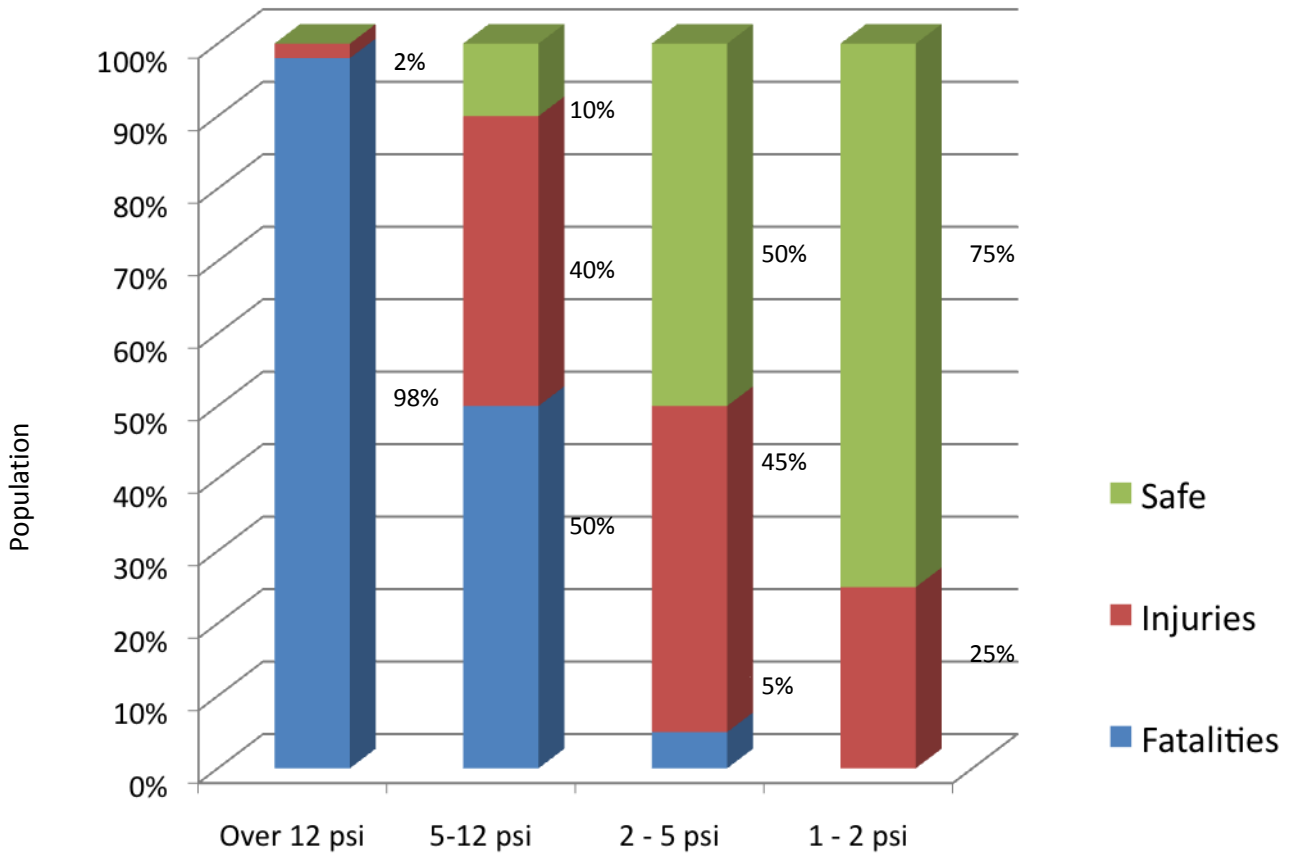
- Nuclear weapons of the order of 100 KT, 500 KT and 1,000 KT can obviously cause more casualties than the Hiroshima Nuclear Bomb (12.5 KT). In order to calculate these casualties, the fatalities and injuries at Hiroshima were extrapolated to fatalities and injury rates caused by Nuclear Weapons of different yields.

- Blast kills people by indirect means rather than by direct overpressure. While a human body can withstand up to 30psi of overpressure, the winds associated with as little as 2 to 3 psi could be expected to blow people out of typical modern office buildings.

- Most blast deaths come about as a result from occupied buildings collapsing, from people being blown into objects or smaller objects being blown onto or into people.

- In order to estimate the number of fatal and injury rates from any given explosion, assumptions have to made about the proportion of people who will be killed or injured at any given over-pressure as shown in the next slide.

Vulnerability of Population in Various Overpressure Zones



(Source: The Effects of Nuclear War. May 1979, Congress of the United States. Office of Technology Assessment)

Expected Effects of Acute Whole-Body Radiation Doses

Acute Exposure (within 24 hours), Roentgens - rems	Probable Effect
0-50	No obvious effect, possibly minor blood changes.
80-120	Vomiting and nausea for about 1 day in 5 to 10% of exposed population; fatigue but no serious disability.
130-170	Vomiting and nausea for about 1 day, followed by other symptoms of radiation sickness in about 25% of those exposed; no deaths anticipated.
180-220	Vomiting and nausea for about 1 day, followed by other symptoms of radiation sickness in about 50% of exposed population; no deaths anticipated.
270-330	Vomiting and nausea in nearly all exposed population on first day, followed by other symptoms of radiation sickness; about 20% deaths within 2 to 6 weeks after exposure; survivors convalescent for about 3 months.
400-500	Vomiting and nausea in all those exposed on first day, followed by other symptoms of radiation sickness; about 50% deaths within 1 month; survivors convalescent for about 6 months.
550-750	Vomiting and nausea in all those exposed within 4 hours 4 hours, followed by other symptoms of radiation sickness, up to 100% deaths; few survivors convalescent for about 6 months.
1,000	Vomiting and nausea in all those exposed within 1 to 2 hours; probably no survivors from radiation sickness.
5,000	Incapacitation almost immediately; all those exposed will be fatalities within 1 week.

(Source: Destruction of Nuclear Energy Facilities in War. Bennet Ramberg. Lexington Books. Page 4)

Low Yield Blast Effects
0.1 KT Surface Burst

Range (meters)	Peak Overpressure	Peak Wind Velocity (meter/sec)	Typical Blast Effects
80	20 psi	210	Reinforced concrete structures are leveled.
115	10 psi	130	Most factories and commercial buildings are collapsed. Small wood-frame and brick residences destroyed and distributed as debris.
170	5 psi	71	Lightly constructed commercial buildings and typical residences are destroyed, heavier construction is severely damaged.
240	3 psi	42	Walls of typical steel-frame buildings are blown away; severe damage to residences. Winds sufficient to kill people in the open.
550	1 psi	16	Damage to structures, people endangered by flying glass and debris.

Source: The Effects of Nuclear War. May 1979, Congress of the United States. Office of Technology Assessment

0.1 Kiloton Nuclear Explosion

- Fireball:
  - The 0.1 KT nuclear explosion produces a fireball of incandescent gas and vapor.
  - Initially, the fireball is many times more brilliant than the sun at noon, but quickly decreases In brightness and continues to expand.
  - In about 1 second, the fireball will have reached its maximum diameter of about 70 meters.
  - After 1 minute, the fireball will have cooled sufficiently so that it no longer glows.

- Blast:
  - Blast casualties may occur due to the direct action of the pressure wave. The destructiveness of the blast depends on its peak overpressure and duration of the positive pressure wave (or Impulse).

- Thermal Radiation:
  - Burn casualties may result from the absorption of thermal radiation energy by the skin, heating or ignition of clothing, and fires started by the thermal pulse or as side effects of the air blast or the ground shock.
  - Exposed eyes are at risk of permanent retinal burns and flash blindness out to relatively large distances (especially at night when the diameter of the pupil is maximum).
  - Under daytime conditions, the 0.1 KT explosion could produce temporarily flash blindness from scattered light out to a distance of distance of 4km (2.5 miles).
  - Individuals who directly view the initial fireball could experience retinal burns to a distance of 9.5 km (about 5.9 miles).
  - Unprotected individuals could receive in excess of the thermal radiation dose required for third degree burns, out to a distance of 0.16 km (0.1 miles).

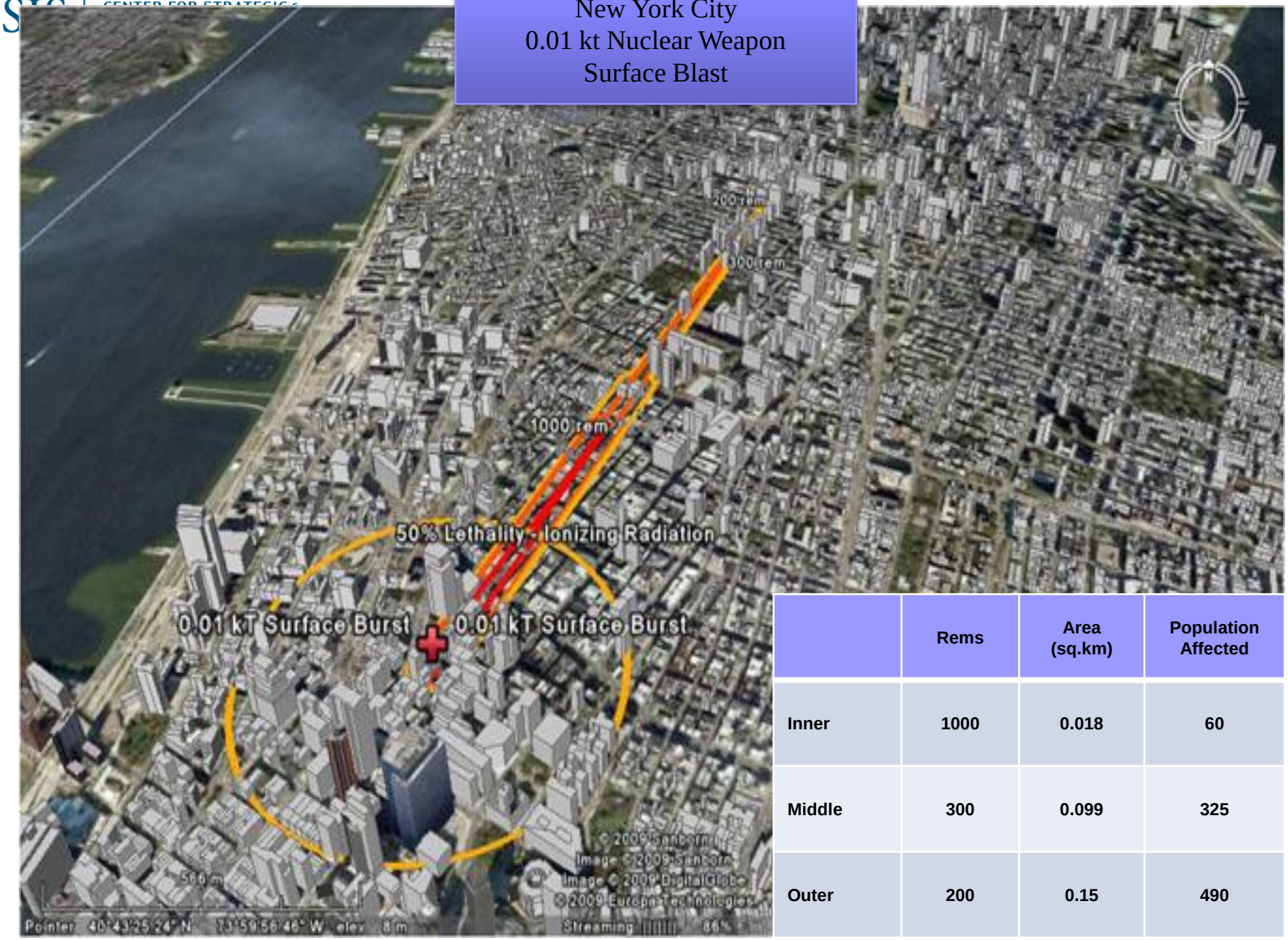
(Reference: Lawrence Livermore National Laboratory. HotSpot version 2.07 Software. Steven G. Homann March 1, 2009)

- Ionizing Radiation:
  - Radiation casualties may be caused by prompt nuclear radiation or by radioactive fallout.
  - Prompt ionizing radiation consists of X-rays, Gamma rays, and neutrons produced in the first minute following the nuclear explosion.
  - Unprotected individuals could receive in excess of the prompt ionization radiation dose required for 50% lethality (within weeks), out to a distance of 0.7 km (0.44 miles).
  - The delayed ionizing radiation is produced by fission products and neutron-induced radio nuclides in surrounding materials (soil, air, structures, nuclear device debris).
  - These radioactive products will be dispersed downwind with the fireball/debris cloud.
  - As the cloud travels downwind, the radioactive material that has fallen and settled on the ground creates a footprint of deposited material (fallout).
  - The exposure to the fallout is the dominant source of radiation exposure for locations beyond the prompt effects of the nuclear detonation.
  - The dose received depends upon the time an individual remains in the contaminated area. Unprotected individuals remaining in the contamination zone for the first hour following the nuclear explosion could receive in excess of the fallout dose required for 50% lethality (within weeks), out to a distance of about 2 km (1 mile).
  - The idealized maximum width of the fallout footprint is about 0.04 km (0.025 miles).
  - For individuals remaining in the contamination for the first 24 hours, the downwind extent of the 50% lethality contour increases to approximately 3 km (2 miles).
  - The 50% lethality contour width increases to about 0.075 km (0.046 miles).

- Electromagnetic Pulse (EMP):
  - The EMP range for the 0.1 KT detonation is approximately 2 km (approximately 1 mile). This range is the outer extent that any EMP effects are expected to occur.
  - Not all electronic equipment within the EMP-effects circle will fail. The amount of failure will increase the closer to ground zero the equipment is located, the larger the equipment's effective receptor antenna, and the equipment's sensitivity to EMP effects.
  - The effects of EMP occur at the instant of the nuclear detonation and ends within a few seconds. Any equipment that will be damaged by EMP will be damaged within those seconds.
  - Electronic equipment entering the area after the detonation will function normally as long as they do not rely on previously damaged equipment, e.g. repeaters, power supplies, etc.

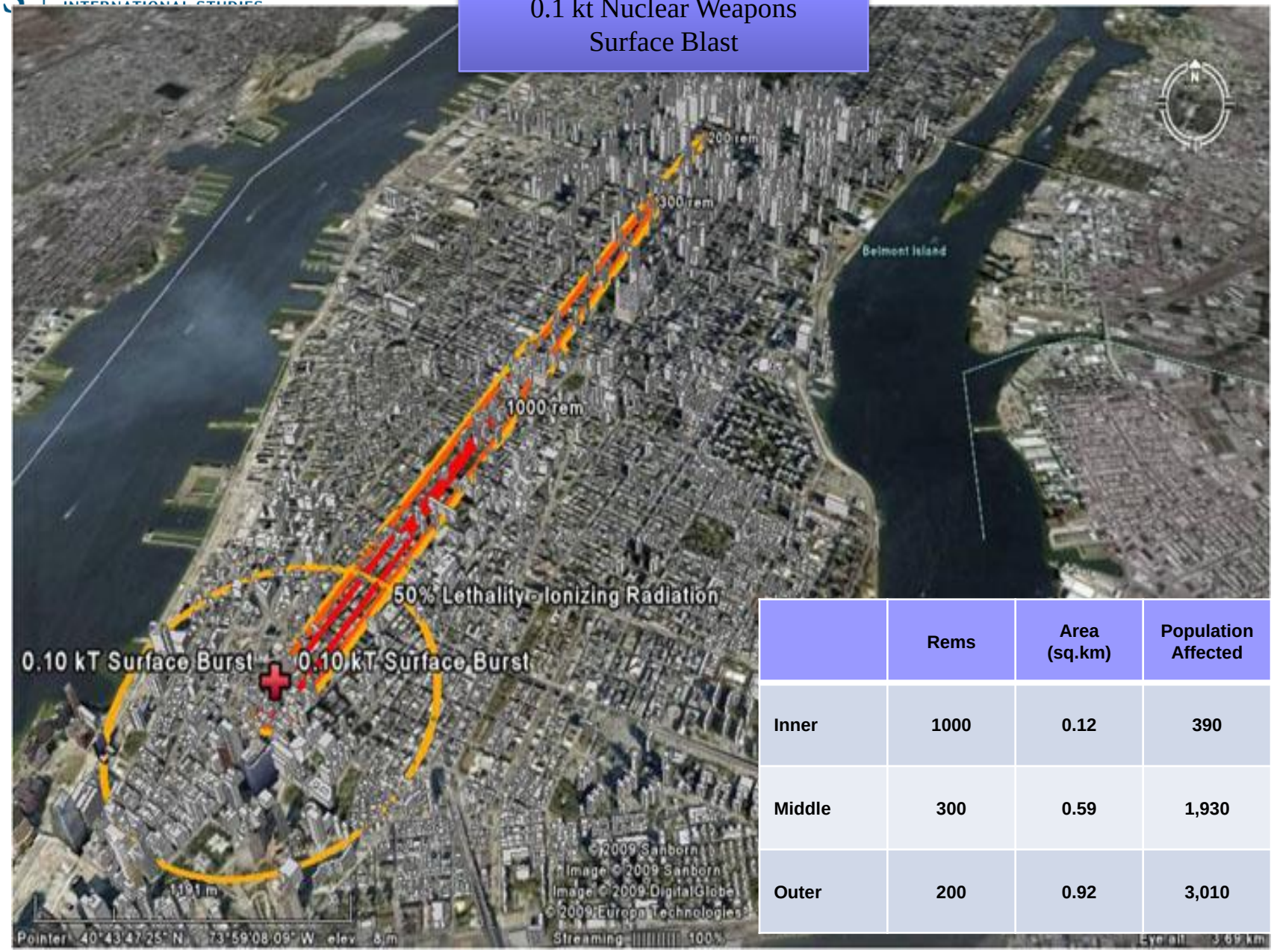
(Reference: Lawrence Livermore National Laboratory. HotSpot version 2.07 Software. Steven G. Homann March 1, 2009)

New York City
0.01 kt Nuclear Weapon
Surface Blast



	Rems	Area (sq.km)	Population Affected
Inner	1000	0.018	60
Middle	300	0.099	325
Outer	200	0.15	490

0.1 kt Nuclear Weapons Surface Blast



	Rems	Area (sq.km)	Population Affected
Inner	1000	0.12	390
Middle	300	0.59	1,930
Outer	200	0.92	3,010

High Yield Explosives

High Yield Explosives

• High yield explosives are another significant threat for weapon effects of mass destruction or mass disruption. Terrorist targeting includes critical infrastructure and key assets, and can also aim at causing mass casualties. Terrorists are relentless and patient; they will seize on opportunity and can demonstrate flexibility in strategy and tactics. Attack may occur against a critical node, system, or function. Beyond the physical damage or destruction, attack may cause a cascading disruption for government, social order, and economics as the public and private sectors react. Intent may focus on damage to national prestige, morale, or confidence, as well as legitimate concerns of public health and safety. An attack can also be exploited to assist in near-simultaneous or follow-on assault against separate targets.

• Acts of terrorism using high yield explosives have been conducted by foreign and domestic terrorists against the United States, and are well known Other considerations for high yield explosive effects include railroad transportation, major storage facilities, and commercial waterway shipping. Maritime vectors could include inland, coastal, and ocean waterways. For example, liquefied natural gas (LNG) is a significant potential threat. In its liquid state, natural gas is not explosive. However, liquid natural gas that spills will form a highly combustible vapor cloud, that if ignited, will cause a tremendous explosion. Conventional explosions have caused the highest number of mass casualties or created the greatest sense of anxiety in a population.

(Reference: US Army TRADOC Handbooks. A Military Guide to Terrorism in the 21st Century. 2007)

Bomb Threat Stand-Off Distances

Threat Description		Explosives Capacity[1] (TNT Equivalent)	Building Evacuation Distance[2]	Outdoor Evacuation Distance[3]
	Pipe Bomb	5 LBS/ 2.3 KG	70 FT/ 21 M	850 FT/ 259 M
	Briefcase/ Suitcase Bomb	50 LBS/ 23 KG	150 FT/ 46 M	1,850 FT/ 564 M
	Compact Sedan	500 LBS/ 227 KG	320 FT/ 98 M	1,500 FT/ 457 M
	Sedan	1,000 LBS/ 454 KG	400 FT/ 122 M	1,750 FT/ 533 M
	Passenger/ Cargo Van	4,000 LBS/ 1,814 KG	600 FT/ 183 M	2,750 FT/ 838 M
	Small Moving Van/ Delivery Truck	10,000 LBS/ 4,536 KG	860 FT/ 262 M	3,750 FT/ 1,143 M
	Moving Van/ Water Truck	30,000 LBS/ 13,608 KG	1,240 FT/ 378 M	6,500 FT/ 1,981 M
	Semi-Trailer	60,000 LBS/ 27,216 KG	1,500 FT/ 457 M	7,000 FT/ 2,134 M

This table is for general emergency planning only. A given building's vulnerability to explosions depends on its construction and composition. The data in these tables may not accurately reflect these variables. Some risk will remain for any persons closer than the Outdoor Evacuation Distance.

(Reference: Department of Homeland Security)

Cyber Terrorism

Cyber Attack

• Cyber terrorism is defined as the premeditated, politically motivated attacks by sub-national groups or clandestine agents, or individuals against information and computer systems, computer programs, and data, which result in violence against non-combatant targets. Government computer networks, financial networks, power plants, are all possible targets for terrorists, to cause disruption on a massive scale.

• Cyber-terrorism differs from other improvements in terrorist technology because it involves offensive information technology capabilities, either alone or in combination with other forms of attack. Some examinations of cyber-terrorism focus on the physical destruction of information hardware and software, or physical damage to personnel or equipment using information technology as the medium. Examples of this approach would include the chaos and destruction caused by disrupting a nation's air traffic control system, crashing two trains together by overriding the railroad signal and switching system, interfering with the control systems for water or electricity, or blocking and falsifying commercial communications to cause economic disruption. Disruption of the rail system could severely impact movement of equipment to a port of embarkation. A successful attack against the telecommunications systems would directly impact the command and control of the operations.

• For a true "cyber-terrorist", the network is the method of attack. It is the weapon, or at the least, the medium through which an attack is delivered. Information warfare of this sort requires that messages and computer commands are transmitted, programs and malicious software be emplaced, fraudulent transactions take place, and information be available for exploitation. Defacing websites, crashing portions of a target network, accessing enemy information, denying network access to other groups, manipulating financial confidence and causing panic exemplify this warfare.

• Although there have been no major cyber attacks caused by terrorist groups that have taken lives or caused severe physical destruction, some government experts believe that terrorists are at the point where they may be able to use the Internet as a direct instrument to cause casualties, either alone or in conjunction with a physical attack.

(Reference: US Army TRADOC Handbooks. A Military Guide to Terrorism in the 21st Century. 2007)

Proposed Analytic Models

• The major question that is generally asked is how can we prevent another 9/11 but this time against terrorist using WMD weapons. To start answering such a question we believe we should start thinking in "worst case scenarios" and to encourage analysts to model their perceptions of terrorist threats and to set recommendations that can be acted upon.

• The decision to escalate violence to new levels will be taken by the top leadership of the terrorist groups. They will decide what level of killing and of social and economic disruption of the society attacked will further their aims. They will then choose the weapons that will best achieve this level of killing and disruption. The choice will be influenced by such factors as: the lethality of the weapon; the ease of acquiring the materials needed to fabricate the weapon; and the ease of constructing the munitions. To generate a better understanding the following general outline shows the approach to such country specific studies:

First, one needs an overarching model to bring together the mass of information regarding different types of threat scenarios, different groups of perpetrators, their objectives and the damage that they can cause. The consequences depend on the effectiveness of their "supply chain" (people and skills, cash, material and communications) as well as that of a nations' emergency response system. One of the components of the model is the choice of a target (or set of targets) by the terrorists.

Second, therefore, one needs an analysis of the different potential targets, including infrastructure systems and networks, in order to find the vulnerabilities of each of them and an assessment of the effects of an attack on these targets.. This second level needs to include a representation of the effects of inter-dependencies among networks and systems that constitute potential targets.

Third one needs to assess the consequences of the different attack scenarios. To that effect, one has to define the dimensions or attributes of these consequences, among which are the levels of economic losses. These include direct and immediate losses but also the secondary ("ripple") effects of primary damage to different parts of the infrastructure(s) that may imply interruption of economic production, consumption, or threat to the defense system. The secondary losses could be, for example, the secondary economic effects of network failures, such as the banking telecommunications network.

(Reference: Probabilistic Modeling of Terrorist Threats: A Systems Analysis Approach to Setting Priorities Among Counter-measures. Elisabeth Pate'-Cornell and Seth Guikema. Military Operations Research, V7 N4 2002)

Appendix

BASIS OF DOSE CALCULATIONS

in Meselson et al.

Atmospheric stability "D"
Wind speed = u = 5 m/sec at 10 m
Release height = 10 m
Source strength = Q spores
Deposition negligible
Infectivity independent of travel time
No mixing layer
Breathing rate = B = 5 X 10^{-4} m^3/sec (= 30 L/min)

$$\text{Dose} = [QB][\pi u \sigma_y \sigma_z]^{-1} \exp[-(1/2)(y/\sigma_y)^2] \exp[-(1/2)(10/\sigma_z)^2]$$

$$= [3.18 \times 10^{-5} Q][\sigma_y \sigma_z]^{-1} \exp[-(1/2)(y/\sigma_y)^2] \exp[-(1/2)(10/\sigma_z)^2]$$

$$\sigma_y = [0.08][x][1+0.0001x]^{-1/2}$$

$$\sigma_z = [0.06][x][1+0.0015x]^{-1/2}$$

Downwind (x) and crosswind (y) distances are in meters.

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