

Iran's Ballistic Missile Capabilities: Assessing the Threat to Civilian Infrastructure

Michael Elleman

**Senior Fellow for Regional Security Cooperation
International Institute for Strategic Studies**

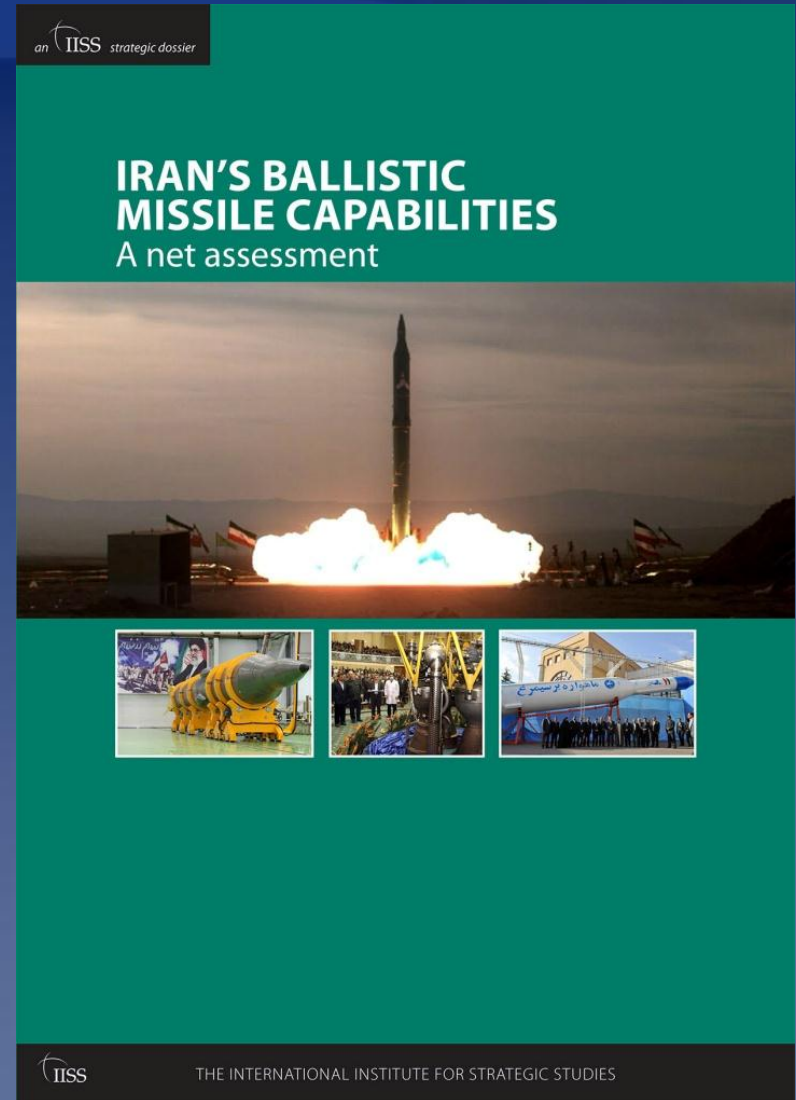
Abu Dhabi

24 April 2012

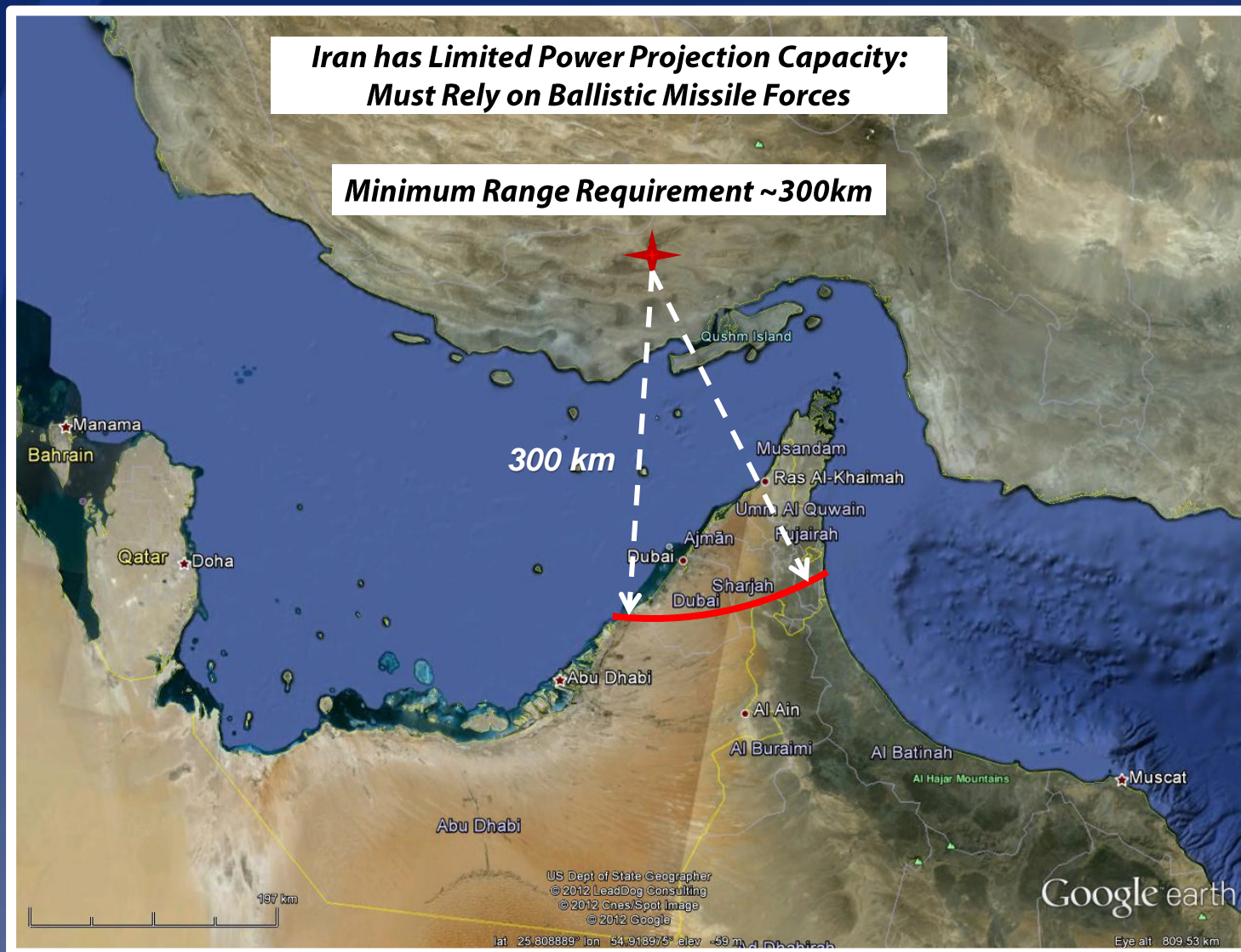
Iranian Ballistic Missile Capabilities

A joint assessment performed by specialists from the U.S., Europe, Russia and the Middle East, all with experience designing, building, testing and/or deploying ballistic missiles.

Focused on “most-likely outcomes,” not on worst-case scenarios.



Iranian Ballistic Missile Capabilities



Iranian Ballistic Missile Capabilities

Iran Has the Largest, Most Diverse Missile Inventory in the Middle East

Missile	Translation	Fuel type	Estimated range	Payload	Note
<i>Zelzal-1</i>	<i>Earthquake-1</i>	Solid	125km	600 kg	Unguided
<i>Zelzal-2</i>	<i>Earthquake-2</i>	Solid	200km	600 kg	Unguided
<i>Fateh-110</i>	<i>Victorious</i>	Solid	200-250km	500kg	Guided?
<i>Khalij Fars</i>	<i>Persian Gulf</i>	Solid	200-250	450kg	AShBM?
<i>Sajjil-2</i>	<i>Baked Clay-2</i>	<i>Solid</i>	<i>2000km</i>	<i>750kg</i>	<i>Testing</i>
<i>Shahab-1</i>	<i>Meteor-1</i>	Liquid	300km	1000kg	Scud-B
<i>Shahab-2</i>	<i>Meteor-2</i>	Liquid	500km	730kg	Scud-C
<i>Qiam-1</i>	<i>Rising</i>	Liquid	500km	700kg	Testing
<i>Shahab-3</i>	<i>Meteor-3</i>	Liquid	800–1000km	1000kg	No-Dong
<i>Ghadr-1</i>	<i>Powerful-1</i>	Liquid	1600km	750kg	Deployed?

Iran is the only country to develop a 2000+ km range missile without first acquiring a nuclear weapon

Iranian Ballistic Missile Capabilities

- **Iran initiated two, parallel missile acquisition strategies in the 1980s**
 - **Importing liquid-propellant missiles based on Soviet *Scud* technology**
 - **Developing an infrastructure for solid-propellant rocket production**
- ***Scud*-B and -C missiles from Libya, Syria and North Korea**
 - **Renamed *Shahab*-1 and -2 respectively**
- **Acquired 900km-range *Nodong* in mid-1990s from North Korea**
 - **First Iranian flight-test of the *Shahab*-3 in 1998 (failure)**
 - **Series of modifications to create *Ghadr*-1, *Safir* SLV and *Simorgh* SLV**
- **Must import liquid-propellant engines and other critical components**
- **Procured solid-propellant production infrastructure from China**
 - **Series of increasingly larger facilities to produce larger, longer-range systems**
 - **Developed 'tacit knowledge' to produce rocket motors domestically**

Iranian Ballistic Missile Capabilities

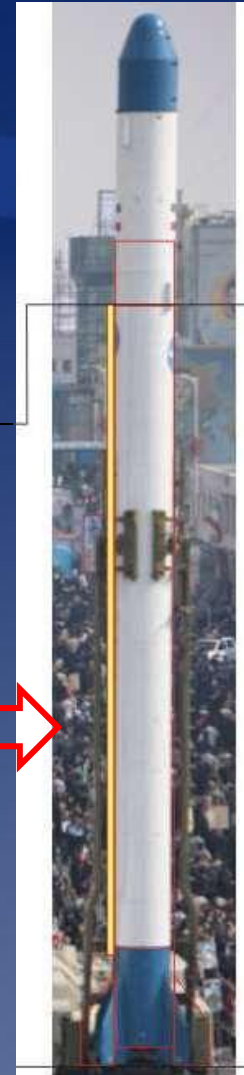
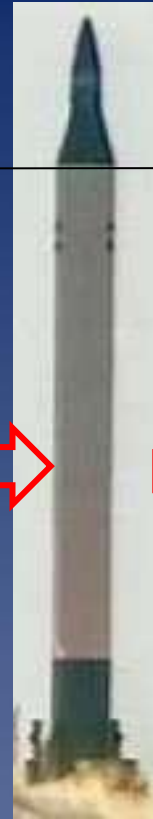
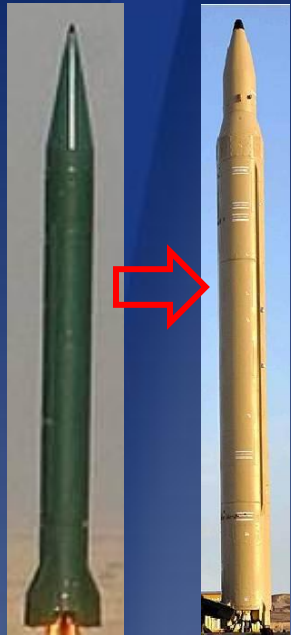
Simorgh- SLV

Safir- SLV

Ghadr-1 Kavoshgar

Shahab-3 Shahab-3M

Shahab-1/2 Qiam

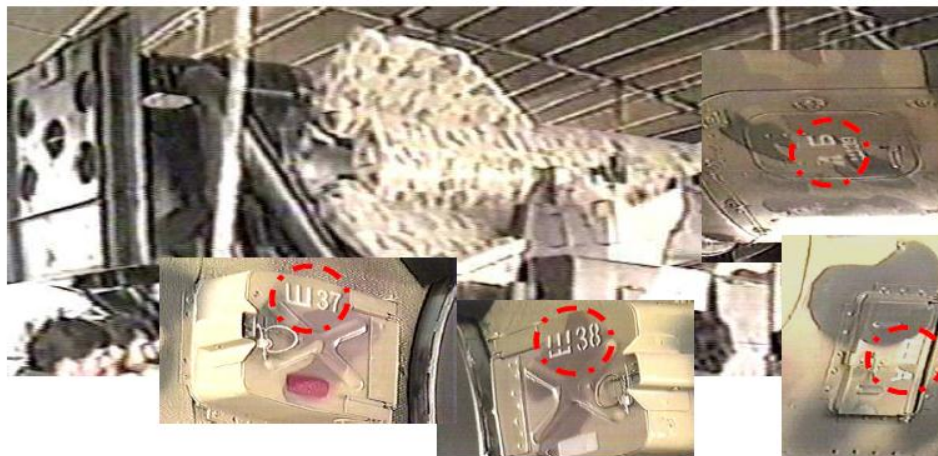


Scud Engine

Based on the Nodong Engine

Iranian Ballistic Missile Capabilities

Cyrillic Letters on Shahab 3



Convincing Evidence that neither Iran nor North Korea manufacture the *Scud* and *Nodong* engines:

- Cyrillic Lettering on components
- Identical Construction, Performance
- Interviews with Russian specialists
- Acquisition history

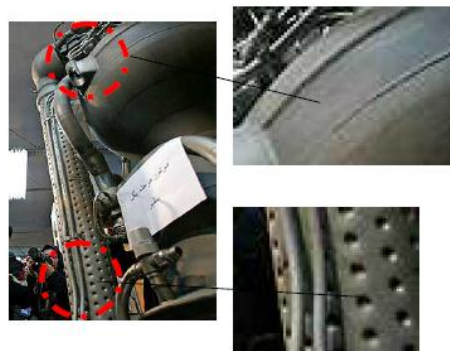
“Reverse-engineering” is a Myth

Russian Textbook on Liquid Missile Engine Production

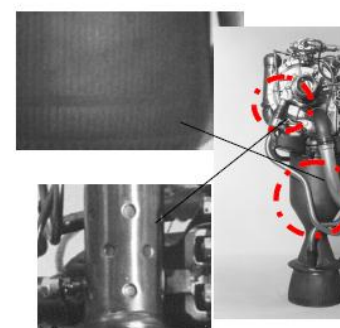


Identical Soviet and Iranian Engine Technologies

Iranian Characteristics

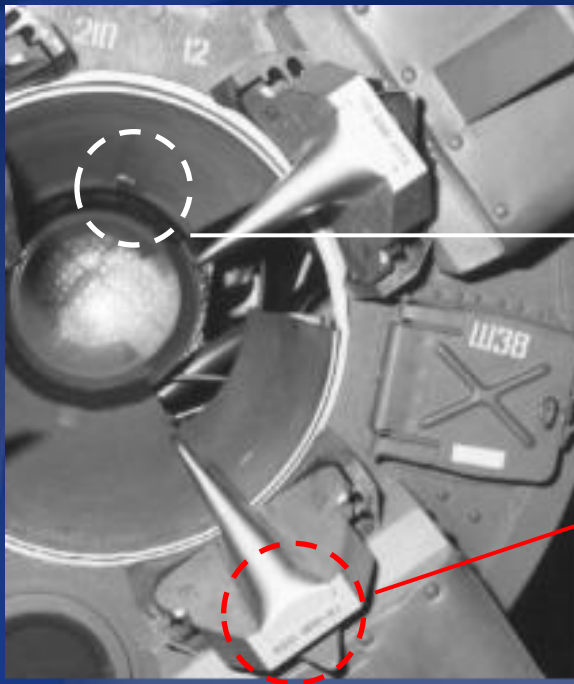


Soviet Characteristics



Iranian Ballistic Missile Capabilities

Details of Soviet and "North Korean" Produced *Scud-B* Missiles



Soviet *Scud-B*

Nozzle Plug

Jet Vane Markings



**North Korean *Scud-B*
(from *So San* intercept)**

Iranian Ballistic Missile Capabilities

Iran's Space Launch Activities

- **Iran has an active and ambitious space launch programme**
 - Three satellites successfully launched to orbit, with more planned
 - Goal is to place man into orbit by 2020
- **Launchers derived from missile stockpile**
 - *Zelzal* transformed into *Kavoshgar* sounding rockets*
 - Stretched *Ghadr-1* is basis for *Safir* SLV first-stage
 - *Safir* second-stage powered by Soviet steering engines
 - From Soviet R-27 or ROTA missile
- **Space launcher → missile conversions are rare**
 - Similar technologies
 - Very different operational requirements
 - UNSCR 1929 prohibits Iranian space launches, but they continue

*Note: First *Kavoshgar* launch was based on a *Ghadr-1* platform

Iranian Ballistic Missile Capabilities

Space Programme

- **Five *Kavoshgar* launches to date**
 - **Scientific payloads**
 - **Reach altitudes of more than 100km**



&



- **Four known *Safir* launches to date**
 - **Three successful launches [2/2009, 6/2011, and 2/2012]**
 - **More scheduled for this year and next**
 - **Small (<50kg) satellites, with limited utility**
 - **Proof-of-Concept and experience**

Iranian Ballistic Missile Capabilities

Space Programme



Simorgh satellite launcher development is part of an ambitious space program with the goal of placing a man in space by the end of this decade.

Inaugural launch May 2013?

Basis for an IRBM?



Satellite image acquired by DigitalGlobe.

Iranian Ballistic Missile Capabilities

Solid-Propellant Systems



Fateh-110



Ashura/Sajjil-2
(Under development)

Iranian Ballistic Missile Capabilities

***Zelzal* artillery rocket
(mid- to late-1990s)**



***Fateh 110* “missile”
(early- to mid-2000s)**



System evolution over two decades

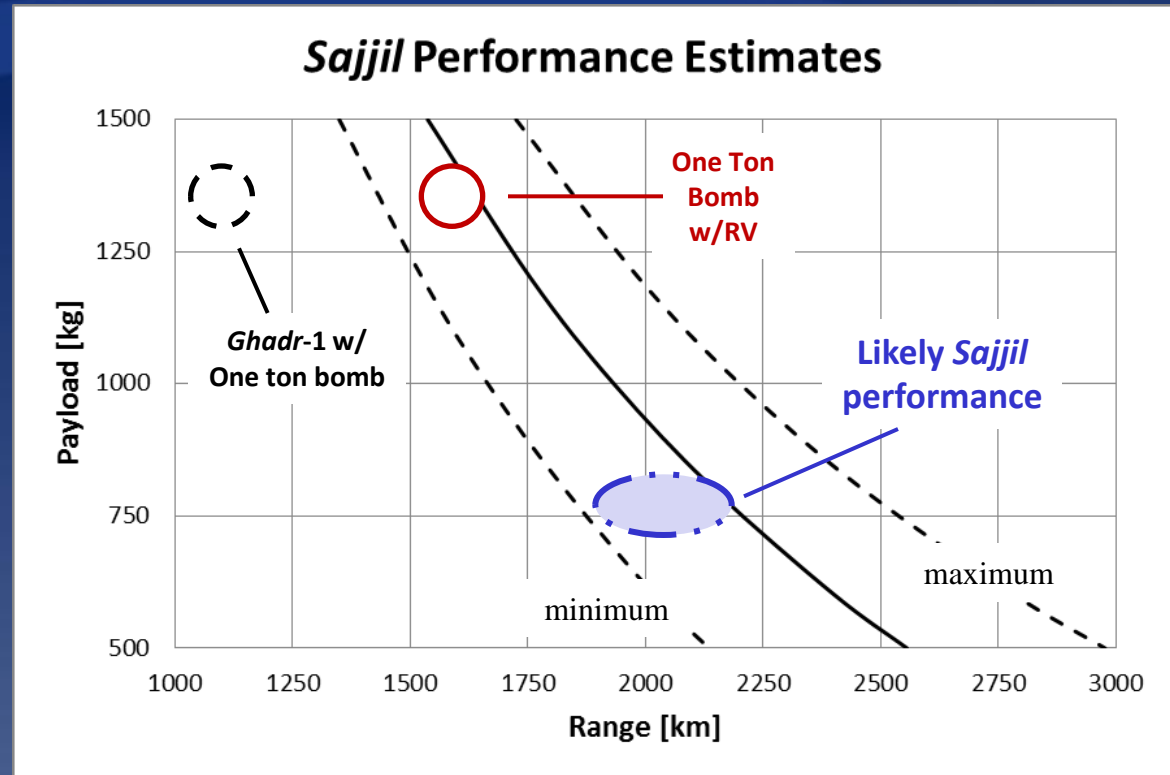
Creation of a solid-propellant industry, and accumulation of ‘tacit knowledge’ for indigenous capacity to design, develop, test, produce and field increasingly sophisticated missiles



***Khalij Fars* “Anti-Ship Missile”
(circa 2011)**

Iranian Ballistic Missile Capabilities

Development of the *Sajjil-2* may have been prompted by concerns that a one-ton, first generation bomb design could not be delivered to Israel by the *Ghadr-1*, unless launched from positions along the Iran-Iraq border, where the launcher and missile would be vulnerable to pre-emptive strikes.



Iranian Ballistic Missile Capabilities

Ballistic Missile Deployment

Mobile Launchers



Numbers

Zelzal and Fateh-110

- **Hundreds of rockets**
- **?? launchers**

Missions

Mass fire; battlefield support



Shahab-1 and -2

- **200-300 missiles**
- **12-18 launchers**

Strategic targets:

Cities, military bases, infrastructure in the Gulf



Shahab-3 / Ghadr-1

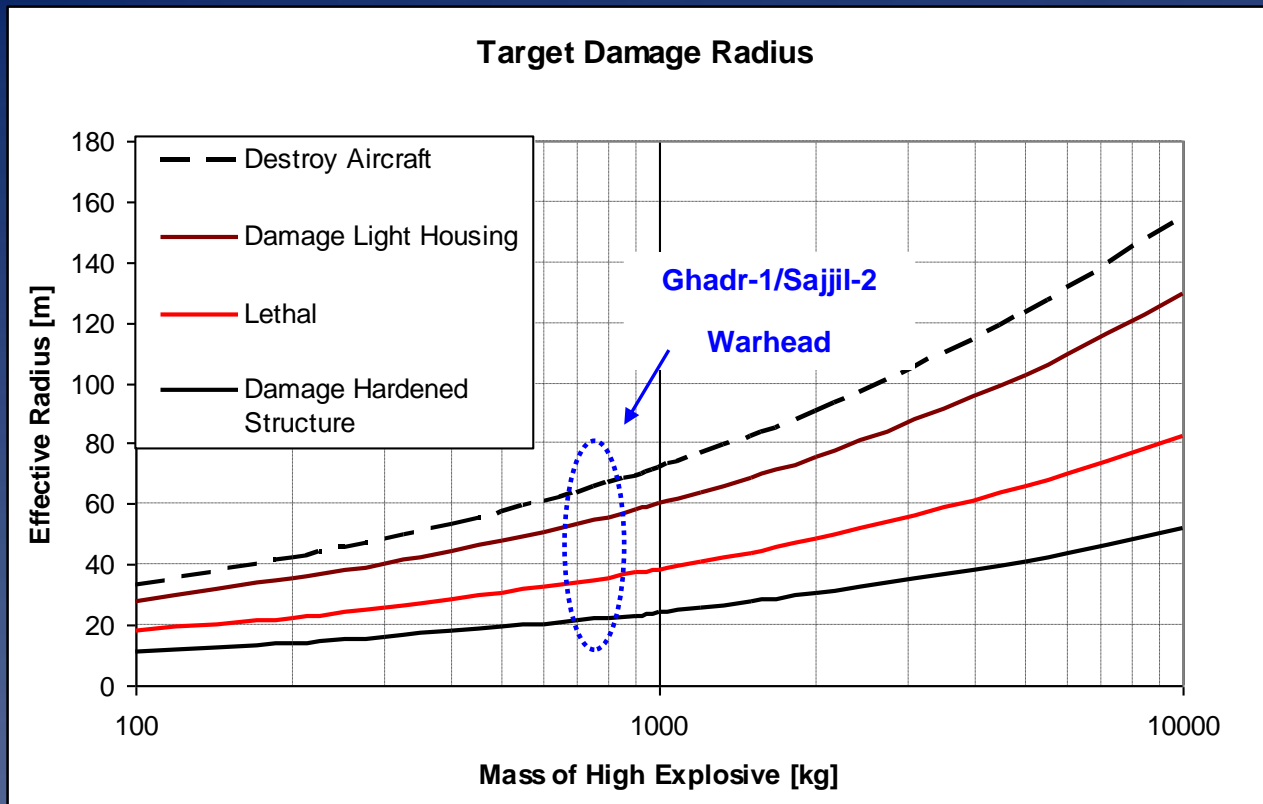
- **25-100 missiles**
- **6+ launchers**

Strategic targets:

**Israel; military bases,
infrastructure beyond the Gulf**

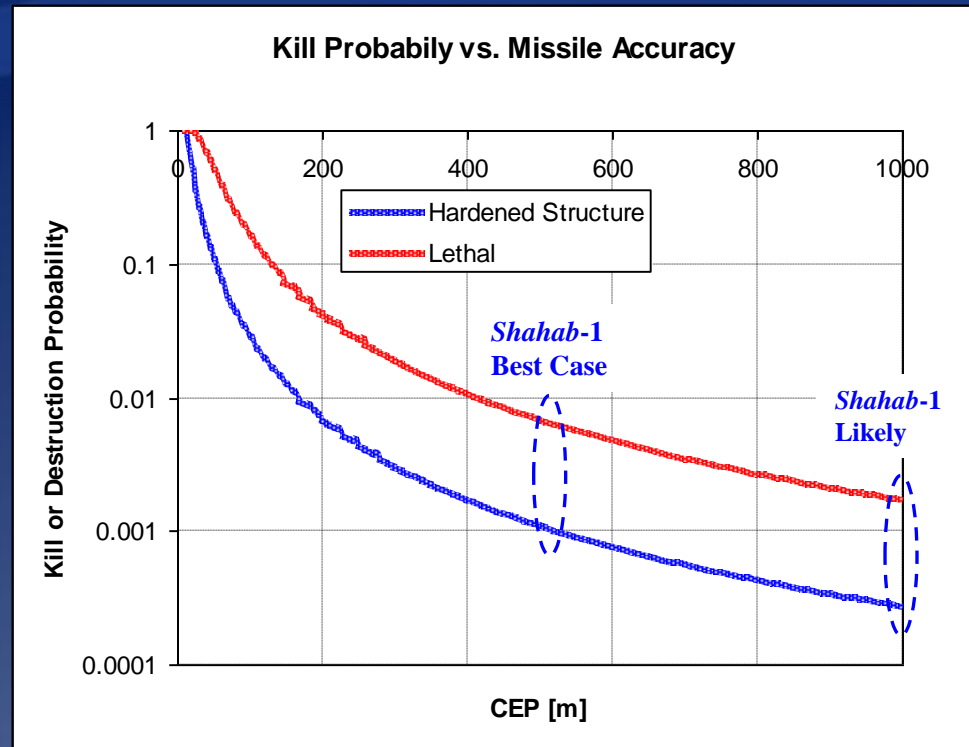
Iranian Ballistic Missile Capabilities

Conventional Warhead Lethality



Iranian Ballistic Missile Capabilities

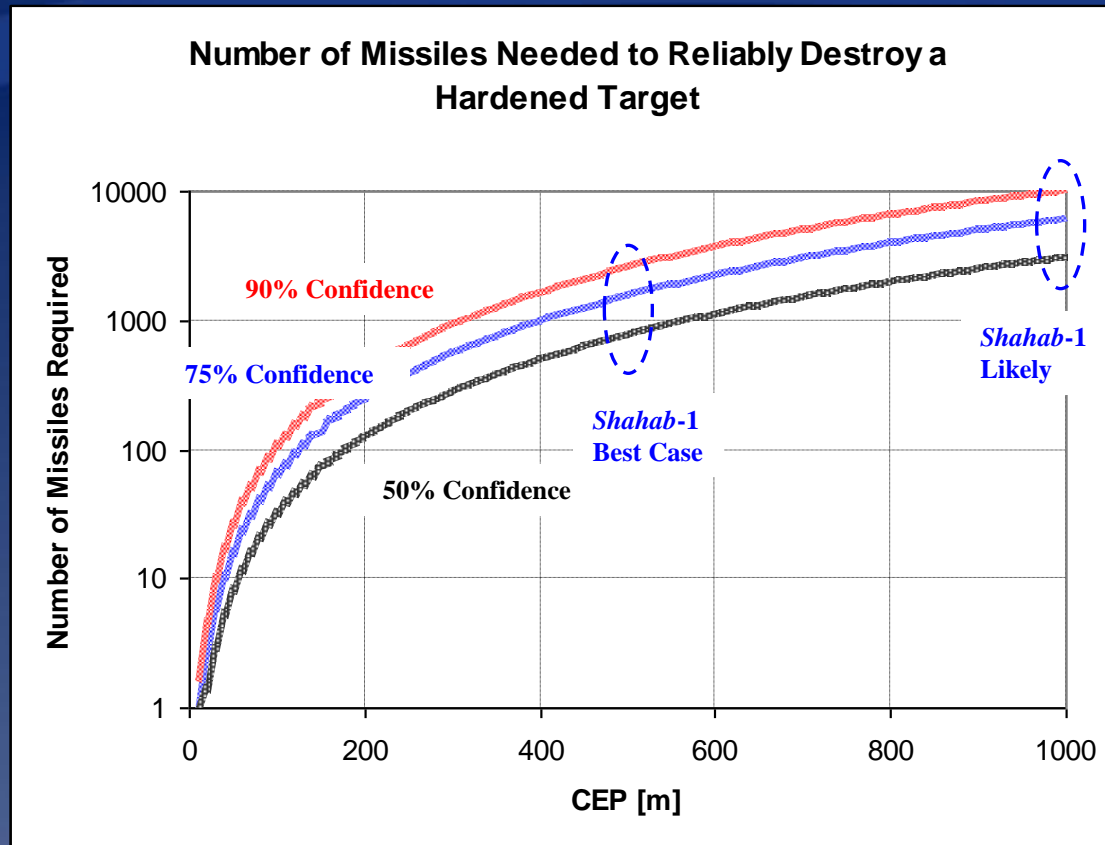
Utility Against Specific Target



Iran's missiles lack the accuracy to be militarily effective.

But, they could be used as a terror weapon, designed to sow fear and degrade political resolve; casualties would likely be limited to 2-3 persons per missile.

Iranian Ballistic Missile Capabilities



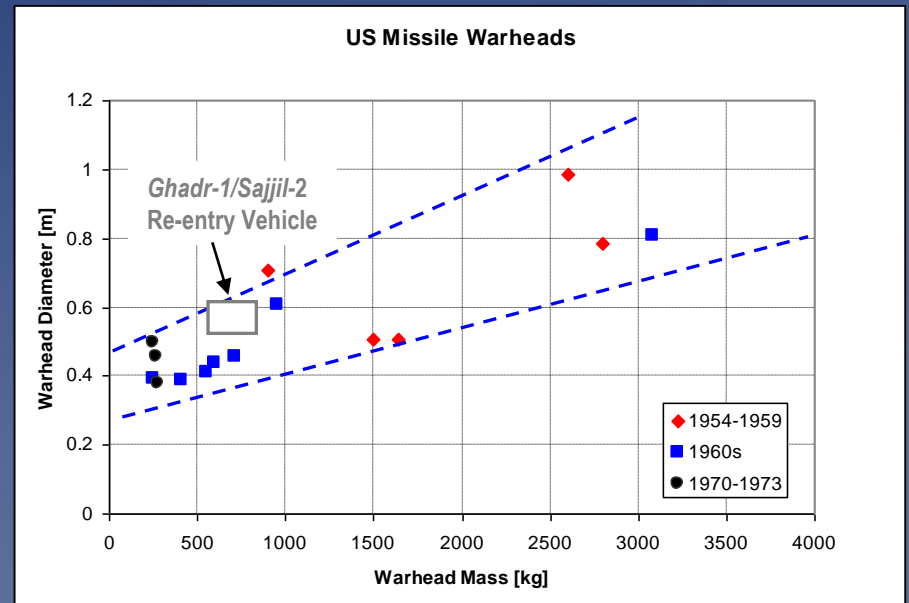
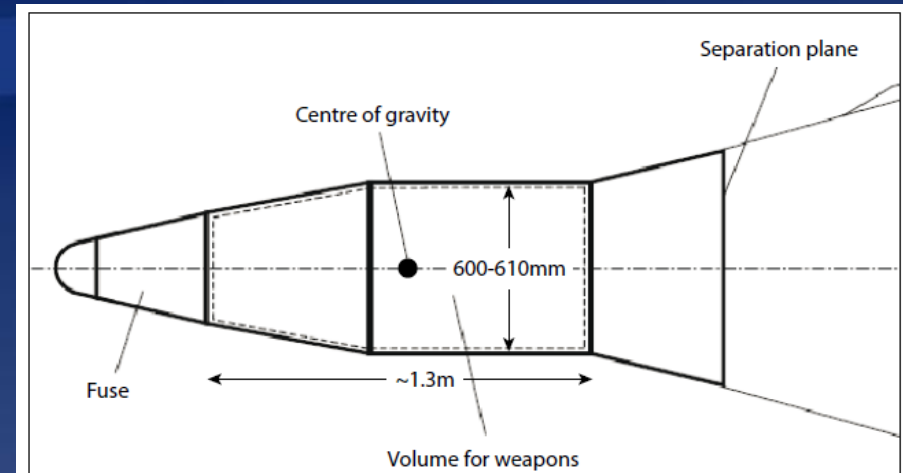
1000+ missiles needed to disable Saudi Arabia's Abqaiq oil stabilization facilities (75% confidence)

Iranian Ballistic Missile Capabilities

Nuclear warheads have a much stronger strategic logic, if Iran can make a bomb small enough.

The most likely delivery platform for a notional Iranian nuclear weapon would be the *Ghadr-1*, or possibly the *Shahab-3*.

After full development, the *Sajjil-2* will likely replace the *Ghadr-1*.



Iranian Ballistic Missile Capabilities

Status of Iran's Missile Industry

- **Iran has invested heavily to establish an indigenous production capacity**
 - **Considerable success to date; but still dependent on foreign sources for key components, materials and manufacturing equipment**
- **Developed and applied a disciplined, robust engineering management process**
 - **Over the long-term, Iran will be able to develop missiles capable of striking Western Europe and the United States, if it so decides**
 - **But, no ICBM before 2020; necessary flight-testing provides 3-4 years warning**
- **Future missiles will be based on solid-propellants; Space launch program will rely on liquid-propellants**
- **Missiles will remain inaccurate, with limited military utility**
 - **GPS will not appreciably improve Iran's ballistic missile accuracy**

Conclusions

- **Ballistic Missiles, Space Launchers are a regime priority**
 - Deterrence and intimidation
 - National prestige and pride
- **Increasingly self-sufficient, but must still import key materials, components and production equipment**
 - Improving technical wherewithal; creative specialists
 - Disciplined and structured engineering management practices
- **Capacity to develop increasingly capable missiles**
 - Three to five years warning of new missile capability
- **Will likely favour accuracy, reliability and survivability enhancements over increased range capabilities**

Responding to Iran Missile Challenge

- **Arms Control and Diplomatic Initiatives**
 - **Contain future developments**
 - **Begin with regional, intermediate-range flight test bans**
 - **Additional confidence building measures**
- **Early Warning and Civil Defence**
 - **EW is inexpensive and effective; 50% reduction in casualties**
 - **Civil Defence can be adaptive, but can get expensive**
- **Missile Defence**
 - **Rely on US/NATO forces in or near to the region; collateral coverage**
 - **Procure independent defences**
 - **Combine with Air-Defence -- PAC-3, THAAD, SM-3**
 - **Consider Russian S-300/400**
 - **Cooperative Missile Defence**
 - **Integrated, regional-wide, shared defences**

Back Up Slides

Iranian Ballistic Missile Capabilities

Khalij Fars (Persian Gulf) Anti-Ship Missile: an assessment



Seeker?



Identical
G&C section

Warhead



Iranian Ballistic Missile Capabilities

Fixed-Site Launch Complexes

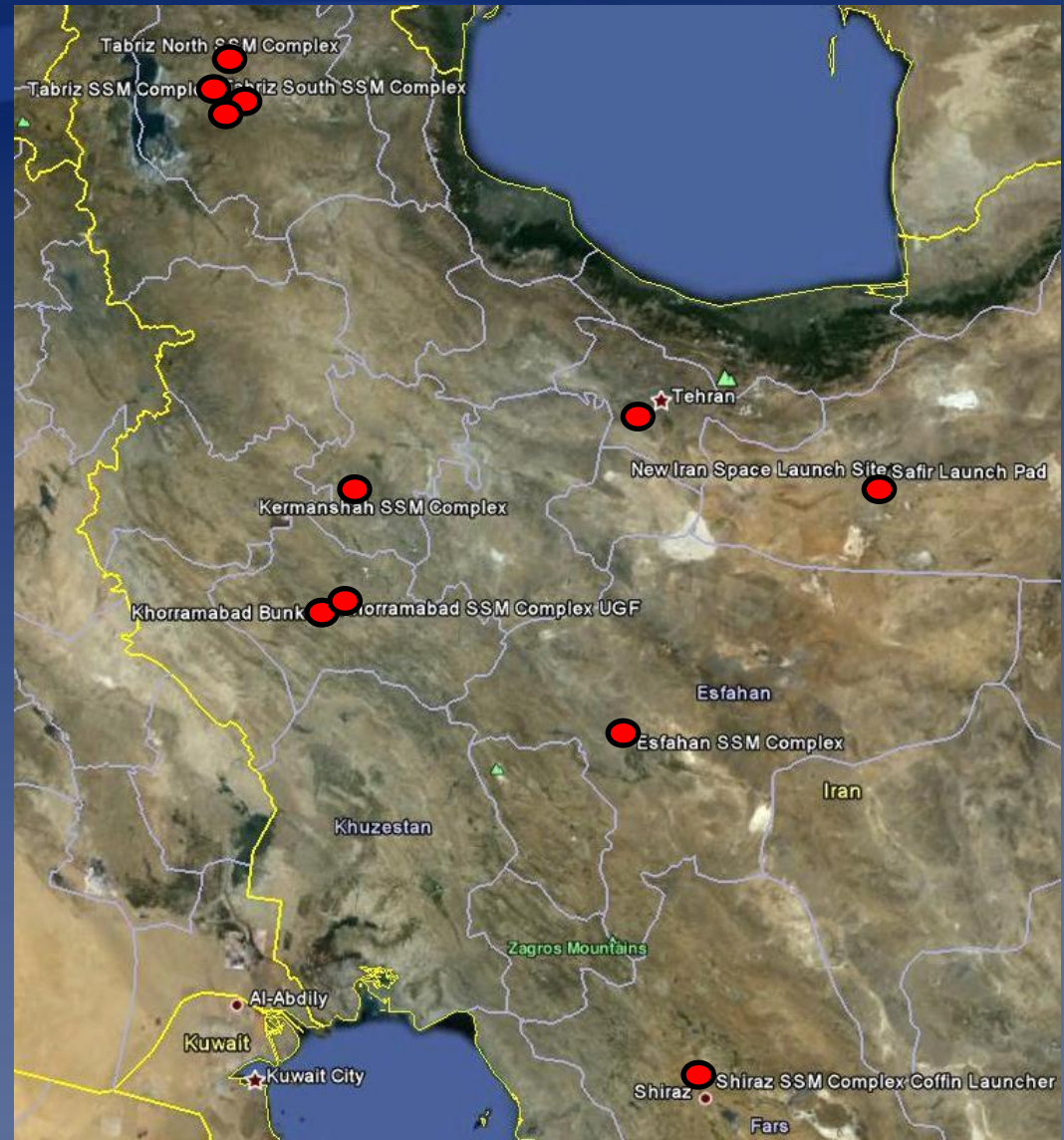
Initiated construction in mid-2000s

At least 10 sites, with most in northwestern Iran

Optimised for targets in Israel and Iraq, except for Shiraz site

Possible rationale:

- Salvo launches?
- Signaling?
- Survivability?
- Deployment diversification?
- Future missile?
- Prestige?



Iranian Ballistic Missile Capabilities

Rudimentary Missile Silos

Offer minimal pre-launch protection; vulnerable to precision munitions

No maintenance access; missiles have to be removed and refurbished monthly

Locations visible on Google Earth

Future BM-25 missile deployment?

Support deployment of longer-range missiles, once developed?



Silo Door



Complex South of Tabriz

Iranian Ballistic Missile Capabilities

Cavern Basing Mode

Modeled on Chinese deployment practices?

More versatile than vertical silos

Better pre-launch survivability



Explosion at Modarres Garrison

Site of
Explosion



November 12, 2011 Explosion southwest of Tehran killed 'the father of Iran's ballistic missile programme, IRGC Major General Hassan Tehrani Maghaddam

The Mystery: Accident or Sabotage?



- **Damage consistent with two or three detonations**
- **Rocket propellants are generally non-detonable**
- **Photo taken ten days after the incident**
- **No conclusive evidence to support either scenario**