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Study on a Possible Israeli Strike on Iran's Nuclear Development Facilities

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Introduction:

- It is always difficult to evaluate a nuclear weapons program without access to concrete intelligence information. This study is based on open sources and we do not claim to be one hundred percent accurate and complete. The aim of the study is to try and get some insight into the level the Iranian Nuclear Program has progressed, and if the intent of the leadership is to produce nuclear weapons then what would the possible timeline be.
- Based on these estimates the study then addresses the possibility of an Israeli strike against the Iranian nuclear facilities, with the objective of either destroying the program or delaying it for some years. The success of the Strike Mission will be measured by how much of the Enrichment program it has destroyed, or the number of years it has delayed Iranian acquisition of enough Uranium, or Plutonium produced from the Arak reactor, to build a nuclear bomb.
- It is not known whether Iran has some secret facilities where it is conducting uranium enrichment and a nuclear weapons program. So far no concrete intelligence information points to this being likely. However, this study refers back to the vast literature on Iran's nuclear program, and on some interviews of the Iranian leadership, such as the VOA of August 29, 2008 "Iran claims to have 4,000 working nuclear centrifuges" and the April 8, 2008, (Time on Line), "Iran: now we have 6,000 nuclear centrifuges", and "Iran's Nuclear Chief Explains Nuclear Fuel Cycle, Comments on US Concerns". (Source: Tehran Vision of the Islamic Republic of Iran Network C2 in Persian-state run television)
- This study does not claim that if Iran might have accumulated over 1000 kg of Low Enriched Uranium (LEU), which is sufficient to produce Highly Enriched Uranium (HEU), that it has done so, and now possess nuclear weapons.
- The Israeli time frame as to when Iran will have a Nuclear Weapon is between 2009 and 2012, whereas the U.S. time frame is after 2013. Israel states that Iran should not be allowed to obtain any nuclear capabilities that could eventually allow it to produce nuclear weapons. Israel views Iran as an Existential Threat and must be dealt with in the immediate future.
- New US policy, under Obama Administration, is to leave all options on the table, and presently favors diplomacy against any military strikes. Containment could be the future course of U.S. Policy if Diplomatic Engagement does not work, and after all other options have been exhausted.

•A military strike by Israel against Iranian Nuclear Facilities is possible and the optimum route would be along the Syrian-Turkish border then over a small portion of Iraq then into Iran, and back the same route. However, the number of aircraft required, refueling along the way and getting to the targets without being detected or intercepted would be complex and high risk and would lack any assurances that the overall mission will have a high success rate.

▪ With regard to the Arab States, they have become extremely frustrated with the U.S. and the West double standard when addressing the Proliferation of Weapons of Mass Destruction in the Middle East. Most probably they will not condone any attack on Iran under the pretext that Iran poses an existential threat to Israel and a security threat to the whole region, whilst Israel has some 200 to 300 nuclear weapons, and the delivery means using the Jericho missiles, in addition to Israel still occupying the West Bank and the Syrian Golan Heights.

• The more there is an Israeli threat to the survival of the regime in Iran, the more Iran will be determined to acquire nuclear weapons. Iran would withdraw from the NPT based on the argument that it needs to acquire nuclear weapons to protect its sovereignty and any further aggression by Israel and the U.S.

• A strike by Israel on Iran will give rise to regional instability and conflict as well as terrorism.

• Iran should be engaged directly by the U.S. with an agenda open to all areas of military and non-military issues that both are in agreement or disagreement. Any realistic resolution to the Iranian nuclear program will require an approach that encompasses Military, Economic, Political interests and differences of the U.S vs Iran.

• The U.S. 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. However, in this area the U.S. will have to walk and negotiate along a very fine line between Israel's WMD and Ballistic Missiles capabilities and the Iranian Nuclear development program. The U.S. must recognize that both are very closely inter-related and are fueling each other. So the U.S. should be prepared to address both issues simultaneously while trying not to be perceived as though it has double standards when it comes to Israel.

Israeli Nuclear and Ballistic Missiles Weapons

- Israel's National Security Doctrine:

This is based on the perception that Arab countries are determined to destroy Israel; that Israel has no reliable international allies and must take care of itself; there is an asymmetrical balance of resources versus the Arab Countries in Demography, Geography, Economic Resources, Structure of Armed Forces in terms of man power.

- Israel's Operational Military Doctrine:

That Israel must have the capability to deter any possible Arab attack, and if deterrence fails then Israel must strive for an early war termination if war breaks out. That any war with the Arab countries would have to be short and decisive. That the war must quickly be carried into and fought on Arab territory giving rise to a rapid offensive and high degree of mobility to sustain continuous forward movement.

- Israel's Nuclear Policy:

A nuclear capability is needed to deter threats to Israel's existence. The possible acquisition of nuclear weapons by any Arab or non-Arab Muslim State in the region is considered as a direct existential threat to Israel. Israel should prevent all States in the Middle East Region from developing a nuclear program that it sees as a threat, or attempting to acquire nuclear weapons. Israel has deliberately maintained a nuclear policy ambiguity about its own nuclear weapons program.

The purpose of the nuclear ambiguity policy was based on the belief that it had introduced an effective "deterrence through uncertainty". Arab states were never sure that Israel would use a nuclear weapon in retaliation to its survival in the event of a major war, or if any of the Arab states try to acquire a nuclear capability.

Israel's nuclear ambiguity policy has been stated by a number of Israeli leaders in such statements as:

"Israel will not be the first to use nuclear weapons" and

"Israel will not be the first to introduce nuclear weapons into the Middle East"

- The Arab States' view is that such nuclear doctrines can never be considered binding in case of war.

- Israel has never officially admitted that it possesses Nuclear Weapons, and is not a signatory to the Nuclear Non-Proliferation Treaty. Many see the present status of Israel as an "Undeclared Nuclear Weapon State", at the same time it has become to be recognized as possessing a very sophisticated arsenal of nuclear weapons.

Israel: Nuclear Facilities

Yodfat:
Possible assembly and dismantling

Eilabun:
Possible Storage Facility

Haifa:
Rafael-Israel Armament Development Authority. Reported Nuclear Design and Assembly.

Soreq:
Nahal Soreq Nuclear Research Center (MAMAG) 5 MW safeguarded pool type reactor; possible weapon design and Research Facility.

Dimona
Negar Nuclear Research Center (KAMAG): Houses a Reactor, Enrichment and Reprocessing Facilities.

Tirosh:
Possible Storage Facility

Mishor Rotern:
Negar Phosphates Chemical Company. Uranium Mining from Phosphate Deposits.



- Uranium exploration began in Negev as early as 1949; Israeli Atomic Energy Commission began to discuss nuclear option in 1952. Cooperation with France in nuclear reactor design and technology began in 1950s. French-Israeli construction of a reactor in Dimona – whose actual capacity was much larger than its announced capacity, began in 1957. US detected the project in 1958, and visited the reactor during the 1960s, but Israel concealed its true output and performance characteristics.
- Britain sells 20-tons of heavy water to Israel in 1959-1960. It also sells beryllium and lithium-6. These sales are critical to bringing the kind of reactor Israel needs on line, and potentially useful in easing its problems in producing —boosted|| fission and fusion weapons.
- Possible nuclear test (implosion proof of principle or —zero yield||) in Negev on November 2, 1966.
- By 1968, the CIA publicly estimated that Israel had nuclear weapons. It estimated that Israel had 10-20 nuclear weapons.
- By 1986, leaks by Mordecai Vanunu, and from other sources, led to estimates that Israel had some 100-200 fission weapons. The possibility existed that it had —boosted fission weapons with yields in the 60-100 kiloton (KT) range.
- October 1973: reports that Prime Minister Golda Meir orders IDF to assemble nuclear weapons for delivery in response to Egyptian and Syrian attacks, and that Jericho missiles at HIRBAT ZACHARIAH and nuclear strike F-4s at Tel Nof are armed.
- Reports of joint nuclear test with South Africa in 1979, but never confirmed. Israel does seem to have cooperated with South Africa in missile design and booster testing.
- The director of the Central Intelligence Agency (CIA) indicated in May 1989 that Israel may be seeking to construct a thermonuclear weapon.
- June 2000: reports begin to surface that Israel will arm submarines with nuclear-armed cruise or ballistic missiles. Such reports have continued ever since. Reports that Israel had modified the Harpoon cruise missile to have nuclear warheads have been regularly repeated since 2003. Germany sells Israel advanced Dolphin-class submarines in 2005.

- Israel has two significant reactor projects: the 5 megawatt highly enriched uranium light-water IRR I reactor at Nahal Soreq; and the 75-200 megawatt heavy-water IRR-2 natural uranium reactor used for the production of fissile Plutonium material at Dimona. Only the IRR-1 is under International Atomic Energy Agency safeguards.
- Dimona has conducted experiments in pilot scale laser and centrifuge enrichment, purifies uranium dioxide (UO₂), converts uranium hexafluoride (UF₆), and fabricates fuel for weapons purpose.
- Uranium phosphate mining in the Negev, near Beersheba, and yellowcake is produced at two plants in the Haifa area and one in southern Israel.
- Pilot-scale heavy water plant operating at Rehovot.
- Estimates of numbers and types of weapons differ sharply.
 - No agreement exists over the plutonium output from the reactor at Dimona. Which is reported at power outputs from 75-200 megawatts. Satellite photos indicate that output is more likely to be below 140 megawatts.
 - Stockpile of at least 60-80 plutonium weapons.
 - May have well over 100 nuclear weapons assemblies, with some weapons with yields over 100 kilotons.
 - U.S. experts believe Israel has highly advanced implosion weapons. Known to have produced Lithium-6, allowing production of both tritium and lithium deuteride at Dimona. Facility no longer believed to be operating.
 - Some weapons may be ER variants or have variable yields.
 - Stockpile of up to 300-400 weapons is possible. Lower limit could be 70-100.
 - There exists a possibility that Israel may have developed thermonuclear warheads.
- Major weapons facilities include production of weapons-grade plutonium at Dimona, nuclear weapons design facility at Nahal Soreq (south of Tel Aviv), missile test facility at Palmachim, nuclear armed missile storage facility at Kefar Zekharya, nuclear weapons assembly facility at Yodefat, and tactical nuclear weapons storage facility at Eilabun in eastern Galilee.

- A useful rule of thumb for gauging the proliferation of any given reactor is that 1 Megawatt-day (thermal energy release, not electricity output) of operation produces 1 gram of Plutonium in any reactor using 20% or lower Enriched Uranium.

(Source: Federation of American Scientists. Plutonium Production-Nuclear Weapons www.fas.org/nuke/intro/nuke/plutonium.htm)

- The number of nuclear weapons Israel produced depends on how much Plutonium has been produced at Dimona. The credibility of Vanunu's statement is essential in trying to assess Israel's nuclear capability.
- According to Mordechai Vanunu the Nuclear Reactor at Dimona was scaled up twice, the first was from 26 MW(t) to 70 MW(t), and the second just before he arrived at the facility was from 70 MW(t) to some higher level which produced 40 kg of Plutonium every year. This study assumes that the Dimona Reactor was operated at 150 MW(t) by 1977, which would result in producing 40 kg of Plutonium per year.
- From this the maximum and minimum yearly output of weapons-grade Plutonium fuel can be estimated, and the number of Plutonium based nuclear weapons that can be produced. (see Appendix). This is shown in the next chart in three stages:
 - First being that Dimona operated at a capacity of 26 MWt from 1963 until end of 1969, then from 1970 up to 1976 it operated at the upgraded capacity of 70 MWt.
 - Total Plutonium produced if the reactor was operating 60% of the time is 147 kg. This is would produce 29 weapons that are 5 kg (10 kt yield), or 18 weapons that are 8 kg (20 kt yield).
 - Total Plutonium produced if the reactor was operating 90% of the time is 224 kg. This is would produce 45 weapons that are 5 kg (10 kt yield), or 28 weapons that are 8 kg (20 kt yield).

➤ Second: Dimona continues to operate at Capacity of 70 MWt from 1976 until 2008 i.e. no upgrade up to 150 MWt.

- Total Plutonium produced if the reactor was operating 60% of the time is 627 kg. This is would produce 125 weapons that are 5 kg (10 kt yield), or 78 weapons that are 8 kg (20 kt yield).

- Total Plutonium produced if the reactor was operating 90% of the time is 960 kg. This is would produce 192 weapons that are 5 kg (10 kt yield), or 120 weapons that are 8 kg (20 kt yield).

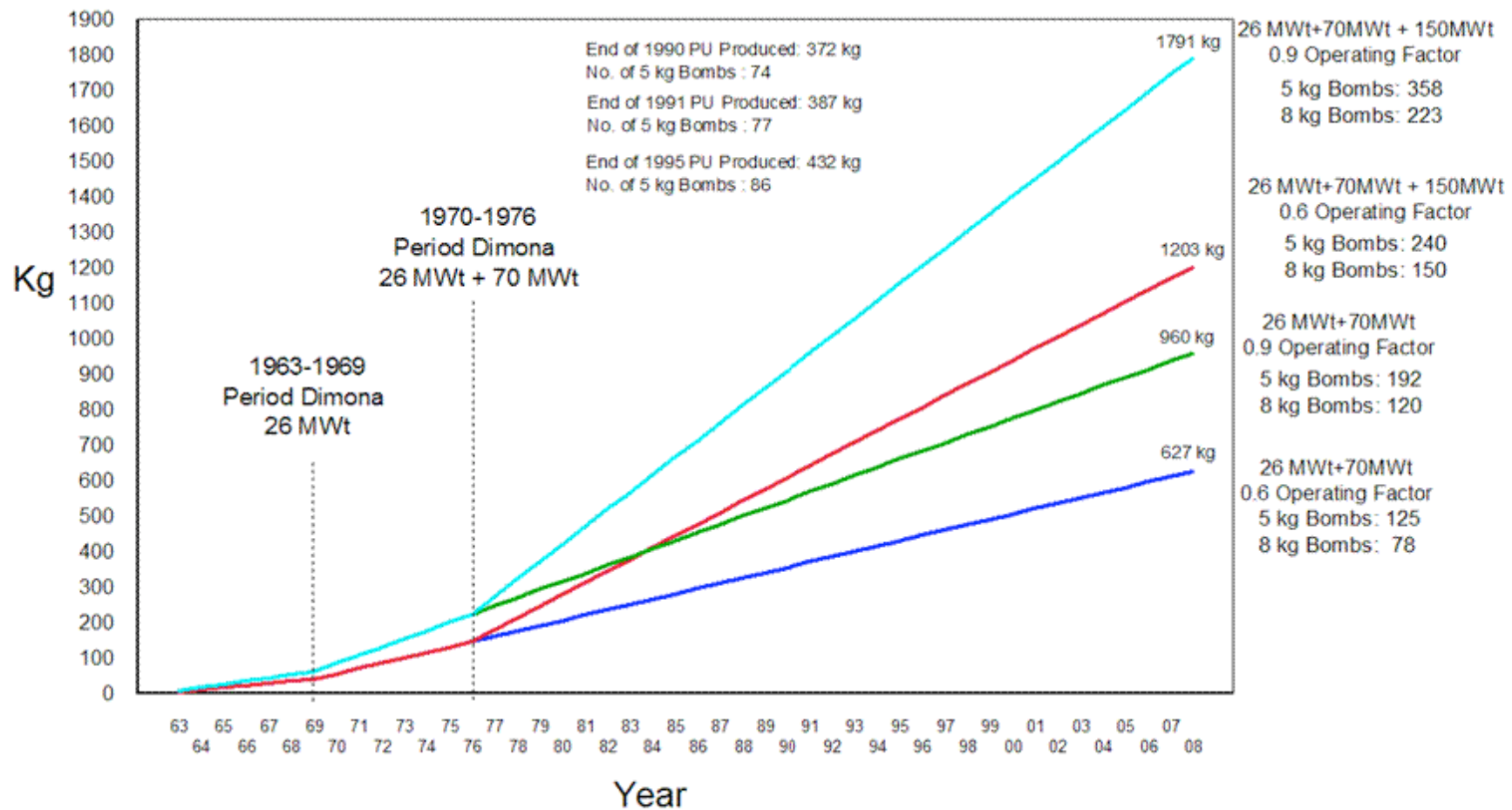
➤ Third: Dimona operates at Capacity of 150 MWt from 1976 until 2008, according to Mordecai Vanunu.

- Total Plutonium produced if the reactor was operating 60% of the time is 1203 kg. This is would produce 240 weapons that are 5 kg (10 kt yield), or 150 weapons that are 8 kg (20 kt yield).

- Total Plutonium produced if the reactor was operating 90% of the time is 1791 kg. This is would produce 358 weapons that are 5 kg (10 kt yield), or 223 weapons that are 8 kg (20 kt yield).

Our calculated estimate comes out to be consistent and close with what was written about Dimona by David Albright at the ISIS. (Source: World Inventory of Plutonium and Highly Enriched Uranium, 1992 David Albright, Frans Berkout and William Walker. SIPRI Oxford University Press 1993.)

Estimated Min and Max Production of Plutonium (Kg) & Nuclear Bombs in Dimona 1963 - 2008



➤ Two Possible Scenarios ➤ Reactor Capacity and Year ➤ % of the Time that Reactor operates at full power (90% Max and 60% for Min) ➤ Total Max and Min Plutonium Produced kg ➤ Total 5 and 8 kg Nuclear Bombs produced	Max (90% Reactor Operating Factor)			Min (60% Reactor Operating Factor)		
	Pu (kg)	5 kg Bomb (10 KT Yield)	8 kg Bomb (20 KT Yield)	Pu (kg)	5 kg Bomb (10 KT Yield)	8 kg Bomb (20 KT Yield)
Scenario I						
26 MW(t): 1963 - 1969	63	12	8	42	8	5
70 MW(t): 1970 - 2008	897	180	112	585	117	73
Total:	960	192	120	627	125	78
Scenario II						
26 MW(t): 1963 - 1969	62	12	7	42	8	5
70 MW(t): 1970 - 1977	210	42	26	138	27	17
150 MW(t): 1978 - 2008	1519	304	190	1023	205	128
Total:	1791	358	223	1203	240	150

- U.S. Government concluded that in the suspected NUMEC burglary, the amount of Uranium missing was enough to build 10 nuclear bombs.
- If Israel did steal the 175.5 kg of NUMEC Uranium then 10 more U-235 Nuclear Weapons should be added to the size of the Plutonium based Nuclear Weapons.
- With an efficiency of 3% for each of the 10 U-235 Bombs (=0.5 kg), this will result in a yield of 10 kt per bomb (from Glasstone).

Estimated Plutonium Production in the Israeli Dimona Reactor, end of 1990

Years	Power MW(t)	Total Pu (kg)	Number of Warheads
1965 - 90	24	140	28
1965 - 90	40	230	46
1965 - 75	40	-	-
1976 - 90	70	330	66
1965 - 90	70	400	80
1965 - 70	40	-	-
1970 - 77	70	-	-
1978 - 90	150	590	118

It is assumed that the reactor operates at full power an average of 60% of the time, thus it produces about 1 gram of Plutonium per MW(t) per day.

(Source: World Inventory of Plutonium and Highly Enriched Uranium, 1992 David Albright, Frans Berkout and William Walker. SIPRI Oxford University Press 1993.)

Estimated Inventories of Israeli Nuclear Weapons – Grade Plutonium Ends of 1990, 1991 and 1995

	End of 1990	End of 1991	End of 1995
Plutonium kg	230 - 400	240 - 415	275 - 475
No. of 5 kg Warheads	46 - 80	48 - 83	55 - 95

- For future Plutonium production projections, it is assumed that the Dimona reactor will maintain a power of 40 to 70 MW(t), and produce about 8.8 to 15 kg of Plutonium per year. It is also assumed that each warhead requires an average of 5 kg of weapon-grade Plutonium.
- Based on the Plutonium production estimates, and the estimate of 5 kg per warhead, Israel could have constructed between 52 and 94 warheads up to the end of 1990, and could have produced another 24 weapons in 1991.

(Source: World Inventory of Plutonium and Highly Enriched Uranium, 1992 David Albright, Frans Berkout and William Walker. SIPRI Oxford University Press 1993.)

Israel Ballistic Missiles

- Israel launched a Jericho II missile across the Mediterranean that landed about 250 miles north of Benghazi, Libya. The missile flew over 800 miles, and U.S. experts felt it had a maximum range of up to 900-940 miles (1,450 kilometers), which would allow the Jericho II to cover virtually all of the Arab world.
- The most recent version of the missile seems to be a two-stage, solid-fuel propellant with a range of up to 900 miles (1,500 kilometers) with a 2,200 pound payload.
- There are reports that Israel is developing a Jericho III missile, based on a booster it developed with South Africa in the 1980s. Jane's estimated that the missile has a range of up to 5,000 kilometers and a 1,000-kilogram warhead. This estimate is based largely on a declassified Defense Intelligence Agency estimate of the launch capability of the Shavit booster that Israel tested on September 19, 1988.

<u>System</u>	<u>Class</u>	<u>Payload</u>	<u>Warhead</u>	<u>Range (km)</u>	<u>Status</u>
Jericho I	Short Range Ballistic Missile (SRBM)	Single Warhead	450 kg; Nuclear 20KT; HE	500 km	Obsolete
Jericho II	Medium Range Ballistic Missiles (MRBM)	Single Warhead	Nuclear 1MT; HE	1500 km	Operational since 1990
Jericho II	Intercontinental Range Ballistic Missile	Single Warhead	750 Kg	4800 – 6500 km	Development Stage, Expected Service 2008

(Source: Israeli Weapons of Mass Destruction. An Overview Anthony H. Cordesman, CSIS, June 2008)

Israel: Missile Facilities

Haifa:
Rafael-Israel Armament
Development Authority.
Reported Nuclear
Missile Design and
Development.

Tel Aviv:
Israel Space Agency
and Israel Aircraft
Industries.

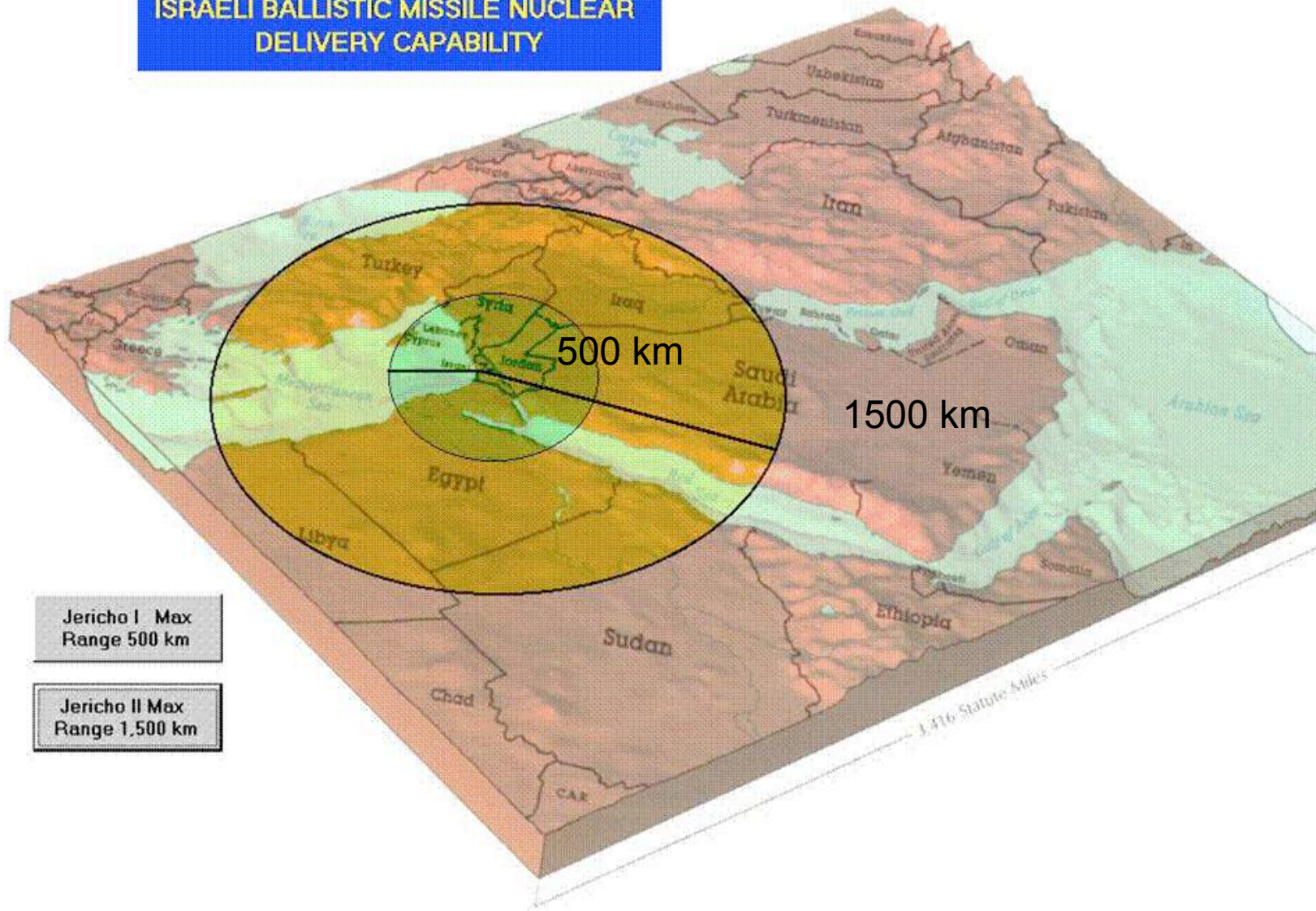
Palmachim Airbase:
Missile Test Range
and Space Launch
Facility.

Be'er Yaakov:
Missile Assembly
Facility; Arrow,
Jericho and Shavit
Missiles.

Kfar Zeharya:
A.K.A. Hirbut
Zachariah/Sdot Micha.
Jericho I missiles,
possible Jericho II.



ISRAELI BALLISTIC MISSILE NUCLEAR DELIVERY CAPABILITY



- ❑ Israel Has carried out the successful test launch of a long-range, ballistic missile capable of carrying a nuclear warhead. Israel has begun a program to extend the range of its existng Jericho-II SSM.
- ❑ The Jericho-III is planned to have a range of 4,800 km to 6,500 km which brings all of Iran and the GCC countries within range.

Iran Nuclear Weapons
and
Ballistic Missiles Program

Iranian National Security Policy, justifying its pursuit of a nuclear capability as a deterrent, is based on the following:

- Iran perceives itself as having a leadership role in the Arab and non-Arab Muslim world and to have a dominant role in the Gulf region especially in any GCC security arrangements.
- Iran considers the occupation of Iraq by the U.S. and the presence of the U.S. Fifth Fleet offshore on the waters of the Gulf, and the past U.S. declared policy for "regime change" in Iran, as a grave threat to its National Security.
- Israeli intentions to destabilize Iran and attack its nuclear facilities.
- Iran is worried about unfriendly neighbors surrounding them, including nuclear- armed Pakistan.

• This section assesses Iran's nuclear program and possible capability to produce nuclear weapons. Iran has signed and ratified the Nuclear Non-Proliferation Treaty (NPT), even though it has increased some rhetoric towards the IAEA, Iran has not pulled out.

• The three central facilities that are addressed in this study constitute the core of the Nuclear Fuel Cycle that Iran needs to produce nuclear weapons grade fissile material. The final phase, which is the process of Uranium Enrichment and fissile material production, is central in any study attempting to assess nuclear weapons production. The question is how quickly could Iran assemble and operate centrifuges in an accelerated program to make enough HEU for at least one 15 – 20 kg nuclear bomb, and when will a Plutonium Production Reactor be fully operational.

- Uranium enrichment can be used for both peaceful (nuclear fuel) and military (nuclear weapons) uses. Gas Centrifuge Technology is central in the Uranium Enrichment process. There are three major risks associated with the application of centrifuge plants:

1. Secret use of a declared, safeguarded LEU (Low Enriched Uranium) plant to produce HEU (Highly Enriched Uranium) or exceed LEU covertly.
2. Construction and operation of a clandestine plant to produce HEU.
3. Conversion of a declared, safeguarded LEU plant to HEU production following breakout (withdrawal from the NPT Treaty).

- In 2005 Iranian officials told the IAEA of Pakistan's scientist A.Q. Khan's 1987 offer of centrifuge enrichment technology. If Iran received the same nuclear weapon design that A.Q. Khan gave Libya then we are looking at the P1 and P2 centrifuges.

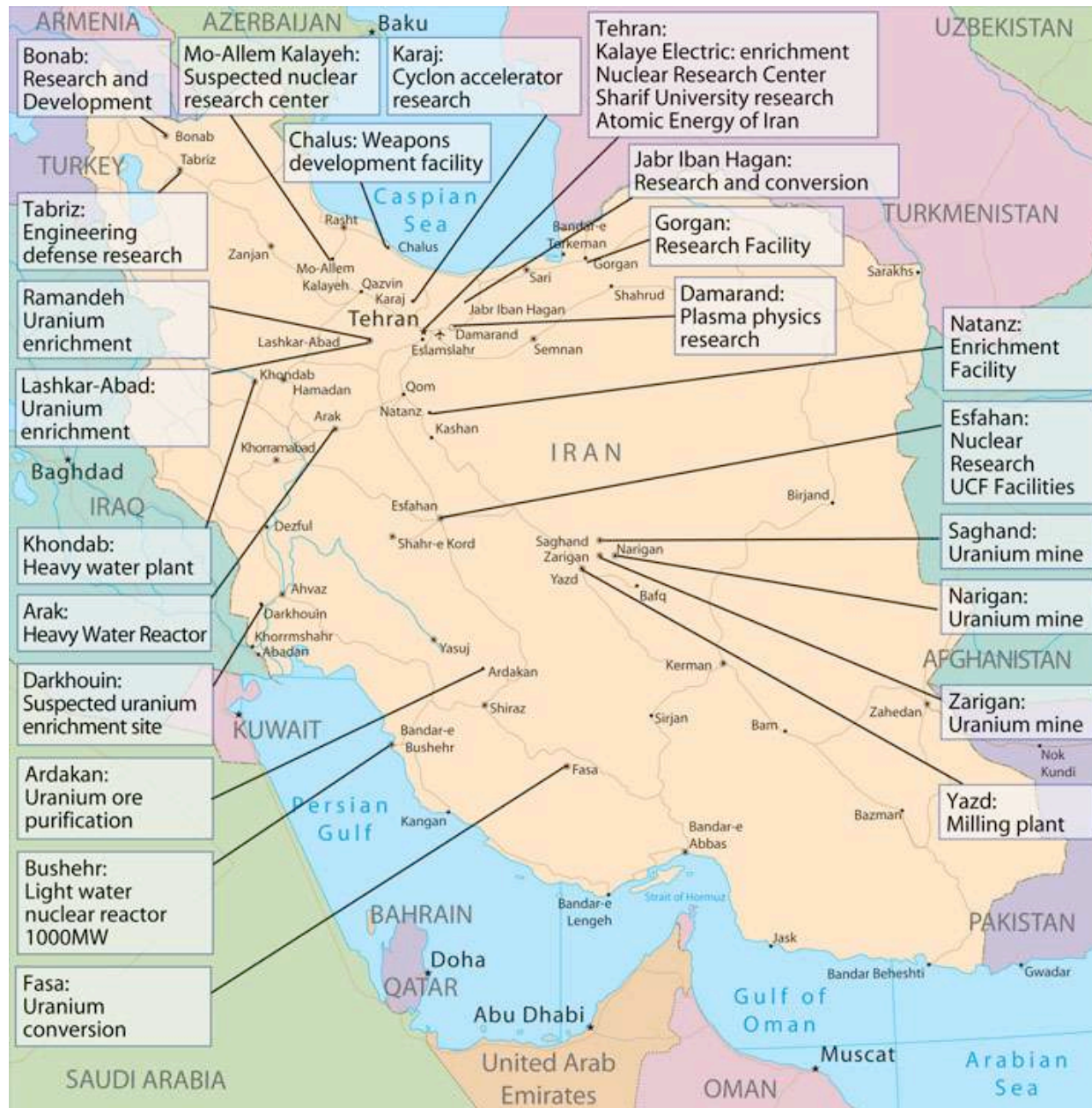
- The P1 centrifuges are based on the original 1970's URENCO design in the Netherlands that Khan acquired knowledge of while employed at the plant. Pakistan started with this technology to produce HEU for nuclear weapons.

- In 2004 Iranian officials admitted that it also possessed more advanced P2 centrifuge technology design. Such advanced designs could double Iran's enrichment capabilities, shortening the time taken for the production of HEU for a bomb.

- An important advantage of the gas centrifuge over the gaseous technique of enrichment is that it is much less energy intensive, and has proven to be better performance and more reliable and have a larger unit enrichment capacity.

(Source: A Fresh Examination of the Proliferation Dangers of Light Water Reactor. Victor Gilinsky, Marvin Miller, Harmon Hubbard. October 22, 2004. The Nonproliferation Policy Educational Center.)

Iran Nuclear Sites



(Source:NTI)

Iran: Nuclear Fuel Cycle

(3) Natanz:

- Uranium Enrichment. UF₆ produced at Esfahan is transported to this facility for enrichment via gas-centrifuge.
- The UF₆ is then sent back to a UCF for further processing to produce low-enriched uranium (3 to 5% U-235) used for fuel in light-water nuclear reactors.
- Side Products are: High-Enriched Uranium (90% U-235). Weapons-grade Uranium. At least 10kg needed for a bomb. Also Depleted Uranium, mainly U-238, can be produced as a high density metal used in weaponry.

Tehran Nuclear Research Center(TNRC):

Small scale uranium laser enrichment pilot plant. Established in 2000 and apparently dismantled in 2003.

Arak:

- 40 MW(t) Heavy Water Nuclear Reactor. Programmed to be operational by 2011.
- Can produce about 8kg of Plutonium per year, enough for a 20KT nuclear bomb every year.

(1) Yazd, Saghand, Narigan, Zarigan:

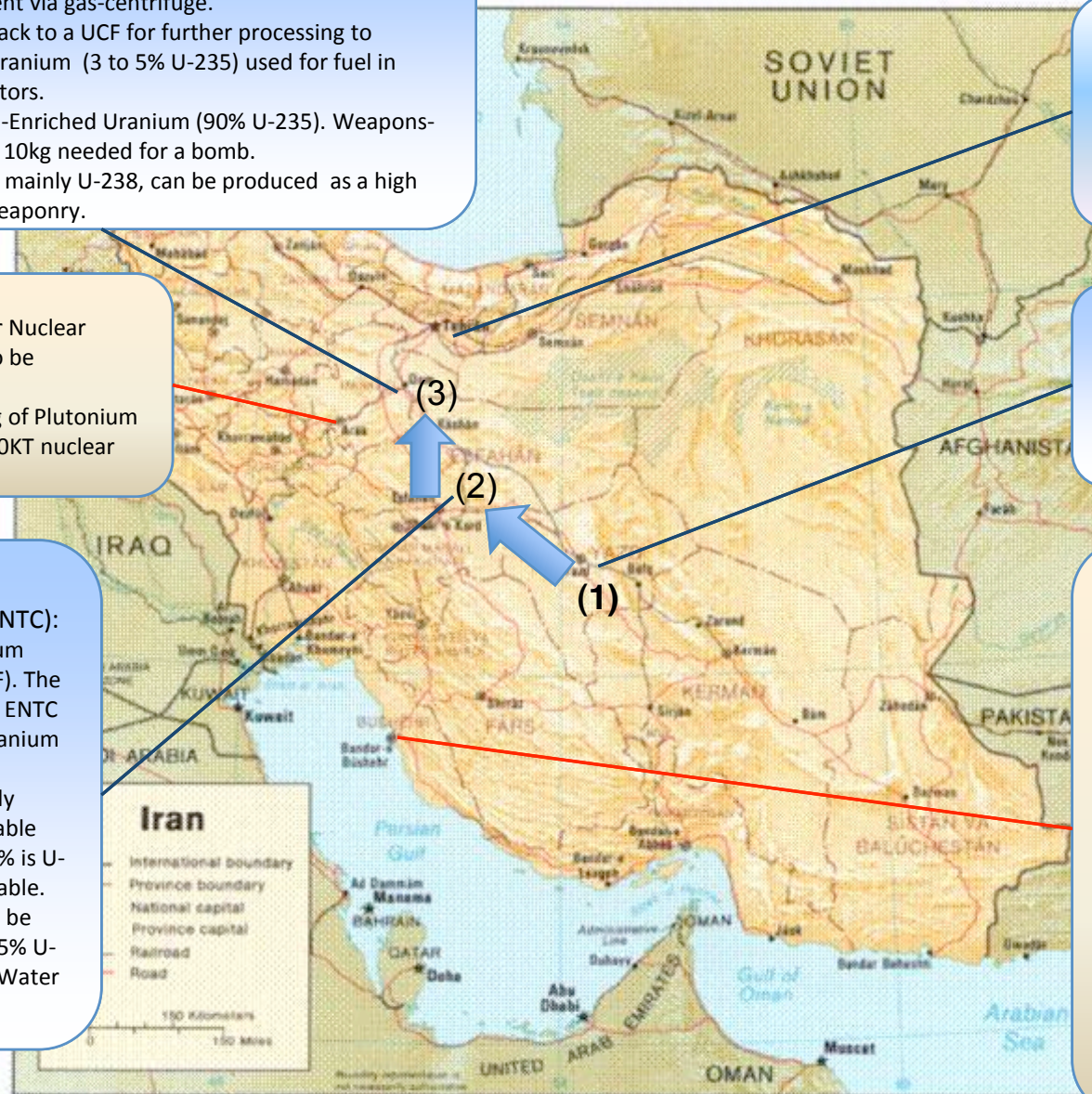
- Mining Uranium Ores
- Milling to produce U₃O₈ Uranium Oxide (Yellow Cake)

(2) Esfahan Nuclear Technology Center (ENTC):

- Industrial-Scale Uranium Conversion Facility (UCF). The U₃O₈ is transported to ENTC to convert it to UF₆ (Uranium Hexafluoride).
- Natural Uranium is only 0.7% U-235, the fissionable isotope. The other 99.3% is U-238 which is not fissionable.
- The Uranium needs to be enriched between 3 to 5% U-235 to be used in Light Water Reactors.

Bushehr:

- 1000 MW(t) Light Water Reactor for Electric Power production.
- Built by Russia and scheduled to be online in 2009.
- Russia will supply the fuel. Also spent fuel rods to be returned to Russia.
- 3 to 5% U-235 is needed for use as a fuel in light water reactors.
- The Uranium fuel for fission reactors will not make a bomb; it takes enrichment to over 90% necessary for weapons applications.



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)

The Fuel Enrichment Plant FEP

- Iran plans eventually to install about 50,000 machines and to install the centrifuges in modules of 3,000 machines that would be designed to produce low enriched uranium for power reactors.
- In a case where just 1,500 of these centrifuges were installed and optimized to produce HEU, these centrifuges could produce enough highly enriched uranium for about one nuclear weapon per year.
- When completed, the FEP could be used to produce roughly 500 kilograms of weapon-grade uranium annually. At 15-20 kilograms per weapon, that would be enough for 25-30 nuclear weapons per year.
- Each of Iran's centrifuges has an output between 2-3 SWU/year (Separative Work Unit per Year). Iran is planning a full scale FEP at Natanz which will eventually house 50,000 centrifuges, giving the plant a capacity of 150,000 SWU/year—enough for annual reloads of LEU for the Bushehr reactor or, if configured differently, 25-30 nuclear weapons worth of HEU per year
- One centrifuge could produce some 30 grams of HEU per year which is equivalent to 5 SWU. As a general rule of thumb, a cascade of 850 to 1000 centrifuge, each around 1.5 meters long operating at 400 m/sec would be able to produce about 20 to 25 kg of HEU per year, enough for one HEU bomb.
- An implosion weapon using U235 would require about 20 kg of 90% U235. Roughly 176 kg of natural uranium would be required per kg of HEU product, and about 230 SWU per kg of HEU, thus requiring a total of about 4,600 SWU per weapon. To enrich natural uranium for one gun-type uranium bomb requires roughly 14,000 SWUs. Thus, producing one HEU weapon in a year would require between 1,100 to perhaps 3,500 centrifuges.

Timeline until Iran produces it's first Nuclear Weapon

The question is how quickly could Iran assemble and operate 1,500 to 4,000 centrifuges in an accelerated Program to make enough HEU for at least one 15 – 20 kg nuclear bomb.

❑ **Mark Fitzpatrick. Survival Vol 48 no.3 Autumn 2006. Assessing Iran's Nuclear program.**

- IISS in September 2005 assessed that earliest Iran could produce sufficient HEU is by 2010. This is achieved by Iran constructing under IAEA supervision 3,000 centrifuge cascades, then when it is ready for full operation, expels the inspectors and uses the cascades for HEU production. Assembling this many centrifuges and getting them working would take until 2009. With 3,000 centrifuges it would take 9 months at the earliest for Iran to produce 25 kg HEU deemed necessary for a simple implosion Device.

❑ **BBC Interview with US Director of National Intelligence John Negroponte. 2 June 2006.**

- Director of National Intelligence John Negroponte told BBC Radio's Today programme:

"Tehran could have a nuclear bomb ready between 2010 and 2015. We don't have a clear-cut Knowledge but the estimate we have made is some time between the beginning of the next decade and the middle of the next decade they might be in a position to have a nuclear weapon, which is a cause of great concern."

❑ **David Albright and Corey Hinderstein, January 12, 2006, ISIS, Iran's Next Steps.**

The timeline created:

- Assemble 1,300 – 1,600 centrifuges. Assuming Iran starts (in January 2006) assembling centrifuges at a rate of 70-100 per month, Iran will have enough centrifuges in 6-9 months., by late 2006.
- Combine centrifuges into cascades, install control equipment, building feed and withdrawal systems, And test the Fuel Enrichment Plant. 1 YEAR
- Enrich enough HEU for a nuclear weapon. 1 YEAR
- Weaponize the HEU, about 3 YEARS.
- Thus total time to build the first bomb would be about 3 YEARS, or by 2009.

□ National Intelligence Estimate. Iran: Nuclear Intentions and Capabilities. November 2007.

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

□ Reuters, Tuesday, February 17, 2009:

- Iran "hasn't really" added any further centrifuges to refine enriched uranium, which is required for use in nuclear reactors or weapons, International Atomic Energy Agency chief Mohamed ElBaradei said on Tuesday.
 - ElBaradei said he thought the reason for this was political. The IAEA said in its latest report in November that Iran had not boosted the number of centrifuges regularly refining uranium since reaching a level of 3,800 in September. "They haven't really been adding centrifuges, which is a good thing," ElBaradei told reporters. "Our assessment is that it's a political decision."
-

- If Iran could operate the 3,800 installed centrifuges, it could produce enough HEU for a minimum of one implosion weapon each year.
- The IISS in a study "Iran's Strategic Weapons Programmes : A Net Assessment." 2005, states that a cascade of 1000 P1 centrifuges could produce 25 kg HEU weapons grade in 2.2 to 2.7 years, whereas a cascade of 3000 P1 centrifuges could produce the same amount between 271 – 330 days.
- There is no reason to believe that Iran could not be capable of installing an additional 3,000 centrifuges in 2009, which would result in Iran having the capability to produce HEU for 2 to 4 nuclear bombs per year.
- Eventually, the 50,000 centrifuges planned to be installed in the Natanz Facility could produce around 500 kg of HEU per year, which is enough for about 25 – 30 nuclear bombs a year.

The Heavy Water Nuclear Reactor at Arak:

- Iran is building a new 40-megawatt thermal-cooled heavy water reactor in Arak. The heavy water program has raised some questions regarding Iran's intentions. Iran first informed the IAEA that it was planning to export heavy water, then they stated that the heavy water will be used as a coolant and moderator for the planned IR-40 reactor for research and development, radio-isotope production and training.
- It has been mentioned by some experts that the Iran IR-40 heavy water reactor could be operational by 2011 and would allow Iran to begin producing weapons-grade material by 2014.
- Using the same basis and reactor operation factor of 0.6 as was done for the Israeli Dimona reactor, we find that the amount of Plutonium produced per year is up to 8 kg of weapons grade, enough for 1 nuclear bomb a year.

Light Water Reactors (1000 MW(t) Bushehr Light Water Reactor for Power Generation:

In a study 'A Fresh Examination of the Proliferation of Light Water Reactors' Victor Gilinsky, Marvin Miller, Harmon Hubbard, October 22, 2004. The Nonproliferation Policy Education Center. They write the following:

The report details how fresh and spent LWR fuel can be used to accelerate a nation's illicit weapons program significantly. In the case of a state that can enrich uranium (either covertly or commercially), fresh lightly enriched reactor fuel rods could be seized and the uranium oxide pellets they contain quickly crushed and fluoridated. This lightly enriched uranium feed material, in turn, could enable a would-be bomb maker to produce a significant number of weapons with one-fifth the level of effort than what would otherwise be required to enrich the natural uranium to weapons grade. As for spent LWR fuel, the report details how about a year after an LWR of the size Iran has was brought on line, as much as 60 Nagasaki bombs' worth of near-weapons grade material could be seized and the first bomb made in a matter of weeks. The report also details how the reliability of the bombs made of this material, moreover, is similar to that of devices made of pure weapons grade plutonium.

The study continues to say...

The running assumption today, of course, is that any nation diverting either the fresh or spent fuel from an LWR site would be detected by IAEA inspectors. This clearly is the premise of the deal the United Kingdom, France, Germany, and Russia are making to Iran: Russia will provide Iran with fresh reactor fuel if Iran promises to suspend activities at its known uranium enrichment facilities and surrenders spent fuel from its LWR for transit and storage in Russia. What's not fully appreciated, however, is that Iran might well be able to divert these materials to covert enrichment or reprocessing plants and might well be able to do so without detection. Lengthy exposure to spent fuel that has just left an LWR of the sort required to package and ship long distances out of the country is quite hazardous. If Iran was set on making bombs, though, it might be willing to take the risks associated with a much shorter transit for quick reprocessing. The health hazards associated with diverting fresh LWR fuel, on the other hand, are virtually nil.



2009: Bushehr Online Start increasing centrifuges in Esfahan 2010: Start producing weapons grade HEU 2011: Arak Operational	2013: When Iran will have a nuclear weapon 2014: All 50,000 centrifuges installed Start Producing 25 to 30 Nuclear Weapon per year Weapon grade material in the Arak Reactor to Produce 1 nuclear bomb a year.
Israeli Threat Time Frame when Iran will have a Nuclear Weapon.	U.S. Threat Time Frame when Iran will have a Nuclear Weapon
• Israel states that Iran should not be allowed to obtain any nuclear capabilities that could eventually allow it to produce nuclear weapons. • Israel views Iran as an Existential Threat and must be dealt with in the immediate Future. • US approach is to leave all options on the table.	

Set of circumstances that could accelerate a strike on Iran's Nuclear Facilities:

- By 2010 Iran could pose a serious threat to its neighbors and Israel. Enough of an inventory of Nuclear Weapons that can serve as a deterrent against U.S. and Israeli strikes.
- A modern SAM air defense system, such as the Russian S-300PMU2 "Favorit", giving Iran an advanced Ballistic Missile Defense (BMD) capability in addition to an advanced SAM Air Defense System.
- A maritime capability that can threaten commercial shipping and Naval Forces in the Gulf , and possibly interrupt the flow of oil through the Straits of Hormuz.
- Having in its possession highly accurate short, medium and long range ballistic missiles, capable of carrying WMD
- Train and Control a number of Counter Insurgency groups to Increase the threat of asymmetric attacks against American interests and allies in the region and even beyond the region.

Options to deal with Iran's Nuclear Program within the Time Frame

- **Diplomacy and Dialog:**
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.
- **Incentives:**
Options that give Iran security guarantees, economic and trade advantages.
- **Containment:**
Creation of a mix of defensive and offensive measures that would both deny Iran the ability to exploit its WMD capabilities and show that any effort to use such weapons to intimidate or gain military advantage would be offset by the response.
- **Sanctions:**
Controls and measures designed to put economic pressure on Iran, limit its access to technology, and/or limit its access to arms.
- **Regime change:**
Efforts to change the regime and create one that will not proliferate.
- **Defense:**
A mix of measures like missile defense, air defense, counterterrorism, counter smuggling/covert operations capability, civil defense, and passive defense that would both deter Iran and protect against any use it can make of its WMD capabilities.
- **Deterrence:**
Creation of military threats to Iran so great that no rational Iranian leader could see an advantage from using weapons of mass destruction.
- **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 military force as a last resort when all other options absolutely fail.

(Source: Anthony Cordesman. CSIS Report. Iranian WMD: Strategic and War fighting Implications of a Nuclear Armed Iran)

Iran Nuclear Target Set

The main facilities which are critical nodes in Iran's Nuclear infrastructure that can stop or at the least delay the program:

- Nuclear Fuel Cycle:
 - Esfahan : Nuclear Research Center. Uranium Conversion Facility (UCF).
 - Natanz : Uranium Enrichment Facility
- Plutonium Production Nuclear Reactor:
 - Arak : Heavy Water Plant and future plutonium production center

- We consider three main target facilities which if attacked could either destroy the program or delay it for some years. After analyzing the targets a damage criteria is suggested measured by the blast pressure of the weapon used. It would be safe to assume a required 5 to 10 psi which would be sufficient to either destroy or damage the facility for a long period of time. Care must be taken not to overkill for this could practically double the strike force required.

- Damage Criteria:

- 10 psi : Reinforced concrete buildings are severely damaged or demolished. Most people are killed.

- 5 psi : Most buildings collapse

- 3 psi : Residential structures collapse

- We then work out how many bombs must be dropped to cover a certain area above and below ground. To be on the safe side, we consider weapons that penetrate hard and deeply buried targets (HDBTs). The Natanz facility for instance is reported to have underground facilities where the centrifuges are installed for uranium enrichment

- Natanz facility apparently covers some 670,000 sq ft in total, the Fuel Enrichment Plant (FEP) complex was built some 8 meters-deep into the ground and protected by a concrete wall 2.5 meters thick, itself protected by another concrete wall. By mid-2004 the Natanz centrifuge facility was hardened with a roof of several meters of reinforced concrete and buried under a layer of earth some 75 feet deep. It is reported that this facility will eventually house some 50,000 centrifuges.

- The Esfahan Nuclear Technology Center (ENTC) is an Industrial-Scale Uranium Conversion Facility (UCF). The U3O8 is transported to ENTC to convert it to UF6 (Uranium Hexafluoride). The area of the buildings is estimated to be around 100,000 sq ft. and are above ground.

- The Arak Facility covers an area of approximately 55,000 sq ft and contains the Heavy Water Reactor and a set of cooling towers. There are no underground facilities reported in this complex.

(Source:GlobalSecurity.org)

300 miles
500 km

TURKEY

Lashkar A'bad



Tehran



Arak



Isfahan



Natanz



Saghand



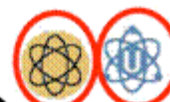
Ardekan

IRAN



1000 MW

Bushehr



Gachin

MW Megawatts



Uranium processing facility



Uranium mines



Heavy-water facility



Research reactors / research facilities



Uranium enrichment facility



Light-water reactor (under construction)

TURKMENISTAN

CASPIAN SEA

MIDDLE EAST

AFGHANISTAN

PAKISTAN

KUWAIT

SAUDI ARABIA

BAHRAIN

QATAR

The Gulf

Gulf of Oman

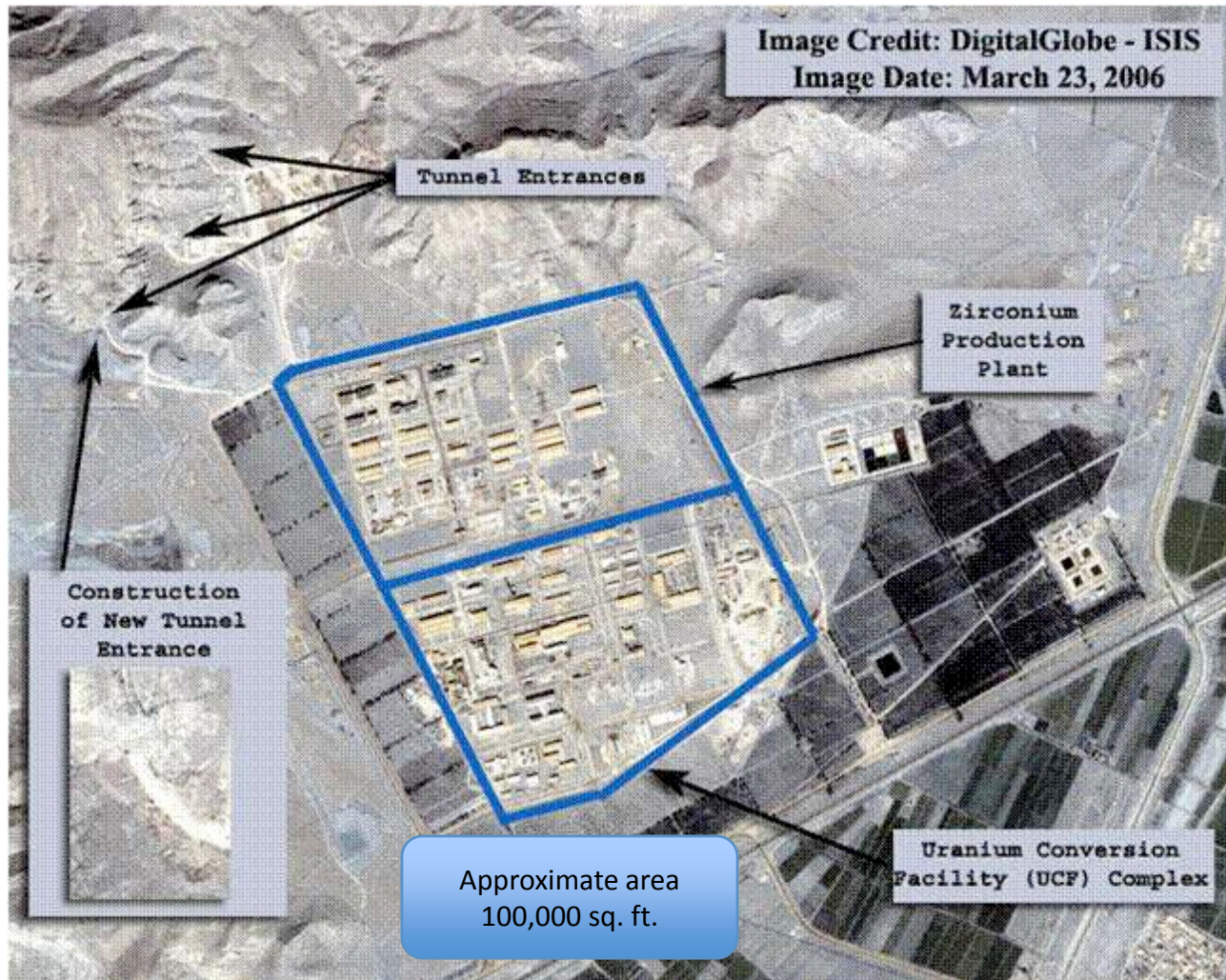
Mission Planning Payloads

GBU-27	BLU-109 2000lb class penetrating warhead. Penetrates 1.8 to 2.4 meters of concrete/hard targets depending on angle of attach. It carries 550 lbs of high explosives, and can penetrate more than 6 feet of reinforced concrete.	This 2000lb weapon would be most likely used against the Esfahan Uranium Conversion Facility. In addition the GBU-10 can also be used.
GBU-28	BLU-113 5000 lb class penetrating warhead. Penetrates at least 6 meters (20 feet) of concrete, presumably reinforced concrete and 30 meters(100 ft) of earth. It is a 5,000 lb laser guided conventional munitions that uses a 4,000 lb penetrating warhead blast/fragmentation, which contains 630 pounds of explosive.	The GBU-28/BLU-113 5000lb penetrator would be the most likely weapon of choice against the Natanz Centrifuge Facility as well as the Esfahan Uranium Conversion Facility. Used as a Bunker Buster. 2 properly sequenced GBU's would most certainly penetrate the 30 meters of earth and up to 6m of concrete. The Probability of Hit (PH) of 2 GBU's aimed at the same point essentially one following the other is 50%.

Peak Overpressure Distance

Weapon	Warhead (kg)	10 psi (ft)	5 psi (ft)	3 psi (ft)
GBU-28	306	62	92	125
GBU-27	240	59	89	118
GB-10	428	69	105	144

Esfahan
Nuclear Research Center.
Uranium Conversion Facility (UCF)



Esfahan

Facility not buried, and area some 100,000 sq ft.

psi	Peak Overpressure Distance (ft)	Number of GBU-27 required to cover 100,000 sq ft.
10	59	9
5	89	4
3	118	2

- We assume that a 5 psi blast is required.
- Assume a 90% system reliability, then 5 GBU-27 would be required.
- This would require 5 F-16Is if each carries 1 GBU-27 PG Bombs.

NATANZ : Uranium Enrichment Facility

Two earth and concrete – covered underground buildings.

323,000 sq.ft.

95,000 sq. ft
Underground
Building.

323,000 sq.ft.

Original Uranium Separation
Pilot Plant : Six buildings over
120,000 total square feet.

Administration
Building

Vehicle access
tunnel

Source: Digital Globe

Natanz Facility

psi	Distance of Peak Overpressure (ft)	Underground Facilities (646,000 sq ft) Number of GBU-28s required	Uranium Separation Plant 6 Buildings (95,500 sq ft) Number of GBU-28s required
10	62	48	7
5	92	22	3
3	125	12	2

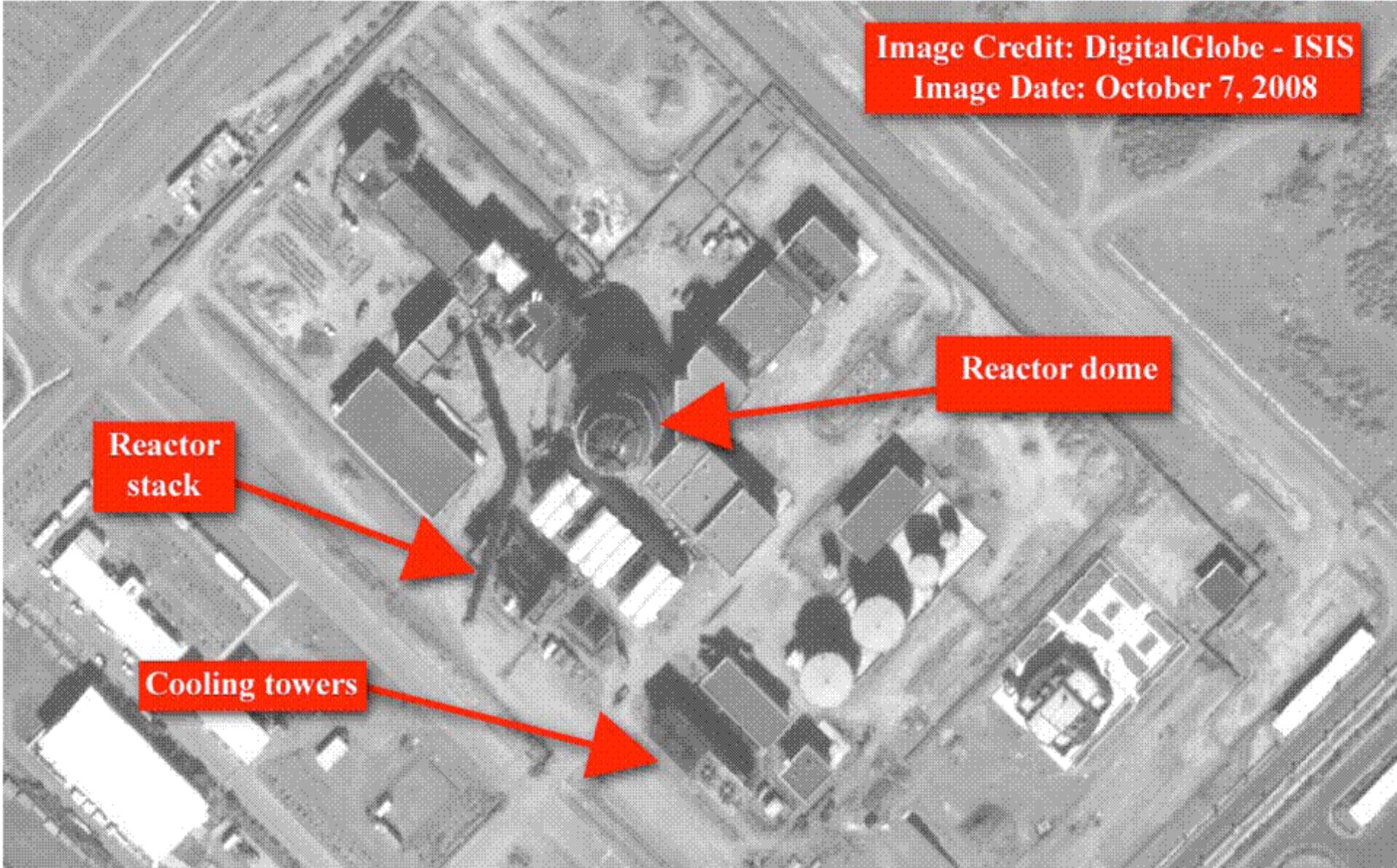
- We assume a required psi of 5psi, as a 10psi requirement could be an overkill.
- We find that 22 GBU-28 are needed to cover the underground facilities of 585,000 sq ft in area.
- This would imply that on the average each GBU-28 covers an area of 26,600 sq ft.
- Since we also assumed a 50% penetration for each GBU-28 pair, we would then require some 44 GBU-28 PG Bombs.
- For the Uranium Separation Buildings, we can assume that the requirement would also be 5 psi, therefore the number of GBU-28 comes out to be 3 that would cover the 85,500 sq ft area.
- A force of either 50 F-15Es have to be allocated if 1 GBU-28 is mounted on the Centerline.
- Or a force of 25 F-15E have to be allocated if 2 GBU-28 are carried.

(We assume that 90% of the surface area of each target site is covered, $0.9 \text{ of } 646,000 = 585,500$)



ARAK Heavy Water Nuclear Reactor And Future Plutonium Production Reactor

Image Credit: DigitalGlobe - ISIS
Image Date: October 7, 2008



October 7, 2008 Digital Globe Image of Arak Heavy Water Reactor in Iran

Source: ISIS Report. David Albright, Paul Brannan. November 13, 2008.

Arak

psi	Distance of Peak Overpressure (ft)	Heavy Water Production Plant some 55,000sq ft. Number of GBU-10s required	Nuclear Reactor Construction Site Number of GBU-10s required
10	69	4	4

- The main elements of the Production Plant to manufacture Heavy Water are the set of towers that cover an area of some 55,000 sq ft.
- 4 GBU-10 would be required to cover the whole area and collapse the towers.
- We shall assume that 4 GBU-10s would be required to destroy the Reactor if the Construction has been completed if and when Israel decides to go ahead with the Mission to Strike Iran's Nuclear facilities.
- Force allocation required would then be 4 to 8 F-16Is if each F-16I carries 1 GBU-10.

Strike Force Required

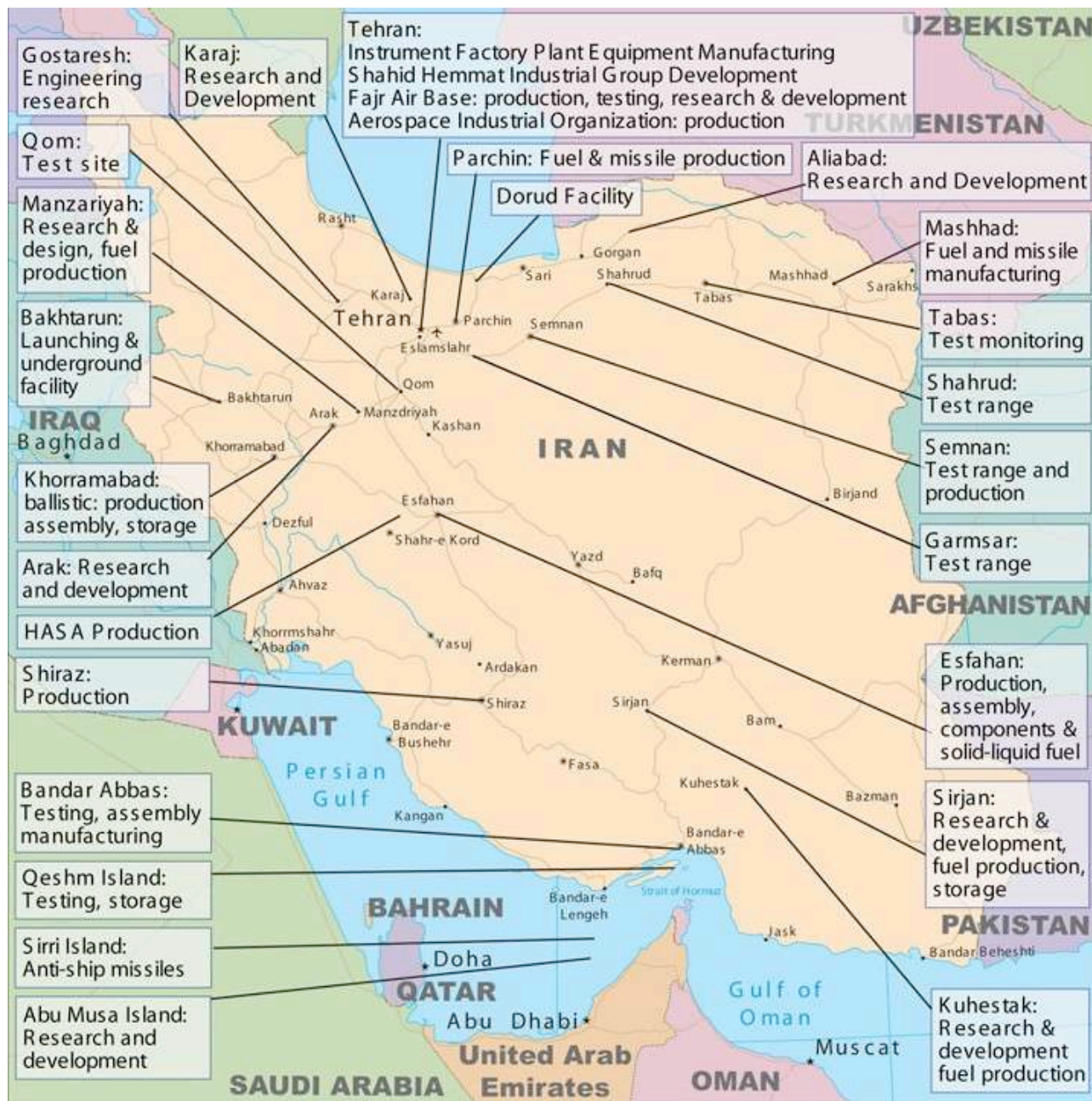
Target Facility	If 2 PG Bombs are carried	If 1 PG Bomb is carried
Natanz	25 F-15E	50 F-15E
Esfahan	3 F-16I	5 F-16I
Arak	4 F-16I	8 F-16I
<i>Total</i>	25 F-15E + 7 F-16I	50 F-15E + 13 F-16I

- F-15E Empty Weight plus Maximum Fuel = 66,831 lbs
- F-15E Take off Gross Weight = 81,000 lbs
- So each F-15E will still be capable of carrying an extra 10,000 lbs, 2 BLU-113 5,000 lb class warheads (2 GBU-28 PG Bombs).

❑ Total Force could be 25 F-15E for strike and 7 F-16I, with 38 F-16I for Air Escort/Fighter Sweep and Suppression of Enemy Air Defense (SEAD).

❑ Bringing the total allocated strike force against Nuclear Targets in Iran to 70 aircraft.

Iran: Missile Sites



(Source:NTI)

Possible Missile Production Target Sites North of Esfahan as well being close to the Nuclear Target Sites

Site	Nuclear	Missiles
Arak	Plutonium Production	Research & Development
Esfahan	Uranium Conversion facility	Production, assembly components & sold fuel propellants
Bakhtarun (Close to Arak)	-	Launching & Underground Facility
Khorramabad (close to Arak)	-	Ballistic, Production, Assembly Storage
Manzariyah (Close to Arak)	-	Research & Design Fuel Production
Qom (Close to Natanz)	Natanz: a Uranium Enrichment Facility	Test Site
Hasa (Close to Esfahan)	-	Production Facility

The GBU-27, 2000lb weapon would be most likely used against the Missiles Sites. In addition the GBU-10 can also be used.

Allocating 4 GBU-27 per site would require 2 F-16I aircrafts per site. For the 5 sites this would bring number of F-16I to 10. Arak and Esfahan will be affected during the Nuclear Facilities strikes.

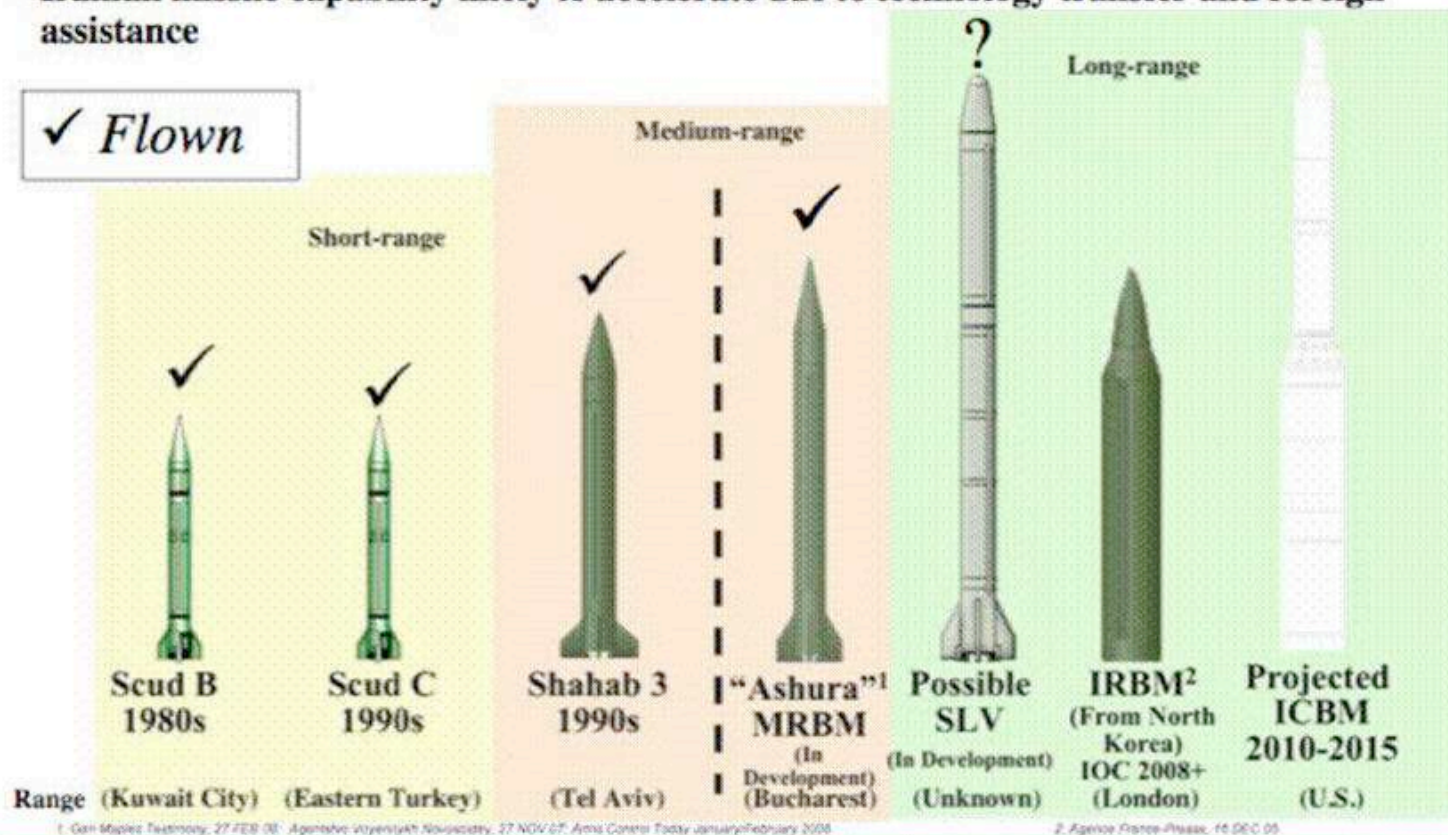
Stages of Development of Iran's Missiles

Designation	Stages	Progenitor Missiles	Propellant	Range (Km)	Payload (Kg)	IOC (Year)	Inventory
Mushak-120	1	CSS-8, SA-2	Solid	130	500	2001	?
Mushak-160	1	CSS-8, SA-2	Liquid	160	500	2002	?
Mushak-200	1	SA-2	Liquid	200	500	NA	0
Shahab-1	1	Soviet SSN-4, N Korean SCUD B	Liquid	300	987-1,000	1995	250-300
Shahab-2	1	Soviet SSN-4, N Korean SCUD C	Liquid	500	750-989	?	200-450 (these are very high estimates)
Shahab-3	1	N Korea Nodong-1	Liquid	1,300	760-1,158	2002	25-100
Shahab-4	2	N Korea Taep'o-dong-1	Liquid	3,000	1,040-1,500	NA	0
Ghadr 101	multi	Pakistan Shaheen-1	Solid	2,500	NA	NA	0
Ghadr 110	multi	Pakistan Shaheen-2	Solid	3,000	NA	NA	0
IRIS	1	China M-18	Solid	3,000	760-1,158	2005	NA
Kh-55	1	Soviet AS-15 Kent, Ukraine	jet engine	2,900-3,000	200kgt nuclear	2001	12
Shahab-5	3	N Korea Taep'o-dong-2	Liquid	5,500	390-1,000	NA	0
Shahab-6	3	N Korea Taep'o-dong-2	Liquid	10,000	270-1,220	NA	0

Source: Adapted from Iran Special Weapons Guide, Global Security.org, available at: <http://www.globalsecurity.org/wmd/world/iran/missile.htm>

Iranian Missile Developments

- Iranian missile capability likely to accelerate due to technology transfer and foreign assistance



"Iran continues to develop and acquire ballistic missiles that can hit Israel and central Europe" – General Maples, Director of U.S. Defense Intelligence Agency

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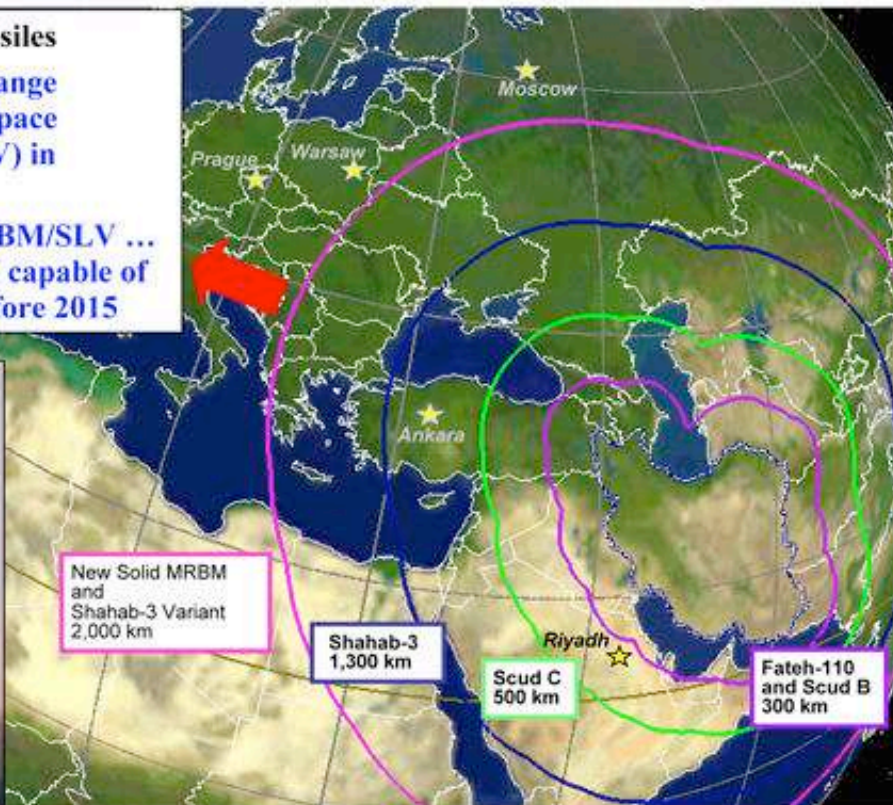
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Iranian Ballistic Missile Threat

• Long-Range Ballistic Missiles

- New Intermediate Range Ballistic Missile or Space Launch Vehicle (SLV) in development
- Likely to develop ICBM/SLV ... could have an ICBM capable of reaching the U.S. before 2015



ms-109673B / 061407

Shahab 3/3A

Range (km)	Payload (kg)
1,350	1,158
1,400	987
1,500	760
1,540	650
1,560	590.27
1,580	557.33
1,600	550
1,780	240
2,000	0

(Source: Missile Defense Program Overview for the European Union, Committee on Foreign Affairs, Subcommittee on Security and Defense. Dr. Patricia Sanders. Executive Director. Missile Defense Agency)

Israel Air Force Aircraft Mission Capabilities.

- The Israeli Airforce has reduced its number of aircraft, over the past decade, but at the same time has effectively increased its qualitative advantage over any Airforce in the region and has been transforming itself into a fighting force that can:

- Detect, track, and engage mobile, concealed as well as Hard and Deeply Buried Targets (HDBTs).
- Rapidly destroying advanced air defense systems.
- Operate long Range, over the horizon, surveillance/intelligence gathering.
- Carry out deep strike missions with aircraft such as the F-15I/F-16I.

- The following would be the requirements for a modern fighting force:

- High Operational Readiness/Full Mission Capable state and High Sortie Rates
- Air to Air weapons
- Air to Ground Weapons
- All Weather Day Night Operational Capability
- C4I/Battle Management
- Integrated Air Defense System/Ballistic Missile Defense (BMD)
- Quick Response Time/Ground Launched Intercepts
- Ground and Airborne Electronic Warfare (ESM/ECM/ECCM)
- Aircraft Systems Capability (Radars)
- Access to Modern technology
- In country Aeronautical and Electronic industry.

- In all above aspects the Israeli Air Force is either Superior or Greatly Superior to the Iranian Airforce which is basically obsolete with an inventory of equipment that goes back to the 1970's, same goes for the Syrian Airforce and SAM Air Defense.

(Source: Israeli-Syrian Air and SAM Strength Analysis. Cordesman and Toukan. CSIS, 10, November 2008)

Main Airbases

Hatzerim

F-15I

F-16I

Hatzor:

F-16C/D

F-16A/B

Ben Gurion:

KC-130H

B-707

Ovda:

F-16A/B

F-16I

Ramat David:

F-16C/D

Ramon:

F-16I

Tel Nof:

F-15A/B

F-15C/D

F-15I

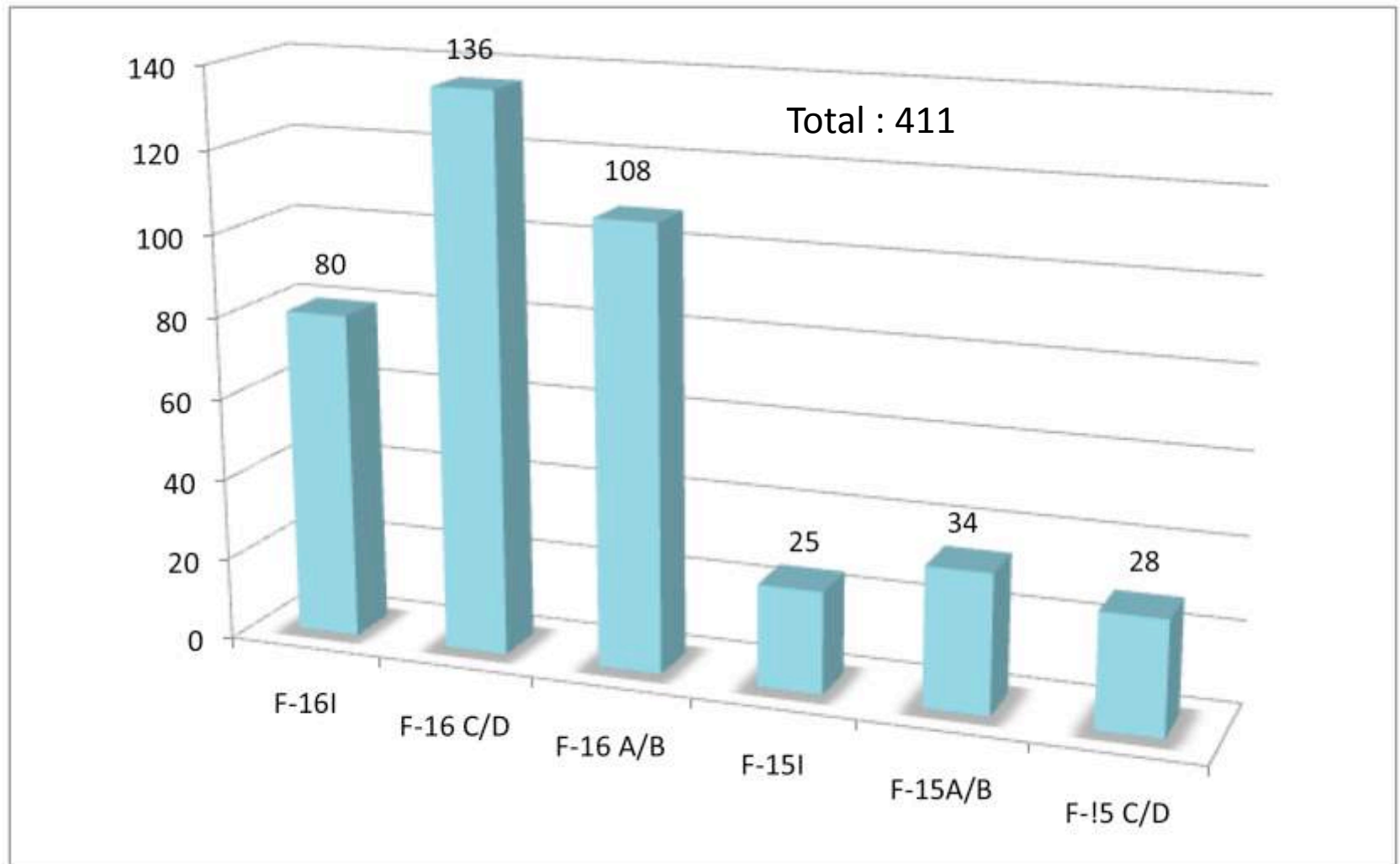
F-16A/B

F-16C/D

(Source:GlobalSecurity.org)



Israel Airforce Order of Battle 2008



(Source: Israeli-Syrian Air and SAM Strength Analysis. Cordesman and Toukan. CSIS, 10, November 2008)

Aircraft Fuel Load

	F-15E	F-16
Internal Fuel	1,987 Gal = 12,916 lbs	1,072 Gal = 6,972 lbs
External Tanks (Left & Right)	2 x 610 Gal = 2 x 3,965 lbs	2 x 370 Gal = 4,810 lbs 2 x 600 Gal = 7,800 lbs
External CL Tanks	610 Gal = 3,965 lbs	300 Gal = 1,950 lbs
Conformal Fuel Tanks (CFTs)	2 x 720 Gal = 2 x 4,680 lbs	-
Max Fuel Load	5,263 Gal = 34,213 lbs	2,572 Gal = 16,722 lbs
Weight Empty (lbs)	32,618 lbs	15,870 lb
Ferry Range- External Tanks Dropped (nmi)	2,500 nmi	2,275 nmi
Take off Gross Weight (TOGW)	81,000 lbs	37,500 lbs

F-16C

Mission	Hi-Lo-Lo-Hi	Hi-Lo-Lo-Hi	Hi-Lo-Lo-Hi	Hi-Lo-Lo-Hi	Air Superiority Hi-Hi	Air Superiority Hi-Hi
AIM-9	2	2	2	2	2	2
MK 82 (500 lbs)	4	4	8	8	-	-
600 Gal Tank	-	2	-	2	-	2
370 Gal Tank	2	-	2	-	2	-
300 Gal Tank	1	1	-	-	1	1
Fuel Quantity (Gallons)	2,113	2,573	1,813	2,273	2,113	2,573
Range nmi – Tanks Dropped	900	1,030	731	877	• 1026 • 1,162 without combat	• 1,125 • 1,365 without combat

Internal Fuel : 6,972 lbs = 1,072 Gal

F-15E

- The F-15E is a two place, high performance, supersonic, all weather, day/night, dual fighter.
- The F-15E carries BVR air-to-air missiles while configured for air-to-ground missions, enabling the aircraft to engage enemy aircraft while enroute to the target area on air-to-ground missions, giving the F-15E a Self-Escort capability.

Mission	Hi-Lo-Lo-Hi	Hi-Lo-Lo-Hi	Hi-Lo-Lo-Hi	Hi-Lo-Lo-Hi	Hi-Lo-Lo-Hi
Air to Air Missiles	4	4	4	4	4
Payload	2 x MK 84	1 x MK 84	2 x GBU-10 PGM	1 x GBU-10 PGM	6 x MK 82
External 600 Gal Tanks	1	2	1	2	2
Range (nmi)	•600 Tanks Dropped •560 Tanks Retained	•750 Tanks Dropped •700 Tanks Retained	•595 Tanks Dropped •540 Tanks Retained	•745 Tanks Dropped •680 Tanks Retained	•650 Tanks Dropped •615 Tanks Retained

F100-PW-229 Engines
 LANTIRN Pods
 Internal Fuel: 12,916 lbs
 2 CFTs Installed : 9,400 lbs
 3 x 610 Gallons : 11,895 lbs
 MK 84 : 2000 lb Bomb
 MK 82 : 500 lb Bomb
 GBU-10 2000 lb class PG Bomb
 lb = 6.5 lb/gal

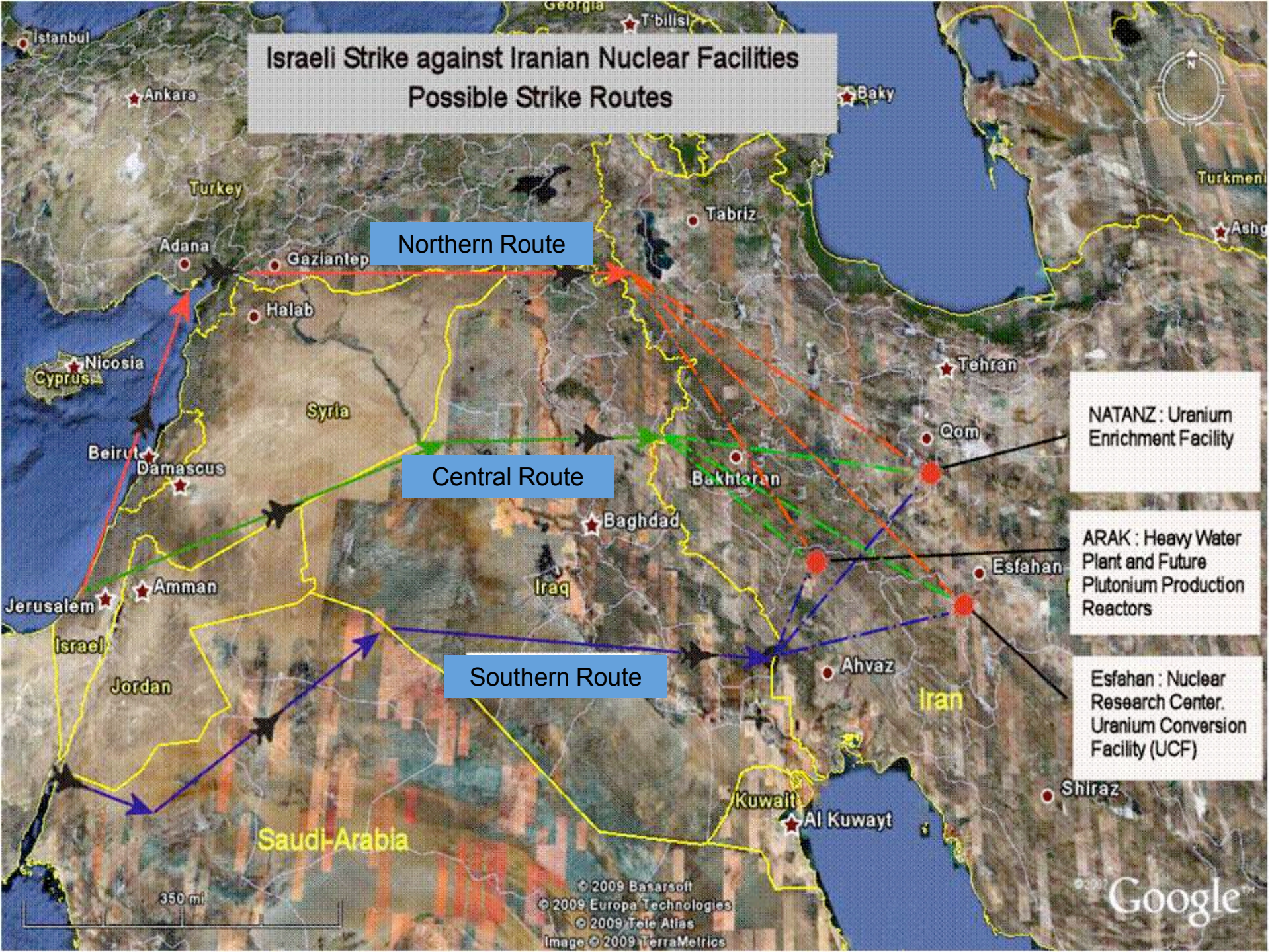
Aerial Refueling

- The F-15E and F-16C refueling system is compatible with the refueling boom from KC-135A and KC-10 tankers.
- Some Future Options to Extend the Range of the F-15E:
 - An in flight refueling (IFR) probe could be incorporated into the F-15E to give the aircraft the capability to refuel from drogue configured tankers.
 - Studies have also taken place regarding Buddy Refueling between F-15Es that can be packaged in an external tank or CFT. This would be useful in an emergency situation when Strike Missions are in Egress from the target area.
 - Larger External Tanks (Dropped Tanks). These tanks would have a fuel capacity of 800 gallons compared to the standard 610 gallons. The F-15E's mission radius would then be increased by about 10%.
 - Additional Internal Fuel added to the outer wing of the F-15E. This would increase the mission radius by 2%
 - Larger Conformal Fuel Tanks (CFTs). The F-15E could still carry the air-to-air and air-to-ground weapons and external pods as well as the fuel tanks. This would increase the mission radius by 5%.

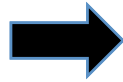
Scenario I
**Israeli Airforce Strike against Iranian
Nuclear Facilities and Ballistic Missile Sites**

Israeli Strike against Iranian Nuclear Facilities

Possible Strike Routes



Northern Route:

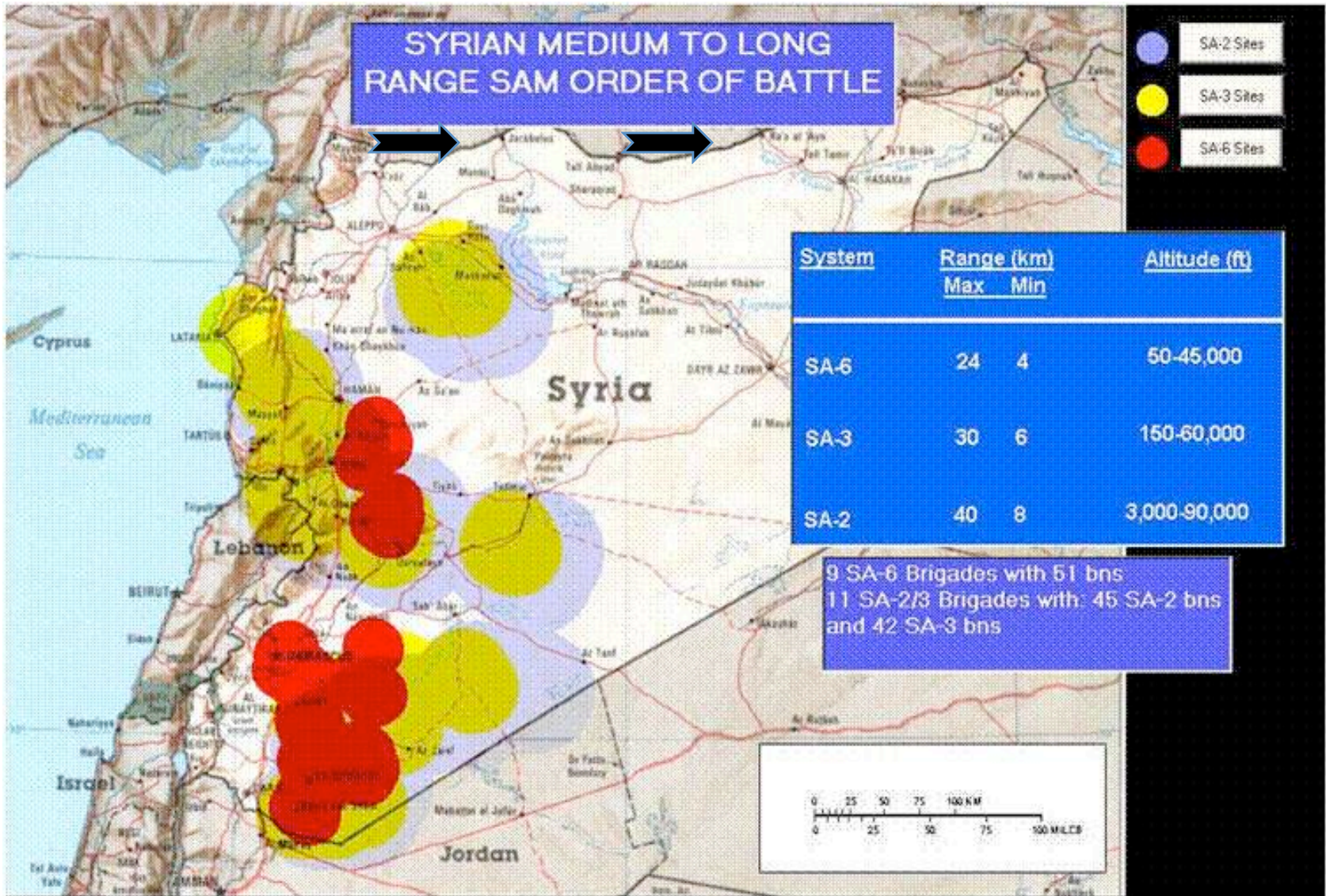


- Flying to the North towards the corner of the Syrian – Turkish borders, then turning East hugging the Syrian border all throughout the West to East flight route.
- Israel could again utilize it's EW capabilities as during the raid on Dayr az-Zawr, Syria, on September, 2007
- The Israeli F-15s and F-16s that got through the Syrian air defense radars without being detected is attributed to a Network Attack System, similar to the U.S. "Suter" system.
- The technology allows users to invade and hack enemy communication networks, so enemy sensors can be manipulated into positions that approaching aircraft can't be seen.
- The process involves locating enemy emitters and then directing data streams into them that can include false targets and cause algorithms that allow control over the system.
- In essence the elements of the attack included:
 - Brute Force jamming
 - Network penetration involving both remote air to ground electronic attack and penetration through computer to computer links.
- (Aviation Week & Space Technology, Nov 25, 2007):

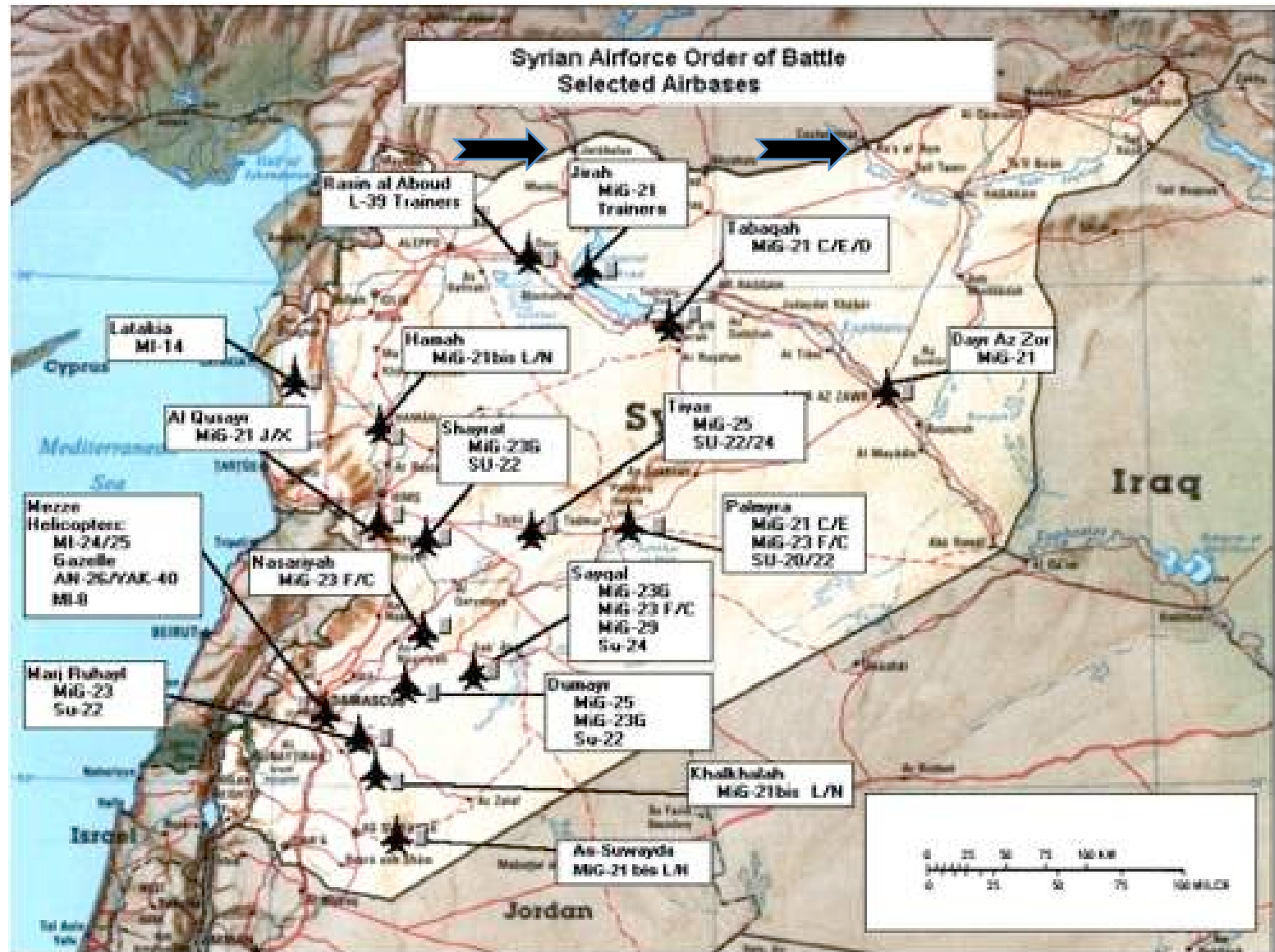
"Israel's capabilities are similar to the "Suter" network-invasion capability that was developed by the U.S. using the EC-130 Compass Call electronic attack aircraft to shoot data streams, laced with sophisticated algorithms, into enemy antennas. The passive, RC-135 Rivet Joint electronic surveillance aircraft then monitored enemy signals to ensure the data streams were having the intended effect on the target sensors. Israel duplicated the capability when it fielded its two new Gulfstream G550 special missions aircraft designs. Both were modified by Israel Aerospace Industries' Elta Div. in time for the 2006 Lebanon war. The ground surveillance radar version can provide data streams from large active, electronically scanned array radars, while the intelligence version provided the signals surveillance and analyses."

- In this EW environment even if Turkey detects an aerial activity it very likely might look upon the Aircraft as friendly and not flying over it's territory. Whereas Syria would be spoofed to believe no major threats are flying over it's border.
- No major Syrian Airbases are close to the Northern border and the aircraft stationed are the MiG-21 type, one airbase for training.
- On the last leg of the flight, only a small fraction of the distance left to the Iranian border could be in Turkey or the Northern tip of the Iraqi borders.
- The flight route would also be ideal for the F-15's and the F-16's to do aerial refueling from airborne tankers, on ingress and egress from Iran.
- This northern route, along the Syrian – Turkish borders, could result in a low political risk with Syria, whom Israel has no Peace Treaty with and not even a formal negotiations process any more.
- If the Israeli aircraft do actually fly over Turkey that would constitute a clear Turkish – Israel and even U.S. conspiracy to attack Iran, so the Political risks could be high with Turkey.
- Operationally, the risk from Syria would be low, whereas the risk from Turkey could be of medium level if Turkey deems it necessary to react militarily.

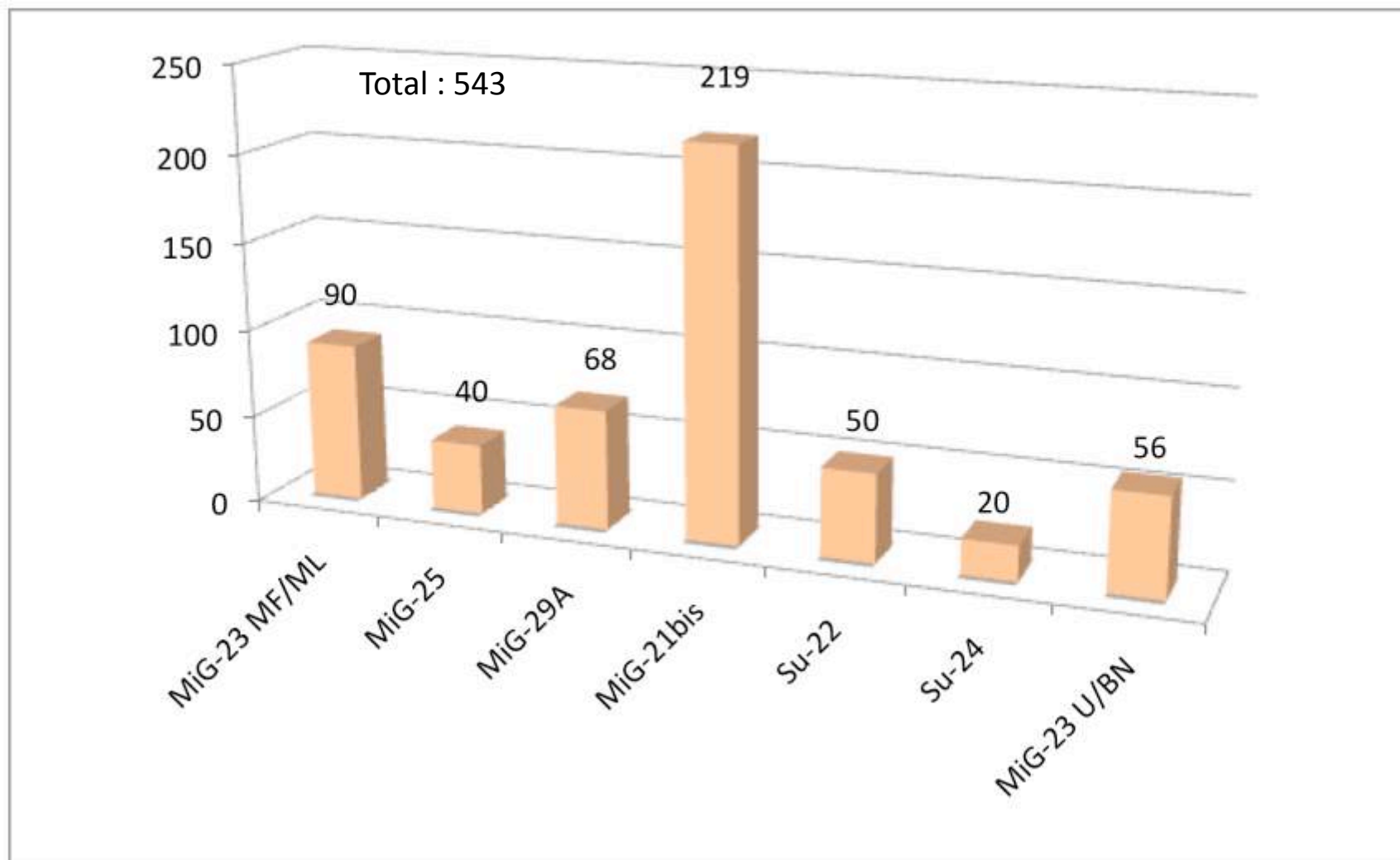
Northern Route



Northern Route



Syrian Airforce Order of Battle - 2008



Central Route: ➡

- Israel has a Peace Treaty with Jordan signed in October 1994.
- Therefore Israel is obligated legally to notify Jordan of any planned flights over Jordan.
- Jordan will not accept an Israeli over flight through Jordanian Airspace to strike Iran.
- High political risks for Israel to violate Jordanian airspace, in effect jeopardizing the Peace Treaty.
- Operationally, an Israeli Strike Mission of the size envisioned would certainly be detected and challenged by Jordan, and the whole region will be informed.
- Israel will encounter some operational risks due to Jordanian Airforce Intercepting the Israeli aircraft. This could upset the whole mission.
- So the Central Route through Jordan, or the Jordanian Syrian border would be of High Risk politically and High Risk Operationally.
- Iraqi airspace will also have to be violated. Iraq would object to this, and the U.S. most probably would detect this and would not allow Israel to proceed through Iraq.

Southern Route: ➡

- Israel could try the June 1981 Iraqi Osirak Nuclear Reactor strike route again, flying through the southern tip of Jordan and into Saudi-Arabia then through Iraq or even Kuwait.
- Politically the U.S. would not allow Israel to take such risks which would jeopardize its strategic relationship with Saudi-Arabia.
- Iraq would also object to any violation of its airspace by Israel, and so would Kuwait.
- This route would create high political risks even though the operational risks could be somewhat low.



Strike Mission Route Planning

Northern Route
Syria - Turkey

Risks	Turkey	Syria
Political	High	Low
Operational	Medium	Low

Central Route
Jordan – Syria - Iraq

Risks	Jordan	Syria	Iraq
Political	High	Low	High
Operational	High	High	Low

Southern Route
Jordan – Saudi
Arabia - Iraq

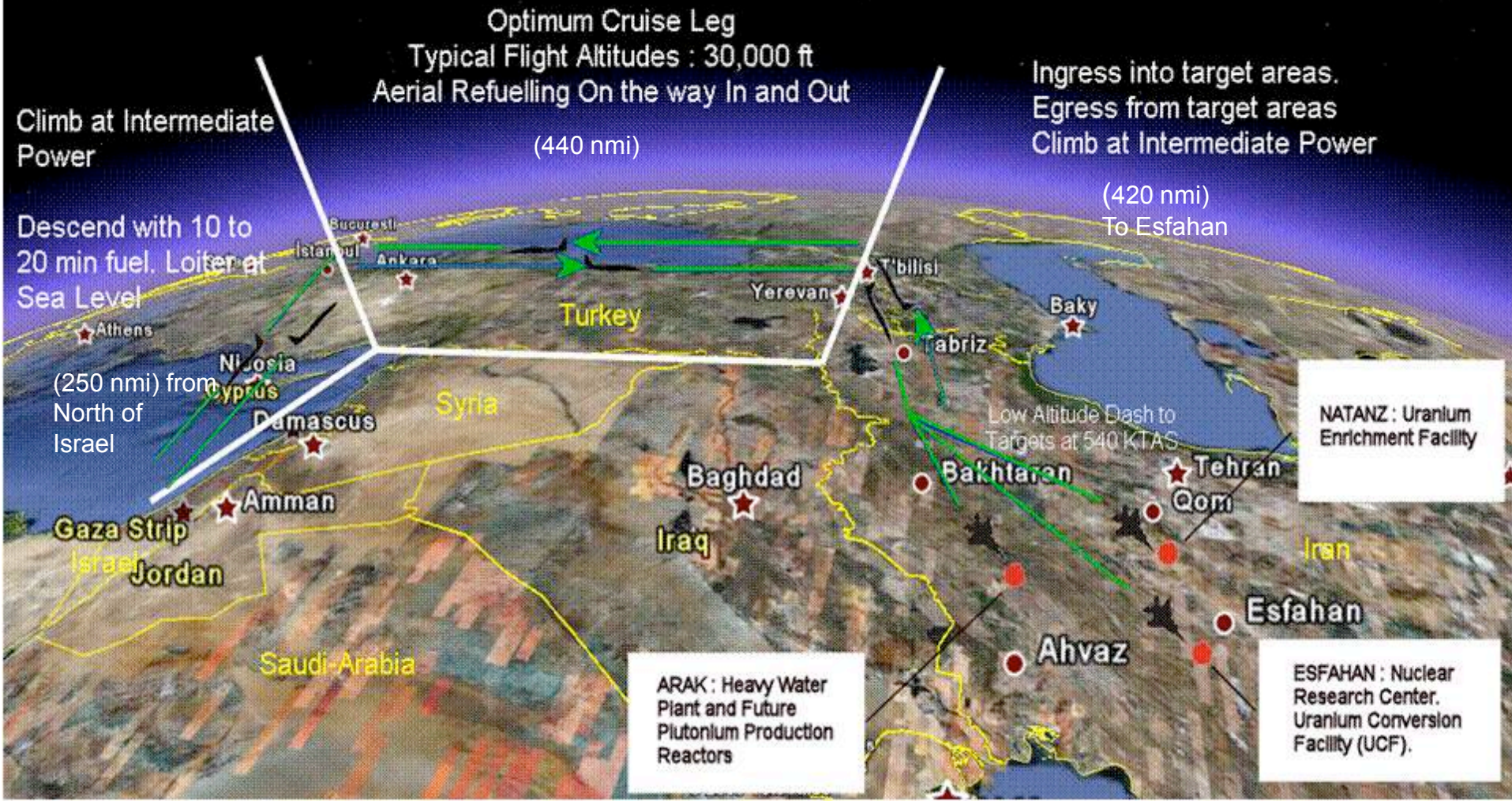
Risks	Jordan	Saudi-Arabia	Iraq
Political	High	High	High
Operational	Low	Low	Low

- The Northern Hi-Lo-Lo-Hi mission route will entail:
 - Climbing to an altitude of around 30,000 ft, then start the phase over the Syrian Turkish border. Aerial refueling along the way.
 - Once arriving at the Iranian borders, decrease flying altitude down to sea level and dash into target area, releasing weapons then egress still at sea level until reaching the Iranian borders and start climbing back to high altitude. Refuel along the way back.
 - Once reaching the western part of Turkey on the Mediterranean start descending back to Airbases in Israel.

Israeli Strike against Iranian Nuclear Facilities

Air To Ground Mission Profile

Hi-Lo-Lo-Hi



Israel Mission Force Allocation Hi-Lo-Lo-Hi

Aircraft	Number	Payload	Mission	Fuel Required (lbs)	KC-130 Tankers required for Refueling
F-15E	25	4 AAM 2 GBU-28	Natanz	657,500	5
F-16I	3	2 AAM 2 GBU-27	Esfahan	44,265	0.5
F-16I	4	2 AAM 2 GBU-10	Arak	59,000	0.5
F-16I	10	2 AAM 2 GBU-27	Bakhtarun (Close to Arak) Khorramabad (close to Arak) Manzariyah (Close to Arak) Qom (Close to Natanz) Hasa (Close to Esfahan)	147,550	1
F-16C	38	AAM ASM	Fighter Sweep Battlefield Air Superiority Suppression of Enemy Air Defense	560,690	5
TOTAL	80				12

The KC-135A has a Range of 1,150 nmi with 120,000 lbs of transferable fuel. (GlobalSecurity.org)

Mission Analysis:

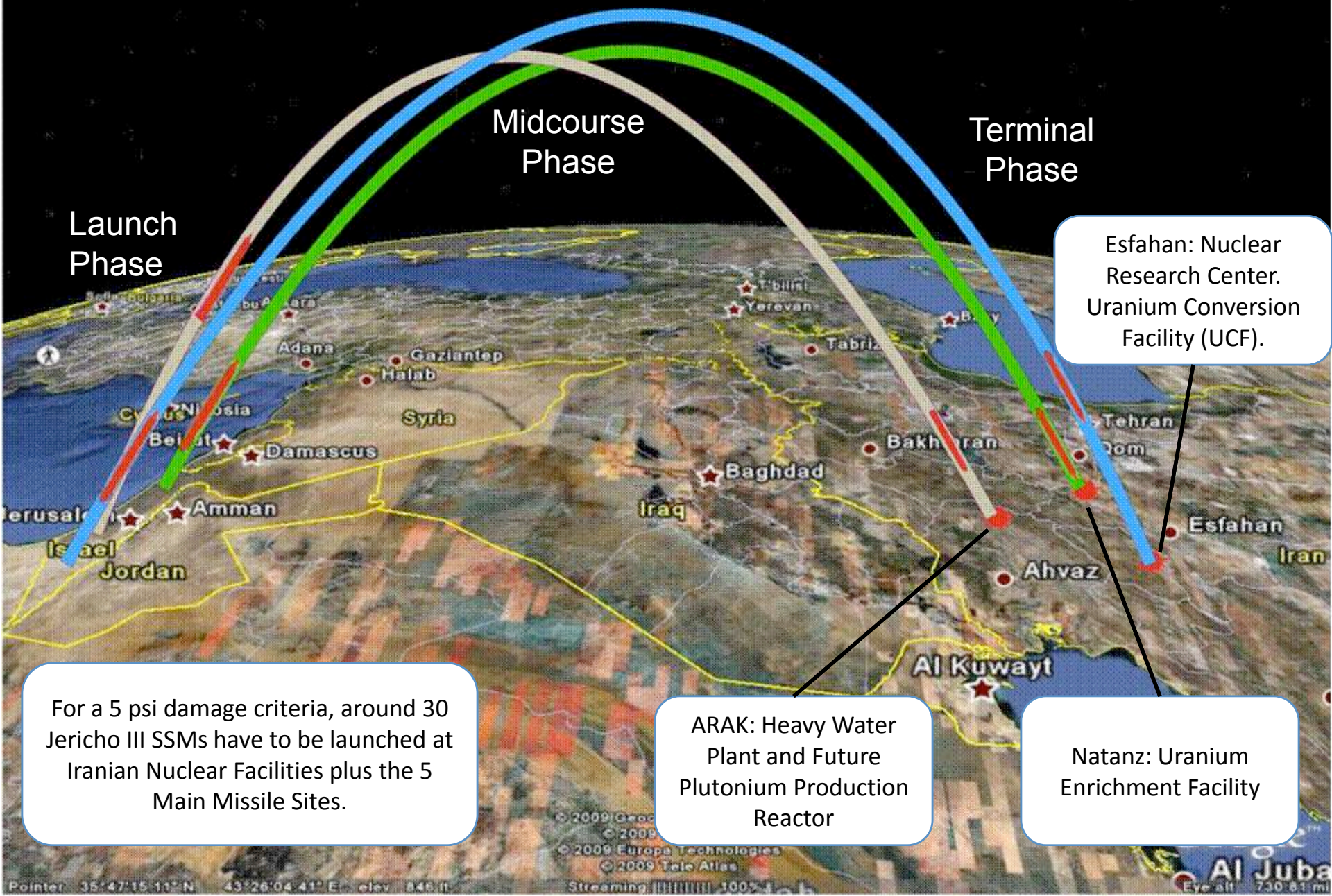
- Approximate range to the furthest target Esfahan is some 1,110 nmi. When approaching the 550 nmi range, the F-15Es and F-16Is need to refuel on the way to Iran and on the way back.
- Refueling can be done in three ways:
 - Refueling from KC-135A and KC-10 tankers.
 - Buddy Refueling between F-15Es and F-16Is
 - A temporary landing strip, along the Syrian, Turkish and Northern Iraq region, where aircraft refueling is available.
- Total Fuel in an F-15E for the Hi-Lo-Lo-Hi strike mission is 26,300 lbs, whereas that for an F-16I is about 14,755 lbs. The total maximum strike package was around 80 aircraft, all the 25 F-15I in the Israeli Airforce Inventory and 55 F-16I/C. The F-15E would then need 5 to 6 KC-130s to refuel from, and the F-16Is would require 6 to 7 KC-130.
- Israel presently has 5 KC-130H and 4 B-700 (Source IISS). So all the Israeli Tankers will have to be airborne to service the F-15E and F-16I Strike Force during the outbound leg and inbound legs of the mission. Could be difficult to find a location along the route such that the tankers could avoid detection and possible interception.
- These estimates were done assuming a 100% aircraft and weapons operational reliability and the strike force not encountering any Iranian Air and Ground Defense. So if we give the overall reliability to be 90% then we should add around 9 to 10 more aircraft, bringing the total strike force to 90.
- So in essence over 20% of the high end combat aircraft of Israeli Airforce and 100% of the Tankers will have to be allocated for this mission.
- We can conclude that a military strike by the Israeli Airforce against Iranian Nuclear Facilities is possible, however, it would be complex and high risk in the operational level and would lack any assurances of a high mission success rate.

Scenario II

**An Israeli Ballistic Missile Attack against
Iranian Nuclear Facilities.**

- We have seen how an air to ground strike mission can be difficult to implement and would involve some risks.
- Flying on a very tight route, practically hugging the Turkish-Syrian borders.
- Aerial refueling along the way and avoid being detected by Turkey, Syria and the U.S.
- Flying down to S/L when in Iranian territory, avoid being detected by flying low and applying ECM all the way. If detected by Iranian air defense be prepared to encounter interceptors and the firing of ground based SAMs.
- All of this can somewhat be avoided if Ballistic Missiles are used to carry out the mission. Israel has this capability and Iran does not have a Ballistic Missile Defense System such as the Russian S-300PMU2 “Favorit” that was designed to intercept ballistic missiles as well as combat aircraft. It has been reported that Iran has been negotiating with Russia for the procurement of the S-300PMU2 and they might get it now that the present US administration is taking the diplomatic dialogue approach with Iran.

Israeli Strike against Iranian Nuclear Facilities with Ballistic Missiles Jericho III



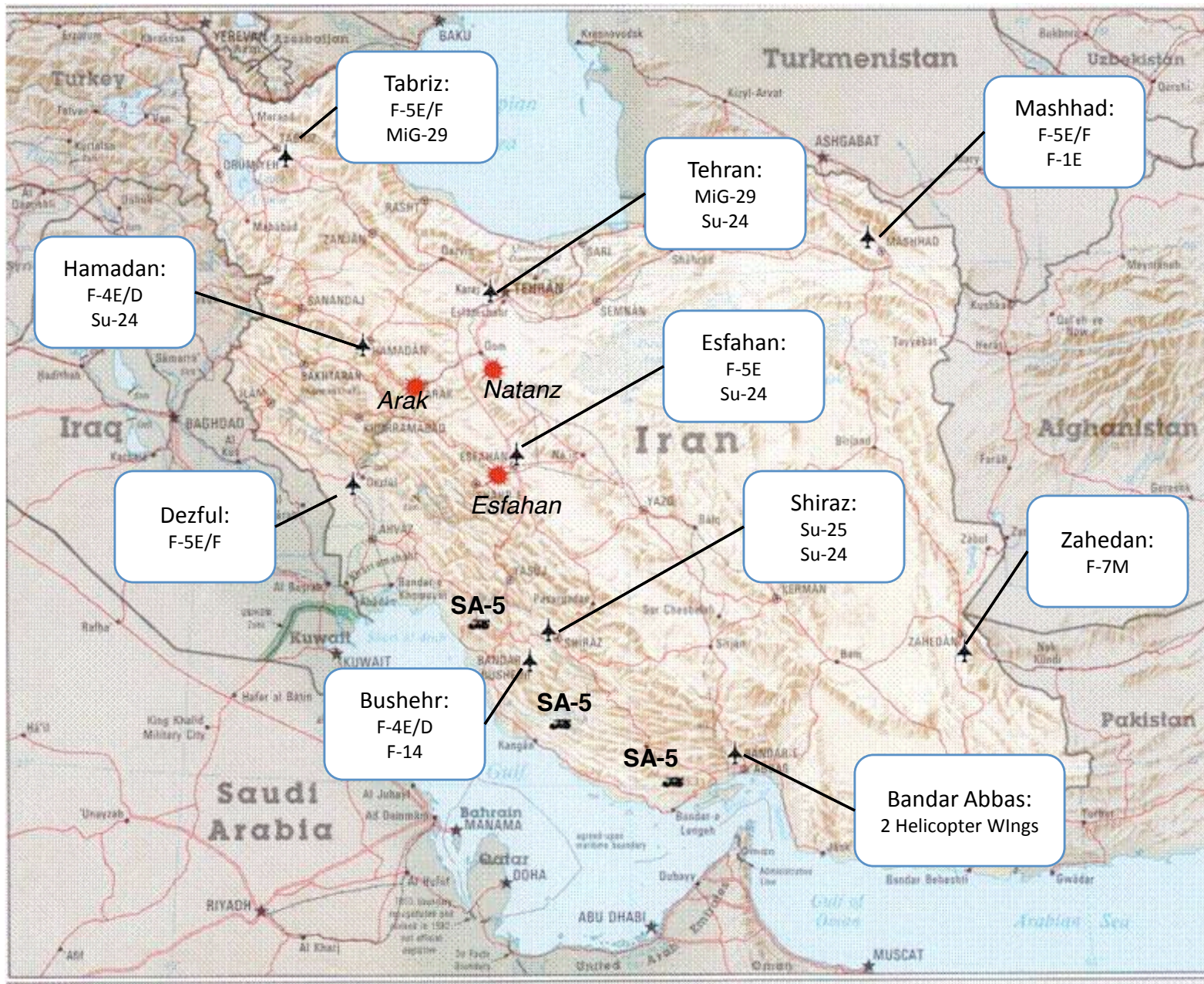
Peak Overpressure Distance

SSM	Warhead (kg)	Range (nmi)	10 psi (ft)	5 psi (ft)
Jericho III	750	2,600 – 3,500	80	120
		Number of Missiles with 750 kg Warhead Required for a 10 PSI	Number of Missiles with 750 kg Warhead Required for a 5 PSI	
Esfahan (100,000 sq ft)		5	2	
Natanz (670,500 sq ft)		34	15	
Arak (55,000 sq ft)		3	1	

- We can assume for a damage criteria of 5 psi, the missile sites that are not within the Nuclear compound would require 2 Jericho III SSM per site. A total of 10 missiles would be needed.
- The damage probability for a single missile is shown in the appendix for various values of the Lethal Range and CEP. If the Jericho III is fully developed and its accuracy (CEP) is quite high then this scenario could look much more feasible than using combat aircraft.
- The danger though would be for countries like Jordan that will be in Ground Zero if a Ballistic Missile Exchange takes place between Israel and Iran, and possibly escalating to the use of WMD Warheads.

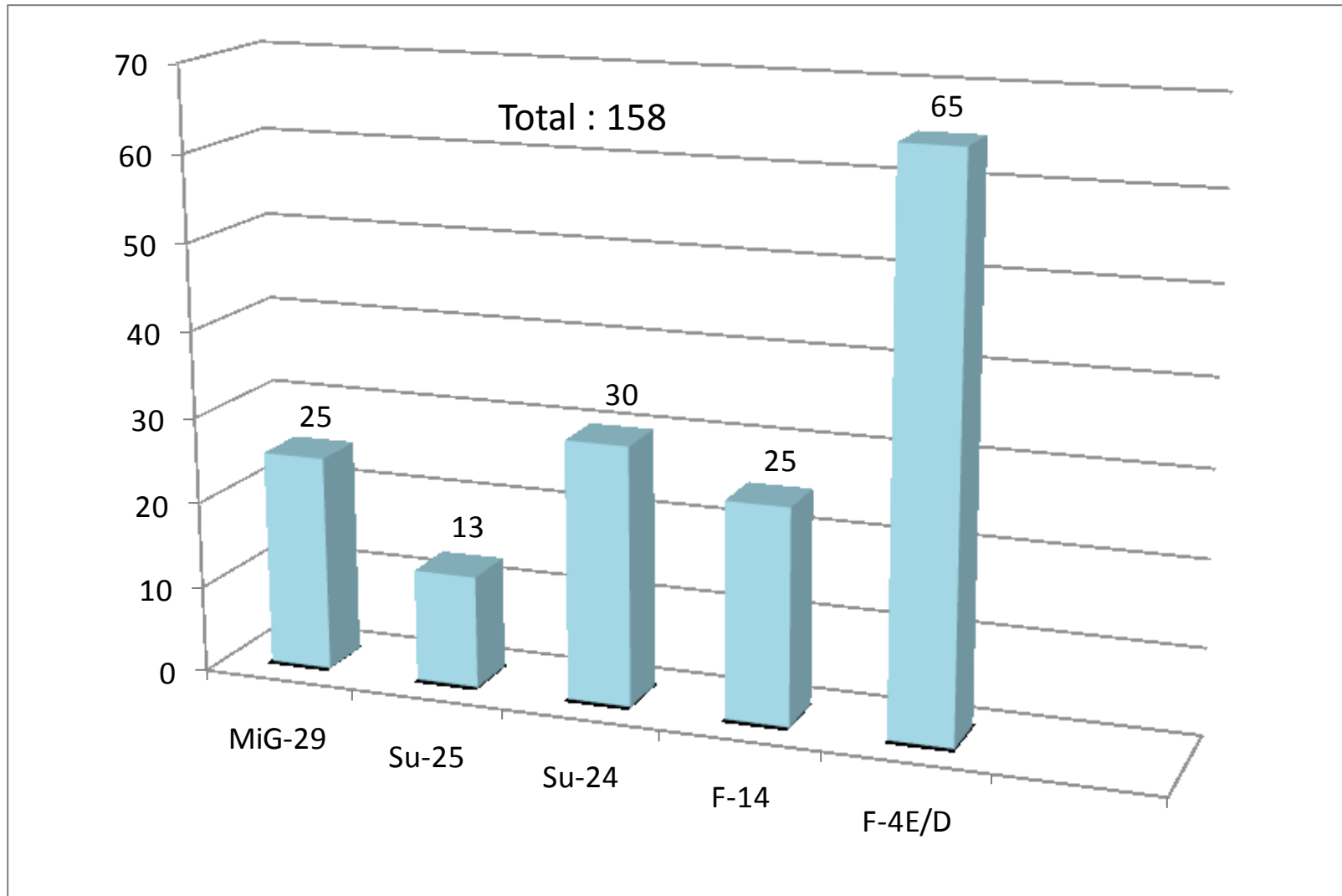
Iranian
Ground and Airborne Defense
Means against an Israeli Strike

Main Iranian Airforce Airbases and SA-5 Air Defense Deployment Sites



(Source: GlobalSecurity.org)

Iran Airforce Order of Battle 2008



(Source: Anthony Cordesman : Iranian Weapons of Mass Destruction)

Iran

Ground Based Air Defense Systems

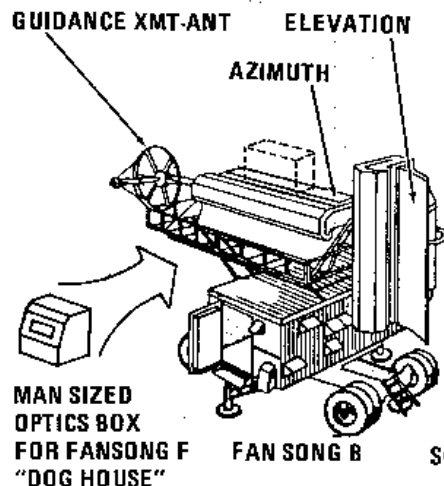
Major SAM	Light SAM	AA Guns
16/150 IHAWK 3/10 SA-5 45 SA-2 Guideline	SA-7/14/16, HQ-7 29 SA-15 Some QW-1 Misaq 29 TOR-M1 Some HN-5 30 Rapier Some FM-80 (Ch Crotale) 15 Tigercat Some FIM-92A Stinger	1,700 Guns ZSU-23-4 23mm ZPU-2/4 23mm ZU-23 23mm M-1393 37mm S-60 57mm

(Source: Anthony Cordesman: Iranian Weapons of Mass Destruction)

- The SA-5 is essentially a long range high altitude system (250 km), each site should have a combination of SA-6/8/9/7 surface to air missiles and ground troops with AAA guns to protect the site from very low altitude penetrating targets. Deployed mostly to protect its major ports and oil facilities along the coast of the Gulf.
- What is known about the Iranian Air Defense system clearly shows how it has become largely obsolescent even though some SA-2 upgrade has been reported to have taken place. So it has become easy to apply ECM against them and destroying them using anti-radiation air to surface missiles.
- Iran lacks the modern weapon systems, integration and C4I Battle Management to reduce the potential destructive effectiveness of any offensive interdiction missions by Israel. One can predict a very low attrition rate to an Israeli Strike.
- Long C4I Early Warning delay time due to antiquated system, semi-automated man in the loop.
- Long Response / Scramble Time by Combat Aircraft
- Low Operational Readiness Rate of Combat Aircraft
- Need Improvement in maintenance operations
- Need Improvement in supply of spare parts
- Low Combat Aircraft Sortie Rates, Sustained and Surge.
- High Loss Rates in a Closing / BVR and Visual Engagement Air to Air Combat Environment.
- Centralized Battle Management
- There have been reports that Russia secretly supplied Iran with the ANTEY-2500 Mobile SAM System/ S-300V (SA-12 Giant). If this is the case then the whole analytic model beginning from C4I Early Warning to Response and Scramble times in the engagement of Israeli combat aircraft with this integrated mobile air defense system will have to be recalculated.
- The attrition rates of the Israeli Air Strike will be high, could go up to 20 to 30%. For a strike mission of some 90 aircraft, the attrition could then be between 20 to 30 aircraft. A loss Israel would hardly accept in paying.

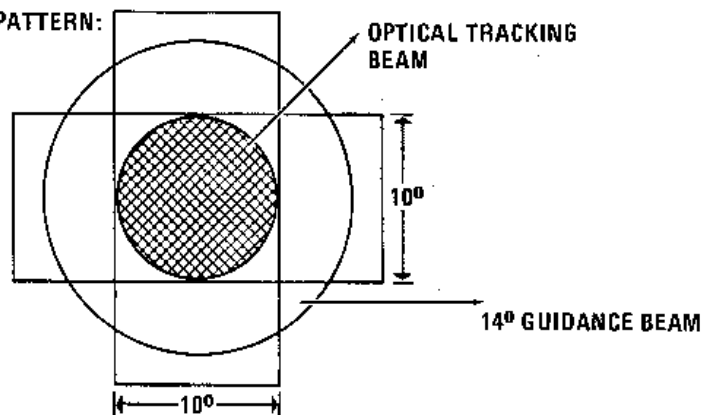
SA-2 Guideline

SA-2b/f FANSONG B/F

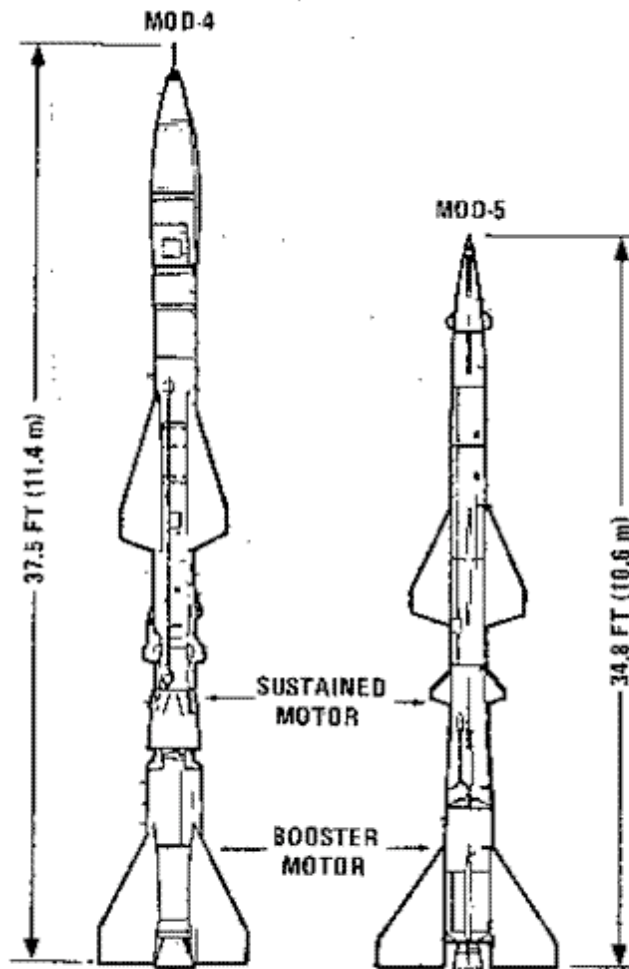


ACQUISITION RADARS:	SPOON REST & FLAT FACE
	A/C BAND
	DETECTION 100-125 NM
FANSONG B/F:	ACQUISITION E/F BAND
	TRACK E/F BAND
	MISSILE BEACON E/F BAND
	COMMAND UPLINK C BAND
MAXIMUM RANGE:	ACQUISITION 60-75 NM
	TRACK LOW PRF 50-60 NM
	HI PRF 30-40 NM
GUIDANCE:	OPTICAL 15-20 NM
	AUTOMATIC - LEAD ANGLE
	MANUAL/OPTICAL - THREE POINT

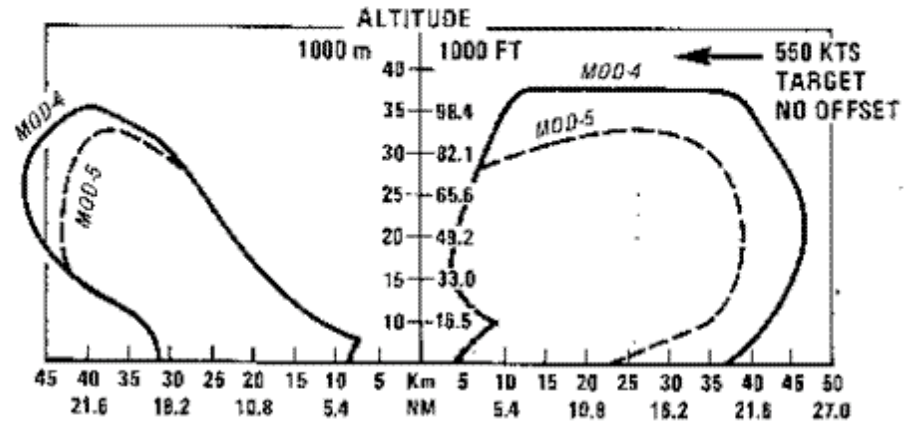
SCAN PATTERN:



GUIDELINE MISSILE FOR THE SA-2 SYSTEM



5620 LBS (2549 Kg)	WEIGHT	5050 LBS (2291 Kg)
3.25 SEC	BOOST	3.25 SEC
56.30 SEC	SUSTAIN	47.00 SEC
650 LBS (295 Kg)	WARHEAD	420 LBS (190 Kg)



SA-2 Target Intercept

SA – 2 (Guideline) SAM

Associated Radar	Frequency (MHz)	PRF (pps)	Pulse Width (microsecond)	Power (KW)	Radar Range
Spoon Rest D (P-18)	150 - 157	300 – 400	4 – 7	200 per beam	185 – 231 km
Tracking/Guidance (1) Fansong A/B	2950 – 3065	1000 – 1250	0.3 – 1.0	600	Acquisition: 120 km (2 sq m) Tracking: Low PRF 92 – 110 km Tracking : High PRF 55 – 75 km Optical Range: 28 – 37 km
Missile Uplink Command	705 – 850	2260 – 2660	0.3 – 0.5		
Missile Beacon	2950 – 3065				
(2) Fansong C/E	4950 – 5050	900 – 1020 1750 – 2070	0.4 – 1.2 0.2 – 0.9	600	Acquisition: 160 km (2 sq m) Tracking: Low PRF 130 km Tracking : High PRF 110 km Optical Range: 28 – 37 km
Missile Uplink Command	715 – 820	1720 - 2070	0.3 – 0.5		
Missile Beacon	4950 – 5050				

SA-5 (Angara/Vega) SAM

Associated Radar	Frequency (MHz)	PRF (pps)	Pulse Width (micro-second)	Power (kw)	Radar Range
Early Warning:					
Back Trap (P-80)	2050 – 2550	366		2000	480 km
Tall King C (P-14)	162 – 177	185 – 210 93-100	1 – 15	2000	550 – 750 km
Height Finder:					
Odd Pair (PRV – 13)	2620 – 2625 2710 – 2712 2823 – 2830	278 - 366	2.8 – 4.2	-	350
Guidance/Tracking:					
Square Pair	6800 - 6950	-	-	2.0	-

Command & Control:

- Vozdukh -I M System:

This is an improved version of the system, it is less vulnerable to jamming.

- Vektor System:

This is a more up-to-date Command & Control Center. The Vektor system is apparently not fully automated, i.e. is a semi-automated system, still with the man in the loop design. The roles and rules of the man in the loop are unknown.

The system gives a projected video of speed, azimuth, direction, and altitude to the operator who in return determines the optimum intercept zone of the target. It is understood that besides the high power early warning radars that pass data to the center, the Vektor system obtains data from the SA-5/ SA-2/SA-3 systems.

Russian ANTEY-2500 Mobile System/S-300VM (SA-12 Giant)

The Russian Antey-2500 Mobile SAM system is considered as the progressive development of the S-300V (SA-12, Giant) long range SAM system. It was designed to protect against air-strikes, including combat aircraft and ballistic missiles of short and medium range. It has been reported that Iran has been negotiating with Russia over this air defense system and the upgraded model the S-200PMU2 for some time.

Radar Detection Unit:

- Range of up to 320 km.
- Targets with speed 4500 km/sec.
- Tracking the trajectories of up to 70 destructive prioritized targets.
- The Antey-2500 can operate either under the Command and Control of higher level command post or autonomously.

- Area protected by one fire unit against:
 - Medium range Ballistic Missiles with 2500 km range: 1000-1750 square km
 - Theater Ballistic Missiles with 1100 km range : 2000-2500 square km
 - Tactical Ballistic Missiles with 600 km range: 2500 square km
 - Piloted air strike up to: 12,500 square km

- Number of Targets simultaneously engaged by one fire unit: 6
- Number of missiles guided at one target:
- One launcher fires: up to 2
- Number of launchers firing: up to 4
- Launching rate from one launcher: 1.5 sec.
- The standard combat crew of an Antey-2500 SAM battalion consisting of four SAM sites (6 launchers, 3 loader/launchers) is 139 personnel. The full crew complement for a SAM battalion is 180.

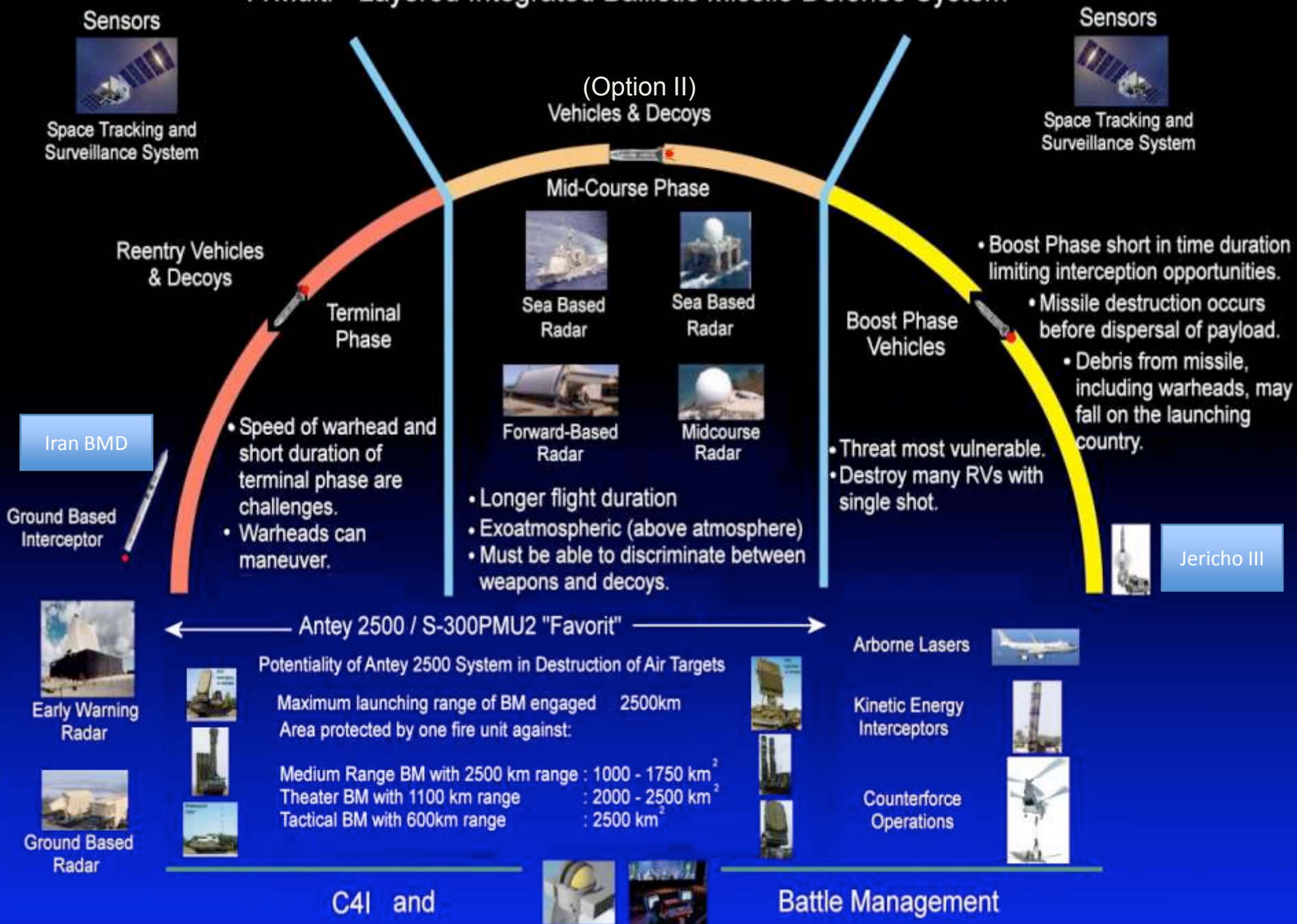
- Command Post of Antey-2500 SAM System
 - The Command Post provides for the Command and Control of all combat assets of the SAM system. It also prioritizes and distributes the targets among the SAM batteries.
 - Number of targets processed : 200
 - Number of target trajectories tracked simultaneously : 70
 - Number of target designations simultaneously transmitted to fire units: 24

- Launcher Vehicle
 - Number of missiles on a launcher : 4
 - Pre-launch preparation of SAM : 7.5 sec
 - Interval between launched : 1.5 sec
 - Weight with missile : 47.5 tons
 - Crew : 2 to 3

- Surface-To-Air Missiles
 - The 9M83ME SAM is designed for destroying aerodynamic targets, including low-flying ones, and those maneuvering up to 12-g loads, in addition to intercepting aero-ballistic and tactical missiles in a heavy ECM environment.
 - The 9M82ME SAM is designed for destroying of medium range, theater, tactical and aero-ballistic missiles, as well as all aircraft types operating at ranges of up to 200 km.
 - The design of both missiles is highly unified, and they differ only in the starting boosters (initial firing stage).
 - Type of engine: solid propellant
 - Launching mode: vertical
 - Weight of missile 9M83ME: 2345 kg
 - Weight of warhead: 150kg Type of warhead: HEF with direct blast
 - Type of fuse: proximity, semi-active radar
 - Maximum speed:
 - 9M83ME SAM: 1700m/sec
 - 9M82ME SAM: 2600m/sec

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

A Multi - Layered Integrated Ballistic Missile Defense System



The Environmental Damages of an Israeli attack on the Bushehr Nuclear Power Plant.

- Highest level of environmental damage is caused by a strike on the Reactor, Spent Fuel Storage and the Reprocessing Plants.
- Actinides and Fission products are highly radioactive elements resulting from the fission process in the Reactor. Iodine-131, Strontium-90, Cesium-137 and Plutonium-239, have all been identified as the most damaging to human health.
- Attacking the Bushehr Nuclear Reactor would release contamination in the form of radionuclides into the air.
- Most definitely Bahrain, Qatar and the UAE will be heavily affected by the radionuclides.
- Any strike on the Bushehr Nuclear Reactor will cause the immediate death of thousands of people living in or adjacent to the site, and thousands of subsequent cancer deaths or even up to hundreds of thousands depending on the population density along the contamination plume.

Half-Lives of Radionuclides in Body Organs

<u>Radionuclide</u>	<u>Radiation</u>	<u>Critical Organ</u>	<u>Half Life</u>		
			<u>Physical</u>	<u>Biological</u>	<u>Effective</u>
Iodine-131	Beta	Thyroid	8 days	138 days	7.6 days
Strontium-90	Beta	Bone	28 years	50 years	18 years
Cesium-137	Gamma	Whole Body	30 years	70 days	70 days
Plutonium-239	Alpha	Bone	24,400 years	200 years	198 years
		Lung	24,400 years	500 days	500 days

Expected Effects of Acute Whole-Body Radiation Doses

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

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

NORTH

SOUTH

IRAN

Bushehr 1000
MWt Nuclear
Reactor

- Prevailing Winds are North – North Westerly most of the year.
- Wind speed up to an average of 5 meters/sec
- Bushehr Climate is mostly dry.

Distance
Downwind

Distance
Downwind

Isodose
Contours

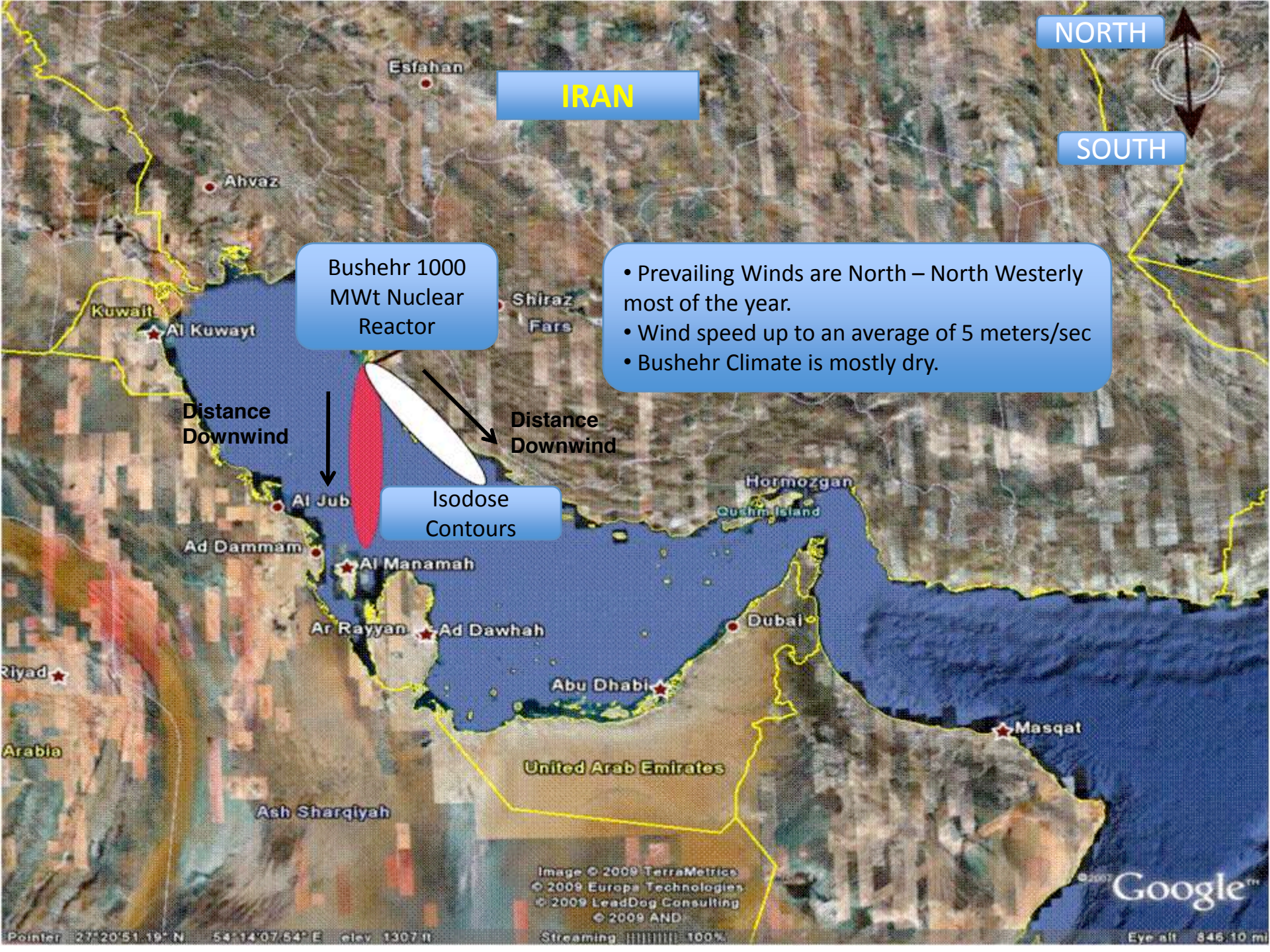


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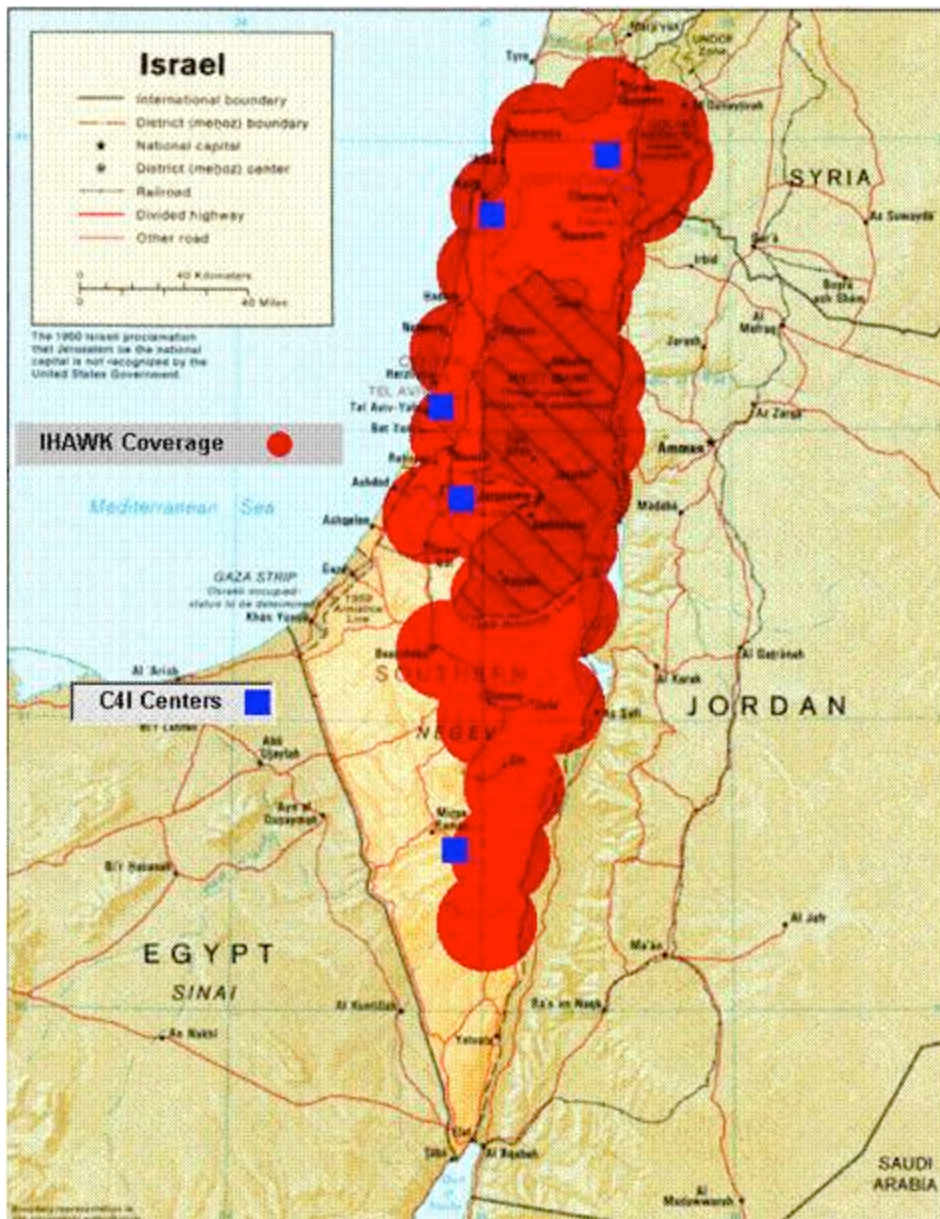
Google™

Pointer 27°20'51.19" N 54°14'07.64" E elev 1307 ft

Streaming 100%

Eye alt 846.10 mi

Israeli Air Defense and Ballistic Missile Defense System
Vs
An Iranian Retaliatory Ballistic Missile Attack using the
Shehab -3



Israel SAM Order of Battle & IHAWS Coverage

Missile Launchers:

MIM-23 IHAWS Batteries: 23

Patriot PAC-2: 48

Air Force Intelligence forces utilize the latest technology for gathering signals and information. Israel has managed to develop the required technology. One example is the Mini RPV (remotely piloted vehicle).

Ground based radars and airborne control aircraft such as the E2C Hawkeye exchange data such that the commanders can control the Theater of Operations and the rapidly developing combat situation.

- Israel also has the Patriot Advanced Capability – 3 (PAC-3) which is part of the US Ballistic Missile Defense System, as a Terminal Phase Interceptor
- Land-based air transportable launcher, single stage Extended Range Interceptor (ERINT) missile armed with explosive warhead, Phased array radar and engagement control station (ECS).
- Most technologically mature BMD system, in US Army service Since 2003; a total of 712 missiles to be in US inventory at end of 2008.

Israel Ballistic Missile Defense System (ARROW)

- The Israeli-US Arrow Weapon System (AWS) is the most technologically mature of the USA's collaborative missile defense development programs.
- The AWS was initially designed and developed to track and destroy ballistic missiles, such as The SCUD series, in the terminal phase of their flight trajectory.
- The Arrow 2 interceptor missile, is equipped with both infra-red and active radar sensors and a blast-fragmentation warhead.
- Israel currently deploys two Arrow 2 batteries, one located at an airbase near Tel Aviv and the other in the North of Israel. And is apparently intending to augment this deployment with more Arrow-2 batteries in northern Israel.
- Each Arrow battery consists of 4 to 8 launchers, One Green Pine Multifunction phased-array radar, and one Citron Tree fire-control center, a launch-control center and approximately 50 Arrow 2 Interceptor missiles.
- In 2007, the Israel Missile Defense Organization (IMDO) conducted the first flight tests of the Arrow-3 interceptor missile.
- The upgraded missile is designed to intercept target missiles at higher altitudes and longer ranges, so that the debris from possible nuclear, biological and chemical warheads will fall farther away from Israeli territory.

- In addition, the tests also employed the improved Green Pine radar with higher resolution for the purpose of identifying decoys and other penetration aids that Iran is assumed to have developed for the purpose of defeating missile defenses.
- Israel is currently studying a new exoatmospheric (outside the atmosphere) interceptor missile – designated Arrow 3 – capable of defending against attacks by ballistic missiles with ranges in excess of 2000 kilometers and possibly carrying WMD warheads.
- The Israel BMD architecture is currently designed to incorporate the Arrow-3/2 and PAC-3 Systems.
- There apparently is interest in Israel in developing a system capable of intercepting Artillery Rockets and Short Range Ballistic Missiles (SRBMs).
- Israel is currently developing a system known as Iron Dome, to counter and intercept short-range rockets and missiles such as the 122mm Katyusha Artillery Rockets.
- In addition, an Israel-US consortium is developing a new SRMD system which is known as David's Sling, to counter threats from the Iranian produced Fajr and Zelzal SRBMs deployed by Hezbollah forces in the South of Lebanon.

(Source: SIPRI 2008 Yearbook. A survey of US Ballistic Missile defense programmes)

- Israel has designed the Nautilus laser system for rocket defense in a joint project with the United States. It has developed into the Theater High Energy Laser. The project has recently been expanded to include interception of not only short-range rockets and artillery, but also medium-range Scuds and longer-range missiles such as Iran's Shahab series.
- Israel is examining the possibility of boost-phase defenses. The Rafael Moab UAV forms part of the Israeli Boost-Phase Intercept System. This is intended to engage ballistic missiles soon after launch, using weapons fired from a UAV. Moab would launch an improved Rafael Python 4 air-to-air missile. Range is stated as 80-100 km depending on the altitude of release.

(Source: Israeli Weapons of Mass Destruction. An OverviewAnthony H. Cordesman, CSIS, June 2008)

Military and Political Consequences of an Israeli Attack on Iran's Nuclear Facilities

Iran's Nuclear Program

- The more an Israeli threat to the survival of the regime in Iran, the more Iran will be determined to acquire nuclear weapons.
- Increase Iran's long term resolve to develop a nuclear deterrent program. Could be the beginning rather than the end of such a program. Iran could start an accelerated program in building its own nuclear weapons. It could also covert its dispersed facilities into a full weapons development program and be brought online in a very short period of time.

Iran and the IAEA

- Iran would withdraw from the NPT based on the argument that it needs to acquire nuclear weapons to deter any further aggression by Israel and the U.S.

Iranian response against Israel

- Immediate retaliation using its ballistic missiles on Israel. Multiple launches of Shahab-3 including the possibility of CBR warheads against Tel Aviv, Israeli military and civilian centers, and Israeli suspected nuclear weapons sites.
- Using proxy groups such as Hezbollah or Hamas to attack Israel proper with suicide bombings, covert CBR attacks, and rocket attacks from southern Lebanon.

Regional Security

- Give rise to regional instability and conflict as well as terrorism.
- Destabilizing Iraq through the Shia against US occupation, further arming insurgency groups when possible.
- Support and upgrade Taliban capabilities in Afghanistan.
- Increase the threat of asymmetric attacks against American interests and allies in the region, especially against countries that host the US military such as Qatar and Bahrain.
- Target U.S. and Western shipping in the Gulf, and possibly attempt to interrupt the flow of oil through the Gulf.

- It is possible that Israel will carry out a strike against Iranian Nuclear Facilities, if the U.S. does not, with the objective of either destroying the program or delaying it for some years. The success of the Strike Mission will be measured by how much of the Enrichment program has it destroyed, or the number of years it has delayed Iranian acquisition of enough Uranium or Plutonium from the Arak reactor to build a nuclear bomb.
- The U.S. would certainly be perceived as being a part of the conspiracy and having assisted and given Israel the green light, whether it did or had no part in it whatsoever. This would undermine the U.S. objectives in increasing stability in the region and bringing about a peaceful solution to the Arab-Israeli conflict. It will also harm for a very long period of time relations between the U.S. and its close regional allies.
- Arab States have become extremely frustrated with the U.S. and the West double standard when addressing the Proliferation of Weapons of Mass Destruction in the Middle East. Arab countries will not condone any attack on Iran under the pretext that Iran poses an existential threat to Israel, whilst Israel has some 200 to 300 nuclear weapons, and the delivery means using the Jericho missiles. In addition to Israel still occupying the West Bank and the Syrian Golan Heights.
- It is doubtful that an Israeli strike on Iranian Nuclear Facilities would bring Syria into a direct conflict with Israel. Syria knows very well that alone its military forces are no match to Israel. However, proxy actors such as Hizbullah would engage Israel in anti-symmetric attacks, with Syrian and Iranian assistance.

Suggested Steps Towards Iran:

- 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 region and the world are addressed. Iran should be engaged directly by the U.S. with an agenda open to all areas of military and non-military issues that both are in agreement or disagreement.
- The U.S. 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. However, in this area the U.S. will have to walk and negotiate along a very fine line between Israel's WMD and Ballistic Missiles capabilities and the Iranian Nuclear development program. The U.S. must recognize that both are very closely inter-related and are fueling each other. So the U.S. should be prepared to address both issues simultaneously while trying not to be perceived as though it has double standards when it comes to Israel.
- 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 Palestinian – Israeli negotiations and the Syrian – Israeli negotiations should be given highest priority as the whole Arab world will not be convinced that the U.S. is interested in establishing Peace, Stability and Security in the region by just addressing the Iranian Nuclear Programs. In fact, it is believed in the region that Peace Agreements with the Palestinians and Arab Countries would deprive Iran of any political context in which to confront Israel.
- An arms control process, on a bilateral basis such as India and Pakistan, and in a 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.
- 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), such as the zone that has been proposed in the Middle East.
- The regional approach which has gained favor in recent years, suggests that whenever possible, regional organizations can join with international organizations, such as the IAEA, to ensure the application of the obligations of the international non-proliferation regimes.
- The ultimate aim is to create a “Cooperative Security Framework” under which disputes and conflicts can be resolved in a peaceful manner. If all methods fail then a “Collective Security” action can take place under the UN Charter. It can be envisioned that regional “Conflict Prevention Centers” can be established within which security cooperation and negotiations can take place on a continuous basis addressing military and non military related issues that can impact regional and international security.
- Containment could be the future course of U.S. Policy if Diplomatic engagement does not work, and after all other options have been exhausted.

APPENDIX

Plutonium Production – Nuclear Weapons

- Basically there is a substantial difference between producing Plutonium and producing Weapons Grade Plutonium.
- Modeling the amount of Plutonium in the spent fuel of a Nuclear Reactor, entails some sophisticated computer code, which requires a knowledge of the burn-up and history of all the fuel elements in the core and the details of the neutron flux, the variation in burn-up throughout the core, and the detailed variation of isotopic ratios with burn-up.....
- This type of analysis is presently outside the scope of this study.

(Source: Keith Barnham, Calculating Plutonium in Spent Fuel Elements. Edited by Frank Barnaby: Plutonium and Security, The Military Aspects of the Plutonium Economy)

- As a general rule a typical 1000 Megawatt Reactor, operating at 70% capacity factor, generates approximately 250 kg of Plutonium annually.
- This Plutonium, which is produced in the reactor through neutron capture by U-238, is then discharged from the reactor along with the other constituents of the spent fuel.
- About 70% of the Plutonium or 175 kg, is fissile (odd) isotopes of Plutonium.
- Upon Chemical Separation from the radioactive Fission products and other components of the spent reactor fuel, the 250 kg of Plutonium produced each year in a 1000 Megawatt Reactor could be used in recycled fuel, to replace a similar quantity of U-235 in a power reactor or, in a bomb assembly, to provide the fissile material for over 25 nuclear weapons.

(Source: David Albright and Harold A. Feiveson, Plutonium Recycling and the Problem of Nuclear Proliferation. Edited by Frank Barnaby: Plutonium and Security, The Military Aspects of the Plutonium Economy).

- The thermal output of a power reactor is three times the electrical capability. That is a 1,000 MW(e) reactor produces about 3,000 MW(t), reflecting the inefficiencies in converting heat energy to electricity.
- A useful rule of thumb for gauging the proliferation of any given reactor is that 1 Megawatt-day (thermal energy release, not electricity output) of operation produces 1 gram of Plutonium in any reactor using 20% or lower Enriched Uranium.

(Source: Federation of American Scientists. Plutonium Production-Nuclear Weapons
www.fas.org/nuke/intro/nuke/plutonium.htm)

From this data the maximum yearly output of weapons-grade fuel can be estimated by the following formula:

$$\text{Pu (1 year)} = (\text{MW(t)} * \text{D}/1000) * (\text{Fraction of Plutonium Fissile})$$

Pu (1 year) : Kilograms of Plutonium produced in one year

MWt : Megawatt Thermal of Reactor

D : Days per year the reactor is operating

For a 1000 MW(t) Reactor

$$\text{D} = 0.7 * 365 = 250$$

Fraction of Plutonium Fissile = 0.7

$$\text{Pu (1 year)} = 250 \text{ kg} * 0.7 = 175 \text{ kg}$$

Assuming we require around 7kg of Plutonium per Nuclear Warhead, then Number of Warheads = 25

Energy Released in Nuclear Fission

- When a free neutron enters the nucleus of a fissionable atom, it can cause the nucleus to split into two smaller parts.
- This is the fission process, which is accompanied by the release of a large amount of energy. The smaller (or lighter) nuclei which result are called the “fission products”
- The complete fission of 1 pound (0.4536 kg) of Uranium or Plutonium releases as much explosive energy as does the explosion of about 8,000 (short) tons of TNT.
- The “Yield” of a nuclear weapon is a measure of the amount of explosive energy it can Produce. It is the usual practice to state the yield in terms of the quantity of TNT that would generate the same amount of energy when it explodes. Thus a 1-kiloton nuclear weapon is one which produces the same amount of energy in an explosion as does 1 kiloton (or 1,000 tons) of TNT.
- 1 Pound of Uranium or Plutonium will release the same amount of explosive energy as about 8,000 tons of TNT, it is evident that in a 20 kiloton nuclear weapon 2.5 pounds of material undergo fission.
- However, the actual weight of Uranium or Plutonium in such a weapon is greater than this amount. In other words, in a fission weapon, only part of the nuclear material suffers fission. The efficiency is thus said to be less than 100%.

The U.S. Hiroshima Nuclear bomb of 1945 (a gun device fueled with Uranium) fissioned 0.7 kilograms (1.5 pounds) of material out of the 60 kg (132 pounds) of U-235 in the bomb, to produce a yield of about 12.5 kilotons.

The Nagasaki Nuclear Bomb (Implosion type) is Plutonium based, fueled with 7 kg of Plutonium and Only 1.3 kg (2.86 lbs) of the overall fuel fissioned.

The bomb released 8 kilotons of explosive energy for every pound of Pu-239 fissioned, so for 2.86 lbs a yield of about 22 kilotons was released.

Assuming the same technology basis as in 1945, then out of 5 to 8 kgs of Plutonium in a bomb about 15% would be able to fission which amounts to 0.75 to 1.3 kg (1.65 to 2,86 lbs) obtaining a yield between 12 to 22 kilotons.

Basic Parameters of Contemporary Centrifuges

Type	P1	P2	Russia	URENCO	US
Rotor Material	A1	MS	CFRC	CFRC	CFRC
Speed (m/sec)	350	500	700	700	>700
Length (m)	1 - 2	1	< 1	3 - 4	12
Kg SWU/year	1 - 3	5	10	40	300

Separative Work Requirements for Producing 90% Enriched Uranium as a Function of Feed and Tails Assays

Feed (% U-235)	0.7% (Natural Uranium)	4% (Reactor Grade Uranium)	4%
Product	90% (Bomb Grade Uranium)	90%	90%
Waste or “Tails”	0.3%	0.3%	2%
Approximate Number of Centrifuges Required to produce 100 kg/year of 90% Enriched Uranium	4,000	1,200	700

The output of a Centrifuge is measured in “Separative Work Units SWU” – which is the measure of the amount of work required to enrich a given amount of Uranium.

(Source: A Fresh Examination of the Proliferation Dangers of Light Water Reactor. Victor Gilinsky, Marvin Miller, Harmon Hubbard. October 22, 2004. The Nonproliferation Policy Educational Center.)

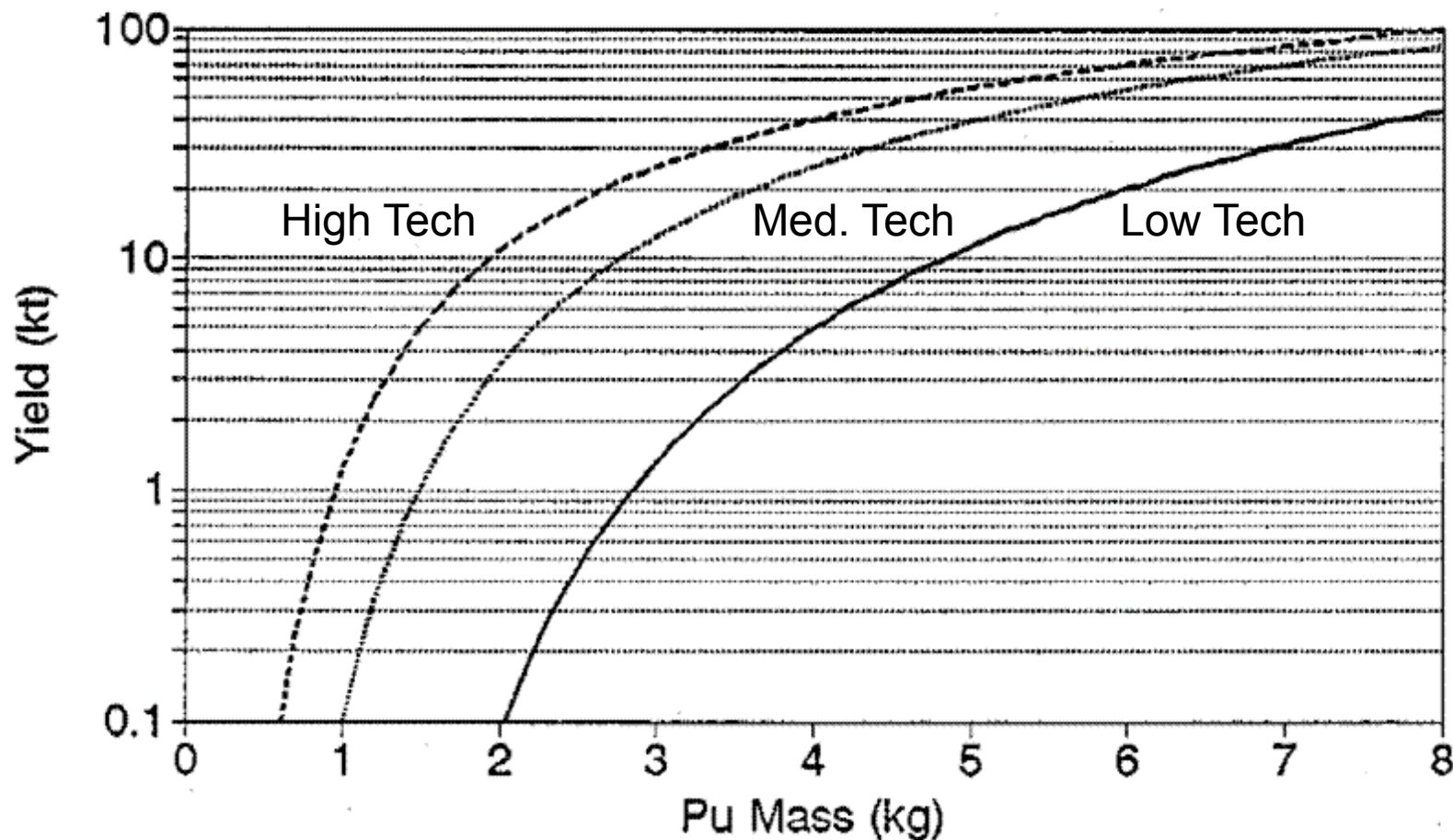
Approximate Fissile Material Requirements For Pure Fission Nuclear Weapons

Yield (Kiloton)	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	4
20	6	3.5	3	16	9	5

(Yields rounded to nearest 0.5 kilograms)

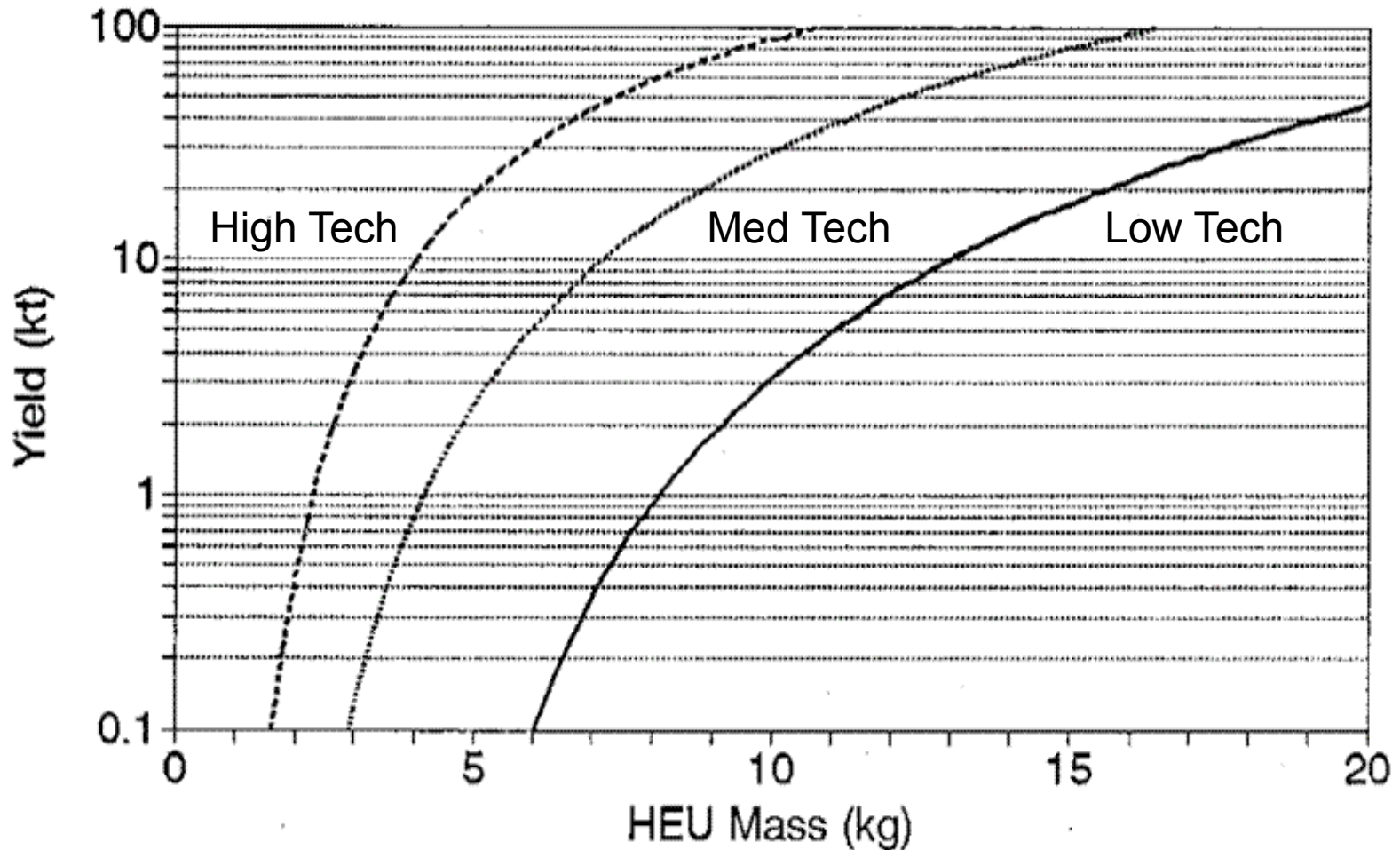
Source: The Amount of Plutonium and HEU Needed for Pure Fission Nuclear Weapons
 Thomas B. Cochran and Christopher E. Paine. 13 April 1995
 National Resources Defense Council, Inc. (NRDC)

Yield vs Plutonium Mass (As a function of Technical Capability)



Source: The Amount of Plutonium and HEU Needed for Pure Fission Nuclear Weapons
Thomas B. Cochran and Christopher E. Paine. 13 April 1995
National Resources Defense Council, Inc. (NRDC)

Yield vs HEU Mass (As a Function of Technical Capability)



Source: The Amount of Plutonium and HEU Needed for Pure Fission Nuclear Weapons
Thomas B. Cochran and Christopher E. Paine. 13 April 1995
National Resources Defense Council, Inc. (NRDC)

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.

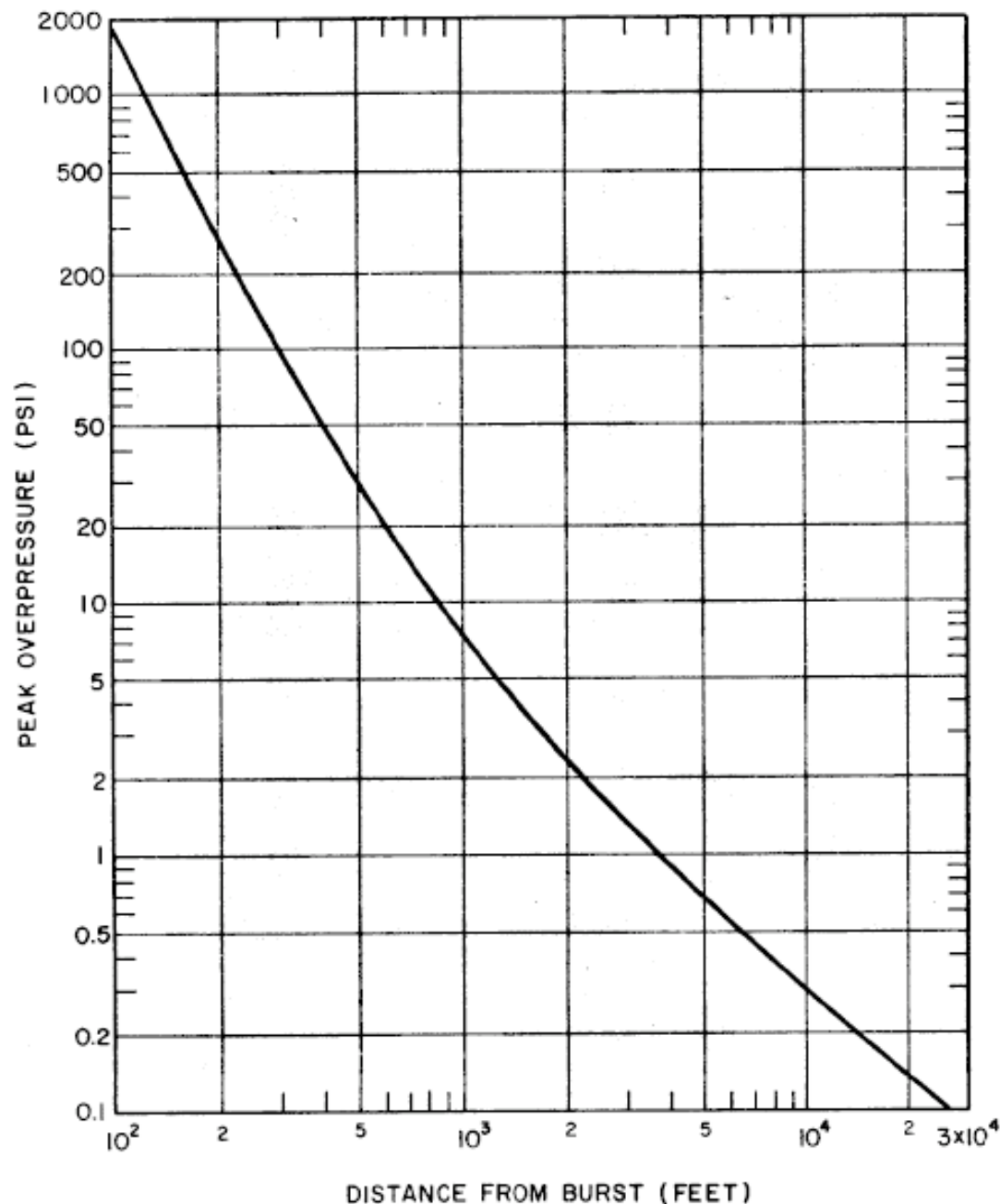
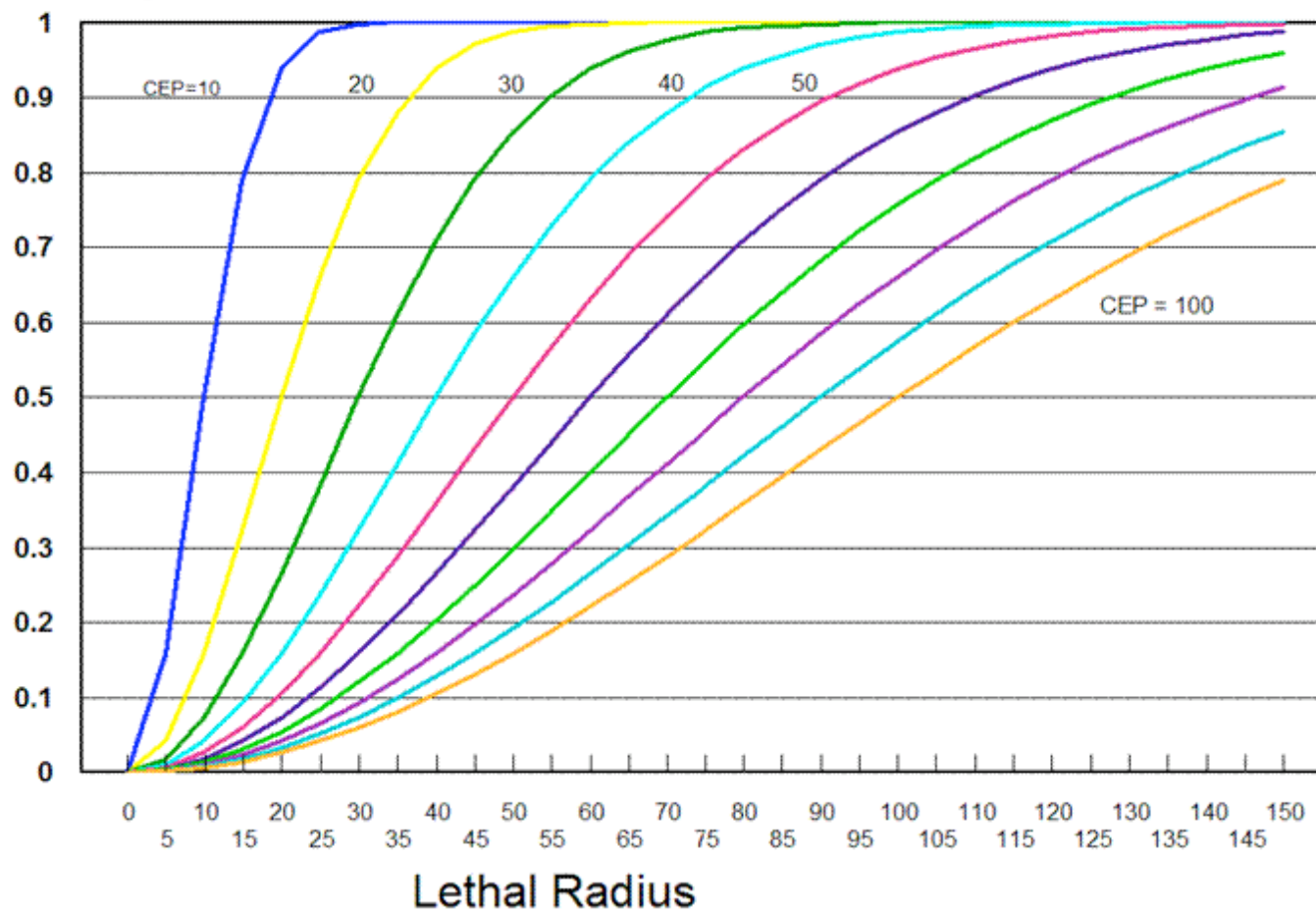


Figure 3.72. Peak overpressure from a 1-kiloton free air burst for sea-level ambient conditions.

Probability of Damage



For a single weapon, a standard value for damage probability is given by:

$$PD = 1 - (1/2)^{(LR/CEP)^2}$$

LR: Lethal radius