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Iran's Nuclear Missile Delivery Capability

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- **Iran's Rocket and Missile Forces and Strategic Options**, available on the Burke Chair section of the CSIS web site at http://csis.org/files/publication/141007_Iran_Rocket_Missile_forces.pdf

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Table of Contents

	Page
Executive Summary and Conclusions	5
Introduction: Technical steps required to build a Nuclear Weapon	26
Update on Iran’s Nuclear Program	33
The possibility of an Emerging Nuclear Weapon State, such as Iran, building a 20kt yield Nuclear Device	39
Iran Ballistic Missiles as Nuclear Weapon Delivery Vehicles	52
Defense against Ballistic Missiles	84
Effects of Nuclear Weapons Exchange between Iran and Israel	93
Effectiveness of the Iranian Shahab-3 missile to inflict damage, using conventional high explosive warhead	114
An Arms Control and Regional Security Process for the Middle East	121

Appendices	Page
Appendix (1): IAEA GOV/2011/65 Report by the Director General : Possible Military Dimension	127
Appendix (2): Estimating the weight of an implosive devise with a given radius	141
Appendix (3): The Defense Nuclear Agency (DNA) 1-kiloton free-air overpressure standard	144
Appendix (4): Probability of Hitting a Circular Target When Aim Error is Zero and Dispersion is Circular Normal	148
Appendix (5): Effects of a 20kt and 100kt yield nuclear weapons	151
Appendix (6): Political and Military Stability Definition of Terms	158
Appendix (7): Articles addressing the Potential Military Dimension of the Iran Nuclear Program and the capability of the Iranian Ballistic Missiles Shahab-3/3M as a nuclear delivery system	162

Summary and Conclusions:

- Recently there has been a lot of attention given to the “Possible Military Dimension” of the Iran Nuclear Program, in particular concerns over Iran’s ballistic missile program and its nuclear delivery capability. Iran’s potential acquisition of nuclear weapons, and future ability to arm its missiles and aircraft with such weapons, represents the most serious risk shaping US, Arab, Israeli, and EU relationship with Iran. It is also an area where the exact details of threat perceptions are particularly critical, although many key aspects of Israeli, US, and Gulf perceptions – as well as the perceptions of other states – are impossible to determine at an unclassified level.
- Estimates of the nature of Iran’s nuclear weapons efforts vary sharply, although most US, European, Gulf, and Israeli policymakers and experts now agree that Iran is actively working towards at least the capability to produce nuclear weapons. Similarly, they agree that Iran possesses virtually all the technology and equipment necessary to produce fission weapons and has significant nuclear weapons design data.
- It is clear that Iran has the Institutional and Industrial Infrastructure steps required to build a Nuclear Bomb and a Delivery System. There is no agreement as to exactly how far Iran has come in weapons design and “weaponization” if a dedicated program exists.

This could lead to two “what if “ scenarios regarding the Iran Nuclear Program:

- Iran as a Nuclear Threshold State. The presence of nuclear weapons production programs with the capability to produce one nuclear weapon (low, medium or high tech).
- Iran already is in possession of a low Yield (20kt) crude Nuclear Weapon (same yield as the nuclear bomb dropped over Nagasaki, Japan) , and has modified its Shahab-3 ballistic missile to fit the weight, size and shape of the nuclear devise.

In November 2007, a report by the U.S. National Intelligence Estimate “Iran: Nuclear Intentions and Capabilities” basically concluded with the following statement: “We judge with high confidence that in fall 2003, Tehran halted its nuclear weapons program; we also assess with moderate-to-high confidence that Tehran at a minimum is keeping open the option to develop nuclear weapons.”

In November 11, 2011, the IAEA published a report claiming "credible" information that Iran had carried out activities "relevant to the development of a nuclear explosive device", the report also included intelligence indicating Iran had a nuclear weapons research program in 2003 but that senior Iranian leaders stopped it when it was discovered and came under increased international pressure. The report identified 12 specific areas, pertaining to Nuclear Explosive Indicators:

- Program management structure
- Procurement activities
- Nuclear material acquisition
- Nuclear components for an explosive device
- Detonator development
- Initiation of high explosives and associated experiments
- Hydrodynamic experiments
- Modelling and calculations
- Neutron initiator
- Conducting a test
- Integration into a missile delivery vehicle
- Fuzing, arming and firing system

The IAEA report concluded:

“As Iran is not providing the necessary cooperation, including by not implementing its Additional Protocol, the Agency is unable to provide credible assurance about the absence of undeclared nuclear material and activities in Iran, and therefore to conclude that all nuclear material in Iran is in peaceful activities.”

(Reference: See Appendix (7), “IAEA GOV/2011/65 Report by the Director General, November 11, 2011”)

3 Items that Iran failed to address which are considered as critical to the “Weaponization” process.

Issues related to Possible Military Dimension of past research	Area of IAEA Concern in 2011 Annex	Addressed by Iran under the Framework for Cooperation September 2014
Structure overseeing Iran’s nuclear program	✓	
Procurement activities	✓	
Nuclear material acquisition	✓	
Nuclear components for an explosive device	✓	
Detonator development	✓	Iran failed to provide full clarification.
Initiation of high explosives	✓	Iran failed to address.
Modelling and calculations	✓	Iran failed to address.
Hydrodynamic experiments	✓	
Neutron initiator	✓	
Testing a nuclear explosive device	✓	

(Bipartisan Policy Center. Update on Iran’s Nuclear Program: September 2014. Blaise Misztal)

- In a “Statement for the Record Worldwide Threat Assessment of the US Intelligence Community Senate Select Committee on Intelligence” James R. Clapper, Director of National Intelligence January 29, 2014 stated: “We do not know if Iran will eventually decide to build nuclear weapons. Tehran has made technical progress in a number of areas—including uranium enrichment, nuclear reactors, and ballistic missiles—from which it could draw if it decided to build missile-deliverable nuclear weapons. These technical advancements strengthen our assessment that Iran has the scientific, technical, and industrial capacity to eventually produce nuclear weapons. This makes the central issue its political will to do so.” (Reference: See Appendix 7)
- He continued to say: “We continue to assess that Iran’s overarching strategic goals of enhancing its security, prestige, and regional influence have led it to pursue capabilities to meet its civilian goals and give it the ability to build missile-deliverable nuclear weapons, if it chooses to do so.” On Iran’s ballistic missiles he said: “We judge that Iran would choose a ballistic missile as its preferred method of delivering nuclear weapons, if Iran ever builds these weapons. Iran’s ballistic missiles are inherently capable of delivering WMD, and Iran already has the largest inventory of ballistic missiles in the Middle East. Iran’s progress on space launch vehicles—along with its desire to deter the United States and its allies—provides Tehran with the means and motivation to develop longer-range missiles, including an intercontinental ballistic missile (ICBM).” (Reference: See Appendix 7)
- So the question asked by many analysts is, if Iran would most likely use it’s ballistic missiles as a nuclear delivery platform, then why is it not included as one of the main issues in the framework of a comprehensive deal on the nuclear program. Iran has rejected this and even went to an extent as reported by FARS News Agency Sat Aug 23, 2014 “Iran's Defense Minister Brigadier General Hossein Dehqan reiterated that any information about the country's missile industry and scientists are highly confidential and would never become a topic of talks between Tehran and the world powers. The missile issue has not been raised in the negotiations and Iran's missile power will never be an issue for negotiations with anyone.” (Reference : See Appendix 7)
- A few months later, April 8, 2014, it was reported by Reuters that Secretary of State Kerry stated that Iran nuclear 'breakout' window now seen as two months. Kerry said such a "breakout" window did not mean Iran would have a warhead or other delivery system. "It's just having one bomb's worth, conceivably, of material, but without any necessary capacity to put it in anything, to deliver it, to have any mechanism to do so," he said. "If they're overtly breaking out and breaking an agreement and starting to enrich and pursue it, they've made a huge consequential decisions. And the greater likelihood is we are going to respond immediately.“ (Reference: See Appendix 7)

November 11, 2014, U.S. DoD News headline “General Dempsey Discusses Iran's Nuclear Ambitions” in which he states: Though the U.S. military will respond to the Iranian nuclear issue if asked, diplomatic resolution remains the preferable option, the chairman of the Joint Chiefs of Staff said today. Obviously, without straying into classified matters, we do have the capability, were we asked to use it, to address a Iranian nuclear capability," Army Gen. Martin E. Dempsey said there is a "challenge," however, using the military instrument of power simply would delay Iran's nuclear ambition, as opposed to eliminating it. He concluded by saying “It would be a "much wiser course" for Iran to go the diplomatic route”. (Reference: See Appendix 7)

Nuclear Weapon Delivery Means:

- There are three types of systems which can deliver nuclear weapons over a considerable distance: aircraft, ballistic missiles and cruise missiles. Combat aircraft can be used as a delivery system however they are slower and vulnerable to conventional ground air defense systems, and could be detected at a very early stage in its flight path to the target. Iranian airforce does not have the capability to travel over 1000km carrying one or two 1000kg bombs, to reach major cities in the Middle East.
- This report will analyze the Iranian Shahab 3/3M Ballistic Missiles as nuclear weapons delivery systems. In the weaponization process of nuclear devices the weight, sizes and the shape of the nuclear weapon must be compatible with the missile.
- Based on the “high technical capabilities” of the nuclear weapon states such as the U.S. and Russia, both gun-type and implosion-type devices can be made small enough to be delivered by missiles, while emerging weapon states with “low technical capability”, such as Iran, are currently unlikely to have the same technical sophistication to design compact warheads.

Findings of the report:

- Based on the assumption that there is sufficient public information available on nuclear weapons, and the enrichment process that a simple low tech implosion type nuclear weapon doesn't need testing. The design is straightforward and has been tried by a number of countries to the extent that scientists and engineers can be confident that the weapon will work without undergoing multiple testing. There is no agreement as to exactly how far Iran has come in weapons design, over the nature of its nuclear weapons program and "weaponization" if a dedicated program exists.
 - The report assumes that Iran can only develop low technology 20kt yield nuclear devices, with an overall warhead weight around 1000kg. Whereas for advanced nuclear states, such as the U.S., Russia, France, Israel being in that category, in the same weight of 1000kg they can build 100kt to 300kt nuclear devices.
 - Given the Political Motivation, if Iran as a non-nuclear weapon state plans to build nuclear weapons, it must undergo the following technical steps:
 - (i) build a scientific and technological infrastructure and capability to conduct research on the design of nuclear weapons;
 - (ii) acquire a sufficient quantity of weapons-grade (Plutonium or Uranium) fissile material;
 - (iii) build a nuclear weapon device;
 - (iv) integrate the nuclear weapons device with a delivery system.
- Steps (iii) and (iv) are referred to as the "weaponization" of nuclear devices.
- The report shows that Iran has the Institutional and Industrial Infrastructure that satisfy the steps required to build a Nuclear Bomb and its Delivery System.

- Approximately 6 kg of Pu239 would be required to produce a low technology crude 20 kt implosion fission weapon. Whereas approximately 16 kg of Highly Enriched Uranium 235 would be required to produce a low technology crude 20 kt implosion fission weapon. (Reference: Nuclear Weapons Databook. “The Amount of Plutonium and Highly-Enriched Uranium Needed for Pure Fission Nuclear Weapons”, by Thomas B. Cochran and Christopher E. Paine. Revised 1995. Natural Resources Defense Council, Inc.)
- An estimate of the size of implosive fission warheads are made by modern emerging nuclear states, subsequently the warhead weights are then used to estimate the maximum deliverable ranges by the ballistic missiles.
- A "nuclear capable" missile is defined by the MTCR as one with a payload capability in excess of 500 kg combined with a range in excess of 300 km. This definition is based on an assumption that an emerging nuclear state will be unable to build nuclear warheads weighing less than 500 kg.
- Iran has received Soviet designed Scud-B missiles and it has adapted the design into two independently-built versions; the Shahab 1 and Shahab 2. Both of which have the same diameter of 88 cm and their ranges, for 750 kg warhead, are 340 and 440 km respectively. For a 1000 kg warhead the ranges become 285 and 370 km. Even though the Shahab-1 could fit a 1000 kg warhead but it cannot reach deep into GCC territory, as shown in Figure (15). Whereas the Shahab 2 nuclear capability is marginal to deliver nuclear warhead in excess of 350 km.
- Iran’s Shahab 3 & 3M missiles which have a diameter of 125 cm and a range in excess of 900 km with a payload of 1,000 kg would be able to deliver a nuclear warhead to many of the Middle East capitals and high-value targets.
- Figure (15) compares the potential ranges of the Iran Shahab missiles versus the Israeli Jericho 2 missile. If Iran launches the Shahab-3M from the Tabriz missile site, carrying a 20kt warhead, it can potentially reach Tel Aviv. Whereas Israel, can by launching a Jericho 2 missile from the north of Israel, reach Tehran Figure (16). The Israeli Jericho 3 missile which is reported to be under development has a estimated maximum range double that of the Jericho 2 for a 1,000 kg nuclear warhead.

Figure (15) Range vs 1000kg payload for Iranian Ballistic Missiles

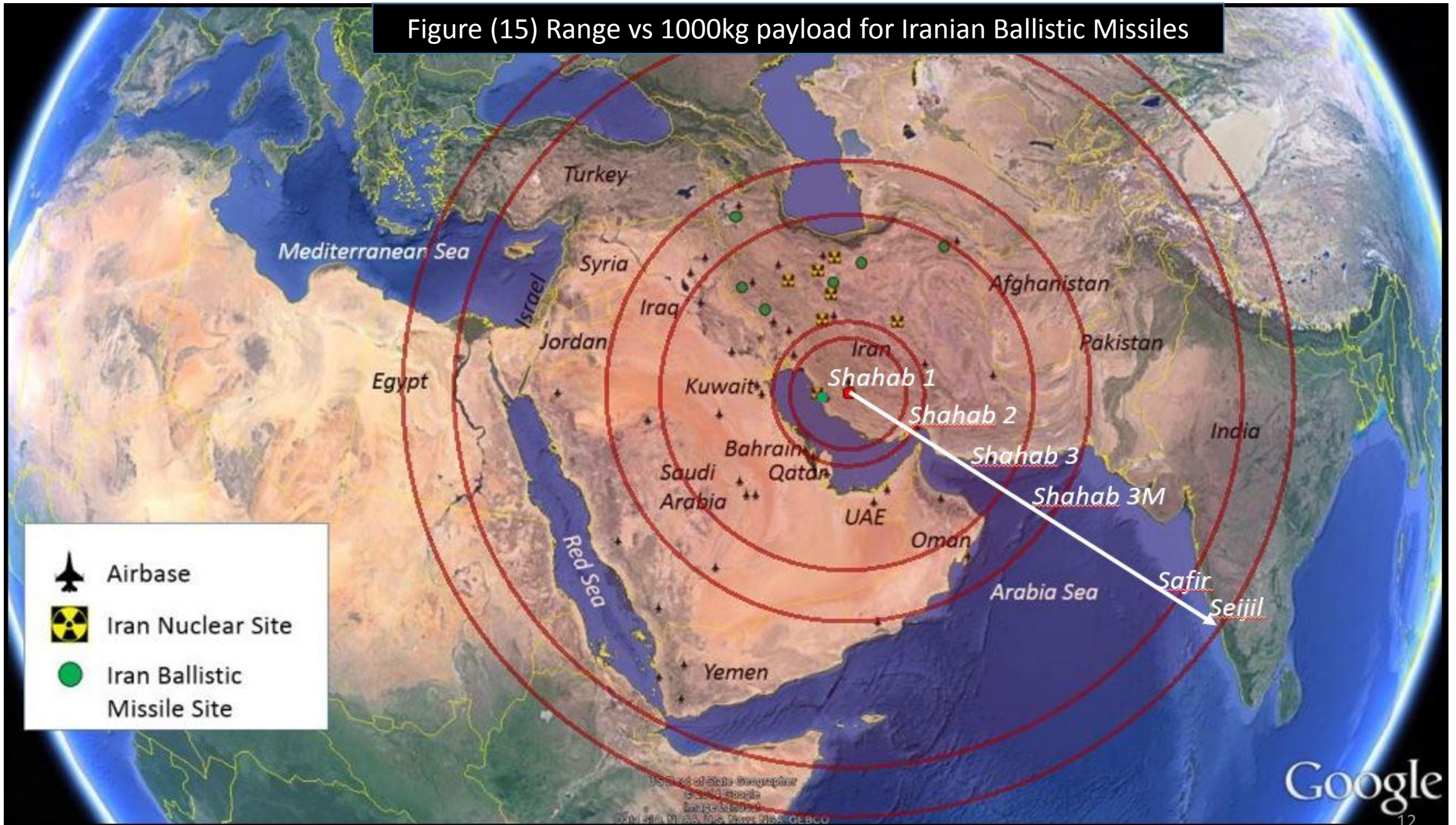


Figure (16): Shahab-3M vs Jericho-2 Range (km)



Regional Implications in accepting Iran as a “Nuclear State”, or as a “Nuclear Threshold State”:

- Strengthen Iran as a regional power in the region leading Iran to demand that it has a say in any Political and Security Arrangements in the Arab Gulf Region, Iraq, Afghanistan and the Middle East Peace Process.
- Cause oil price shocks giving rise to further economic pressures on highly dependent industries and consumers, as well as raising geopolitical tensions, whenever the opportunity arises that serves Iran’s interests.
- Increase the dangers of and Arms Race and Weapons of Mass Destruction Proliferation in the Middle East region.

U.S. Policy in the Region:

- The U.S. will need to deprive Iran of any advantages it hopes to gain by possessing nuclear weapons by:
 - Having a more active political and military role in the region
 - Providing more defense assistance to the states in the region.
 - Increase sanctions regime on Iran to increase the costs of developing and possessing nuclear weapons.
 - Extend a nuclear deterrent regime to the region, in the hope that this negates the need for the Arab countries to acquire any form of weapons of mass destruction.
 - Military options that would destroy Iran’s ability to proliferate and/or deploy significant nuclear forces. To build an international consensus to allow the use of military force as a last resort when all other options absolutely fail.
- As a response, the U.S. policy objective has been not to allow the Arabian Gulf region to be dominated by a hegemonic Iran. The United States believes that Iran cannot try to dominate the Gulf region as long as a U.S. military power is present
- By pursuing Nuclear Weapons the U.S. position is that this will:
 - not advance Iran’s security;
 - not achieve its goal of enhance its power both regionally and globally;
 - spark a nuclear arms race in the region;
 - cause Iran to become more insecure;
 - Iran possessing nuclear weapons would be unacceptable to the U.S.;
 - Washington would arm allies in the region, and extend a “defense umbrella”.
 - By extending assistance and a defense umbrella, Iran will not be able to intimidate and dominate its neighboring countries in particular the GCC, as Iran believes it can, once it possesses nuclear weapons.

US and GCC cooperation to defeat the Ballistic Missile threat Iran poses to the Gulf:

- The only effective counter-strike capability Iran has other than asymmetric warfare in the Gulf, and the use of proxies like Hezbollah, is their Ballistic Missile Force. A massive retaliation strike with whatever launching sites that have survived the U.S. first strike could still cause quite a considerable damage to the GCC states, on energy, finance and various other critical infrastructure centers.
- The U.S. is working with its GCC allies to develop the capability to defeat the threat Iran poses to the Gulf, allied territory, and the flow of trade and energy exports. GCC countries worry that during a crisis, Iran could try to prevent their ships from traversing the Strait of Hormuz, cutting off their oil export business – 17 million barrels/day flows through the Straits of Hormuz, which is roughly 35% of all seaborne trader oil, or 20% of oil traded worldwide (Reference U.S. EIA)
- The U.S. is currently involved in building a Defensive Shield against such a massive Iranian Ballistic Missile attack targeted at the GCC states Table (12). The defensive shield consists of a Multi-Tier Ballistic Missile Defense System consisting of Terminal High Altitude Air Defense (THAAD) and Patriot Advanced Capability, PAC-3, missile systems supported with the most advanced Radar and Command and Control facilities.
- Ballistic missile defense (BMD) systems have been provided to Kuwait, the United Arab Emirates, Qatar, Oman, and planning for Saudi Arabia, as well as stationing Aegis-equipped warships in the waters of the Arabian Gulf. The U.S. has been developing an integrated early warning radar system across the GCC states that could help U.S. and GCC forces to quickly respond to an Iranian missile attack.

Table (12)

Country	TBMD System
UAE	<ul style="list-style-type: none"> The UAE is so far the first GCC country to buy the Terminal High Altitude Air Defense (THAAD) missile system. On Dec 31, 2011 Pentagon announced that the UAE will be buying 2 full THAAD batteries, 96 missiles, 2 Raytheon AN/TPY-2 radars, and 30 years of spare parts. Total Value \$3.34 billion. In 2008 the UAE ordered Patriot PAC-3: 10 fire units, 172 missiles, First delivery 2009.
Kuwait	<ul style="list-style-type: none"> July 2012, Pentagon informed Congress of a plan to sell Kuwait \$4.2 billion in weapon systems, including 60 PAC-3 missiles, 20 launching platforms and 4 radars. This will be in addition to the 350 Patriot missiles bought between 2007 and 2010. In 1992, Kuwait bought 210 of the earlier generation Patriots and 25 launchers. Kuwait bought a further 140 more in 2007.
Saudi Arabia	<ul style="list-style-type: none"> In 2011 Saudi Arabia signed a \$1.7 billion US contract to upgrade it's Patriot anti-missile system. U.S. is planning a \$1.75 billion Patriot Missile sale to Saudi Arabia. The Saudi government had requested the purchase of 202 Patriot Advanced Capability (PAC)-3 missiles — the most sophisticated version of the Patriot anti-missile weapons — as well as a flight test target, telemetry kits and other related equipment, the Defense Security Cooperation Agency said in a statement. (www.businessinsider.com October 1, 2014).
Qatar	<ul style="list-style-type: none"> The U.S. is building a Missile Warning Facility in Qatar that would utilize an AN/TPY-2-X Band Radar. Qatar has selected the Lockheed Martin's PAC-3 Missile. The initial contract is for missile and command launch system production. (PRNewswire: October 15, 2014)
Oman	<ul style="list-style-type: none"> Oman set to buy a \$2.1 billion missile system (PAC-3) built by Lockheed Martin as part of a U.S. drive to install a coordinated air-defense system linking the GCC states. (UPI May 21, 2013)

(Source: Anthony Cordesman and Alexander Wilner, CSIS “Iran and the Gulf Military Balance -1” July 11, 2012.
Anthony Cordesman CSIS “Iran’s Rocket and Missile Forces and Strategic Options” October 7, 2014)

US Extended Deterrence against the proliferation of WMD and their delivery systems.

- The interrelation between conflicts and disputes in the region coupled with advanced conventional weapons and WMDs with their ballistic delivery systems, giving some of the regional countries a Strategic Striking Capability, have highlighted and reinforced the security linkages between states in the region.
- The U.S. sees Iran with its ballistic missiles and potential of developing a nuclear weapon is a direct threat to the GCC and also poses a threat to all friends and allies in the Middle east region.
- The U.S. administration has stated that the full range of U.S. military capability in both conventional and unconventional weapons will be available and ready to be committed to defending its allies and friends against any threat. The U.S. has started implementing a strategy to influence the decision-making bodies in Iran as to the devastating consequences if the GCC, and any other allies are attacked or threatened.
- Should deterrence fail, the U.S. will have already provided the GCC countries with Ballistic Missile Defense Systems which have all the Early Warning and Command Control facilities. This will limit the damage should they be attacked, and to enhance the conventional deterrence capability of the GCC.
- The U.S. is aware that the action of a military strike could be destabilizing for the entire Middle East region and potentially generate a nuclear weapons race in that part of the world. The U.S. also needs its Gulf allies as key partners and must consider the “law of unintended consequences.” Preventive military strikes could push the presently volatile middle east region into a war with far reaching global political, military, and economic consequences.

GCC and Non-GCC Arab States Response

- The Arab Gulf states have been investing heavily in the modernization and upgrading of their force structures. The United States, France and United Kingdom have been the major weapons suppliers. They also recognize that the assistance of outside regional powers will be required to deal with any military aggression in the region. As a result they have signed bilateral defense agreements with their Western allies - United States, Britain and France.
- Saudi Arabia is looked upon to play a pivotal role in the Security Arrangements of the Gulf and the Arab Israeli conflict. Saudi Arabia's oil resources, population and strategic depth make it a major and essential participant in any regional security arrangements or conflict in the Gulf region.
- Any realistic resolution to the Iranian nuclear program will require an approach that encompasses Military, Economic, Political interests and differences of the West vs Iran. There will be no lasting resolution to the Iranian nuclear program until the broader interests of Iran, the US, the GCC states and the world are addressed. Iran should be engaged directly by the U.S., with direct consultations with the GCC states, with an agenda open to all areas of military and non-military issues that both are in agreement or disagreement. The U.S. is central to any Diplomatic solution in dealing with the Iranian Nuclear Program, and the only country that can launch a successful Military Solution, if all peaceful options have been exhausted and Iran has left no other means to convince it to stop or change its course in pursuing Nuclear Weapons, The U.S. should alone determine what the timeline could be if Iran does pursue the path to develop nuclear weapons.
- The U.S. should continue trying to make diplomacy and engagement the priority in dealing with the Iranian Nuclear Program, and will have to try to make Comprehensive Verification of Iran's Nuclear Development Program as one of the priorities in any diplomatic dialogue, while trying at the same time to persuade Iran to stop its enrichment program and to cooperate and answer to all enquiries of the IAEA to the Possible Military Dimensions of the IAEA Director General's Report.
- The Arab States position is that controlling Iran's Nuclear Program using all options available are alone not sufficient conditions to establish peace and security in the Middle East region. In fact, a solution to the Palestinian-Israeli conflict through a two state solution, and for a regional peace based on the Arab Peace Initiative are central and fundamental to establishing peace and security in the Middle East region.

Nuclear Exchange between Israel and Iran:

- The report presents a brief description of the major civilian effects if a nuclear conflict between Iran and Israel takes place in the future, assuming by then that Iran has a fully operational nuclear weapons capability, and the possible broader impact on other countries in the Middle East such as Jordan and Damascus. Threat perceptions and security concerns between Israel and Iran could reach to a critical point that a nuclear exchange becomes inevitable, even if limited in nature.
- Nuclear warheads have long been targeted at population centers in addition to military targets, with the primary purpose of destroying an entire city with just one or two nuclear weapons. Actual damages are likely to be greater than that calculated in this study, due to indirect effects such as deaths resulting from injuries and the unavailability of medical attention and facilities.
- It is highly possible that in a Nuclear Missile exchange between Israel and Iran, one or two of the Iranian missiles stray off their respective flight paths and land on Amman the capital of Jordan, with the other missile landing on Damascus the capital of Syria.
- Furthermore, if a nuclear warhead missile lands in Tel Aviv, destruction will not be limited to that city but would spill out into the density of the surrounding region. This will include the West Bank and Jerusalem. The Jordan Valley, the food bowl for Jordan and Palestine, the ancient Dead Sea region and eventually to Amman itself. That is in the eventuality that a stray missile does not land in Amman itself that would shift the radius of impact and destruction further out.

Conventional Unitary Warheads on the Shahab-3 missile:

- The report looks into the effectiveness of the Iranian Shahab-3 missile, to inflict damage, when fitted with a conventional unitary high explosive warhead.
- Iran's Ballistic Missiles, operational and under development, cover the complete spectrum range from 150 km up to 5,500 km, the Short, Medium, and Intermediate Ranges.
- Iran believes that Ballistic Missiles will compensate for any deficiencies in its Air Power.
- Deploying Ballistic Missiles against military targets would require a number that is very likely to be beyond the current Inventory in Iran.
- Presently the Shahab Missile is known to have a CEP (Circular Error Probability) greater than 500m, which is large compared to the lethal radius of hardened structures, a large number of missiles with unitary warheads will be required to ensure destruction of such targets. For example a psi of 40 is required to damage a reinforced command center, with a 1000 kg TNT explosive weight, the weapon lethal radius is 21 meters. For a required damage of 0.75 the number of missiles required, if the CEP of the missile is 500 meter, is 1,286.
- However, if the missiles are used against large military bases and installations, even with missiles that have large CEPs they are likely to hit something or at least cause some form of damage and disrupt activities. Ballistic Missiles can also be used with success against Soft Targets, in open areas and cities to inflict maximum human casualties and create terror. In essence what is considered as a major component in Asymmetric Warfare in the form of high civilian casualties.

Options and Risks in Dealing with Iran's Nuclear Program :

- The issue of Iran's Nuclear program is complex and bears lasting global consequences if not approached with adequate knowledge and awareness, particularly so if not taking the high risk tracks involved into consideration. The threat is perfectly understood: all are in agreement that Iran as a Nuclear Threshold State or a Nuclear State, will be unacceptable to the security and stability of the region. The last thing this region needs is becoming more a part of the global arms race or the heightened dangers of more weapons of mass destruction proliferation, especially within the so far relatively stable GCC region that remains the global hydrocarbon reserve and has attained impressive and model levels of socio-economic development and globalization.
- GCC states are clear in their "End Game" approach, which is based on a clear statement of the final aims in stopping Iran from building nuclear weapons and their delivery systems. The next step should be a clear outline of the strategic policies that should be adopted to achieve the aims, while keeping the risks associated with the consequences of each Strategic Policy Option to a minimum.
- The concern is that such a clear "end game" approach might in the P5+1 negotiations with Iran turn into a "process approach" in which an open ended dialog, talking for the sake of talking, until a light at the end of the tunnel is seen, that will guide the parties to the next step. For instance, how long will the international community tolerate the duration and depth (or even eventual shallowness in results) of an open ended dialogue and diplomacy with Iran. The risk perceived is that Iran just wants to exploit an open-ended dialogue to buy time and alleviate the pressure of sanctions, with no intent to terminate any of its nuclear activities. Additionally this will give Iran time to accelerate the process of further dispersing its enrichment facilities to locations buried deep underground. The possibility of dispersed facilities complicates any assessment of a potential mission success, making it unclear what the ultimate effect of a strike would be on Iran's nuclear facilities. (Reference: "Israel: Possible Military Strike Against Iran's Nuclear Facilities" Congressional Research Service. March 28, 2012).
- The ideal solution would be dialog and diplomacy with economic incentives, if all agree, in particular Iran, to enter the negotiations with a serious political intent in finding a solution and a workable plan. This is not a zero-sum game i.e. one side wins and the other side loses. All sides should come out feeling that they won with a strong set of confidence-building measures to resume dialog between the parties, increase transparency, reduce the possibility of miss-calculations rather than threats and counter threats which most probably will lead to war.

Options that are presently discussed to deal with Iran's Nuclear Program

- **Diplomacy, Dialog and Economic Incentives:**

Efforts to persuade Iran to not proliferate, and by convincing Iran that it does not face a sufficient threat to proliferate and cannot make major gains in power or security by doing so. IAEA full access for inspections to ensure that no nuclear weapons program is taking place. Incentives can be in the form of economic and trade advantages much needed to bring back the Iranian economy from a highly critical and unstable level down to a more stable level.

- **Sanctions and Regime Change:**

Controls and measures designed to put economic pressure on Iran, limit its access to technology, and/or limit its access to arms. Plus efforts to change the regime and create one that will not proliferate. In general to influence Iranian policy and promote a more positive nature of the regime. Move from a Confrontational to a Cooperative foreign policy.

- **Extended Deterrence and Active Defense:**

A mix of measures such as: advanced technology combat aircraft, TBMD Systems, Asymmetric Warfare capabilities, counterterrorism, civil defense, and passive defense that would both deter Iran and protect against any use it can make of its WMD capabilities and other war fighting capabilities, and show that any effort to use WMD weapons to intimidate or gain military advantage would be offset by the response.

- **Preventive or Preemptive Strikes Before Iran has a Significant Nuclear Force:**

Military options that would destroy Iran's ability to proliferate and/or deploy significant nuclear forces. To build an international consensus to allow the use of military force as a last resort when all other options absolutely fail. Plus covert operations:

- Target assassination of Iranian scientists
- Sabotage of the main enrichment facilities and ballistic sites
- Cyber Warfare such as the Stuxnet attack with the goal of destroying as many centrifuges as possible in the Iranian Fuel Enrichment Plant at Natanz and other enrichment facilities.

End game formulation on how to deal with the Iranian Nuclear Program:

The Aim (End Game): What policies should the West take to end possible *horizontal proliferation*, the spread of nuclear weapons to new states, in the Middle East region, and *Vertical Proliferation Risks*, increase in the size and sophistication of nuclear arsenals, in Israel and in Iran, if any exist.

The Strategic Policy Options to achieve the aim: Diplomacy, Dialog and Economic Incentives; Sanctions and Regime Change; Extended Deterrence and Active Defense; preventive military strike before Iran can build a significant nuclear force; plus adding the possibility of accepting Iran as a Threshold State or a Nuclear State.

Constraints: risks associated with the consequences of each Strategic Policy Option.

The question can be phrased as follows:

Which strategic policy options or combination of these options does the United States, Regional Countries, and the international community need to adopt, in order to achieve the aim, while keeping risk consequences to security, economic and financial systems, globally and regionally, to a minimum.

- The current P5+1 negotiations with Iran points to the direction of adopting dialogue and diplomacy, sanctions, deterrence and active defense, carefully balancing the timing, duration, and level of intensity of implementation in each phase of trying to defuse the crisis with Iran, and inducing Iran to abide with all international agreements and to cooperate fully with the IAEA. With regards to a Military Strike, it should be made clear that it remains on the table as an option of “Last Resort”, if all else fails.
- It should be strongly emphasized that the U.S. must put all its weight in not allowing any unilateral military strikes by Israel that can definitely push the presently volatile middle east region into a war with far reaching global consequences and a high end price for Israel itself. The issue has become an existential threat for the entire region rather than any one country alone.

Dialog and Diplomacy Risks

- Some recommend that the U.S. should remain open to dialog and negotiations with Iran, in the words of President Obama, he said, "I believe there is a window of time to solve this diplomatically, but that window is closing," Obama told reporters.
- There is the suspicion that Iran wants to start an open-ended dialog and negotiations to buy time to reduce pressure for sanctions, use it as a screen to crush all domestic opposition and unrest, with no commitments to terminate its pursuit of nuclear weapons. By continuing a diplomatic engagement with the P5+1 until it feels the political conditions are just right giving it the option to “breakout” of the NPT, and move towards the production of nuclear weapons in a short period of time.
- Iran to use the process domestically showing that the hardline stance of the regime, in not making any concessions, has made the West respect and acknowledge Iran’s sovereign right to pursue Nuclear Power.
- To show that there exists cooperation with the IAEA, and it accepts a limited freeze, making sure it does not alter its fundamental aim and program in developing a knowledge in the enrichment of Uranium and nuclear warhead weaponization. As an enrichment program in Iran will give it the option to “breakout” of the NPT, and move towards the production of nuclear weapons. Furthermore, Iran will not accept any “Rollback” of its enrichment program.
- Iran to buy time in accelerating the process of moving its enrichment activities into facilities buried deep underground, putting them out of the reach of even the most penetrating “bunker buster” bombs.

- **A Recommended Arms Control and Regional Security process in the region with Israel and Iran participating, leading to a Nuclear Weapons Free Zone in the Region.**
- Both James R. Clapper, Director of National Intelligence, and Gen. Martin E. Dempsey, the Chairman of the U.S. Joint Chiefs of Staff emphasized that the central issue is Iran's political will to pursue nuclear weapons. General Dempsey stated "using the military instrument of power simply would delay Iran's nuclear ambition, as opposed to eliminating it. He concluded by saying "It would be a "much wiser course" for Iran to go the diplomatic route".
- The political and diplomatic route would include an arms control process, on a bilateral basis and a multilateral level, such as the M.E. Arms Control and Regional Security (ACRS), be proposed to start as soon as possible. Iran was not invited to participate in the ACRS process of the 90s. A lot of groundwork was covered and it should not be difficult to reintroduce the areas and concepts that the Arab Countries negotiated with Israel. Iran can certainly benefit from all this past work and join in the negotiations as a principal participant.
- This process can start addressing Confidence and Security Building Measures (CSBMs) in both Political-Military and Technical-Military areas. Military-to-military talks and negotiations need to address military doctrines, defense postures, threat perceptions and security concerns. The United States with the international community should encourage and provide support to regional countries interested in establishing Weapons of Mass Destruction Free Zones (WMDFZ), based on the zone that has been proposed in the Middle East.
- These measures can create an atmosphere and an environment that can induce disputing parties to negotiate in a less threatening environment and can remove misunderstandings and surprises. One recent example is for countries to adopt the "International Code of Conduct against Ballistic Missiles Proliferation". This constructive engagement should take place between regional parties under a regional institutional framework.
- International arms control regimes and treaties should be strengthened. Countries need to sign and ratify the NPT, CWC and the BWC, as well as strengthening the verification and monitoring procedures that follow. Other agreements such as the Missile Technology Control Regime (MTCR), Comprehensive Test ban Treaty (CTBT) and Fissile Material Cut-Off should also be adhered to by all states and should be applied as a law in the respective countries.

Introduction

Technical steps required to build a Nuclear Weapon

Introduction:

- The risk of proliferation of Weapons of Mass Destruction (WMD) and their delivery systems on both *horizontal proliferation* (the spread of nuclear weapons to new states) and *vertical proliferation* (increases in the size and sophistication of nuclear arsenals within existing nuclear states) has become one of the gravest threats facing international peace and security.
- For a state to manufacture nuclear weapons there must be two major elements present: the capability to do so, Nuclear Capability, and the Motivation as well as Political Will.
 - “**Nuclear capability**”, consists of the inputs, technical know-how and resources. Resources include the needed materials for a nuclear weapon such as nuclear reactors, uranium enrichment, and the delivery means. In his 2013 annual worldwide threat assessment to the US Congress, US Director of National Intelligence James R. Clapper (January 29, 2014), stated:
 - “We do not know if Iran will eventually decide to build nuclear weapons. Tehran has made technical progress in a number of areas—including uranium enrichment, nuclear reactors, and ballistic missiles—from which it could draw if it decided to build missile-deliverable nuclear weapons. These technical advancements strengthen our assessment that Iran has the scientific, technical, and industrial capacity to eventually produce nuclear weapons. This makes the central issue its political will to do so”
 - “**Motivation and political will**” are based on a state’s Threat Perception and Security Concerns, consequently the political decision to acquire Nuclear Weapons.

- The following summarizes views from Iran and western analysts addressing Iran's Threat Perception and Security Concerns:
 - Views itself as a Gulf power, its aim is to keep the waters free from any foreign military presence, and to prevent outside countries from shaping the political & security future of the Gulf.
 - Views itself as a regional power in the Middle East therefore has a say in the internal affairs of regional countries and in the M.E. Peace Process.
 - The presence of U.S. 5th fleet in the waters of the Gulf as a direct threat to its National Security.
 - That the U.S. is building bases in the Gulf as launching pads for a strike against it.
 - How Israel views Iran as an Existential Threat and Iran must be dealt through a Military Strike, within the immediate future.
 - Israel having some 200 nuclear weapons as a direct threat to Iran
 - The U.S. and Israel are working to destabilize Iran, politically and economically, and to deny it a Nuclear Energy Program.
 - Countries in the region and adjacent are politically unstable, with internal violence.
 - How Iran can be isolated from the international community, economically and diplomatically.
 - The national economy to be in a crises and Iran becoming a failed state

- Given the Political Motivation, if Iran as a non-nuclear weapon state plans to manufacture nuclear weapons, it must undergo the following technical steps:
 - (i) build a scientific and technological capability to conduct research on the design of nuclear weapons;
 - (ii) acquire a sufficient quantity of weapon-grade (Plutonium or Uranium) fissile material;
 - (iii) build a nuclear weapon device;
 - (iv) integrate the nuclear weapons device with its delivery systems.

Steps (iii) and (iv) are referred to as the "weaponization" of nuclear devices.

(i) Iran Science and Technology Institutes

Iran's interest in nuclear technology was initiated by the Shah in the late 1950s, and in 1957 a nuclear cooperation agreement with the United States was concluded upon which Iran started receiving U.S. assistance under the "Atoms for Peace" program. In 1973, the Atomic Energy Organization of Iran (AEOI) was established. The AEOI was responsible to oversee the civilian nuclear program which would include over 20 nuclear power reactors. Over the past 40 years Iran consistently built Nuclear Education, Training and Research & Development Institutes. The following is the presently existing operational sites.

Nuclear-Education and Training

- Amir Kabir University of Technology
- Imam Hussein University (IHU)
- Institute for Studies in Theoretical Physics and Mathematics (IPM)
- Malek Ashtar University (MAU)
- Sharif University of Technology (SUT)
- University of Tehran (UT)

Nuclear-Research and Development

- Bonab Atomic Energy Research Center
- Graphite Sub-Critical Reactor (ENTC GSCR)
- Heavy Water Zero Power Reactor (ENTC-HWZPR)
- Isfahan (Esfahan) Nuclear Fuel Research and Production Center (NFRPC)
- Isfahan (Esfahan) Nuclear Technology Center (INTC)
- Karaj Agricultural and Medical Research Center
- Light Water Sub-Critical Reactor (ENTC-LWSCR)
- Plasma Physics Research Center
- Tehran Nuclear Research Center (TNRC)
- Yazd Radiation Processing Center (YRPC)

(ii) Iran Enrichment of Weapons Grade Plutonium and Uranium Fissile Material

Uranium Enrichment Facilities such as the Natanz Enrichment plant with an Industrial capacity of 50,000 centrifuges. Another enrichment plant is Fordow, which as reported by November 2013, the plant had produced 221.4kg of UF₆ enriched up to 20%. In addition a 40MW Heavy Water Research Reactor, in the Arak Nuclear Facility. Heavy water reactors are considered a Proliferation Risk as high quality weapons grade plutonium can be produced after separating it from the reactor's spent fuel.

Nuclear-Mining and Milling

- Ardakan Yellowcake Production Plant
- Bandar Abbas Uranium Production Plant (BUP)
- Saghand

Nuclear-Heavy Water Production

- Heavy Water Production Plant (HWPP)

Nuclear-Fuel Fabrication

- Fuel Fabrication Laboratory (FFL)
- Fuel Manufacturing Plant (FMP)
- Zirconium Production Plant (ZPP)

Nuclear-Enrichment

- 7th of Tir Industries
- Defense Industries Organization (DIO)
- Farayand Technique
- Fordow Fuel Enrichment Plant
- Fuel Enrichment Plant (FEP)
- Kalaye Electric Company
- Kaveh Cutting Tools Company
- Lashkar Ab'ad
- Natanz Enrichment Complex
- Pars Trash
- Pilot Fuel Enrichment Plant (PFEP)
- Tehran Research Reactor (TRR)

(iii) Iran Building of a Nuclear Device

As to the weaponization part, Iran had built a number of Institutes and research facilities that could potentially be used to develop a Nuclear Device. The Parchin Military complex, which is subordinate to the Defense Industries Organization of Iran, is a major site that consists of hundreds of buildings and test site, as well as additional underground facilities. Iran is believed to be conducting experiments involving “high explosive shaped charges with an inert core of depleted uranium”.

R&D on a Nuclear Weapons Devise sites:

- Institute of Applied Physics (IAP)
- Kimia Maadan Company (KM)
- Parchin Military Complex
- Physics Research Center (PHRC)
- Tehran Nuclear Research Center (TNRC)

(iv) Iran Ballistic Missile as a Nuclear Weapon Delivery System

Missile Technical Design & Engineering sites:

- Aerospace Industries Organization (AIO)
Location: Tehran
- Defense Industries Organization (DIO)
Location: Tehran
- Garmsar Missile Test Range
Location: Garmsar, Tehran province
- Gostaresh Scientific Research Center
Location: Hamadan
- Imam Hussein University (IHU)
Location: Tehran
- Imam Khomeini Space Center
Location: Semnan, Iran
- Iran Aircraft Manufacturing Industries
Location: Isfahan
- Isfahan Missile Complex
Location: Isfahan
- Karaj Missile Development Complex
Location: Karaj
- Kuhestak Missile Battery
Location: Kuhestak
- Lavizan Technical and Engineering Complex
Location: Tehran, Lavizan district
- Parchin Military Complex
Location: Parchin
- Qods Aeronautics Industries
Location: Tehran
- Sanam College
Location: Tehran, Lavizan district
- Semnan Missile Complex
Location: Semnan

- Shahid Bakeri Industrial Group
Location: Tehran
- Shahid Hemmat Industrial Group
Location: Tehran
- Shahroud Missile Test Site
Location: Shahroud, Tehran province
- Shiraz Missile Plant
Location: Shiraz, Fars
- Sirjan Missile Plant
Location: Sirjan, Kerman
- Tabas
Location: Tabas, Khorasan province
- Tabriz Missile Base
Location: Tabriz

Main Missile Launch Sites

- Abu Musa Island
Location: Abu Musa Island
- Bakhtaran Missile Base
Location: Kermanshah
- Bandar Abbas
Location: Bandar Abbas, Hormozgan
- Imam Ali Missile Base
Location: Khorramabad, Lorestan
- Tabriz Missile Base
Location: Tabriz
- Mashad Airbase
Location: Mashad, Khorasan

- It is clear that Iran has the Institutional and Industrial Infrastructure steps required to build a Nuclear Bomb and a Delivery System. There is no agreement as to exactly how far Iran has come in weapons design and “weaponization” if a dedicated program exists.
- In a “Statement for the Record Worldwide Threat Assessment of the US Intelligence Community Senate Select Committee on Intelligence” James R. Clapper, Director of National Intelligence January 29, 2014 stated: “We do not know if Iran will eventually decide to build nuclear weapons. Tehran has made technical progress in a number of areas—including uranium enrichment, nuclear reactors, and ballistic missiles—from which it could draw if it decided to build missile-deliverable nuclear weapons. These technical advancements strengthen our assessment that Iran has the scientific, technical, and industrial capacity to eventually produce nuclear weapons. This makes the central issue its political will to do so.” (Reference: See Appendix 7)
- He continued to say: “We continue to assess that Iran’s overarching strategic goals of enhancing its security, prestige, and regional influence have led it to pursue capabilities to meet its civilian goals and give it the ability to build missile-deliverable nuclear weapons, if it chooses to do so.” On Iran’s ballistic missiles he said: “We judge that Iran would choose a ballistic missile as its preferred method of delivering nuclear weapons, if Iran ever builds these weapons. Iran’s ballistic missiles are inherently capable of delivering WMD, and Iran already has the largest inventory of ballistic missiles in the Middle East. Iran’s progress on space launch vehicles—along with its desire to deter the United States and its allies—provides Tehran with the means and motivation to develop longer-range missiles, including an intercontinental ballistic missile (ICBM).” (Reference: See Appendix 7)

Update on Iran's Nuclear Program

- In November 11, 2011, the IAEA published a report claiming "credible" information that Iran had carried out activities "relevant to the development of a nuclear explosive device", the report also included intelligence indicating Iran had a nuclear weapons research program in 2003 but that senior Iranian leaders stopped it when it was discovered and came under increased international pressure. The report identified 12 specific areas, pertaining to Nuclear Explosive Indicators:
 - Program management structure
 - Procurement activities
 - Nuclear material acquisition
 - Nuclear components for an explosive device
 - Detonator development
 - Initiation of high explosives and associated experiments
 - Hydrodynamic experiments
 - Modelling and calculations
 - Neutron initiator
 - Conducting a test
 - Integration into a missile delivery vehicle
 - Fuzing, arming and firing system

The IAEA report concluded:

“As Iran is not providing the necessary cooperation, including by not implementing its Additional Protocol, the Agency is unable to provide credible assurance about the absence of undeclared nuclear material and activities in Iran, and therefore to conclude that all nuclear material in Iran is in peaceful activities.”

(Source: IAEA GOV/2011/65 Report by the Director General, November 11, 2011)

Table (1)

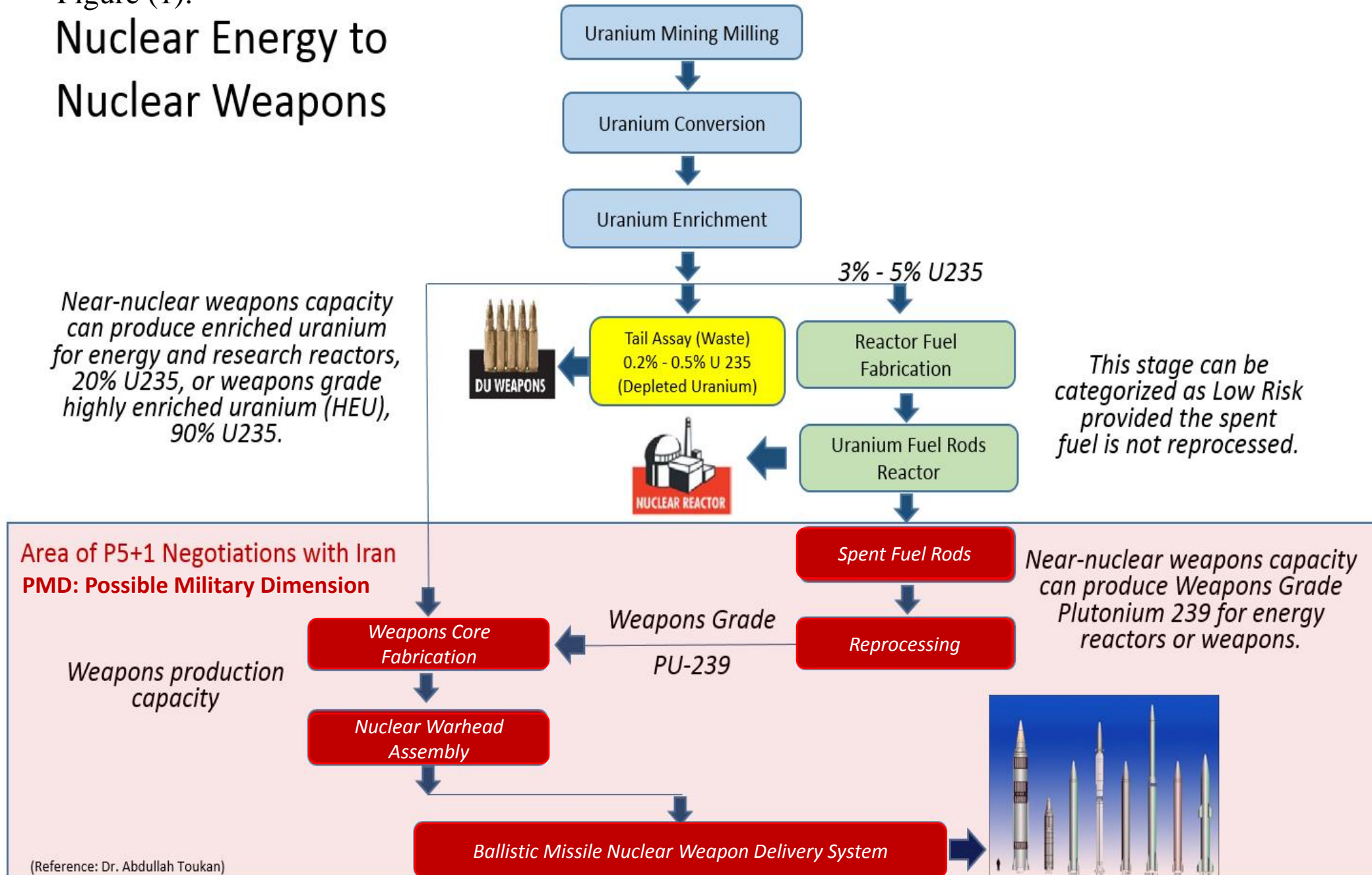
Issues related to current and future nuclear projects	Area of IAEA Concern in 2011 Annex	Addressed by Iran under the Framework for Cooperation September 2014
Access and information: Gchine mine		✓
Access and information: Arak		✓
Information on new research reactors		✓
Designated sites for nuclear power plants		✓
Additional enrichment facilities		✓
Laser enrichment technology		✓
Access and information: Saghand mine		✓
Access and information: Ardakan concentration plan		✓
Design Information		✓
Questionnaire for the IR-40 reactor		
Safeguards Approach for the IR-40 reactor		✓
Information and access: Lashkar Ab'ad Laser Centre		✓
Information on source material		✓
Access and information: centrifuge facilities		✓

Table (1)

Issues related to Possible Military Dimension of past research	Area of IAEA Concern in 2011 Annex	Addressed by Iran under the Framework for Cooperation September 2014
Structure overseeing Iran’s nuclear program	✓	
Procurement activities	✓	
Nuclear material acquisition	✓	
Nuclear components for an explosive device	✓	
Detonator development	✓	Iran failed to provide full clarification.
Initiation of high explosives	✓	Iran failed to address.
Modelling and calculations	✓	Iran failed to address.
Hydrodynamic experiments	✓	
Neutron initiator	✓	
Testing a nuclear explosive device	✓	

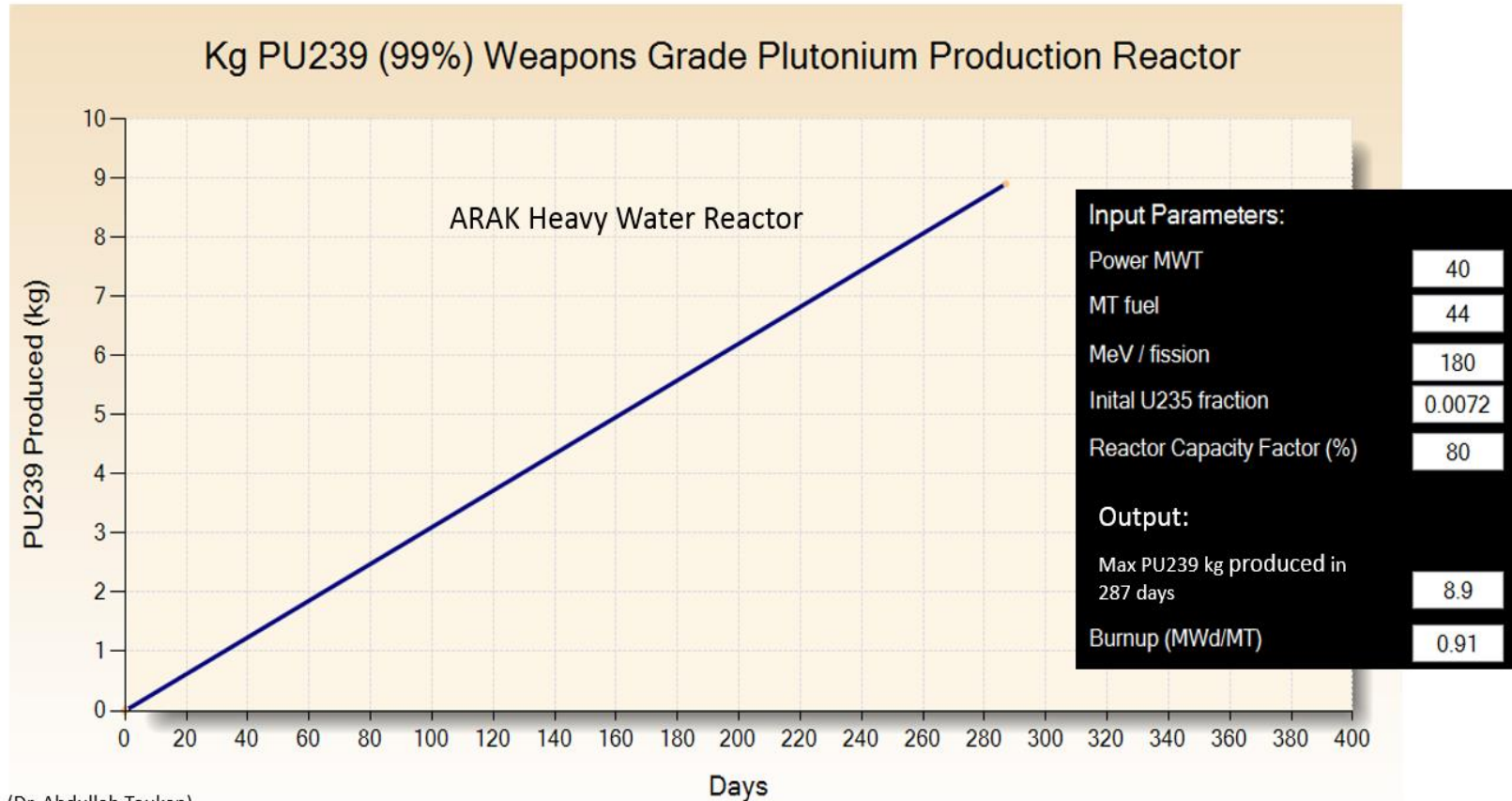
(Bipartisan Policy Center. Update on Iran’s Nuclear Program: September 2014. Blaise Misztal)

Figure (1):
**Nuclear Energy to
 Nuclear Weapons**



(Reference: Dr. Abdullah Toukan)

Figure (2): 40MWT Plutonium Producing Reactor such as the one in ARAK can produce weapons grade PU-239 for 1 nuclear weapon a year.



ARAK: 40 Megawatts of Thermal Power. Reactor could produce up to 10 kg of weapons grade Plutonium per year, enough for 1 bomb per year. Once ARAK is up and running, it will not pose an immediate threat, the reactor would have to run 12 to 18 months to produce enough plutonium containing spent fuel for a bomb. Also, Iran currently does not have any known reprocessing facility for extracting the Plutonium from the spent fuel rods.

The possibility of an Emerging Nuclear Weapon State, such as Iran, building a 20kt yield Nuclear Device.

- There are three types of systems which can deliver nuclear weapons over a considerable distance: aircraft, ballistic missiles and cruise missiles. Combat aircraft can be used as a delivery system however they are slower and vulnerable to conventional ground air defense systems, and could be detected at a very early stage in its flight path to the target. Iranian airforce does not have the capability to travel over 1000km carrying one or two 1000kg bombs, to reach major cities in the Middle East.
- This report will analyze the Iranian Shahab 3/3M Ballistic Missiles as nuclear weapons delivery systems. In the weaponization process of nuclear devices the weight, sizes and the shape of the weapon must be compatible with the missile.
- Based on the “high technical capabilities” of the nuclear weapon states such as the U.S. and Russia, both gun-type and implosion-type devices can be made small enough to be delivered by missiles, while emerging weapon states with “low technical capability”, such as Iran, are currently unlikely to have the same technical sophistication to design compact warheads.
- This report assumes that there exists sufficient public information available on nuclear weapons and the enrichment process that a simple low tech nuclear weapon would not be difficult to design. Scientists and engineers can be confident that the weapon will work without undergoing multiple testing. For a state to have the capability to produce one nuclear weapon (low, medium or high tech) it could be considered a “Nuclear Threshold State”.

Table (2): Approximate Fissile Material Requirements for Pure Fission Nuclear Weapons
(Values rounded to nearest kilogram)

Yield (kt)	Weapon Grade Plutonium (kg)			Highly Enriched Uranium (kg)		
	Technical Capability			Technical Capability		
	Low	Medium	High	Low	Medium	High
1	3	1.5	1	8	4	2.5
5	4	2.5	1.5	11	6	3.5
10	5	3	2	13	7	5
20	6	3.5	3	16	9	5

(Reference: Nuclear Weapons Databook. “The Amount of Plutonium and Highly-Enriched Uranium Needed for Pure Fission Nuclear Weapons”, by Thomas B. Cochran and Christopher E. Paine. Revised 1995. Natural Resources Defense Council, Inc.)

“For single-stage pure fission weapons, a spherically symmetric implosion design requires the least amount of fissile material to achieve a given explosive yield, relative to other possible designs. For this type of device the amount of fissile material required depends primarily upon the type of fissile material used, e.g., plutonium, U-233, or HEU, the desired explosive yield of the device, and the degree to which the fissile material is compressed at the timer disassembly of the fissile material begins due to the release of energy from the rapid nuclear chain reaction.

The degree of compression achieved depends on the sophistication of the design and degree of symmetry achieved by the imploding shock wave. There are, of course, other factors – such as the timing of the initiation of the chain reaction and the type of neutron reflector used --but we will assume that the proliferant state or subnational group already has acquired the necessary skills so that these factors are of secondary importance.”

“In Figures 3 and 4 we plot the explosive yield of a pure fission weapon as a function of the quantity of fissile material (WG, weapon-grade plutonium (Pu239) in Figure 3 and HEU in Figure (4) for three degrees of compression. In the figures the degree of compression is labeled according to our judgement as to the sophistication of the design; that is, whether it represents low, medium or high technology.

As seen from Figure 3, the Nagasaki bomb, *Fat Man*, which produced a 20 kilotons (kt) explosion with 6.1 kilograms (kg) of WGPu, falls on the "low technology" curve.

A non-nuclear weapons state today can take advantage of the wealth of nuclear weapons design information that has been made public over the past 50 years, and do even better. As seen from Figure 3, to achieve an explosive yield of 1 kt, we estimate that from 1 to 3 kg of WGPu is required, depending upon the sophistication of the design.

And from Figure 4, we estimate that some 2 to 7 kg of HEU is required to achieve an explosive energy release of 1 kt. Table 2 presents the same results of tabular form. We estimate, for example, that as little as 2 kilograms of plutonium or about 4 kilograms of HEU are required to produce a yield of 10 kilotons.

Light weight boosted-fission weapons with yields up to about 15 kt can be made with as little as 3.5 kg of plutonium; and in fact, modern boosted-fission primaries of U.S. thermonuclear weapons are made with less than 4 kg of plutonium. U.S. Government classification policy now permits USDOE nuclear weapon experts to acknowledge that nuclear weapons can be constructed with as little as 4 kg of plutonium.”

(Reference: Nuclear Weapons Databook. “The Amount of Plutonium and Highly-Enriched Uranium Needed for Pure Fission Nuclear Weapons”, by Thomas B. Cochran and Christopher E. Paine. Revised 1995. Natural Resources Defense Council, Inc.)

Figure (3): Yield vs Pu Mass as a Function of Technical Capability)

For Low Tech, approximately 6 kg of Pu239 would be required to produce a 20 kt implosion fission weapon.

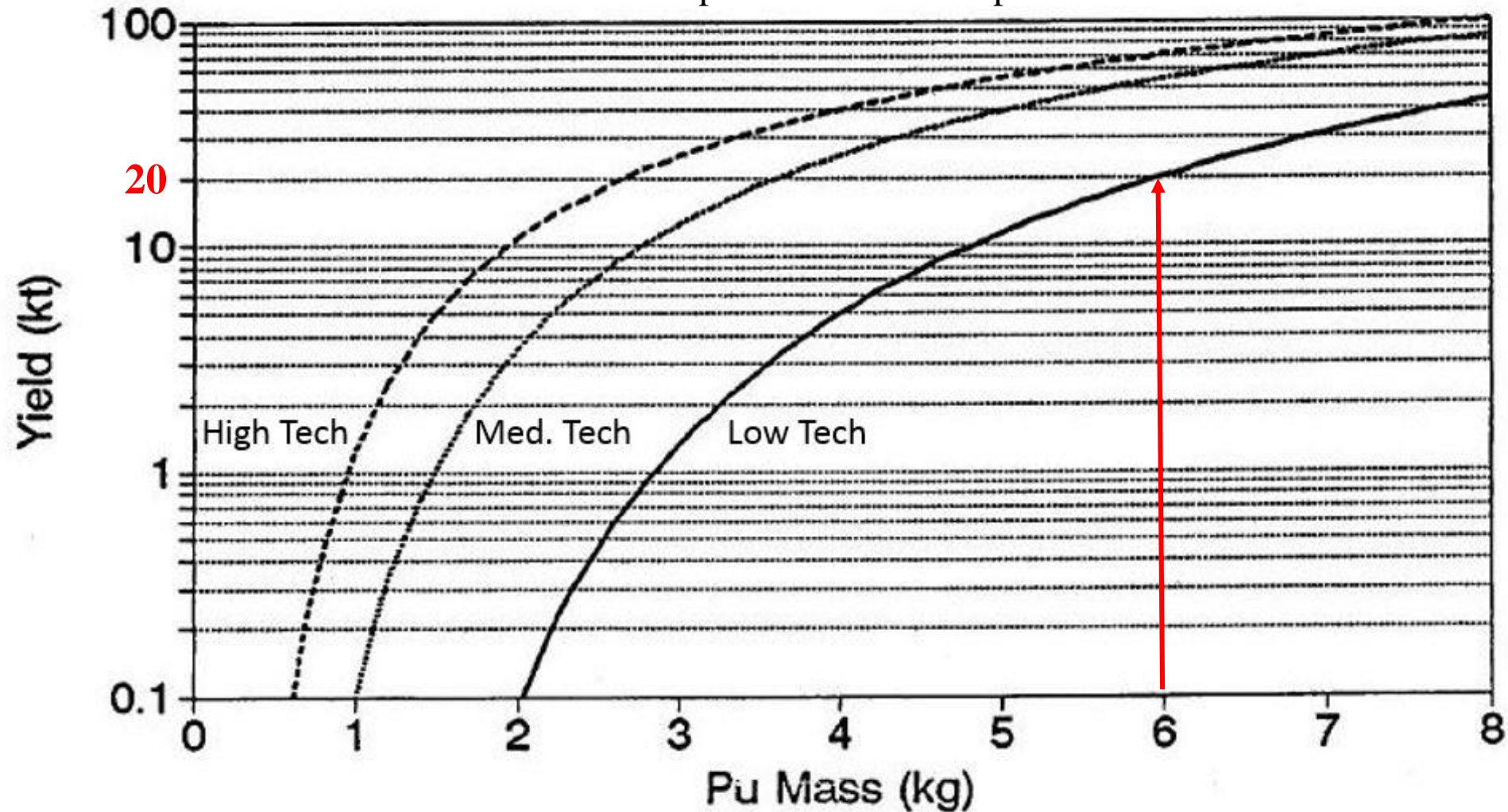
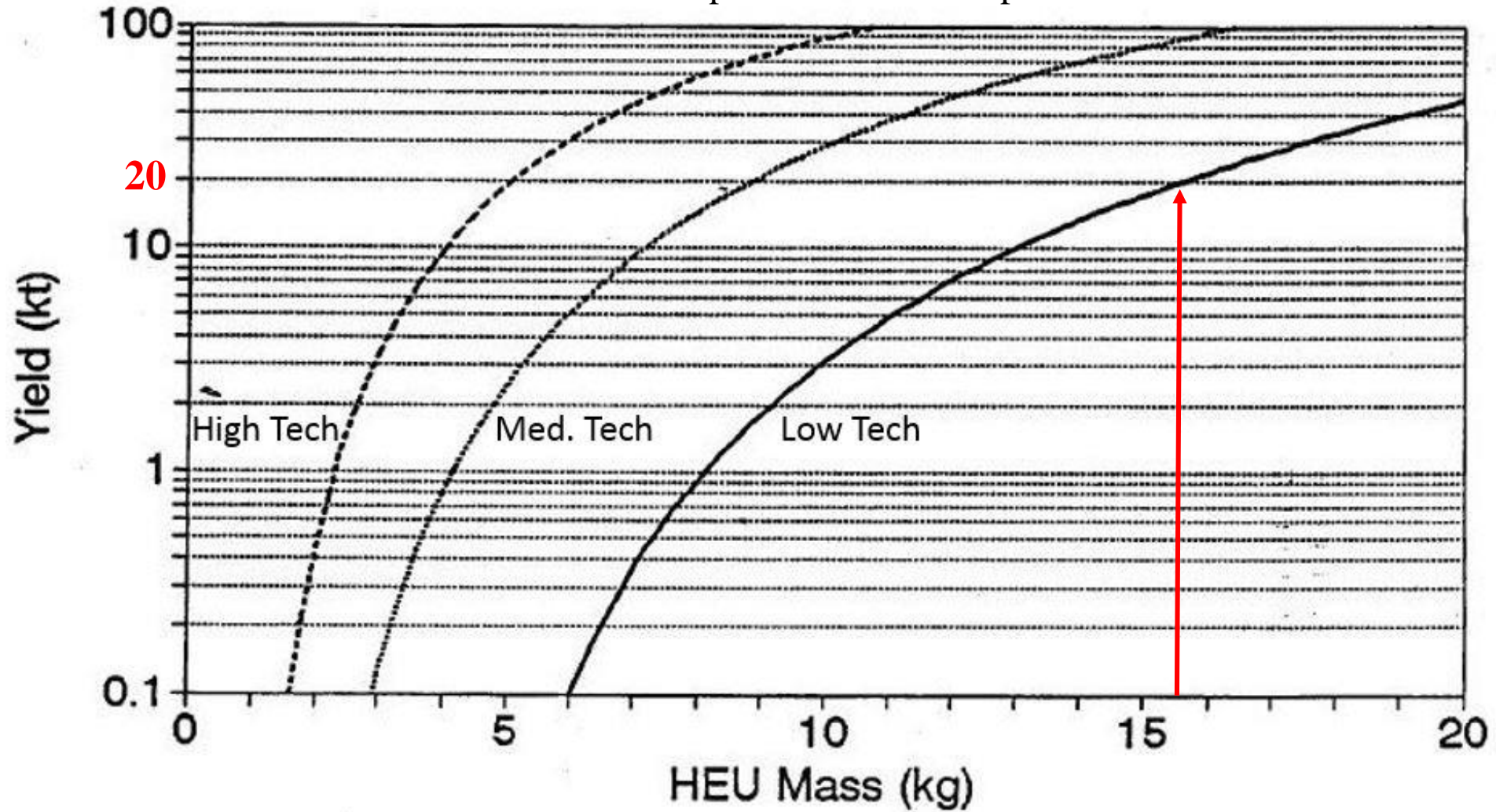


Figure (4): Yield vs HEU Mass as a Function of Technical Capability

For Low Tech, approximately 16 kg of HEU would be required to produce a 20 kt implosion fission weapon.



Amount of Fissile Material needed to build an Atomic Bomb

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

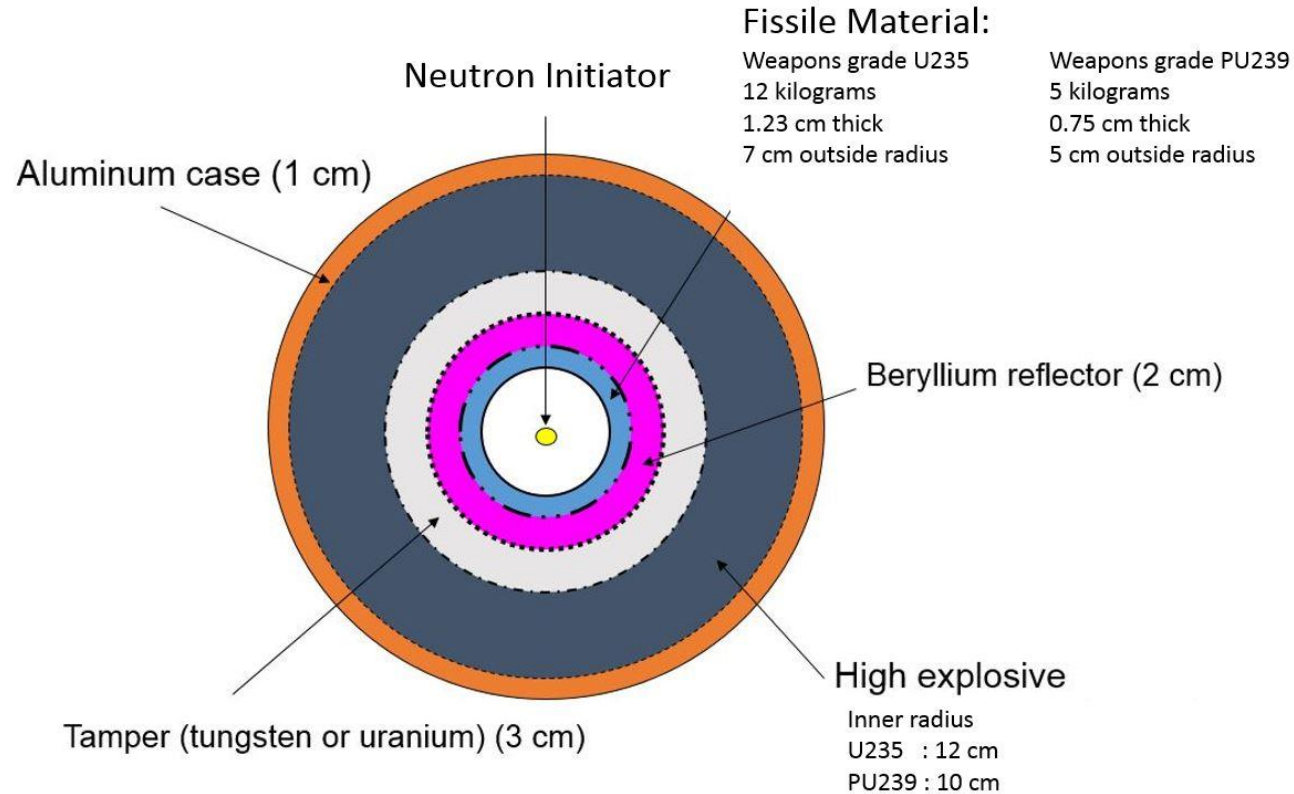
- The amount of HEU needed to make a nuclear weapon varies with the degree of enrichment and sophistication of the weapon design.
- In general, the higher the enrichment level, the less HEU is needed to make a bomb.
- For a HEU-based nuclear weapon, there are two basic design options:
 - Gun-type weapon
 - Implosion weapon
 - Gun-type weapons are far simpler in design, whereas the implosion weapon is more difficult technically but requires less HEU
 - Plutonium based nuclear weapons only work as implosion weapons, with more sophisticated weapons using less plutonium.

(Source: Union of Concerned Scientists. Fact Sheet. April 2004)

Implosion-Type Device Used in this Report

In 1990, Fetter et al. used a simple model of a hypothetical implosion fission explosive with the weight and volume of typical light warheads or primaries in the U.S. and Soviet nuclear arsenals to estimate the neutron and gamma radiation from such warheads. This hypothetical model of the fission explosive, as in figure (5), had a weight of approximately 180 kg and a radius of 23 cm for weapons grade uranium (WgU), and a weight of approximately 130 kilograms with a radius of 21 cm for weapons grade plutonium (WgPu).

Figure (5): Schematic of Primary Part of Implosion Fission Weapon Model used in this report



(Reference: Detecting Nuclear Warheads: Fetter et al. Science & Global Security, 1990, Volume 1, pp 225-302)

Table (3)

WgU + depleted uranium	Mass kg	WgPu + depleted uranium	Mass kg
WgU	12	WgPu	4
Beryllium	3	Beryllium	2
Depleted uranium	79	Depleted uranium	52
High explosive	71	High explosive	56
Aluminum	17	Aluminum	14
	182		128
WgU + tungsten		WgPu + tungsten	
WgU	12	WgPu	4
Beryllium	3	Beryllium	2
Tungsten	81	Tungsten	53
High explosive	71	High explosive	56
Aluminum	17	Aluminum	14
	184		129

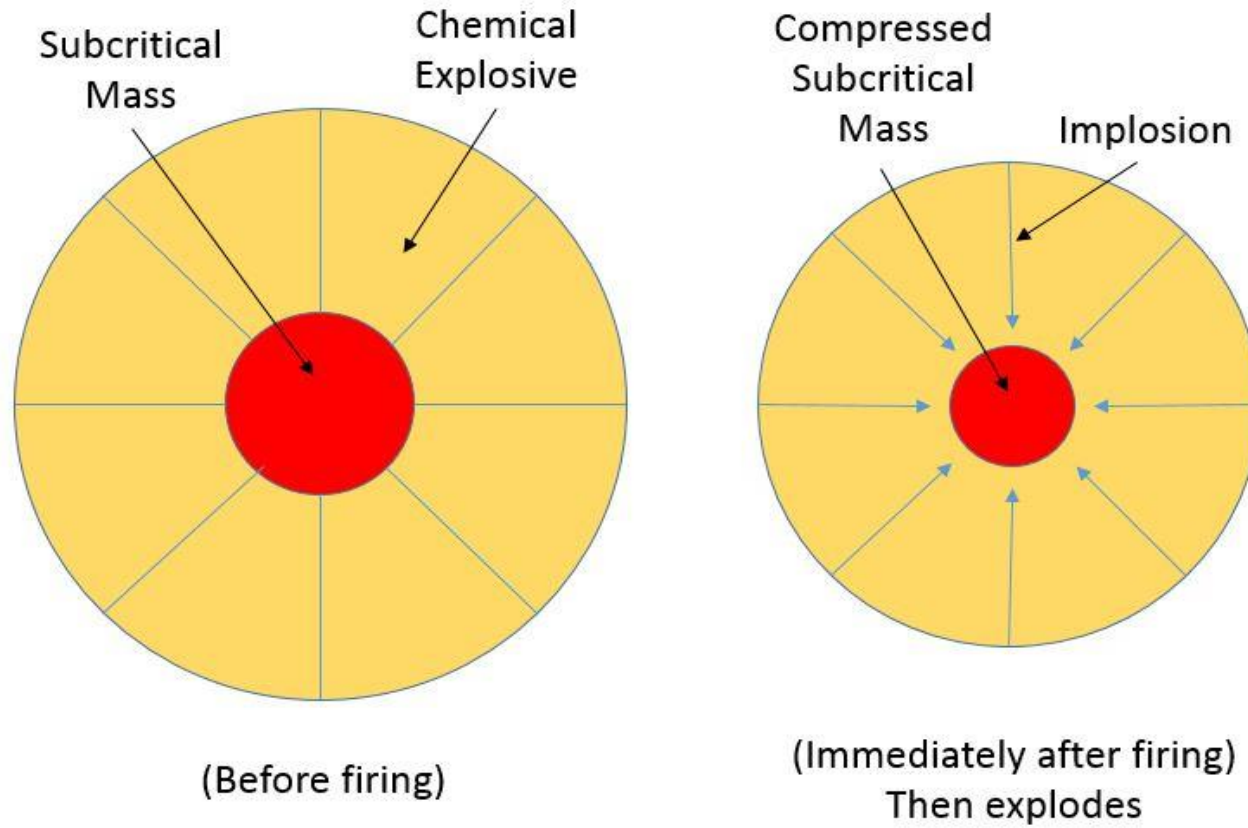
“Two general methods have been described for bringing about a nuclear explosion, that is to say, for quickly converting a subcritical system into a supercritical one. In the first method, two or more pieces of fission able material, each less than a critical mass, are brought together very rapidly in order to form one piece that exceeds the critical mass. This may be achieved in some kind of gun-barrel device, in which an explosive propellant is used to blow one subcritical piece of fissionable material from the breech end of the gun into another subcritical piece firmly held in the muzzle end.”

“The second method makes use of the fact that when a subcritical quantity of an appropriate isotope of uranium (or plutonium) is strongly compressed, it can become critical or supercritical as indicated above. The compression may be achieved by means of a spherical arrangement of specially fabricated shapes (lenses) of ordinary high explosive. In a hole in the center of this system is placed a subcritical sphere of fissionable material. When the high explosive lens system is set off, by means of a detonator on the outside of each lens, an inwardly-directed spherical "implosion" wave is produced. A similar wave can be realized without lenses by detonating a large number of points distributed over a spherical surface. When the implosion wave reaches the sphere of uranium (or plutonium), it causes the latter to be compressed and become supercritical. The introduction of neutrons from a suitable source can then initiate a chain reaction leading to an explosion.”

(Reference: *The Effects of Nuclear Weapons. Compiled and edited by Samuel Glasstone and Philip J. Dolan. Third Edition. Prepared and published by the United States Department of Defense and the Energy Research and Development Administration. 1977*)

The second method, as shown in Figure (6) is used in this report.

Figure (6): Principle of an implosion-type nuclear device



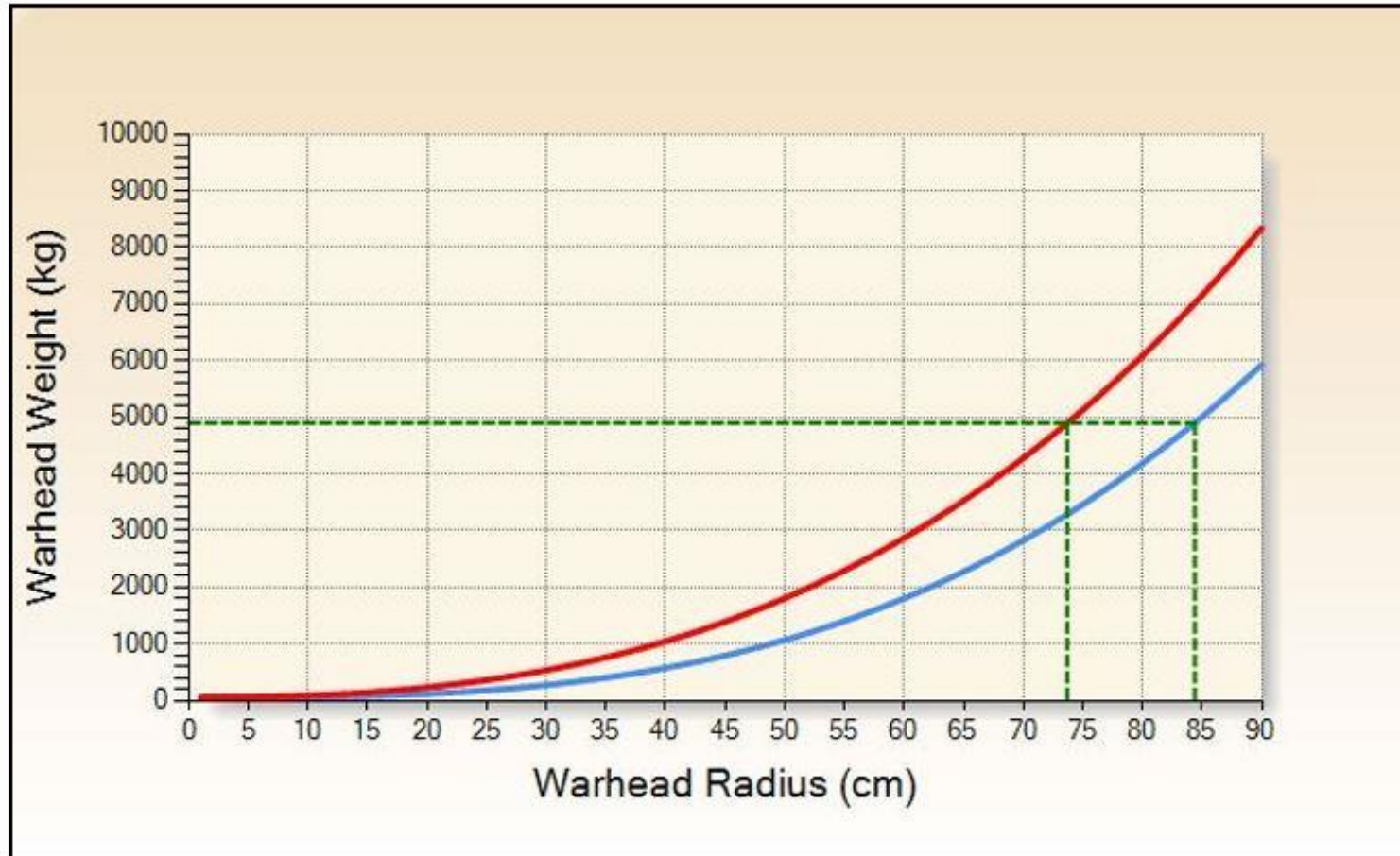
“Fetter's models represent very compact nuclear devices. An emerging State may not be able to design such small devices. Its weapon designers would use more high explosives to ensure that a device would work. It is assumed that the first three layers (weapon-grade-fissile material, neutron reflector and tamper) of a device remain the same when more high explosive is involved. The size of the case will increase to contain more high explosives.

In Fetter's model, the high explosive is contained by a perfect spherical case which has a minimum weight. The shape of an actual case may not be spherical. So its weight could be heavier than a spherical one with the same inner radius. It is assumed that the total weight of the actual case is more than the weight of a spherical shell but is less than ten times that.”

(Reference :Nuclear Missile Delivery Capabilities in Emerging Nuclear States”, li Bin, Science and Global Security, 1997, Volume 6, pp311-331)

- Appendix 2, shows how the maximum weight range is calculated for a given missile radius. Figure (6) displays the maximum weight range of an implosion type device with Plutonium 239 core versus the radius of the device.

Figure (6)
Maximum weight range of implosion-type device with
Pu-239 core vs the radius of the device



(Source: Abdullah Toukan adapted by using calculation in Appendix 2)

From figure (6) above, the radius of the Fat Man bomb (a WgPu implosive device detonated over Nagasaki – yield of 20kt) which weighed 4,900 kg could have been between 74 cm and 84 cm. The actual radius of Fat Man was 76.2 cm, which is right in the given range.

Iran Ballistic Missiles as Nuclear Weapon Delivery
Vehicles

Proliferation of Ballistic Missiles

Many nations see ballistic missiles as highly effective weapons that will provide deterrence, coercive diplomacy, and prestige, that other weapons systems do not. For a state to enhance its security through more procurement of Ballistic Missiles is often self-defeating, because steps taken to enhance security can diminish other states' security, leading them to react by acquiring more ballistic missiles.

Table (4)

Ballistic Missile Range Classifications

SRBM	Short- Range Ballistic Missile	< 1000 km
MRBM	Medium-Range Ballistic Missile	1,000 – 3,000 km
IRBM	Intermediate-Range Ballistic Missile	3,000 – 5,500 km
ICBM	Intercontinental-Range Ballistic Missiles	> 5,500 km
Strategic Ballistic Missile		Sufficient range to reach the enemy's vital strategic targets.
Tactical Ballistic Missiles		Insufficient range for strategic attacks.
Theater Ballistic Missiles (TBM)		Sufficient range to cover an entire Theater of War (i.e. less than 5,000 km)
Submarine-Launched Ballistic Missile (SLBM)		Launched from a Submarine, regardless of maximum range.

Iran's Ballistic Missiles

Iran has been developing ballistic missile capabilities based on Russian, North Korean, and Chinese technology or weapons systems since the early 1980s. Iran currently possesses the largest ballistic missile inventory in the Middle East, and the country's military and scientific establishments are working to increase the sophistication, scale, and reach of its missiles. At present, Iran's rockets and missiles lack the combination of accuracy (Circular Error Probability – CEP) and range to pose a major threat to GCC critical energy facilities and U.S. military facilities.

Iran sees its missile capabilities as a way to compensate for its shortcomings in conventional forces, as well as a means to strike at high-value targets with little warning, such as population centers, and Western and Western-backed forces in the region, including US bases in the Gulf. As such, ballistic missiles play an integral role in Iran's asymmetric warfare doctrine. Given the emphasis Iran places on its missile program, it is clear that Iran considers its ballistic missile arsenal among its most important assets as both a deterrent to attack and leverage over other regional players.

Marking a significant shift in Iranian missile development and capabilities, in November 2008 Tehran successfully tested a two-stage, solid-propellant 2000 km medium-range ballistic missile (MRBM), the Sejil. Since 2008, Iran has conducted five additional tests of the Sejil, two successfully. The Sejil has not been officially accepted into service, and technological hurdles remain before it could be used as an effective military weapon. Solid-propellant missiles offer numerous advantages over liquid-propellant missiles, and it is likely that Tehran will continue to develop the Sejil and other solid-fueled missiles as its program moves forward. .(www.nti.org)

Iran Missiles

.....”In addition to its missile program, Iran is actively developing a space launch capability. Iran successfully launched three satellites into space in February 2009, June 2011, and February 2012 aboard the Safir space launch vehicle (SLV). Some analysts fear that the Safir represents the technical basis for Tehran to develop long-range ballistic missiles. However, Tehran would need to significantly modify the second stage of the Safir before it could be used as an ICBM, and has not demonstrated it would be able to do so, or developed the requisite reentry vehicle for an ICBM. Since 1999, the U.S. intelligence community has estimated Iran could potentially test an ICBM by 2015, but its most recent assessment from January 2014 reportedly "dials back" this estimate. Expert debate concerning Iran's technological capacity to develop ICBMs in the near future is significant and ongoing.“(www.nti.org)

Table (5)

Country	SRBM < 1,000 KM	MRBM 1,000 – 3,000 km	IRBM 3,000 – 5,500 km	ICBM > 5,500 km
Iran	Shahab - 1	Shahab - 3	Shahab - 5	Shahab - 6
	Shahab - 2	Shahab – 3M	-	-
	Mushak - 120	Ghadr - 101	-	-
	Mushak - 160	Ghadr - 110	-	-
	Mushak - 200	IRIS	-	-
	-	Sejil	-	-
	-	Safir	-	-
Syria	SCUD-B	-	-	-
	SCUD-C	-	-	-
	SCUD-D	-	-	-
	SS-21b	-	-	-
ISRAEL	Jericho-2			Jericho-3
Pakistan	Shaheen I	Shaheen II	-	-
	Hatf I	Ghauri I	-	-
	Hatf II	Ghauri II	-	-
	Hatf III	Ghauri III	-	-
	M-11	-	-	-
India	Agni I	Agni II	Agni III	Surya
	Prithvi I	-	-	-
	Prithvi II	-	-	-

- The aging Iranian airforce will definitely be no match against the U.S. and even the GCC airforces. In addition the Iranian Air Defense systems do not have the Command Control Communications and Intelligence required to detect, track and shoot down the US advanced military combat aircraft. However U.S. planners will definitely take all operational planning precautions necessary to ensure that both the Iranian Airforce and Air Defense system are ineffective and all U.S. combat aircraft have a high probability of survival throughout.
- Iran's most advanced fighters consist of a small number of export versions of the Su-24 and MiG-29, whose avionics lag far behind their Russian counterparts. It is reported that Iran has less than 30 export versions of MiG-29, some not operational. These limits to Iran's air force are particularly important as Iran has air bases that are only a few minutes flight time from critical targets in the Gulf and in the coastal areas of the southern Gulf states. They are also important because Iran's weaknesses in air-to-air combat, and its weaknesses in surface-to-air missile defense leave it highly vulnerable to any US attack.
- Iran claims to have modernized the avionics on some of these aircraft, and to have adapted its F-14s to carry the Hawk air-to-surface missile as a long-range air-to-air missile to compensate for the fact its F-14s were sabotaged during the fall of the Shah and cannot make effective use of Phoenix missiles – which in any case are long beyond their useful life. It also claims to have created electronic warfare aircraft and to have modernized the avionics on its 3 PF-3 Orion maritime patrol aircraft – which are as close to an AWACS/airborne warning and control aircraft as Iran has. It also has claimed to have a mix of unmanned combat aerial vehicles (UCAVs and UAVs) it can use to make up for some of the limitation in its aircraft.
- U.S. officials are working with allies in the Gulf to develop the capability to defeat the threat Iran poses to the Gulf, allied territory, and the flow of trade and energy exports GCC countries worry that during a crisis, Iran could try to prevent their ships from traversing the Strait of Hormuz, cutting off their oil export business.
- The only effective counter-strike capability Iran has other than asymmetric warfare in the Gulf, and the use of proxies like Hezbollah, is their Ballistic Missile Force. A massive retaliation strike with whatever launching sites that have survived the U.S. first strike could still cause quite a considerable damage to the GCC states, in energy, finance and various other critical infrastructure centers.

- The U.S. is currently involved in building a Defensive Shield against a massive Iranian Ballistic Missile attack targeted at the GCC states. The defensive shield consists of a Multi-Tier Ballistic Missile Defense System consisting of Terminal High Altitude Air Defense (THAAD) and Patriot Advanced Capability, PAC-3, missile systems supported with the most advanced Radar and Command and Control facilities.
- Ballistic missile defense (BMD) systems have been provided to Kuwait, the United Arab Emirates, Qatar and Oman, as well as stationing Aegis-equipped warships in the waters of the Arabian Gulf. The U.S. has been developing an integrated early warning radar system across the GCC states that could help U.S. and GCC forces to quickly respond to an Iranian missile attack.
- The U.S. has been developing an integrated early warning radar system across the GCC states that could help U.S. and GCC forces to quickly respond to an Iranian missile attack. The moves are intended to reassure Gulf countries that they would be protected against possible offensive action from Tehran. U.S. officials stressed the defensive nature of the actions being taken throughout the region.
- U.S. officials also are working with allies in the Gulf to ensure freedom of navigation in the region. Arab countries worry that during a crisis, Iran could try to prevent their ships from traversing the Strait of Hormuz, cutting off their oil export business. US officials have repeatedly insisted they are keeping "all options on the table," which includes a military strike option, when it comes to Iran. Secretary of State Clinton made the following remarks with Saudi Arabian Foreign Minister on March 31, 2012 (US State Department).
 - “We believe strongly that, in addition to our bilateral military cooperation between the United States and every member nation of the GCC, we can do even more to defend the Gulf through cooperation on ballistic missile defense. We began that conversation in this forum today. Admiral Fox, the commander of the Fifth Fleet, made a presentation outlining some of the challenges that we face when it comes to ballistic missile defense. But we are committed to defending the Gulf nations and we want it to be as effective as possible.
 - So we want to begin expert discussions with our friends about what we can do to enhance ballistic missile defense. There are some aspects of a ballistic missile defense system that are already available, some of which have already been deployed in the Gulf. But it’s the cooperation – it’s what they call interoperability that we now need to really roll up our sleeves and get to work on.”

For Aircraft delivering Nuclear Payload.

In any encounter the Target Kill Probability, with an Aircraft, is dependent on:

- Probability of mission survival going to target and egress.
- Probability of target acquisition
- Probability of weapon reliability
- Probability of target single shot kill probability given a hit

- Probability of mission survival depends on:
 - Intelligence, Surveillance and Reconnaissance (ISR)
 - Location of target
 - Self Protection Electronic Equipment
 - Aircraft has a self escort defense capability
 - Successful Suppression of Enemy Air Defense (SEAD) operations along the way to target
 - C4I

- Probability of Target Acquisition depends on:
 - Radar and other sensors on Aircraft.

- Probability of weapon reliability depends on:
 - Technology involved in weapons design and Aircraft systems reliability.

- Probability of single shot kill given a hit probability depends on:
 - Accuracy of targeting system on weapon (CEP)
 - Lethal range of weapon warhead.

Figure 7: Air to Ground Mission Radius for Iran Airforce F-4E and Su-25. These aircraft can be used as a delivery system however they are slower and vulnerable to conventional ground air defense systems, and could be detected at a very early stage in its flight path to the target. Iranian Airforce does not have the capability to travel over 1000km carrying one or two 1000kg bombs, to reach major cities, and high value targets, in the Middle East.



GCC vs Iran Airforce

- Iran's most advanced fighters consist of a small number of export versions of the Su-24 and MiG-29, whose avionics lag far behind their Russian counterparts. It is reported that Iran has less than 30 export versions of MiG-29, some not operational. These limits to Iran's air force are particularly important as Iran has air bases that are only a few minutes flight time from critical targets in the Gulf and in the coastal areas of the southern Gulf states. They are also important because Iran's weaknesses in air-to-air combat, and its weaknesses in surface-to-air missile defense which are described shortly, leave it highly vulnerable to any US attack.
- Iran claims to have modernized the avionics on some of these aircraft, and to have adapted its F-14s to carry the Hawk air-to-surface missile as a long-range air-to-air missile to compensate for the fact its F-14s were sabotaged during the fall of the Shah and cannot make effective use of Phoenix missiles – which in any case are long beyond their useful life. It also claims to have created electronic warfare aircraft and to have modernized the avionics on its 3 PF-3 Orion maritime patrol aircraft – which are as close to an AWACs/airborne warning and control aircraft as Iran has. It also has claimed to have a mix of unmanned combat aerial vehicles (UCAVs and UAVs) it can use to make up for some of the limitation in its aircraft.

(Source: Anthony Cordesman CSIS)

Table (6) : GCC Force Level Sortie Rate Generation

Tactical Fighter	Country	Order of Battle	Operational Readiness (%)	Force Available	Sorties per Aircraft per day	Force Total Sorties per day	Postulated Employment
Tornado IDS	Saudi Arabia	69	65	45	3	135	Deep Strike
Typhoon-2	Saudi Arabia	32	75	24	3	72	FS,BAS,AD,Escort
Mirage 2000	UAE	60	75	45	3	135	FS,BAS,AD,Escort
	Qatar	12	75	9	3	27	
F-18L	Kuwait	39	70	27	3	81	FS,BAS,AD,Escort,CAS,BI,SEAD
F-16C/D	Bahrain	21	80	17	3	51	FS,BAS,AD,Escort,CAS,BI
	Oman	12	80	10	3	30	
	UAE	78	80	62	3	186	
F-15C/D	Saudi Arabia	81	75	61	3	183	FS,BAS,AD,Escort,CAS,BI
F-15S	Saudi Arabia	71	75	53	3	159	Deep Strike,FS,AD,Escort,CAS,BI
Total		475		353		1059	

(Source: Anthony Cordesman, Abdullah Toukan CSIS)

FS : Fighter Sweep
 BAS : Battlefield Air Superiority
 AD : Air Defense
 CAS : Close Air Support
 BI : Battlefield Interdiction
 SEAD : Suppression of Enemy Air Defense

Table (7) : Iran Force Level Sortie Rate Generation

Tactical Fighter	Order of Battle	Operational Readiness (%)	Force Available	Sorties per Aircraft per day	Force Total Sorties per day	Postulated Employment
MiG-29	36	60	22	2	44	AD,Escort,FS,BAS
Su-23	13	60	8	2	16	CAS,BI,Deep Strike
Su-24	30	60	18	2	36	CAS,BI,Deep Strike
F-14	43	60	26	2	52	AD,FS
F-4E	65	60	39	2	78	AD,Strike,SEAD
Total	187		113		226	

(Source: Anthony Cordesman, Abdullah Toukan CSIS)

Table (8) Israel Force Level Sortie Rate Generation

:

Tactical Fighter	Order of Battle	Operational Readiness (%)	Force Available	Sorties per Aircraft per day	Force Total Sorties per day	Postulated Employment
F-16A/B	104	80	83	3	249	AD,Escort,FS,BAS
F-16C/D	121	80	97	3	291	CAS,BI,Deep Strike
F-16I	101	80	81	3	243	CAS,BI,Deep Strike
F-15A/B	41	80	33	3	99	AD,FS,CAS,BI
F-15C/D	26	80	21	3	63	AD,FS,BI
F-15I	25	80	20	3	60	Deep Strike,SEAD
Total	418		335		1005	

(Source: Anthony Cordesman, Abdullah Toukan CSIS)

- The GCC have been planning their defenses so as to provide a military deterrent sufficient to make any direct confrontation as costly as possible to Iran or any other adversary. It is in this deterrent role that lies the ultimate rationale for any GCC Joint Defense Pact and Cooperation.
- Two main considerations underlying the choice of a Military Doctrine by the GCC states have been: Balance of Forces and Strategic Depth. In particular for the Arabian Gulf “front line states” Kuwait, Bahrain, Qatar, UAE and Oman, the main concern would be strategic depth to an Iranian attack.
- Defense Performance Criteria should be a 85% Probability that the defense shoots down all the incoming threat aircraft; this also means an 85% of zero leakage. Furthermore a 90% Probability that incoming threat aircraft are successfully detected early and tracked by the GCC Air Defense.
- Lack of Strategic Depth results in limitations on the area of operational maneuverability during conflict, time to respond, and an increase in the vulnerability of vital strategic critical infrastructure economic centers due to the proximity to the borders. Saudi Arabia is the only state that has strategic depth, and is looked upon to play a pivotal role in the Security Arrangements of the Gulf and the Arab Israeli conflict.
- When transformed into an operational doctrine, the GCC states would base their Force Structure Planning on: Defensible Borders. Borders which can be defended without a pre-emptive initiative, and the parallel capability to take the war to the enemy and to fight on enemy territory.
- The requirement would be to enhance the conventional military ability for the GCC states consisting of four major components: Force Structure; Modernization; Readiness; Sustainability. In addition it would include developing an asymmetric warfare capability. The total GCC Air Power is 475 combat aircraft (Table 6), the total available operationally available (full mission capable) force will be 353 and with a sortie rate of 3 per aircraft per day the total number of sorties generated would be 1059. Whereas for Iran Table (7), a total of 187 aircraft with the combat force operationally available (full mission capable) is 113, and with 2 sorties per aircraft per day the total sorties generated will come to 226. The 4.7:1 ratio of sorties generated projects the weakness of the Iranian Airforce vs the those of the GCC countries.
- By following the guidelines of the USAF Doctrine manuals in the missions needed for Offensive Counterair, Defensive Counterair as well as Counterland Operations, the 4.7:1 ratio clearly implies that there is a substantial advantage in favor of the GCC Airforces achieving the specified wartime objective of winning an air war or destroying a target set.

What Iran lacks in Air Power:

The following are some general criteria that would be required for Iran to try and maintain a technological and qualitative edge over the GCC Airforces:

• Aircraft:

- Multi-mission capability.
- High Operational Readiness/Full Mission Capable state and high sortie rates.
- All weather day / night operational capability
- Quick response / ground launched interceptors against incoming intruders.
- High Endurance.
- Airborne Electronic Warfare (ESM/ECM/ECCM) survivability
- Detect track and engage multiple mobile ground targets as well as Hard and Deeply Buried Targets (HDBTs).
- Rapidly destroy advanced air defense systems.
- Capable of carrying out deep strike missions.
- Short C4I Early Warning delay time due to having antiquated System, semi-automated man in the loop, giving rise to long Response / Scramble Time by Combat Aircraft

• Air to Air Missiles:

- Aircraft to be capable of multiple target engagement. Fire and Forget/Launch and leave with high single shot kill capability.
- Good target discrimination and enhanced resistance to countermeasures.
- Increase in range of firing missile at the same time shortening the flight time to the target.
- low Loss Exchange Ratio in a Closing / BVR Environment and Visual Engagement Environment.

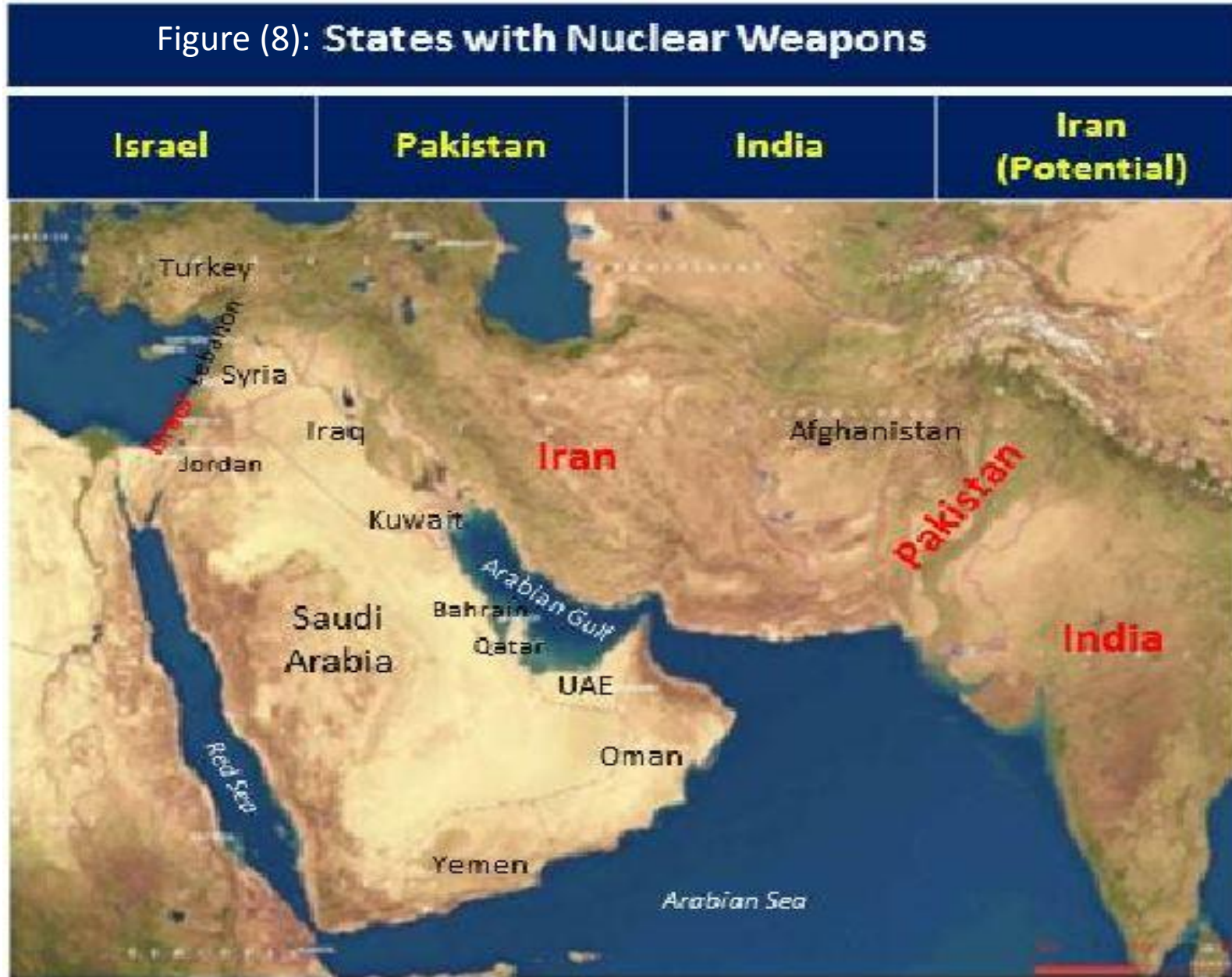
Air to Ground:

- Weapons that serve as an effective force multiplier.
 - Stand-off capability, operating from ranges outside enemy point defenses.
 - Low and high altitude launches.
 - Preserve crew and aircraft survivability
 - Effective against a wide array of land and sea targets with high single shot kill probability.
 - Weapons that employ launch and leave with high accuracy (small CEP).
 - Capable of day/night and adverse weather conditions
- Since Iran presently does not have access to modern technology weapon systems, it will continue to invest in the Development of Ballistic Missiles as a means to project power and a capability for in-depth defense by launching an attack deep from within its own territory. Ballistic Missiles will also compensate for deficiencies in Iran's conventional forces capabilities.

Tactical Ballistic Missiles Threat:

- Iran's ballistic missiles cover the complete spectrum range from 150 km up to 5,500 km, the Short, Medium, and Intermediate Ranges of Ballistic Missiles. Iran believes that these will compensate for any deficiencies in its Air Power.
- Ballistic Missiles can be used with success against Soft Targets, in open areas and cities to inflict maximum human casualties and create terror. In essence what is considered as a major component in Asymmetric Warfare in the form of high civilian casualties.
- This arsenal of Ballistic Missiles possessed by Iran has been declared to be for defensive purposes against any foreign invasion, in particular against the U.S.
- However, it has become very clear that it is an arsenal that is intended to inflict maximum casualties and damage, in essence a major component for Asymmetric Warfare in the form of high attrition and defenses in depth and to compensate for any deficiencies in its Air Power.
- At the same time, many of Iran's missile systems are still in a development phase where their mobility, survivability, reliability, accuracy over large distances are impossible to predict.

Iran is the only state between the four that has signed and ratified the NPT Treaty.



IRGC Official: Iran among World's Top 10 Missile Powers

FARS News Agency – FNA September 28, 2014

TEHRAN (FNA)- A senior official of the Islamic Revolution Guards Corps (IRGC) appreciated the Iranian Armed Forces for their astonishing progress in building different defensive tools and weapons, and said Iran is now standing among the world's top missile powers.

"Today, the Islamic Iran has grown into the world's sixth missile power and this is a major source of pride for the Revolution," Deputy Head of the IRGC Officer Training College Brigadier General Nourollah Nourollahi said in the Northern province of Semnan on Sunday. He underlined that Iran now ranks 16th in the world's science, and is the first power in the region.

Tehran launched an arms development program during the 1980-88 Iraqi imposed war on Iran to compensate for a US weapons embargo. Since 1992, Iran has produced its own tanks, armored personnel carriers, missiles and fighter planes.

Yet, Iranian officials have always stressed that the country's military and arms programs serve defensive purposes and should not be perceived as a threat to any other country.

In March, the Iranian defense ministry started the mass-delivery of different ballistic missiles, including Qadr, Qiam, Fateh 110 and Khalij-e Fars missiles, as well as Mersad air defense system to the IRGC and Khatam ol-Anbia Air Defense Base.

“The honorable specialists of the Defense Ministry’s Aerospace Organization displayed the defense industry' power and capability in providing the Armed Forces' needs to the most advanced missile equipment by supplying them with Qadr, Qiam, Fateh 110 and Khalij-e Fars (Persian Gulf) ballistic missiles and Mersad air defense system and showed that the different and comprehensive sanctions of the enemies imposed strictly and specially on our defense sector have totally failed to undermine their resolve and determination,” Defense Minister Brigadier General Hossein Dehqan said, addressing a ceremony held to mark the delivery of the new missile systems to the IRGC and Khatam Ol-Anbia Air Defense Base.

“These missiles can strike and destroy enemy targets with a high precision capability and provide for a wide range of the Armed Forces’ needs to missiles with different ranges,” he added.

Dehqan underlined that all these missiles have been built by Iranian specialists, and said, “Today the Armed Forces enjoy such a high degree of defensive capabilities that they can counter back any kind of threat posed from beyond the borders of the Islamic Republic of Iran.”

He also described enemies’ threats of military action against Iran as media hype for internal use.

Qadr is a 2000km-range, liquid-fuel and ballistic missile which can reach territories as far as Israel. Qiam is also a new type of surface to surface and cruise missile.

The Fateh-110 is a short-range, road-mobile, solid-propellant, high-precision ballistic missile with advanced navigation and control systems.

The Fateh-110 has been designed and developed by the Iranian experts in the Defense Ministry's Aerospace Organization and has not been modeled on any foreign product.

The supersonic Khalij-e Fars (Persian Gulf) missile, which carries a 650-kilogram payload, is smart and immune to interception, and features high-precision systems.

The supersonic ballistic missile is the most advanced and most important missile of the IRGC Navy.

The distinctive feature of the missile lies in its supersonic speed and trajectory. While other missiles mostly traverse at subsonic speeds and in cruise style, Khalij-e Fars moves vertically after launch, traverses at supersonic speeds, finds the target through a smart program, locks on the target and hit it.

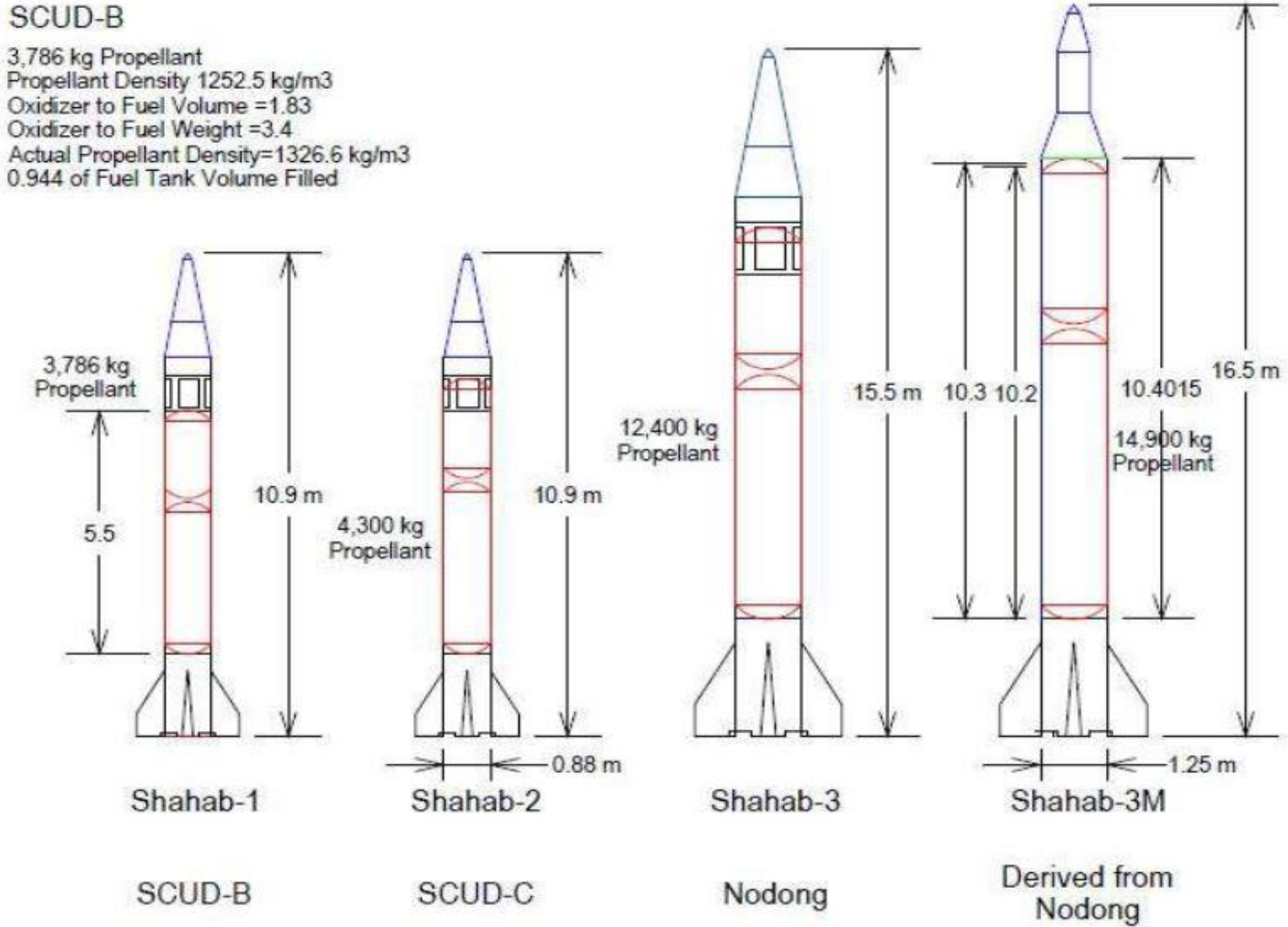
The range of the solid-fuel missile is 300km and it can be fired from triple launchers.

The missile could successfully hit a mobile target one-tenth of an aircraft carrier in its early tests. Also, Mersad Air Defense Missile System is a completely indigenized system developed by the Iranian experts and technicians to promote the country's combat power.

The system has already passed field tests and is used as part of the country's integrated air defense network.

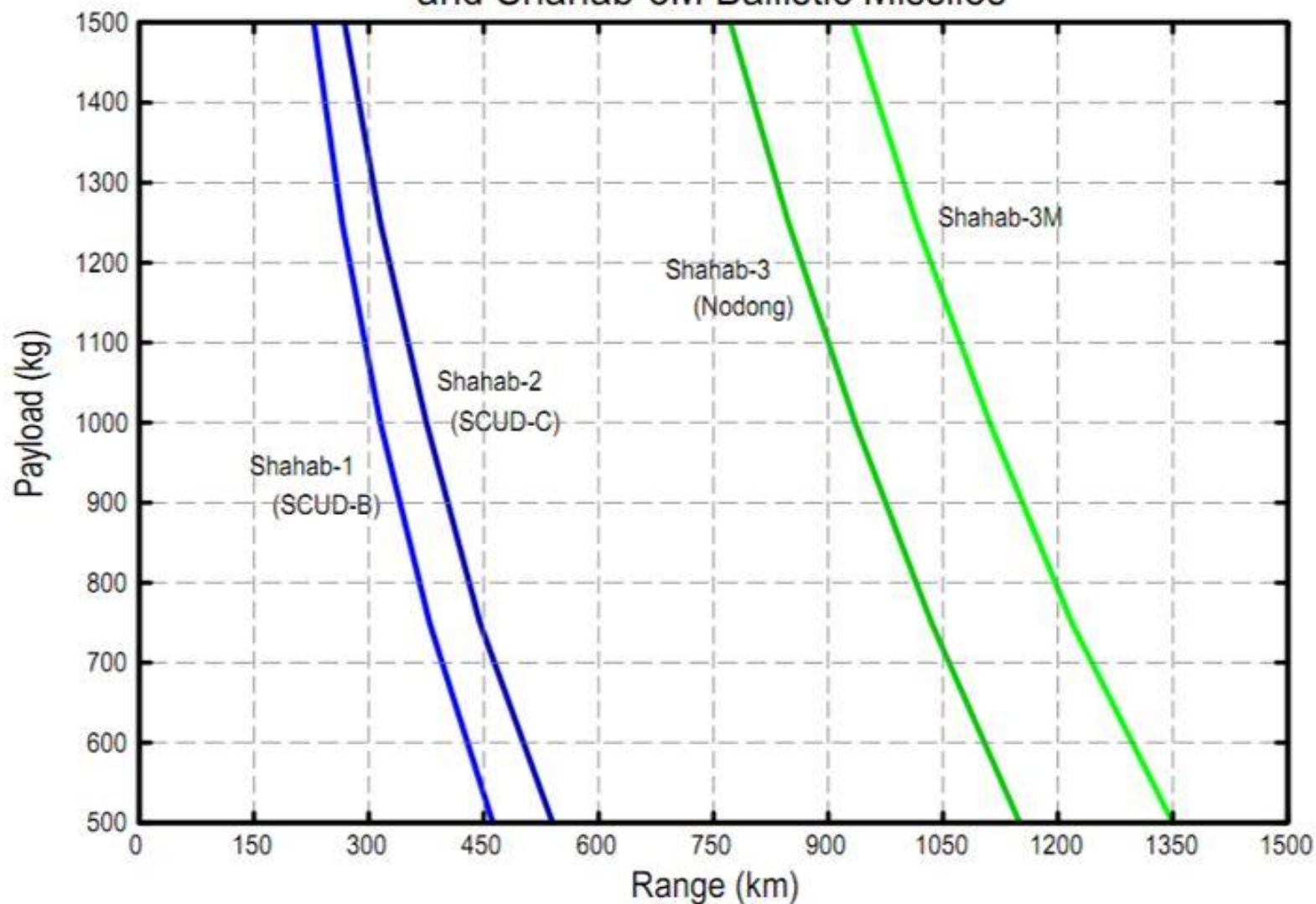
The Mersad system equipped with Shahin missiles is capable of tracing and targeting any enemy aircraft at 70 to 150km altitude and is considered as a mid-altitude system among the country's missile shields.

Figure (9): IRAN Operational Shahab Ballistic Missiles



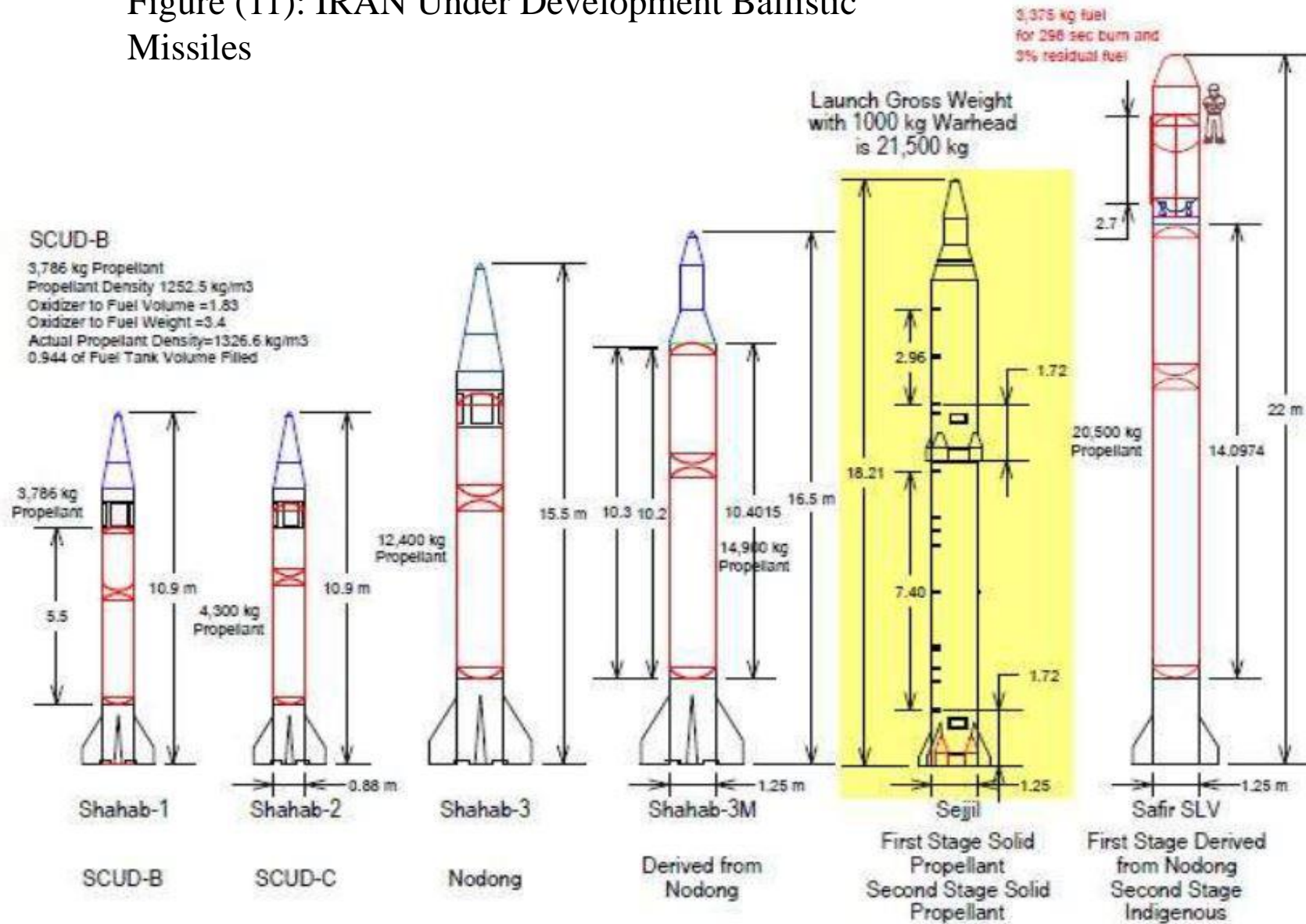
(Reference: Theodore Postol, "A Technical Assessment of Iran's Ballistic Missile Program" May 6, 2009. Technical Addendum to the Joint Threat Assessment on Iran's Nuclear And Missile Potential.)

Figure (10): Range Versus Payload of SCUD-B, SCUD-C, Nodong and Shahab-3M Ballistic Missiles



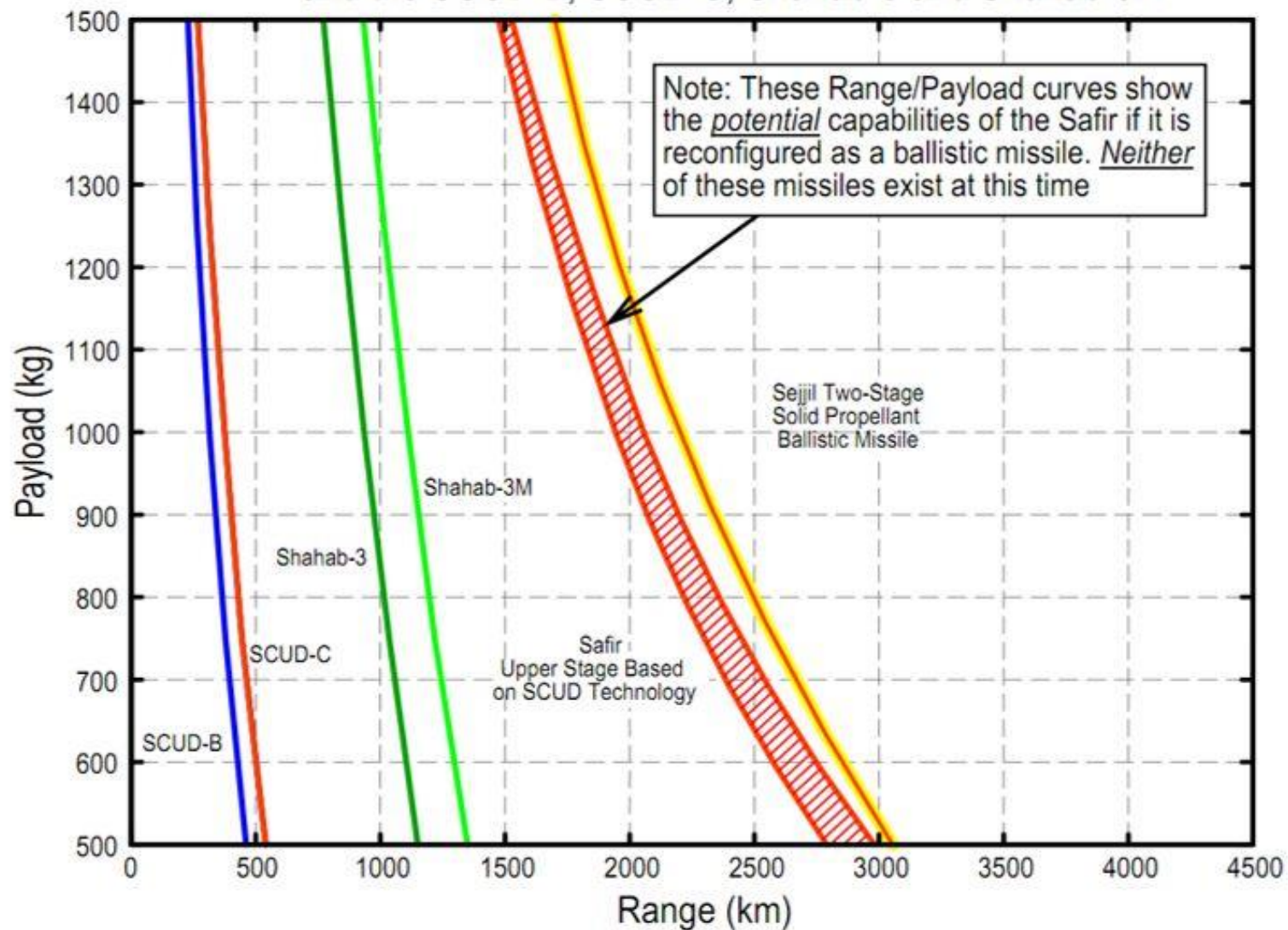
Source: Theodore Postol, *A Technical Assessment of Iran's Ballistic Missile Program*, from "Technical Addendum to the Joint Threat Assessment on the Iran's Nuclear and Missile Potential." (JTA) May 6, 2009.

Figure (11): IRAN Under Development Ballistic Missiles



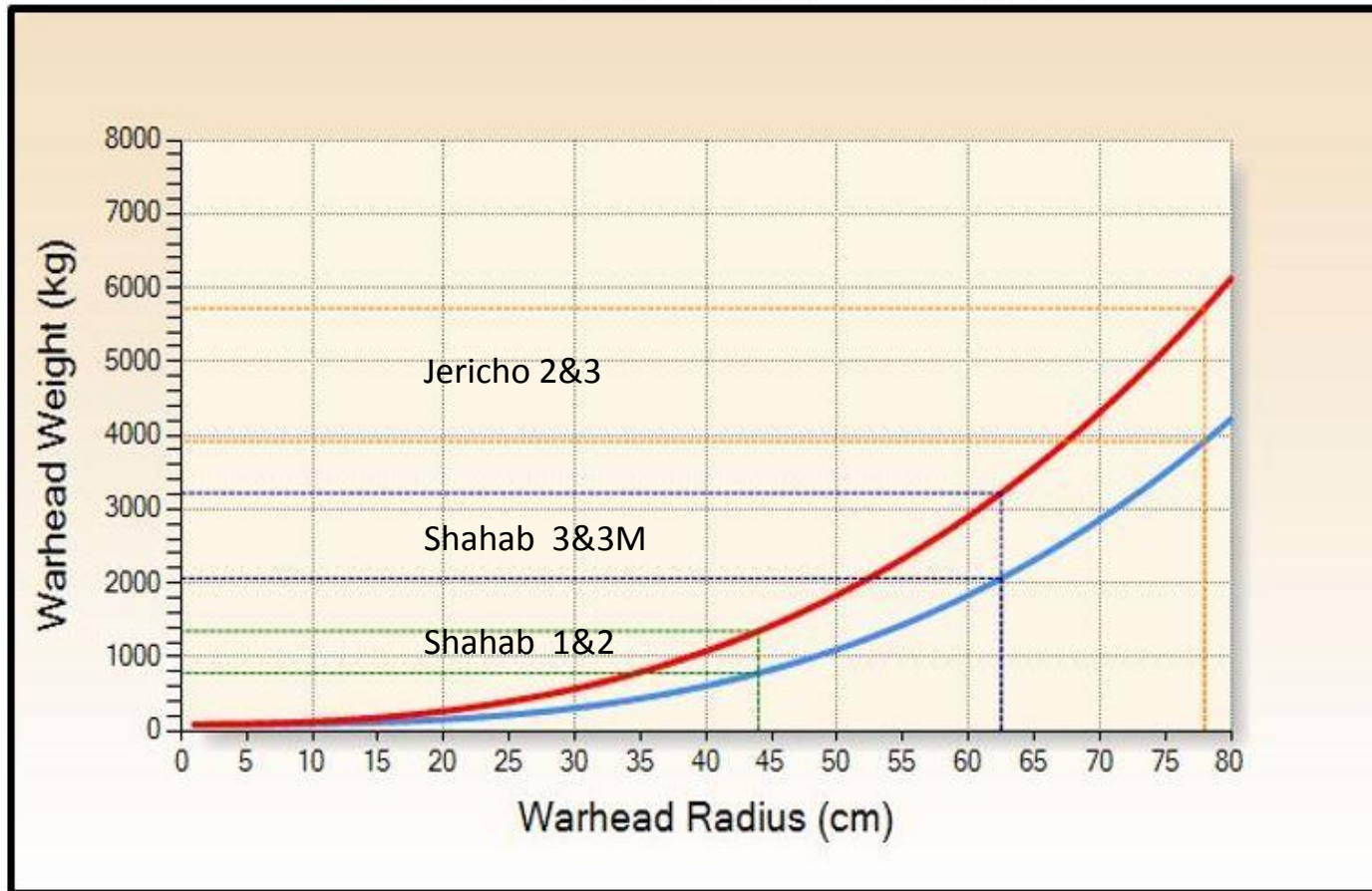
(Reference: Theodore Postol, "A Technical Assessment of Iran's Ballistic Missile Program" May 6, 2009. Technical Addendum to the Joint Threat Assessment on Iran's Nuclear And Missile Potential.)

Figure (12): Range Versus Payload of the Iranian Sejjil and Safir Two-Stage Ballistic Missiles and the SCUD-B, SCUD-C, Shahab-3 and Shahab-3M



Source: Theodore Postol, *A Technical Assessment of Iran's Ballistic Missile Program*, from "Technical Addendum to the Joint Threat Assessment on the Iran's Nuclear and Missile Potential." (JTA) May 6, 2009.

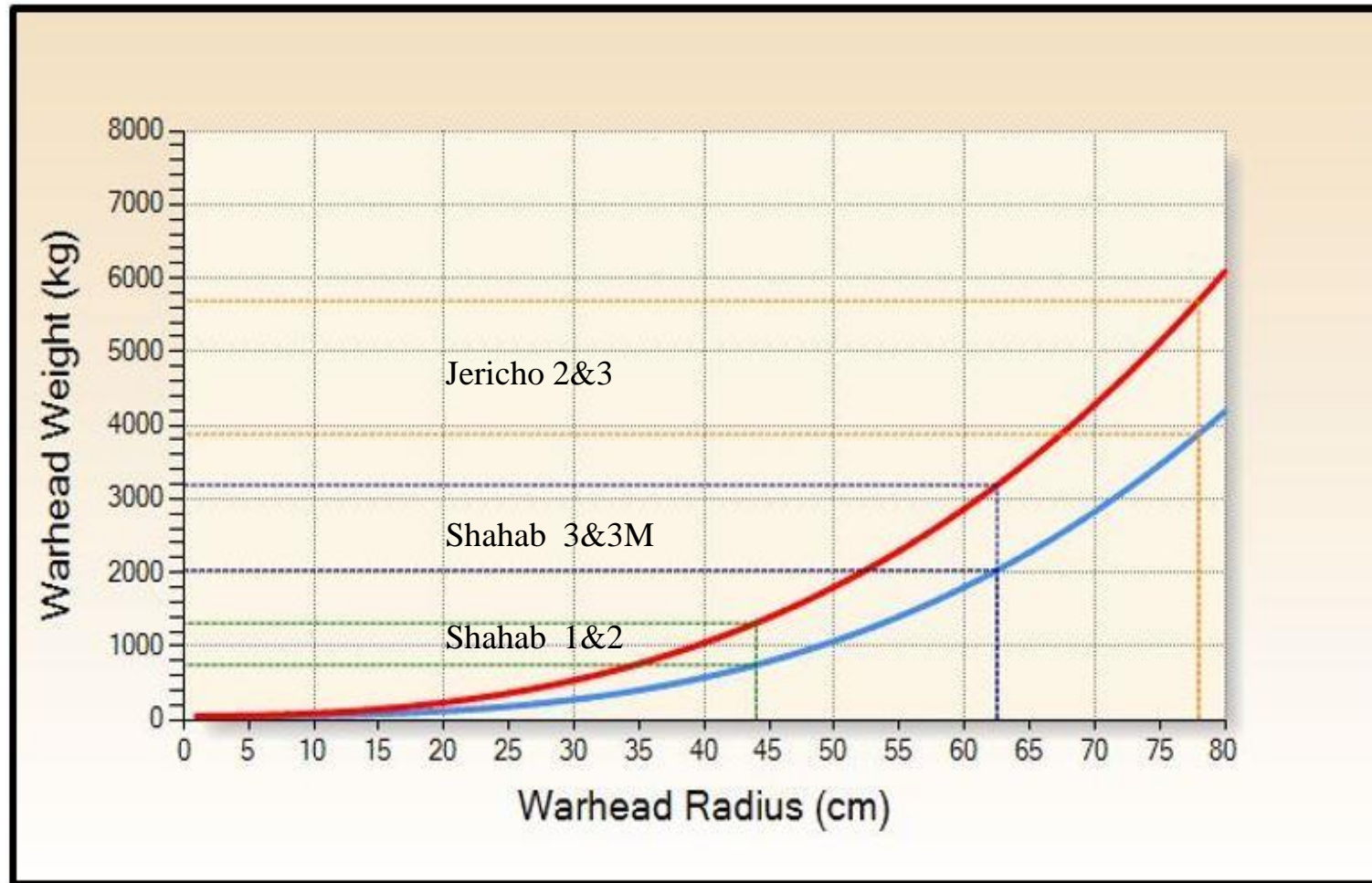
Figure (13): Maximum weight range of implosion-type device with U-235 core vs. the radius of the device



(Source: Abdullah Toukan adapted by using calculation in Appendix 2)

From figure (13) above the maximum weight of a nuclear warhead that could fit Shahab 1 & 2 missiles with 88 cm missile diameter is 750 – 1315 kg. For Shahab 3 & 3M missiles, with 125 cm missile diameter, 2030 – 3190 kg. For the Israeli Jericho 2 missile, with 156 cm diameter missile, 3880 – 5690 kg.

Figure (14): Maximum weight range of implosion-type device with PU-239 core vs. the radius of the device



(Source: Abdullah Toukan adapted by using calculation in Appendix 2)

- This model can also be used to estimate the size of implosive fission warheads made by modern emerging nuclear states, the warhead weights are then used to estimate the maximum deliverable ranges as shown in Table (3).
- A "nuclear capable" missile is defined by the MTCR as one with a payload capability in excess of 500 kg combined with a range in excess of 300 km. This definition is based on an assumption that an emerging nuclear state will be unable to build nuclear warheads weighing less than 500 kg.
- Iran has received Soviet designed Scud-B missiles and it has adapted the design into two independently-built versions; the Shahab 1 and Shahab 2. Both of which have the same diameter of 88 cm and their ranges, for 750 kg warhead, are 340 and 440 km respectively. For a 1000 kg warhead the ranges become 285 and 370 km. Even though the Shahab-1 could fit a 1000 kg warhead but it cannot reach deep into GCC territory, as shown in figure (15). Whereas the Shahab 2 nuclear capability is marginal to deliver nuclear warhead in excess of 350 km.
- Iran's Shahab 3 & 3M missiles which have a diameter of 125 cm and a range in excess of 900 km with a payload of 1,000 kg would be able to deliver a nuclear warheads to many of the Middle East capitals and targets.
- Figure (15) compares the potential ranges of the Iran Shahab missiles. If Iran launches the Shahab-3M from the Tabriz missile site, it can potentially reach Tel Aviv carrying a 20kt warhead. Whereas Israel, can by launching a Jericho 2 missile from the north of Israel, reach Tehran Figure (16).
- The Israeli Jericho 3 missile which is reported to be under development has a maximum range double that of the Jericho 2 for a 1,000 kg nuclear warhead.

Table (9): Nuclear Missile Delivery Capability for a 1,000 kg Warhead Weight

Iran Ballistic Missiles	Status	Missile warhead radius (cm)	Max weight of a nuclear device that could fit the missile (kg)	Max warhead deliverable range (km)	Missile range required to reach main targets (km)	Nuclear missile delivery capability
Shahab 1	In Service	44	750 - 1,310	285	>350	No
Shahab 2	In Service	44	750 - 1,310	370	>350	Marginal
Shahab 3	In Service	62.5	2,030 - 3,200	910	>500	Yes
Shahab 3M	In Service	62.5	2,030 - 3,200	1,150	>500	Yes
Safir	Under Development	62.5	2,030 - 3,200	1,910	>1,000	Yes
Sejjil	Under Development	62.5	2,030 - 3,200	2,160	>1,000	Yes
Israel Ballistic Missiles						
Jericho 2	In Service	78	3,880 - 5,720	1,510	>1,000	Yes
Jericho 3	Development/In Service	78	3,880 - 5,720	3,500	>1,000	Yes

Figure (15) Range vs 1000kg payload for Iranian Ballistic Missiles

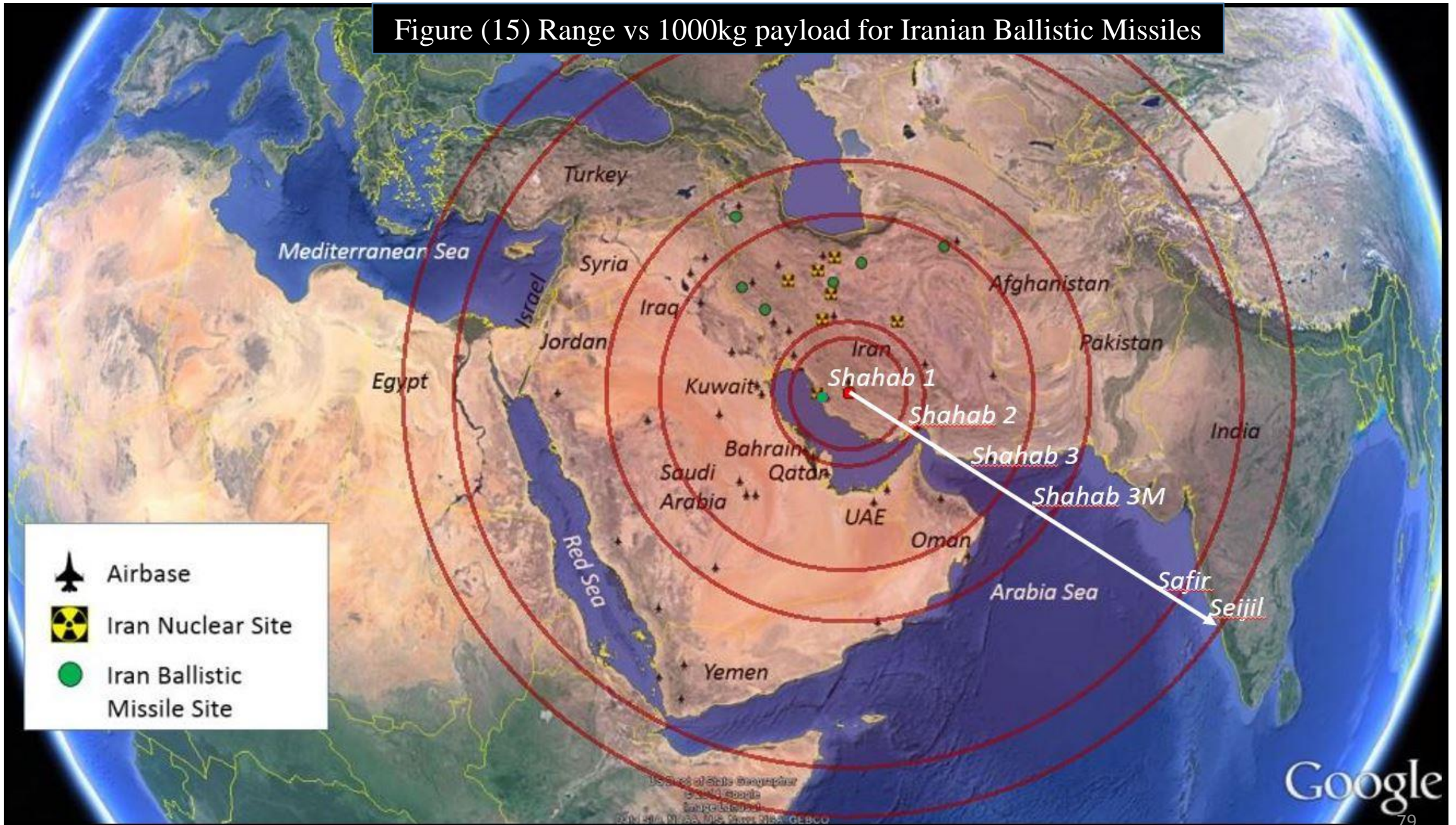


Figure (16): Shahab-3M vs Jericho-2 Range (km)



- Missiles time of flight is very short. Shorter flying times could allow a state armed with ballistic missiles to destroy the enemy's air-defense capability as well as any retaliatory capability, by targeting air defense sites, command and control centers, combat aircraft parked or in shelters, and even ballistic missile sites before the defending country could initiate a retaliatory strike. By reducing the target country's capabilities and lowering risks of retaliation can make aggression more tempting.
- Figure (18) shows the time to target over a range of 320 km, the time it takes for a typical modern aircraft is approximately 22 minutes, for a cruise missile 11 minutes compared to Ballistic Missiles which is approximately 4 minutes.

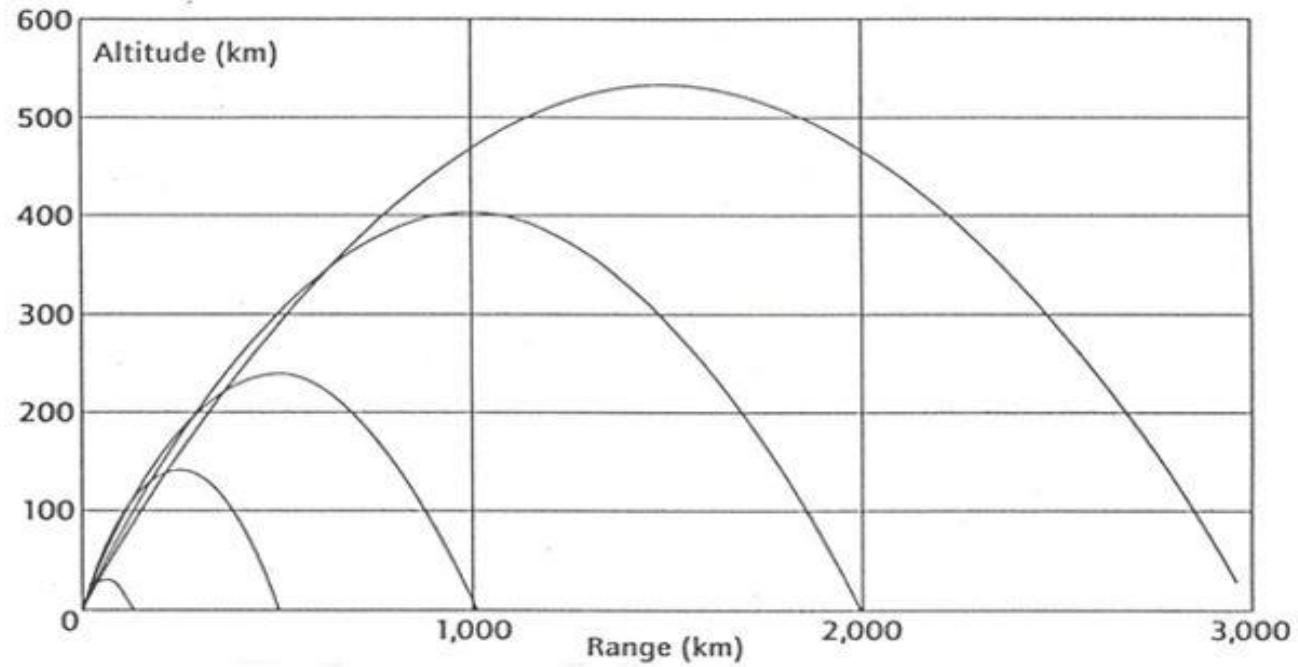
Table (10): Typical Missile Ranges and Time of Flight for a 1000kg Warhead

Missile	Missile Range (km)	Time of Flight (sec)/(min)
Shahab 1	285	300/5
Shahab 2	370	340/5.66
Shahab 3	910	490/8.12
Shahab 3M	1,150	570/9.5
Jericho 2	1,510	660/11

(Source: Abdullah Toukan)

Figure
(17):

Typical Trajectories of Theatre Ballistic Missiles (TBMs)



Range (Km)	Class	Burn-out velocity (km/sec)	Boost Phase (sec)	Flight Time (min)
120	SRBM	1.0	16	2.7
500	SRBM	2.0	36	6.1
1,000	SRBM	2.9	55	8.4
2,000	MRBM	3.9	85	11.8
3,000	MRBM	4.7	122	14.8

Figure
(18)

Missile Defense Challenge



* Based on Approximate Range of 320 Km

Responsive Missile Defense System is Crucial

(Dennis Cavin, "Counterforce Capabilities Against Cruise and Ballistic Missiles". MEMAD 14 & 15 December, 2008)

Defense against Ballistic Missiles

- Defense against ballistic missiles can only be carried out by a dedicated Ballistic Missiles Defense (BMD) System. Without a reliable Ballistic Missile Defense (BMD) against ballistic missile attack, many nations have responded to enemy missile threat by acquiring ballistic missiles themselves as a deterrent.
- Some countries enjoy advanced air defense systems that make them less vulnerable to attack by maintaining advanced Ballistic Missile Defense (BMD) Systems such as the THAAD and PAC3 to defend against their adversaries. For this reason a state may fire a number of missiles in order to increase the burden on the BMD system in the number of shots that need to be fired on the attacking missiles to achieve an 80% destruction of the Ballistic Missiles before they reach their targets.
- Iran continued its attempts to persuade Moscow to resurrect the S-300 deal that was cancelled after a UN arms embargo was imposed on the Islamic republic in 2010. The following report was posted by Missile Threat.com:

Iran Completing Domestic Version of Russian S-300

Fars News Agency

Originally published at <http://english.farsnews.com/newstext.aspx?nn=13930701001677>

Posted on September 23, 2014 by editor

“The indigenized version of the S-300 missile defense system (which is called Bavar 373 in Iran) is in the final stages of completion and will be unveiled,” Lieutenant Commander of Khatam ol-Anbia Air Defense Base for Research and Self-Sufficiency Jihad Brigadier General Mohammad Hossein Shamkhani told reporters today.

He noted that after Russia refrained from delivery of S-300 missiles to Iran under the pretext of sanctions, domestic experts began designing and building its Iranian version.

“The S-300 missile defense system comprises different parts and our experts have now made good progress for completing it,” Shamkhani said, adding, “God willingly, this missile system will be unveiled in the second military parades which will be held in future.”

Last month, senior Iranian military officials announced that their home-grown version of the Russian S-300 missile defense system, called Bavar (Belief)-373, has already been put into test-run operation and has once shot at a target successfully.

Commander of Khatam ol-Anbia Air Defense Base Brigadier General Farzad Esmayeeli told the Iranian state-run TV that “Bavar-373 has fired a first successful shot”.

“We believe that ‘Bavar’ and ‘3rd of Khordad’ missile shields are better than some other long-range missile defense systems of the country,” he added.

After Russia violated the terms of its contract with Iran on the delivery of the S-300 long-range missile defense system more than two years ago, the Iranian military said it would design and build its own version of the Russian system called Bavar (Belief)-373.

Senior military officials in Tehran announced a few months ago that the Iranian missile shield enjoys even better features than the Russian version, as it has better agility, mobility and precision capabilities and can intercept all targets in low, mid and high altitudes.

General Esmayeeli had stated in February that the Iranian missile system would have “higher capabilities than the (Russian) S-300” once it starts operation, adding that “the indigenized system will be more powerful than S-300 missile system”.

Lieutenant Commander of the Iranian Army’s Self-Sufficiency Jihad Rear Admiral Farhad Amiri said in May, 2013 that Bavar-373 missile defense system had reached the production stage and its subsystems had been tested successfully.

In 2007, Iran signed a contract worth \$800mln to buy five Russian S-300 missile defense systems. But the deal was scrapped in 2010 by then-Russian President Dmitry Medvedev, who was unilaterally expanding on sanctions against Iran imposed by the UN Security Council.

Table (11)

Combat Characteristics Vs Attacking Ballistic Missiles	S-300PMU2 "Favorit"	Antey 2500 S-300V
Number of SAM complexes to one firing unit	6	4
Missile Guidance	Illumination & Radar Command	SAR during last leg of flight
Maximum Range (km)	40	40
Minimum Range (km)	5	5
Minimum Altitude (meters)	20	25
Maximum Altitude (km)	25	30
Rate of Fire (sec)	3	1.5
Reaction Time (sec)	7 to 8	7.5
Missile Maximum Speed (meters/sec)	2,000	2,600
Number of Guided Missiles by one Launcher	4	2
Missile Warhead (kg)	180	150
Illumination and Guidance Radar:		
• Maximum Tracking Range (km)	200	200
• Number of simultaneously tracked BM targets	36	24
• Number of simultaneously guided missiles	72	70
• Maximum Speed of Tracked Target (meters/sec)	2,800	4,500
Time to deploy launcher (minutes)	5	5

US and GCC cooperation to defeat the threat Iran poses to the Gulf:

- U.S. officials are working with allies in the Gulf to develop the capability to defeat the threat Iran poses to the Gulf, allied territory, and the flow of trade and energy exports GCC countries worry that during a crisis, Iran could try to prevent their ships from traversing the Strait of Hormuz, cutting off their oil export business.
- The only effective counter-strike capability Iran has other than asymmetric warfare in the Gulf, and the use of proxies like Hezbollah, is their Ballistic Missile Force. A massive retaliation strike with whatever launching sites that have survived a U.S. first strike could still cause quite a considerable damage to the GCC states, on energy, finance and various other critical infrastructure centers.
- The U.S. is currently involved in building a Defensive Shield against a massive Iranian Ballistic Missile attack targeted at the GCC states Table (12). The defensive shield consists of a Multi-Tier Ballistic Missile Defense System consisting of Terminal High Altitude Air Defense (THAAD) and Patriot Advanced Capability, PAC-3, missile systems supported with the most advanced Radar and Command and Control facilities.
- Ballistic missile defense (BMD) systems have been provided to Kuwait, the United Arab Emirates, Qatar, Oman, and in planning for Saudi Arabia, as well as stationing Aegis-equipped warships in the waters of the Arabian Gulf. The U.S. has been developing an integrated early warning radar system across the GCC states that could help U.S. and GCC forces to quickly respond to an Iranian missile attack.

Figure (19):

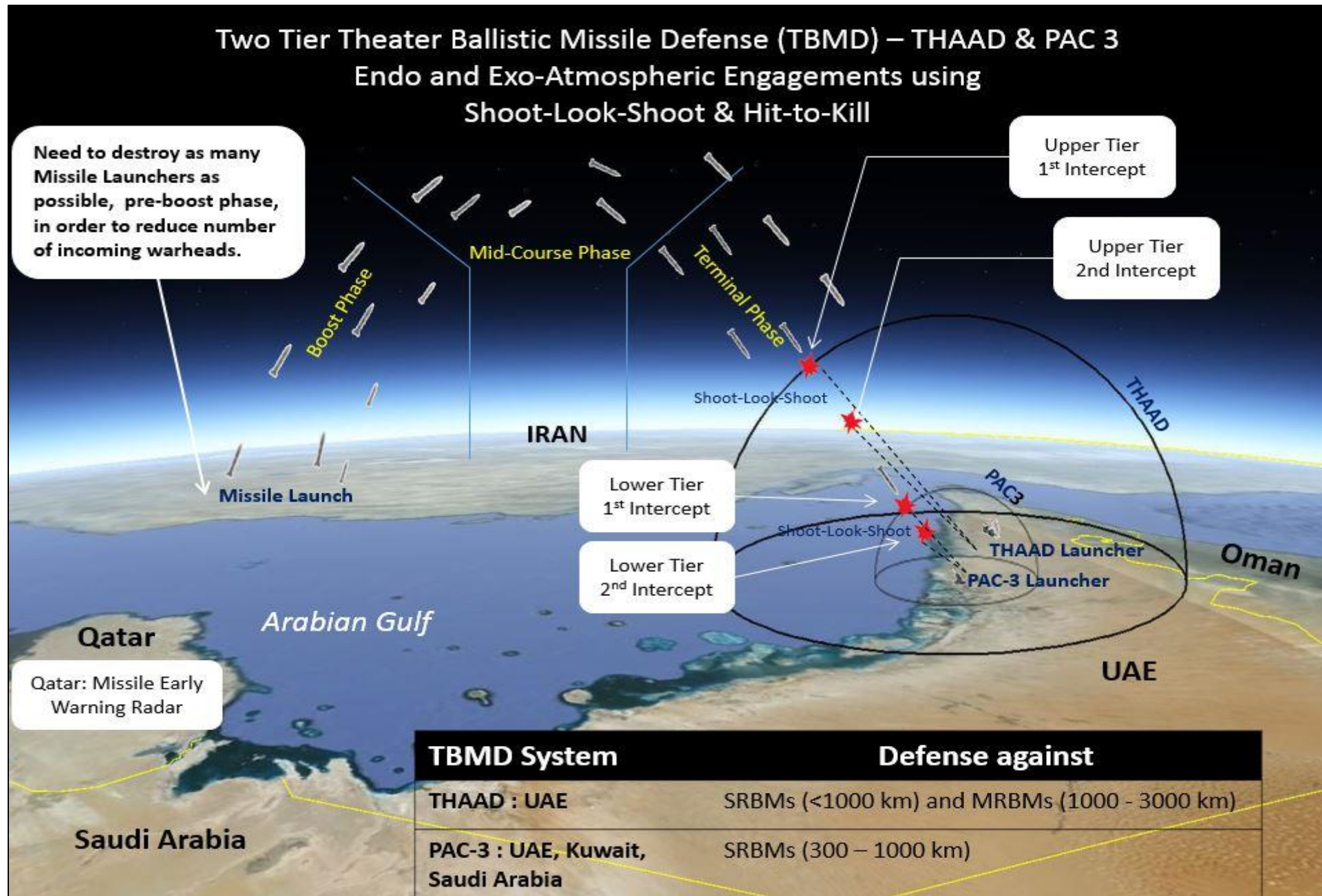


Figure (20): Defense Required to meet Performance Criteria

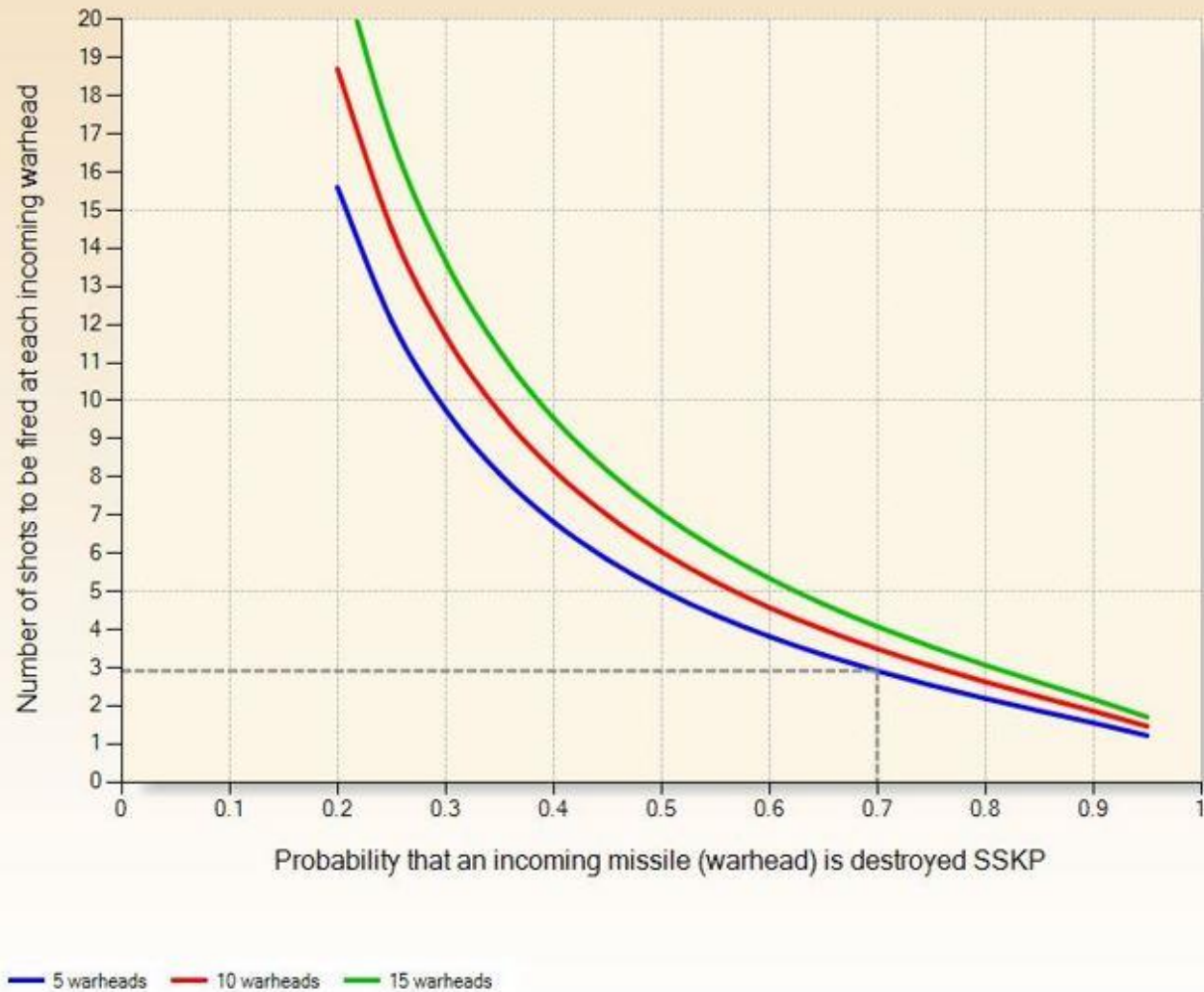


Table (12) :

Country	TBMD System
UAE	<ul style="list-style-type: none">• The UAE is so far the first GCC country to buy the Terminal High Altitude Air Defense (THAAD) missile system.• On Dec 31, 2011 Pentagon announced that the UAE will be buying 2 full THAAD batteries, 96 missiles, 2 Raytheon AN/TPY-2 radars, and 30 years of spare parts. Total Value \$3.34 billion.• In 2008 the UAE ordered Patriot PAC-3: 10 fire units, 172 missiles, First delivery 2009.
Kuwait	<ul style="list-style-type: none">• July 2012, Pentagon informed Congress of a plan to sell Kuwait \$4.2 billion in weapon systems, including 60 PAC-3 missiles, 20 launching platforms and 4 radars. This will be in addition to the 350 Patriot missiles bought between 2007 and 2010. In 1992, Kuwait bought 210 of the earlier generation Patriots and 25 launchers. Kuwait bought a further 140 more in 2007.
Saudi Arabia	<ul style="list-style-type: none">• In 2011 Saudi Arabia signed a \$1.7 billion US contract to upgrade it's Patriot anti-missile system.• U.S. is planning a \$1.75 billion Patriot Missile sale to Saudi Arabia. The Saudi government had requested the purchase of 202 Patriot Advanced Capability (PAC)-3 missiles — the most sophisticated version of the Patriot anti-missile weapons — as well as a flight test target, telemetry kits and other related equipment, the Defense Security Cooperation Agency said in a statement. (www.businessinsider.com October 1, 2014).
Qatar	<ul style="list-style-type: none">• The U.S. is building a Missile Warning Facility in Qatar that would utilize an AN/TPY-2-X Band Radar.• Qatar has selected the Lockheed Martin's PAC-3 Missile. The initial contract is for missile and command launch system production. (PRNewswire: October 15, 2014)
Oman	<ul style="list-style-type: none">• Oman set to buy a \$2.1 billion missile system (PAC-3) built by Lockheed Martin as part of a U.S. drive to install a coordinated air-defense system linking the GCC states. (UPI May 21, 2013)

(Source: Anthony Cordesman and Alexander Wilner, "Iran and the Gulf Military Balance -1" July 11, 2012)

Table (13) : Comparative Chart between PAC-3 and the S-300 BMD Systems

	PAC-3	S-300
Maximum Firing Range (km)	150	200
Maximum Range for Destruction of BM (km)	40	40
Maximum Launching Range of BM Destroyed (km)	1,000	2,500
Upper Limit of Destruction Zone (km)	30	30
Area Covered Against BM Strike (km ²)	1,200	2,500
Maximum Speed of Destroyed Target (meter/sec)	3,000	4,500
Maximum Scattering RCS of Destroyed Target (m ²)	0.05 - 1	0.02

Effects of Nuclear Weapons Exchange between Iran
and Israel

Nuclear Exchange Introduction:

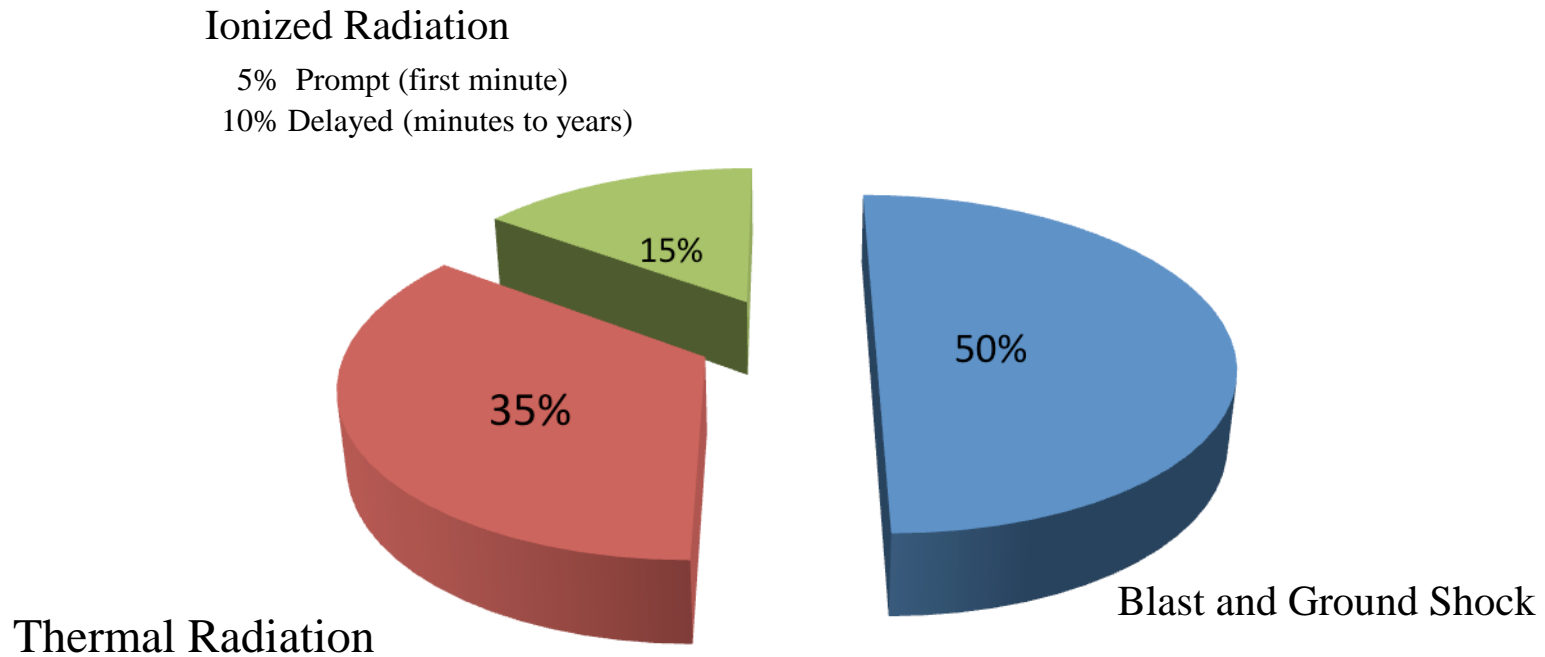
- The following section presents a brief description of the major civilian effects if a nuclear conflict between Iran and Israel takes place in the future, assuming by then that Iran has a fully operational nuclear weapons capability, and the possible broader impact on other countries in the Middle East such as Jordan and Damascus. Threat perceptions and security concerns between Israel and Iran could reach to a critical point that a nuclear exchange becomes inevitable, even if limited in nature.
- Nuclear warheads have long been targeted at population centers in addition to military targets, with the primary purpose of destroying an entire city with just one or two nuclear weapons. Actual damages are likely to be greater than that calculated in this study, due to indirect effects such as deaths resulting from injuries and the unavailability of medical attention and facilities.
- It is highly possible that in a Nuclear Missile exchange between Israel and Iran, one or two of the Iranian missiles stray off their respective flight paths and land on Amman the capital of Jordan, with the other missile landing on Damascus the capital of Syria.
- Furthermore, if a nuclear warhead missile lands in Tel Aviv, destruction will not be limited to that city but would spill out into the density of the surrounding region. This will include the West Bank and Jerusalem. The Jordan Valley, the food bowl for Jordan and Palestine, the ancient Dead Sea region and eventually to Amman itself. That is in the eventuality that a stray missile does not land in Amman itself that would shift the radius of impact and destruction further out.

- The population of Palestinians living in the West Bank (area 5,860 sq.km) is 2,731,052, giving a population density of 466 per sq. km (source: CIA Factbook 2014). In a 20KT nuclear detonation over Tel Aviv, a large % of the West Bank Palestinian population will be exposed to a radiation fallout.
- This section addresses the extent to which civilian targets will be damaged and the casualties associated with such a war. The study discounts any other consequential damages that may result for instance out of building and forest fires, the level of Civil Defense, Emergency Response Centers in the country, and the level of medial attention and readiness of hospitals to take in large casualties in a short period of time.
- The models we used to calculate fatalities and injuries are somewhat restricted to the immediate and short term effects of a nuclear weapon detonation. Clearly other effects on the society overall, the collapse of the industrial sector close to the attack area, the long term economic destruction, and the possibility that significant ecological damage has been inflicted, will unfold over the years or even generations.
- For lives to be saved immediately after a nuclear attack, it is necessary to provide food, water, electricity, medical supplies and care, hospitals, and shelter. Rescue and recovery operations conducted by an Emergency Response Center – if such centers even exist in Tehran for example, will depend heavily on their reestablishment.
- Given the dissemination of improved design and boosted weapon technology and the probable thermonuclear capability of Israel, the report consider yields 20KT, 100KT and 300KT for the Nuclear Weapons.

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:

Figure (21)



- Fireball:
 - A 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.
 - Because of the extremely high temperatures, the fireball emits thermal (or heat) radiation capable of causing skin burns and starting fires in flammable material at a considerable distance.
 - In a matter of seconds, the fireball will have reached its maximum diameter after which it starts cooling down and in a matter of minutes will have cooled sufficiently so that it no longer glows.
 - Consequently, a lengthening (and widening) column of cloud (or smoke) is produced. This cloud consists chiefly of very small particles of radioactive fission products and weapon residues. The speed with which the top of the radioactive cloud continues to rise depends on the meteorological conditions as well as the energy Yield of the weapon.
 - After the radioactive cloud attains its maximum height in a matter of minutes, it grows laterally to produce the characteristic mushroom shape. The cloud may continue to be visible for almost an hour before being dispersed by the winds into the surrounding atmosphere.

- 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).

- 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).
 - The delayed ionizing radiation is produced by fission products and neutron-induced radionuclides 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).

 - The Roentgen is a measure of exposure to gamma rays or x-rays. It is a unit of energy absorption of all kinds of nuclear radiation.
 - Dose in Rems = Dose in Rads x RBE
 - RBE: Biological Dose.
 - REM: Roentgen Equivalent in Man.

- Electromagnetic Pulse (EMP):
 - 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....

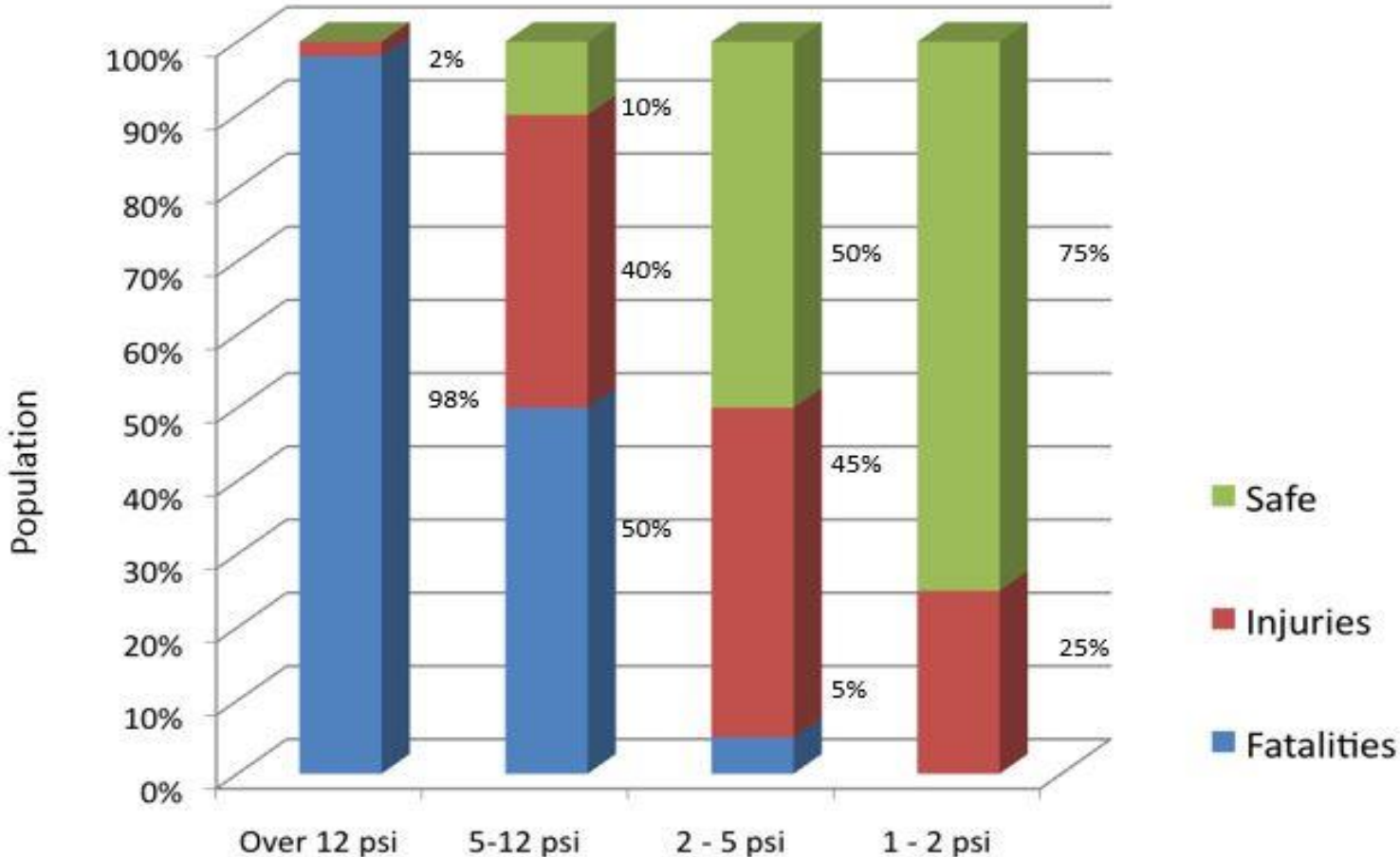
Table (14)		20 KT	100 KT	500 KT
Fireball	Elapsed time to reach maximum diameter	1 sec	1 sec	1 sec
	Maximum diameter	580 m	1,100 m	2,100 m
Thermal Radiation	Temporarily flash blindness from scattered light out to a distance of :	23 km 14 miles	26 km 16 miles	29 km 18 miles
	Individuals who directly view 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

Table (15)

Peak Overpressure (psi)	Typical Blast Effects
5	Light House Destroyed
10	Brick Housing/Commercial Building Destroyed
20	Reinforced Concrete Structures Destroyed
100-500	Nuclear Weapons Storage Bunkers
100-1,000	Command Bunkers
500 – 10,000	Missile Silos
1,000 – 10,000	Deep Underground Command Facilities

- 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 be made about the proportion of people who will be killed or injured at any given over- pressure as shown in the next slide.

Figure (22): Vulnerability of Population in Various Overpressure Zones



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

Table (16)

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

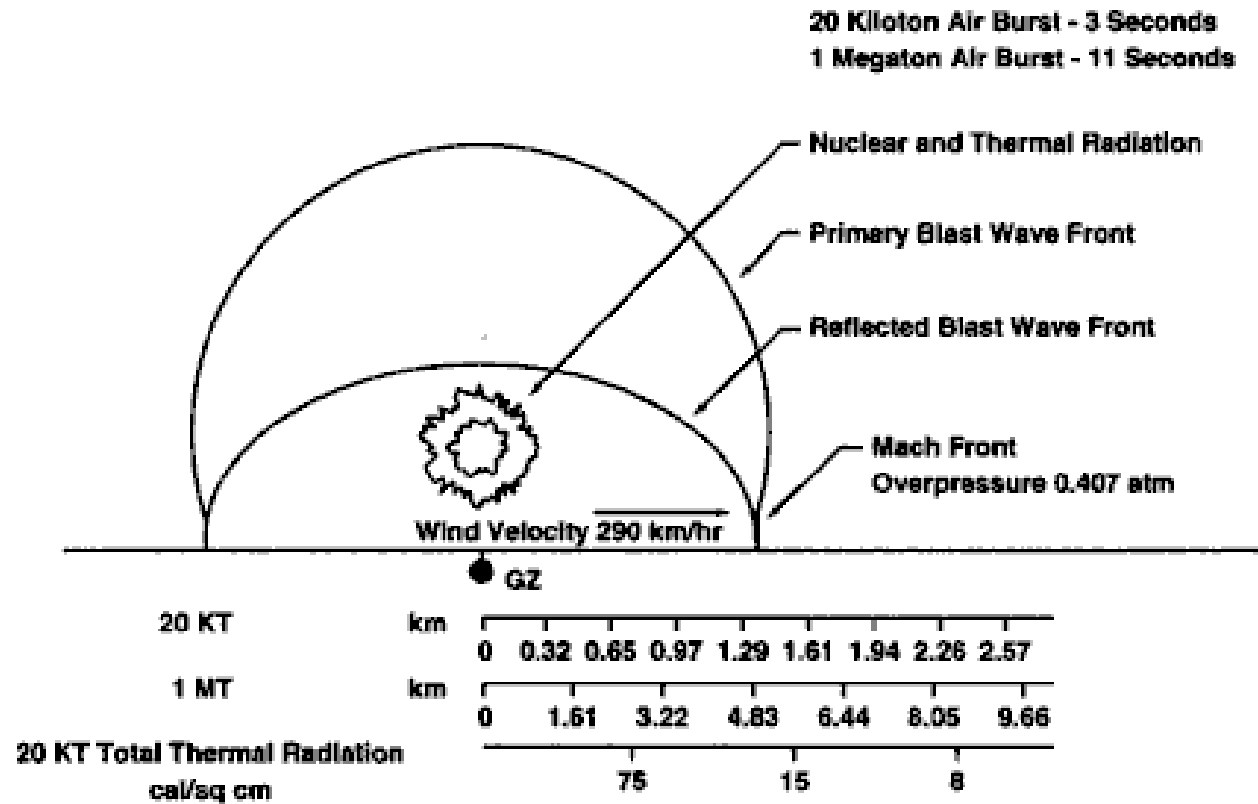
(Reference: The Effects of Nuclear War. May 1979, Congress of the United States. Office of Technology Assessment)

Table (17)
Radial Distance in meters

PSI	1kt	10kt	20kt	100kt	300kt
3	514	1,107	1,394	2,384	3,439
5	370	797	1,004	1,717	2,477
10	248	535	674	1,153	1,663
15	201	438	546	934	1,347
20	175	377	475	812	1,171
25	158	339	428	731	1,055
30	145	312	394	673	971
35	135	292	368	629	907
40	128	275	347	593	855
45	121	262	330	564	813
50	116	250	315	539	777
100	88	189	238	406	586
500	48	103	130	222	320
1000	37	80	101	173	249

(Source: Abdullah Toukan using methodology in Appendix 3)

- Acting on the human body, the shock waves cause pressure waves through the tissues. These waves mostly damage junctions between tissues of different densities (bone and muscle) or the interface between tissue and air, lungs and the gut, which contain air, are particularly injured.
- The damage causes severe hemorrhaging or air embolisms, either of which can be rapidly fatal. The overpressure estimated to damage lungs is about 68.9 kPa (10 psi). Some eardrums would probably rupture around 22 kPa (0.2 atm, 3 psi) and half would rupture between 90 and 130 kPa (0.9 to 1.2 atm, 13 to 18 psi). (1 kilopascal kPa=0.145 psi)



Chronological Development of an Air Burst

Table (18)

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)

Table (19): 50% Lethality Effectiveness
Radial Distance (km)

Yield (kt)	Blast	Ionization	Thermal Radiation
20	0.4	1.58	1.9
100	0.66	2.0	3.9
300	0.96	2.35	6.3

- Iran can launch a salvo of Shahab 3M ballistic missiles each carrying a 20kt yield warhead with the aim of having at least three penetrating Israeli defenses and landing in Tel Aviv. This would be give a higher confidence in achieving the damage required rather than trying to launch one ballistic missile with a 300kt warhead.
- Israel On the other hand has a more sophisticated technology capability that by launching a salvo of Jericho 2 ballistic missiles, each carrying a 100 or 300kt yield warhead, there would be a high confidence that three would land on Tehran.
- Blast radial distance of a 300kt to a 20 kt yield warhead is nearly 2.5 to 1, Ionization 1.5 to 1, and Thermal Radiation 3.3 to 1
- Appendix (5) addresses the effects of a 20kt and 100kt yield nuclear explosions.

Figure (23): Salvo of 3 x 20kt Nuclear Warhead Missiles launched at Tel Aviv by Iran

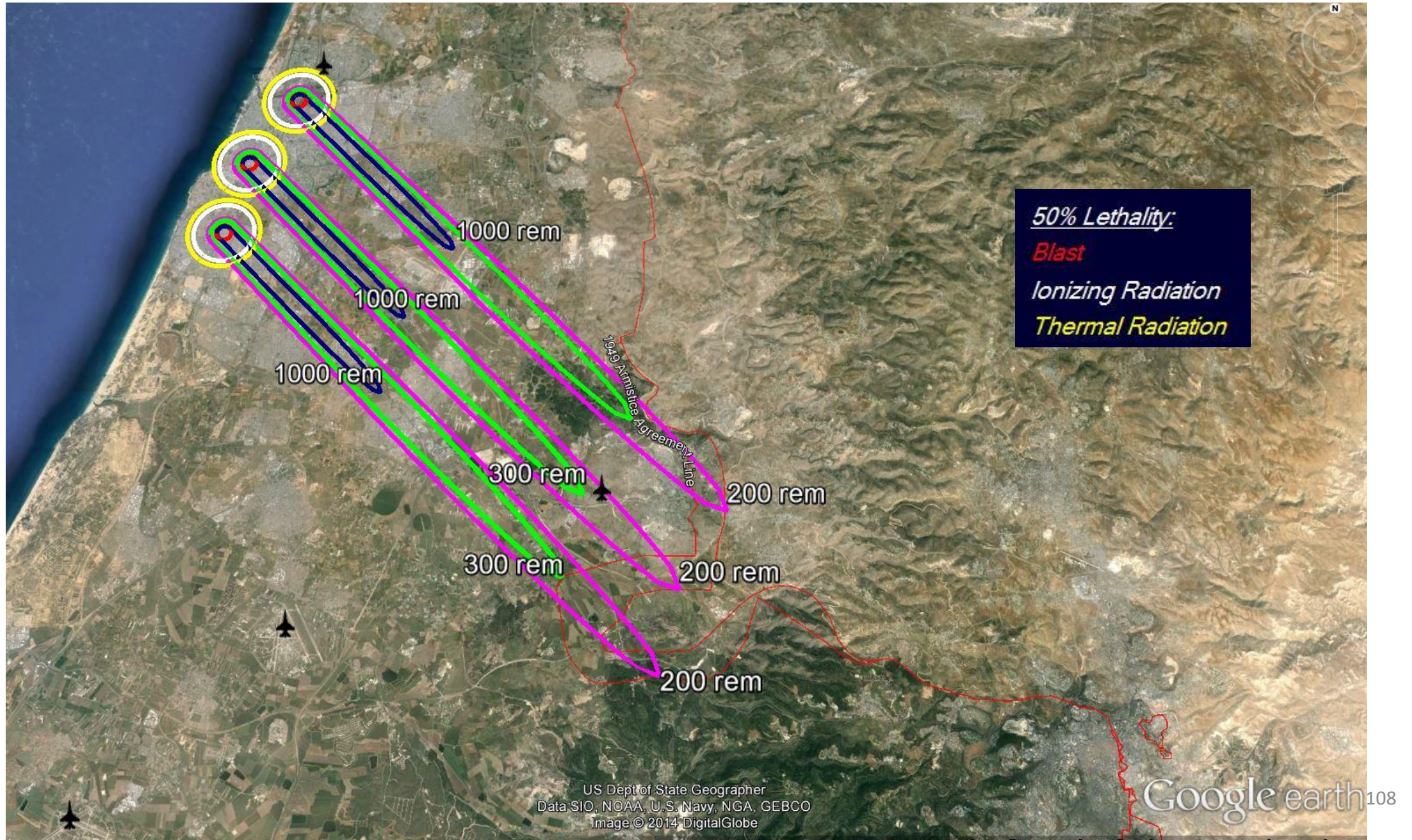


Figure (24): Salvo of 3 x 100kt Nuclear Warhead Missiles launched at Tehran by Israel

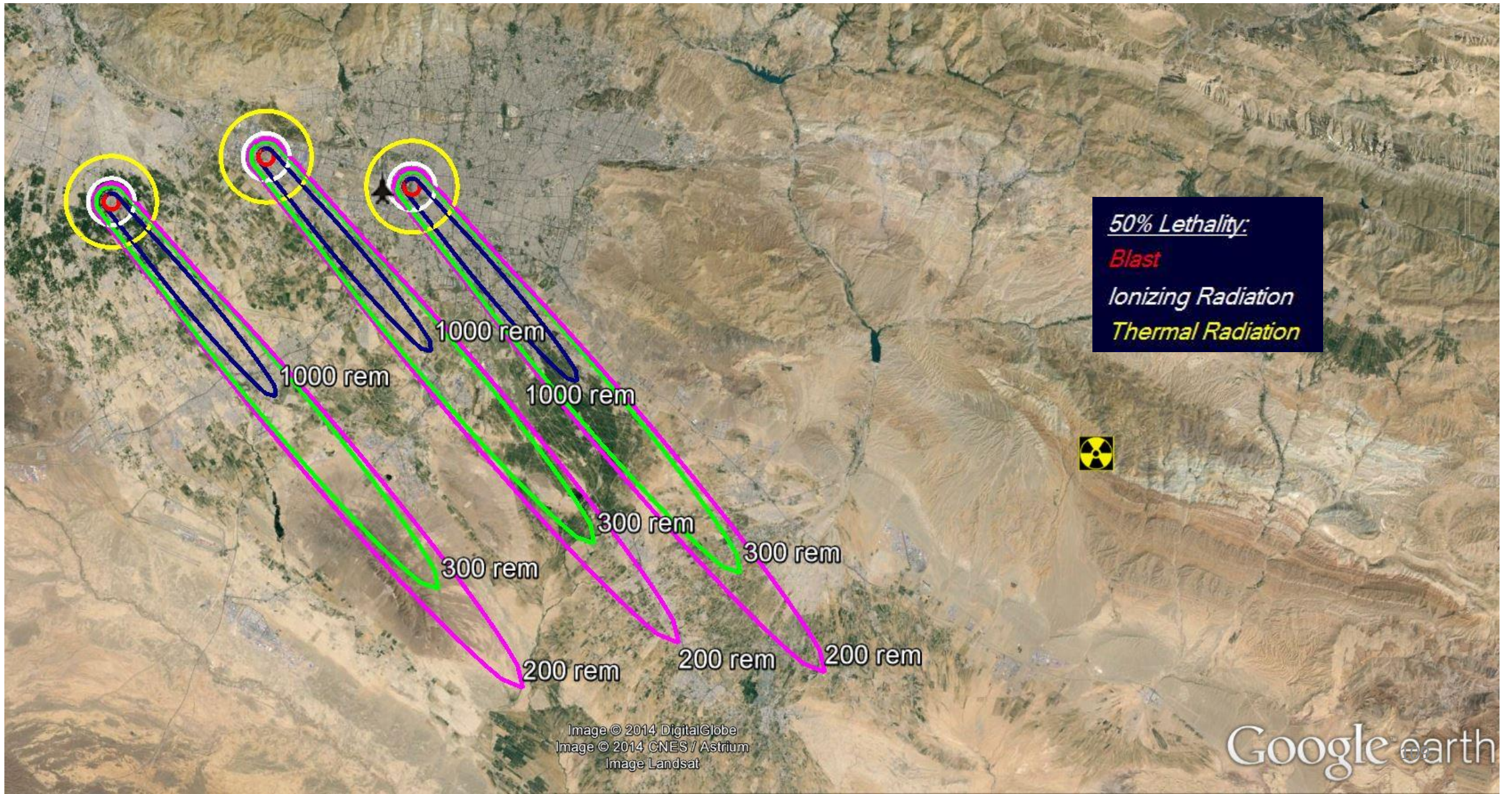


Figure (25): Salvo of 3 x 300kt Nuclear Warhead Missiles launched at Tehran by Israel

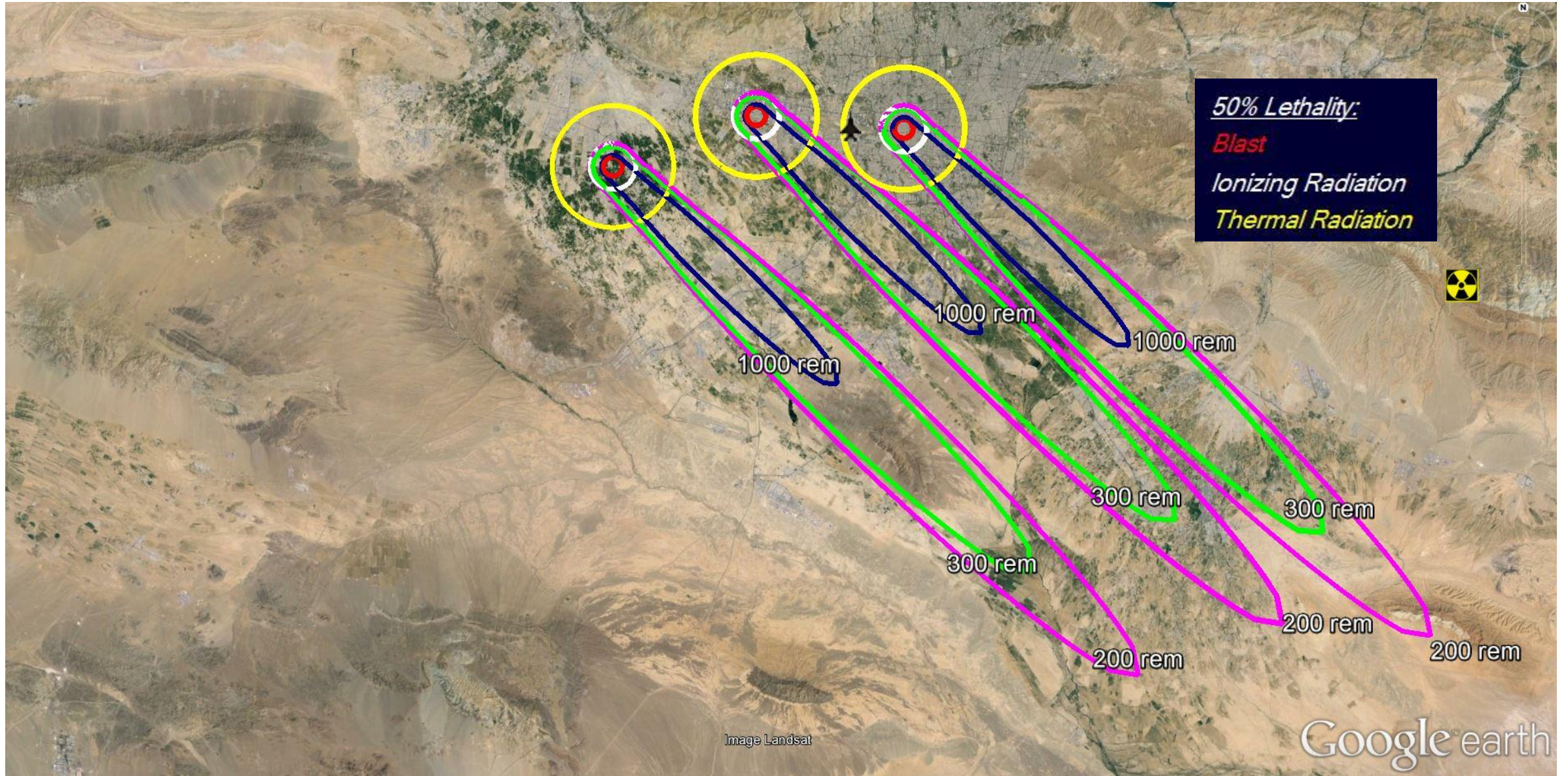
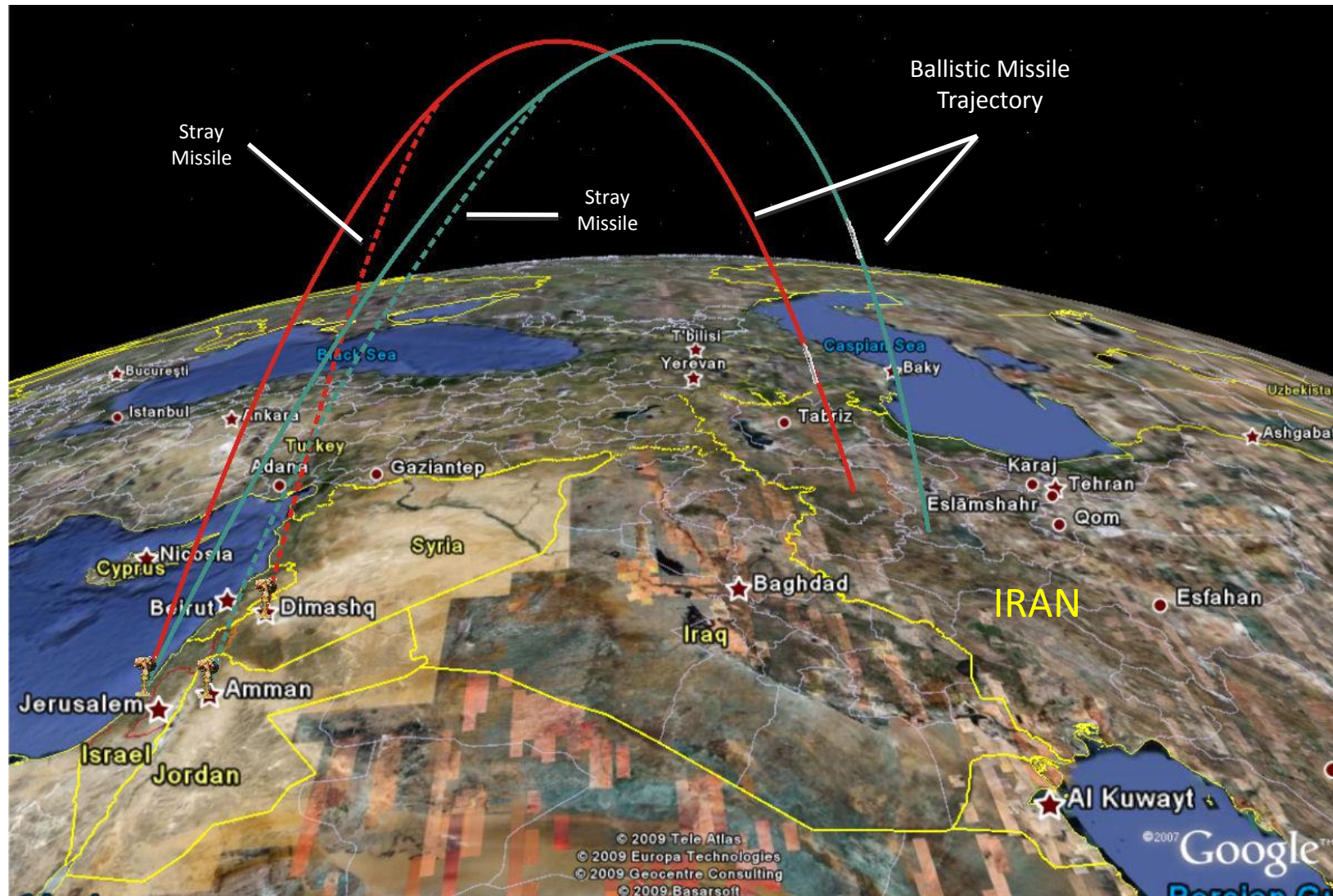


Figure (26) :Iranian Nuclear Strike at Tel-Aviv Israel
with missiles straying from the Flight Path on Amman and Damascus



Consequences if Iranian Ballistic Missiles Fall in the Jordan Valley and the Dead Sea

- The Jordan Valley is divided into several distinct geographic sub-regions. The northern part is known as the “Ghor”, and it includes the Jordan River. The region is several degrees warmer than the rest of Jordan and its year-round agricultural climate, fertile soil and water supply have made it the food basket of Jordan. Jordan’s main agricultural farms are located in the Jordan Valley.
- The Dead Sea is a salt lake some 420 meters below sea level, making it the lowest point on the surface of the earth on dry land. Its main tributary is the River Jordan. Main product produced is Potash and down stream mineral industries for health and cosmetics.
- So any missile with a nuclear warhead landing in Tel-Aviv, Israel, will affect the West Bank causing a large number of fatalities and injuries to the Palestinian inhabitants, pollute and contaminate the agricultural land and resources that lie in the Jordan Valley, and over the longer term fallout radiation reaching the outskirts of Amman, Jordan, which is some 108km from Tel Aviv.
- In addition to being affected by fallout radiation as a result of an Iranian missile landing in Tel Aviv, there is also the probability that a missile can stray away from its ballistic flight path and land in Amman, or Damascus, and even in the heart of the West Bank on the Palestinian people.

Effectiveness of the Iranian Shahab-3 missile, to inflict damage, using conventional unitary high explosive warhead.

- When an explosive munition detonates near a target, the generated blast waves impinge upon that target thereby inflicting varying degrees of damage depending upon weapon characteristics and target resistance. If the level of damage achieved is equal to or greater than the prescribed damage criteria, the target is presumed killed.
- The maximum distance from the periphery of the target at which weapon detonation will inflict the necessary damage for a kill is termed the lethal blast distance for that weapon – target combination.

Tactical Ballistic Missiles Threat:

- Iran’s ballistic missiles cover the complete spectrum range from 150 km up to 5,500 km, the Short, Medium, and Intermediate Ranges.
- Iran believes that these will compensate for any deficiencies in its Air Power.
- Deploying Ballistic Missiles against military targets would require a number that is very likely to be beyond the current Inventory in Iran.
- Since the Shahab Missile has a CEP greater than 500m which is large compared to the lethal radius of hardened structures, a large number of missiles with unitary warheads will be required to ensure destruction of such targets. However, if the missiles are used against large military bases and installations, even with missiles that have large CEPs they are likely to hit something or at least cause some form of damage and disrupt activities.
- Ballistic Missiles can also be used with success against Soft Targets, in open areas and cities to inflict maximum human casualties and create terror. In essence what is considered as a major component in Asymmetric Warfare in the form of high civilian casualties.

Figure (28): Effectiveness of Iranian missiles using conventional high unitary explosive warhead

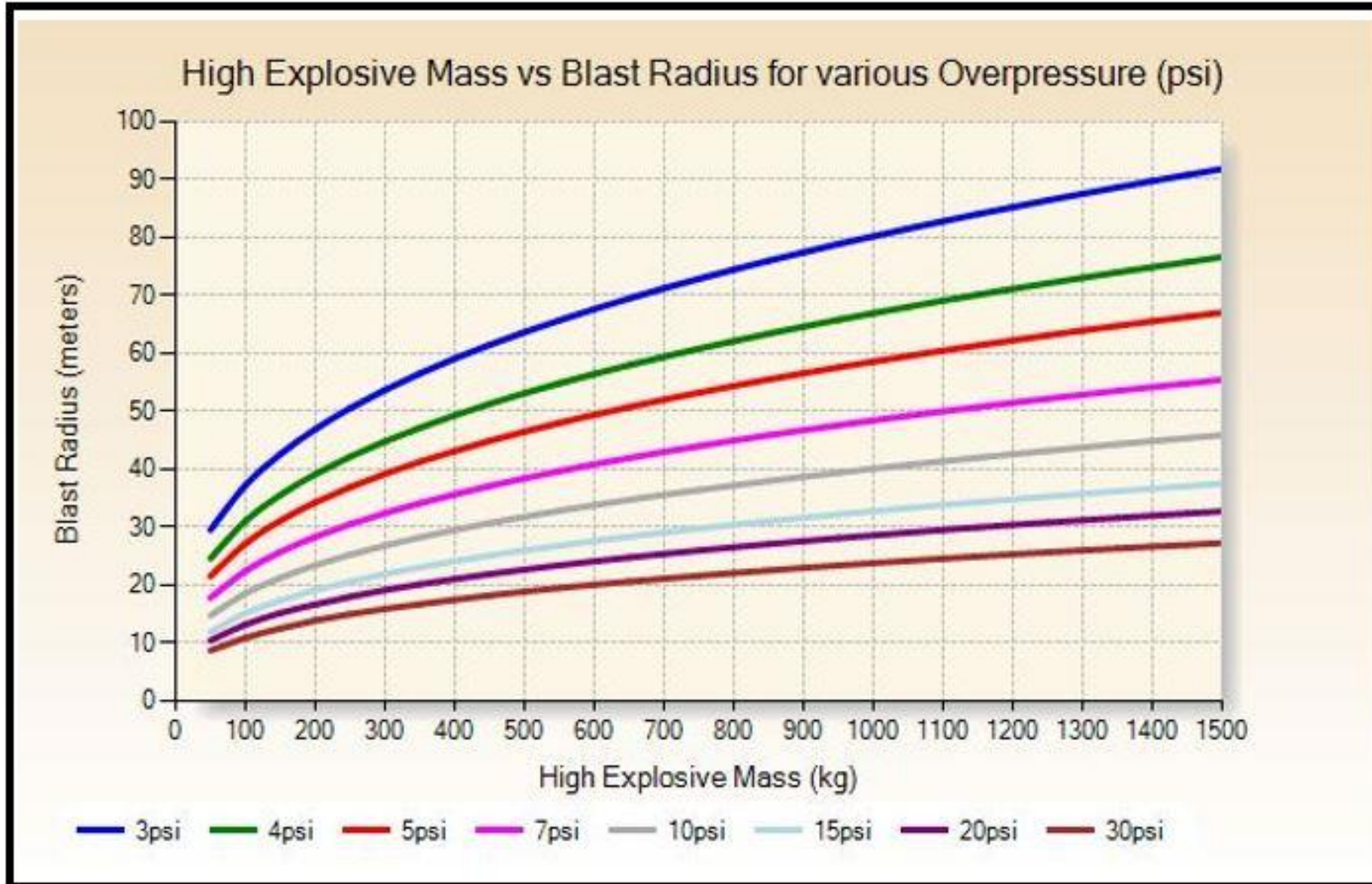
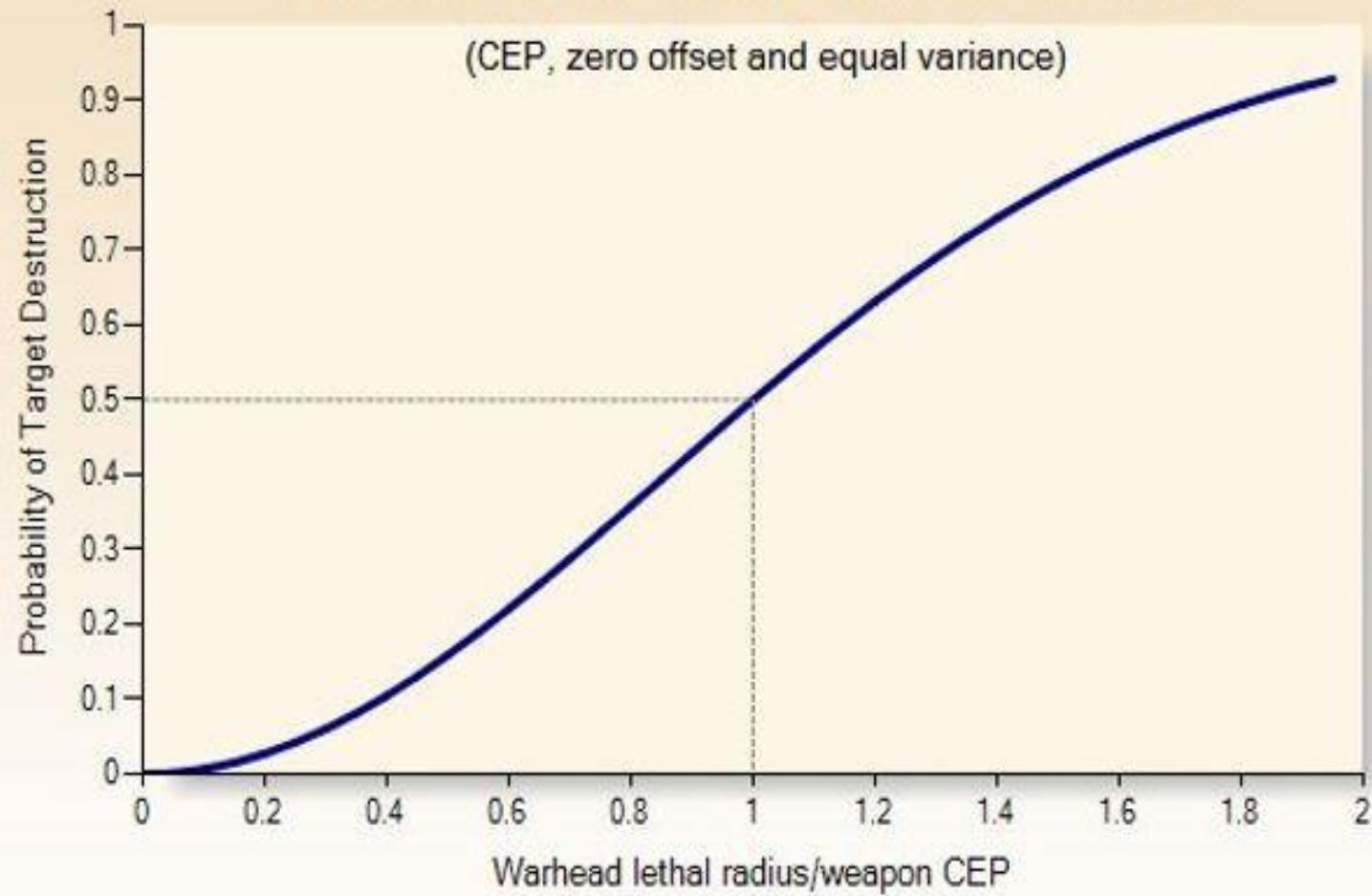


Table (20)

Target	Over Pressure	Lethal Distance MK84 2000 lb bomb with 634 kg of TNT explosives	Lethal Distance 1000 kg TNT explosive warhead
	psi	LMD (m)	LMD (m)
Radar Antenna destroyed	8	38	47
Commercial building destroyed plus 50% population fatalities	10	34	40
Light houses destroyed, 5% population fatalities and 45% injuries	5	50	58
Reinforced concrete, structures destroyed	20	24	28.5
Parked Aircraft destroyed	25	22	25
Command Centers destroyed	40	18	21

Figure (29): Guided and Unguided Weapons against Point Targets



(Source Abdullah Toukan using formula in Appendix 4)

Table (21) Major Iranian Missile Force: An Overview

	Shahab-1	Shahab-2	Shahab-3	Ghadr-1	Sejjil	Khalij Fars	Fateh-100	Zelzal-1/2/3
Payload (kg)	1000	1000-700	1000	1000-750	1000	650	500	600
CEP (m)	450-1000	50-700	190-2500	1000	Unknown	<50	100-300	100-3000
Number in Service	200-300	100-200	25-1--	25-300	Unknown	Unknown	Unknown; likely in hundreds	Unknown; likely in thousands
Fuel	Liquid	Liquid	Liquid	Liquid	Solid	Solid	Solid	Solid

(Source: Anthony Cordesman. "Iran's Rocket and Missile Forces and Strategic Options" CIS October 7, 2014)

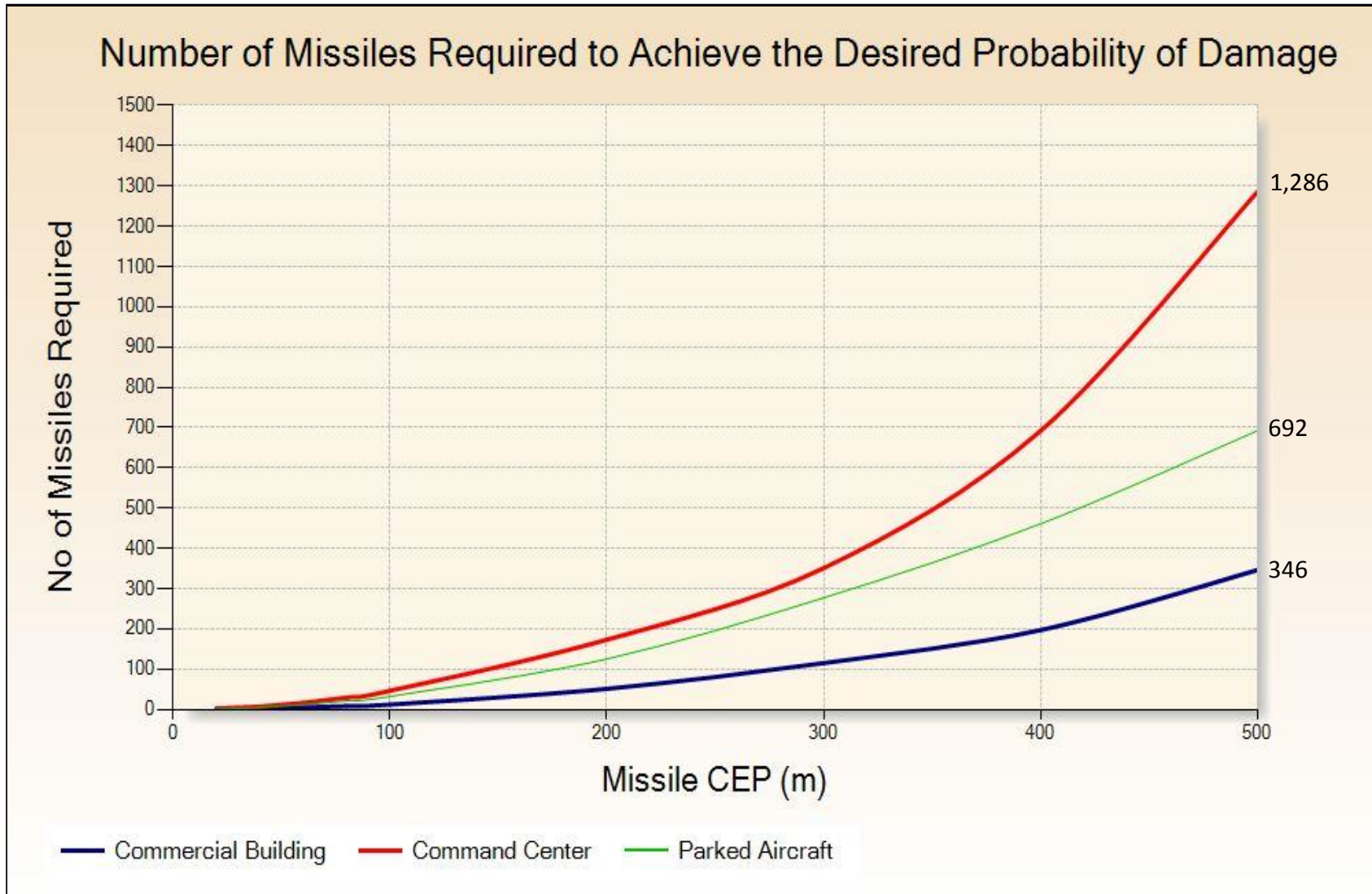
Figure (30) shows that in the best case assumption the Shahab Missile has a CEP of 500m, which is large compared to the lethal radius of hardened structures. A large number of missiles with unitary warheads will be required to ensure destruction of such targets, much more than what is reported to be in service.

A psi of 25 is required to damage parked aircraft, with a 1000 kg TNT explosive weight the weapon lethal radius is 25 meters. For a required damage of 0.75 the number of missiles required, if the CEP of the missile is 500 meter, is 692.

A psi of 40 is required to damage a reinforced command center, with a 1000 kg TNT explosive weight the weapon lethal radius is 21 meters. For a required damage of 0.75 the number of missiles required, if the CEP of the missile is 500 meter, is 1,286.

A psi of 10 is required to damage commercial building, search radar antenna, and to inflict a 50% population fatality, with a 1000 kg TNT explosive weight, the weapon lethal radius is 40 meters. For a required damage of 0.75 the number of missiles required, if the CEP of the missile is 500 meter, is 346.

Figure (30): Importance of Improving Missile CEP



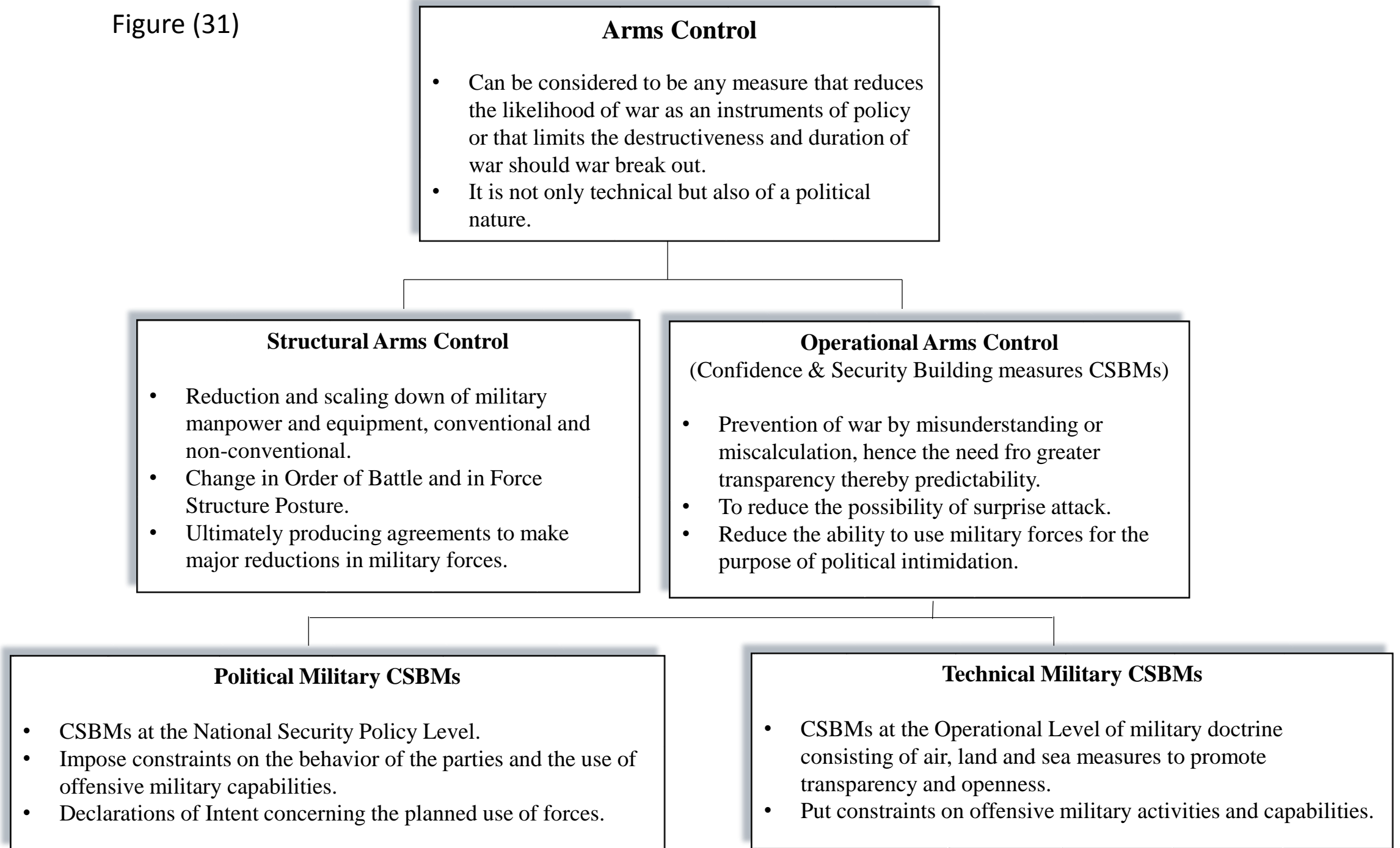
For a Command Center, if the missile CEP is reduced from 500m to around 200m the number of missiles required to achieve the desired damaged will be reduced from 1,286 down to 190, a factor of 6.

A Recommended Arms Control and Regional
Security Process for the Middle East

A Recommended Arms Control and Regional Security process in the region with Israel and Iran participating

- An arms control process, on a bilateral basis and a multilateral regional context such as the M.E. Arms Control and Regional Security (ACRS), should also be started as soon as possible. Iran was not invited to participate in the ACRS process of the 90s. A lot of groundwork was covered and it should not be difficult to reintroduce the areas and concepts that the Arab Countries negotiated with Israel. Iran can certainly benefit from all this past work and join in the negotiations as a principal participant.
- This process can start addressing Confidence and Security Building Measures (CSBMs) in both Political-Military and Technical-Military areas. Military-to-military talks and negotiations need to address military doctrines, defense postures, threat perceptions and security concerns.
- These measures can create an atmosphere and an environment that can induce disputing parties to negotiate in a less threatening environment and can remove misunderstandings and surprises. One recent example is for countries to adopt the “International Code of Conduct against Ballistic Missiles Proliferation”. This constructive engagement should take place between regional parties under a regional institutional framework.
- International arms control regimes and treaties should be strengthened. Countries need to sign and ratify the NPT, CWC and the BWC, as well as strengthening the verification and monitoring procedures that follow. Other agreements such as the Missile Technology Control Regime (MTCR), Comprehensive Test ban Treaty (CTBT) and Fissile Material Cut-Off should also be adhered to by all states and should be applied as a law in the respective countries.

Figure (31)



Examples of Technical – Military CSBMs:

- Pre-notification of certain military activities and exercises.
- Exchange of military information
- Develop Maritime CSBMs
- Establish a communications network system.

- Pre-notification of Certain Military Activities:
 - Information on yearly major exercises and large scale transfer of land forces.
 - Pre-notification of certain military activities should include the scope and thresholds.
 - The number of days in advance that a notification should take place.

- Exchange of Military Information:
 - Information on aggregate numbers on military personnel
 - Information on the administrative and organizational charts of military establishments
 - Sharing information submitted to the U.N. register
 - Information on basic threat perceptions and security concerns
 - Military contacts and dialogue for purpose of mutual familiarization and confidence building
 - Information on the acquisition of military equipment through transfer, procurement and indigenous production
 - Information on overall military holdings
 - Information on military stockpiles and storage
 - Information on defense budgets
 - Information on research and development in the military field
 - Information on the location of certain military forces
 - Information on relevant areas relating to weapons of mass destruction and their delivery systems
 - Information on the military use of outer space
 - Information on the organizational structure of force levels.
 - Establishment of a regional data base bank.

Maritime:

- A finalized operational aspects of the elements of an “Incidents at Sea Text”
- Search and Rescue
- A framework for Maritime CSBMs

Examples of Political – Military CSBMs:

- National long term objectives on arms control and regional security.
- Regional Security Environment and Threat Perceptions.
- The parties to develop a Statement on Arms Control & Regional Security.
- Delineation of the Middle East region for the purpose of arms control.
- Develop elements to start arms control negotiations.
- Dialog on Military Doctrines and Concepts of Deterrence.
- Development of a declaratory posture regarding intentions.
- Negotiations on political, economic and diplomatic actions to prevent proliferation by dissuading or impeding access to or distribution of Weapons of Mass Destruction and ballistic Missile technology, material and expertise.
- Calling on all parties to sign and ratify the NPT, CWC, BWC and other treaties such as the Comprehensive Test Ban Treaty (CTBT) and the Missile Technology Control Regime (MTCR).
- Start discussions on establishing a Weapons of Mass Destruction Free Zone (WMDFZ) in the region.
- Verification and Monitoring in Arms Control.

Regional Security

- In an Arms Control negotiations, it should be agreed that the National Security of each state will be enhanced through measures of cooperation between the other states in the region.
- A Cooperative search for security – usually referred to as Strategies of Reassurance – rather than Competitive search for security – usually referred to as Strategies of deterrence – should be the fundamental criteria for security relationship between states.
- As regional parties build their partnership in peace and work towards enhancing security of the region, each should strike a balance between Deterrence and Reassurance. Reassurance to “strengthen” the Peace, and Deterrence to “protect” the peace from any external threats. A deterrence that is based on a qualitative conventional capability for self-defense that ensures self-reliance.

Regional Security Arrangement Requirement:

- A future security arrangement that put “prevention” before “intervention” and “reaction”.
- A security arrangement that stresses preventing threats before they arise, rather than merely being prepared to respond to them militarily if and when they substantiate.
- Within this context cooperative security can integrate military and non-military measures into a comprehensive security regime framework that can organize responses to possible sources of conflict. Clearly cooperative and collective security are mutually reinforcing.

Regional Security Arrangements:

- Move from Confrontational to Cooperative Security
- Develop Codes of Conduct between states.
- Establishing an Effective Counter-Terrorism Network in the region.
- Establishing a Weapons of Mass Destruction Free Zone (WMDFZ) in the region.
- Move from Conflict Resolution & Management to Conflict Prevention.
- Establish dialogue between the Middle East and other Regional Security Frameworks; Europe; Asia, and Africa.
- Establish Regional Security Centers.

Appendix (1)

IAEA GOV/2011/65 Report by the Director General
: Possible Military Dimension

C.4. Nuclear components for an explosive device

31. For use in a nuclear device, HEU retrieved from the enrichment process is first converted to metal. The metal is then cast and machined into suitable components for a nuclear core.

32. As indicated in paragraph 5 above, Iran has acknowledged that, along with the handwritten one page document offering assistance with the development of uranium centrifuge enrichment technology, in which reference is also made to a reconversion unit with casting equipment, Iran also received the uranium metal document which describes, inter alia, processes for the conversion of uranium compounds into uranium metal and the production of hemispherical enriched uranium metallic components.

33. The uranium metal document is known to have been available to the clandestine nuclear supply network that provided Iran with assistance in developing its centrifuge enrichment capability, and is also known to be part of a larger package of information which includes elements of a nuclear explosive design. A similar package of information, which surfaced in 2003, was provided by the same network to Libya.³⁵ The information in the Libyan package, which was first reviewed by Agency experts in January 2004, included details on the design and construction of, and the manufacture of components for, a nuclear explosive device.³⁶

34. In addition, a Member State provided the Agency experts with access to a collection of electronic files from seized computers belonging to key members of the network at different locations. That collection included documents seen in Libya, along with more recent versions of those documents, including an up-dated electronic version of the uranium metal document.

³³ GOV/2008/15, para. 24.

³⁴ GOV/2008/38, para. 21.

³⁵ The same network was also the source of an unsolicited offer to Iraq in 1990 for the provision of information dealing with centrifuge enrichment and nuclear weapon manufacturing (GOV/INF/1998/6, Section B.3).

³⁶ GOV/2004/11, para. 77; GOV/2004/12, paras 30–32.

35. In an interview in 2007 with a member of the clandestine nuclear supply network, the Agency was told that Iran had been provided with nuclear explosive design information. From information provided to the Agency during that interview, the Agency is concerned that Iran may have obtained more advanced design information than the information identified in 2004 as having been provided to Libya by the nuclear supply network.

36. Additionally, a Member State provided information indicating that, during the AMAD Plan, preparatory work, not involving nuclear material, for the fabrication of natural and high enriched uranium metal components for a nuclear explosive device was carried out.

37. As the conversion of HEU compounds into metal and the fabrication of HEU metal components suitable in size and quality are steps in the development of an HEU nuclear explosive device, clarification by Iran is needed in connection with the above.

C.5. Detonator development

38. The development of safe, fast-acting detonators, and equipment suitable for firing the detonators, is an integral part of a programme to develop an implosion type nuclear device. Included among the alleged studies documentation are a number of documents relating to the development by Iran, during the period 2002–2003, of fast functioning detonators, known as “exploding bridgewire detonators” or “EBWs” as safe alternatives to the type of detonator described for use in the nuclear device design referred to in paragraph 33 above.

39. In 2008, Iran told the Agency that it had developed EBWs for civil and conventional military applications and had achieved a simultaneity of about one microsecond when firing two to three detonators together,³⁷ and provided the Agency with a copy of a paper relating to EBW development work presented by two Iranian researchers at a conference held in Iran in 2005. A similar paper was published by the two researchers at an international conference later in 2005.³⁸ Both papers indicate that suitable high voltage firing equipment had been acquired or developed by Iran. Also in 2008, Iran told the Agency that, before the period 2002–2004, it had already achieved EBW technology. Iran also provided the Agency with a short undated document in Farsi, understood to be the specifications for a detonator development programme, and a document from a foreign source showing an example of a civilian application in which detonators are fired simultaneously. However, Iran has not explained to the Agency its own need or application for such detonators.

40. The Agency recognizes that there exist non-nuclear applications, albeit few, for detonators like EBWs, and of equipment suitable for firing multiple detonators with a high level of simultaneity. Notwithstanding, given their possible application in a nuclear explosive device, and the fact that there are limited civilian and conventional military applications for such technology, Iran’s development of such detonators and equipment is a matter of concern, particularly in connection with the possible use of the multipoint initiation system referred to below.

C.6. Initiation of high explosives and associated experiments

41. Detonators provide point source initiation of explosives, generating a naturally diverging detonation wave. In an implosion type nuclear explosive device, an additional component, known as a multipoint initiation system, can be used to reshape the detonation wave into a converging smooth implosion to ensure uniform compression of the core fissile material to supercritical density.³⁹

42. The Agency has shared with Iran information provided by a Member State which indicates that Iran has had access to information on the design concept of a multipoint initiation system that can be used to

³⁷ GOV/2008/15, para. 20.

³⁸ The authors of the papers have affiliations to Malek Ashtar University and the Air Defence Industries Group of Tehran.

³⁹ “Supercritical” density is one at which fissionable material is able to sustain a chain reaction in such a manner that the rate of reaction increases.

initiate effectively and simultaneously a high explosive charge over its surface.⁴⁰ The Agency has been able to confirm independently that such a design concept exists and the country of origin of that design concept. Furthermore, the Agency has been informed by nuclear-weapon States that the specific multipoint initiation concept is used in some known nuclear explosive devices. In its 117 page submission to the Agency in May 2008, Iran stated that the subject was not understandable to Iran and that Iran had not conducted any activities of the type referred to in the document.

43. Information provided to the Agency by the same Member State referred to in the previous paragraph describes the multipoint initiation concept referred to above as being used by Iran in at least one large scale experiment in 2003 to initiate a high explosive charge in the form of a hemispherical shell. According to that information, during that experiment, the internal hemispherical curved surface of the high explosive charge was monitored using a large number of optical fibre cables, and the light output of the explosive upon detonation was recorded with a high speed streak camera. It should be noted that the dimensions of the initiation system and the explosives used with it were consistent with the dimensions for the new payload which, according to the alleged studies documentation, were given to the engineers who were studying how to integrate the new payload into the chamber of the Shahab 3 missile re-entry vehicle (Project 111) (see Section C.11 below). Further information provided to the Agency by the same Member State indicates that the large scale high explosive experiments were conducted by Iran in the region of Marivan.

44. The Agency has strong indications that the development by Iran of the high explosives initiation system, and its development of the high speed diagnostic configuration used to monitor related experiments, were assisted by the work of a foreign expert who was not only knowledgeable in these technologies, but who, a Member State has informed the Agency, worked for much of his career with this technology in the nuclear weapon programme of the country of his origin. The Agency has reviewed publications by this foreign expert and has met with him. The Agency has been able to verify through three separate routes, including the expert himself, that this person was in Iran from about 1996 to about 2002, ostensibly to assist Iran in the development of a facility and techniques for making ultra-dispersed diamonds (“UDDs” or “nanodiamonds”), where he also lectured on explosion physics and its applications.

45. Furthermore, the Agency has received information from two Member States that, after 2003, Iran engaged in experimental research involving a scaled down version of the hemispherical initiation system and high explosive charge referred to in paragraph 43 above, albeit in connection with non-nuclear applications. This work, together with other studies made known to the Agency in which the same initiation system is used in cylindrical geometry, could also be relevant to improving and optimizing the multipoint initiation design concept relevant to nuclear applications.

46. The Agency’s concern about the activities described in this Section derives from the fact that a multipoint initiation system, such as that described above, can be used in a nuclear explosive device. However, Iran has not been willing to engage in discussion of this topic with the Agency.

C.7. Hydrodynamic experiments

47. One necessary step in a nuclear weapon development programme is determining whether a theoretical design of an implosion device, the behaviour of which can be studied through computer simulations, will work in practice. To that end, high explosive tests referred to as “hydrodynamic experiments” are conducted in which fissile and nuclear components may be replaced with surrogate materials.⁴¹

48. Information which the Agency has been provided by Member States, some of which the Agency has been able to examine directly, indicates that Iran has manufactured simulated nuclear explosive components using high density materials such as tungsten. These components were said to have

⁴⁰ GOV/2008/15, Annex, Section A.2, Document 3.

⁴¹ Hydrodynamic experiments can be designed to simulate the first stages of a nuclear explosion. In such experiments, conventional high explosives are detonated to study the effects of the explosion on specific materials. The term “hydrodynamic” is used because material is compressed and heated with such intensity that it begins to flow and mix like a fluid, and “hydrodynamic equations” are used to describe the behaviour of fluids.

incorporated small central cavities suitable for the insertion of capsules such as those described in Section C.9 below. The end use of such components remains unclear, although they can be linked to other information received by the Agency concerning experiments involving the use of high speed diagnostic equipment, including flash X ray, to monitor the symmetry of the compressive shock of the simulated core of a nuclear device.

49. Other information which the Agency has been provided by Member States indicates that Iran constructed a large explosives containment vessel in which to conduct hydrodynamic experiments. The explosives vessel, or chamber, is said to have been put in place at Parchin in 2000. A building was constructed at that time around a large cylindrical object at a location at the Parchin military complex. A large earth berm was subsequently constructed between the building containing the cylinder and a neighbouring building, indicating the probable use of high explosives in the chamber. The Agency has obtained commercial satellite images that are consistent with this information. From independent evidence, including a publication by the foreign expert referred to in paragraph 44 above, the Agency has been able to confirm the date of construction of the cylinder and some of its design features (such as its dimensions), and that it was designed to contain the detonation of up to 70 kilograms of high explosives, which would be suitable for carrying out the type of experiments described in paragraph 43 above.

50. As a result of information the Agency obtained from a Member State in the early 2000s alleging that Iran was conducting high explosive testing, possibly in association with nuclear materials, at the Parchin military complex, the Agency was permitted by Iran to visit the site twice in 2005. From satellite imagery available at that time, the Agency identified a number of areas of interest, none of which, however, included the location now believed to contain the building which houses the explosives chamber mentioned above; consequently, the Agency's visits did not uncover anything of relevance.

51. Hydrodynamic experiments such as those described above, which involve high explosives in conjunction with nuclear material or nuclear material surrogates, are strong indicators of possible weapon development. In addition, the use of surrogate material, and/or confinement provided by a chamber of the type indicated above, could be used to prevent contamination of the site with nuclear material. It remains for Iran to explain the rationale behind these activities.

C.8. Modelling and calculations

52. Information provided to the Agency by two Member States relating to modelling studies alleged to have been conducted in 2008 and 2009 by Iran is of particular concern to the Agency. According to that information, the studies involved the modelling of spherical geometries, consisting of components of the core of an HEU nuclear device subjected to shock compression, for their neutronic behaviour at high density, and a determination of the subsequent nuclear explosive yield. The information also identifies models said to have been used in those studies and the results of these calculations, which the Agency has seen. The application of such studies to anything other than a nuclear explosive is unclear to the Agency. It is therefore essential that Iran engage with the Agency and provide an explanation.

53. The Agency obtained information in 2005 from a Member State indicating that, in 1997, representatives from Iran had met with officials from an institute in a nuclear-weapon State to request training courses in the fields of neutron cross section calculations using computer codes employing Monte Carlo methodology, and shock wave interactions with metals. In a letter dated 14 May 2008, Iran advised the Agency that there was nothing to support this information. The Agency has also been provided with information by a Member State indicating that, in 2005, arrangements were made in Iran for setting up projects within SADAT centres (see Section C.1 and Attachment 1), inter alia, to establish a databank for “equation of state” information⁴² and a hydrodynamics calculation centre. The Agency has also been provided with information from a different Member State that, in 2005, a senior official in SADAT solicited assistance from Shahid Behesti University in connection with complex calculations relating to the state of criticality of a solid sphere of uranium being compressed by high explosives.

⁴² An “equation of state” is a thermodynamic equation describing the state of matter under a given set of physical conditions (such as temperature, pressure, volume or internal energy).

54. Research by the Agency into scientific literature published over the past decade has revealed that Iranian workers, in particular groups of researchers at Shahid Behesti University and Amir Kabir University, have published papers relating to the generation, measurement and modelling of neutron transport.⁴³ The Agency has also found, through open source research, other Iranian publications which relate to the application of detonation shock dynamics to the modelling of detonation in high explosives, and the use of hydrodynamic codes in the modelling of jet formation with shaped (hollow) charges. Such studies are commonly used in reactor physics or conventional ordnance research⁴⁴, but also have applications in the development of nuclear explosives.

C.9. Neutron initiator

55. The Agency has information from a Member State that Iran has undertaken work to manufacture small capsules suitable for use as containers of a component containing nuclear material. The Agency was also informed by a different Member State that Iran may also have experimented with such components in order to assess their performance in generating neutrons. Such components, if placed in the centre of a nuclear core of an implosion type nuclear device and compressed, could produce a burst of neutrons suitable for initiating a fission chain reaction. The location where the experiments were conducted was said to have been cleaned of contamination after the experiments had taken place. The design of the capsule, and the material associated with it, are consistent with the device design information which the clandestine nuclear supply network allegedly provided to Iran.

56. The Agency also has information from a Member State that work in this technical area may have continued in Iran after 2004, and that Iran embarked on a four year programme, from around 2006 onwards, on the further validation of the design of this neutron source, including through the use of a non-nuclear material to avoid contamination.

57. Given the importance of neutron generation and transport, and their effect on geometries containing fissile materials in the context of an implosion device, Iran needs to explain to the Agency its objectives and capabilities in this field.

C.10. Conducting a test

58. The Agency has information provided by a Member State that Iran may have planned and undertaken preparatory experimentation which would be useful were Iran to carry out a test of a nuclear explosive device. In particular, the Agency has information that Iran has conducted a number of practical tests to see whether its EBW firing equipment would function satisfactorily over long distances between a firing point and a test device located down a deep shaft. Additionally, among the alleged studies documentation provided by that Member State, is a document, in Farsi, which relates directly to the logistics and safety arrangements that would be necessary for conducting a nuclear test. The Agency has been informed by a different Member State that these arrangements directly reflect those which have been used in nuclear tests conducted by nuclear-weapon States.

C.11. Integration into a missile delivery vehicle

59. The alleged studies documentation contains extensive information regarding work which is alleged to have been conducted by Iran during the period 2002 to 2003 under what was known as Project 111. From that information, the project appears to have consisted of a structured and comprehensive programme of engineering studies to examine how to integrate a new spherical payload into the existing payload chamber which would be mounted in the re-entry vehicle of the Shahab 3 missile.

⁴³ The modelling of neutron transport refers to the study of the motions and interactions of neutrons with materials which are used to see where they are and in what direction and at what speed they are going.

⁴⁴ For example, the shaped (hollow) charge studies said by Member States to have been carried out by the Centre for Research and Development of Explosion and Shock Technology, also known as “METFAZ”, have conventional military applications (such as for developing armour piercing projectiles), but can also be used to develop computer codes which can then be adapted to model nuclear explosives.

60. According to that documentation, using a number of commercially available computer codes, Iran conducted computer modelling studies of at least 14 progressive design iterations of the payload chamber and its contents to examine how they would stand up to the various stresses that would be encountered on being launched and travelling on a ballistic trajectory to a target. It should be noted that the masses and dimensions of components identified in information provided to the Agency by Member States that Iran is alleged to have been developing (see paragraphs 43 and 48 above) correspond to those assessed to have been used in Project 111 engineering studies on the new payload chamber.

61. During these studies, prototype components were allegedly manufactured at workshops known to exist in Iran but which Iran refused the Agency permission to visit. The six engineering groups said to have worked under Project 111 produced many technical reports, which comprise a substantial part of the alleged studies documentation. The Agency has studied these reports extensively and finds that they are both internally consistent and consistent with other supporting information related to Project 111.

62. The alleged studies documentation also shows that, as part of the activities undertaken within Project 111, consideration was being given to subjecting the prototype payload and its chamber to engineering stress tests to see how well they would stand up in practice to simulated launch and flight stresses (so-called “environmental testing”). This work would have complemented the engineering modelling simulation studies referred to in paragraph 60 above. According to the information reflected in the alleged studies documentation, within Project 111, some, albeit limited, preparations were also being undertaken to enable the assembly of manufactured components.

63. Iran has denied conducting the engineering studies, claiming that the documentation which the Agency has is in electronic format and so could have been manipulated, and that it would have been easy to fabricate.⁴⁵ However, the quantity of the documentation, and the scope and contents of the work covered in the documentation, are sufficiently comprehensive and complex that, in the Agency’s view, it is not likely to have been the result of forgery or fabrication. While the activities described as those of Project 111 may be relevant to the development of a non-nuclear payload, they are highly relevant to a nuclear weapon programme.

C.12. Fuzing, arming and firing system

64. The alleged studies documentation indicates that, as part of the studies carried out by the engineering groups under Project 111 to integrate the new payload into the re-entry vehicle of the Shahab 3 missile, additional work was conducted on the development of a prototype firing system that would enable the payload to explode both in the air above a target, or upon impact of the re-entry vehicle with the ground. Iran was shown this information, which, in its 117 page submission (referred to above in paragraph 8), it dismissed as being “an animation game”.

65. The Agency, in conjunction with experts from Member States other than those which had provided the information in question, carried out an assessment of the possible nature of the new payload. As a result of that assessment, it was concluded that any payload option other than nuclear which could also be expected to have an airburst option (such as chemical weapons) could be ruled out. Iran was asked to comment on this assessment and agreed in the course of a meeting with the Agency which took place in Tehran in May 2008 that, if the information upon which it was based were true, it would constitute a programme for the development of a nuclear weapon. Attachment 2 to this Annex reproduces the results of the Agency’s assessment as it was presented by the Secretariat to the Member States in the technical briefing which took place in February 2008.

⁴⁵ GOV/2008/15, para. 22.

Appendix (2)

Estimating the weight of an implosive devise with a
given radius

With the weights in table (A1), an estimate of the weight of an implosive device with a given radius is derived:

Table A(1)

		U-235	PU-239
Fissile material core weight (fissile core + reflector + tamper)	wo	94 kg	58 kg
Inner radius of high explosive	r	12 cm	10 cm
Density (high explosive)	ρh	1.9 g/cm ³	1.9 g/cm ³
Density (aluminum)	ρa	2.66 g/cm ³	2.66 g/cm ³
Fissile material density		18.8 g/cm ³	19.7 g/cm ³

The weight of the spherical case:

$$w_e \text{ (kg)} = (4\pi(\rho_a)/3) [(R^3 - (R-1)^3] /1000$$

R is the outer radius of the case.

The weight of the high explosive is:

$$w_h \text{ (kg)} = (4\pi(\rho_a)/3) [(R-1)^3 - r^3] /1000$$

The weight of an implosion type fission device is assumed to be between w_1 and w_2 :

$$w_1 \leq w \leq w_2$$

where

$$w_1 = w_o + w_h + w_e$$

$$w_2 = w_o + w_h + 10w_e$$

(Reference :Nuclear Missile Delivery Capabilities in Emerging Nuclear States”, li Bin, Science and Global Security, 1997, Volume 6, pp311-331)

Appendix (3)

The Defense Nuclear Agency (DNA) 1-kiloton free-air overpressure standard

1. Free-Air Equations for Blast

INPUT	OUTPUT
ALT—Altitude (m); model limits: 0 to 25,000	SP—Altitude scaling factor for pressure
Y—Weapon Yield (kT); model limits: 0.1 to 25,000	SD—Altitude scaling factor for distance
RANGE—Range (m); model limits: (16 · Y ³ · SD) to (4000 · Y ³ · SD) where Y ₃ = Y ^{1/3} and SD is the altitude scaling factor.	ST—Altitude scaling factor for time
	C—Altitude-dependent speed of sound (m/s)
	PFREE—Free-air peak overpressure (Pa)
	QFREE—Free-air dynamic overpressure (Pa)
	TAFREE—Free-air time of arrival (s)

1.1 Altitude Scaling Factors (SP, SD and ST): For $0 \leq ALT < 11,000$, the altitude scaling subfactors are:

$$T = 1 - (2 \cdot 10^9)^{-0.5} \cdot ALT \quad [1] \text{ and } [2]$$

$$P = T^{5.3}$$

For $11,000 \leq ALT < 20,000$, the altitude scaling subfactors are:

$$T = 0.7535 \cdot [1 + (2.09 \cdot 10^{-7}) \cdot ALT] \quad [3] \text{ and } [4]$$

$$P = 1.6^{0.5} \cdot [1 + (2.09 \cdot 10^{-7}) \cdot ALT]^{-754}$$

For $20,000 \leq ALT$ the altitude scaling subfactors are:

$$T = 0.684 \times [1 + (5.16 \times 10^{-6}) \cdot ALT] \quad [5] \text{ and } [6]$$

$$P = 1.4762 \times [1 + (5.16 \times 10^{-6}) \cdot ALT]^{-33.6}$$

The altitude scaling factors for pressure, distance and time are

$$SP = P [7]; \quad SD = SP^{-1/3} [8]; \quad ST = SD \cdot T^{-0.5} [9]$$

The altitude-dependent speed of sound is (rule of thumb: C increases 1.8% for each 10°C rise above 15°C):

$$C = (340.5)SD / ST [10]$$

1.2 Overpressure, Dynamic Pressure, and Blast Wave Time of Arrival: Scale the range by the altitude scaling factor for distance and also the weapon yield:

$$R = (\text{RANGE}) / (\text{SD} \cdot Y^{1/3}) \quad \mathbf{[11]}$$

The Defense Nuclear Agency (DNA) 1-kiloton free-air overpressure standard is given by the expression:

$$\Delta P_{DNA} = \frac{3.04 \cdot 10^{11}}{R^3} + \frac{1.13 \cdot 10^9}{R^2} + \frac{7.9 \cdot 10^6}{R \left(\ln \left[\frac{R}{445.42} + 3 \exp \left[\frac{-1}{3} \sqrt{\frac{R}{445.42}} \right] \right] \right)^{1/2}} \quad \mathbf{[12]}$$

The free-air peak overpressure is simply: $\Delta P_{FREE} = \Delta P_{DNA}$ **[13]**

The free-air peak overpressure at altitude is: $\Delta P_{FREE} = \Delta P_{FREE} \cdot SP$ **[14]**

(Reference: "Nuclear War Plan: A Time for Change". Mathew G. McKinzie, Thomas B. Cochran, Robert S. Norris, William M. Arkin. Natural Resources Defense Council June 2001.)

The curve in Fig. 3.72 shows the variation of peak overpressure with distance for a 1 KT free air burst in a standard sea-level atmosphere.

Scaling. For targets below 5,000 feet and for burst altitudes below 40,000 feet, the range to which a given peak overpressure extends for yields other than 1 KT scales as the cube root of the yield, i.e.,

$$D = D_1 \times W^{1/3},$$

where, for a given peak overpressure, D_1 is the distance (slant range) from the explosion for 1 KT, and D is the distance from the explosion for W KT.

Source: The Effects of Nuclear Weapons.
Compiled and edited by Samuel Gladstone and
Philips J. Dolan. 3rd Edition.

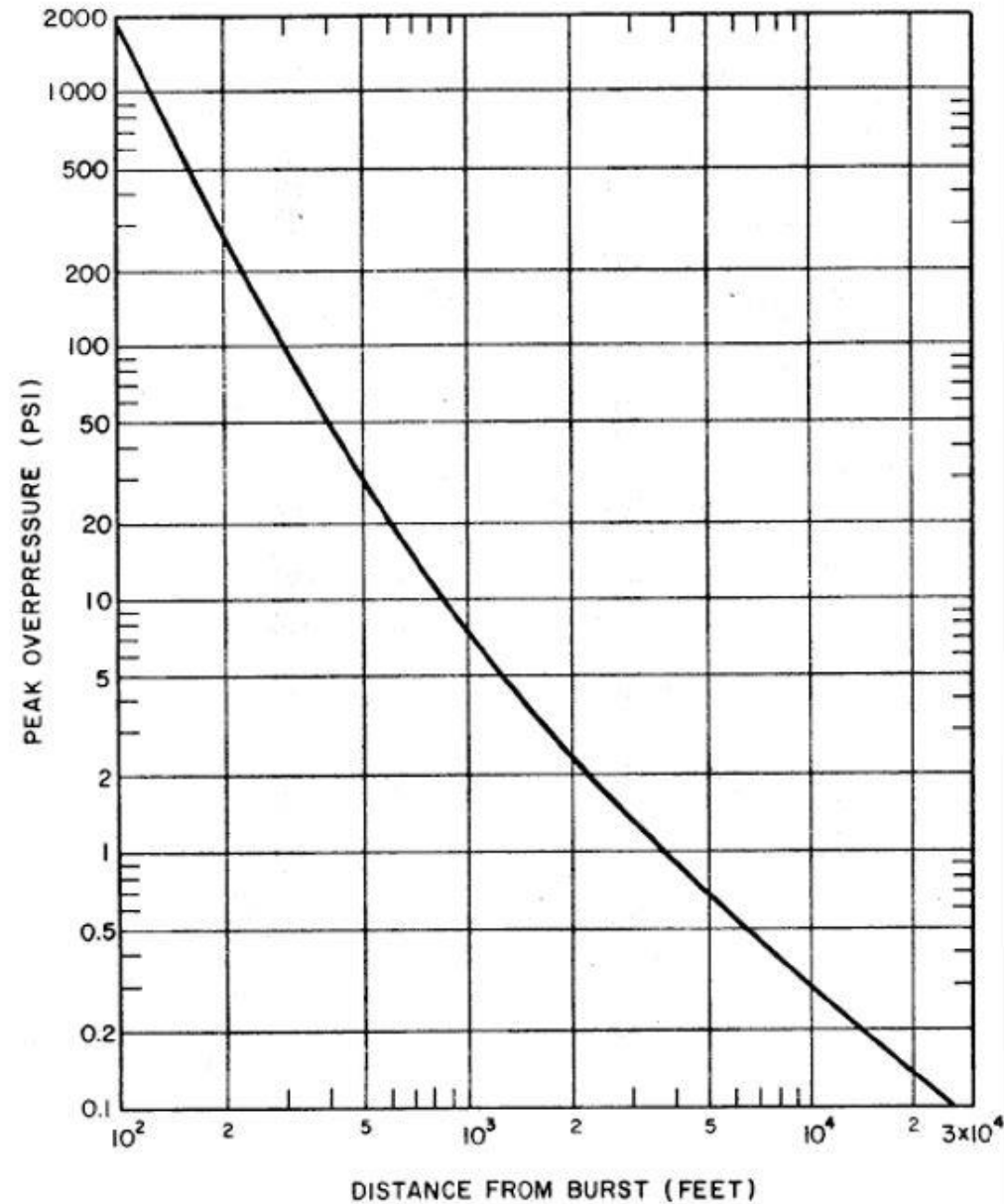


Figure 3.72. Peak overpressure from a 1-kiloton free air burst for sea-level ambient conditions.

Appendix (4)

Probability of Hitting a Circular Target When Aim
Error is Zero and Dispersion is Circular Normal

2.12 Probability of Hitting a Circular Target When Aim Error is Zero and Dispersion is Circular Normal

Key Words: Indirect Fire, Circular Target

Abstract: This algorithm estimates the probability that a specific target will be hit by a round fired from a weapon with no aim error and a circular normal dispersion.

Principal Assumptions:

- A cookie cutter weapon with lethal radius R is used.
- The impact pattern has a circular normal distribution, thus $\mu_x = \mu_y = 0$, $\sigma_x = \sigma_y = \sigma$, and $\sigma_{xy} = 0$.
- There is no bias in aiming, thus $\mu_u = \mu_v = 0$ and $\sigma_u = \sigma_v = 0$.

Algorithm: P_{hit} is solely a function of the distance r between the impact point of the weapon and the center of the target. Thus

$$P_{hit} \text{ (at } r) = \frac{r}{\sigma^2} \exp\left(\frac{-r^2}{2\sigma^2}\right). \quad [2.12-1]$$

This is a Rayleigh distribution. It is closely related to the exponential distribution which is the probability density function of $x^2 + y^2 = r^2$. P_{hit} can be written in closed form as

$$P_{hit} = \int_0^R \frac{r}{\sigma^2} \exp\left(\frac{-r^2}{2\sigma^2}\right) dr$$

thus

$$P_{hit} = 1 - \exp\left(\frac{-R^2}{2\sigma^2}\right). \quad [2.12-2]$$

If we use the Circular Error Probable (CEP) ($= 1.774\sigma$ for a circular normal distribution), this equation can be expressed in terms of R and CEP as

$$P_{hit} = 1 - (0.5)^{(R/CEP)^2} \quad [2.12-3]$$

because $\frac{R^2}{2\sigma^2} = \left[\frac{R^2}{CEP^2} \right] \left[\frac{CEP^2}{2\sigma^2} \right]$ and $\exp\left(\frac{-CEP^2}{2\sigma^2}\right) = 0.5$

(e.g., when $R = CEP$, $P_{hit} = 0.5$).

Data Inputs:

- Radius of target
- Circular error probable (CEP) ($CEP = 1.1774\sigma$) or dispersion parameter of weapon, σ

- Probability of damage/kill that a missile will inflict on a target is generally written as the product of:
 - Pd : probability of overall damage
 - Pl : probability of successful missile launch
 - Ps : probability of survival during flight
 - Pp : probability of successfully penetrating the defense
 - Ph : Probability of hit
- Pd = Pl x Ps x Pp x Ph
- Probability of launch failure could result from fuel related, since the Shahab missile is a liquid propellant, or could be mechanical failure prior to take off.
- Probability of survival during flight is a measure of the reliability of the missile during flight. For example the missile does not break-up after launch.
- Probability of penetration is a measure of the missile successfully penetrating the ground based air defense in the target area. Ballistic missiles have a higher probability of penetration compared to conventional combat aircraft, mostly due to the speed of the missile. Aircraft are much slower to reach the target area and can be detected at a very early stage of the flight path.
- Probability of hit is the probability that the missile lands within a lethal distance (lethal miss distance LMD) from the target. The formula to calculate Ph is shown in the next slide.

Appendix (5)

Effects of a 20kt and 100kt yield nuclear weapons

20 Kiloton Nuclear Explosion

- Fireball:
 - The 20.0 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 580 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 20 KT explosion could produce temporarily flash blindness from scattered light out to a distance of distance of 23 km (14 miles).
 - Individuals who directly view the initial fireball could experience retinal burns to a distance of 25 km (about 16 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).

(Source: Lawrence Livermore National Laboratory. HOTSPOT Health Physics Codes. Livermore California)

- 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 1.6 km (0.98 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 9 km (6 miles).
 - The idealized maximum width of the fallout footprint is about 0.47 km (0.29 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).
 - The 50% lethality contour width increases to about 1.2 km (0.80 miles).

- Electromagnetic Pulse (EMP):
 - The EMP range for the 20.0 KT detonation is approximately 5 km (approximately 3 miles). 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.

(Source: Lawrence Livermore National Laboratory. HOTSPOT Health Physics Codes. Livermore California)

20 KT Nuclear Explosion Effects

Range (km)	Blast Peak Overpressure (psi)	Prompt Neutron (rad-eq)	Prompt Gamma (rad)	Total Prompt Ionizing Radiation (rad-eq)	Thermal @ Visibility 40km (cal/cm2)	Cloud Arrival Time	Actual Dose Rate @ Cloud Arrival Time (rem/hr)
0.2	155	3.6E+06	2.7E+05	3.8E+06	7.0E+02	<1 min	5.4E+05
0.5	18	2.6E+05	4.1E+04	3.0E+05	1.1E+02	1 min	1.8E+05
1.0	5	5.6E+03	3.0E+03	8.6E+03	2.6E+01	3 min	7.9E+04
2.0	1.8	1.2E+01	2.1E+01	3.3E+01	5.9E+00	6 min	3.4E+04
4.0	Minimal	Minimal	Minimal	-	1.2E+00	13 min	1.5E+04
6.0	Minimal	Minimal	Minimal	-	4.4E-01	19 min	0.5E+04
8.0	Minimal	Minimal	Minimal	-	2.0E-01	26 min	0.2E+04
10.0	Minimal	Minimal	Minimal	-	1.1E-01	33 min	0.11E+04
20.0	Minimal	Minimal	Minimal	-	0.097E-01	1 hr 6 min	1.8E+02
40.0	Minimal	Minimal	Minimal	-	0.0033E-01	2 hr 13 min	0.32E+02

100 Kiloton Nuclear Explosion

- Fireball:

- The 100.0 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 1100 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 100 KT explosion could produce temporarily flash blindness from scattered light out to a distance of distance of 26 km (16 miles).
- Individuals who directly view the initial fireball could experience retinal burns to a distance of 30 km (about 19 miles).
- Unprotected individuals could receive in excess of the thermal radiation dose required for third degree burns, out to a distance of 3.9 km (2.4 miles).

(Source: Lawrence Livermore National Laboratory. HOTSPOT Health Physics Codes. Livermore California)

- 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 2.0 km (1.24 miles).
 - The delayed ionizing radiation is produced by fission products and neutron-induced radionuclides 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 13 km (8 miles).
 - The idealized maximum width of the fallout footprint is about 0.78 km (0.49 miles).
 - For individuals remaining in the contamination for the first 24 hours, the downwind extent of the 50% lethality contour increases to approximately 22 km (21 miles).
 - The 50% lethality contour width increases to about 3.1 km (1.9 miles).

- Electromagnetic Pulse (EMP):
 - The EMP range for the 100.0 KT detonation is approximately 6 km (approximately 4 miles). 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.

100 KT Nuclear Explosion Effects

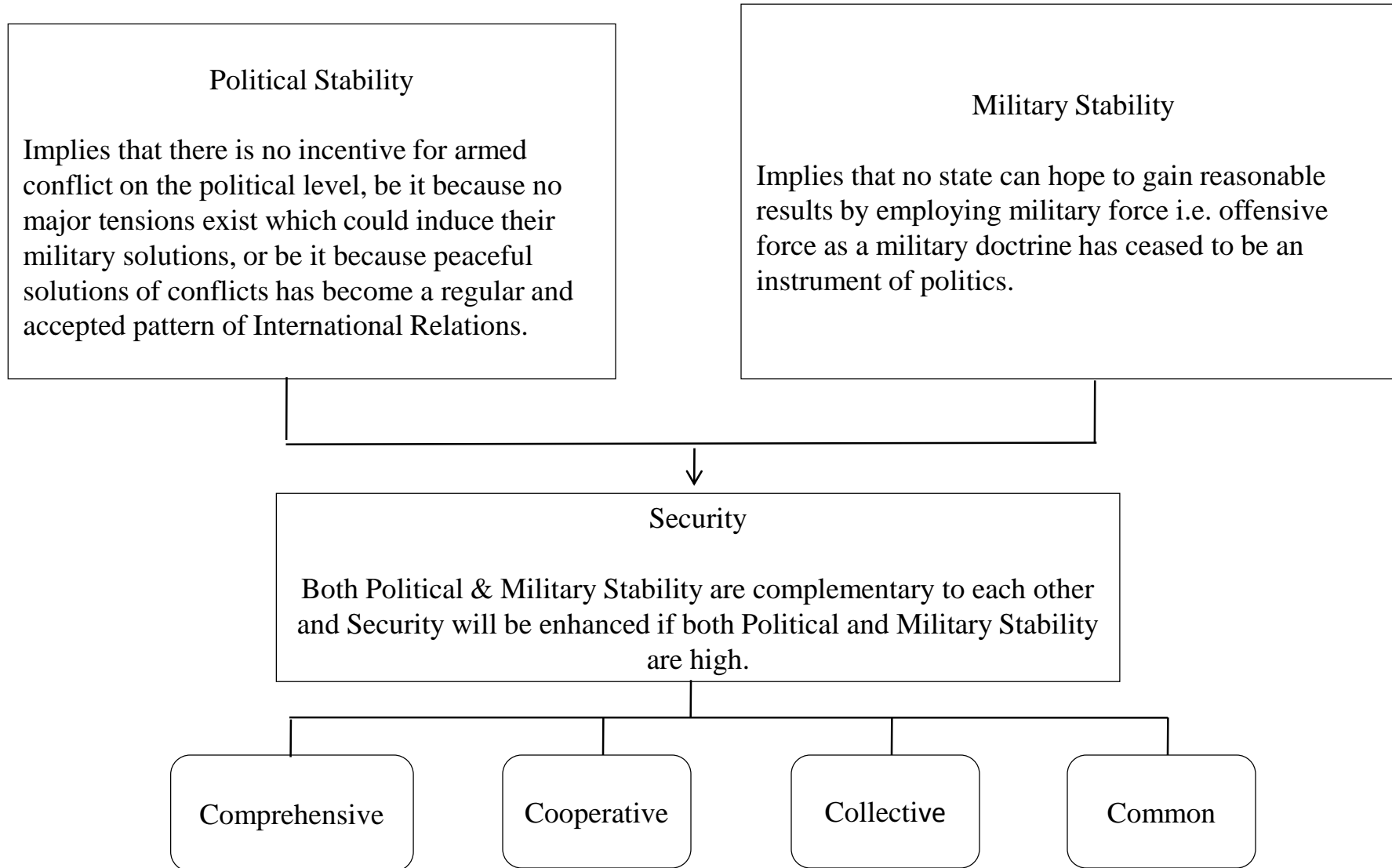
Range (km)	Blast Peak Overpressure (psi)	Prompt Neutron (rad-eq)	Prompt Gamma (rad)	Total Prompt Ionizing Radiation (rad-eq)	Thermal @ Visibility 40km (cal/cm2)	Cloud Arrival Time	Actual Dose Rate @ Cloud Arrival Time (rem/hr)
0.2	665	1.8E+07	1.4E+06	1.9E+07	3.5E+03	<0.01 min	5.4E+05
0.5	60	1.3E+06	2.3E+05	1.5E+06	5.5E+02	1 min	1.8E+05
1.0	13.1	2.8E+04	2.3E+04	5.1E+04	1.3E+02	3 min	7.9E+04
2.0	3.9	6.2E+01	2.1E+02	2.8E+02	2.9E+01	6 min	3.4E+04
4.0	1.4	Minimal	Minimal	-	6.0E+00	13 min	1.5E+04
6.0	Minimal	Minimal	Minimal	-	2.2E+00	19 min	9.2E+03
8.0	Minimal	Minimal	Minimal	-	1.0E+00	26 min	6.5E+03
10.0	Minimal	Minimal	Minimal	-	5.3E-01	33 min	4.5E+03
20.0	Minimal	Minimal	Minimal	-	4.8E-02	1 hr 6 min	4.9E+02
40.0	Minimal	Minimal	Minimal	-	1.6E-03	2 hr 13 min	8.3E+01

Appendix (6)

Political and Military Stability

SECURITY

“Absence of the Threat of War”



Common Security:

- Seeks security with other countries rather than against them. It is predicated on the assumption that States share a common interest in avoiding war, and that war avoidance is best pursued through strategies which emphasize cooperation and reassurance and reduce the emphasis on confrontation and deterrence.
- Common Security attempts to find an appropriate and stable balance between the requirements of deterrence and reassurance.

Collective Security:

- Directed against an aggressor coming from outside. Participation in a Collective Security organization entails a commitment by each member to join a coalition, being based either on defense in its traditional sense, or upon deterrence.
- Collective Security is relevant because it helps generate the domestic support to go to war and the international legitimacy to win the peace.

Cooperative Security:

- Refrains from the very idea of enforcing stability in a confrontational way. It exclusively aims at promoting cooperation in order to prevent:
 - The emergence of conflicts in a political sphere, or
 - To reduce the danger of armed confrontation.
- More specifically, Cooperative Security Policy aims at preventing emerging conflicts from escalating into larger proportions – in this sense it depends on the cooperation of all.

Comprehensive Security:

- Emphasizes on non-military means of achieving and maintaining security. Comprehensive security stresses the importance of the non-military instruments of security policy.

Security Assurances

Positive Security Assurances:

U.N. Security Council whose Nuclear Weapon States will provide assistance to any non-nuclear weapons state (party to the NPT) that is a victim of an act of aggression or an object of a threat of aggression in which nuclear weapons are used.

Negative Security Assurances:

A commitment by Nuclear Weapons States that they would not use or threaten to use nuclear weapons against non-nuclear weapon states.

Appendix (7)

In this Appendix the following articles address the Potential Military Dimension of the Iran Nuclear Program and the capability of the Iranian Ballistic Missiles Shahab-3/3M as a nuclear delivery system.

- Iran: Nuclear Intentions and Capabilities, National Intelligence Estimate, November 2007, Key Judgments
- IAEA GOV/2011/65 Report by the Director General, November 11, 2011
- Statement for the Record Worldwide Threat Assessment of the US Intelligence Community Senate Select Committee on Intelligence James R. Clapper, Director of National Intelligence January 29, 2014
- Bloomberg News reported on August 21, 2014, on Iran's Military Doctrine according to an unclassified Pentagon Report to the US Congress
- Kerry says Iran nuclear 'breakout' window now seen as two months, BY PATRICIA ZENGERLE, REUTERS, WASHINGTON Tue Apr 8, 2014 4:46pm EDT
- CRS Report R43480_Iran-North Korea-Syria Ballistic Missile and Nuclear Cooperation April 16, 2014
- CRS report "Iran: U.S. Concerns and Policy Responses", Kenneth Katzman, October 1, 2014
- FARS News Agency, Sat Aug 23, 2014 1:15, DM: Iran's Missiles Not Negotiable
- Possible Military Dimensions, 5 September 2014, Report by the IAEA Director General, GOV/2014/43
- Bipartisan Policy Center. Update on Iran's Nuclear Program: September 2014. Blaise Misztal
- AlMonitor, IAEA: Military issues in Iran's nuke program won't block deal, Barbara Slavin, Posted October 31, 2014
- IAEA: Military issues in Iran's nuke program won't block deal, Barbara Slavin, Posted October 31, 2014
- Dempsey Discusses Iran's Nuclear Ambitions, US DoD News

Iran: Nuclear Intentions and Capabilities

National Intelligence Estimate

November 2007

Key Judgments

A. We judge with high confidence that in fall 2003, Tehran halted its nuclear weapons program; we also assess with moderate-to-high confidence that Tehran at a minimum is keeping open the option to develop nuclear weapons. We judge with high confidence that the halt, and Tehran's announcement of its decision to suspend its declared uranium enrichment program and sign an Additional Protocol to its Nuclear Non-Proliferation Treaty Safeguards Agreement, was directed primarily in response to increasing international scrutiny and pressure resulting from exposure of Iran's previously undeclared nuclear work.

- We assess with high confidence that until fall 2003, Iranian military entities were working under government direction to develop nuclear weapons.
- We judge with high confidence that the halt lasted at least several years. (Because of intelligence gaps discussed elsewhere in this Estimate, however, DOE and the NIC assess with only moderate confidence that the halt to those activities represents a halt to Iran's entire nuclear weapons program.)
- We assess with moderate confidence Tehran had not restarted its nuclear weapons program as of mid-2007, but we do not know whether it currently intends to develop nuclear weapons.
- We continue to assess with moderate-to-high confidence that Iran does not currently have a nuclear weapon.
- Tehran's decision to halt its nuclear weapons program suggests it is less determined to develop nuclear weapons than we have been judging since 2005. Our assessment that the program probably was halted primarily in response to international pressure suggests Iran may be more vulnerable to influence on the issue than we judged previously.

B. We continue to assess with low confidence that Iran probably has imported at least some weapons-usable fissile material, but still judge with moderate-to-high confidence it has not obtained enough for a nuclear weapon. We cannot rule out that Iran has acquired from abroad—or will acquire in the future—a nuclear weapon or enough fissile material for a weapon. Barring such acquisitions, if Iran wants to have nuclear weapons it would need to produce sufficient amounts of fissile material indigenously—which we judge with high confidence it has not yet done.

C. We assess centrifuge enrichment is how Iran probably could first produce enough fissile material for a weapon, if it decides to do so. Iran resumed its declared centrifuge enrichment activities in January 2006, despite the continued halt in the nuclear weapons program. Iran made significant progress in 2007 installing centrifuges at Natanz, but we judge with moderate confidence it still faces significant technical problems operating them.

- We judge with moderate confidence that the earliest possible date Iran would be technically capable of producing enough HEU for a weapon is late 2009, but that this is very unlikely.
- We judge with moderate confidence Iran probably would be technically capable of producing enough HEU for a weapon sometime during the 2010-2015 time frame. (INR judges Iran is unlikely to achieve this capability before 2013 because of foreseeable technical and programmatic problems.) All agencies recognize the possibility that this capability may not be attained until *after* 2015.

D. Iranian entities are continuing to develop a range of technical capabilities that could be applied to producing nuclear weapons, if a decision is made to do so. For example, Iran's civilian uranium enrichment program is continuing. We also assess with high confidence that since fall 2003, Iran has been conducting research and development projects with commercial and conventional military applications—some of which would also be of limited use for nuclear weapons.

E. We do not have sufficient intelligence to judge confidently whether Tehran is willing to maintain the halt of its nuclear weapons program indefinitely while it weighs its options, or whether it will or already has set specific deadlines or criteria that will prompt it to restart the program.

- Our assessment that Iran halted the program in 2003 primarily in response to international pressure indicates Tehran's decisions are guided by a cost-benefit approach rather than a rush to a weapon irrespective of the political, economic, and military costs. This, in turn, suggests that some combination of threats of intensified international scrutiny and pressures, along with opportunities for Iran to achieve its security, prestige, and goals for regional influence in other ways, might—if perceived by Iran's leaders as credible—prompt Tehran to extend the current halt to its nuclear weapons program. It is difficult to specify what such a combination might be.

- We assess with moderate confidence that convincing the Iranian leadership to forgo the eventual development of nuclear weapons will be difficult given the linkage many within the leadership probably see between nuclear weapons development and Iran's key national security and foreign policy objectives, and given Iran's considerable effort from at least the late 1980s to 2003 to develop such weapons. In our judgment, only an Iranian political decision to abandon a nuclear weapons objective would plausibly keep Iran from eventually producing nuclear weapons—and such a decision is inherently reversible.

F. We assess with moderate confidence that Iran probably would use covert facilities—rather than its declared nuclear sites—for the production of highly enriched uranium for a weapon. A growing amount of intelligence indicates Iran was engaged in covert uranium conversion and uranium enrichment activity, but we judge that these efforts probably were halted in response to the fall 2003 halt, and that these efforts probably had not been restarted through at least mid-2007.

G. We judge with high confidence that Iran will not be technically capable of producing and reprocessing enough plutonium for a weapon before about 2015.

H. We assess with high confidence that Iran has the scientific, technical and industrial capacity eventually to produce nuclear weapons if it decides to do so.

Statement for the Record Worldwide Threat Assessment of the US Intelligence Community Senate Select Committee on Intelligence
James R. Clapper, Director of National Intelligence January 29, 2014:

“We continue to assess that Iran’s overarching strategic goals of enhancing its security, prestige, and regional influence have led it to pursue capabilities to meet its civilian goals and give it the ability to build missile-deliverable nuclear weapons, if it chooses to do so. At the same time, Iran’s perceived need for economic relief has led it to make concessions on its nuclear program through the 24 November 2013 Joint Plan of Action with the P5+1 countries and the European Union (EU). In this context, we judge that Iran is trying to balance conflicting objectives. It wants to improve its nuclear and missile capabilities while avoiding severe repercussions—such as a military strike or regime-threatening sanctions.

We do not know if Iran will eventually decide to build nuclear weapons. Tehran has made technical progress in a number of areas—including uranium enrichment, nuclear reactors, and ballistic missiles—from which it could draw if it decided to build missile-deliverable nuclear weapons. These technical advancements strengthen our assessment that Iran has the scientific, technical, and industrial capacity to eventually produce nuclear weapons. This makes the central issue its political will to do so.

Of particular note, Iran has made progress during the past year by installing additional centrifuges at the Fuel Enrichment Plant, developing advanced centrifuge designs, and stockpiling more low-enriched uranium hexafluoride (LEUF6). These improvements have better positioned Iran to produce weapons grade uranium (WGU) using its declared facilities and uranium stockpiles, if it chooses to do so. Despite this progress, we assess that Iran would not be able to divert safeguarded material and produce enough WGU for a weapon before such activity would be discovered. Iran has also continued to work toward starting up the IR-40 Heavy Water Research Reactor near Arak.

We judge that Iran would choose a ballistic missile as its preferred method of delivering nuclear weapons, if Iran ever builds these weapons. Iran’s ballistic missiles are inherently capable of delivering WMD, and Iran already has the largest inventory of ballistic missiles in the Middle East. Iran’s progress on space launch vehicles—along with its desire to deter the United States and its allies—provides Tehran with the means and motivation to develop longer-range missiles, including an intercontinental ballistic missile (ICBM).

We assess that if Iran fully implements the Joint Plan, it will temporarily halt the expansion of its enrichment program, eliminate its production and stockpile of 20-percent enriched uranium in a form suitable for further enrichment, and provide additional transparency into its existing and planned nuclear facilities. This transparency would provide earlier warning of a breakout using these facilities.”

Bloomberg News reported on August 21, 2014:

“While Iran’s military has toned down its rhetoric about military capabilities and exercises, it continues a low-profile buildup of weapons in and near the Strait of Hormuz, according to a classified Pentagon assessment.

Iran’s military strategy is defensive and designed to deter an attack, survive an initial strike, retaliate against an aggressor and force a diplomatic solution while avoiding major concessions, says the unclassified executive summary of a congressionally mandated Pentagon report submitted to lawmakers on July 7.

Since the August 2013 election of President Hassan Rouhani, the Iranian government “has adjusted some of its tactics” to achieve core objectives such as preserving the rule of Supreme Leader Ayatollah Ali Khamenei, according to the summary, which was obtained by Bloomberg News.

Defense Secretary Chuck Hagel wrote in his cover letter transmitting the classified report that it contains analysis of Iran’s conventional, unconventional and nuclear weapons capabilities “and intelligence gaps the Department currently has” with Iran.

Even so, the new assessment says, “Tehran is quietly fielding” increasing numbers of anti-ship ballistic missiles, “small but capable submarines,” coastal missile batteries and attack craft.

Iranian officials periodically have threatened to disrupt the Strait of Hormuz in response to U.S.-led economic sanctions on its nuclear program and Israel’s threat to launch a strike against it.

About 20 percent of the world’s traded oil is shipped daily through the Strait, which is 21 miles (34 kilometers) wide at its narrowest point.

Separately, Iran possesses “a substantial inventory of missiles capable of reaching targets throughout the region, including Israel.”

(Bloomberg News <http://www.Bloomberg.com/news>. “Iran Speaks More Softly But Keeps Building Bigger Sticks” By Tony Capaccio, August 21, 2014)

Kerry says Iran nuclear 'breakout' window now seen as two months

BY PATRICIA ZENGERLE

REUTERS

WASHINGTON Tue Apr 8, 2014 4:46pm EDT

(Reuters) - Iran can produce fissile material for an atomic weapon in two months, U.S. Secretary of State John Kerry on Tuesday told a Senate hearing in which he faced tough questions from lawmakers about negotiations with Iran over its nuclear program.

"I think it's public knowledge today that we're operating with a time period for a so-called breakout of about two months. That's been in the public domain," Kerry testified at a Senate Foreign Relations Committee hearing.

..... Kerry said such a "breakout" window did not mean Iran would have a warhead or other delivery system. "It's just having one bomb's worth, conceivably, of material, but without any necessary capacity to put it in anything, to deliver it, to have any mechanism to do so," he said.

.... "If they're overtly breaking out and breaking an agreement and starting to enrich and pursue it, they've made a huge consequential decisions. And the greater likelihood is we are going to respond immediately," Kerry said.

In a CRS Report R43480_Iran-North Korea-Syria Ballistic Missile and Nuclear Cooperation April 16, 2014, the report states:

“(U) Since the Iran-Iraq War, Tehran has placed significant emphasis on developing and fielding ballistic missiles to counter perceived threats from Israel and coalition forces in the Middle East and to project power in the region. Iran has a substantial inventory of missiles capable of reaching targets throughout the region, including Israel, and the regime continues to develop more sophisticated missiles. Iran has publicly stated it may launch a space launch vehicle by 2015 that could be capable of intercontinental ballistic missile ranges if configured as a ballistic missile.

(U) Iran continues to develop technological capabilities that could be applicable to nuclear weapons and long-range missiles, which could be adapted to deliver nuclear weapons, should Iran's leadership decide to do so. On 24 November, 2013, Iran agreed to a Joint Plan of Action (JPA) with the permanent members of the UN Security Council plus Germany (P5+ 1) that included enhanced monitoring of Iran's nuclear facilities and a six-month halt to enrichment activities over 5 percent and further advances on the IR-40 Heavy Water Research Reactor. In public statements, some Iranian officials have minimized the JPA's impact on the nuclear program.

(U) Iran continues to develop its anti-access and area denial (A2AD) capabilities to control the Strait of Hormuz and its approaches. Tehran is quietly fielding increasingly lethal symmetric and asymmetric weapon systems, including more advanced naval mines, small but capable submarines, coastal defense cruise missile batteries, attack craft, and anti-ship ballistic missiles.”

In a CRS report “Iran: U.S. Concerns and Policy Responses”, Kenneth Katzman, October 1, 2014:

Ballistic and Cruise Missiles and Warheads

The Administration’s insistence that missile limitations be part of a comprehensive nuclear settlement is based, at least in part, on the apparent view that Iran’s ballistic missiles and its acquisition of indigenous production of anti-ship cruise missiles (ASCMs) provide capabilities for Iran to project power. DNI Clapper testified on March 12, 2013, that the intelligence community assesses that “Iran’s ballistic missiles are capable of delivering WMD.” There has been a long-standing U.S. estimate that Iran would likely not be able to fully develop a missile of intercontinental range (ICBM) until 2015. The executive summary of the Defense Department’s 2014 report on Iranian military power, referenced above, altered the U.S. formulation of the ICBM assessment by referring to Iran’s publicly stated intent to launch a space launch vehicle by 2015 that could be capable of intercontinental ballistic missile ranges.

Tehran views its conventionally armed missiles as an integral part of its strategy to deter—and if necessary retaliate against—forces in the region, including U.S. forces. A particular worry of U.S. commanders remains Iran’s inventory of cruise missiles, which can reach U.S. ships in the Gulf quickly after launch. U.S. officials and reports have estimated that Iran is steadily expanding its missile and rocket inventories and has “boosted the lethality and effectiveness of existing systems with accuracy improvements and new sub-munition payloads.”

It is unclear the extent to which Iran continues to receive outside assistance for its missile program. Some reports suggest Iranian technicians may have witnessed North Korea’s satellite launch in December 2012, which, if true, could support the view that Iran North Korea missile cooperation is extensive. “**Table 7**” contains some details on Iran’s missile programs.⁴³ It is also not clear to what extent, if any, Iran’s missile programs might have been set back by the November 12, 2011, explosion at a ballistic missile base outside Tehran that almost completely destroyed it and killed the base commander.

“Table 7. Iran’s Missile Arsenal”

Missile System

Shahab-3 (“Meteor”)	800-mile range. The missile is operational, and Defense Department report of April 2012, indicates Tehran has improved its lethality and effectiveness, tempering previous assessments by experts that the missile is not completely reliable.
Shahab-3 “Variant” /Sijil/Ashoura	1,200-1,500-mile range. The April 2010 Defense Department report had the liquid fueled Shahab-3 “variant” as “possibly deployed,” and the April 2102 report indicates the solid fuel version (Sijil or Ashoura) is increasing in range, lethality, and accuracy. These missiles potentially put large portions of the Near East and Southeastern Europe in range, including U.S. bases in Turkey. A U.N. experts panel reported in May 2011 that Iran tested the missile in October 2010 although the launch was “reported by a [U.N.] Member state,” and not announced publicly. In concert with the beginning of 10-day “Great Prophet Six” military exercises, on June 28, 2011, Iran unveiled underground missile silos.
BM-25	1,500-mile range. On April 27, 2006, Israel’s military intelligence chief said that Iran had received a shipment of North Korean-supplied BM-25 missiles. Missile said to be capable of carrying nuclear warheads. <i>The Washington Times</i> appeared to corroborate this reporting in a July 6, 2006, story, which asserted that the North Korean-supplied missile is based on a Soviet-era “SS-N-6” missile. Press accounts in December 2010 indicate that Iran may have received components but not the entire BM-25 missile from North Korea.
ICBM	U.S. officials believe Iran might be capable of developing an intercontinental ballistic missile (3,000 mile range) by 2015, a time frame reiterated by the April 2012 DOD report.

“Table 7. Iran’s Missile Arsenal”

Missile System

Short Range Ballistic Missiles and Cruise Missiles

Iran is fielding increasingly capable, short range ballistic missiles, according to DOD 2012 and 2014 reports, such as ability to home in on and target ships while the missile is in flight. One version could be a short range ballistic missile named the Qiam, tested in August 2010. Iran has long worked on a 200 mile range “Fateh 110” missile (solid propellant), which it again tested in August 2012. A version of it is the Khaliji Fars (Persian Gulf) anti-ship ballistic missile that could threaten maritime activity throughout the Persian Gulf. Iran also is able to arm its patrol boats with Chinese-made C-802 anti-ship cruise missiles. Iran also has C-802’s and other missiles emplaced along Iran’s coast, including the Chinese-made CSSC-2 (Silkworm) and the CSSC-3 (Seersucker). Iran also possesses a few hundred short-range ballistic missiles, including the *Shahab-1* (Scud-b), the *Shahab-2* (Scud-C), and the *Tondar-69* (CSS-8).

Space Vehicle

In February 2008 Iran claimed to have launched a probe into space, suggesting its missile technology might be improving to the point where an Iranian ICBM is realistic. Following an August 2008 failure, in early February 2009, Iran successfully launched a small, low-earth satellite on a Safir-2 rocket (range about 155 miles). The Pentagon said the launch was “clearly a concern of ours” because “there are dual-use capabilities here which could be applied toward the development of long-range missiles.” A larger space vehicle, Simorgh, was displayed in February 2010. Iran claimed a satellite launch into orbit on June 16, 2011. Iran says it plans another space launch in late December 2013.

Warheads

Wall Street Journal report of September 14, 2005, said that U.S. intelligence believes Iran is working to adapt the Shahab-3 to deliver a nuclear warhead. Subsequent press reports say that U.S. intelligence captured an Iranian computer in mid-2004 showing plans to construct a nuclear warhead for the Shahab.

FARS News Agency

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DM: Iran's Missiles Not Negotiable

TEHRAN (FNA)- Iran's Defense Minister Brigadier General Hossein Dehqan reiterated that any information about the country's missile industry and scientists are highly confidential and would never become a topic of talks between Tehran and the world powers.

"The missile issue has not been raised in the negotiations and Iran's missile power will never be an issue for negotiations with anyone," Dehqan told reporters in a press conference in Tehran on Saturday.

Asked if Tehran has permitted the International Atomic Energy Agency (IAEA) to visit its military site in Parchin, near Tehran, he said, "The Agency has visited Parchin several times and taken samples; therefore, this is not an issue for discussions now." Dehqan stressed that Iran would never provide anyone with "information about its defense scientists", and added, "This issue is not acceptable to us."

Asked if the UN nuclear watchdog has raised new questions on Iran's use of Exploding Bridge Wire (EBW) detonators, he said, "The Agency hasn't raised new questions and they were the same old questions which had already been answered and no new ambiguities were raised."

He added that Iran has presented detailed response to the IAEA's questions about EBW detonators during the recent visit to Tehran by IAEA chief Yukiya Amano.

The US officials have stated several times that they intend to include Iran's ballistic missile technology in the nuclear talks, while Tehran has repeatedly stressed that it would not allow inclusion of any other topic in the negotiations but those related to its nuclear program.

Iranian Foreign Minister and top negotiator in talks with the world powers Mohammad Javad Zarif had also stressed earlier that Iran's defensive missiles is no topic for the ongoing negotiations between Tehran and the sextet of powers.

"It will be wrong to assume that the only application of Iran's defensive missiles that have not and will not be the subject of any negotiations is carrying unconventional weapons," Zarif said in a joint press conference with his Austrian counterpart Sebastian Kurz in Tehran earlier this year and in response to a question by an Austrian reporter who asked if Iran did not have a nuclear weapons program then why it produced ballistic missiles which have Europe within their range.

The Iranian foreign minister underlined that such wrong assumptions were based on certain media hypes.

Zarif reiterated that the Iran-world powers talks would never deal with subjects other than the nuclear issue.

"Iran's nuclear program will always remain peaceful and in this case no one can claim that Iran's missiles will carry nuclear weapons, because Iran does not produce nuclear weapons to be carried by missiles or any other delivery system," the Iranian foreign minister said.

In February, Zarif dismissed media reports that Tehran and the Group 5+1 (the US, Russia, China, Britain and France plus Germany) would discuss Iran's missile program in their talks in Vienna, and said the country's nuclear program has no military dimensions.

"Iran's nuclear program is not related to the military issues and our military program is not related to the current negotiations," Zarif told reporters after meeting EU foreign policy chief Catherine Ashton - who presided the G5+1 delegations in talks with Iran - in Vienna for a working dinner on February 17.

Tehran launched an arms development program during the 1980-88 Iraqi imposed war on Iran to compensate for a US weapons embargo. Since 1992, Iran has produced its own tanks, armored personnel carriers, missiles and fighter planes.

Yet, Iranian officials have always stressed that the country's military and arms programs serve defensive purposes and should not be perceived as a threat to any other country.

Possible Military Dimensions

5 September 2014

Report by the Director General

GOV/2014/43

“62. Previous reports by the Director General have identified outstanding issues related to possible military dimensions to Iran’s nuclear programme and actions required of Iran to resolve these. The Agency remains concerned about the possible existence in Iran of undisclosed nuclear related activities involving military related organizations, including activities related to the development of a nuclear payload for a missile. Iran is required to cooperate fully with the Agency on all outstanding issues, particularly those which give rise to concerns about the possible military dimensions to Iran’s nuclear programme, including by providing access without delay to all sites, equipment, persons and documents requested by the Agency.

63. The Annex to the Director General’s November 2011 report (GOV/2011/65) provided a detailed analysis of the information available to the Agency at that time, indicating that Iran has carried out activities that are relevant to the development of a nuclear explosive device. This information is assessed by the Agency to be, overall, credible. The Agency has obtained more information since November 2011 that has further corroborated the analysis contained in that Annex.

64. In February 2012, Iran dismissed the Agency’s concerns, largely on the grounds that Iran considered them to be based on unfounded allegations. In a letter to the Agency dated 28 August 2014, Iran stated that “most of the issues” in the Annex to GOV/2011/65 were “mere allegations and do not merit consideration”.

65. As indicated above (para. 9), one of the seven practical measures agreed in the second step of the Framework for Cooperation on 20 May 2014 was the provision by Iran of “information and explanations for the Agency to assess Iran’s stated need or application for the development of Exploding Bridge Wire detonators”. In this regard, as indicated in the Director General’s previous report, Iran provided the Agency with information and explanations in April 2014 and additional information and explanations in May 2014, including showing documents, to substantiate its stated need for the development of EBW detonators and their application. At a technical meeting in Tehran on 16 August 2014, the Agency asked for additional clarifications, certain of which Iran provided.

66. During the technical meetings on 16 and 17 August 2014, the Agency and Iran also held discussions on the practical measures relating to the initiation of high explosives and to neutron transport calculations. As indicated above (para. 15), at the technical meeting in Tehran on 31 August 2014, the Agency and Iran began discussions on these two practical measures and agreed that another meeting would be convened.

67. Since the Director General's previous report, at a particular location at the Parchin site, the Agency has observed through satellite imagery ongoing construction activity that appears to show the removal/replacement or refurbishment of the site's two main buildings' external wall structures. One of these buildings has also had a section of its roof removed and replaced. Observations of deposits of material and/or debris, and equipment suggest that construction activity has expanded to two other site buildings. These activities are likely to have further undermined the Agency's ability to conduct effective verification. It remains important for Iran to provide answers to the Agency's questions and access to the particular location in question.

68. As indicated in the Director General's previous report and as reiterated by the Director General following his meetings in Tehran on 17 August 2014, the Agency needs to be able to conduct a "system" assessment of the outstanding issues contained in the Annex to GOV/2011/65. This will involve considering and acquiring an understanding of each issue in turn, and then integrating all of the issues into a "system" and assessing that system as a whole."

Table (1), shows the present 2014 status of the issues from the 2011 IAEA Report of the Director General.

AlMonitor

IAEA: Military issues in Iran's nuke program won't block deal

Author: Barbara Slavin Posted October 31, 2014

Yukiya Amano, director general of the International Atomic Energy Agency (IAEA), told Al-Monitor Oct. 31 that Iran's halting cooperation so far in explaining possible military-related nuclear work would not derail ongoing negotiations on a long-term nonproliferation agreement.

"It should not be an impediment," Amano said after the conclusion of remarks at the Brookings Institution in Washington.

Iran, which signed a new framework for resolving so-called PMD, or "possible military dimensions," issues with the IAEA a year ago, has so far provided information about only one of a dozen key questions, Amano said, involving so-called exploding bridge wires. He said he was not surprised that cooperation had slowed as negotiators from the five permanent members of the UN Security Council plus Germany (P5+1) enter the endgame in talks that currently have a Nov. 24 deadline.

"Now is not the best time to make progress," Amano acknowledged in response to another question from Al-Monitor. "I continue to hope this issue of possible military dimensions will be clarified as soon as possible. It is the intention of Iran and it is the intention of the IAEA."

Many experts doubt that a deal can be concluded next month but suggest that the major elements of an agreement could be reached.

"I see no possibility of achieving a comprehensive deal by Nov. 24," Robert Einhorn, a former senior nuclear expert with both the Obama and Clinton administrations who hosted the event with Amano, told Al-Monitor. "The best that can be achieved is to reach agreement on the key parameters of a deal and to take several more months to flesh out the parameters."

Critics of a possible nuclear deal with Iran have insisted that the Tehran government must fully explain any possible military-related work before the international community can have confidence that it will abide by any new agreement. According to the CIA, Iran had a structured weapons program in the late 1990s at least until 2003, when it stopped the work in the aftermath of the US invasion of Iraq and disclosure of Iranian enrichment facilities.

Experts such as David Albright of the Institute for Science and International Security have said that it is critical to know the full scope of Iran's past activities to verify the completeness of any Iranian declaration of what it possesses now

Other experts such as Edward Levine, a former staffer on the Senate Foreign Relations Committee, say it is more important to put in place an intrusive verification system that impedes Iran from developing nuclear weapons in the future and that such an agreement should not be hostage to what Iran may or may not have done a decade ago. Iran has agreed to ratify the so-called additional protocol of the Treaty on the Non-Proliferation of Nuclear Weapons and provide even more intrusive monitoring if a deal is reached.

Amano seemed to have come down on the latter side of the argument.

He said that Iranian President Hassan Rouhani had repeatedly stated that he is willing to “accelerate clarification” of allegations of past research connected to developing the most common form of nuclear weapon. But Amano suggested that further progress would have to wait for conclusion of a comprehensive deal. He added that “this is not an endless process,” and that he expected that the outstanding issues about possible military work could be resolved “within a reasonable time frame” that he defined as less than a decade and more than one month.

Iran has charged that the allegations are the result of forgeries by Israeli and other foreign intelligence services. The IAEA has said that the material — much of which was smuggled out of Iran on a so-called laptop of death in 2005 — is credible and consistent in showing activities relevant to trying to build a nuclear explosive device.

Amano did not answer questions about the authenticity of the material and sidestepped a question about whether the IAEA would share the original documents with Iran as Iranian officials have repeatedly requested.

“We are prepared to share the documents when we consider it appropriate and necessary,” he said.

“We are asking questions to clarify issues,” he added. “We have given the questions to Iran in writing and we have explained the background. I think our counterpart understands the questions well.”

Amano also declined to answer a question about whether it was more important to have access to personnel who may have been involved in weapons research or to sites where such research might have taken place. Iran has refused to let the IAEA return to a military base called Parchin, which arms inspectors visited twice in the previous decade. “Access to scientists is very sensitive because of their experience in recent years,” Amano added, referring obliquely to the assassination of five Iranian scientists working on nuclear-related matters in recent years.

Overall, the impression the former Japanese diplomat conveyed was that the process, while slow-moving, shows promise. At some point, Amano said, he will bring his findings to the board of governors of the IAEA, which will make a decision about whether to close the file.

Ultimately, “the reality is that everything we deal with is very political,” Amano said.

Dempsey Discusses Iran's Nuclear Ambitions

By Lisa Ferdinando

US DoD News

Army News Service

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WASHINGTON, Nov. 6, 2014 - Though the U.S. military will respond to the Iranian nuclear issue if asked, diplomatic resolution remains the preferable option, the chairman of the Joint Chiefs of Staff said today.

"Obviously, without straying into classified matters, we do have the capability, were we asked to use it, to address a Iranian nuclear capability," Army Gen. Martin E. Dempsey said during a forum at the Carnegie Council for Ethics in International Affairs in New York City.

There is a "challenge," however, Dempsey said: using the military instrument of power simply would delay Iran's nuclear ambition, as opposed to eliminating it.

Iran Abandoning Nuclear Ambitions is Best Solution

"What really makes the nuclear capability of Iran an issue is not centrifuges and ballistic missiles, but rather the human capital that has the expertise to regenerate it," the general explained. "Ultimately, the Iranian government itself would have to take a decision to move away from that aspiration entirely, and that's why the diplomatic track is actually the right track."

Iran has an opportunity for a diplomatic solution through negotiations with the five permanent members of the U.N. Security Council plus Germany, known as the P5-plus-1, the chairman said.

"If they refuse to take the opportunity that the P5-plus-1 are presenting to them, and if asked, we do have the capability to delay their nuclear enterprise by some number of years, which I won't, obviously, articulate here," he added.

It would be a "much wiser course" for Iran to go the diplomatic route, Dempsey said.