Chapter 8

SAFEGUARDS, NON-PROLIFERATION AND PEACEFUL NUCLEAR ENERGY

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"I know not with what weapons World War III will be fought, but World War IV will be fought with sticks and stones."
Albert Einstein

"For nothing can seem foul to those that win."
William Shakespeare

"Simpler explanations are, other things being equal, generally better than more complex ones."
"Among competing hypotheses, the one that makes the fewest assumptions should be selected."
"It is futile to do with more things that which can be done with fewer."
Occam's Razor Principle, William of Ockham, Medieval philosopher.

"We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances. Therefore, to the same natural effects we must, so far as possible, assign the same causes."
Isaac Newton

"Whenever possible, substitute constructions out of known entities for inferences to unknown entities."
Bertrand Russell

"If a thing can be done adequately by means of one, it is superfluous to do it by means of several; for we observe that nature does not employ two instruments [if] one suffices."
Thomas Aquinas

8.1 INTRODUCTION

According to Article VI of the Non Proliferation Treaty, NPT:

> "Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a Treaty on general and complete disarmament under strict and effective international control."

In January 2015, the Bulletin of the Atomic Scientists set its "Doomsday Clock" to 3 minutes to midnight. The last time it was set to that time was in 1983, when the USA-Soviet Union relations were at their iciest point. The only other time when the situation was worse occurred in 1953, when the clock was set to 2 minutes to midnight, as the USA exploded its first thermonuclear device in October 1952. Unchecked climate change and the nuclear arms race resulting from the modernization of huge nuclear arsenals pose "extraordinary and undeniable threats to the continued existence of humanity", according to the Bulletin of Atomic Scientists [14]. In November 2014, Russia announced that it would boycott the 2016 Nuclear Security Summit in the USA. In December 2014, the USA Congress voted, for the first time

in 25 years, not to approve funding to safeguard nuclear materials in the Russian Federation. Russia terminated cooperation in almost all aspects of nuclear security after two decades of cooperation [14]. Russia and the USA are modernizing their nuclear arsenals, and NATO recently announced that it was rethinking its nuclear strategy. Russia is accused of using the so-called "Hybrid Warfare," from propaganda to cyber warfare and funding and supporting separatists with clandestine military operations. Risky encounters between Eastern and Western troops, especially in the air, are becoming more and more common [14].

According to the Bulletin of Atomic Scientists in 2015:

> "Unchecked climate change, global nuclear weapons modernizations, and outsized nuclear weapons arsenals pose extraordinary and undeniable threats to the continued existence of humanity, and world leaders have failed to act with the speed or on the scale required to protect citizens from potential catastrophe. These failures of political leadership endanger every person on Earth." Despite some modestly positive developments in the climate change arena, current efforts are entirely insufficient to prevent a catastrophic warming of Earth. Meanwhile, the United States and Russia have embarked on massive programs to modernize their nuclear triads—thereby undermining existing nuclear weapons treaties. "The clock ticks now at just *three* minutes to midnight because international leaders are failing to perform their most important duty—ensuring and preserving the health and vitality of human civilization."

A sober assessment of the status of the nuclear safeguards and proliferation regimes is attempted. The argument is here made that under the present status of these regimes; nuclear weapons have become obsolete and unusable, leading to a discernible shift in threat and security considerations. In this context we discuss the application of the decision theory Lanchester Law developed by the English engineer Frederick Lanchester based on the study of air battles during the First World War.

As of May 2010, the USA possessed 5,113 nuclear warheads in its strategic stockpile, an 84 percent reduction from a peak of 31,255 warheads in 1967 during the Cold War period. Earlier, the USA and the Soviet Union had accumulated a total of about 50,000 nuclear devices. Because of the futility of the Mutual Assured Destruction (MAD) doctrine that these weapons supported, the end of the Cold War, their becoming obsolete with the advent of precision munitions, their upkeep cost and their deterioration by age, they agreed to dismantle parts of their obsolete nuclear arsenals.

The Strategic Arms Reduction Treaty (START) calls for cutting the nuclear warhead count from around 9,000 per side to 6,000 per side. This was followed by the START II Treaty aimed at eliminating multiple-warhead, land-based missiles, would further reduce the strategic-weapons arsenals to 3,500 per side. The USA has withdrawn all short-range and naval nuclear weapons formerly stored outside its borders. Russia says it no longer target the USA with Inter Continental Ballistic Missiles (ICBMs).

The USA President Barack Obama and Russia's President Dmitry Medvedev signed a successor to the 1991 START treaty in April 2010 at Prague, the Czech Republic. Both

countries' nuclear arsenals will be cut by another 30 percent, to 1,550 warheads each, leaving either side with plenty of devices to incinerate most major population centers on Earth.

Yet, hesitation and failure by the nuclear power states to abide by their commitment to gradually reduce then totally eliminate their nuclear weapons stockpiles is creating an incentive for some potential newcomers aspiring to join the nuclear club. They reason that what is beneficial for the security of the nuclear weapons states should be also suitable for them.

The "axiom of proliferation" states that as long as some states cling to the possession of nuclear weapons, others will also seek to acquire them. According to "catastrophe theory," serious nuclear disarmament is apparently waiting for some event that would stir action toward the eventual goal of humanity to eliminate nuclear weapons. An analogy is advanced of a village fully aware about the need to build gates along railroad tracks that pass through it, remaining inactive then spring into action until the time that one of its residents is hit by a passing train.

The International Atomic Energy Agency (IAEA) was established in 1957 as an autonomous inter-governmental organization in the United Nations (UN) family of organizations, to coordinate among nations the peaceful uses of nuclear energy. The UN itself was created after the Second World War to prevent and resolve conflicts and to promote disarmament.

Since atomic weapons were used in warfare against Japan, the world's community has determined that they should not be used again and a vision for a nuclear weapons-free world dominates the political scene worldwide.

Article II of the IAEA statutes states that: "The International Atomic Energy Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the World. It shall ensure, so far it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose."

Parties to the treaties met in 1995 at the Fifth NPT Review and Extension Conference, and decided on the indefinite extension of the Treaty and adoption of the Principles and Objectives for Nuclear Non-Proliferation and Disarmament. They met in April and May of 2000, for a sixth review conference of the Treaty. Another review was held in 2005, with review meetings planned to be held every five years.

Nuclear weapons caused a de facto freeze in the national borders in their present state, and prevented total war. Small arms, like the Kalashnikov AK-47, in spite of its mediocre accuracy and limited range, and the M-16, became the weapon of choice in asymmetric warfare. They proliferated from state to state, army to army, non-national group to non-national group and man to man, and became the principal weapon used for modern war and political violence.

The West's attention was fixated on nuclear weapons and their risks and developed an intellectual, diplomatic and material infrastructure to suppress their acquisition by its adversaries and actively restrict their proliferation with invasion, occupation and regime change if deemed to be necessary.

The Mikhail Kalashnikov's assault rifle, in its dozens of versions, and other complementary arms such as the Rocket Propelled Grenade (RPG), are causing the killing. Few people were killed by high ticket items such as submarines, and none by nuclear weapons. In actual practice, assault rifles have proven themselves to be much more deadly than nuclear weapons.

With the advent of superior new warfare technologies such as Unmanned Aerial Vehicles (UAV), nuclear weapons have become obsolete, leaving the field clear for the peaceful applications of nuclear technology. The tremendous energy release in nuclear weapons could be used in the future in planetary engineering like terra forming Mars and Venus, restoring the Earth's global equatorial current in response to global warming or civil nuclear engineering projects. Space travel within and beyond the solar system would have to depend on nuclear energy for propulsion and for power in space or on bases on the moon or Mars. In them might be the salvation of life on Earth in deflecting or shattering undesirable stellar invaders in the form of comets or asteroids. For humans to spread all of life throughout the Milky Way galaxy and beyond in the known universe, nuclear energy will be their most valuable tool.

8.2 NUCLEAR ARMS CONTROL TREATIES

LIMITED TEST BAN TREATY, LTBT, 1963

The USA, the Soviet Union and the UK signed the treaty to prohibit nuclear weapons tests in space, above ground and under water on August 5, 1963. Underground tests were also outlawed if they resulted in spreading radioactive debris outside the territorial limits of the state where the explosion is conducted. The treaty, which is of unlimited duration, entered into force on October 10, 1963.

President John F. Kennedy signed his name to the Nuclear Test Ban Treaty on October 7, 1963. President Kennedy regarded the LTBT as a "Clear and honorable national commitment to the cause of man's survival."

NON-PROLIFERATION TREATY, NPT, 1968

The USA, the Soviet Union and the UK signed the treaty on July 1st, 1968. It limits the spread of military nuclear technology by the recognized nuclear-weapon states: USA, USSR, UK, France and China, to non-nuclear nations wishing to build or acquire atomic weapons.

Non weapon states agree not to get nuclear arms and countries with nuclear weapons will negotiate for disarmament. It specified that countries without nuclear weapons will allow the UN International Atomic Energy Agency (IAEA) to oversee their nuclear facilities. Countries also should exchange peaceful nuclear technology.

It has since been signed by 187 countries and was extended indefinitely in 1995. India, Pakistan, Israel and Cuba are the only countries that have not signed it. India and Pakistan tested nuclear devices in 1998, and Israel possesses a nuclear capability estimated at 80-200 nuclear devices, with about 50 carried on ballistic missiles, cruise missiles on submarines and the rest for delivery by aircraft, according to the Stockholm International Peace Research Institute, SIPRI.

ANTI-BALLISTIC MISSILE TREATY, ABMT 1972

President Richard Nixon and Soviet Premier Leonid Brezhnev signed the Anti-Ballistic Missile Treaty, ABMT, at the end of the Strategic Arms Limitation Talks (SALT I) on May

26, 1972. It limited antiballistic missile launchers in each country to 200 launchers and interceptors, 100 at each of two widely separated deployment areas, and imposed a 5 year freeze on testing and deployment if Inter Continental Ballistic Missiles (ICBMs) and Submarine Launched Ballistic Missiles (SLBMs) at 1972 levels.

It was based on the assumption that the fear of Mutual Assured Destruction (MAD) would stop the Soviet Union and the USA from launching a nuclear attack. It was ratified in 1972 by the USA and amended in 1974 to reduce the number of launchers to 100 and only one launch site.

President George W. Bush administration tried to amend the treaty to clear the way for a decision to mount a limited missile defense system in Europe in Poland to protect against threats from so-called "rogue states" such as North Korea and Iran. Russia opposed it as an intrusion into its sphere of influence.

STRATEGIC ARMS LIMITATION TALKS, SALT II, 1979

President Jimmy Carter and Soviet Premier Leonid Brezhnev signed the SALT II Treaty on June 18, 1979. It restricted the number of strategic offensive weapons to 2,400 nuclear delivery vehicles as ICBMs, SLBMs and heavy bombers, for each side and banned the testing of many new missiles and launch systems.

The USA did not ratify the treaty after the Soviet Union invaded Afghanistan in December 1979. But President Jimmy Carter, and later President Ronald Reagan, agreed to comply with the provisions of the treaty as long as the Soviet Union reciprocated. Leonid Brezhnev made a similar statement regarding Soviet intentions.

MUTUAL ASSURED DESTRUCTION, MAD DOCTRINE

The Mutually Assured Destruction (MAD) doctrine evolved over the 1950s and 1960s as a way to create a stable equilibrium in the nuclear arms race. When nuclear weapons were first deployed, there was a view that a first strike by either the USA or the Soviet Union could incapacitate the opponent and win the Cold War. This view paradoxily led to a highly unstable situation; there was continual pressure to attack first before being attacked.

Each side overbuilt up their nuclear armaments to create a "second-strike" capability. If one were attacked first, enough weapons would survive to strike back. This second strike would deter the first-strike since the attacker had as much to lose as the victim.

As a result of the second-strike theory, each side continued to build first-strike weapons, especially multiple warhead missiles, to eradicate the second-strike capability. Each side also built more weapons to increase its own second-strike survivability. The line between first-strike and second-strike weapons was blurred. The nuclear arms race spun out of control.

Eventually arms limitation treaties and the existence of the nuclear triad of land, air, and sea launch capability, established a balance of terror. Each side had enough weaponry to survive a first-strike, and the parties agreed not to expand those capabilities.

NO FIRST STRIKE PLEDGES

If you have a stable balance with second-strike capability, why not renounce a first-strike. This pledge of "no first use" of nuclear weapons has been made by China and India.

The Soviet Union also made the pledge and pressured the USA to do likewise, although Russia reversed that pledge in 1993. Today Russia and NATO both reserve the right to the first use of nuclear devices.

The USA reserved the right to first use until 2010 when President Obama announced a "partial no first use" policy where the USA would not use nuclear weapons against non-nuclear powers that agreed to the Non Proliferation Treaty (NPT) and honored their obligations. A potential first use policy was retained against nuclear powers such as Russia and China, and non-compliant states like Iran.

INTERMEDIATE-RANGE NUCLEAR FORCES (INF) TREATY, 1987

President Ronald Reagan and Soviet Premier Mikhail Gorbachev signed the INF treaty on December 8, 1987. It required the elimination of all intermediate-range missiles, shorter-range missiles and associated equipment. The treaty required the elimination of all missiles with ranges between 625 and 3,500 miles by June 1, 1991, and all missiles with ranges between 300 and 625 miles within 18 months.

In all, 2,692 missiles were to be eliminated. In addition, all associated equipment and operating bases were closed out from any further INF missile system activity. Altogether it resulted in the elimination of 846 USA INF missile systems and 1,846 Soviet INF missile systems. The INF treaty was the first nuclear arms control agreement to actually reduce nuclear arms, rather than establish ceilings.

STRATEGIC ARMS REDUCTION TREATY, START I, 1991

Soviet Premier Mikhail Gorbachev and USA President George Bush signed START I on July 31, 1991. The bilateral agreement set a ceiling of 1,600 strategic nuclear delivery vehicles and 6,000 "accountable" warheads for each country. Following the 1991 breakup of the USSR., Belarus, Kazakhstan, Russia and the Ukraine became Parties to START I as legal successors to the former communist nation with the signing of the Lisbon Protocol. In addition to the elimination of missiles, their launchers and bombers, START established prohibitions on locations, training, testing and modernization.

When reductions were completed in 2001, Belarus, Kazakhstan and Ukraine had no strategic nuclear forces and the strategic arsenals of the USA and former Soviet Union had been reduced by 30-40 percent.

STRATEGIC ARMS REDUCTION TREATY, START II, 1993

President George W. H. Bush and Russian President Boris Yeltsin signed START II on January 3, 1993, which required the two countries to destroy 30 percent of long-range nuclear missiles and eliminate land-based multiple-warhead missiles. It halved the USA and Russian nuclear arsenals to between 3,000 and 3,500 warheads each. Only ICBMs carrying a single-warhead remained. No more than 1,700-1,750 deployed warheads may be on SLBMs. The agreement called for limitations and reductions to be completed from Jan. 1, 2003, to Dec. 31, 2007.

The USA Senate ratified the treaty in 1996, but not the relevant protocols, which would interfere with possible plans for a USA missile defense program. Russia's lower house of

parliament ratified both the treaty and the protocols in 2000. Ratifying START II became a moot point on May 24, 2002, when Presidents George W. Bush and Vladimir Putin signed the Treaty of Moscow.

COMPREHENSIVE TEST BAN TREATY, CTBT, 1996

The USA, Russia, the UK and 90 other nations signed the CTBT on October 10, 1996, which would ban any and all nuclear tests above and below the Earth's surface. The Treaty established an organization to ensure implementation.

India and Pakistan refused to sign. Twenty-nine of the required 44 countries have ratified it. The USA Senate refused to ratify it in 1999.

STRATEGIC ARMS REDUCTION TREATY, START III

The START III Framework sought to establish by December 31, 2007, a ceiling of 2,000-2,500 strategic nuclear weapons for each of the parties, representing a 30 percent to 45 percent reduction in the number of total deployed strategic warheads permitted under START II.

Talks for START III were supposed to commence when START II took effect. However because of disagreements over the USA's missile defense program, START II was not employed.

MOSCOW TREATY ON STRATEGIC OFFENSIVE REDUCTION

President George W. Bush and Russian President Vladimir Putin signed a treaty to slash their long range nuclear warheads by two thirds. The treaty commits the former Cold War adversaries to cutting their arsenals to between 1,700 and 2,200 warheads and bombs by the year 2012. The two nuclear giants held about 6,000 warheads each at the time of signing.

In 2002, USA President George W. Bush and Russian President Vladimir Putin signed the "Moscow Treaty on Strategic Offensive Reductions."

In 2004, USA President George W. Bush issued a directive to cut the entire USA nuclear stockpile of both deployed and reserve warheads in half by 2012 relative to 2001. The goal was achieved by 2007; five years ahead of schedule.

Critics say the treaty merely rearranges the arsenals of the two nations, because the agreement does not require either nation to destroy any warheads or delivery vehicles. It instead allows the USA and Russia to comply with the treaty by putting warheads in storage, where it is possible they could be used at some point in the future.

STRATEGIC ARMS REDUCTION TREATY, START IV, NEW START

The USA President Barack Obama and Russia's President Dmitry Medvedev signed a successor to the 1991 START treaty in April 2010 at Prague, the Czech Republic. Both countries' nuclear arsenals will be cut by another 30 percent, to 1,550 warheads each, leaving either side with plenty of devices to incinerate most major population centers on Earth.

The USA Congress has ratified the New START disarmament treaty, on Wednesday, December 22, 2010. The USA Senate approved the treaty by 71 votes to 26. At least 13 Republicans voted with the Democrats after being won over by President Barack Obama.

Russia and the USA cut their stock of nuclear warheads by 30 percent and will also introduce a new mutual inspection regime. This is the most significant arms control agreement in nearly two decades. It replaces the START treaty, which was signed in 1991 and expired in December 2009.

8.3 THE TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS (NPT)

The NPT (Appendix I) was opened for signature on July 1, 1968 and entered into force on March 5, 1970 after it had been ratified by its depositories: the Union of Soviet Socialist Republics (USSR), the United Kingdom (UK), and the United States of America (USA), as well as forty other states signatory to the Treaty. The Non-Proliferation Treaty (NPT) has as its goals:

1. Halt the further spread of nuclear weapons,
2. Provide security for non-nuclear-weapon states which have given up the nuclear weapons option,
3. Create a climate where cooperation in the peaceful uses of nuclear energy is fostered,
4. Encourage good faith arms control negotiations leading to the eventual elimination of nuclear weapons.

Under it, most of the nuclear weapons-free states have legally committed themselves not to acquire nuclear weapons or other nuclear explosive devices in any manner whatsoever. They also accept the obligation to conclude comprehensive safeguards agreements with the IAEA covering all of their peaceful nuclear activities. In return, the declared nuclear weapons states have committed themselves to undertake negotiations in good faith for nuclear and general disarmament. Although not obliged to conclude comprehensive safeguards agreements, the nuclear weapon states have agreed that the Safeguards regime would be applied to all or part of their civilian nuclear activities. All parties have pledged to promote the transfer of peaceful nuclear technology to other parties. The NPT entered into force in 1970 and was extended indefinitely in 1995. As of April 2000, it had 187 States parties and provides the foundations of the nuclear non-proliferation regime. Depositary governments are the Russian Federation, the UK, and USA.

The NPT has been criticized by many nations for its perceived double standards: demanding the renunciation of nuclear weapons from the non-weapons states, while tolerating a nuclear arms race among the nuclear weapons states, and maintaining the strategic advantage that nuclear weapons provide them with. In addition to the lack of concrete steps on the side of the weapons states towards nuclear disarmament, they are accused by the non-weapons states to have adopted an unofficial policy of “Denial of Technology,” particularly what is designated as “Dual Use Technology,” in favor of low level “Appropriate Technology.” This is being justified on the basis of the dual nature of some technologies such as aerospace and nuclear energy, in that they can be used for both peaceful and military purposes. This is an

acknowledged failure of the NPT encouraging those countries that are committed to the acquisition of modern technologies for economical or strategic purposes to avoid it.

There are prominent successes though. The primary incentive to the acquisition of nuclear weapons has been concerns about the national security of the weapons states. Insecurity nowadays lies in the economic and environmental spheres as trade deficits, drought or global warming and environmental pollution. As the Cold War between the Eastern and Western blocs waned down, the risk of war between the great powers is becoming remote. As a result stockpiles of aging nuclear weapons that are becoming unsafe due to deteriorating explosives and corrosion of metallic components; needing to be remanufactured, are being dismantled and are not being reassembled into newer weapons. The fissile materials such as Highly Enriched Uranium (HEL) in the aging weapons is diluted with natural uranium into Low Enriched Uranium (LEU) and used by the electrical utilities for producing electricity in fission power plants.

Regional Treaties such as the Tlatelolco Treaty, have been successful in stopping the regional introduction of nuclear weapons in South America. Voluntarily, Brazil in 1990, South Africa in 1991 and under pressure, Lybia in 2003 dismantled with the help of the IAEA their existing nuclear weapons programs. Iran and Brazil agreed to the IAEA inspections of undeclared U^{235} centrifuge enrichment facilities.

Iraq was forced to dismantle a suspected nuclear weapons program, and because of uncertainties and disinformation by regime dissidents about its compliance with the imposed IAEA inspections, was forcefully invaded and in 2003 in part because of the uncertainty surrounding the inspection process, and subjected to "regime change," and to military occupation.

Pressured for inspections, and fearing an invasion like in the case of Iraq, the Democratic People Republic of Korea (DPRK), gave due notice and withdrew from the NPT in 2003. It then reprocessed its plutonium stockpile, and declared itself in possession of an unspecified "deterrent" in 2004 with later testing. In 2007, it agreed to IAEA inspection in return for economic incentives.

There is still concern about the threat of the existing modernized nuclear stockpiles. Nuclear non-proliferation commitments are not yet universal. The Nuclear Weapons Club consisting for a long period of 5 members: The USA, Russian Federation, China, UK, and France, saw two new members added to it as India tested nuclear devices in 1974 and 1998 and with Pakistan following up in 1998.

There exists one single undeclared member of the club of weapons states: Israel, which suggests that it needs nuclear weapons to protect itself against conventional and nuclear attack. With progress towards peace and democracy and peace in the Middle East the perceived need for these weapons will hopefully fade away. Clandestine efforts at acquiring nuclear weaponry are suspected in several states such as Iran, Brazil, Algeria, Syria the People's Republic of Korea and possibly others.

In addition, most of the industrialized states that have developed a nuclear infrastructure such as Japan, Brazil and Germany are in fact virtual or latent Nuclear Weapons States, in that they are capable at developing nuclear weaponry on a short notice, due to the availability of materials, facilities and equipment. Not acquiring nuclear weapons was a choice on their part based on economic and political reasons. A classification of nuclear weapons policies in different states is shown in Table 1.

A reliable renunciation of nuclear weapons is mutually reinforcing among neighbors and within regions, and has been successful for instance in South America. On the other hand, concern about the reliability of these commitments and the possible clandestine development and retention of these weapons has lead to a publicized nuclear arms race on the Indian subcontinent, and to an unpublicized one in the Middle East region. The latter is in need for a regional treaty similar to the other successful ones.

Table 1. Classification and breakdown of national nuclear weapons policies

Policy	Fraction of world population (percent)
Declared nuclear weapons states	31
Other large nuclear weapons states	10
Other small nuclear weapons states	6

Subtotal	47
States under USA nuclear umbrella	1
States under other nuclear umbrellas	1
Former nuclear weapons states	2

Subtotal	4
USA allies with technology	8
Other states with technology	2
States keeping weapons of mass destruction option	13
Nuclear threshold states	19
Proliferant states	1
States advancing the technology	6

Subtotal	49
Total	100

8.4 NON-PROLIFERATION TREATY REVIEWS

Every five years, the 188 members of the NPT meet for a month to review the landmark treaty. The 2005 review ended without any agreement on how to improve the accord. Many delegates blamed both the USA and the Islamic Republic of Iran (IRI) for what they described a failure of the conference to do anything. The USA delegation worked hard to prevent the conference, which works by consensus, from approving any documents that refer to its 1995 and 2000 NPT review meetings pledges to nuclearly disarm, while the IRI blocked anything that referred to it as a proliferation threat and possible NPT violator.

The 2005 review conference chairperson, Sergio Duarte of Brazil, declared that the disagreements between the nuclear weapons and non nuclear weapons states ran so deep that "very little has been accomplished." When asked what the fundamental cause of the failure was, he said: "I think you can write several books on that."

The review conference, which takes place every five years, had once been seen as a chance to deal with gaping loopholes in the treaty that have allowed a resurgence in the possible spread of nuclear weapons.

In the months leading up to the meeting, it became clear that little progress was likely, and in the end the disagreement between the USA, which wanted to focus on the People Democratic Republic of Korea (DPRK) or North Korea and Iran, and countries demanding that the USA and the nuclear weapons states shrink their own arsenals according to their earlier commitments, ran so deep that no real negotiations over how to stem proliferation ever took place.

8.5 USA COUNTER-PROLIFERATION REGIME, PROLIFERATION SECURITY INITIATIVE

President George W. Bush had repeatedly declared that nuclear proliferation, including the perceived risk of terrorists obtaining a nuclear weapon, is the biggest single threat to the USA whose administration decided against sending Secretary of State Condoleeza Rice to the conference, leaving arguments to mid-level diplomats. The 150 or so nations at the conference spent several weeks arguing about the agenda.

The USA's secretary of State Condoleezza Rice described the treaty as "an extremely important document" and said: "We will continue to support it." But she warned that: "It is fraying in many ways," choosing to concentrate the attention to the USA's "counter-proliferation" programs, from intercepting suspected nuclear cargo to bringing down global nuclear sales networks.

Conferees criticized, without naming them, the USA for ignoring its commitments, and other nations for failing to grapple with the Iran and DPRK problems. The Canadian representative, Paul Meyer, said: "We have let the pursuit of short-term, parochial interest override the collective long-term interest in sustaining this treaty's authority and integrity."

Mohammed El Baradei, director general of the International Atomic Energy Agency, who had proposed new mechanisms for international control of nuclear material so nations could not secretly produce weapons grade fuel, said: "absolutely nothing" had come out of the meeting and said: "We are ending after a month of rancor, when everyone agreed that the system is ailing but not busted, and the same issues continue to stare us in the eyes."

Non-nuclear states insisted that the USA and other nuclear powers focus on radically reducing their armaments, reminding them of commitments made five years earlier in the previous review meeting by the USA's President Bill Clinton administration.

The USA insisted that conditions had changed radically since then. A history of milestones in its counter-proliferation policy published by the American delegation omitted references to commitments that President George W. Bush administration had rejected and tried to focus the conference on how to deal with problems like the DPRK, which abandoned the treaty two years earlier and has declared that it has a small nuclear arsenal. The American representative, Jackie W. Sanders, said the USA wanted to continue the discussion "in other fora," without describing when or where. The USA administration's favored approach is its Proliferation Security Initiative, an effort to organize dozens of nations into a loose dragnet that would stop ships, train and airplanes believed to be carrying nuclear related goods. Its most famous success came in 2003, when a Libya bound freighter, the BBC China, was forced into port in Taranto, Italy, to disgorge equipment to enrich uranium. Libya, under pressure,

renounced its nuclear arms program soon after. That effort does not fully address how to deal with countries that are permitted under the treaty to make nuclear material for civilian energy purposes, and then concurrently run secret weapons programs.

Echoing the mutual suspicions between nuclear and non-nuclear weapons states, Javad Zarif, the Iranian ambassador to the United Nations accused the USA and Israel of representing the real nuclear threat to the world. He suggested that the USA never intended to scrap its nuclear arsenal, despite promising to eventually disarm when it signed the 1970 nuclear Non Proliferation Treaty, the landmark arms control pact. Javad Zarif dismissed as hollow USA pledges in 1995 and 2000 reaffirming its commitment to scrap its nuclear arsenal saying: "The USA never had any intention of living up to its commitments under Article 6 of the treaty." He argued that Israel, which is widely believed to have nuclear weapons, was the threat to the Middle East region. "There is unanimity on the threat that is posed not only by Israeli nuclear weapons but by its aggressive policy (in general)." Javad Zarif said USA threat of attacks on Iran's nuclear program were a "smoke screen to divert attention from its violations" that included a USA's willingness "to use nuclear weapons against non-nuclear weapon states."

Washington is backing efforts by the UK, France and Germany to persuade Iran to halt its nuclear fuel enrichment program, which they fear may be intended to make atomic bombs. Iran denies this, insisting its program is peaceful.

The IAEA, which has extensively monitored Iran's nuclear activities since 2003, said in its latest report that it found no "components of a nuclear weapon" or "related nuclear physics studies" in the country.

In Article VI of the NPT the five treaty signatories with nuclear weapons, the Russian Federation, the USA, France, UK and China, agreed to eventually disarm.

8.6 GLOBAL NUCLEAR ENERGY PARTNERSHIP, GNEP

This nuclear fuel access control program was announced by USA Energy Secretary Samuel Bodman in 2006 as a plan to form an international partnership to reprocess spent nuclear fuel in a way that renders the plutonium in it usable for nuclear fuel but unusable for nuclear weapons with 11 countries signed up as members.

This program is an alternative to the regulatory arm of the IAEA.

8.7 REGIONAL TREATIES

There exist currently several regional treaties that supplement the global NPT:

1. The Treaty of Tlatelolco, or the Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean requires its parties to conclude comprehensive safeguards agreements with the IAEA. Figure 1 shows the geographical area covered by the Tlatelolco Treaty.
2. The Treaty of Bangkok for South East Asia.
3. The Treaty of Rarotonga or the South Pacific Nuclear Free Zone Treaty.
4. The Treaty of Pelindaba for Africa.

Some of these regional treaties provide for complementary nuclear inspection arrangements. In the European Union, the European Atomic Energy Commission

(EURATOM) provides safeguards inspections. In Brazil and Argentina, inspections are also carried out by their own Agency for Accounting and Control of Nuclear Material (ABACC).

The possibility of a nuclear weapons free zone in the Middle East has been suggested. With the conflict ridden history of this region and the slow creep towards peace there, its implementation would be a major achievement for the nations of the region. Because a high level of trust would have to be generated, a combination of bilateral agreements, and regional and multilateral measures would have to be adopted.

Figure 1. The geographical area encompassed by the regional Tlatelolco Treaty.

8.8 NUCLEAR WEAPONS FREE ZONES

SOUTHEAST ASIAN NUCLEAR WEAPONS FREE ZONE (SEANWFZ)

During a July 29, 2007 meeting in Manila, Philippines, foreign ministers from the Association of South Eastern Asian Nations (ASEAN) member states reviewed the implementation of the South East Asian Nuclear Weapons Free Zone (SEANWFZ) treaty and endorsed a five year plan of action to strengthen it.

The ten members of the ASEAN: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam, have all signed the regional non-proliferation treaty. However, Brunei, Indonesia, Malaysia, Thailand and Vietnam, have yet to ratify their support for the accord.

Since 1997, a treaty creating the SEANWFZ has been in force in the region, limiting the use of nuclear energy by members to peaceful purposes, such as power generation. Under the treaty, ASEAN members may not develop or test nuclear weapons and pledge not to allow

the storage or transport of those weapons within their territories. However, naval ships from countries such as the USA often pass through busy Southeast Asian shipping lanes, without confirmation whether the ships are carrying nuclear weapons.

PROPOSED MIDDLE EAST NUCLEAR WEAPONS FREE ZONE

The UN General Assembly approved a resolution on December 3, 2012 calling on Israel to quickly open its nuclear program for inspection and backing a high-level conference to ban nuclear weapons from the Middle East that was just canceled.

All Arab nations and Iran had planned to attend the conference in mid-December 2012 in Helsinki, Finland, but the USA announced on November 23, 2012 that it would not take part, citing political turmoil in the region and Iran's defiant stance on nonproliferation. Iran and some Arab nations countered that the real reason for the cancellation was Israel's refusal to attend.

The resolution, approved by a vote of 174-6 with 6 abstentions, calls on Israel to join the Nuclear Nonproliferation Treaty "without further delay" and open its nuclear facilities to inspection by the International Atomic Energy Agency. Those voting "no" were Israel, the USA, Canada, the Marshall Islands, Micronesia and Palau. Resolutions adopted by the 193-member General Assembly are not legally binding, but they do reflect world opinion and carry moral and political weight.

Israel refuses to confirm or deny it has nuclear bombs, though it is widely believed to have a nuclear arsenal. It has refused to join the Nuclear Nonproliferation Treaty, or NPT, along with three nuclear weapon states: India, Pakistan and North Korea.

The Arab proposal to create a weapons-of-mass-destruction-free zone in the Mideast, and to pressure Israel to give up its undeclared arsenal of 80-400 nuclear warheads, was endorsed at an NPT conference in 1995 but never acted on. In 2010, the 189 parties to the 1970 treaty called for convening a conference in 2012 on the establishment of a WMD-free zone in the Middle East. The Final Document of the 2010 NPT Review Conference called for a conference in 2012 to implement a resolution of the 1995 NPT Review Conference that calls for the establishment of a Middle East Zone free of weapons of mass destruction.

The resolution, which was approved by the assembly's disarmament committee before the conference was cancelled, noted the decision to hold it "with satisfaction." Israel said there first must be a Mideast peace agreement before the establishment of a Mideast zone free of weapons of mass destruction. The region's other nations argue that Israel's undeclared nuclear arsenal presents the greatest threat to peace in the region.

The conference's main sponsors were the USA, Russia and Britain. British Foreign Office Minister Alistair Burt has said it is being postponed, not cancelled. Whilst the USA voted against the resolution, it voted in favor of two paragraphs in it that were put to separate votes. Both support universal adherence to the NPT, and call on those countries that are not parties to ratify it "at the earliest date." The only "no" votes on those paragraphs were India and Israel.

8.9 THE SAFEGUARDS SYSTEM

The IAEA has been mandated an important role in the implementation and fulfillment of the NPT, through its Safeguards system. States transferring nuclear technology, material or

equipment that could be of some relevance weapons development programs make the acceptance of safeguards a condition for such transfer. For some more important installations most suppliers impose an even stronger condition of "full-scope" or "comprehensive safeguards" in that the recipient country accepts safeguards over all its relevant nuclear activities.

Safeguards are thus in most situations a verification process imposed by the nuclear technology suppliers. They require a guarantee that their exports will not contribute to nuclear weapons development.

Under Article III of the NPT, the IAEA is responsible to verify that non-nuclear-weapon States parties to the treaty are not diverting nuclear material from peaceful uses to nuclear weapons or other nuclear explosive devices. Under Article IV of the NPT, the IAEA provides the main multilateral channel for expanding of the application of nuclear energy for peaceful purposes. It is providing the verification systems for nuclear weapons free zones envisaged in Article VII, and is contributing to the verification of activities relevant to Article VI.

8.10 STATUS OF EXISTING SAFEGUARDS AGREEMENTS

Legal agreements between the member states and the IAEA based on the NPT commitments are the basis of IAEA safeguards. Most agreements are designated as "full-scope" or "comprehensive" agreements in that they extend to all peaceful nuclear activities in a member state.

The following Table 2 displays a compilation of the different status of safeguards agreements by different countries worldwide. The presence or non-presence of asterisks in the seven vertical numbered columns indicates the existence or nonexistence of the following types of agreements:

1. States having a Safeguards agreement in force, which satisfies the requirements of the Non-Proliferation Treaty (NPT) and/or the Treaty of Tlatelolco in South America.
2. States that are parties to the NPT, which have not yet signed NPT's Safeguards agreements.
3. States, which have concluded a comprehensive Safeguards agreement, which is pursuant to NPT and/or Tlatelolco Treaty.
4. States not party to NPT having Safeguards agreements in force.
5. Nuclear Weapons States (NWS) with voluntary offer agreements in force.
6. States where International Atomic Energy Agency (IAEA) Safeguards are actually applied.
7. States that have signed the NPT Safeguards agreements, but with these agreements have not entered into force yet.

Table 2. Safeguards Agreements Worldwide

Country	1	2	3	4	5	6	7
Afghanistan	*						
Albania		*	*				
Algeria	*					*	
Angola		*					
Andorra		*					

Antigua and Barbuda	*						
Argentina	*					*	
Armenia	*					*	
Australia	*					*	
Austria	*					*	
Azerbaijan	*						
Bahamas	*						
Bahrain		*					
Bangladesh	*					*	
Barbados	*						
Belarus	*					*	
Belgium	*					*	
Belize	*						
Benin		*					
Bhutan	*						
Bolivia	*						
Bosnia and Herzegovina	*						
Botswana		*					
Brazil	*					*	
Brunei Darussalam	*						
Bulgaria	*					*	
Burkina Fasso		*					
Burundi		*					
Cambodia		*					
Cameron							*
Canada	*					*	
Cape Verde		*					
Central African Republic		*					
Chad		*					
Chile	*					*	
China, Rep. of					*	*	
Columbia	*					*	
Comoros		*					
Congo		*					
Costa Rica	*						
Côte d'Ivoire	*						
Croatia	*						
Cuba				*		*	
Cyprus	*						
Czech Republic	*					*	
Dem. People's Rep. of Korea	*					*	
Dem. Rep. of the Congo	*					*	
Denmark	*					*	
Djibouti		*					
Dominica	*						

Dominican Republic	*						
Ecuador	*						
Egypt	*					*	
El Salvador	*						
Equatorial Guinea		*					
Eritrea		*					
Estonia	*					*	
Ethiopia	*						
Fiji	*						
Finland	*					*	
France					*	*	
Gabon							*
Gambia	*						
Georgia							*
Germany	*					*	
Ghana	*					*	
Greece	*					*	
Grenada	*						
Guatemala	*						
Guinea		*					
Guinea Bissau		*					
Guyana	*						
Haiti							*
Holy See	*						
Honduras	*						
Hungary	*					*	
Iceland	*						
India				*		*	
Indonesia	*					*	
Iran, Islamic Rep. of	*					*	
Iraq	*					*	
Ireland	*					*	
Israel				*		*	
Italy	*					*	
Jamaica	*					*	
Japan	*					*	
Jordan	*						
Kazakhstan	*					*	
Kenya		*					
Kiribati	*						
Korea, Rep. of	*					*	
Kuwait							*
Kyrgyzstan							*
Lao People's Dem. Rep.							*
Latvia	*					*	

Lebanon	*						
Lesotho	*						
Liberia		*					
Libyan Arab Jamahiriya	*					*	
Liechtenstein	*						
Lithuania	*					*	
Luxembourg	*					*	
Macedonia, Rep. of		*					
Madagascar	*						
Malawi	*						
Malaysia	*					*	
Maldives	*						
Mali		*					
Malta	*						
Marshall Islands		*					
Mauritania		*					
Mauritius	*						
Mexico	*					*	
Micronesia		*					
Monaco	*						
Mongolia	*						
Morocco	*						
Mozambique		*					
Myanmar	*						
Namibia	*						
Nauru	*						
Nepal	*						
Netherlands	*					*	
New Zealand	*						
Nicaragua	*						
Niger		*					
Nigeria	*					*	
Norway	*					*	
Oman		*					
Pakistan				*		*	
Palau		*					
Panama	*						*
Papua New Guinea	*						
Paraguay	*						
Peru	*					*	
Philippines	*					*	
Poland	*					*	
Portugal	*					*	
Qatar		*					
Rep. of Moldova							*

Romania	*					*	
Russian Federation					*	*	
Rwanda		*					
St. Kitts and Nevis	*						
St. Lucia	*						
St. Vincent and Grenadines	*						
Samoa	*						
San Marino	*						
Sao Tome and Principe		*					
Saudi Arabia		*					
Senegal	*						
Seychelles		*					
Sierra Leone							*
Singapore	*					*	
Slovak Republic	*						
Slovenia	*					*	
Solomon Islands	*						
Somalia		*					
South Africa	*					*	
Spain	*					*	
Sri Lanka	*						
Sudan	*						
Suriname	*						
Swaziland	*						
Sweden	*					*	
Switzerland	*					*	
Syrian Arab Republic	*					*	
Tajikistan		*					
Thailand	*					*	
Taiwan, Rep. of China	*					*	
Togo							*
Tonga	*						
Trinidad and Tobago	*						
Tunisia	*						
Turkey	*					*	
Turkmenistan		*					
Tuvalu	*						
Uganda		*					
Ukraine	*					*	
United Arab Emirates		*					
United Kingdom					*	*	
United Rep. of Tanzania							*
United States of America					*	*	
Uruguay	*					*	
Uzbekistan	*					*	

Vanuatu		*					
Venezuela	*					*	
Viet Nam	*					*	
Yemen, Rep. of		*					
Yugoslavia	*					*	
Zambia	*						
Zimbabwe	*						

8.11 THE INSPECTION PROCESS

Inspectors affiliated with the Safeguards process regularly visit nuclear facilities to perform the following activities:

1. Nuclear Material Accountancy.

This system is comparable to a financial accounting system where inspectors verify records that State authorities keep on the whereabouts of nuclear material under their control. It establishes the quantities of nuclear materials present in a nuclear facility and the changes in these quantities that take place over time.

Reports on the whereabouts of nuclear materials covering stocks of nuclear fuel and the export and import of safeguarded materials and equipment are regularly received, reviewed and stored in computer data files.

2. Containment and Surveillance.

Surveillance cameras and electronic surveillance instruments are installed at nuclear facilities, to complement the accounting process. Continuous and automatic recording is supplemented by small metal seals, which are fixed on cameras housings, at nuclear materials storage areas and containers to prevent tampering. The films and the seals are regularly analyzed. A number of about 4,884 videotapes, 932 optical surveillance films and 26,824 fixed seals are verified in a given year.

3. Inspection and Verification.

The inspection process, like an independent auditing process, aims at building confidence that the non-proliferation commitments are being met. To confirm the physical inventories of nuclear materials, inspectors with agreed rights of access, regularly visit nuclear facilities to verify records, check instruments and surveillance equipment and confirm physical inventories of nuclear materials.

A characteristic of the inspection process is that it is a voluntary process, since the IAEA is not considered as being a supranational organization with powers to impose its inspection regime on any state.

Safeguarded facilities and materials are growing with the growing use of nuclear energy, as well as the acceptance of the Safeguards concept. Inspections are applied intensively at locations containing special nuclear materials that can be turned into nuclear explosives such as plutonium and highly enriched uranium. A sampling of the different types

of inspected facilities is shown in Table 3. The Safeguards process appears to be minimal and of a symbolic nature in the declared nuclear weapons states.

8.12 DETECTION OF UNDECLARED ACTIVITIES:

INTRODUCTION

Safeguards activities are aimed predominantly at verifying "declared" nuclear materials and items. Inspectors are not permitted to roam about in a random search for hidden nuclear materials or clandestine nuclear activities.

A strengthened and more rigorous inspection program has been introduced in May 1997 under the Model Protocol Additional to States Agreements. This includes supplementary measures such as the use of new information gathering and verification techniques and access to locations not subject to safeguards.

Table 3. Safeguarded Installations or with Safeguarded Nuclear Material.

Installation	Nuclear Weapons States	Total
Nuclear Power Reactors	1	236
Research reactors and critical assemblies	1	169
Chemical conversion plants	0	13
Fuel fabrication plants	0	46
Fuel reprocessing plants	0	6
Uranium enrichment plants	3	14
Separate storage facilities	8	70
Other facilities	1	82
	____	_____
Subtotal	14	636
Other locations	0	448
Non-nuclear Installations	0	1
	___	_____
Total	14	1085

Nuclear materials have distinctive radioactive characteristic particles and photon emissions such as gamma and x-rays, which facilitate their detection and measurement with a high degree of accuracy from aerospace platforms. Sensitive environmental sampling techniques of air and soil, can detect the presence of undeclared activities. Samples from equipment surfaces and from buildings, and from the air, water, sediment and vegetation are analyzed at a Safeguards Analytical Laboratory, or sent to laboratories in member states. Independent confirmations of the enrichment level and content of nuclear materials are conducted on-site.

SAFEGUARDS INSPECTIONS

Under the Safeguards agreements pursuant to the NPT, all nuclear materials and installations in a member State are subject to Safeguards. However the Safeguards inspection system was designed to detect diversion of nuclear material in declared installations. It was not designed to detect clandestine nuclear facilities and undeclared materials in them. The detection of clandestine facilities is a difficult problem. Inspectors cannot randomly search for undeclared installations: the formal Safeguard agreements do not allow such action. The inspectors must possess reliable information to lead them to relevant sites.

In Iraq, before Gulf War I, such reliable information was neither available to the Safeguards inspectors, nor to other governments. A rude awakening showed the inability of the Safeguard system as practiced before the Gulf War I to detect clandestine nuclear installations. Under the mandate of the Security Council resolution 687 in 1991, as asserted by the IAEA, inspection missions revealed that Iraq did in fact not divert the previously declared and safeguarded quantities of nuclear materials to weapons programs. However, those same missions, supplemented by intelligence reports by other member states, particularly the USA, revealed the existence of undeclared research facilities for the enrichment of uranium using electromagnetic and centrifuge processes. Even though these facilities were experimental in nature and incapable of producing industrially sufficient quantities of fissile materials for a weapons program, they attracted considerable public and media attention.

One process in particular had no hope for success. The development of the electromagnetic separation process as part of the Manhattan project in the USA was an enormous red herring and failed spectacularly in providing a significant amount of fissile materials for the project. The plants built at Oak Ridge on the basis of Lawrence's experimental California Cyclotron or Calutron were soaking up one fourth of the total 2 billion dollars allocated to the project. Its enriched uranium product was so impure that it could only be used to feed one of the other separation processes. Yet, the information about it was allowed at this time to be smuggled out to Russia to divert its efforts toward infertile grounds.

In 1954, Brig. Gen. Leslie Groves, under oath, commented about the information smuggled to Russia about the electromagnetic separation process: “I would like to emphasize that the information he (Joseph Weinberg) passed on was probably with respect to the electromagnetic process … we were never too much concerned about this; because I personally felt that while the electromagnetic process was a process, while it was of extreme importance to us during the war, and we saved at least a year's time by doing it, that it was not the process we would follow after the war. That is one of the reasons why we put silver in those magnets, because we knew we could get it out.”

It appears that a similar disinformation situation was swallowed by Iraq, with the probable added intention of siphoning as much as possible of its oil money by unscrupulous equipment suppliers.

The uniquely tailored and highly intrusive inspection regime imposed by the Security Council upon Iraq, and that Iraq had no choice but accepting under the cease fire agreement, allocated much incomparably wider inspections powers to the IAEA, than under the normal NPT Safeguards agreements. Under these wider powers conveyed by the Security Council, and with information obtained from other Member States such as the USA, the Iraqi nuclear program was practically dismantled. Yet uncertainty did prevail about full disclosure and allowing the IAEA inspectors full access. This uncertainty was exploited as a pretext for an already planned regime change, invasion, and occupation and dismemberment of Iraq.

8.13 DISMANTLING NUCLEAR WEAPONS PROGRAMS: THE SOUTH AFRICAN EXPERIENCE

Following South Africa's signing of the NPT in 1991, and its announcement of abandoning its nuclear weapons program, the IAEA General Conference requested the Director General to verify the completeness of the inventory of nuclear installations and materials include in its report to the IAEA. The filling of a shaft prepared in the Kalahari Desert for an intended nuclear test is shown in Fig. 2.

South Africa enters history as the first country to have voluntarily rolled back from an undeclared nuclear weapons state status. The nuclear weapons that it built were dismantled and all the nuclear material in South Africa was declared to the Safeguards program.

Figure 2. Filling out the Kalahari Desert nuclear test hole in South Africa.

Lybia in 2003 also invited the IAEA to dismantle a research program under USA pressure and UK brokering, and preempted the possibility of being subjected to a planned regime change scenario similar to the Iraqi one.

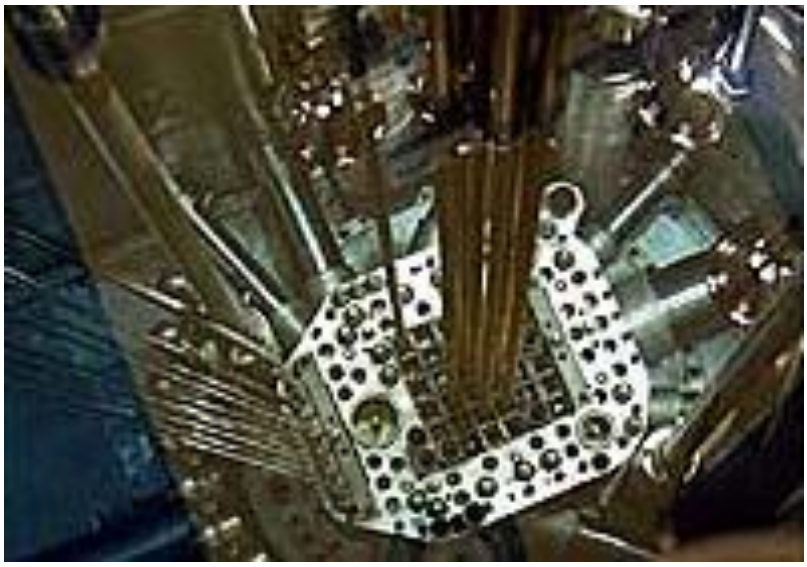


Figure 3. Lybia's pool research at Tajura, east of Tripoli.

Lybia turned over to the USA, UK and IAEA in early 2004 about 4,000 centrifuges, some still in their wooden packing crates acquired from Abdul Qadeer Khan's network after spending $100-200 million. They were flown to the USA's Oak Ridge National Laboratory, ORNL at Oak Ridge, Tennessee contingent on compensation by the USA, including conventional weapons and nonconventional military equipment, which did not materialize. Lybia did not figure out how to make the system function as a whole. As part of the deal, thousands of chemical munitions shells were bulldozed, even though a stockpile of difficult to handle mustard gas remained behind. As of 2009, the USA was demanding that Lybia turns in any low enriched uranium that would have been produced by the centrifuge program.

This suggests that transparency regarding all nuclear related activities is important in building confidence in a state's nuclear materials and installations.

Acceptance of inspections "anywhere anytime" would help to inspire confidence. This would include military sites, with the Safeguards program becoming responsible to protect legitimate military secrets from revelation.

SECRET AGREEMENT

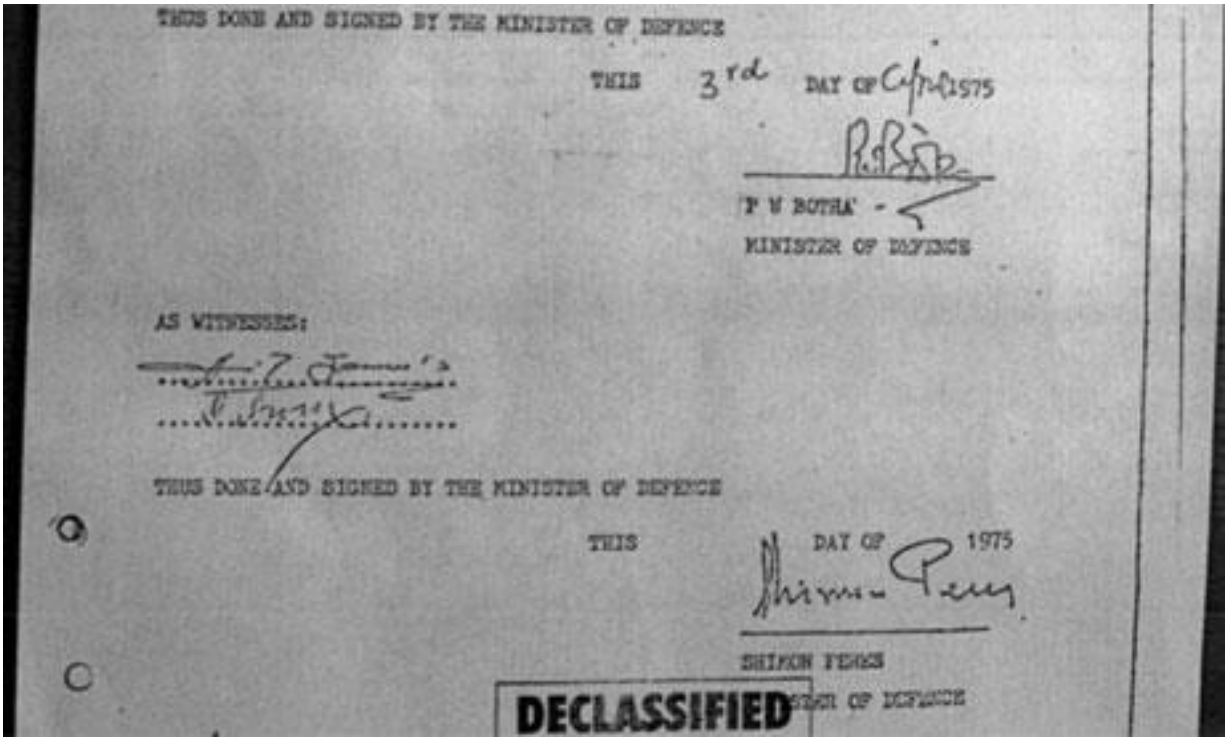


Figure 4: Secret 1975 military agreement signed by Shimon Peres and P. W. Botha during the South Africa apartheid period. Source: The Guardian.

According to the Guardian:

“Secret South African documents reveal that Israel offered to sell nuclear warheads to the apartheid regime, providing the first official documentary evidence of the state's possession of nuclear weapons.

The "top secret" minutes of meetings between senior officials from the two countries in 1975 show that South Africa's defence minister, PW Botha, asked for the warheads and Shimon Peres, then Israel's defence minister and now its president, responded by offering them "in three sizes". The two men also signed a broad-ranging agreement governing military ties between the two countries that included a clause declaring that "the very existence of this agreement" was to remain secret.

The documents, uncovered by an American academic, Sasha Polakow-Suransky, in research for a book on the close relationship between the two countries, provide evidence that Israel has nuclear weapons despite its policy of "ambiguity" in neither confirming nor denying their existence.

The Israeli authorities tried to stop South Africa's post-apartheid government declassifying the documents at Polakow-Suransky's request and the revelations will be an embarrassment, particularly as this week's nuclear non-proliferation talks in New York focus on the Middle East.

They will also undermine Israel's attempts to suggest that, if it has nuclear weapons, it is a "responsible" power that would not misuse them, whereas countries such as Iran cannot be trusted.

A spokeswoman for Peres today said the report was baseless and there were "never any negotiations" between the two countries. She did not comment on the authenticity of the documents.

South African documents show that the apartheid-era military wanted the missiles as a deterrent and for potential strikes against neighbouring states.

The documents show both sides met on 31 March 1975. Polakow-Suransky writes in his book published in the US this week, The Unspoken Alliance: Israel's secret alliance with apartheid South Africa. At the talks Israeli officials "formally offered to sell South Africa some of the nuclear-capable Jericho missiles in its arsenal".

Among those attending the meeting was the South African military chief of staff, Lieutenant General RF Armstrong. He immediately drew up a memo in which he laid out the benefits of South Africa obtaining the Jericho missiles but only if they were fitted with nuclear weapons.

The memo, marked "top secret" and dated the same day as the meeting with the Israelis, has previously been revealed but its context was not fully understood because it was not known to be directly linked to the Israeli offer on the same day and that it was the basis for a direct request to Israel. In it, Armstrong writes: "In considering the merits of a weapon system such as the one being offered, certain assumptions have been made: a) That the missiles will be armed with nuclear warheads manufactured in RSA (Republic of South Africa) or acquired elsewhere."

But South Africa was years from being able to build atomic weapons. A little more than two months later, on 4 June, Peres and Botha met in Zurich. By then the Jericho project had the codename Chalet.

The top secret minutes of the meeting record that: "Minister Botha expressed interest in a limited number of units of Chalet subject to the correct payload being available." The document then records: "Minister Peres said the correct payload was available in three sizes. Minister Botha expressed his appreciation and said that he would ask for advice." The "three sizes" are believed to refer to the conventional, chemical and nuclear weapons.

The use of a euphemism, the "correct payload", reflects Israeli sensitivity over the nuclear issue and would not have been used had it been referring to conventional weapons. It can also only have meant nuclear warheads as Armstrong's memorandum makes clear South Africa was interested in the Jericho missiles solely as a means of delivering nuclear weapons.

In addition, the only payload the South Africans would have needed to obtain from Israel was nuclear. The South Africans were capable of putting together other warheads.

Botha did not go ahead with the deal in part because of the cost. In addition, any deal would have to have had final approval by Israel's prime minister and it is uncertain it would have been forthcoming.

South Africa eventually built its own nuclear bombs, albeit possibly with Israeli assistance. But the collaboration on military technology only grew over the following years. South Africa also provided much of the yellowcake uranium that Israel required to develop its weapons.

The documents confirm accounts by a former South African naval commander, Dieter Gerhardt – jailed in 1983 for spying for the Soviet Union. After his release with the collapse of apartheid, Gerhardt said there was an agreement between Israel and South Africa called Chalet which involved an offer by the Jewish state to arm eight Jericho missiles with "special warheads". Gerhardt said these were atomic bombs. But until now there has been no documentary evidence of the offer.

Some weeks before Peres made his offer of nuclear warheads to Botha, the two defence ministers signed a covert agreement governing the military alliance known as Secment. It was so secret that it included a denial of its own existence: "It is hereby expressly agreed that the very existence of this agreement... shall be secret and shall not be disclosed by either party".

The agreement also said that neither party could unilaterally renounce it.

The existence of Israel's nuclear weapons programme was revealed by Mordechai Vanunu to the Sunday Times in 1986. He provided photographs taken inside the Dimona nuclear site and gave detailed descriptions of the processes involved in producing part of the nuclear material but provided no written documentation.

Documents seized by Iranian students from the US embassy in Tehran after the 1979 revolution revealed the Shah expressed an interest to Israel in developing nuclear arms. But the South African documents offer confirmation Israel was in a position to arm Jericho missiles with nuclear warheads.

Israel pressured the present South African government not to declassify documents obtained by Polakow-Suransky. "The Israeli defence ministry tried to block my access to the Secment agreement on the grounds it was sensitive material, especially the signature and the date," he said. "The South Africans didn't seem to care; they blacked out a few lines and handed it over to me. The ANC government is not so worried about protecting the dirty laundry of the apartheid regime's old allies."

8.14 STOPPING UNDECLARED ACTIVITIES: THE DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA (DPRK) PROGRAM

INTRODUCTION

The use of advanced analytical techniques after the 1991 Gulf War confirmed the conclusion that there was more weapons-grade Pu in the Democratic People's Republic of Korea (DPRK), than was previously declared to the IAEA, and that it was capable of producing several nuclear devices. Inspections conducted in 1992 found inconsistencies between the information provided by the DPRK and the information obtained by analysis of samples of material taken by IAEA inspectors. The DPRK did not allow the IAEA to carry the necessary activities to resolve the discrepancies; the issue was reported to the IAEA Board of Governors, which referred the matter to the United Nations Security Council.

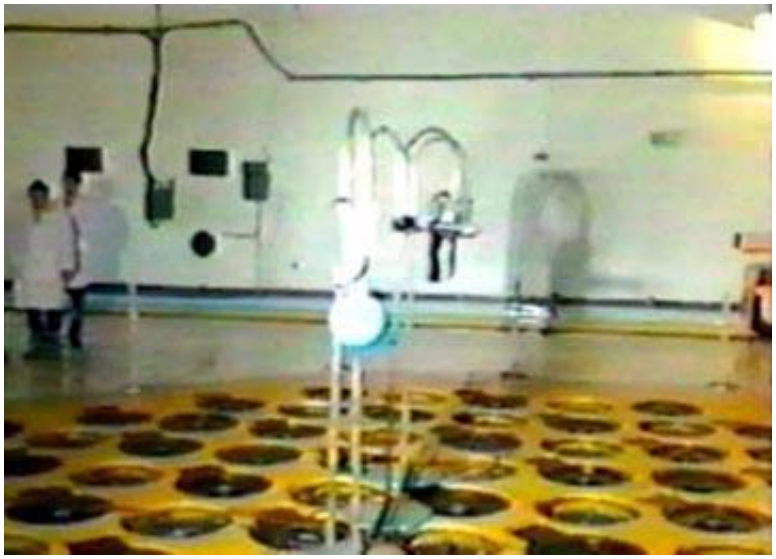


Figure 5. Inside view of Yongbyon-1, 5 MWth graphite-moderated, gas-cooled research reactor in the DPRK in a May 1992, IAEA Photograph.

Figure 6. Fuel storage pool of Yongbyon-1, 5 MWth research reactor in the DPRK. AP Photograph.

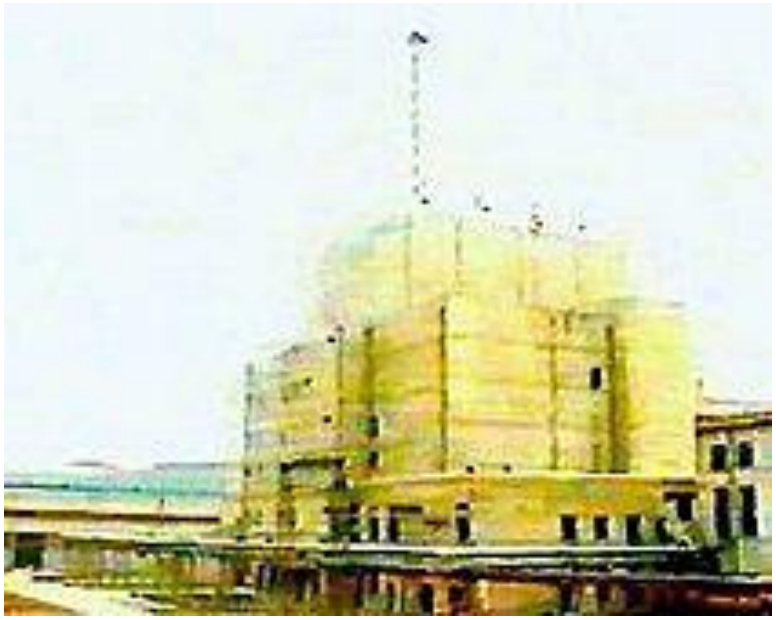


Figure 7. Exterior view of Yongbyon 1, 5 MWth research reactor in the DPRK.

Figure 8. Aerial photograph of the Taechon 200 MWe power reactor under construction and the Yongbyon 1, 5 MWth research reactor in the DPRK. The cooling tower that appears to have been demolished in 2008 as a result of agreements was being reconstructed in 2013.

The authorities there chose to discharge the fuel from their 5 MWth experimental power reactor without the Safeguards authorities' supervision. This action did not allow a determination of the exact amounts of fissile material present.

FISSILE FUEL PRODUCTION ESTIMATION

The fission process releases about 200 MeV per fission event of which 10 MeV, or 5 percent, are in the form of antineutrinos whose energy is not extractable.

For a reactor generating a thermal power of P MWth, the fission rate of an extractable fission energy yield of 190 [MeV/fission], is given by:

$$\frac{\mathrm{d(fissions)}}{\mathrm{dt}} = \mathrm{P\ MW_{th}} \times \frac{10^6 \mathrm{W_{th}}}{\mathrm{MW_{th}}} \times \frac{1\mathrm{Joule}}{\mathrm{W_{th}.sec}} \times \frac{\mathrm{MeV}}{1.6\times10^{-13}\,\mathrm{Joule}} \times \frac{\mathrm{fissions}}{190\ \mathrm{MeV}} \times \frac{24\times60\times60\,\mathrm{sec}}{\mathrm{day}}$$
$$= 2.7\times10^{21}\, P\, \frac{\mathrm{fissions}}{\mathrm{day}} \qquad (1)$$

This fission rate can be expressed in terms of Avogadro's law as:

$$\frac{\mathrm{d(fissions)}}{\mathrm{dt}} = \frac{\mathrm{g[grams/day]}}{\mathrm{A}} \mathrm{A_v} \qquad (2)$$
$$\textit{where}: \mathrm{A}=235\,\mathrm{amu}, \mathrm{A_v} = \mathrm{Avogadro's number}$$

The U^{235} fuel burnup rate, is "g" and is given by:

$$
\begin{aligned}
g &= \frac{A}{A_v}\frac{\mathrm{d(fissions)}}{\mathrm{dt}} \\
&= 2.84\times10^{21}\,\frac{235}{0.6021\times10^{24}}\,P\,\frac{\text{fissions}}{\text{day}} \\
&= 1.11P\,\frac{gm}{day}
\end{aligned}
\tag{3}
$$

Not all the fissile nuclei undergo fission to produce power. A fraction of them undergo a radiative capture process, in which a neutron is absorbed with the emission of a gamma photon, without fissioning. Thus we define the fuel consumption rate as a function of its microscopic radiative capture cross section σ_c and its microscopic fission cross section σ_f as:

$$
\begin{aligned}
consumption\ rate &= \frac{\sigma_c+\sigma_f}{\sigma_f}\,burnup\,rate \\
&= 1.11(1+\frac{\sigma_c}{\sigma_f})\mathrm{P} \\
&= 1.11(1+\alpha)\mathrm{P}
\end{aligned}
\tag{4}
$$

The ratio of microscopic capture to fission cross sections is:

$$
\alpha = \frac{\sigma_c}{\sigma_f} = \frac{99}{582} = 0.17, \text{for thermal fissions in } \mathrm{U}^{235}. \tag{5}
$$

For a non-breeder reactor which has a conversion factor C defined as the number of fissile nuclei produced per fissile nucleus consumed, the fissile production rate would be:

$$
fissile\ production\ rate = 1.11(1+\alpha)C\mathrm{P}\ \text{[gm/day]} \tag{6}
$$

If the reactor had a high conversion factor C = 0.95, such a heavy water moderated reactor, after a year of operation an upper limit for fissile fuel as Pu^{239} production for a P = 5 MW(th) reactor would be:

$$
\begin{aligned}
fissile\ production\ rate &= 1.11(1+0.17)0.95\times5\times365\ \text{[gm/year]} \\
&= 2251.6\text{[gm/year]} \\
&= 2.25\text{[kg/year]}
\end{aligned}
\tag{7}
$$

This is considered an upper limit since some of the produced plutonium will undergo fission itself.

This estimate is well below a single unreflected critical mass size for Pu^{239} at around 10 kgs. In addition such plutonium that was irradiated for a long period of time contains even mass number isotopes of plutonium such as Pu^{240} that make the material effectively unsuitable for weapons manufacture, unless sophisticated methods of assembly and detonation are used.

Thus regarding the fears that a 5 MWth reactor can be used for a sustained weapons program appear overblown.

Larger power reactors are needed for any significant weapons program at the power level of the P = 100 MWth, producing in this case:

$$\begin{aligned} \textit{fissile production rate} &= 1.11(1+0.17)0.95\times 100\times 365 \text{ [gm/year]} \\ &= 45{,}032.4\text{[gm/year]} \\ &= 45\text{[kg/year]} \end{aligned} \tag{8}$$

This upper figure will be further reduced by reprocessing and manufacturing losses.

FRAMEWORK AGREEMENT

Nevertheless, the non-compliance with safeguards agreements, and the rejection of a request for a special inspection has been reported to the Security Council and became a cause of concern, generating international pressure for the DPRK to adhere to the Safeguards agreements that it earlier committed itself to. Initially, the Safeguards program did not specifically assert that nuclear material has been diverted to a clandestine nuclear power program, since it had no evidence to this effect. However, the DPRK has been reported to be in non-compliance with its safeguards agreement, that nuclear material could have been diverted and that the DPRK was rejecting a request for a special inspection.

The request for a special inspection was based on satellite imagery provided by other member states at a reported five inches resolution, and which is now available commercially at a 1 meter resolution, about locations where suspicious construction activities were occurring and that were worthy of further inspections.

A framework was reached between the DPRK and the USA and was reported to the Security Council, which involves a freeze of a number of nuclear installations in the DPRK. On October 21, 1994, the USA and North Korea signed the "Agreed Framework," calling upon the freeze of the operation and construction of nuclear reactors suspected of being part of a covert nuclear devices program. The freeze agreement was reached in return for a promise by the USA to lead a consortium to build two civilian nuclear power reactors and providing an interim supply of oil until these reactors are built.

The four-page agreement terms are as follows:

USA-DPRK obligations:

1. Both nations committed to move toward normalized economic and political relations.
2. Commitment not to nuclearize the Korean peninsula.

DPRK obligations:

1. Freezing of operations on its 5 MWth research reactor and plutonium reprocessing plant at Yongbyon and a 200 MWe power plant under construction at Taechon.
2. Provide full access to IAEA inspectors to all nuclear facilities in the country.
3. Pull all spent fuel from the 5 MWth reactor into containers and remove them from the country.

4. The DPRK to remain a party to the Nuclear Nonproliferation Treaty.

USA obligations:

1. Lead a consortium to build two 1,000 MWe light water nuclear power plants by 2003.
2. Provide heavy oil shipments until the reactor project is finished.

Even though concrete has been poured for the first reactor, the building of these reactors was thrown years behind schedule by political and funding problems. The agreement was reached by USA Secretary of State Madeleine Albright with a Democratic Party administration in the USA under President William (Bill) Clinton.

The following Republican administration with Secretary of State Colin Powell under President George W. Bush, did not feel itself obligated to adhere to the previous administration's agreement. In October of 2002, the USA confronted the DPRK with satellite imagery of a secret program to enrich uranium for weapons using centrifuge technology, which the DPRK admitted that it existed. The USA and its allies including South Korea, Japan and the European Union suspended the agreed-upon fuel oil shipments.

As a response, the DPRK declared that it will restart its 5 MWth reactor at Yongbyon, moved fresh fuel rods to the facility, removed UN monitors seals and surveillance cameras and expelled UN inspectors and showed signs that it will withdraw from the NPT. In fact, it gave the legal due notice and withdrew from the NPT. It later declared in 2004 that it has acquired an unspecified "deterrent." It later declared that it tested a nuclear device, which, because of its low seismically detected yield was most probably a fizzle or a dud.

The DPRK promised to resolve concerns about its nuclear developments if the USA would sign a non-aggression treaty. As part of the Agreed Framework, both sides agreed that within three months of its signing, "Both sides will reduce barriers to trade and investment, including restrictions on telecommunications services and financial transaction." Although some economic restrictions were removed, the DPRK remained on the USA's State Department "list of countries that sponsor terrorism." This list rules out bank loans from the World Bank and other international financial organizations, such as the UN World Food Program, which are strongly influenced by the USA.

The DPRK has a fear of the USA's military designs and of a hardening of its policies, which adopted the concept of a "pre-emptive strike doctrine," "unilateral intervention," place it in an "axis of evil" with Iraq and Iran. It invokes terms from the Agreed Framework including the USA's pledge to provide it with "formal assurances … against the threat or use of nuclear weapons by the USA." USA officials responded that they are not considering an invasion of the DPRK, and want a peaceful solution to the dispute. The drama is still ongoing with hopefully peaceful results, maybe along a modified form of the initial framework agreement that addresses both sides concerns.

North Korea told visiting USA scholars that it intended to build a prototype light water nuclear reactor at the Yongbyon atomic complex site, before then rolling out larger reactors. Images taken by the DigitalGlobe satellite at the beginning of November 2010 show a rectangular structure being erected, flanked by at least two construction cranes.

In 2013, alarmist rumors arose to the effect that the DPRK has developed nuclear devices using clandestine centrifuge technology and U^{235}. This is questionable since this would have required a long period of undeclared clandestine activities and extensive undiscovered

hidden underground facilities. In 2015, claims of the development of a thermonuclear device, possibly a boosted device were reported by the media.

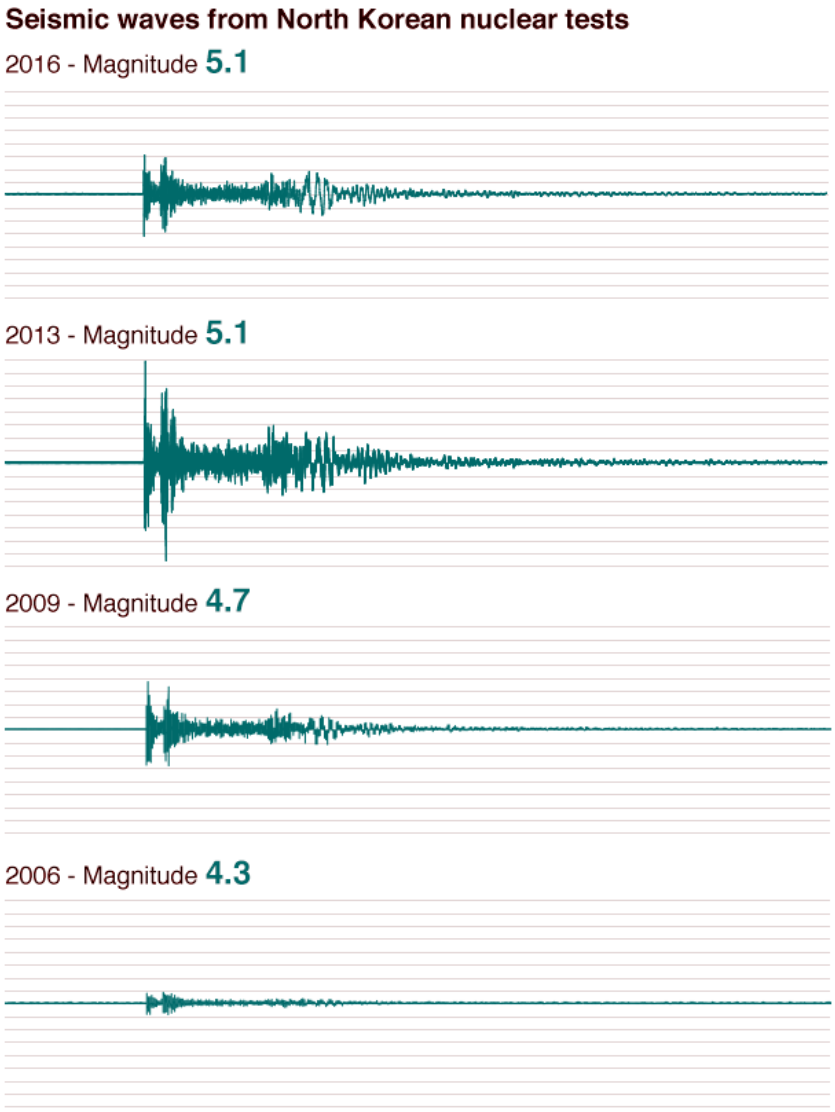


Figure 9. Seismographs from DPRK nuclear tests as measured in Mundanjiang, China. Nuclear tests as usually associated with the release of the fission product Xe^{133}. Source: BBC.

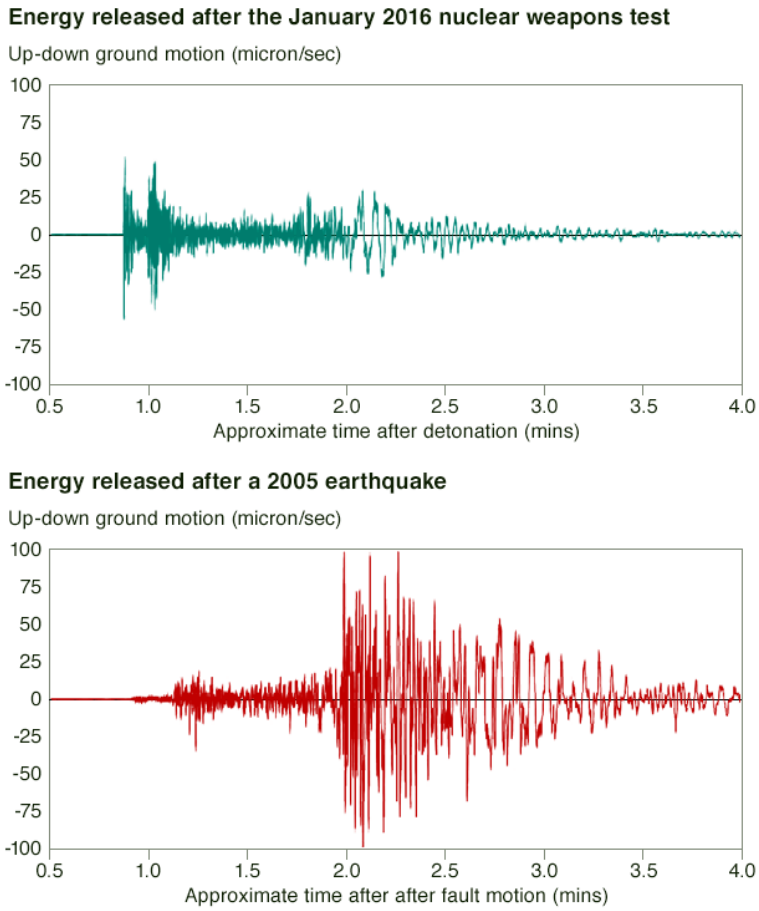


Figure 10. Distinction between nuclear tests and earthquakes signatures. Two peaks are associated with nuclear devices the first being the nuclesr explosive followed by the collapse of the created molten rock cavity. Source: Incorporated Research Institute for Seismology, BBC.

Figure 11. DPRK nuclear device showing explosive lenses. Source: Rodong Sinmun, BBC.

SOUTH KOREA NUCLEAR PROGRAM, DOMINO EFFECT

South Korea failed to reach a compromise agreement with the USA on its civil nuclear energy program. Secretary of State John Kerry had called for an agreement before a planned summit between President Barack Obama and his South Korean counterpart, Park Geun Hye on May 7, 2013. The differences remained over South Korea's demand that the USA ban on enriching uranium and reprocessing spent nuclear fuel be lifted. The USA had South Korea commit itself to the ban in a treaty signed in 1972 when the USA transferred nuclear material and technical expertise to help South Korea's civilian nuclear energy industry. The treaty expired in March 2014.

South Korea states that it wishes for the ban to be lifted so it can enrich uranium to make nuclear fuel, which it now imports. It also wants to reprocess spent nuclear fuel to reduce its almost full nuclear spent fuel storage and turn the spent fuel into new MOX fuel for a next generation of reactors it is developing.

South Korea denied any intentions of developing nuclear devices. However, some members of the South Korean governing party are urging their government to consider building nuclear devices to counter to the DPRK acquisition of the same.

8.15 FORCEFUL DISMANTLEMENT: IRAQ'S NUCLEAR PROGRAM

INTRODUCTION

Iraq has had an ill-conceived and ill-fated nuclear program riddled with defections, failures, fraud, corruption, mismanagement, spying, assassinations, treason and insider sabotage. Most of the effort did not get beyond theoretical and experimental studies and never went beyond the pilot plant stage. Yet it was perceived and presented, ironically even by Iraqi authorities themselves, to the world as a possibly successful program, and precipitated sanctions, attacks to destroy its research facilities, regime change, execution of its president, war and military invasion and occupation and dismantling of the country among its various ethnic and religious factions.

A research reactor supplied by France, named Tamuz and modeled after the French research reactor Osiris and designated as Osirak, was bombed by the Israeli air force in 1981 after flying over Jordanian and Saudi Arabian territory, before it even became critical, even though it was under IAEA safeguards. The loss of this facility did not stop Iraq from pursuing a clandestine weapons development program.

In 1991, USA's F-16s and stealth F-117 aircraft took again aim at the Osirak reactor at Tuwaitha. After the Israeli raid, it had been fortified against air attack. The defenses included 300 feet earth berms surrounding the facility, topped by towers carrying cables that crossed the site. Surface-to-air-missile (SAM) batteries also surrounded the site. Smoke pots were activated against the first wave of attacks with non-stealth F-16s in the attack role, preventing accurate laser weapons delivery. The defenses were intense with an F-16 pilot reporting being attacked by seven SAMs at one time.

During the following day's Air Tasking Order (ATO) briefing, an F-117 pilot volunteered the 37th TFW for the target, and eight stealth F-117s struck it that night, delivering 16 weapons and destroying 16 targets. The F-117 was armed with the GBU-27 laser guided bomb, which combined either with a standard Mk84 2,000-pound bomb or a BLU-109 guided

hard-target bomb. The F-117 was equipped with an infrared targeting turret in front of its windshield. On subsequent nights, the F-117s systematically destroyed Osirak. Air operations in Iraq ended on February 28, 1991, bringing Iraq's reactor program to a total and complete halt.

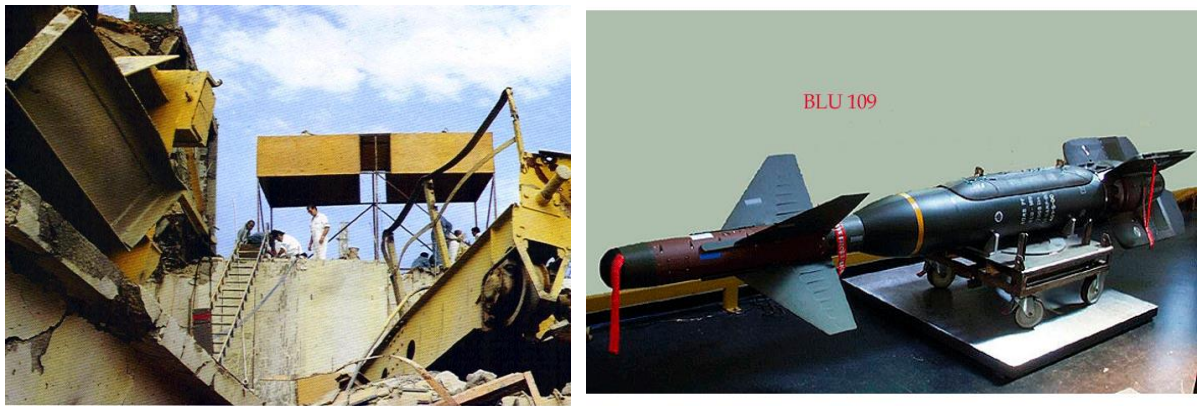


Figure 12. Testing dispersed fuel at a bombed-out, using BLU-109 penetrator bunker buster munitions by the USA, Tuwaitha research reactor in the 1991 Gulf War. Picture is a variant of a Guided Bomb Unit GBU-24( )/B. The warhead is a BLU-109( )/B penetrator (warhead = **B**omb, **L**ive **U**nit), and the guidance/tail kit is from the Paveway III family. Together, it is called a GBU-24/B. If a Joint Direct Munition (JDAM) guidance system kit is strapped on it, it would be a GBU-31.

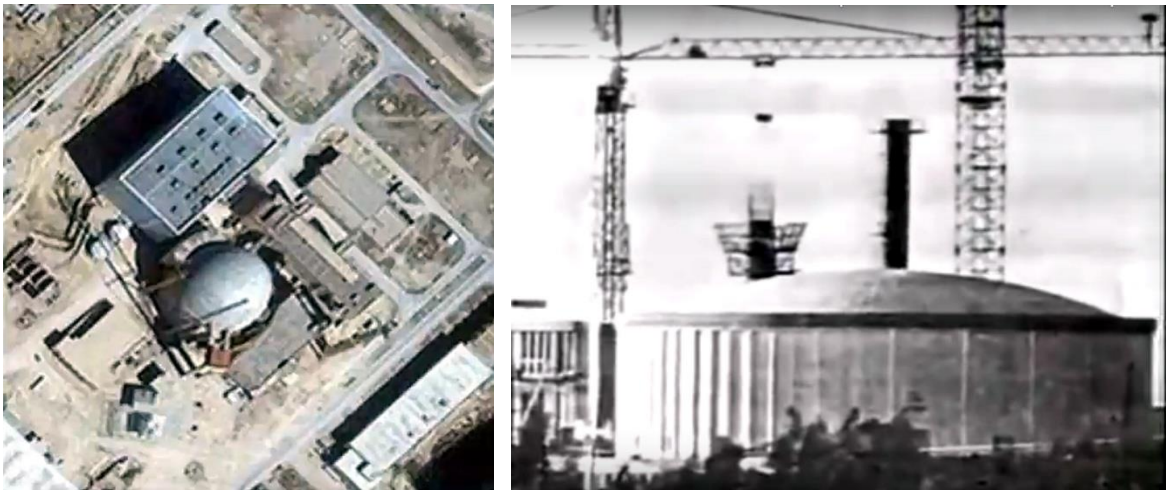


Figure 13. Osiraq, Tamuz building destroyed by the Israeli bombing raid, Operation Opera, June 7, 1981, Iraq.

After the 1991 Gulf War, inspections uncovered a program involving the separation of a few grams of Pu from irradiated fuel, which is insufficient for any meaningful weapons program. The highly enriched uranium in the fuel of the safeguarded reactor at Tuwaitha was not used in the weapons development program. What led to controversy was an experimental program of uranium enrichment involving large quantities of undeclared uranium ore.

IAEA INSPECTIONS

The IAEA extensive inspection activities between 1991 and 1998 uncovered a failed, yet well-funded clandestine program in Iraq aimed at the indigenous development and exploitation of nuclear technologies. The inspectors, under accusations of spying activities, were withdrawn by the IAEA to protect them against a threatened cruise missiles attack by the USA. They were readmitted by Iraq to carry on their inspections at the end of 2002. Their reported inspections covered any nuclear related activities and sites in Iraq.

Uranium mining, production and processing were based at the following nuclear and dual-use sites:

1. Al Tuwaitha Nuclear Research Center,
2. Al Jazira uranium conversion facility,
3. Al Qaim uranium recovery plant, constructed between 1982-1984,
4. The Akashat phosphate and uranium processing plant,
5. The Skhair mine,
6. The Rashdiya Engineering and Design Center,
7. The Tarmiya magnetic enrichment site,
8. Al Furat gas centrifuge enrichment site,
9. Al Qaqaa explosives facility,
10. Al Atheer weapons development and production plant.

Iraq had proceeded since 1979 in the overt importation, procurement and production of uranium compounds from different sources:

1. Importation from Italy in 1979 of 4.006 metric tonnes of natural uranium and 6.005 metric tonnes of depleted uranium. This depleted uranium may have been intended for the production of anti-armor projectiles and armor shields.
2. Importation from Russia and France of 50 kgs of Highly Enriched Uranium (HEU).
3. From Portugal in 1980, 429 drums containing 138.098 metric tonnes of yellow cake (U_3O_8), then again in 1982, 487 drums containing 148.348 metric tonnes of yellow cake.
4. From the Niger Republic in 1981, 432 drums containing 137.435 metric tonnes of yellow cake, then in 1982, 426 drums containing 139.409 metric tonnes of yellow cake.
5. From Brazil in 1982-1982 24.260 metric tonnes of uranium dioxide (UO_2). This claim is based on falsified documents meant for disinformation,
6. Produced at Al Qaim uranium recovery plant 109 metric tonnes of uranium and 168 metric tonnes of yellow cake.
7. Produced 426 drums containing 99.457 metric tonnes of UO_2 at Al Jazira uranium conversion facility.
8. Produced an unspecified amount of uranium hexafluoride (UF_6) at the Rashdiya Engineering and Design Center.
9. From uranium dioxide, produced uranium tetrafluoride (UF_4), uranium metal and UF_6 at the Tuwaitha Nuclear Research Center's Chemical laboratories.
10. Processed UO_2 and yellowcake to produce uranium metal and various uranium compounds such as UF_4, UO_3, U_3O_8 and UO_4 at the Tuwaitha Experimental Research Laboratory for Fuel fabrication.
11. Processed UO_2 to produce uranium tetrachloride (UCl_4) at the Tuwaitha Engineering Research Laboratories.

URANIUM ENRICHMENT EFFORTS

Having had its reactor facilities destroyed in the first Israeli air strike, the Iraqis redirected their effort on trying to indigenously produce enriched uranium using several experimental approaches, including centrifugation and electromagnetic separation; none of them successful enough to produce any significant amounts of fissile materials.

1. Use of Calutrons or Electro-Magnetic Isotope Separation (EMIS):

At Tuwaitha, between 1982-1987, electromagnets were designed and constructed as parts of different magnetic separation systems. These included the design and construction of one so-called R-50 and three R-100 separator systems starting from 1985 and operated until 1991. At the Tarmiya site an R-120 and an R-60 separator system were built and produced an insignificant amount of 640 grams of enriched uranium with an average again insignificant enrichment of 7.2 percent. These are unequivocally insufficient to produce any nuclear device, considering that the critical mass of highly enriched at 94 percent U^{235} is at about 50 kgs.

The IAEA reports that: "Iraq was at, or close to, the threshold of success in such areas as the production of HEU through the EMIS process, the production and pilot cascading of single-cylinder sub-critical gas centrifuge machines, and the fabrication of the explosive package for a nuclear weapon." This IAEA's assertion is debatable since an enrichment of 7.2 percent is hardly weapons grade material which normally reaches a level of 93-98 percent enrichment in U^{235}. The Iraqis failed in producing any weapons grade material.

This program was a typical example of fraud by the equipment suppliers and consultants to the Iraqis. It is a well-known fact that the Calutron project in the USA was a "White Elephant" that did not succeed and was kept going by General Leslie Groves as a way to trap the Russians into pursuing a dead end way to the production of enriched uranium. Apparently, the Iraqis were fraudulently led along the same path by their European suppliers and by mismanagement, ignorance, faked compliance under threat of punishment by their government and military authorities, public relations, and possibly internal sabotage. This suggestion of success may have been a continuing attempt at convincing the Iraqis to keep proceeding towards the same dead end, by ironically suggesting to them that they were: " at, or close to, the threshold of success."

Figure 14. Destroyed vacuum chamber casing of a single experimental Calutron electromagnetic separation device.

2. Gaseous Diffusion enrichment:

This program was initiated in 1982, with related research facilities constructed at Tuwaitha and Rashdiya. The only product of this program was the manufacture of a barrier tube sought to be suitable for operation with uranium hexafluoride gas (UF_6).

3. Gas Centrifugation enrichment:

This program was started in 1987, with laboratory tests first on an oil-bearing centrifuge built in 1987, followed by a magnetic bearing centrifuge. In 1989, a series of sub-critical centrifuge designs were developed. In 1990 centrifuges with a carbon composite rotor and a magnetic bearing were designed and assembled. A pilot cascade hall was constructed at the Al Furat site and construction work for the mass production of centrifuges was started in 1989.

Claims were made that the Iraqis imported aluminum tubes by USA Secretary of State Collin Powell for centrifuges, but this was dismissed later as part of a disinformation campaign by dissidents and opponents of the Iraqi regime. It was later disclosed that these tubes were meant for conventional rockets manufacture. Similar disinformation techniques used falsified documents signed by inexistent officials, as determined by the IAEA safeguards system, about importation of uranium ore from the Niger Republic.

4. Other enrichment methods:

In 1981 laser isotopic separation research was undertaken on both the Atomic Vapor Laser Isotope Separation (AVLIS) and Molecular Laser Isotope Separation (MLIS). Some research on chemical uranium enrichment was attempted.

DIVERSION OF RESEARCH REACTOR FUEL

Iraq is reported to have planned on diverting highly enriched uranium used in research reactors that was subjected to the IAEA safeguards. Under a crash program at the Tuwaitha site, a chemical reprocessing plant was constructed in about three months in 1990 to extract highly enriched uranium from research reactor fuel. Although the diversion never occurred, Iraq may have been capable of carrying out the conversion of highly enriched uranium from the reactor's UNH fuel to uranium metal in 1991. Its usefulness is doubtful since research reactors fuel is usually only in the 20 percent range, hence unsuitable for nuclear devices.

REACTOR PRODUCTION OF PLUTONIUM

Theoretical studies on the construction of nuclear reactors never went beyond the theoretical studies stage. The IRT-5000 research facility was used to irradiate three indigenously fabricated natural uranium fuel elements. On a laboratory scale, a minute amount of 5 grams of plutonium were separated at a laboratory scale process line at Tuwaitha.

WEAPONIZATION RESEARCH

Some reports allege that Iraq's primary focus was on a crude implosion fission design driven by high explosive lenses, even though its scientists were aware of more advanced weapon design concepts. Using open source literature and theoretical studies, it ran various computer codes through Iraq's mainframe computer to adapt the codes and develop the physical constants for the program.

Experiments with high explosives to produce explosive lenses and convergent shock waves were conducted at the Al Qaqaa facility. Experimental work was conducted with high explosives to produce implosive shock waves, and a 32 point electronic firing system using detonators and explosives lenses. Flash x-ray systems, gas gun systems, fiber optics with fast response electronic equipment, high speed electronic streak cameras were used for the testing of high explosives. These included stocks of HMX and RDX chemical explosives. An RDX production plant was operational. Polonium was produced by irradiating bismuth in a neutron flux for use in a Po-Be neutron source as an initiator for a possible crude nuclear device, even though other initiator options using particles accelerators were considered.

Capabilities were generated for the production, casting, and machining of uranium metal. A uranium sphere of about five centimeters in diameter, and several hemispheres of similar size were manufactured. A small number of rods weighing 1.2 kg each were made to machine "sub-caliber munitions." It is not clear whether this was meant to manufacture anti-armor munitions, which devastated Iraqi armor in the 1991 Gulf war, rather than a nuclear device capability. Interestingly, any capabilities about plutonium metal are not reported by the IAEA. This suggests that the program was never even able to acquire a significant amount of plutonium to develop any metallurgical techniques for its alloying and manufacture.

As a delivery system for a potential nuclear device, the production of a derivative of the Al Hussein/Al Abbas missile, designed to deliver a one metric tonne warhead to a maximum range of 650 kms, was undertaken. An unmodified Al Hussein missile with a range of 300 kms was also considered.

DISMANTLING THE IRAQI NUCLEAR PROGRAM

As of December 16 1998, the IAEA asserted that: "There were no indications to suggest that Iraq was successful in its attempt to produce nuclear weapons. Iraq's explanation of its progress towards the finalization of a workable design for its nuclear weapons was considered to be consistent with the resources and time scale indicated by the available program documentation."

Further: "There were no indications that Iraq had produced more than a few grams of weapons-grade nuclear material through its indigenous processes. There were no indications that Iraq otherwise clandestinely acquired weapons-usable material. All the safeguarded research reactor fuel was verified and fully accounted for by the IAEA and removed from Iraq. There were no indications that there remains in Iraq any physical capability for the production of amounts of weapons-usable nuclear material of any practical significance."

Inspections revealed no indication that Iraq's plan for an indigenous plutonium production reactor proceeded beyond a feasibility study. The facilities at Tuwaitha used for irradiated fuel reprocessing research and development as well any chemical processing plants were destroyed during the Gulf War.

The IAEA by 2003 had practically dismantled the Iraqi nuclear weapons programs by the following actions:

1. Removal of all known weapon usable materials from Iraq.
2. All indigenous facilities capable of producing uranium compounds useful to a nuclear program as well as facilities capable of producing uranium compounds useful for fuel fabrication and for isotopic enrichment were destroyed by aerial bombardment during the Gulf War. The IAEA inspected and completed the destruction of such facilities, and continued the monitoring of these sites.
3. Took custody of all known imported compounds and indigenously produced uranium compounds.
4. Destroyed, removed or rendered harmless all known single-use equipment used in enrichment research and development, as well as all known facilities and equipment for the enrichment of uranium.
5. Subjected to on-going monitoring and verification all facilities and known dual-use equipment capable of being used in enrichment research and development.

6. Destroyed the principal buildings of Al Atheer weapons development and production plant.
7. Removed or rendered harmless all known purpose-specific equipment for weaponisation and implosion-based devices.
8. Verified, accounted for, and recovered the entire inventory of research reactor fuel.
9. It also arranged for the removal of all highly enriched uranium from Iraq.

It was overall just a research, not full industrial production program that was not transparent enough to be trusted by all the parties concerned. It was used as a pretext for the invasion, occupation and dismantling of Iraq.

8.16 SYRIAN PROGRAM, RIDDLE WRAPPED IN MYSTERY

HISTORY

In the late 1980s and early 1990s, Syria showed an interest in acquiring nuclear power and desalination plants from Russia and elsewhere, but nothing came to fruition. In 1988 Syria initiated a plan to build 6 nuclear power plants scheduled by the late 1990s capable of producing 6,000 MWe at a cost of $3.6 billion. Although Belgium, the then Soviet Union and Switzerland were approached for assistance, the plan came to naught as a result of denial of dual-use technology transfer, financial, technical and lack of resolve issues.

In 1991, the Peoples Republic of China informed the International Atomic Energy Agency (IAEA) about the sale of a small 27 kWth research reactor to Syria. Another effort in 1995 became nullified when the USA persuaded Argentina into abandoning a proposed sale of a research reactor to Syria.

In 1997, it was reported that the Russian government was interested in selling a nuclear reactor to Syria. On February 23 1998, Syria and Russia signed an agreement on the peaceful use of nuclear energy. In July 1998, the two sides agreed on the time table for the realization of a 25 MWth light water nuclear research reactor in Syria with the participation of Russia's Atomstroyeksport and Nikiet. Russia and Syria have approved a draft program on cooperation on civilian nuclear power. According to a London Financial Times report on January 16, 2003, Russian government sources indicated that Russia is negotiating to build a nuclear power plant in Syria.

The USA National Intelligence Council in December 2001 indicated in a report the establishment of nuclear research center at Dayr Al Hajar around the small Chinese supplied 27 kWth research reactor.

In August 2004 there came reports alleging that Syria may have acquired centrifuge enrichment technology from the Pakistan's A. Q. Khan network. American officials believed that Syria received an unspecified number of Pakistan 1 (P1) centrifuge components from North Korea. Syrian goods, including an annual shipment of 100,000 tons of Durum wheat for five years, worth a total of $120 million were bartered for industrial goods from North Korea.

There are unconfirmed reports that Syria has conducted work to examine the feasibility of exploiting phosphate rocks to recover uranium. It is well known that Syria is rich in phosphate rock deposits and produces around one fifth of the phosphate rock mined in the entire Middle East. According to statistics, in 2001, Syria mined over 2.04 million tons of

phosphate. A food-grade phosphoric acid micro pilot plant is operating at Homs under IAEA safeguards.

RAID ON UNDECLARED AL KIBAR NUCLEAR FACILITY, OPERATION ORCHARD, MITZVA BUSTAN

In the early hours of September 6, 2007 a joint Israeli-USA strike was reportedly aimed at a shipment from North Korea. The cargo might allegedly have included equipment and materials related to nuclear technology. Turkey asked Israel for clarification after finding two unmarked fuel tanks dropped from warplanes on its territory near the Syrian border. The Turks announced that two Israeli fuel tanks had been dropped inside of Turkish territory, one in the Gaziantep province and the other in the Hatay province. That would mean the aircraft did come under some sort of fire and dropped fuel tanks to increase speed and maneuverability. It also would mean the plane was flying close to Turkish territory or over Turkish territory, at the north western tip of Syria. Turkey's Hurriyet newspaper carried photographs of what it said were fuel tanks jettisoned by Israeli planes sent to gather intelligence on Syrian installations near the Turkish border.

The Israeli air force reportedly used computer codes allegedly sold to them by the Russians that showed hundreds of planes echoes on the Syrian aerial defense radars, then made the radar echoes suddenly disappear. The Syrian defenders thought it was a freak technical glitch, allowing the Israeli airplanes to penetrate their defenses unopposed past midnight. Some missile locks apparently were initiated by the Syrian defenders, and they did fire some SAM missiles, but the attackers escaped unscathed.

President George W. Bush at the White House was informed that "Something that never existed, does not exist anymore." President Bashar Al Assad of Syria was informed that Israel would not take credit for the raid, so as not to embarrass his government. Both countries were content to pretend that the bombing did not occur, at least for a while. An Israeli navy seals commando raid on August 2nd, 2008 had two snipers assassinate Syrian General Mohammed Suleiman, the project's mastermind, at the dinner table among his guests on the terrace at his beach villa weekend second home on the Mediterranean Sea at Tartous; "a very happy accident," according to Israel sources.

The New York Times reported that the strike, authorized by President George W. Bush had targeted a partially-built nuclear reactor, a tall square structure in the desert about 750 yards from the Euphrates River, near the town of Deir Al Zour, 250 miles northeast of Damascus. Officials in the USA asserted that the Al Kibar facility was an incomplete graphite-moderated, water cooled nuclear reactor modeled closely on North Korea's Yongbyon reactor.

The roof of the building makes it impossible to see what was inside. The building was 47 square yards, similar to the 48 x 50-yard Yongbyon reactor in North Korea. The targeted Syrian facility appeared to have been much farther from completion than the Iraqi Osiraq reactor that the Israelis destroyed in 1981, that the September 6, 2007 raid echoed. President George W. Bush administration officials had been divided over the attack, with some State Department officials seeing it as premature and considered it as an effort at derailing ongoing negotiations with North Korea.

The Israeli satellite Ofek 7, launched in June 2007, was diverted from monitoring Iran to Syria. It sent out high quality images of a northeastern area every 90 minutes, making it easy for Israeli air force specialists to spot the facility.

USA sources said that up to ten F-15 and F-16 fighter-bomber aircraft armed with AGM-65 bombs were used. They were capable of breaking the lock of radar systems and equipped with Electronic Counter Measures (ECM) and flares, were involved in the operation. Three F-15 airplanes were detected on radar by German ships in the Mediterranean off the coast of Lebanon as a part of a peace-keeping mission. The three planes could have created a diversion by being intentionally detected and creating sonic booms. The origin of the 7 other planes is reportedly Turkey or Iraq, suggesting a USA contribution. Another report suggests that the Israeli Hammer Squadron pilots followed a route west over the Mediterranean Sea then East over Turkish air space into North Syria.

A leak originating in the USA implied that there might have been Israeli Special Forces involved as well. The UK's Sunday Times suggested that the raiders seized material from a compound near Dayr Al Zoor in northern Syria and that tests of it in Israel showed it was of North Korean origin. The commando raid by the elite Sayeret Matkal was personally directed by Ehud Barak, Israel's defense minister who once commanded the unit.

A shipment of cement had been delivered to Syria from North Korea a few days before the incident and implied that this shipment might have contained nuclear equipment of some sort that was the real target of the attack. A ship "Al Hamed" stopped at an Egyptian port on its way to Syria was probably clandestinely inspected by Egyptian and USA personnel.

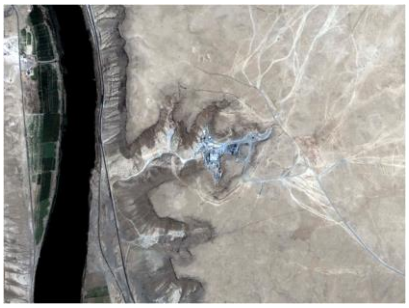
The attack involved a flight through the airspace of Turkey by up to seven aircraft, including cutting edge F-15Is and F-16s equipped with 500-pound or 227 kilogram bombs and AGM-65 Maverick missiles.

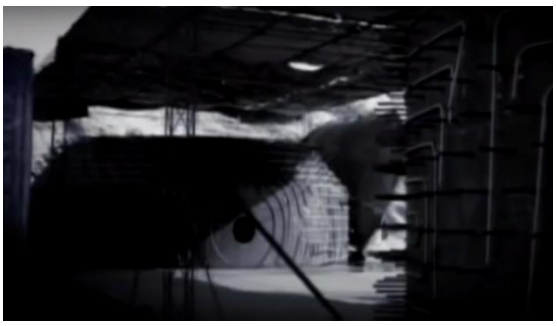
In another account, 10 F-15I aircraft from Israel's Ramat David air base south of the port city of Haifa flew a diversionary flight around 11 pm on September 5, 2007. Three of the aircraft were ordered back to base and the others continued east-northeast at low altitude. They used precision weapons to eliminate a Syrian radar station, then headed to an 18 minutes flight to Deir Al Zour. Upon destruction of the target, Israeli Prime Minister Ehud Olmert called Turkish Prime Minister Recep Tayyip Erdogan and asked him to inform President Assad of Syria that Israel would not tolerate such a project, that no further hostile action was planned, and that if no attention is drawn to the strike, he would do the same.

According to Israeli sources, American air force codes were given to the Israeli air force attaché in Washington to ensure Israel's F15Is would not mistakenly attack their USA counterparts as they flew close to USA air force bases in south Turkey.

The target was identified as a northern Syrian facility reported to be an agricultural research center on the Euphrates River. Israel had been monitoring it for some time, concerned that it was being used to extract uranium from phosphate rocks.

The raid occurred just after midnight with the 69th Squadron of Israeli F15Is crossed into Syrian air space. On the ground, Syria's air defenses went dead probably through the use of the Suter system. At a rendezvous point on the ground, a Shaldag air force commando team was waiting and used their laser beams to irradiate the target for the approaching jets. The team had arrived a day earlier, taking up position near a large underground depot.





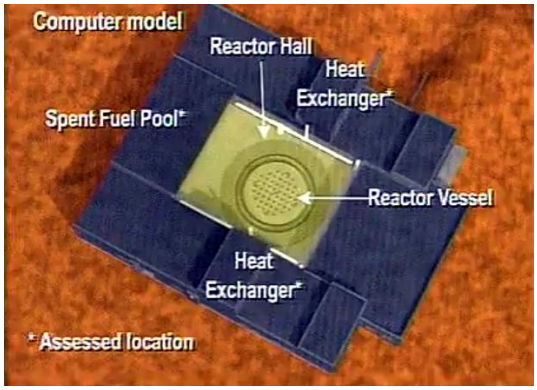


Figure 15. Satellite photograph of destroyed Al Kibar Syrian facility by the Euphrates River taken on September 16, 2007, top, August 10, 2007, middle left, and October 24, 2007, middle right. Bottom: new construction above site. GeoEye/SIME, AFP/DigitalGlobe/ISIS pictures.

The raided site is on the eastern bank of the Euphrates River, 90 miles north of the Iraqi border. The original building, slightly larger than a baseball diamond, was located in Syria's eastern desert near the village of Al Tibnah, a few hundred yards from the Euphrates River. USA officials said the building closely resembled structures associated with a North Korean reactor at Yongbyon.

The Syrian building size suggests that the reactor thermal power would be in the range of about 20-25 MWth. Satellite Images taken in August, before the raid, show a tall building about 150 feet wide on each side that analysts suspect might have sheltered a half-built nuclear reactor. Also visible is a pumping station on the Euphrates, which may be significant because reactors need water for cooling. The size of the structures suggested that Syria might have been building a gas cooled graphite reactor similar to the one North Korea built at Yongbyon. The photos show little progress had been made at the site between 2003 and 2007.

AFTERMATH

Syrian President Bashir Al Assad said Israel targeted an unused military building. The only facility in the area in question was a desertification research center.

The International Atomic Energy Agency (IAEA), the UN nuclear watchdog, has repeatedly asked Syria about its activities. Syria, a signatory to the nuclear Non Proliferation Treaty (NPT), has one small 27 kWth research reactor supplied by China that operates under international safeguards.

After Israel bombed the Osirak reactor in 1981, Iraq simply continued its nuclear weapons program in secret and initiated programs in biological and chemical warfare. It was not the bombing of Osirak, but rather UN inspections, which eventually nuclearly-disarmed Iraq.

8.17 LATENT NUCLEAR POWER: BRAZIL NUCLEAR PROGRAM

INTRODUCTION

Brazil scrapped a nuclear weapons program in 1985. Its military continued working on building a U^{235} device until August 1990, when the program was terminated. It was restarted in 2007 to produce highly enriched U^{235} needed for a nuclear submarine program.

In the early 1980s the Brazilian Navy started a nuclear propulsion program and initiated the development of centrifuge enrichment to produce the highly enriched fuel of up to 98 percent U^{235} enrichment, needed for naval propulsion reactors. Brazil also needed enriched fuel for its civilian nuclear power plants.

Brazil's nuclear program raised concern when it refused to allow the International Atomic Energy Agency (IAEA) to inspect the nuclear facilities at Resende, 100 kilometers southwest of Rio de Janeiro. It cited as a reason the need to protect proprietary industrial secrets. Being a party to the Nuclear Non Proliferation Treaty (NPT), eventually an agreement was reached allowing the inspections to go ahead with Brazil having to unveil its centrifuges for inspection.

As of 2009, Brazil planned on producing all the enriched uranium used by the Angra I power plant, and that needed by the Angra II plant by 2012. This national production of enriched uranium should save Brazil $25 million / year that it has been paying to foreign enrichment services.

The enrichment technology was developed at the Navy Technological Center (CTMSP) in Sao Paolo and by the Nuclear and Energy Research Institute (IPEN), making Brazil the ninth country to develop the enrichment technology. The factory at Resende expects to have ten cascade centrifuges within 2012.

With its capability of producing highly enriched uranium using the centrifuge process, Brazil can be considered as a latent nuclear power, capable of acquiring a nuclear weapons capability on a short notice should it be subjected to a conventional or a nuclear threat.

BRAZIL'S NUCLEAR MILITARY PROGRAM

Brazil has signed the Nuclear Nonproliferation Treaty (NPT) since 1998, and is a member of the local South American Tlatelolco Treaty. The nations of South America and the Caribbean region signed that treaty on February 14, 1967, at the Tlatelolco district of Mexico City, with the objective of keeping their region free from nuclear weapons.

Following a new constitution in 1988, it renounced development of nuclear weapons and an Argentine-Brazil Agency for the Accounting and Control of Nuclear Materials (ABACC) was set up with full scope safeguards under IAEA auspices since 1994. In 1996 it became a member of the Nuclear Suppliers' Group. Brazil has not accepted the "Additional Protocol" in relation to its safeguards agreements with the IAEA as being excessively intrusive.

In 2003, Brazil's science minister at the time, Eduardo Campos, caused concern when he said Brazil should pursue "Any form of scientific knowledge, whether the genome, DNA or nuclear fission." The comment was interpreted to mean that Brazil intended to develop nuclear weapons. The Brazilian government denied having any such goal, stressing that Brazil's constitution bans the use of nuclear energy for non peaceful purposes.

The information about Brazil's nuclear weapons program was disclosed in August of 2005 from José Luiz Santana, the former president of Brazil's nuclear energy commission, known by its Portuguese acronym CNEN. He divulged that the Brazilian military was preparing a nuclear test when the program was ultimately dismantled in August, 1990. The former president Jose Sarney, who led Brazil's first civilian government after a 1964-85

military rule, corroborated the information stating that he scrapped a program to build an atomic bomb when he came to power in 1985.

The Brazilian military was still working on an atomic device when former President Fernando Collor succeeded President José Sarney in 1990 and hoped to conduct an underground test blast in September of 1990 at a remote base in Brazil's eastern Amazon.

Military officials had obtained the enriched uranium needed for the weapon from an undisclosed source. Mr. Santana contended that it took him and his team seven months to dismantle the program. "I took office in April, 1990, but it was only in August that CNEN managed to gain control of the container" of enriched uranium from the military.

Brazil's CNEN denied Mr. Santana's contentions. "There do not exist any documents in the institutional archives or information that prove the claims in the story," and added that all nuclear material in Brazil is stored under the IAEA Safeguards program.

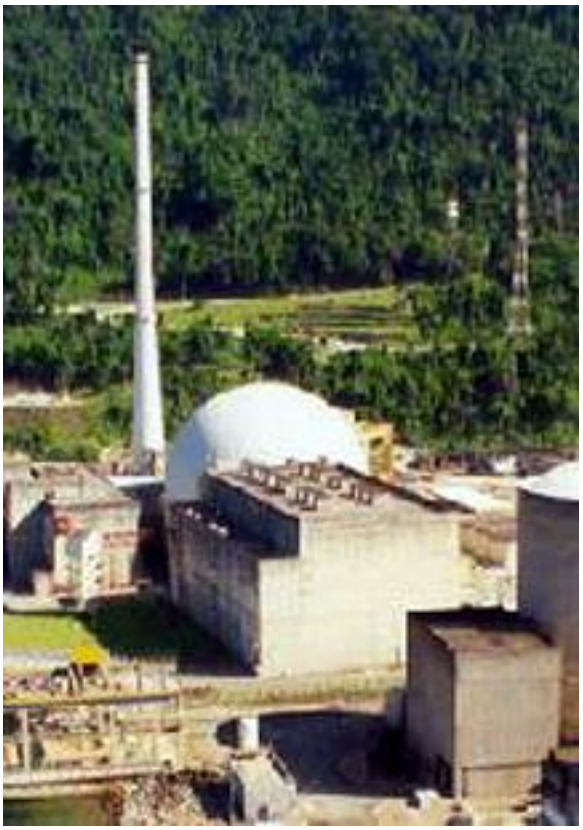


Figure 16. Brazil Angra-2, PWR reactor went on line on July 21, 2000.

NAVY NUCLEAR PROGRAM

According to the NPT Brazil is allowed to legally enrich uranium. Its navy is producing Highly Enriched Uranium (HEU) for an intended use in an active nuclear submarines program.

Figure 17. Launch of Brazil’s nuclear submarine Tikuna, March 9, 2005.

In October 2009, the American periodical “Foreign Policy,” published an article titled: “The Future Nuclear Powers You Should Be Worried About.” According to the author, Iran, Kazakhstan, Bangladesh, Burma, the United Arab Emirates and Venezuela are the next candidates for membership in the club of nuclear powers. With HEU, Brazil is a de facto latent nuclear power state, much like Japan and Germany who possess the capability of manufacturing nuclear weapons, but have so far forgone it..

Brazil's National Defense Strategy was unveiled in late 2008. In addition to the mastery of the complete nuclear fuel cycle, which has since been achieved, the document calls for the building of nuclear-powered submarines.

Brazil already had three secret military nuclear programs over the period 1975-1990, with each branch of its armed forces pursuing its own route. The navy's approach proved to be the most successful. It used imported high-performance centrifuges to produce highly enriched uranium from imported uranium hexafluoride, so as to be able to operate small reactors for submarines. At the appropriate time, the country's newly acquired nuclear capabilities were to be revealed to the world with a "peaceful nuclear explosion," based on the example set by India. The 300-meter or 984-foot shaft for the test had already been drilled. According to statements by the former president of the National Nuclear Energy Commission, in 1990 the Brazilian military was on the verge of building a nuclear device.

During the course of Brazil's democratization, the secret nuclear programs were effectively abandoned. Under the country's 1988 constitution, nuclear activities were restricted to "peaceful uses." Brazil ratified the Tlatelolco Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean in 1994 and, in 1998, the Nuclear Nonproliferation Treaty (NPT) and the Comprehensive Nuclear-Test-Ban Treaty.

Under its past president Lula da Silva, a few months after his inauguration in 2003, Brazil officially resumed the development of a nuclear-powered submarine.

During his election campaign, President Lula d Silva criticized the NPT, calling it unfair and obsolete. Although Brazil did not withdraw from the treaty, it tightened the working conditions for inspectors from the International Atomic Energy Authority (IAEA).

The situation became tense in April 2004, when the IAEA was denied unlimited access to a newly built enrichment facility at Resende, near Rio de Janeiro. The Brazilian government also made it clear that it did not intend to sign the additional protocol to the NPT, which would have required it to open previously undeclared facilities to inspection.

In mid-January 2009, during a meeting of the Nuclear Suppliers Group, a group of nuclear supplier countries that works toward nonproliferation by controlling exports of nuclear materials, Brazil's representative objected to requirements that would have made the nuclear submarine program transparent.

Vice President José Alencar openly advocated Brazil's acquisition of nuclear weapons in September 2009. For a country with a 15,000-kilometer border and rich offshore oil reserves, Alencar says, these weapons would not only be an important tool of "deterrence," but would also give Brazil the means to increase its importance on the international stage. When it was pointed out that Brazil had signed the NPT, Alencar reacted calmly, saying it was "a matter that was open to negotiation."

A precondition for the legal construction of small reactors for submarine engines is that nuclear material regulated by the IAEA is approved. But because Brazil designates its production facilities for nuclear submarine construction as restricted military areas, the IAEA inspectors are no longer given access.

Nuclear submarines are operated with HEU up to 97 percent U^{235} to be able to overcome the xenon reactor dead time, for compactness, and for high burnup fuel allowing long periods between refuelings, which also happens to be weapons grade U^{235}.

CIVILIAN NUCLEAR POWER PROGRAM

Electricity consumption in Brazil has grown significantly since 1990. Per capita consumption is 2235 kWh/yr. Nuclear energy provides 4 percent of the country's electricity at about 13 billion kWh per year.

About 40 percent of Brazil's electricity is produced by the national Centrais Eletricas Brasilerias SA or Eletrobras system. About 30 percent of electricity is generated by state owned utilities, and 20 percent from the 12.6 GWe Itaipu hydroelectric scheme on the Paraguayan border. About 9 percent is from self producers and private generators. Eletrobras was set up in 1962 as a holding company controlled by the Ministry of Mines and Energy, and is 70 percent government owned. It is the main shareholder in Eletronuclear, the Brazilian nuclear utility.

In 1970 the Brazilian government decided to seek bids for an initial nuclear plant. The turnkey contract for Angra-1 was awarded to the Westinghouse from the USA, and construction started in 1971 at a coastal site between Rio de Janeiro and Sao Paulo.

In 1975 the government adopted a policy becoming fully self-sufficient in nuclear technology and signed an agreement with West Germany for supply of eight 1,300 MWe nuclear units over 15 years. The first two were to be built immediately, with equipment from Siemens KWU. The rest were to have 90 percent Brazilian content under the technology

transfer agreement. A state-owned company Empresas Nucleares Brasileiras or Nuclebras, was set up with a number of subsidiaries focused on particular aspects of engineering and the nuclear fuel cycle.

Brazil's economic problems caused the construction of the first two Brazilian-German reactors to be interrupted, and the whole program was reorganized at the end of the 1980s. In 1988 a new company, Industrias Nucleares Brasileiras SA (INB) replaced Nuclebras and most of its subsidiaries, but with limited authority and function related to fuel cycle activities. INB is a subsidiary of the National Nuclear Energy Commission (CNEN).

Responsibility for the construction of Angra-2 and Angra-3 was transferred to the utility Furnas, a subsidiary of Eletrobras. Construction of Angra-2 resumed in 1995, with USA $ 1.3 billion of new investment provided by German banks, Furnas and Eletrobras.

In 1997 a new company Eletrobras Termonuclear SA or Eletronuclear was set up as a subsidiary of Eletrobras and made responsible for all construction and operation of nuclear power plants. It combined the nuclear side of Furnas with the engineering company Nuclen, and Siemens then relinquished its 25 percent share in it. Nuclen is the continuing subsidiary from the Nuclebras period, handling heavy equipment manufacturing and now a subsidiary of CNEN, with INB. Table 4 shows the existing and planned nuclear power plants in Brazil.

The Angra-1 plant suffered continuing problems with its steam supply system and was shut down for some time during its first few years. Its lifetime load factor over the first 15 years was only 25 percent, but since 1999 it has been much better. Angra-2 has performed well.

Table 4. Nuclear Power Reactors in Brazil.

Reactor Name	Design	Power MWe	Online Date
Angra-1	PWR	626	1982
Angra-2	PWR	1275	2000
Angra-3	PWR	1224	2006

The 1,224 MWe Angra-3 unit was part of the same contract as Angra-2 and was designed to be a twin of it. While 70 percent of the equipment is on site, construction has not started. Eletrobras is seeking a private partner with USA $ 1.8 billion to complete it. Its completion date was slated for 2006.

NUCLEAR FUEL CYCLE

Active mineral exploration in the 1970s and 1980s, resulted in Known Resources, defined as Reasonably Assured Resources plus Estimated Additional Resources of category 1, with a cost up to USA $ 80/kg, of 143,000 metric tonnes of uranium. This is 4 percent of the world total resource.

Three main deposits are Pocos de Caldas mine which was closed in 1997, the operating mine Lagoa Real, and Itataia which is an undeveloped phosphate deposit from which uranium can be obtained as a by product.

Uranium has been mined since 1982, but the only extant mine is INB's Lagoa Real Unit, with 340 tU/yr capacity. All mined uranium is used domestically. Conversion and enrichment was done abroad, until a centrifuge enrichment program was developed in Brazil.

In the early 1980s the Brazilian Navy started a nuclear propulsion program and started the development of the centrifuge enrichment process. A demonstration plant was built at Ipero, and then an industrial plant at Resende which is planned to provide for much of the enriched uranium fuel needs of the Angra reactors. The first enrichment cascade was inaugurated in 2002 by INB. Stage 1 consists of four modules generating 115,000 Separative Work Units per year (SWU/yr) and costing USA $ 140 million. Stage 2 increases the capacity to 200,000 SWU/yr. The centrifuges are domestically-developed and very similar to the European Urenco technology.

INB's fuel fabrication plant designed by Siemens is also at Resende, with a capacity of 160 metric tonnes per year pellet production and 280 t/yr fuel assembly.

The CNEN is responsible for management and disposal of radioactive wastes. Legislation issued in 2001 provides for repository site selection, construction and operation. Spent fuel is stored at the Angra plant site. There is no defined policy on fuel reprocessing.

REGULATION AND LEGISLATION

The main legislation concerning regulation and safety is the national policy on nuclear energy set in 1962. The CNEN was set up in 1974 and amending legislation was passed in 1989 and 1999.

The Brazilian nuclear regulatory body is the Directorate of Radiation Protection and Safety (DRS) of the CNEN. It is responsible for licensing and supervision of all nuclear facilities. The Brazilian Institute for the Environment is involved with licensing facilities.

The CNEN reported initially to the Presidential Secretary for Strategic Affairs but currently comes under the Ministry of Science and Technology.

A Nuclear Program Co-ordination and Protection Commission has representatives from every organization concerned with nuclear issues and is open to local government and others with relevant interests.

RESEARCH FACILITIES AND ACTIVITIES

The CNEN Directorate of Research and Development is responsible for all fuel cycle, reactor technology, radioisotopes. Five nuclear research centers carry out various research work.

At IPEN, Sao Paulo, there are two research reactors, one a 5 MWth pool type, and a cyclotron used for radioisotopes production.

At IEN, Rio de Janiero, there is a small Argonaut research reactor.

At CDTN, Belo Horizonte, there is a small Triga research reactor.

At CTSMP, the Navy Technology Centre at Sao Paulo, a prototype reactor for naval propulsion was being developed, but this program was redirected into possible applications for small power plants in the northeast of the country.

Brazil has been involved in the Generation IV International Forum, and in the IAEA INPRO program, both developing new generation reactor designs and systems. CNEN was also involved with Westinghouse in developing the IRIS modular reactor.

8.18 TRANSPARENT PROGRAM: EGYPT NUCLEAR PROGRAM

INTRODUCTION

Within the context of proposing a regional nuclear nonproliferation treaty in the Middle Eastern region, interest arises in the nuclear programs of different countries there. A regional declaration of the Middle East as a nuclear weapons free zone, with mutual inspections and verification, supplementing the global Nuclear Nonproliferation Treaty (NPT) along the line of the Tlatelolco South American Treaty would eliminate suspicion, enhance the cause of peace, and lead to regional stability and local cooperation in the peaceful applications of nuclear science and technology.

In February 2005 the USA praised Egypt for its cooperation with the United Nations (UN) International Atomic Energy Commission (IAEA) in a statement to the IAEA 35 nation board of governors stating that Cairo's safeguards transparency was a model for other states: "This example is one that we believe all states should follow. Egypt is demonstrating the appropriate means for resolving outstanding safeguards issues, specifically, full cooperation with the IAEA on steps to address all concerns. The United States joins the Director General in welcoming Egypt's cooperation in remedying its past safeguards reporting failures." Mohammed El Baradei, head of the IAEA admitted that Egypt had failed in reporting some sensitive nuclear activities but: "We haven't seen a proliferation concern yet."

EGYPT NUCLEAR PROGRAM

Egypt drew up plans to build four nuclear reactors by 2022 with a capacity of 4,000 MWe. The first plant would be a Pressurized water Reactor (PWR) with a capacity of 950 - 1,650 MWe and will be located at Al Dabaa, on Egypt's north-west coast. Egypt, which has an installed capacity of about 23,500 MWe, needs a further 3,000 MWe to meet the country's growing demand.

Russia's state-owned nuclear firm Rosatom at Dabaa will build a 4-unit planr along the Mediterranean shore with a loan from Russia to be paid off over 35 years. Russia is the largest supplier of both tourists and grain to the Arab World's most populous country. Russia has plans to establish a naval military base described as "a facility where ships could refuel and pick up supplies to strengthen the Russian fleet presence in the Mediterranean Sea." Russia has been losing the grip on its base at the port of Tartous in Syria as a result of the Sunni, Shiite and Kurdish factional conflict there. In November 2013, Russia supplied Egypt with air defense systems and military helicopters worth $2 billion, with funds provided by Saudi Arabia. The USA State Department announced on October 9, 2013 that it would halt the delivery of large-scale military systems and cash assistance to Egypt's government, pending "credible progress toward an inclusive, democratically elected civilian government through free and fair elections". The decision comes as part of "recalibrating" USA aid to Egypt.

Egypt's interest in nuclear power started in 1954, when its Nuclear Energy Authority was established. The first studies to use nuclear energy to generate electricity and desalinate sea water started in 1964, when a tender was held to build the first nuclear reactor in the coastal city of Borg Al Arab and Al Dabaa . The national project was stalled after the 1967 war. The idea was revived after the 1973 war and a joint collaborative report was issued after a meeting

between Presidents Jimmy Carter and President Anwar Sadat in 1978 studying the possibility of constructing nuclear power plants in Egypt by 2000 to cover 80 percent of the electrical power needs. Nothing since then has materialized for lack of funds and determination, except for numerous experts' and consultant's travels back and forth on leisure trips disguised as working missions.

SAFEGUARDS CONCERNS

An IAEA report had criticized Egypt for failing to declare nuclear sites and materials but said its inspectors had found no evidence of a nuclear weapons program and that Egypt's breaches were minor.

The report said that Egypt was guilty of repeated failures to report nuclear activities but downplayed any suggestion this could be related to secret atomic weapons development. The agency also found traces of plutonium, a potential atomic weapons material, in hot cells used to handle radioactive material. Egypt said this was due to contamination rather than plutonium production.

According to the report, Egypt's minor failures to abide by international nuclear safeguards agreements, including not reporting a research plutonium reprocessing experiment, were "a matter of concern," but that Cairo was now cooperating, saying it had erred as it had not understood its reporting obligations.

Any lingering questions about Egypt's nuclear program were on whether it was carefully structured to be able to move towards weapons development if the decision for this step was taken. The activities were related to research into the nuclear fuel cycle in order to build nuclear power plants, rather than part of an atomic weapons program. In the late 1970s Egypt considered the construction eight nuclear power plants to produce electricity and fresh water desalination, but did not build any for lack of funding.

The IAEA report said: "The nuclear material and facilities seen by the agency to date are consistent with the activities described by Egypt," which are strictly peaceful.

Egypt's nuclear program is transparent and is now open to international inspection by the International Atomic Energy Agency (IAEA). Egypt has ratified the Nonproliferation Treaty (NPT) and is under IAEA Safeguards inspections. It joined the Treaty in 1981, but is one of its critics. In 1995, Egypt strongly opposed efforts to extend the Treaty indefinitely. A previous Egyptian Foreign Minister, Amr Moussa remarked at a gathering of Middle Eastern experts and journalists in Washington D. C.: "If there is a nuclear program in Israel, then we can blame nobody and no country if they want to acquire the same. This is an invitation to an arms race; a very, very serious and dangerous policy." He argued that Israel's failure to join the NPT means that the treaty is "Incapable of safeguarding Egypt" and has created "An extremely dangerous situation" in the Middle East.

The German daily newspaper Die Welt ran a story claiming that Egypt is interested in enriching uranium it mines in the Sinai, with the help of China. Unlike Iran who would need enriched uranium to fuel a completed light water cooled power reactor at Bushehr and one under construction at Darkhovin, Egypt has only two research reactors in operation. The sensational implication of the newspaper was that Egypt may be developing a weapons program.

An official from Israel commented that he had no proof that Egypt is involved in a military nuclear program. An American official called the Die Welt report "disinformation."

The Israeli source noted that intelligence cannot always know about everything going on, and that every country puts most of its effort into keeping nuclear developments secret.

NUCLEAR ASSYMETRY

Countries in the Middle East realize that Israel already possesses nuclear weapons, making it immune to both conventional and nuclear attack. The power asymmetry creates an incentive for them to counter the Israeli advantage by either creating alliances with nuclear weapons states, effectively acquiring a protective nuclear umbrella or to move to the illicit acquisition of nuclear weapons.

Israeli Minister without Portfolio Dan Meridor, a veteran of Israeli nuclear policy, warned that an arms race could arise among the Middle Eastern countries struggling among themselves for hegemony in the region

An Iraqi research program was dismantled by bombing of its facilities by Israel, international inspections and sanctions after the first Gulf war in 1991, and later by invasion, occupation, regime change and installation of a friendly regime in 2003. A Lybian program has also been dismantled through interception of enrichment equipment parts shipped to Lybia on the high seas and a threat of invasion and regime change, which occurred anyway by the assassination of its leader Muammar Al Gadhafi. Iran is collaborating with Russia and building two power reactors at Bushehr and Darkhovin, is indigenously building a research heavy water reactor at Arak, and has facilities for manufacturing fuel for it.

The USA offered Russia compensation for ceasing nuclear cooperation with Iran, and, according to USA administration officials testifying to the Senate, warned that if the Russians continue to not cooperate, Washington would reduce strategic cooperation in the pipeline for Moscow. John Wolf, an assistant secretary of state in the bureau for non-proliferation, told Congress that "we made clear to the Russians they have to end that aid, and not only to Iran, or we will have to impose sanctions." In response, Russia beefed up its rules for exporting nuclear technology, and has cracked down on some projects. The USA did agree that Russia could continue helping with Iran's Bushehr and Darkhovin nuclear power plants, but insisted on stepped-up security arrangements and monitoring. The main effort will be to ensure that the irradiated fuel rods are returned to Russia so that the Iranians cannot extract fissile nuclear material from them.

EGYPT'S NUCLEAR PROGRAM HISTORY

The Egyptian nuclear research program was launched in 1954. Egypt acquired its first research reactor from the Soviet Union in 1961. The 2 thermal megawatts (MWth) research reactor was inaugurated by then President Gamal Abdel Nasser at the Inshass Nuclear Research Center near the village of Inshass, in the Nile Delta.

Emphasis has been on studies for developing a peaceful nuclear potential designated for use in sea water desalting and production of fresh water for irrigation of arid land and electrical power generation, at El Dabaa on the Mediterranean coast. Hoping for foreign funding that never materialized, the project never saw the light of day. Progress has materialized, however in the areas of isotopes applications in medicine, agriculture, biotechnology, and genetics. Mining from four explored uranium deposits was planned,

including the extraction and enrichment of uranium for subsequent use as fuel for nuclear power plants.

A project for the building of a 50 MWth pilot plant for sea water desalination and an associated experimental agricultural farm using the produced water was initiated. The project would have depended on cost sharing, with the Westinghouse Corporation in the USA contributing half the costs in return for gaining access to the operational experience of the project. A Nuclear Engineering Department was initiated at the University of Alexandria close to the site of the project to educate the scientists and engineers for the pioneering project. The 1967 war withdrew the funding of the project toward armaments, and the project human expertise was dispersed through migration to other parts of the world such as Europe, Canada and the USA.

In the mid-1970s the USA promised to provide Egypt with eight nuclear power plants and the necessary cooperation agreements were signed. During the negotiations for this project, Egypt ratified the Non Proliferation Treaty (NPT) to assure that the project will be exclusively used for peaceful purposes. In the late 1970s, the USA, under Israeli pressure, unilaterally revised the bilateral agreements and introduced new excessively intrusive conditions that were expected to be unacceptable to the Egyptian government.

Before his assassination in 1981, President Anwar Al Sadat announced plans to build two nuclear power stations along the Mediterranean coast. These plans, though, were subsequently shelved. There are poorly attested reports that Egypt planned for a Chinese-made power reactor, variously assessed at between a thermal power of 300 MWth and 600 MWth.

Upon losing its Russian supplied research reactor core to a rumored unreported accident of a stuck control rod or fuel element leading to a local core melt, and apparently to avoid the disclosure of the accident, in early 1992, Egypt expended its own funds and acquired from Argentina the Egypt Research Reactor number 2 (ETRR-2); an open pool research reactor with a power of 22 MWth. This reactor is the work horse of the Egyptian nuclear program.

A contract was signed in 1991 for the delivery to Egypt of a Russian MGD-20 cyclotron accelerator remained in force.

Since 1990 Egypt has been a member of the Arab Power Engineering Organization uniting 11 Arab countries for hoped for, but never materializing projects because of the political rivalries among them.

Figure 18. Exterior of the Egypt Research Reactor ETRR-2, 22 MWth research reactor at Inshass, Egypt.

A number of Egyptian scientific projects have been carried out successfully with Egyptian rather than Arab or international funding under the aegis of the International Atomic Energy Agency (IAEA).

There are bilateral agreements in the area of the peaceful use of nuclear energy with Germany, the USA, Russia, India, China, and Argentina. There are, moreover, agreements with Great Britain and India to provide assistance in training national cadres for scientific research and work on the country's atomic enterprises.

INSHASS NUCLEAR RESEARCH CENTER

The focus of Egypt's nuclear program resides at the Inshass Nuclear Research Center near Cairo. Inshass hosted a 2 MWth, Soviet-supplied research reactor that started in 1961 and used on 10 percent-enriched uranium fuel. The reactor was shut down reportedly for renovation during the 1980s, but most probably as a result of an unreported accident. It was renovated or repaired and restarted up again in 1990. It has been replaced in 1992 by the ETRR-2; an open pool research reactor with a power of 22 MWth.

A number of other research facilities at Inshass. These include a small French-supplied hot cell complex for radiochemistry and radioactive isotopes extraction research, the Middle East's first industrial electronic accelerator, and a pilot nuclear fuel factory, completed in 1987, used to process natural uranium mined in Egypt. Egypt had a project that never materialized to build a larger fuel fabrication plant, reportedly with hoped for help from Germany.

RESEARCH AND POWER REACTORS PROGRAM

In 1990, the Israeli press falsely alleged that Egypt was cooperating with Pakistan, Iraq and Argentina to build a plutonium producing reactor. Argentina later revealed that it was preparing to supply a 22 MWth research reactor to Egypt under international IAEA inspection,

though Argentina faced competitive bidding from other bidders, including the Atomic Energy of Canada Ltd., and France's nuclear giant then Framatome and now Areva.

In September 1992, Egypt signed a contract with Invap, Argentina's leading nuclear organization, to build the 22 MWth research reactor at Inshass. Construction began in March 1993.

During the bidding stage USA and Canadian officials steered Egypt away from a Chinese design. In exchange for giving up the Chinese version, Egypt was promised help from the Atomic Energy of Canada Limited (AECL) and the USA Bechtel company to study the feasibility of cooperation in the building of power reactors in Egypt. The newsletter, Nucleonics Week, reported in September 1992 that an AECL-Bechtel study found that only 30 percent of the CANDU Canadian design power reactor could be locally produced in Egypt.

Faced with a shortage of fresh water and electricity supplies, and not being a major oil producer, Egypt hopes to build nuclear power reactors for sea water desalination. Egyptian officials have expressed hope since the early 1980s about building up to eight 1,000 MWe reactors to supply up to 40 percent of Egypt's electricity needs. By 1985, three international supplier groups bid to build the first two reactors: one group led by Germany's Kraftwerk Union, a second Franco-Italian group led by Framatome, and a third headed by Westinghouse of the USA.

The power reactors would be sited at Al Dabaa, west of Alexandria on the Mediterranean coast, and would be owned and operated by Egypt's Nuclear Power Plants Authority. Expecting funding from the USA that did not materialize, and lacking local funding, the Egyptian government did not announce the award of any contract.

According to Forbes Magazine [15]:

> Russian President Vladimir Putin and Egyptian President Abdel Fattah el-Sisi signed a preliminary agreement to jointly build Egypt’s first nuclear power plant, after the two leaders met in Cairo on February 9-10, (2015).
>
> This announcement comes after multiple reports last November about Russia’s state nuclear power company Rosatom’s agreement to help Iran build several nuclear reactors, including reactors at Iran’s Russian-built Bushehr nuclear power plant.
>
> Putin had travelled to Cairo this week upon Sisi’s invitation. Russian-Egyptian relations began improving after the July 2013 military ouster of former president Mohamed Morsi, when U.S.-Egyptian relations began to decline. Cairo grew increasingly concerned with what it perceived to be U.S. engagement with the Muslim Brotherhood, and felt abandoned in its fight against terrorists, particularly in the restless Sinai—a hotbed of radicalism and instability going back to President Hosni Mubarak’s time. Washington also delayed weapons deliveries to Egypt, withheld military aid, and later halted the nascent bilateral strategic dialogue. The decline of U.S.-Egyptian relations created an opportunity for Putin to step in and assert his national interests in Egypt.
>
> Putin and Sisi see eye to eye on a number of issues. Putin would certainly prefer to see a secular government in Egypt. Unlike President Obama, Putin enthusiastically endorsed Sisi’s bid for Egyptian presidency.

Russia's Supreme Court has designated the Muslim Brotherhood a terrorist organization in February 2003. Russia continues to battle an increasingly-radicalized insurgency in the Caucasus and the Kremlin has long believed the Brotherhood helped arm radical Islamists in Russia. Putin certainly won't criticize Sisi on his democratic backslide.

Economic relations have significantly improved between Egypt and Russia in recent years. In 2014, out of Russia's 10 million tourists, over three million have visited Egypt, primarily the Sinai resort of Sharm al-Sheikh. According to Putin, approximately half as few Russian tourists visited Egypt in 2013. Trade between the two countries also grew by approximately 50 percent since 2013 according to Putin, to over $4.5 billion in 2014. Russia provides approximately 40 percent of Egypt's grain.

Putin's trip to Cairo created a political opportunity for him to show to the West, in light of his aggression in Ukraine, that he is not isolated, no matter what the West says. His announcement of a number of agreements reached in Cairo helps bolster this claim, even if at this point they are still preliminary.

Both Russia's and Egypt's economies are stagnating. Russia has entered a deep recession in the context of declining oil prices and Western sanctions in response to his annexation of Crimea in March 2014. Egypt, for its part, is also struggling with violent domestic opposition, terrorist threats, poverty and unemployment. Putin is unlikely to provide anything to Sisi for free. Indeed, a major $3.5 billion Russian-Egyptian arms deal, reached last year, has not yet moved forward, most likely because the Egyptians could not finance it.

Yet by pushing Cairo away as an ally, and continuing to ignore its real security and energy needs, Washington is increasing Egypt's necessity to build a nuclear power plant in the first place. Cairo used to be Washington's partner on energy cooperation. This is no longer the case.

In February 2006, the George W. Bush administration announced the Global Nuclear Energy Partnership (GNEP). It aimed to create an international partnership, which would advance safe and extensive global expansion of nuclear power through so-called "cradle-to-grave fuel services" within a regulated market for enriched uranium, where several large countries would provide enriched uranium to smaller countries. This plan aimed to address crucial concerns about nuclear weapons proliferation and waste management, and to eliminate the need for smaller countries to build facilities for uranium processing and disposal in the first place, saving them billions.

Egypt was among participant countries in GNEP. President Obama, however, effectively scrapped parts of GNEP and now shows little interest in expanding the strategic energy partnership with Egypt. Putin is only too happy to fill the gap, and is not concerned with the safeguards inherent to GNEP.

The Obama Administration is correct to criticize Sisi on his democratic backslide. Yet ignoring Egypt's concerns only hurts U.S. interests, including those of providing security and advancing human rights.

The instability in the Sinai Peninsula presents a real threat to U.S. security, and withdrawing support for Sisi only pushes him closer to Putin and other anti-Western players. The preliminary agreement on the nuclear deal is a case in point."

NUCLEAR ACTIVITIES IN EGYPT

URANIUM RESOURCES

Egypt has surveyed its indigenous uranium ore resources. For energy supply security, it would like to develop its own capability to manufacture uranium fuel for nuclear reactors. Egypt's Nuclear Materials Authority has carried uranium exploration to concentrate on four ore areas in the eastern desert: Djabal Gattar, Al Missikat, Al Erediya and Umm Ara.

A new uranium-ore bearing area, Djabal Kadabora, has been discovered in the central eastern desert. In addition, the Nuclear Materials Authority is constructing a pilot scale plant to extract uranium from phosphoric acid. Egypt reportedly signed contracts with Australia, Canada and Niger to buy mining technology and for help in processing uranium ore.

Egypt is an exporter of phosphate rock used in the production of phosphoric acid and manufactures phosphate based agricultural fertilizers from it. Phosphate rock contains uranium as a trace element. It can be extracted as by product in the wet phosphoric acid production process. Egypt seems to be aware of the existence of such a potential source of uranium fuel but because of lack of funding, did not pursue it. Egypt also has deposits along its seashores of black sand containing the monazite and ilmenite ores, which contains heavy elements such as thorium. The black sand is used for the manufacture of abrasives and sand paper, and no attempt to extract thorium from it was pursued.

RESEARCH REACTOR ETRR-1

The acronym ETRR-1 stands for Egypt Research Reactor number 1. It was a scientific-research reactor with a power of 2 MWth. It was started in 1961 with Soviet technical assistance. Upon an unreported stuck control rod or fuel element accident leading to a local core meltdown in an aging core, it was shut down and renovated. An agreement was signed with India in 1991 to increase the thermal power of this reactor to 5 MWth. It is not clear whether it is still actively used after its replacement by ETRR-2. The extended operation of the reactor has enabled Egypt to acquire its own scientific base and fairly skilled technical cadres.

MULTIPURPOSE NUCLEAR REACTOR ETRR-2

USAGE

This is an open pool type reactor, with 22 MWth of power, cooled and moderated by light water and reflected by beryllium. It has replaced the aging ETRR-1 reactor.

The reactor is of the open pool type, with a nominal power of 22 MWth and a maximum thermal neutron flux of $2.7\text{-}2.8 \times 10^{14}$ [neutrons/(cm^2. sec)] in its neutron flux trap where nuclear isotopes are produced. The ETTR-2 average thermal flux is 1.4×10^{14} [neutrons/(cm^2.sec)].

It is used for research in neutron physics, materials science, nuclear fuel research and development, radioisotopes production, neutron radiography, activation analysis, boron neutron capture cancer therapy and training in nuclear engineering and reactor operation.

The reactor is primarily used for the production of radioisotopes for medical, agricultural and industrial purposes, basic and applied physics and engineering research. Its main features are a high neutron flux, easy operation, enhanced reliability and safety in accordance with international standards.

The reactor features several beam tubes, hot cells, high pressure test loops and other research equipment. The reactor is located at the Inshass site of the Atomic Energy Authority, 60 km from Cairo, Egypt.

As a high flux material testing reactor, it could be used for research and development for an indigenous industry for the construction of other reactor designs, particularly for sea water desalting and fresh water production for planting the arid desert areas characteristic of the Middle East. Such a vision, repeatedly advocated and proposed by its scientists, is not being pursued for lack of available funds.

SUPPLIER

The Argentinian company Investigacion Aplicada (Invap) won the tender from the Egyptian Electricity and Energy Ministry in 1990 to construct the reactor, and in September 1992 the contract was signed. To manage the project, Invap established a branch office in Nasr City. The project was worth an estimated US$100 million to Invap and was an important international contract for Argentina.

Construction of the multipurpose reactor began in 1993 and was carried out jointly by Argentina and Egypt. In November 1997 the ETRR-2 achieved initial criticality, and President Hosni Mubarak and Argentine President Carlos Menem inaugurated the reactor in February 1998.

REACTOR BUILDING

The building is seismically qualified and features a massive block built of heavy concrete containing the reactor and auxiliary pools. A Neutron House is connected to the reactor building through a corridor designed to contain the neutron beams guide.

The reactor building has a four level design: basement, ground floor, first floor and second floor. The reactor hall is located on the second floor. The hall has the required height to refuel the fuel elements contained within the reactor pool. The building has three areas: reactor hall, restricted area and non restricted area. These three areas have been defined according to their radioactive contamination risk levels. They each have independent ventilation and circulation systems.

REACTOR POOL AND CORE

The reactor pool is cylindrical, has a diameter of 4.5 meters and is made of stainless steel. An auxiliary pool for fuel storage and radioactive materials handling is connected to it.

The core is configured in a 5 x 6 grid surrounded by a Zircaloy chimney, 10 meters below the pool surface. The core reactivity is controlled by six Ag-In-Cd alloy control plates. The plates are driven by mechanisms located beneath the reactor pool.

The core is cooled by demineralized light water in a forced convection upwards flow. After shutdown, the decay heat power is removed by natural convection of the reactor pool water.

Being a pool type rector, its core can be reconfigured. A typical core configuration has 24 to 30 fuel elements. The fuel elements are lodged in an aluminum core grid, and each fuel element is locked from below to counteract the force induced by the upwards coolant flow. The fuel elements have a square section (8 x 8 cm), and their active length is 80 cm. Each fuel element has 19 aluminum clad fuel plates with plate thickness of 1. 5 mm, with 2.7 mm wide coolant channels.

The fuel elements are of the low enriched uranium type with aluminum cladding with 19.75 percent enrichment in Uranium^{235}. Each fuel element has 19 flat plates. Beryllium neutron reflectors are positioned around the core outside the reactor chimney.

Figure 19. Interior views of the ETRR-2, open pool type 22 MWth research reactor at Inshass, Egypt.

IRRADIATION FACILITIES

Irradiation boxes or rabbits can be placed inside the core to irradiate samples for radioisotope production. Boxes are either inserted in the core or positioned within the reflector. Manipulation and distribution of irradiated items is carried out within the hot cells located at the top of the reactor pool. Additional labs and hot cells are also contemplated to study and manipulate irradiated materials. A large working facility for neutron beam experimentation is located around the block of the reactor. There is an auxiliary pool for spent fuel storage and for storing irradiated samples. A transference gate connects the reactor pool to the auxiliary pool.

The chimney that contains the core serves several purposes: it guides the coolant flow through the core, it houses four independent chambers for the secondary shutdown system and it protects the core in the event that the reactor pool is accidentally drained.

Outside the core there are several structures: cooling system piping, nuclear and non nuclear instrumentation, a graphite thermal column, one tangential beam tube, three radial beam tubes, one underwater neutron radiography system, two pneumatic transport system stations and two devices for high pressure with one loop for the fuel element rod and one for the fuel bundles.

COOLING SYSTEMS

The reactor is equipped with several cooling systems:

1. The primary cooling system: removes the power delivered at the core by an upwards forced circulation of the demineralized water. The temperature at the core inlet is about 40 ^{o}C, and the average temperature at the core outlet is 50 ^{o}C for a cooling flow of 2,000 [m^3/hr]. Outside the pool, the primary cooling piping splits into two loops. Each loop contains one heat exchanger and two parallel pumps with one in reserve, and has capacity to extract 50 percent of the reactor power.

2. The pool cooling system: removes the power delivered at the structures outside the core chimney including the reflectors and thermal column, by downwards forced circulation of water.

3. The secondary cooling system; cools the heat exchangers of the primary and pool cooling systems. The power is rejected to the environment through cooling towers. A water purification and distribution system with mixed resin beds ensures that the coolant is kept within the chemical and corrosion technical specifications. To reduce the radiation doses at the reactor pool surface a hot water layer is established by a special water purification and circulation system. All piping connections to the reactor tank are located above the core level and siphon effect breaker devices are provided to prevent the pool from draining in case of Loss of Coolant Accident (LOCA). Flapper valves are placed on the primary and pool circuits to allow natural circulation in case of electrical power loss or primary pumps loss.

WASTE MANAGEMENT

Irradiated fuel elements are stored in baskets in the auxiliary pool. The basket design and coolant conditions ensure that integrity of the fuel cladding is preserved.

A radioactive liquid waste management system classifies, collects and temporarily stores liquid waste originated during operation of the reactor. The system also includes a LOCA drainage system, with enough capacity to store all the water contained in the reactor and auxiliary pools.

Storage pools at the reactor basement permit activated liquid wastes to decay. Similar pools for storage of spent purification resins are provided. These pools have a double wall design and feature a leak detection device. Liquid wastes coming from the hot cells and radiochemical laboratories are stored in special tanks.

FUEL MANUFACTURING PILOT PLANT (FMPP)

This facility was constructed to supply the ETRR-2 reactor with the necessary nuclear fuel elements needed for its operation. The ETRR-2 uses Material Testing Reactor (MTR) style plate type with 19.75 percent U^{235} enrichment fuel elements.

Figure 20. Fuel Manufacturing Pilot Plant (FMPP), Egypt.

The fuel elements are fabricated at the Fuel Element Pilot Plant, which was designed and constructed by Invap under contract with Egypt Atomic Energy Authority (AEA) beginning on March 1, 1996, with preliminary acceptance May 9, 1998.

The fuel plant capacity is reportedly either 24 to 40 fuel elements per year, which is sufficient for the continuous operation of the reactor. The main processes performed at the plant include manufacturing of U_3O_8 yellow powder, structural components, fuel plates, fuel assembly and quality control tasks.

The starting material is imported non weapons grade uranium hexafluoride (UF_6) gas at 19.75 percent U^{235} enrichment. A consensus among experts is that an assigned value of less than 20 percent enrichment makes the fuel as proliferation resistant grade material. This is converted into U_3O_8 through treatment with ammonia and water in chemical reactors. It is followed by filtration and thermal treatment to get the appropriate particle size of U_3O_8.

The oxide powder is mixed with aluminum powder and cold-pressed under 4.5 [tons/cm^2] into compacts, which are then clad with sheets of aluminum 6061 alloy, and sealed by welding.

The processes are carried out in glove boxes. The clad fuel compacts are rolled, in four stages, into plates 1.5 mm in thickness. Each rolling pass is followed by a thermal annealing process. The plates are then straightened and assembled into fuel elements. Each element comprises 19 plates and contains about 2 kgs of uranium.

The plant has a workshop capable of producing all mechanical parts of the fuel element, and includes laboratories for characterization, inspection and quality control according to nuclear standards.

HOT LABORATORY AND WASTE MANAGEMENT CENTER (HLWMC)

This facility includes a small French supplied hot cell complex for radiochemistry, radioisotopes production and waste management research. The Hot Laboratory and Waste Management Center was established in 1980. The center aims at the development of expertise in the fields of the back end of the fuel cycle, radioactive waste treatment as well as radioisotope production for various medical and industrial applications. Major research and service facilities in the center include the low and Intermediate Level Liquid Waste Station, the Radioisotope Production Laboratories, and the Radwaste Disposal Site.

DISCUSSION

Egypt has adhered to the nuclear weapons Nonproliferation Treaty (NPT). Since 1974, it has supported the proposal to turn the Middle East into a nuclear-weapons free zone, calling on all countries in the region without exception to join the Nuclear Non Proliferation Treaty (NPT).

In April 1990, Egypt took the initiative of submitting a proposal to render the Middle East free of weapons of mass destruction. The 1991 Madrid Peace Conference established a multinational mechanism to work on making the Middle East a nuclear weapons free zone. This mechanism, however, was stalled.

Egypt hosted in April 1996 the conference for signing the declaration on rendering Africa a nuclear weapons free zone.

There are no reports of the existence of a nuclear weapons program in Egypt. Egypt's possessing nuclear weapons is not expected in the foreseeable future.

Serious work on developing a nuclear potential designated for use in power engineering, agriculture, medicine, biotechnology, and genetics is underway. Industrial

operation of four explored uranium deposits is studied, including the extraction and fabrication of uranium for subsequent use as fuel for nuclear power plants. There is no evidence of enrichment research activity.

Yet, there is unease and a strong feel of insecurity within the Egyptian population, particularly after some ill-advised remarks by an Israeli politician threatening to drown Egypt's Nile Delta, where the majority of its population dwells, by targeting its Aswan High dam with nuclear devices. The level of insecurity can be sensed from the remarks of a previous Egyptian Foreign Minister. Amr Mousa remarked at a gathering of Middle Eastern experts and journalists in Washington D. C.: "If there is a nuclear program in Israel, then we can blame nobody and no country if they want to acquire the same. This is an invitation to an arms race; a very, very serious and dangerous policy." He argued that Israel's failure to join the NPT means that the treaty is "Incapable of safeguarding Egypt" and has created "An extremely dangerous situation" in the Middle East. This makes the pursuit of a regional nonproliferation agreement associated with signing an overall peace agreement more urgent and worthwhile.

Egypt, which ratified the nuclear Non-Proliferation Treaty in 1981, advocates a nuclear weapons free Middle East and regularly criticizes Israel for its undeclared nuclear arsenal.

However, Egypt has also said it will not sign a voluntary additional protocol to the NPT that would allow more intrusive inspections, saying it could make it too dependent on other countries for nuclear energy needs.

8.19 IRAN'S THRESHOLD-LATENT NUCLEAR POWER PROGRAM

INTRODUCTION

The Islamic Republic of Iran (IRI) appears satisfied with the status of a threshold, virtual or latent nuclear power state, and does not possess nuclear weapons, according to IAEA inspections, and despite the media and political hysteria that is reminiscent of the prelude to the Iraq war. Iran has identified 16 sites for the construction of nuclear power plants including coastal areas of the Arabian-Persian Gulf, the Sea of Oman, the Khuzestan province and in coastal areas of the Caspian Sea, and desires to develop an independent closed nuclear fuel cycle. If it would have desired just a weapons program, it would have adopted solely a program producing cheaper Pu^{239} from dedicated production reactors instead of opting for the more expensive U^{235} enrichment path.

A contract has been signed for the construction of two nuclear power plants in cooperation with China. The two 1,000 MW plants will be Iran's first projects of this kind after the Bushehr nuclear plant built in collaboration with Russia. The plants will be built in the southeastern Iranian coasts of Makran, near the port city of Chabahar with a total budget of $10 billion. Iran also plans to build other small 100 MW plants, whose contracts are at initial stages of negotiation with China.

With the implementation of the agreement reached between Iran and the Group of 5+1: Russia, China, USA, UK, France and Germany, all nuclear-related sanctions against the Islamic Republic of Iran were terminated. European countries and Asian states including China, Japan, and South Korea are eager for cooperation with Iran in the nuclear field.

Iran has not reached "breakout capacity," or the ability to begin assembling a nuclear device if it is so desired militarily, or was forcefully pushed into withdrawing from the NPT treaty through threats or military intervention, and decided politically as in the case of the

DPRK. Convincing signs of the existence in the country of a coordinated integrated military nuclear program have not been detected.

Iran has around 11,000 centrifuges producing 3.5 percent uranium for its PWR power reactors program. About 700 centrifuges were producing 20-percent enriched uranium at the Fordo site intended for isotope-producing research reactors. This 20 percent level of enrichment is compliant with its NPT obligations which allow such a level of enrichment. It has set up around 350 more non-operational centrifuges at the site. While the reason for that could be purely technical, it could also be a signal that it is waiting for progress in the international negotiations on the relief from imposed sanctions.

The International Atomic Energy Agency has found traces of uranium enriched up to 27 percent at the Fordo enrichment plant in central Iran. That is still substantially below the 90-percent or higher level needed to make the fissile core of nuclear devices. But it is above Iran's highest-known enrichment grade, which is close to 20 percent and can be turned into weapons-grade material more quickly than the Iran's main stockpile, which can only be used for fuel at around 3-5 percent enrichment. The find did not necessarily mean that Iran was covertly raising its enrichment threshold toward weapons-grade level. The centrifuges that produce enriched uranium could have over-enriched at the start of operation as the technical staffs adjusted their output.

In 1979, Iran's spiritual leader, Ayatollah Ruhallah Al Khomeni categorically opposed the development of nuclear weaponry dismissing the nuclear program as a "suspicious Western innovation." Weapons of mass destruction are considered as "sinful" or "haram" in the Islamic Faith. In July 1988, Ayatollah Ruhallah Al Khomeini, with a heavy heart, agreed to a ceasefire with the war with Iraq, then supported by the Western powers. The decision was "more bitter than poison." At this point, the position of Iran on nuclear weapons may have been reconsidered. When the faith is faced with an existential threat, Islamic Shiite scholars advocate the adoption of the process of self-protection or "Takiya" to protect the faith and the Islamic Nation or "Ummah."

The present condition of industrial potential in Iran is such that without outside help, the IRI is unable to organize production of weapons grade nuclear materials. A consensus report of key USA intelligence agencies, the National Intelligence Estimate, concluded in December 2007 that a military-run program to develop nuclear weapons in Iran was halted in 2003. At a meeting with USA President George W. Bush in the White House Situation Room in 2007, the Director of Intelligence Mike McConnell presented the president and his advisors with the National Intelligence Estimate (NIE), a 140-page study by the nation's intelligence agencies. The key sentence reads: "We judge with high confidence that in Fall 2003, Tehran halted its nuclear weapons program." The NIE conclusion is not as clear-cut as it appears at first glance. It also states: "We also assess with moderate-to-high confidence that Tehran at a minimum is keeping open the option to develop nuclear weapons."

Iran ratified the NPT in 1970, and since February 1992 has allowed the IAEA to inspect any of its nuclear facilities. IAEA inspections have not revealed violations of the nuclear weapons Non Proliferation Treaty (NPT). In June 2008 the Iranian government declared that it had 6,000 centrifuges, up from 3,500 earlier in the year. It continues to enrich uranium insisting that it wants only to produce fuel for its nuclear power plants at a level of 3.7 percent according to the IAEA inspection reports. It has raised its enrichment goal to the NPT allowable level 20 percent level as a feed to a research reactor that it is constructing. Nuclear weapons production requires an enrichment level above 90 percent.

Russia delivered 82 tons of nuclear fuel to the one billion dollars Bushehr plant project under IAEA safeguards starting in December 2007, for startup operation in 2012. The construction of the plant has been delayed for several years due to the UN Security Council's intervention under USA pressure. The council has imposed three rounds of sanctions resolutions against Iran demanding that the country abandons all enrichment activities.

The Vienna-based IAEA has regularly conducted snap inspections of Iranian nuclear sites and has reported that all "declared nuclear material in Iran has been accounted for, and therefore such material is not diverted to prohibited activities." Iran may have installed its uranium enrichment centrifuges in a hurry, at the cost of the ability to operate them properly. Of the 8,610 centrifuges installed by 2010, only 3,700 were operational. The devices were constantly cracking under the high rotational stresses. It is possible that through industrial sabotage, collaborative efforts by the Siemens German Company and the Idaho National Laboratory in the USA, some of the centrifuges were made unusable through infiltration of the industrial controls software by the Stuxnet computer worm.

Suspicions linger that the IRI's nuclear program aims at acquiring a nuclear weapons capability, leading the UN to impose increasing economic sanctions. President George W. Bush suggested that the USA opposes "the knowledge" acquired by the Iranian nuclear program that positions Iran to become a threshold or latent nuclear power without actually acquiring nuclear weaponry. The USA demanded the termination of a fuel enrichment program and the construction of a heavy water reactor at Arak, under the threat of further sanctions, possibly followed by bombing of its nuclear facilities and regime change, repeating the Iraqi experience.

SAFEGUARDS CONCERNS

France, Germany, Britain, and other countries in the European Union have been negotiating with the Iranian leadership to give up its nuclear enrichment program in exchange for economic aid and trade benefits. Iran agreed to temporarily halt its Uranium^{235} enrichment program, which aims at manufacturing enriched fuel for its Bushehr and Darkhovin nuclear power plants. The Iranian facilities are legal under the Nuclear Non-Proliferation Treaty, (NPT) that Iran has ratified. Iran contended that it has no intention of acquiring nuclear weapons. The USA and Israel asserted the opposite.

The goal of talks, which were held in Brussels, Belgium was to persuade Iran to dismantle its nuclear program. Iran insists, in return, that it needs to see the economic sanctions imposed on it lifted. These sanctions prevent it from modernizing its oil industry and prevent it from acquiring needed oil production technology, heavy industrial equipment, armaments and a fleet of Airbus planes.

The Europeans invited the USA to join in these negotiations. However its neoconservative voices advanced the view that negotiations are a bad deal, that the only thing the Iranians understand is pressure, and that they also need to be "whacked."

Under the sanction regime imposed on Iran, the extent of its nuclear program is semi-transparent and its progress is not fully known. Western intelligence agencies believed in 2012 that Iran is at least three to five years away from a capability to independently produce nuclear warheads. Its work on a missile delivery system is far more advanced. This assessment is doubtful since Iran is known to have serious technical problems in the production of the uranium hexafluoride (UF_6) gas step in manufacturing nuclear fuel.

The European negotiations with Iran took the tone of a "lose-lose" situation without the lack of involvement of the USA. An offer by the USA to allow entry of Iran into the World Trade Organization (WTO), in return for dismantling its nuclear program, was promptly dismissed. The options that remained were referral to the Security Council to wrestle a resolution like in the case of Iraq, declaring Iran in violation of NPT and imposing further sanctions on it. The UN sanctions were to be followed by a planned preemption campaign.

ENRICHMENT ACTIVITIES

Iran has sought help from the IAEA, France, Russia and the USA for fuel rods for a research reactor in Tehran used for medical and industrial isotopes applications. Having not received the help it requested, it proceeded to enriching uranium for the reactor to the IAEA and NPT allowed level of 20 percent. In 2010, it produced 25 kgs of the 120 kgs that are needed. It is capable of producing around 5 kgs per month. But it actually produced 3 kgs that it immediately put into use as fuel for the reactor.

The then director of the International Atomic Energy Agency (IAEA), Egyptian lawyer and diplomat Mohammed El Baradei announced in 2004, after meeting Iranian officials on a visit to Tehran that Iran has agreed to a timetable for nuclear inspections. Mohammed El Baradei said that a team of inspectors would travel to Tehran to verify that all its uranium enrichment activities had stopped.

Similarly, Iran declared that it has stopped its uranium enrichment activities. The Islamic Republic of Iran, according to an agreement with the IAEA, has voluntarily stopped all its nuclear activities including enrichment of uranium, according to Gholamreza Aghazadeh, head of the Atomic Energy Organization of Iran.

In October 2003, Iran promised it would suspend uranium enrichment and accept snap inspections of its nuclear facilities. However, the IAEA has since complained that it has been frustrated by delays. On March 29, 2004, Iran announced that it had stopped building centrifuges for uranium enrichment. Gholamreza Aghazadeh suggested that Iran would voluntarily suspend its centrifuge work starting April 9, 2004.

The USA has accused Iran of pursuing a nuclear weapons program, and implicitly suggested that it would become the next target on its regime change schedule after Iraq. The same threat earlier compelled Lybia to abandon a failed program and to ship its acquired enrichment equipment to the USA and the UK. Iran countered that its nuclear ambitions are confined to generating electricity and closing a complete nuclear fuel cycle for the type of nuclear reactors it is building in collaboration with Russia. These are Pressurized Water Reactors (PWRs) requiring fuel enrichment to a low level around 3 to 5 percent. The USA suggests that Iran is an oil rich nation and does not need to develop nuclear energy, suggesting that Iran has sought the development of a nuclear weapons capability over a 19 years period, partly in secrecy under the sanctions regime and partly under the disguise of a civilian nuclear power program. This would be in violation of the nuclear Non-proliferation Treaty (NPT) that Iran has signed.

Earlier IAEA inspections uncovered small traces of 27 percent highly enriched uranium, suitable for a weapons program, and not for a civilian power program based on the PWR design. This discovery reinforced the USA's argument that Iran was illegally pursuing a nuclear weapons program. The Iranians replied that some of the equipment had been

imported, possibly from Pakistan, and may have been contaminated with trace impurities of highly enriched uranium.

Controversy aroused when parts found were compatible with the P2 centrifuge a more advanced design than the model Iran has acknowledged using. The machinery was found at the Doshan-Tappeh air base near Tehran.

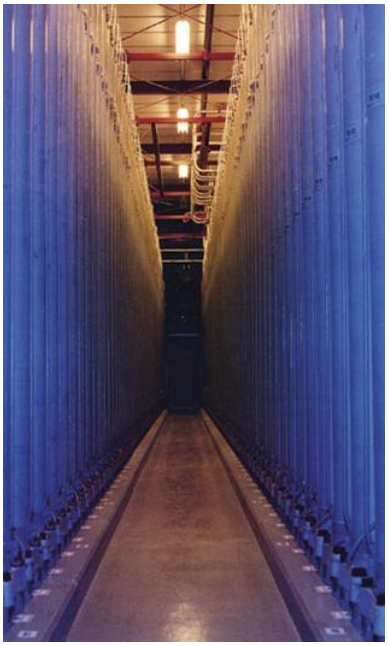


Figure 21. View of a centrifuges bank.

Gas centrifuges, can be used to enrich natural uranium in the U^{235} isotope. Centrifuges spin at supersonic speeds to separate fissile U^{235} from the fissionable U^{238} uranium isotope. A single gas centrifuge is shown in Fig. 19.

Figure 22. European-design Urenco single gas centrifuge.

The Iranian components matched drawings of equipment found in Libya and supplied by the clandestine network in Pakistan and Malaysia headed by Pakistani scientist Abdel Quadeer Khan. The P2 centrifuge is a Pakistani version of the advanced Western G2 design. Nuclear experts at the IAEA in Vienna said Abdel Quadeer Khan was selling designs for a basic centrifuge known as a G-1, which the Iranians had admitted to having, but that the new design was for a G-2, an improved and more efficient version. They said the IAEA was using revelations from Libya to track what Iran was doing, since they were being supplied by the same black market. Abdel Quadeer Khan obtained designs for these centrifuges from the British-Dutch German consortium Urenco while working in the Netherlands in the 1970s.

The G2 centrifuge design originated in Europe. Khan modified the design, now dubbed the P2 (for Pakistan 2) by nuclear experts, and allegedly sold it to Iran. Abdel Quadeer Khan allegedly supplied Lybia with three items: the G1/P1 centrifuge, the G2/P2 centrifuge, and a nuclear weapon design that lacked critical components. Iran has admitted to having the G1/P1 centrifuge and now apparently has the G2/P2 centrifuge supplied by the same source.

Iran has built a number of centrifuges based on the P1 design at the Natanz site. The reported number is about 214, which is much less than the cascades of thousands of centrifuge needed to attain the high the high enrichment needed for nuclear devices.

Another facility near the city of Al Qom was declared to the IAEA in September 2009, at a time when an agreement for sending enriched uranium fuel to European and Russian location for manufacturing was being negotiated.

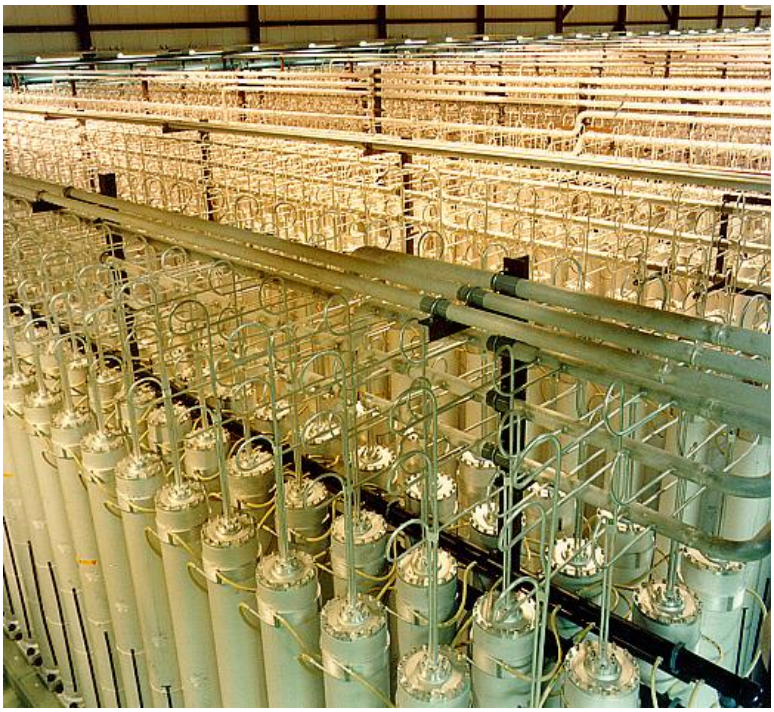


Figure 23. Urenco U^{235} enrichment gas centrifuges cascade.

Iran's acceptance of the stringent recent IAEA's safeguards inspections signals that it has changed its strategy from becoming an outright nuclear weapons state to becoming a

threshold or latent nuclear state such as Japan and Germany. Those states opted not to develop nuclear weapons programs, in favor of accumulating the knowledge and technology to develop nuclear weapons on a short notice, should their nations become threatened at a future date.

Figure 24. Iranian pilot plant centrifuges designs at Natanz, Iran.

Figure 25. Underground Missile bases in Iran. Source: Fars News Agency.

HEAVY WATER REACTOR AT ARAK

The International Atomic Energy Agency (IAEA) reported that it was informed by Iran of its intention to build a heavy water reactor in central Iran at Arak. The Heavy Water plant distillation towers at Arak, in the Iranian Islamic Republic (IRI) are shown in Fig. 26. The site already includes in addition to the projected heavy water reactor, a heavy water production plant and a nuclear fuel fabrication plant.

Cooling pumps of the Arak's IR-40 project has been mechanically sabotaged in March 2014 during their installation. Iran's nuclear facilities have previously been subject to an attack by a computer virus known as Stuxnet, developed by the USA and Israel to affect the Siemens German Company's widely used industrial control software. The virus was discovered in 2010 after it was used to impair the centrifuges at Iran's Natanz uranium enrichment facility. It was the first publicly known example of a cyber-attack on industrial machinery.

Figure 26. Heavy Water plant distillation towers at Arak, IRI.

Iran and Russia have been cooperating in the nuclear energy field. They began work building a reactor worth $800 million near the south-western port of Bushehr in 2002. The plant was scheduled to begin operating in June 2004 with the loading of nuclear fuel into the reactor set for December 2003. The project was further delayed with startup scheduled for 2009. A Russian firm took on the project which was started by the Siemens German firm in 1972 but abandoned it after the Iranian revolution in 1979. A photograph of the power plant at the port of Bushehr is shown in Fig. 27.

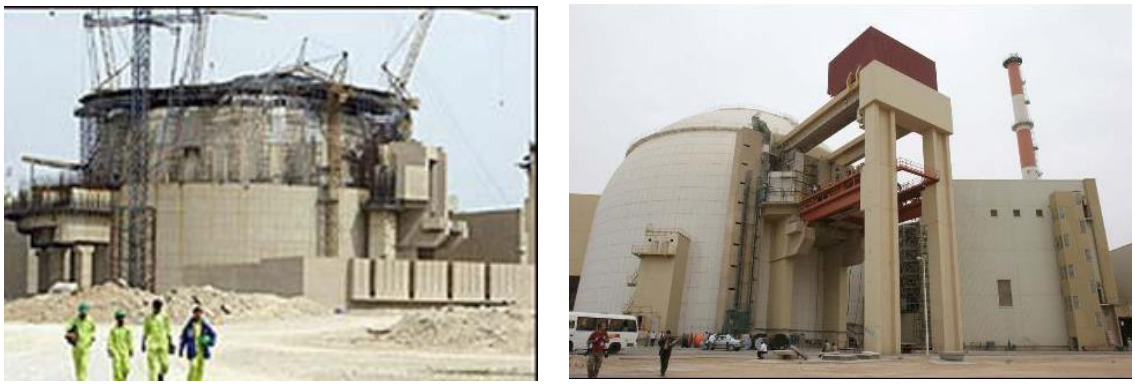


Figure 27. The Nuclear power plant at the port of Bushehr, Iran, under different stages of construction.

In addition to the Heavy Water reactor to be built at Arak, Iran has a research reactor at the Iranian nuclear agency headquarters.

Figure 28. Research reactor at Iranian Nuclear Agency Headquarters.

Iran asserts that the projected heavy water reactor will be used both for medical and industrial purposes for producing isotopes. USA sources suggest it can be used for producing weapons grade plutonium that cannot be produced in nuclear power plants.

Mark Gwozdecky, an IAEA spokesperson, says the agency was aware of Iran's intention to start building a heavy water reactor near Arak. In 2003, Iran declared to the agency its construction at Arak of a heavy water production plant and its planned construction of a heavy water reactor. Iran provided preliminary design information on the reactor along with preliminary information of the facility intended to manufacture the natural uranium fuel.

Mohamed Al Baradei, IAEA director mentioned in a report that his inspectors were surprised that the information given by Iran on the Arak reactor did not include information about planned hot cells for radioisotopes separation and production. Upon confronting the

Iranian authorities, they acknowledged that two hot cells had been planned, but neither the design nor detailed information was available.

Western diplomats say a heavy water reactor is a huge investment and there is no justification for such an outlay for civilian use. Israel, with France's help, built the similar heavy water Dimona reactor based on the (Eau Lourde 2, French for: Heavy Water 2) EL2 design, increased its power level by implementing initially-oversized thermal cooling equipment, and used it for its nuclear weapons development program.

The USA and other countries suspect that Iran's nuclear program is a cover for building nuclear weapons, which is denied by Iran.

PRE-EMPTION IN IRAN

At issue with Iran was its conversion of 37 metric tonnes of yellowcake into metallic uranium. About three tonnes of this amount already was fully converted into uranium hexafluoride. If fully processed, the 37 tonnes of yellowcake can theoretically yield more than 200 pounds of weapons-grade Highly Enriched Uranium (HEU), enough to make five crude nuclear devices.

It is expected that Iran would not yield to the USA's counter proliferation policy demand of dismantling its nuclear enrichment program. Following failure of the talks between Iran and the Europeans, Iran would be referred to the UN Security Council for sanctions and other measures. If any resolution imposing sanctions on Iran is vetoed by China or Russia, the United Nations would be conveniently blamed ahead of a rumored planned preemption campaign by the USA.

Pre-emption in this case precludes an outright invasion like in the case of Iraq. From 1991 to 2001, the Iraqi army had been softened by continuous aerial bombardment for about ten years, and was ineffective as a fighting force. This is not the case with the Iranian army which could offer stiff resistance to a land invasion.

The rivalries between the Sunnis, Shiites and Kurds were cleverly exploited in Iraq with an alliance with the 60 percent of the population Shiites and 20 percent Kurds against the 20 percent ruling Sunnis. This strategy would not be possible in Iran, with a uniform Shiite population which is supportive of its government.

The proposed new strategy in this case is for the USA and Israel to aerially bomb the Iranian air force, naval, military and nuclear facilities with the help of Special Forces and commando raids aiding the process by laser illumination and Global Position System identification of the targets, based on the experience from Afghanistan. Once "defanged," it is surmised that the Iranian government will fall under its own weight by public discontent from the defeat to a change into a secular friendly government. The advocacy for this preemptive campaign, like the case of Iraq, in spearheaded both the neoconservative and the extremist evangelical movements in the USA.

Secretary of Defense Donald Rumsfeld was rumored to have created a unit called the Strategic Support Branch to end "near total dependence" on the CIA for human intelligence. The unit deployed teams of case officers, linguists, interrogators and technical specialists with special operations forces. These defense intelligence missions were subject to fewer legal constraints and has operated in Iraq and Afghanistan, as well as other undisclosed locations such as Iran, Syria, Lebanon, Sudan, Somalia, Yemen, Indonesia, the Philippines and Georgia.

The Strategic Support Branch was established with "reprogrammed" funds and without explicit authority from the USA Congress.

The Israeli government is skeptical of the European approach to negotiations with Iran. Silvan Shalom, the Foreign Minister, said in an interview with a New Yorker journalist, "I don't like what's happening. We were encouraged at first when the Europeans got involved. For a long time, they thought it was just Israel's problem. But then they saw that the [Iranian] missiles themselves were longer range and could reach all of Europe, and they became very concerned. Their attitude has been to use the carrot and the stick—but all we see so far is the carrot." He added: "If they can't comply, Israel cannot live with Iran having a nuclear bomb."

Patrick Clawson, an Iran expert who is the deputy director of the Washington Institute for Near East Policy, articulated the view in an essay that force, or the threat of it, was a vital bargaining tool with Iran. Clawson wrote that if Europe wanted cooperation with the Bush Administration it "would do well to remind Iran that the military option remains on the table." He added that the argument that the European negotiations hinged on Washington looked like: "a preemptive excuse for the likely breakdown of the EU-Iranian talks." Clawson suggested that, if some kind of military action was inevitable, "it would be much more in Israel's interest—and Washington's—to take covert action. The style of this Administration is to use overwhelming force—'shock and awe.' But we get only one bite of the apple."

There are many military and diplomatic experts who dispute the notion that military action, on whatever scale, is the right approach. Shahram Chubin, an Iranian scholar who is the director of research at the Geneva Centre for Security Policy, suggested: "It's a fantasy to think that there's a good American or Israeli military option in Iran. The Israeli view is that this is an international problem. 'You do it,' they say to the West. 'Otherwise, our Air Force will take care of it.'" In 1981, the Israeli Air Force destroyed Iraq's Osirak reactor, setting its nuclear program back several years. But the situation now is both more complex and more dangerous, Chubin said. The Osirak bombing "drove the Iranian nuclear-weapons program underground, to hardened, dispersed sites," he said. "You can't be sure after an attack that you'll get away with it. The USA and Israel would not be certain whether all the sites had been hit, or how quickly they'd be rebuilt. Meanwhile, they'd be waiting for an Iranian counter-attack that could be military or terrorist or diplomatic. Iran has long range missiles and ties to Hezbollah, which has drones—you can't begin to think of what they'd do in response."

Chubin added that Iran could also renounce the Nuclear Non Proliferation Treaty. "It's better to have them cheating within the system," he said. "Otherwise, as victims, Iran will walk away from the treaty and inspections while the rest of the world watches the NPT unravel before their eyes."

The USA is reported to be conducting secret reconnaissance missions inside Iran at least since the summer of 2004 using operatives disguised as hikers or tourists. Much of the focus is on the accumulation of intelligence and targeting information on Iranian nuclear, chemical, and missile sites, both declared and suspected. The goal is to identify and isolate three dozen, and perhaps more, such targets that could be destroyed by precision strikes and short term commando raids. "The civilians in the Pentagon want to go into Iran and destroy as much of the military infrastructure as possible,"

Some of the missions involve extraordinary cooperation. An American commando task force has been set up in South Asia and was working closely with a group of Pakistani scientists and technicians who had dealt with Iranian counterparts. In 2003, the IAEA disclosed that Iran

had been secretly receiving nuclear technology from Pakistan for more than a decade, and had withheld that information from inspectors. The American task force, aided by the information from Pakistan, has been penetrating eastern Iran from Afghanistan in a hunt for underground installations. The task force members, or their locally recruited agents, secreted remote detection devices, known as sniffers, capable of sampling the atmosphere for radioactive emissions and other evidence of nuclear enrichment programs.

Getting such evidence was a pressing concern for the President George W. Bush's Administration. A former high level intelligence official stated: "They don't want to make any WMD intelligence mistakes, as in Iraq. The Republicans can't have two of those. There's no education in the second kick of a mule." The official added that the government of Pervez Musharraf, the Pakistani President, has won a high price for its cooperation: American assurance that Pakistan will not have to hand over Abdel Quadeer Khan, known as the father of Pakistan's nuclear bomb, to the IAEA or to any other international authorities for questioning. In addition Pakistan was promised permission to receive delivery of F-16 fighter planes that it had paid for a long time earlier.

For two decades, Abdel Quadeer Khan has been linked to a vast consortium of nuclear black market activities. In 2004, President Musharraf professed to be shocked when Abdel Quadeer Khan, in the face of overwhelming evidence, "confessed" to his activities. A few days later, President Musharraf pardoned him, and refused to allow the IAEA or American intelligence to interview him. Abdel Quadeer Khan lived under house arrest in a villa in Islamabad. "It's a deal—a trade-off," a former high-level intelligence official explained. "'Tell us what you know about Iran and we will let your Abdel Quadeer Khan guys go.' It is the neoconservatives' version of short-term gain at long-term cost. They wanted to prove that President George W. Bush is the anti-terrorism guy who can handle Iran and the nuclear threat, against the long-term goal of eliminating the black market for nuclear proliferation."

The agreement came at a time when President Musharraf had authorized the expansion of Pakistan's nuclear weapons arsenal. "Pakistan still needs parts and supplies, and needs to buy them in the clandestine market," the former diplomat said. "The USA. has done nothing to stop it."

There has also been close, and largely unacknowledged, cooperation with Israel. The government consultant with ties to the Pentagon said that the Defense Department civilians, under the leadership of Douglas Feith, have been working with Israeli planners and consultants to develop and refine potential nuclear, chemical weapons, and missile targets inside Iran. This included the targeted assassinations of key personnel in the Iranian nuclear program. After the Osirak bombing in Iraq, Iran situated many of its nuclear sites in remote areas of its eastern provinces, in an attempt to keep them out of striking range of other countries, especially Israel. Distance no longer lends such protection, however: Israel has acquired from Germany three submarines capable of launching cruise missiles and has equipped some of its aircraft with additional fuel tanks, putting Israeli F-16I fighters within the range of most Iranian targets.

The belief is that about three quarters of the potential targets can be destroyed from the air, and a quarter are too close to population centers, or buried too deep, to be targeted. Some suspicious sites need to be checked out by American or Israeli commando teams in on-the-ground surveillance before being targeted.

The Pentagon's contingency plans for a broader invasion of Iran were also being updated. Strategists at the headquarters of the USA Central Command, in Tampa, Florida, have been asked to revise the military's war plan, providing for a maximum ground and air

invasion of Iran. Updating the plan makes sense, whether or not the Administration intends to act, because the geopolitics of the region have changed dramatically. Previously, an American invasion force would have had to enter Iran by sea, by way of the Persian Gulf or the Gulf of Oman; now troops could move in on the ground, from Afghanistan or Iraq. Commando units and other assets could be introduced through new bases in the Central Asian republics.

It is possible that some of the American officials who talk about the need to eliminate Iran's nuclear infrastructure and personnel are doing so as part of a propaganda campaign aimed at pressuring Iran to give up its weapons planning. If so, the signals are not always clear. President George W. Bush, who depicted Iran as a member of the "axis of evil," at some point publicly emphasized the need for diplomacy to run its course. "We don't have much leverage with the Iranians right now," "Diplomacy must be the first choice, and always the first choice of an administration trying to solve an issue of nuclear armament. And we'll continue to press on diplomacy."

The USA administration believed that it will soon become clear that the Europeans' negotiated approach cannot succeed, and that at that time the Administration will act. "We're not dealing with a set of National Security Council option papers here," "They've already passed that wicket. It's not if we're going to do anything against Iran. They're doing it."

The immediate goals of the attacks would be to destroy, or at least temporarily derail, Iran's ability to go nuclear by targeting its manpower involved in the nuclear program of about 10,000 scientists, engineers and technicians. But there are other, equally purposeful, motives at work. The hawks in the Pentagon, in private discussions, have been urging a limited attack on Iran because they believe it could lead to a toppling of the religious leadership. "Within the soul of Iran there is a struggle between secular nationalists and reformers, on the one hand, and, on the other hand, the fundamentalist Islamic movement," "The minute the aura of invincibility which the mullahs enjoy is shattered, and with it the ability to hoodwink the West, the Iranian regime will collapse"—like the former Communist regimes in Romania, East Germany, and the Soviet Union.

On the other hand, "The idea that an American attack on Iran's nuclear facilities would produce a popular uprising is extremely ill informed," said Flynt Leverett, a Middle East scholar who worked on the National Security Council in President George W. Bush Administration. "You have to understand that the nuclear ambition in Iran is supported across the political spectrum, and Iranians will perceive attacks on these sites as attacks on their ambitions to be a major regional player and a modern nation that's technologically sophisticated." Leverett, who is a senior fellow at the Saban Center for Middle East Policy, at the Brookings Institution, warned that an American attack, if it takes place, "will produce an Iranian backlash against the United States and a rallying around the regime." Iran considers nuclear energy as a "Divine Blessing."

The former Secretary of Defense in the USA Donald Rumsfeld planned and lobbied for more than two years before getting Presidential authority, in a series of findings and executive orders, to use military commandos for covert operations. One of his first steps was bureaucratic: to shift control of an undercover unit, known then as the Gray Fox, from the Army to the Special Operations Command (Socom), in Tampa, Florida. Gray Fox was formally assigned to Socom in July 2002, at the instigation of Rumsfeld's office, which meant that the undercover unit would have a single commander for administration and operational deployment. Then, in the fall of 2004, Rumsfeld's ability to deploy the commandos expanded. According to a Pentagon consultant, an Execute Order on the Global War on Terrorism,

referred to throughout the government as Gwot, was issued at Rumsfeld's direction. The order specifically authorized the military "to find and finish" terrorist targets. It included a target list that cited Al Qaeda network members, Al Qaeda senior leadership, and other high-value targets. The order had been cleared throughout the national-security bureaucracy in Washington.

In late November, 2004, the Times magazine reported that President George W. Bush had set up an interagency group to study whether it "would best serve the nation" to give the Pentagon complete control over the CIA's own élite paramilitary unit, which has operated covertly in trouble spots around the world for decades.

IRAN'S NUCLEAR FACILITIES

Until 1979 Iran was implementing a program to use atomic energy for peaceful purposes which envisioned the construction of 23 Nuclear Power Stations. Today it is implementing a more moderate program which employs the following bodies:

Nuclear Research Center, Tehran

Since 1968 the center operated a research reactor with a nominal capacity of 5 MWth delivered from the USA and under IAEA safeguards with an installation for producing radioisotopes. There is a non-operational installation for producing yellow cake.

A research wing called Ebn e Qasem was added to the center's territory in October 1992; with a laser technology laboratory, that is involved in civilian applications.

The Nuclear Technology Center, Esfahan

A miniaturized neutron source reactor, MNSR research reactor with a capacity of 2.5 - 5 MWth was bought from the People Republic of China (PRC). It is devoted to peaceful nuclear research applications.

Nuclear Research Center for Agriculture and Medicine, Karaj

One building houses a dosimetry laboratory and an agricultural radiochemistry laboratory. A calutron or electromagnetic separator for extracting nonradioactive stable isotopes is housed there. It was bought from the PRC for the purpose of separating isotopes for targets which are to be irradiated with neutron streams in the 30 MeV cyclotron installed in 1995.

Nuclear Research Department, Yazd

It is affiliated with the local university and is engaged in geophysical research and the geology of a uranium deposit located 40 kilometers southeast of the populated point of Sagend, which in turn lies 165 kilometers northeast of the city of Yazd. The unexploited deposit is 100-150 square kilometers in area, and reserves are estimated at 3,000-4,000 tonnes of uranium oxide U_3O_8 equivalent. Its U^{235} content is very low at about 0.08 to 1.0 percent.

Moalem Kalaye Installation

This installation is located near Qazvin in the mountains north of Tehran. .It has been checked by IAEA inspectors and according to their official report in 1992 nuclear activities are not being carried out at this installation.

ACTIVE INDUSTRIAL SABOTAGE OF IRANIAN NUCLEAR PROGRAM

STUXNET COMPUTER WORM, CYBER WARFARE

The Stuxnet computer worm, according to the New York Times, was developed in cooperation with the Mossad and the IDF Unit 8200 in order to damage the Iranian centrifuges' control systems. The USA and its allies contend that the Bushehr nuclear power plant and the associated centrifuge enrichment program for its fuel is part of a civilian energy program that Iran is using as a cover for a covert military program to develop a nuclear weapons capability. Iran denies the accusation and invokes the articles of the NPT Treaty that allows the participating countries to close their nuclear fuel cycle and enrich their own fuel.

President George W. Bush explained the objections to the enrichment program in Iran that the real issue is the acquisition of "knowledge" about enrichment by Iran. The Western allies have been involved in an industrial sabotage effort to the Bushehr plant and the Iranian centrifuge enrichment program.

The Bushehr power plant is a 1,000 MWe light water reactor project dating back to 1974, when Iran's USA-supported Shah Mohammed Reza Pahlavi contracted with the German company Siemens to build the reactor. The company withdrew from the project after the 1979 Islamic Revolution toppled the shah.

In 1992, Iran signed a $1 billion deal with Russia to complete the stalled project and work began in 1995. Under the contract, the Bushehr power plant was originally scheduled to come on stream in July 1999 but the startup has been delayed repeatedly by construction and supply glitches. The Bushehr plant itself is not among the Western nations main worries because safeguards are in place to ensure that the spent fuel will be returned to Russia and it is an established technical and scientific fact that power reactor-grade Pu^{239} is unsuitable in the first place for weapons manufacture, since it is contaminated with the Pu^{240} isotope.

The startup of the facility has been delayed for years. Iran said when it began inserting its fuel rods in October 2010, that the power plant would begin producing electricity to Iranian cities by December 2010. But it pushed back the timing to February 2010, citing a "small leak" and other unspecified reasons.

In February 28, 2011, technicians had to unload fuel from the power plant because of a shattered cooling pump during its initial startup phase. In a cost-cutting measure, the Russians had to use parts delivered by the German Siemens Company that are 30 years old. The reactor core and the primary cooling system had to be thoroughly cleaned-up to remove metal shards resulting from the pump failure. Metallic shards as small as 3 mm in size can damage the reactor core's instrumentation and the zirconium cladding of the fuel. Larger sizes can obstruct the coolant channels in the core and the tubing in the steam generators.

The Bushehr plant is sited at the junction of three tectonic plates which was subject to a 4.6 Richter scale magnitude earthquake in 2002. The winds in the Persian Gulf blow from East to West in the direction of Saudi Arabia, Kuwait and the United Arab Emirates, raising concerns about air, land and water contamination in the case of an accident.

Russia, having built the reactor, has an incentive to ensure that it operates safely. Atomstroyexport JSC, the export arm of Rosatom, has nuclear power plants planned or under construction in 14 countries and plants are under construction in India and Bulgaria. A serious accident at Bushehr would bring a stop to its projects.

It has been implied that the computer worm known as Stuxnet might have caused more damage at the Bushehr plant than previously acknowledged. The Bushehr plant has international approval and is supervised by the UN's nuclear monitoring agency, the International Atomic Energy Agency, IAEA.

Computer experts believe the Stuxnet worm sabotage attack was a joint effort of Germany, the USA and Israel. It is suggested that it has infected other industrial control systems originated by the Siemens German Company throughout the world, and that it remains dormant until a message it sent to initiate it whenever needed through the global computer network, and some even suggest through wireless signals.

The control systems at Bushehr may have been penetrated by the malware or malicious software designed to infiltrate industrial computer control systems. Through a joint effort between the German Siemens Company and the Idaho National Engineering Laboratory, INEL, the Stuxnet computer worm was designed to spread into the control systems of Iran's centrifuge systems and send them into uncontrolled spinning leading to their destruction through excessive centrifugal forces without letting the operators know about the abnormal event.

The enrichment program was severely disrupted in 2010 by Stuxnet and the Iranian officials acknowledged the incident. They maintained that Stuxnet was only found on several laptop computer belonging to plant employees that were infected through the connection to memory sticks to computers used by plant operators on their trips to Europe and did not affect the facilities control systems.

EARLIER VERSION OF STUXNET

Researchers at the cyber security firm of Symantec discovered a version of the Stuxnet computer virus which predates by two years the cyber weapon that was used to sabotage Iran's main nuclear enrichment facilities.

The New York Times reported that President George W. Bush initiated the attacks, a program which has continued under President Barack Obama's administration. Symantec said it had found a string of code it called "Stuxnet 0.5," which dates back to 2005.

The virus targeted computers running Siemens software used in industrial control systems. All told, it infected software in at least 14 industrial sites in Iran and is thought to be the first known malware that targeted the controls at industrial facilities.

Symantec said that Stuxnet became more aggressive in subsequent incarnations. The original attack code was used to sabotage valves important to the uranium enrichment process with the intent of damaging the centrifuges and the system as a whole. But the virus did not go after the uranium enrichment centrifuges directly. Instead, it was created to shut off the valves that supplied uranium hexafluoride gas into the centrifuges. That, in turn, inflicted damage on the centrifuges and the uranium enrichment system. Later versions released in 2009 and 2010 were deployed for attacks on the Natanz enrichment facility.

The code in the 2005 version was complete and did not resemble a beta copy that escaped into the wild. The later evolution of Stuxnet indicated that the authors adjusted their

attack strategy in order to inflict a wider damage. It appears that it did not work according to their liking so they got more aggressive in the 1.x version.

DUQU REMOTE ACCESS TROJAN (RAT)

The Duqu virus appears to be similar to Stuxnet. It was named Duqu because it creates files with "DQ" in the prefix file identifier . The USA Department of Homeland Security (DHS) Industrial Control Systems Cyber Emergency Response Team issued a public alert in October 2011 about its occurrence.

Parts of Duqu are nearly identical to Stuxnet, but with a completely different purpose. Duqu is essentially the *precursor* to a future Stuxnet-like attack. Stuxnet is a malicious software that targets widely used industrial control systems built by the German firm Siemens. Cyber experts say its sophistication indicates that Stuxnet was produced on a collaborative basis by the USA, Germany and Israel. The new Duqu computer virus is designed to gather data from industrial control system manufacturers to make it easier to launch an attack *in the future* by capturing information including individual keystrokes. Through Duku, the attackers are looking for information such as design documents that could help them mount a future attack on an industrial control facility. Duqu does not contain any code related to industrial control systems and is primarily a Remote Access Trojan (RAT). The threat does not self-replicate.

In contrast to Stuxnet, Duqu has been found in only a handful of organizations. The program is designed to last 36 days and then *remove itself* from the system it infected. Like Stuxnet, Duqu tries to prove its authenticity by using a stolen digital certificate, this one apparently taken from a Taiwanese company. The computer security firm Symantec was able to revoke the security certificate after it was discovered stolen because the company owns the VeriSign authentication service that controls the certificate infrastructure.

Duqu shares a great deal of code with Stuxnet, but instead of being designed to sabotage an industrial control system, the new virus is designed to gain remote access capabilities. It is evident that the creators of Duqu had access to the source code of Stuxnet.

SANCTIONS AND INTERIM DEAL

A Sanction Regime was imposed on Iran including:

1. United Nations sanctions that started in 2006, when Iran was blocked from trading nuclear materials and equipment. The financial assets of some people and entities involved with the nuclear program were frozen. In the following years that list of people and entities grew and an arms embargo was imposed. In an action that has contributed to crippling the Iranian economy, financial institutions were practically forbidden from lending money to Iran.

2. The USA froze $12 billion in Iranian assets after the 1979 hostage crisis, but most assets were unblocked and the embargo was lifted in the early 1980s. In 1987, the USA banned the import of Iranian goods and services. Among other sanctions added later, Americans also cannot be involved with petroleum development in Iran and virtually all trade and investment by Americans in that country is prohibited. Even some foodstuffs and carpets of Iranian origin were included in the sanctions.

3. The European Union (EU) imposed an extensive list of sanctions against Iran. Among the most damaging are an oil embargo imposed in 2012 and the expulsion of Iranian banks from a global electronic banking system, which paralyzed Iran's ability to do international trade. The EU froze Iranian assets, banned trade of precious metals and the provision of new Iranian banknotes and coins.

In return for an Interim Deal on November 25, 2013, the USA has agreed to provide $6 billion to $7 billion in sanctions relief, American officials said. Of this, roughly $4.2 billion would be oil revenue that has been frozen in foreign banks.

Before the deal, Iran had enough uranium enriched at lower levels and centrifuges to produce fuel for a weapon or a "nuclear breakout", in between one and two months, according to a study by the Institute for Science and International Security, a Washington-based group that has been skeptical of Iran's peaceful claims.

According to the Interim Deal, Iran could keep its 11,000 usable centrifuges, but new centrifuges cannot be installed. The centrifuges already in place but not currently operating cannot be started up. The country has to stop enriching its 7,154 kgs of 3.5 enriched uranium beyond 5 percent and has to dilute or convert into oxide its 196 kgs of 20 percent enriched stockpile.

THWARTED ISRAELI ATTACK

A claim circulated on March 1st, 2015, after Israeli media outlet Arutz Sheva posted an article saying President Barack Obama thwarted a planned Israeli attack on Iran with a threat of military force. Arutz Sheva attributed the claim to Bethlehem-based news agency Ma'an, which itself cited a Kuwaiti newspaper report. According to Arutz Sheva:

> "According to Al-Jarida (The Newspaper), the (Benjamin) Netanyahu government took the decision to strike Iran some time in 2014 soon after Israel had discovered the United States and Iran had been involved in secret talks over Iran's nuclear program and were about to sign an agreement in that regard behind Israel's back.
>
> The report claimed that an unnamed Israeli minister who has good ties with the US administration revealed the attack plan to Secretary of State John Kerry, and that Obama then threatened to shoot down the Israeli jets before they could reach their targets in Iran.
>
> Al-Jarida quoted "well-placed" sources as saying that Netanyahu, along with Minister of Defense Moshe Yaalon, and then-Foreign Minister Avigdor Liberman, had decided to carry out airstrikes against Iran's nuclear program after consultations with top security commanders.
>
> According to the report, "Netanyahu and his commanders agreed after four nights of deliberations to task the Israeli army's chief of staff, Benny Gantz, to prepare a qualitative operation against Iran's nuclear program. In addition, Netanyahu and his ministers decided to do whatever they could do to thwart a possible agreement between Iran and the White House because such an agreement is, allegedly, a threat to Israel's security.

> The sources added that Gantz and his commanders prepared the requested plan and that Israeli fighter jets trained for several weeks in order to make sure the plans would work successfully. Israeli fighter jets reportedly even carried out experimental flights in Iran's airspace after they managed to break through radars."

The claim coincided with the Israeli prime minister's contentious visit to the USA and a scheduled address on March 3rd, 2015 to a joint session of Congress in which Prime Minister Benjamin Netanyahu would lay out his concerns about Iran's nuclear program, a speech that President Barack Obama administration has been flatly against.

FATEFUL CROSSROADS, "BREAK-OUT TIME," "DEADLY GAME OF THRONES," "HIDE AND CHEAT GAME," KICKING THE CAN DOWN THE ROAD, SABRE RATTLING

Israeli Prime Minister Benjamin Netanyahu seized the bully pulpit of Congress on Marh 3rd, 2015 to warn against trusting Iran to curb its nuclear ambitions, even as President Barack Obama's negotiators continued talking with the Iranians in hopes of closing a deal. He insisted he is privy to emerging details of a potential agreement. He said he meant no disrespect to President Barack Obama but is morally obliged to warn against any deal that might leave open the way to a nuclear-armed Iran. The speech came just two weeks ahead of a tight national election in Israel in which Netanyahu was fighting to hold onto his job.

In the address to America's leading pro-Israel lobby AIPAC on March 2nd, 2015 Benjamin Netanyahu said he would speak to Congress "about an Iranian regime that is threatening to destroy Israel, that is devouring country after country in the Middle East, that is exporting terror throughout the world and that is developing, as we speak, the capacity to make nuclear weapons — lots of them." He was suspicious of international efforts to reach a nuclear deal, fearing the U.S. and its negotiating partners will give Iran too many concessions.

Benjamin Netanyahu believed that preventing a nuclear-armed Iran, whilst Israel already possessed a nuclear arsenal, would be his crowning achievement — and that a bad deal would be a setback and far worse than no deal at all.

About 40 members of the House and more than a handful of senators skipped the speech, which many have labeled a partisan political stunt. Vice President Joe Biden, president of the Senate, also was not there, being on a trip to Central America and his seat on the dais was be filled by Sen. Orrin Hatch, president pro tempore.

A transcript of the "sabre rattling" speech reveals historical lack of trust and irreconcilable differences:

> "Thank you. Thank you. Speaker of the House John Boehner, President Pro Temp Senator Orrin Hatch, Senator Minority — Majority Leader Mitch McConnell, House Minority Leader Nancy Pelosi, and House Majority Leader Kevin McCarthy. I also want to acknowledge Senator, Democratic Leader Harry Reid. Harry, it's good to see you back on your feet. I guess it's true what they say, you can't keep a good man down.
>
> My friends, I'm deeply humbled by the opportunity to speak for a third time before the most important legislative body in the world, the U.S.

Congress. I want to thank you all for being here today. I know that my speech has been the subject of much controversy. I deeply regret that some perceive my being here as political. That was never my intention. I want to thank you, Democrats and Republicans, for your common support for Israel, year after year, decade after decade.

I know that no matter on which side of the aisle you sit, you stand with Israel. The remarkable alliance between Israel and the United States has always been above politics. It must always remain above politics. Because America and Israel, we share a common destiny, the destiny of promised lands that cherish freedom and offer hope. Israel is grateful for the support of American — of America's people and of America's presidents, from Harry Truman to Barack Obama. We appreciate all that President Obama has done for Israel. Now, some of that is widely known. Some of that is widely known, like strengthening security cooperation and intelligence sharing, opposing anti-Israel resolutions at the U.N.

Some of what the president has done for Israel is less well- known. I called him in 2010 when we had the Carmel forest fire, and he immediately agreed to respond to my request for urgent aid. In 2011, we had our embassy in Cairo under siege, and again, he provided vital assistance at the crucial moment. Or his support for more missile interceptors during our operation last summer when we took on Hamas terrorists. In each of those moments, I called the president, and he was there. And some of what the president has done for Israel might never be known, because it touches on some of the most sensitive and strategic issues that arise between an American president and an Israeli prime minister. But I know it, and I will always be grateful to President Obama for that support.

And Israel is grateful to you, the American Congress, for your support, for supporting us in so many ways, especially in generous military assistance and missile defense, including Iron Dome. Last summer, millions of Israelis were protected from thousands of Hamas rockets because this capital dome helped build our Iron Dome. Thank you, America. Thank you for everything you've done for Israel.

My friends, I've come here today because, as prime minister of Israel, I feel a profound obligation to speak to you about an issue that could well threaten the survival of my country and the future of my people: Iran's quest for nuclear weapons. We're an ancient people. In our nearly 4,000 years of history, many have tried repeatedly to destroy the Jewish people. Tomorrow night, on the Jewish holiday of Purim, we'll read the Book of Esther. We'll read of a powerful Persian viceroy named Haman, who plotted to destroy the Jewish people some 2,500 years ago. But a courageous Jewish woman, Queen Esther, exposed the plot and gave for the Jewish people the right to defend themselves against their enemies. The plot was foiled. Our people were saved.

Today the Jewish people face another attempt by yet another Persian potentate to destroy us. Iran's Supreme Leader Ayatollah Khamenei spews the oldest hatred, the oldest hatred of anti-Semitism with the newest

technology. He tweets that Israel must be annihilated — he tweets. You know, in Iran, there isn't exactly free Internet. But he tweets in English that Israel must be destroyed.

For those who believe that Iran threatens the Jewish state, but not the Jewish people, listen to Hassan Nasrallah, the leader of Hezbollah, Iran's chief terrorist proxy. He said: If all the Jews gather in Israel, it will save us the trouble of chasing them down around the world.

But Iran's regime is not merely a Jewish problem, any more than the Nazi regime was merely a Jewish problem. The 6 million Jews murdered by the Nazis were but a fraction of the 60 million people killed in World War II. So, too, Iran's regime poses a grave threat, not only to Israel, but also the peace of the entire world. To understand just how dangerous Iran would be with nuclear weapons, we must fully understand the nature of the regime.

The people of Iran are very talented people. They're heirs to one of the world's great civilizations. But in 1979, they were hijacked by religious zealots — religious zealots who imposed on them immediately a dark and brutal dictatorship. That year, the zealots drafted a constitution, a new one for Iran. It directed the revolutionary guards not only to protect Iran's borders, but also to fulfill the ideological mission of jihad. The regime's founder, Ayatollah Khomeini, exhorted his followers to "export the revolution throughout the world."

I'm standing here in Washington, D.C. and the difference is so stark. America's founding document promises life, liberty and the pursuit of happiness. Iran's founding document pledges death, tyranny, and the pursuit of jihad. And as states are collapsing across the Middle East, Iran is charging into the void to do just that.

Iran's goons in Gaza, its lackeys in Lebanon, its revolutionary guards on the Golan Heights are clutching Israel with three tentacles of terror. Backed by Iran, Assad is slaughtering Syrians. Backed by Iran, Shiite militias are rampaging through Iraq. Back by Iran, Houthis are seizing control of Yemen, threatening the strategic straits at the mouth of the Red Sea. Along with the Straits of Hormuz, that would give Iran a second choke-point on the world's oil supply.

Just last week, near Hormuz, Iran carried out a military exercise blowing up a mock U.S. aircraft carrier. That's just last week, while they're having nuclear talks with the United States. But unfortunately, for the last 36 years, Iran's attacks against the United States have been anything but mock. And the targets have been all too real. Iran took dozens of Americans hostage in Tehran, murdered hundreds of American soldiers, Marines, in Beirut, and was responsible for killing and maiming thousands of American service men and women in Iraq and Afghanistan.

Beyond the Middle East, Iran attacks America and its allies through its global terror network. It blew up the Jewish community center and the Israeli embassy in Buenos Aires. It helped Al Qaida bomb U.S. embassies

in Africa. It even attempted to assassinate the Saudi ambassador, right here in Washington, D.C.

In the Middle East, Iran now dominates four Arab capitals, Baghdad, Damascus, Beirut and Sanaa. And if Iran's aggression is left unchecked, more will surely follow. So, at a time when many hope that Iran will join the community of nations, Iran is busy gobbling up the nations. We must all stand together to stop Iran's march of conquest, subjugation and terror.

Now, two years ago, we were told to give President Rouhani and Foreign Minister Zarif a chance to bring change and moderation to Iran. Some change! Some moderation! Rouhani's government hangs gays, persecutes Christians, jails journalists and executes even more prisoners than before. Last year, the same Zarif who charms Western diplomats laid a wreath at the grave of Imad Mughniyeh. Imad Mughniyeh is the terrorist mastermind who spilled more American blood than any other terrorist besides Osama bin Laden. I'd like to see someone ask him a question about that.

Iran's regime is as radical as ever, its cries of "Death to America," that same America that it calls the "Great Satan," as loud as ever. Now, this shouldn't be surprising, because the ideology of Iran's revolutionary regime is deeply rooted in militant Islam, and that's why this regime will always be an enemy of America.

Don't be fooled. The battle between Iran and ISIS doesn't turn Iran into a friend of America. Iran and ISIS are competing for the crown of militant Islam. One calls itself the Islamic Republic. The other calls itself the Islamic State. Both want to impose a militant Islamic empire first on the region and then on the entire world. They just disagree among themselves who will be the ruler of that empire. In this deadly game of thrones, there's no place for America or for Israel, no peace for Christians, Jews or Muslims who don't share the Islamist medieval creed, no rights for women, no freedom for anyone. So when it comes to Iran and ISIS, the enemy of your enemy is your enemy.

The difference is that ISIS is armed with butcher knives, captured weapons and YouTube, whereas Iran could soon be armed with intercontinental ballistic missiles and nuclear bombs. We must always remember — I'll say it one more time — the greatest dangers facing our world is the marriage of militant Islam with nuclear weapons. To defeat ISIS and let Iran get nuclear weapons would be to win the battle, but lose the war. We can't let that happen.

But that, my friends, is exactly what could happen, if the deal now being negotiated is accepted by Iran. That deal will not prevent Iran from developing nuclear weapons. It would all but guarantee that Iran gets those weapons, lots of them. Let me explain why. While the final deal has not yet been signed, certain elements of any potential deal are now a matter of public record. You don't need intelligence agencies and secret information to know this. You can Google it.

Absent a dramatic change, we know for sure that any deal with Iran will include two major concessions to Iran. The first major concession would leave Iran with a vast nuclear infrastructure, providing it with a short break-out time to the bomb. Break-out time is the time it takes to amass enough weapons-grade uranium or plutonium for a nuclear bomb. According to the deal, not a single nuclear facility would be demolished. Thousands of centrifuges used to enrich uranium would be left spinning. Thousands more would be temporarily disconnected, but not destroyed. Because Iran's nuclear program would be left largely intact, Iran's break-out time would be very short — about a year by U.S. assessment, even shorter by Israel's. And if — if Iran's work on advanced centrifuges, faster and faster centrifuges, is not stopped, that break-out time could still be shorter, a lot shorter.

True, certain restrictions would be imposed on Iran's nuclear program and Iran's adherence to those restrictions would be supervised by international inspectors. But here's the problem. You see, inspectors document violations; they don't stop them. Inspectors knew when North Korea broke to the bomb, but that didn't stop anything. North Korea turned off the cameras, kicked out the inspectors. Within a few years, it got the bomb. Now, we're warned that within five years North Korea could have an arsenal of 100 nuclear bombs.

Like North Korea, Iran, too, has defied international inspectors. It's done that on at least three separate occasions — 2005, 2006, 2010. Like North Korea, Iran broke the locks, shut off the cameras. Now, I know this is not gonna come a shock — as a shock to any of you, but Iran not only defies inspectors, it also plays a pretty good game of hide-and-cheat with them. The U.N.'s nuclear watchdog agency, the IAEA, said again yesterday that Iran still refuses to come clean about its military nuclear program. Iran was also caught — caught twice, not once, twice — operating secret nuclear facilities in Natanz and Qom, facilities that inspectors didn't even know existed.

Right now, Iran could be hiding nuclear facilities that we don't know about, the U.S. and Israel. As the former head of inspections for the IAEA said in 2013, he said, "If there's no undeclared installation today in Iran, it will be the first time in 20 years that it doesn't have one." Iran has proven time and again that it cannot be trusted. And that's why the first major concession is a source of great concern. It leaves Iran with a vast nuclear infrastructure and relies on inspectors to prevent a breakout. That concession creates a real danger that Iran could get to the bomb by violating the deal.

But the second major concession creates an even greater danger that Iran could get to the bomb by keeping the deal. Because virtually all the restrictions on Iran's nuclear program will automatically expire in about a decade. Now, a decade may seem like a long time in political life, but it's the blink of an eye in the life of a nation. It's a blink of an eye in the life of our children. We all have a responsibility to consider what will happen when

Iran's nuclear capabilities are virtually unrestricted and all the sanctions will have been lifted. Iran would then be free to build a huge nuclear capacity that could product many, many nuclear bombs. Iran's Supreme Leader says that openly. He says, Iran plans to have 190,000 centrifuges, not 6,000 or even the 19,000 that Iran has today, but 10 times that amount — 190,000 centrifuges enriching uranium. With this massive capacity, Iran could make the fuel for an entire nuclear arsenal and this in a matter of weeks, once it makes that decision.

My long-time friend, John Kerry, Secretary of State, confirmed last week that Iran could legitimately possess that massive centrifuge capacity when the deal expires. Now I want you to think about that. The foremost sponsor of global terrorism could be weeks away from having enough enriched uranium for an entire arsenal of nuclear weapons and this with full international legitimacy. And by the way, if Iran's Intercontinental Ballistic Missile program is not part of the deal, and so far, Iran refuses to even put it on the negotiating table. Well, Iran could have the means to deliver that nuclear arsenal to the far-reach corners of the Earth, including to every part of the United States.

So you see, my friends, this deal has two major concessions: one, leaving Iran with a vast nuclear program and two, lifting the restrictions on that program in about a decade. That's why this deal is so bad. It doesn't block Iran's path to the bomb; it paves Iran's path to the bomb. So why would anyone make this deal? Because they hope that Iran will change for the better in the coming years, or they believe that the alternative to this deal is worse?

Well, I disagree. I don't believe that Iran's radical regime will change for the better after this deal. This regime has been in power for 36 years, and its voracious appetite for aggression grows with each passing year. This deal would wet appetite — would only wet Iran's appetite for more. Would Iran be less aggressive when sanctions are removed and its economy is stronger? If Iran is gobbling up four countries right now while it's under sanctions, how many more countries will Iran devour when sanctions are lifted? Would Iran fund less terrorism when it has mountains of cash with which to fund more terrorism? Why should Iran's radical regime change for the better when it can enjoy the best of both worlds: aggression abroad, prosperity at home?

This is a question that everyone asks in our region. Israel's neighbors — Iran's neighbors know that Iran will become even more aggressive and sponsor even more terrorism when its economy is unshackled and it's been given a clear path to the bomb. And many of these neighbors say they'll respond by racing to get nuclear weapons of their own. So this deal won't change Iran for the better; it will only change the Middle East for the worse. A deal that's supposed to prevent nuclear proliferation would instead spark a nuclear arms race in the most dangerous part of the planet. This deal won't be a farewell to arms. It would be a farewell to arms control. And the Middle East would soon be crisscrossed by nuclear

tripwires. A region where small skirmishes can trigger big wars would turn into a nuclear tinderbox.

If anyone thinks — if anyone thinks this deal kicks the can down the road, think again. When we get down that road, we'll face a much more dangerous Iran, a Middle East littered with nuclear bombs and a countdown to a potential nuclear nightmare.

Ladies and gentlemen, I've come here today to tell you we don't have to bet the security of the world on the hope that Iran will change for the better. We don't have to gamble with our future and with our children's future. We can insist that restrictions on Iran's nuclear program not be lifted for as long as Iran continues its aggression in the region and in the world. Before lifting those restrictions, the world should demand that Iran do three things. First, stop its aggression against its neighbors in the Middle East. Second… Second, stop supporting terrorism around the world. And third, stop threatening to annihilate my country, Israel, the one and only Jewish state. Thank you.

If the world powers are not prepared to insist that Iran change its behavior before a deal is signed, at the very least they should insist that Iran change its behavior before a deal expires. If Iran changes its behavior, the restrictions would be lifted. If Iran doesn't change its behavior, the restrictions should not be lifted. If Iran wants to be treated like a normal country, let it act like a normal country.

My friends, what about the argument that there's no alternative to this deal, that Iran's nuclear know-how cannot be erased, that its nuclear program is so advanced that the best we can do is delay the inevitable, which is essentially what the proposed deal seeks to do? Well, nuclear know-how without nuclear infrastructure doesn't get you very much. A racecar driver without a car can't drive. A pilot without a plan can't fly. Without thousands of centrifuges, tons of enriched uranium or heavy water facilities, Iran can't make nuclear weapons.

Iran's nuclear program can be rolled back well-beyond the current proposal by insisting on a better deal and keeping up the pressure on a very vulnerable regime, especially given the recent collapse in the price of oil.

Now, if Iran threatens to walk away from the table — and this often happens in a Persian bazaar — call their bluff. They'll be back, because they need the deal a lot more than you do. And by maintaining the pressure on Iran and on those who do business with Iran, you have the power to make them need it even more.

My friends, for over a year, we've been told that no deal is better than a bad deal. Well, this is a bad deal. It's a very bad deal. We're better off without it.

Now we're being told that the only alternative to this bad deal is war. That's just not true. The alternative to this bad deal is a much better deal. A better deal that doesn't leave Iran with a vast nuclear infrastructure and such a short break-out time. A better deal that keeps the restrictions on Iran's nuclear program in place until Iran's aggression ends. A better deal

that won't give Iran an easy path to the bomb. A better deal that Israel and its neighbors may not like, but with which we could live, literally. And no country … no country has a greater stake — no country has a greater stake than Israel in a good deal that peacefully removes this threat.

Ladies and gentlemen, history has placed us at a fateful crossroads. We must now choose between two paths. One path leads to a bad deal that will at best curtail Iran's nuclear ambitions for a while, but it will inexorably lead to a nuclear-armed Iran whose unbridled aggression will inevitably lead to war. The second path, however difficult, could lead to a much better deal that would prevent a nuclear-armed Iran, a nuclearized Middle East and the horrific consequences of both to all of humanity.

You don't have to read Robert Frost to know. You have to live life to know that the difficult path is usually the one less traveled, but it will make all the difference for the future of my country, the security of the Middle East and the peace of the world, the peace, we all desire. My friend, standing up to Iran is not easy. Standing up to dark and murderous regimes never is.

With us today is Holocaust survivor and Nobel Prize winner Elie Wiesel. Elie, your life and work inspires to give meaning to the words, "never again." And I wish I could promise you, Elie, that the lessons of history have been learned. I can only urge the leaders of the world not to repeat the mistakes of the past. Not to sacrifice the future for the present; not to ignore aggression in the hopes of gaining an illusory peace.

But I can guarantee you this, the days when the Jewish people remained passive in the face of genocidal enemies, those days are over. We are no longer scattered among the nations, powerless to defend ourselves. We restored our sovereignty in our ancient home. And the soldiers who defend our home have boundless courage. For the first time in 100 generations, we, the Jewish people, can defend ourselves.

This is why — this is why, as a prime minister of Israel, I can promise you one more thing: Even if Israel has to stand alone, Israel will stand. But I know that Israel does not stand alone. I know that America stands with Israel. I know that you stand with Israel. You stand with Israel, because you know that the story of Israel is not only the story of the Jewish people but of the human spirit that refuses again and again to succumb to history's horrors.

Facing me right up there in the gallery, overlooking all of us in this (inaudible) chamber is the image of Moses. Moses led our people from slavery to the gates of the Promised Land. And before the people of Israel entered the land of Israel, Moses gave us a message that has steeled our resolve for thousands of years. I leave you with his message today, (In Hebrew), "Be strong and resolute, neither fear nor dread them."

My friends, may Israel and America always stand together, strong and resolute. May we neither fear nor dread the challenges ahead. May we face the future with confidence, strength and hope. May God bless the state of Israel and may God bless the United States of America. Thank you.

Thank you very much. Thank you all. You're wonderful. Thank you, America. Thank you. Thank you."

THRESHOLD, LATENT NUCLEAR POWER

The P5+1: the USA, United Kingdom, France, Russia, China and Germany, were willing to stop short of demanding full disclosure of any secret weapon work by Tehran. They presented Iran with an accord that would restrict its nuclear program for roughly 10 years and cap its ability to produce fissile material for a weapon during that time to a minimum nine-month additional period, from three months. The deal would rely on Russia to convert Iran's current uranium stockpile into fuel rods for peaceful use. The proposal included an inspection regime that would attempt to follow the program's entire supply chain, from the mining of raw material to the syphoning of that material to various nuclear facilities across Iran.

The best of a worst-case scenario in the reached deal, is for inspections to go perfectly and for Iran to choose to abide by the deal for the entire decade-long period. The proposal shows that mass dismantlement of Iran's nuclear infrastructure, including the destruction, and not the mere warehousing, of its parts, was no longer on the table in the talks.

After the duration of the agreement, the most intrusive inspections will continue: the Additional Protocol, which encompasses very intrusive transparency, and which Iran has already said it will implement, will continue.

The sunset clause is troublesome to some experts, since it specifies that after this ten years period of time, Iran is basically free to do whatever it wants. The treatment of Iran as any other signatory of the Nuclear Non-Proliferation Treaty; 189 countries are members, including Iran; would allow Tehran to ultimately acquire an industrial-sized capability with "the breakout times to a nuclear weapon" effectively zero. Iran would be able to comply with international standards for a decade and then walk, not sneak, into the nuclear club. That leaves Iran as a "threshold nuclear power", because they have the capability to break out quickly if they wanted to. This also legitimizes Iran as a military nuclear power in the future.

DISCUSSION

The erection of a factory for processing uranium ore in Iran was completed by 2005. Some Western experts express doubts about the proposition that there are no grounds for the international community to put up obstacles to prevent Tehran from realizing its peaceful nuclear program even under IAEA control.

Various levels of official representatives of the USA and Israel have repeatedly declared they are certain that Iran is implementing a military nuclear program. Other experts suggest that the claim is questionable.

The essence of Iran's approach is to comply with the NPT and build its own peaceful nuclear program in such a way that if the appropriate political decision is made under conventional or nuclear threat, the expertise gained in the peaceful sphere in terms of specialists and equipment could be used to create nuclear weapons. The conclusion is reached according to the new counter proliferation policy that countries that supply nuclear technology should refrain from any cooperation with Iran in the nuclear field until there is sufficiently strong evidence of Iran's sincere and lasting adherence to exclusively peaceful use of nuclear

energy. Pressure is being applied by serious threats and plans of decapitating Iran's human and technological nuclear capability by both the USA and Israel.

The accusations against Iran are frequently based on unconfirmed information. A campaign in 1992-1994 in the foreign mass information media, especially American and West European media, over four nuclear warheads which Tehran supposedly bought from Kazakhstan is known. Meanwhile, as the leadership of the CIA has repeatedly stated, it has not recorded any sale of nuclear weapons from the republics of the former USSR.

8.20 AMBIGUOUS OPAQUE PROGRAM: ISRAEL'S NUCLEAR PROGRAM

INTRODUCTION

Israel's Middle Eastern neighbors are signatories to the nuclear non-proliferation treaty, but Israel is not. The only other nuclear nations that have not signed-on are Pakistan, India and China. North Korea withdrew from the treaty. Inspectors from the International Atomic Energy Agency (IAEA) are not allowed to visit Israel to determine whether nuclear material is entering or exiting the country, or any other aspects of weapons development. The only exception is for a small research reactor. Israel did not hesitate to use force to stop its neighbors from joining it in the nuclear club. In 1981, Israeli jets destroyed an Iraqi weapons facility and in 2007 Israeli fighters bombed a Syrian facility.

The Bulletin of the Atomic Scientists suggests that Israel possesses at least 80 operative nuclear warheads and has enough material to produce 190 more. Nuclear weapon proliferation experts Robert Norris and Hans Kristensen estimate that Israel halted its production of nuclear warheads back in 2004 "once it reached around 80 munitions."

A Die Welt article by Colonel Hans Rühle [16], former Head of Planning for Germany's Ministry of Defense: "Hat Deutschland Israels Atomwaffen finanziert?" it is suggested that German Chancellor Adenauer set up payment with Ben-Gurion to finance "development of the Negev" atomic-powered seawater desalination plant and a textile factory. This project never happened even though money kept going to Israel for "industrial and infrastructure projects" with 3.6 percent flat rate loans. It is suspected the money has been used for construction of the, initially 24 MWth then upgraded to 120-150 MWth, Dimona reactor and the acquisition of 385 tons of Natural Uranium, with the French delivering the reactor and reprocessing plant. An article in Israeli newspaper Haaretz, "How Dimona nuclear reactor was concealed from the U. S.", claims that German defense minister Franz Josef Strauss had made 500 million German marks available to finance the reactor at Dimona. Strauss used unauthorized "Reptilienfonds" or slush funds from the German government. "For these claims, there is still no evidence." the article states. "Germany made a wider reparation to Israel contributing to the protection of Israel against the dangers of the future," said Strauss who was forced to resign.

In May of 2014, an informant tied to the USA Department of Justice came up with a story implying that Germany has a decades-long secret protocol with Israel, whereby Germany funds weapons research and production for Israel and supplies that nation with submarines specially configured for launching nuclear cruise missiles, and Israel, in return, supplies Germany with nuclear devices.

Israeli Ambassador to the USA, and later Prime Minister Yitzhak Rabin informed the USA State Department that Israel's understanding of not to be the first in "introducing" nuclear weapons into the Middle East meant that they would be tested and publicly declared, while just possessing the weapons did not constitute "introducing" them.

The USA intelligence community estimates that Israel has 80-200 nuclear warheads with the capability of launching these warheads via a ballistic missiles called the Jericho 2 that has a range of about 1,500 kilometers, or 930 miles, on missiles on USA-supplied F-15s and F-16 fighter jets and on cruise missiles aboard diesel-powered submarines supplied by Germany.

In 1969, then Israeli Prime Minister Golda Meir presumably confessed to USA President Richard Nixon about the existence of the Israeli nuclear weapons capability. Documents from the Nixon Administration, declassified in 2006, revealed that President Richard Nixon agreed to allow Israel's leader Golda Meier to continue developing nuclear weapons as long as Israel did not acknowledge it or conduct public weapons tests, according to Avner Cohen, senior fellow at the Monterey Institute for International Studies and author of several books on Israel's nuclear program.

However, "Keen to ward off regional foes while avoiding an arms race, Israel maintains a 'strategic ambiguity' over a nuclear arsenal considered to be the world's sixth-largest, neither confirming nor denying it exists."

General Moshe Dayan after the Six Days War became Israeli minister of defense. When he visited Bonn in the fall of 1977, he told then Chancellor Helmut Schmidt about neighboring Egypt's fear "that Israel might use nuclear weapons." Dayan said that he understood the Egyptians' worries, and pointed out that in his opinion the use of the bomb against the Aswan dam to flood the valley of the Nile would have "devastating consequences." He did not even deny the existence of a nuclear weapon.

Mohammed El Baradei, as IAEA director, unsuccessfully pressed Israel to enter talks on regional disarmament, but it ruled out any change in its nuclear policy before there is peace with its neighbors.

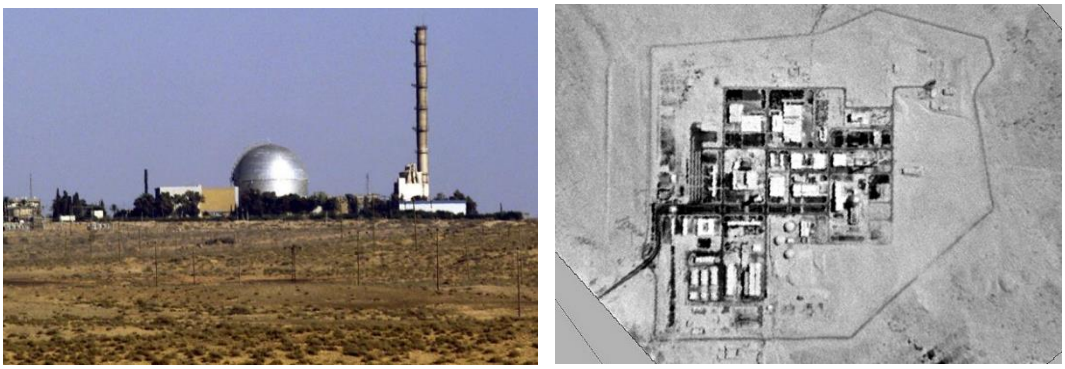


Figure 29. Nuclear Research Facility (NRF) Dimona Heavy water, natural uranium, 120-150 MWth plutonium production reactor, Negev Desert.

Figure 30. Spherical Pu pit, U tamper/reflector mockup photographs released to Britain's Sunday Times by Mordechai J. C. Vanunu, a dissident whistle-blower advocating a nuclear weapons free world, from Israel's nuclear program. He was a technician who worked at the Israeli Dimona nuclear complex. He revealed some details about Israel's nuclear weapons to the British press in 1986. He was then lured to Italy, kidnapped by Israeli agents, and was confined in the next 18 years in prison in solitary confinement.

OPERATION SAMSON

In the 1960s, Israel's Ben-Gurion had entrusted Shimon Peres with a highly sensitive project: Operation Samson, named after the Biblical figure who is supposed to have lived at the time when the Israelites were being oppressed by the Philistines. Samson was believed to be invincible, but he was also seen as a destructive figure. The goal of the operation was to

build an atomic bomb. The Israelis told their allies that they needed cheap nuclear energy for seawater desalination, and that they planned to use the water to make the Negev Desert bloom.

Israel's nuclear program has been ongoing since the early 1950′s, and became accelerated when then French President Charles De Gaulle provided Israel with the initially 26 MWth power Heavy Water moderated, natural Uranium-fueled, Al clad, Pu production reactor at Dimona in the Negev Desert. The primary heavy water D_2O moderator is cooled by a light water H_2O secondary circuit.

Both oversized coolant circuits were built into the original design with the apparent intention of later increasing the reactor power level, and hence its plutonium production capability. A not-so-well known characteristic of nuclear reactors is that they can be operated at any desired power level provided enough cooling is provided to extract the generated heat. The nominal power rated power of the reactor was originally 26 MWth in 1964 but its cooling circuits allowed its power to be scaled up to 70 MWth. The power may have been increased after 1976 to the 120-150 MWth level, and hence its Pu production capacity.

A chemical reprocessing of the irradiated fuel facility extending six floors underground was completed with French assistance in the mid-1960s. About 40-60 kilograms of fissile Pu could be processed annually. The facility is reported to have the capacity to produce Pu^{239} for five to ten nuclear devices per year. There is also a facility for the production of the Li^6 isotope to be irradiated into tritium for spiked sophisticated fission-fusion devices and possibly for LiD for thermonuclear devices.

General Charles DeGaulle's idea was that a nuclear-armed Israel could be a counterweight against Egypt's President Gamal Abdel Nasser support of Algeria in its Independence War from France. That period culminated into the Suez Canal 1967 Six Day War, in which a coalition of France, the UK and Israel attacked Egypt after its nationalization of the Suez Canal to provide funds needed for the construction of the Aswan High Dam.

The Nuclear Research Facility (NRF) came under a world spotlight in 1986 when the Dimona nuclear technician Mordechai Vanunu presented Britain's Sunday Times newspaper with 62 photographs that he took inside the secret facility. He alleged that it possessed a capability to produce 1.2 kg of Pu^{239} per week or 1.2 x 52 = 62.4 kg /year used for 4-12 nuclear devices per year. Lured from Britain to Italy by a female Israeli agent, Mordechai Vanunu was kidnapped on September 30, 1986 in Rome, Italy and secretly transferred back to Israel, where he was charged with treason and was sentenced for life in prison, later commuted to 18 years in jail. Regardless, Israel has never confirmed it has a nuclear weapons capability.

Israel has two nuclear reactors in operation: a plutonium production reactor at Dimona, and a research reactor at Sorek, between the cities of Tel Aviv and Ashdod. Israel's nuclear program has been described as being "in a state of ambiguity" for years due to a belief supported by the CIA in the USA of it possession of about 80-200 nuclear fission and fission-fusion spiked devices and their associated delivery vehicles as cruise missiles on diesel-powered submarines, ballistic missiles and aircraft.

The Carnegie Endowment for the Humanities suggests that: Israel "is believed to have deployed" 100 Jericho short-range and medium-range missiles that are nuclear-capable. In addition, it has nuclear devices that could be delivered from USA-made F-16 fighter jets and USA-built Harpoon missiles that could be launched from planes or ships. Israel's nuclear-capable, sea-launched cruise missiles were tested in May 2000 and might have a range of more than 900 nautical miles. With three German-built diesel engine propelled submarines, Israel could "have a deployment at sea of one nuclear-armed submarine at all times."

A special Unit 840 is reported to have been providing Highly Enriched Uranium (HEU) U^{235} since 1979 on a production scale. This may consist of a gas centrifuge facility for the production of highly enriched uranium for dual core devices. A laser isotope separation facility is reported to be used for the enrichment of uranium and to increase the proportion of the isotope Pu^{239} in the stockpiled Pu. A Depleted Uranium (DU) manufacturing plant turns it into tips of anti-armor shells as well as armor for military vehicles and tanks for local production and for export to Switzerland.

The country's military situation following the Egyptian and Syrian surprise attack during the 1973 Yom Kippur war was so desperate that Prime Minister Golda Meir ordered her Defense Minister Moshe Dayan to prepare several nuclear devices for combat and deliver them to air force units. Then, just before the warheads were to be armed, the tide turned. Israel's forces gained the upper hand on the battlefield, and the nuclear devices found their way back to their underground storage bunkers.

In the first hours of the 1991 Gulf War, an American satellite registered that Israel had responded to the bombardment by Iraqi Scud missiles by mobilizing its nuclear force. Israeli analysts had erroneously assumed that the Scuds would be armed with poison gas.

A conspiracy-theory report about the occurrence of an accident at the Dimona reactor around 1988-1990 circulated in the blogosphere media:

> "Perhaps because of a welding flaw or the use of copper coated welding rods rather than the required steel, a part of a fuel rod assembly broke free during a refueling while hot and running. The resulting flash-over nearly blew up the whole place. The French technicians brought in to advise the Israelis recommended pumping the containment full of concrete and welding the doors shut. The Israelis choose to proceed with a clean-up even though it exposed their workers to dangerous radiation. However, the reactor could not be fully repaired because the structure was so loaded with neutrons."

Another related bizarre conspiracy-theory story is described by Gordon Duff, a Marine combat veteran of the Vietnam War:

> "A US Army intelligence group working within Israel, headed by Colonel James Hanke, had discovered that the nuclear weapons facility at Dimona had suffered a catastrophic accident between 1988 and 1990. Israel's nuclear weapons inventory could no longer be maintained and expanded from domestically-produced weapons grade nuclear material.
>
> Israel's complicity was proven when, according to sources within the IAEA and Able Danger team, a combined operation between the US Department of Defense and Department of Justice, initially headed by FBI Agent John O'Neill, had discovered discrepancies in the US nuclear weapons inventory.
>
> It was not just 350 missing nuclear pits, but fully one third of America's post SALT II (Strategic Arms Limitations Talks) inventory. The records of our nuclear weapons inventory had been systematically

sabotaged to hide this attack on America's weapons inventory, or so they thought.

Able Danger established the presence of an espionage organization answerable personally to Benjamin Netanyahu. The organization included the then head of the Dept. of Energy, the AIPAC Lobby, the Anti-Defamation League, key commanders of America's nuclear forces, the Joint Special Operations command under VP Dick Cheney, and members of the International Atomic Energy Agency, a UN organization.

Their investigation had tied corrupt officials at the highest levels of the US Department of Energy to the leak of classified nuclear "pit" configuration data and altering records of decommissioned nuclear weapons. Three hundred fifty W54 nuclear warheads were missing from inventories at the Pantex nuclear facility in Amarillo, Texas.

An investigation team led by Roland Carnaby, the CIA agent killed in a mysterious shooting in 2005, discovered that the missing "pits" had been stolen and taken to a nearby meat packing facility, where they were sorted using leaked DOE data in order to allow them to be safely melted down and reconfigured to replace the depleted Israeli stockpile.

Investigators from the DOE and IAEA confirm that weapons from this stolen stockpile were used in the demolition of the World Trade Center on 9/11/2001 — nuclear "pits" originally produced at the Hanford DOE facility in Washington. This information was part of the highly classified 2003 9/11 report given to congressional and White House leaders only, and later leaked by Russian Naval Intelligence, believed to have been among a trove of documents received from Edward Snowden.

In March 2013, a group of business executives meeting in Tulsa, Oklahoma, received a briefing on the 2003 "Nuclear 9/11" report as part of a "Threat Assessment Conference" where Veterans Today staff were among the presenters. The briefing also included a version of the now famous "Shrimpton nuclear scare" story, confirming the recovery of a missing nuclear weapon somewhere in the EU in 2012.

Leaked documents on the Able Danger investigation, received in September 2014 revealed that most investigation functions had ended in 1998 at the request of President Clinton, then under impeachment threat tied to his relationship with Monica Lewinsky, in a reputed Mossad "honey trap."

Investigative chief and FBI Special Agent John O'Neill left government service and pursued leads until his untimely death during the 9/11 "event". According to a 2005 report, thirty-five of the Able Danger investigators were also killed on 9/11, when the Pentagon office they were called to for an emergency briefing by the Chairman of the Joint Chiefs of Staff, General Myer, (who did not show up for the meeting and did not die, a lucky day for him) was demolished by an airliner, though little or no physical evidence of such a happenstance exists.

After 1998, the FBI investigation team was divided into two units under the supervision of Special Agent Mike Dick; one team was tracking

arms dealer Victor Bout, and was coordinated with IAEA investigators. The second unit investigated the theft of the "pit matching" documents and centered on the American Israeli Public Affairs Committee, AIPAC, eventually leading to the arrest of leaders of that group.

Charges were later dropped when the White House refused to turn over required evidence, and Attorney General John Ashcroft, one of the key planners of the CIA torture program, ordered an end to the investigation. Witness statements included testimony indicating White House officials had passed key nuclear secrets to Israeli embassy representatives at a Washington cocktail party in the presence of both Paul Wolfowitz and Condoleezza Rice.

The second unit, assisted by CIA agent Roland Carnaby, followed the theft of nuclear weapons from the sorting facility near Amarillo to a fertilizer plant outside Waco, Texas. In April 2014, as Snowden reputedly handed Able Danger documents to Russian intelligence, the plant where the nuclear weapons were stored, the West Fertilizer Plant, was destroyed in a massive explosion, killing 15.

The entire operation was run by Victor Bout, working directly for the office of the Vice President of the United States, according to private sources with access to the Plame/Siddiqui investigation.

The nuclear pits had been moved by truck to the Port of Houston, where they had been placed on ships and transferred to the Canary Islands and later to Mauritania. The weapons were, according to Able Danger documents, stored at a mine controlled by former South African Prime Minister De Klerk inside a region controlled by the rebel Polisario Front. From there, weapons were sold to Taiwan, South Korea, Saudi Arabia and other nations, along with restocking Israel.

Other weapons were set aside for use by intelligence agencies. IAEA sources report weapons from Hanford/Pantex were used for the Oklahoma City bombing in 1995, at the Khobar Towers in Saudi Arabia in 1996, the destruction of the World Trade Center in 2001, and the Bali bombing in 2005. The IAEA confirms up to 50 nuclear weapons have been used surreptitiously since 1945, often in configurations that minimize blast and radiation."

DOLPHIN CLASS SUBMARINE-LAUNCHED CRUISE MISSILES ARSENAL

Figure 31. Dolphin class submarines fleet with nuclear-tipped cruise missiles under construction at Kiel, Germany and at the port of Haifa, Israel. The modern submarines are quiet and have a cruising range of 4,500 nautical miles. Source: DPA.

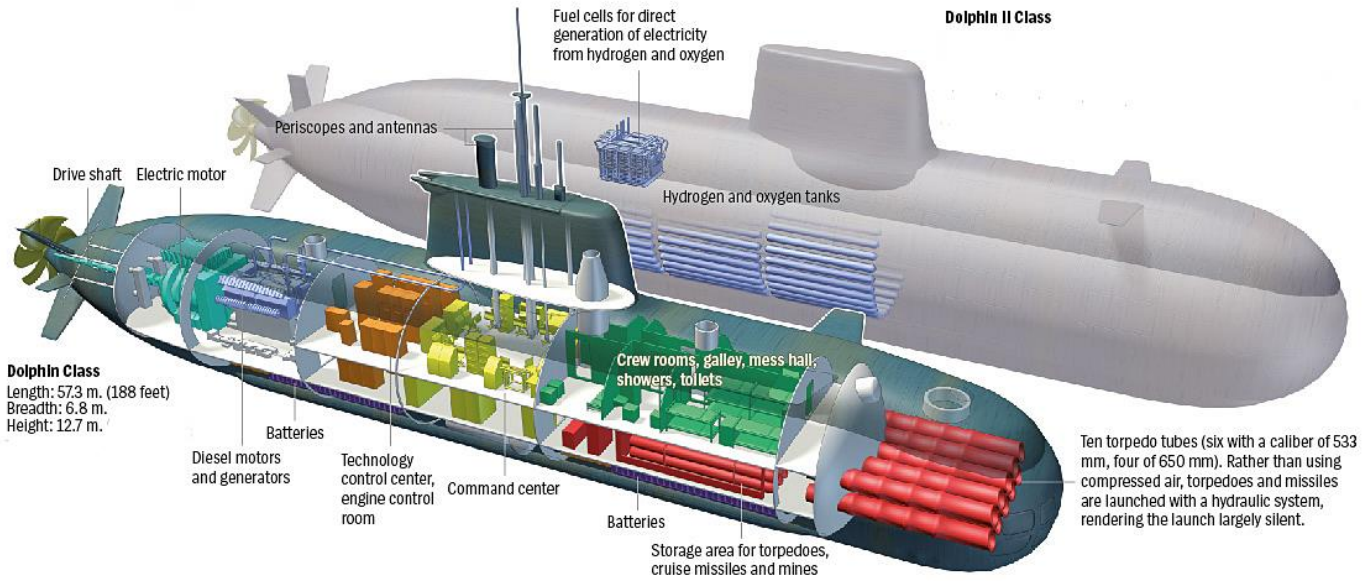


Figure 32. The Dolphin II class of submarines is equipped with modern diesel-electric propulsion and uses silent fuel cells using hydrogen and oxygen for electrical propulsion allowing it to remain submerged for several weeks. The Dolphin I and II use silent hydraulic instead of compressed air torpedo and cruise missile launching systems. Decks 2 and 3 are where the nuclear devices would be stored. Source: DPA.

A German shipyard at the northern city of Kiel, Germany, built three submarines for Israel, and three more were planned by 2017 to be armed with nuclear-tipped cruise missiles. The German government has known about Israel's nuclear weapons program for decades.

Israel is equipping the submarines that are one third paid-for by the German government with nuclear-tipped cruise missiles. The missiles can be launched using a previously secret hydraulic ejection system. Israeli Defense Minister Ehud Barak stated that the Germans should be "proud that they have secured the existence of the state of Israel for many years."

Unlike conventional submarines, the Dolphins do not have torpedo tubes with a 533-millimeter diameter in the steel bow. The Howaldtswerke-Deutsche Werft (HDW) Company engineers designed four additional tubes that are 650 millimeters in diameter; a special design not found in any other submarine in the Western world. In a classified 2006 memo, the German government argued that the tubes are an "option for the transfer of special forces and the pressure-free stowage of their equipment" such as combat swimmers, who can be released through the narrow shaft for secret operations. The same explanation is given by Israel.

In the USA it is recognized that the wider shafts are intended for ballistic missiles armed with nuclear warheads. This suspicion was fueled by an Israeli request for USA Tomahawk cruise missiles in 2000. The conventional-explosives missiles have a range of over 600 kilometers, while the nuclear versions can even fly about 2,500 kilometers. The USA

rejected the request twice. This is why the Israelis still rely on ballistic missiles of their own design, such as the Popeye Turbo. Their use as nuclear delivery missiles is readily possible in the Dolphin submarines.

The HDW Company equipped the Israeli submarines with a newly-developed hydraulic ejection system instead of a compressed air ejection system. In this process, water is compressed with the help of a hydraulic ram. The resulting pressure is then used to catapult the weapon out of the shaft. The resulting momentum is limited, however, and it is not enough to eject a three to five-ton midrange missile out of the ship. This is not the case with lighter-weight missiles weighing up to 1.5 tons, like the Popeye Turbo or the American Tomahawk, which weighs just in the 1.5 tons range, including the nuclear warhead. With the expanded tubes, the Israelis wanted to keep open the option of future, more voluminous developments.

Israel has a policy of not commenting officially on its nuclear weapons program. Documents from the archives of the German Foreign Ministry reveal that the German government has known about the program since 1961. The last discussion for which there is evidence took place in 1977, when then German Chancellor Helmut Schmidt spoke to then-Israeli Foreign Minister Moshe Dayan about the topic.

The Dolphin II version submarines use fuel cells and have been designed specifically for use in the shallow waters of the Persian Gulf. Their cruise missiles could easily reach any target in Iran. The submarines provide an effective deterrent as a second-strike capability. The electronics were provided by Siemens and Atlas, a Bremen-based electronics company. Israeli defense technology company Rafael built the missiles for the nuclear weapons involving the development of cruise missiles of the Popeye Turbo Submarine Launched Cruise Missile (SLCM) type, which are supposed to have a range of around 1,500 kilometers or 940 miles and which could reach Iran with a warhead weighing up to 200 kilograms or 440 pounds. The Israeli cruise missiles development involved a test conducted off the coast of Sri Lanka.

The Dolphin II submarine comes equipped with a technological revolution: fuel cell propulsion that allows the ships to work even more quietly and for longer periods of time. Earlier Dolphin class submarines had to surface every couple of days to start up the diesel engine and charge their batteries for continued underwater travel. The new propulsion system, which does not require these surface breaks, vastly improves the submarines' possible applications. They are able to travel underwater at least four times as far as the previous Dolphin I, their fuel cells allowing them to stay below the surface at least 18 days at a time. The whole Persian Gulf area and Europe are within the operational range of the Israeli fleet.

In the Haifa harbor, the Tekumah's submarine diesel engines growl loudly enough that conversation is just barely possible. Out at sea, though, when the submarine is in true operation and all systems are functioning cleanly, "you can barely hear the motors at all," says the naval officer in charge of the boat. The Tekumah can plow through the water at speeds of 20 knots and higher, “a sleek and powerful predator.” But the real skill, says the officer, comes in the low-speed littoral operations carried out near enemy coasts, places where the Israeli Navy works covertly, where the Tekumah and the other submarines have to approach their targets with great care gathering signal intelligence.

The submarines were built by the German shipyard HDW in Kiel. Three submarines have already been delivered to Israel by 2012, and three more by 2017. Israel is considering ordering 3 more submarines from Germany. Germany financed one-third of the cost of the sixth submarine, around €135 million or $168 million, and allowing Israel to defer its payment until 2015. German Chancellor Angela Merkel unsuccessfully attempted to associate the

delivery of the sixth submarine to a request that Israel stop its expansionist settlement policy and allow the completion of a sewage treatment plant in the Gaza Strip, which is partially financed by German aid funds.

A reaction to Israel's acquisition of the Dolphin Class of submarines is a German sale of two export versions 209 class submarines to Egypt. These are built by the HDW and Nordseewerke companies. The Type 209 diesel-electric attack submarine was developed for the export market by Howaldtswerke-Deutsche Werft of Germany. Five variants of the class (209/1100, 209/1200, 209/1300, 209/1400 and 209/1500) have been exported to 13 countries, with more than 60 submarines being built and commissioned.

The Egyptian Navy is equipped with obsolete four Romeo class submarines. Negotiations for ex-German Navy Type 206A boats were reported to have occurred in December 2004. Egypt has over 2,000 km of coastline on the Mediterranean Sea and the Red Sea and enforces a joint Egyptian-Israeli blockade of the Gaza strip.

Figure 33. The exclusively-for-export Type 209/1400 class German attack submarine delivered to South Africa, 2005, is not operated by the German Navy (top left). The 3-5 Dolphin class submarines used by the Israeli Navy are based on the Type 209, but are highly modified and enlarged. Flotilla of 5 fuel-cell submarines reportedly armed with nuclear tipped cruise missiles (top right, bottom).

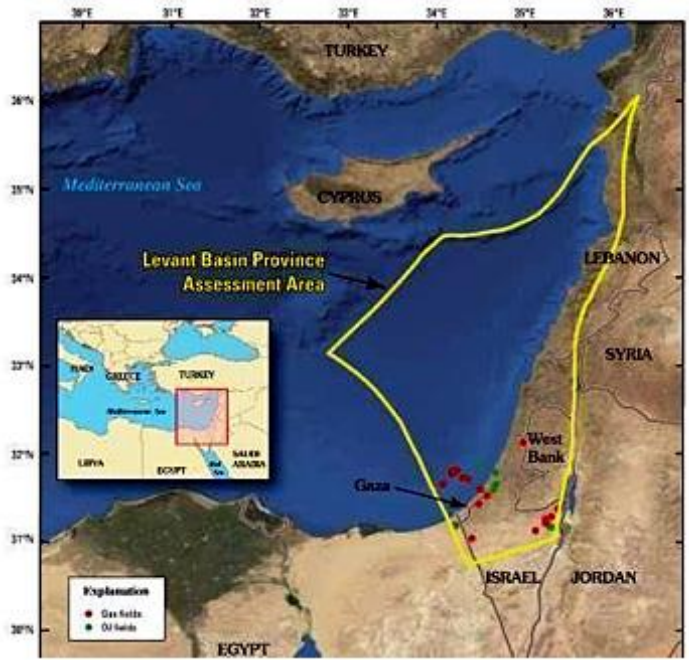


Figure 34. “Levant Basin Province” Hydrocarbons offshore and onshore area. Oil and gas wells are already identified East of the Dead Sea and off the coast of Gaza. The area is part of the ancient Tethys Sea. It can provide Israel with its energy needs for 150 years and allow for exports of Liquefied Natural Gas LNG). Noble Energy signed a deal to supply gas to Egypt via the same pipeline that supplied Israel with Egyptian gas for years.

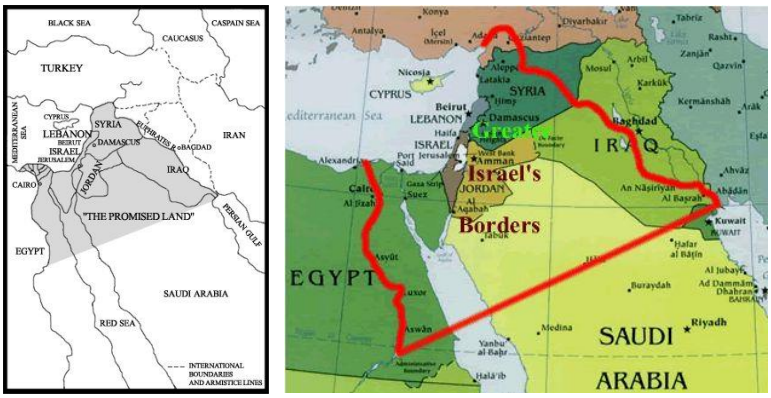


Figure 35 Maps depicting “Greater Israel’s Borders” and “The Promised Land” extent from the Nile River to the Euphrates River. According to a peaceful humanistic interpretation, the peoples of the region would concurrently prosper and thrive within the area with coexistence, tolerance and open borders for trade, commerce and tourism. According to an extreme interpretation, it represents extended boundaries exploiting the religious confessional and ethnic differences of the populations of the region.

Figure 36. An expanded version of the Promised Land encompasses Sudan and the whole Arab Peninsula. According to a peaceful humanistic interpretation, the peoples of the region would concurrently prosper and thrive within the area with coexistence, tolerance and open borders for trade, commerce and tourism. According to an extreme interpretation, it represents extended boundaries exploiting the religious confessional and ethnic differences of the populations of the region.

FUTURE CONFLICT PROSPECTS

The seeds of future conflict are sown in the Middle East in the form of territorial claims, particularly concerning the issue of what constitutes Greater Israel, the Promised Land and Eretz Israel. According to a peaceful humanistic interpretation, the peoples of the region would concurrently prosper and thrive within the area with coexistence, tolerance and open borders for trade, commerce and tourism. According to an extreme interpretation, it represents extended boundaries exploiting the religious confessional and ethnic differences of the populations of the region.

PEACEFUL ALTERNATIVES

Presently, Israel is turning its head to the consideration of peaceful electrical nuclear power production and fresh water desalination in addition to renewable solar and wind energy sources. In a conference at Israel's southern city of Eilat on the Red Sea, Yiftach Ron-Tal, Chairman of the Israel Electric Company, addressed the conference attendees that: "Israel should build a nuclear power station, and it must be made to be safe." The proposed plant would be built in Israel's northern Negev Desert region.

As part of the ancient Tethys Sea, Israel is also turning its attention for satisfying its future energy needs to a large hydrocarbons offshore and onshore prospect, particularly natural gas, in "The Levant Basin Province" of its Mediterranean coast as well as the coasts of Cyprus, Lebanon, Syria, Gaza and Egypt. Prospecting is actively carried out by the Noble Oil Company which identified natural gas and oil prospects. There is a possibility that Israel could become a major exporter of natural gas in pipelines under the Mediterranean Sea or as Liquefied Natural Gas (LNG) to the EU market, in addition to satisfying its own energy needs for over 150 years.

MIDDLE EASTERN NUCLEAR WEAPONS FREE ZONE

The United Nations General Assembly adopted on December 2nd, 2014 an Arab-backed resolution urging Israel to join the Non-Proliferation Treaty (NPT). The assembly approved of the resolution in a 161-5 vote, with 18 countries abstaining. The USA and Canada were among the countries that opposed the resolution.

The resolution urges Israel to join the NPT and put its nuclear facilities under the safeguard of the UN's International Atomic Energy Agency. Backed by 18 Arab countries, it expresses deep concern over Israel's nuclear capabilities. Israel, which is widely believed to be the only possessor of nuclear arms in the Middle East, reportedly maintains between 200 and 400 atomic warheads. Israel has never allowed any inspection of its nuclear installations.

Hans Blix, the former head of the IAEA, said that he is convinced Israel possesses nuclear weapons. He demanded that Israel join the NPT, saying that its refusal to sign international nuclear treaties and its deliberate ambiguity policy with regards to its nuclear program are because of support from the USA.

8.20 JORDAN'S NUCLEAR PROGRAM

Jordan plans to build its first nuclear power plant to produce power by 2020. It also needs fresh water supplies. By 2020 the current fresh water resources will not be sufficient to cover 1/3 of Jordan's needs. Jordan's nuclear efforts are driven by its dependence on oil and gas imports for energy generation and a domestic energy shortfall estimated to reach 6.8 GWs by 2030. A hereditary monarchy of 6.25 million people, it is economically challenged and has been subject to sporadic unrest since the start of the uprisings that began to sweep the Arab world in 2011.

On October 29, 2013, Russia's State Nuclear Energy Corporation Rosatom won a contract to build and operate Jordan's first nuclear power plant. The $10 billion contract is one of the world's first reactor projects since the Fukushima station-blackout due to flooding from the March 2011 earthquake and tsunami.

The chairperson of the Jordan Atomic Energy Commission (JAEC) Dr. Khaled Toukan said Atomstroyexport (ASE), Rosatom's international arm, will construct, and possibly operate, the plant which will provide 12 percent or 2,000 MWs of the kingdom's energy needs, and is due for completion in 2020. ASE will finance 49 percent of the project and Jordan will pay for 51 percent and acquire a controlling share.

A Build-Own-Operate (BOO) scheme will be used to construct two separate 1,000-MWs units, 25 miles from the capital Amman. ASE used the same business model to finance a plant in Turkey, where it is building a 4.8 GWs facility worth $20 billion.

Breaking ground on the reactors is planned by 2015, with the first unit anticipated to be launched in 2024 and the second in 2026. Rosatom emerged as the preferred bidder over proposals from France's AREVA and Canada's AECL. Rosatom's Pressurized Water Reactor (PWR) AES92 VVER1000 reactor technology was selected. The Russian state-owned firm would pay 49 percent of the estimated $10 billion cost of the station while Jordan would pay the remaining 51 percent to retain a majority stake in the nuclear project.

Jordan generates its energy from oil and diesel fuel, though it has also produced power from natural gas initially imported from Egypt, and presently from Israel. Jordan has few natural resources and imports nearly 98 percent of its energy and electricity. It has been experiencing a severe energy crisis. Price hikes have brought protests to the streets and also triggered several, sometimes life-threatening, blackouts. The cost of buying diesel and fuel from abroad has risen above $5 billion over the 2011-2012 period or approximately 15 percent of Jordan's Gross Domestic Product (GDP). Previously, Jordan imported cheap natural gas from Egypt, which is no longer a viable option due to a shortage of natural gas in Egypt and repetitive attacks on the pipeline in northern Sinai.

Under a $2 billion International Monetary Fund (IMF) loan, Jordan has been advised to cut subsidies on electricity, but has been given slight leeway as the arrival of Iraqi then Syrian war-refugees has further strained the country's energy crisis. State-owned electricity firm NEPCO sells electricity at about half the price is produces, buffered by large government subsides. The government is compelled to raise electricity prices by 18 percent to balance out the subsidy gap. Foreign investment in power plants is high, as they produce over 60 percent of the kingdom's power.

By 2030, Jordan hopes to source 30 percent of its energy from nuclear facilities, a goal set out in 2007 when Jordan first set up a nuclear energy strategy committee.

The Red Sea to Dead Sea Peace canal remains its only hope to desalinate 800 million cubic meters of water per year using a 1,000 MWe nuclear power plant. This is in comparison to the United Arab Emirates (UAE) which contracted with South Korea for the construction of four 1,000 MWe electrical nuclear plants at a capital cost of $5 billion each, and is contemplating two more units. Saudi Arabia is also considering 16 dual purpose plants for electrical energy and fresh water desalination by 2030.

Jordan's goal is to use nuclear power as part of its efforts to end its power and water shortages and its heavy dependence on energy imports. In 2010, Jordan imported around 97 percent of its natural gas, oil and energy from abroad at a cost of $4 billion, amounting to some 20 percent of its Gross Domestic Product (GDP). The Arab Spring upheaval in Tunisia, Egypt, Lybia, Yemen, Syria and other Middle Eastern countries starting in January 2011 resulted in the collapse of an amicably favorable pricing agreement for Egyptian natural gas, upon which Jordan relied for 80 percent of its electricity generation need. Jordan's fuel bill could rise to 22 percent of its GDP. Deep natural gas reserves are being considered from the eastern Risha gas field. This has placed a greater emphasis on Jordan's drive for nuclear power and renewable energy sources including wind and solar power.

Active prospecting, in collaboration with the French Company Areva, lead to the identification of an estimated 65,000-120,000 metric tonnes of 400-600 ppm low-grade U ore reserves estimated at a worth of $7 billion, offering a hope for attaining energy independence. This could be judiciously supplemented with low-grade 200 ppm U and Th that are extractable as by-products from its large reserves of phosphate rock if value-added phosphoric acid as a

food product and phosphate fertilizer is manufactured from it instead of exporting of the phosphate rock ore as raw material.

An initial plan to build the plant along the Red Sea by the resort port city of Aqaba for a combined production of electricity and desalted fresh water was apparently abandoned based on seismic risk and touristic resort income considerations. It would have been a part of the Red Sea to the Dead Peace Canal visionary project. An initial design contained unconventional questionable features such as a provision that the nuclear power plant would obtain its cooling water from the desalination plant output instead of directly from the Red Sea; and another one providing that the plant be located 8 km inland far away from the touristic shore areas and hence its main cooling supply.

A study carried out by Tractebel Engineering of Belgium, proved that a "number of locations" in southern Jordan are suitable for a nuclear reactor. The location to be the focus of the environmental impact studies is about 20 kms from Aqaba, several kms inland and unrealistic 450 m above sea level. A government-private sector partnership is being considered as a means of financing the project to build the country's first power reactor.

Jordan obtained its first research 5 MWth reactor by 2014 under a contract signed by JAEC and a consortium headed by the Korean Atomic Energy Research Institute (Kaeri) with Daewoo in December 2009. The reactor is to be built at the Jordan University of Science and Technology (JUST) at Irbid, 67 kms north of the capital Amman. It could in the future expand to include a fuel fabrication plant, radioactive waste and cold neutron facilities.

The country plans to start building its nuclear power plant by 2015, and has been evaluating the design offerings of various international reactor vendors. The JAEC set on Australian consultancy Worley Parsons to carry out the pre-construction phase of the project.

JAEC granted French Areva exclusive mining rights for uranium in central Jordan. Funds from the World Bank to study the project were used to pay various consulting companies' feasibility studies. These produced impressive colored reports meant for the inspection of potential private investors and the World Bank's officials. They failed in generating a concrete viable and workable engineering design. Jordan neighbors Saudi Arabia and Israel expressed concern over the safety and environmental seismic and heat rejection grounds. Israel sought participation in the project and consultation about the engineering design on the basis of the vicinity of the site of the city of Aqaba to its own resort port city of Eilat as well as its sharing with Jordan the shores of the Dead Sea along the proposed Red Sea to Dead Sea canal.

In April 2012, JAEC announced that it had narrowed down the list of seven offers from four reactor vendors to two from AtomStroyExport of Russia and the Areva-Mitsubishi Heavy Industries joint venture, for their respective AES-92 model VVER-1000 and Atmea designs.

The latest sites are under consideration are one near Aqaba on the Red Sea coast, a second at Kherbat Al Samra east of the capital Amman, and the third in the eastern Badia desert.

Economic feasibility studies for the nuclear power plant found that the cost of electricity generation would be 80 fils or 11.3 USA cents per kWhr. This cost could drop once the cost of the plant has been covered and its use in water desalination taken into account. Sufficient uranium reserves in central and southern Jordan could meet the demands of the country's nuclear program for 150 years.

Electricity generation currently costs the government some $2 billion per year. Using a nuclear energy program some 500 tonnes of uranium would be sufficient to meet this demand.

The Jordan Atomic Energy Commission (JAEC) expects to start building a 750-1100 MWe nuclear power plant in 2015 for operation by 2020 and a second one for operation by 2025. Longer-term, four nuclear reactors are envisaged. Further nuclear projects are likely to involve desalination.

Jordan is endowed with another favorable alternative location with an abundant water supply that would be an ideal site for a power plant siting at the Al Zarqa River and the King Talal Dam Lake which is an artificial water reservoir. The artificial lake could be used as a cooling sink. Its large surface area would help in heat dissipation without much incremental water loss through evaporation. As an alternative, a minimal amount of water would be withdrawn from the lake for make-up water if cooling towers are used. Dry cooling towers can even be implemented without any substantial evaporative water loss.

Figure 37. King Talal Dam artificial lake near Al Majdal by Jerash, Jordan.

Figure 38. Khirbat Al Samra waste water treatment plant and gas turbines power plant near Balama, 40 km from Amman, Jordan.

In an unexpected turn of events, the desalination option was abandoned as: “Studies had showed many obstacles in terms of higher infrastructure cost and the topography of the

site." The Gulf of Aqaba site was summarily moved to an alternative industrial location some 40 kms north-east of the capital Amman. The site near Balama and Zarqa is already the site of the Khirbat Al Samra Gas Turbine Power Station, built by Turkey, and the Khirbet Al Samra steel plant and a cement plant. To placate the environmental groups, the cooling of the nuclear power plant was advertised to be provided with waste water from the Khirbet Al Samra Wastewater Treatment Plant. Even though such a cooling venue could be used for a small gas-turbine plant, it is considered as a highly unconventional approach of dependably cooling a large nuclear power plant. A 2 square kilometers plot of land is dedicated to the plant.

Jordan forged ahead and opened a bidding process for the plant at the new site and invited private investors to finance the project. Financing was hard to obtain from private sources at a time of a dearth of available global investment capital, which places the financing prospects into difficulty.

Three bidders emerged for the construction project: Atomic Energy of Canada Limited (AECL), a French-Japanese consortium allying Areva with Mitsubishi Heavy Industries, and Russian Atomstroy Export. Expected bids from other sources such as South Korean and American companies did not materialize as a result of doubts about the engineering feasibility, the available financing as well as applied subtle political pressure as Jordan declined the signing of the "123 Advanced Protocol Agreement" introduced by the USA as a supplement to the Nuclear Non-Proliferation Treaty (NPT).

Jordan's nuclear power program entails the construction of up to four 1,000 MWe plants to produce over half the country's electricity needs in addition to smaller wind and solar power projects. Construction of the first plant was tentatively due to begin in 2015 and was expected to be completed by 2020.

Figure 39. Organized well-supplied, dressed and financed western-style protest against nuclear energy in Jordan.

Subtle political pressure adopted the much-successful USA Defense Secretary Donald Rumsfeld's doctrine. It was successfully exercised with the aim of generating more effective "internal" opposition rather than ineffective direct "external" pressure on the project. With the active participation and funding of Non-Government Organizations (NGOs) such as Green Peace, the residents from adjacent locations such as Irbid, Jerash and Al Mafreq were convinced to join together to form the "Irhamouna" in Arabic or "Have Mercy Upon Us," coalition to campaign against the nuclear plant project. A criticism leveled at the project is that

Jordan is vulnerable to earthquakes along the Syria-Africa Rift Valley and that it is short of water for cooling the plant. Adnan Marajdeh, the president of the Jordan Environment Protection and Prevention Society, a military retiree and resident of the Al Hashemiyyeh District near the planned site at Balama, some 40 kms northeast of the capital Amman, said there has been growing concern among local residents over the social and environmental impact of the plant. Deputy Ahmed Shaqran, from Irbid, 4th District, a member of the Lower House Environment Committee, insisted that the jury is still out on whether Jordan should continue its pursuit of nuclear energy: "We are not ready to say there is corruption in the nuclear program, but we need to have all the studies and figures at the end of the day before we should take this project forward."

Jordan, heavily reliant on foreign aid and under pressure to cancel its nuclear program, saw the Jordanian parliament in May 2012 suspending its nuclear power station and uranium exploration plans pending the completion of economic feasibility and environmental impact assessments and declaring them as "hazardous and costly."

The Jordanian Atomic Energy Commission suggested that any reactor built must meet current Western standards of safety and would undergo a full safety assessment by an experienced and credible independent safety regulatory body.

On February 19, 2013 Russian President Vladimir Putin and Jordan's King Abdullah II met in Moscow to discuss bilateral economic co-operation, including the proposed Russian participation in a project to build Jordan's first nuclear power plan. Seeking to participate in the Jordanian nuclear plans, Russian state nuclear corporation Rosatom provided 12 Jordanian students with scholarships to study in Russia.

Russia has offered Jordan a deal under which it will construct four nuclear power reactors. Rosatom's reactor export subsidiary AtomStroyExport (ASE) approached the Jordan Atomic Energy Commission (JAEC) with a proposal to build four 1,200 MWe VVER units, similar to the agreement it reached with Turkey. If all four units are built, 4,000 MWe of generating capacity would be added to the grid, more than doubling Jordan's current generating capacity. This would transform the country from an energy importer to an energy exporter.

Three vendors made bids: an Areva-Mitsubishi Heavy Industries consortium, Russia's AtomStroyExport and Canada's SNC-Lavalin International. The designs under consideration are the Atmea1 pressurized water reactor, the AES-92 model VVER-1000, and the Enhanced Candu-6 pressurized heavy-water reactor.

JAEC expects to start building a 750-1100 MWe nuclear power plant in 2015 for operation by 2020 and a second one for operation by 2025. Longer-term, four nuclear reactors are envisaged. Further nuclear projects are likely to involve desalination.

Jordan already has signed nuclear cooperation agreements with France, Spain, China, South Korea, Canada, Russia, the UK and Argentina. The USA looks likely to join that list in the future. Jordan has declined to sign an accord with the USA that, like a similar document agreed between the UAE and the USA that would commit it to not enriching uranium and recycle nuclear fuel as part of its nuclear plan.

The USA has insisted that it will not allow Jordan to enrich uranium because of what it sees as the risk of proliferation in a volatile region made more insecure by conflicts in Syria and Iraq, and growing tensions over Iran. Continued Jordanian resistance to USA wishes could cause problems with Congress and with Israel. An accord would open up opportunities for USA companies, which Jordan would otherwise be forbidden from contracting with. Jordan has historically been so dependent on USA financial and political support that few observers

see it as able to deny Washington's wishes, making some kind of face-saving deal the likeliest outcome.

One possible solution would be for Jordan to make a political commitment that for a period of time it would not seek an enrichment or reprocessing capacity, in return for a USA commitment to ensure Jordanian access to the market for nuclear fuel.

TURKEY'S NUCLEAR PROGRAM

Three quarters of Turkey's energy needs come from imports for which it pays around $60 billion / year. Turkey is introducing nuclear power generation with 3-4 nuclear power plants within 15 years with an investment cost of £12.6 billion.

Turkey's first nuclear power plant is planned at the southern Mediterranean coastal town of Akkuyu to be built the Russian company Rosatom that contracted to build, own and operate the plant.

The second nuclear power plant is planned at the Black Sea port city of Sinop to be built by a Japanese-French consortium that includes Japanese Mitsubishi Heavy Industries Ltd. and French Areva which won a contract to build four nuclear reactor units in the Black Sea city of Sinop with strong backing from Japan's Prime Minister Shinzo Abe, who is pushing nuclear energy exports as part of his growth strategy.

In May 2010, an intergovernmental agreement was signed by Russia and Turkey under which Turkey's first nuclear power plant will be built, owned and operated by a Russian project company. The deal, worth some $20 billion, covers the construction of four 1,200 MWe VVER units at the Akkuyu site on Turkey's Mediterranean coast. Russian state-owned nuclear enterprise Rosatom will create a project company subsidiary, which will initially be 100 percent Russian-owned. In the longer term, Russia may sell up to 49 percent of the company to other investors from Turkey and elsewhere, but will retain the 51 percent controlling stake.

Japan and Turkey agreed to conclude a nuclear energy pact, as a precondition for exporting nuclear technology, in May 2013. It requires the recipient country to use technology, as well as equipment and materials, only for peaceful purposes. The Japanese-Turkish pact includes a provision allowing Turkey to enrich uranium and extract plutonium from spent fuel if the two countries agree in writing. A Japanese senior Foreign Ministry official said the clause was added at the request of Turkey. The agreement would also pave the way for exporting Japan's enrichment and spent-fuel reprocessing technologies if revisions are made. Japan placed restrictions on enrichment and reprocessing in its nuclear energy agreements with Vietnam, South Korea, Jordan and Russia, which took effect in 2012, as well as with the United Arab Emirates. Japan promised to set up a science and technology university in Turkey.

SAUDI ARABIA'S PEACEFUL ON-OFF PROGRAM

In 1902, Abdul Aziz Bin Abdul Rahman Bin Faisal Al Saud, or Ibn Saud in short, was a warrior chieftain of great charisma and shrewdness. He left Kuwait and retook the lands on the Arabian Peninsula that had formerly been ruled by his father. He became the first man since the Prophet Mohammed to reunite the Arabs of the peninsula, except for those of the British protectorates, to form the Kingdom of Saudi Arabia in 1932.

In 1945, Ibn Saud met President Roosevelt in Egypt as he was returning from the Yalta Conference. Exuding charm, Roosevelt succeeded in convincing Ibn Saud that the USA, rather than the UK, was the only country that could guarantee the Kingdom's security. This encounter produced a most important treaty in which Saudi oil was traded for America's military muscle. This understanding formed the basis of Gulf War I, when President George H.W. Bush was shrewd enough to leave the President Saddam Hussein of Iraq in power to keep a lid on the simmering tensions between Sunni and Shiite Moslems. This was similar to President Hsrry Truman leaving the Japanese Emperor on his Throne in 1945.

President George W. Bush toppled President Saddam Hussein and unleashed mayhem in the Middle East area. President Barack Obama compounded this catastrophic error by withdrawing unilaterally to leave his Sunni Arab allies politically and militarily exposed. In addition, President Barack Obama appeared to drop Saudi Arabia as a key regional ally in favor of Iran to conclude a nuclear deal that seemingly threatens the Sunnis Moslems, Israel and any future perceived enemies of Iran. As well as appearing weak and indecisive, President Barack Obama has made the USA appear disloyal to its allies and has fermented growing distrust, unrest and war-risk in the Middle East.

WORK FORCE STRESS

In 2012, the Saudi Arabian government announced plans to build 16 commercial reactors for electricity and fresh water production by 2030 and signed a technology agreement with China. It earlier signed a memorandum of understanding with the USA in 2008, promising USA assistance with civil nuclear power with the understanding that Saudi Arabia would not pursue sensitive nuclear technologies. Saudi Arabia’s objective to uphold a robust association with the USA prevents it from any desire to develop nuclear weapons.

With about 20 percent of the world's proven oil reserves and producing between 10 and 13 percent of the global oil usage, Saudi Arabia is the world's leading oil producer ahead of the USA, China, Iran and Canada. With its developed and easily accessible oil fields, Saudi Arabia has some of the lowest lifting costs in the world. It costs less than $5 to extract a barrel of oil from its petroleum fields. This is in contrast to the much higher costs in rival countries and offshore and shale producers.

However, in 2011 a Citigroup Bank report warned that Saudi Arabia may run out of oil to export by 2030. Inside the country, many believe that the kingdom must get ready for a future without petroleum exports. The International Monetary Fund (IMF) has urged the Saudi Arabian government to spend less and use its money better for a time when oil runs out. The concern of a post-oil era extended to neighboring Kuwait, albeit amongst a much smaller population.

Saudi Arabia suffers from an unemployment problem among its youths and needs to provide them with future job opportunities, so it launched a jobs “Saudisation” campaign, targeting illegal workers. It has a population of about 28 million and a jobless rate of around 12.5 per cent. Roughly one third of Saudi Arabians under the age of 30 are unemployed, as well as 35 percent of women, according to government statistics. A stronger educational system appears to be the most important means of promoting Saudisation, since Saudi citizens who are qualified for high-skilled job positions will have a competitive edge over foreign candidates in both domestic and foreign firms.

The urgency of jobs creation in Saudi Arabia is unique in the Gulf region, where the majority of nationals are employed by their governments. At its current rate of growth, the

International Monetary Fund (IMF) estimates that the Saudi Arabian labor force is growing at a rate of 3.6 percent per year. If nothing changes, that will mean that 1.4 million Saudi Arabians could be unemployed within a decade. The government's Technical and Vocational Training Corporation (TVTC), was formed as an organization aimed at boosting Saudi Arabian private-sector employment. TVTC initially pays a portion of the salaries of new graduates employed by the private-sector, which would otherwise be lower than in the public sector.

Education is recognized as the primary way to create better job opportunities, and covers 25 per cent of state expenditures in Saudi Arabia. Enrollment in vocational schools has grown impressively, in line with the numbers of students pursuing higher education overall. The country hopes to graduate 450,000 vocational school students annually by 2015, up from just 94,000 in 2009. TCTV offers two-year diploma courses at 36 men's colleges and 18 women's colleges, with 15,000 staff teaching 84,600 students. About 94 per cent of the graduates land jobs in the private sector after graduation. Many of the students are paired with companies before graduation through internships in an attempt to make sure that their training caters to the existing job openings. In addition to teaching skills, vocational training also is changing the expectations of incoming workers about the work-load private companies will expect them to carry.

In another direction at Saudisation, since November 4, 2013, the Saudi Arabian authorities have launched a visa crackdown on undocumented foreign workers, rounding them or imprisoning them in detention camps, then systematically deporting them. Among them were foreigners who overstayed their visas, pilgrims who had sought jobs, and migrants working under one sponsor trying to get a different position in the job market. Having an official sponsor is a legal requirement in Saudi Arabia and most other Gulf states.

Plans to create jobs for Saudi Arabian nationals were implemented by reducing the number of foreign workers from neighboring countries such as Yemen, Somalia, Ethiopia, Malaysia, Bangladesh, the Philippines, India, Pakistan, Nepal, Syria and Egypt, who total around 8.5 million people out of a total Saudi Arabian population of 28 million. Economists suggest that there are another two million unregistered foreign workers. Six million foreign workers are employed in menial jobs unaccepted by Saudi Arabians, and 68 per cent of them are paid less than 1,000 riyals per month. The majority of Saudi Arabians prefer secure employment in the public sector, where they are better paid for shorter working hours and enjoy more holidays.

The deportations are part of an organized Saudi Arabian campaign to expel undocumented foreign workers. In a major exodus, hundreds of thousands of workers have left Saudi Arabia on their own amid tough conditions for migrants and a loss of economic prosperity caused by a reduced global demand for petroleum with the advent of the new technologies of hydraulic fracturing and horizontal drilling of tight shale oil and gas formations. This is occurring in conjunction with a need to assure the long term productivity of major petroleum assets such as the giant Al Ghawar field oil reserves. Clashes erupted between migrant workers protesting the crackdown and vigilante Saudi Arabians in the capital Riyadh and in the port city of Jeddah when police combed the areas for illegal immigrants.

At the end of an amnesty and grace period to establish legal residence, on November 4, 2013, thousands of illegal residents including children who were born and raised in Saudi Arabia to those who overstayed their visas, such as pilgrims who had sought jobs and migrants working under one sponsor trying to get jobs elsewhere, were rounded up across Saudi Arabia. Rather than risk prosecution, nearly one million workers took advantage of the amnesty offer

to leave back to their home countries. About four million were able to establish legal residency before the grace period ended.

A side-effect of the deportations is that private property developments felt the impact of the measures and media reports estimate that 40 per cent of small and medium contracting companies have stopped work completely. These companies have been unable to correct the status of tens of thousands of illegal workers given the costs associated with obtaining residency including medical cover, social security and government fees. The minimum percentage of Saudisation for the construction and building sector is 7.5 per cent, as per the Labor Ministry regulations. The sector is labor-intensive, and companies cannot find Saudis to hire onsite as they are not adequately trained for the intended positions. In addition, construction jobs are not preferred by Saudi Arabian citizens. Work on infrastructure projects initiated by the Saudi Arabian government has not stopped. The kingdom still needs the private sector to meet its urgent needs, especially with multibillion projects in the pipeline such as the 27 billion riyals King Abdul Aziz airport development in Jeddah and Riyadh's 82 billion riyals metro project.

SAUDI ARABIAN AND IRANIAN RIVALRY

At the Münich, Germany Security Conference in February 2014, USA Senator Lindsey Graham asked Saudi Prince Turki Al Faisal, the kingdom's former intelligence chief, if any final agreement that allowed Iran to maintain an enrichment capability would cause Saudi Arabia and other Arab states to invoke their own right to enrich uranium. Prince Turki Al Faisal suggested that if the Islamic Republic of Iran retained a uranium-enrichment ability, then the Kingdom of Saudi Arabia and other Arab governments could pursue enrichment programs of their own: "I think we should insist on having equal rights for everybody, this is part of the Nuclear Nonproliferation Treaty (NPT) arrangement."

The Kingdom of Saudi Arabia is understood to be worried that world powers will agree to allow Iran to maintain some limited uranium-enrichment capability in a potential lasting deal on its nuclear program. Saudi Arabia has an established interest in developing a peaceful nuclear energy program for electrical power generation and water desalination, but it has expressed concerns about Iran' activities.

Figure 40. Islamic historic Sunni and Shiite divide in the Middle East. Source: Der Spiegel.

Figure 41. Oil and Gas infrastructure in Saudi Arabia.

The USA's Institute for Science and International Security (ISIS) president and founder David Albright (M. Sc. Physics, Indiana University, M. Sc. Mathematics, Wright State University, Honorary Doctorate of Humane Letters from Wright State University), made unsubstantiated claims to the media that he had learned from an "unidentified European intelligence agency" of Saudi Arabia's pursuit in recent years of the scientific and engineering

expertise necessary to carry out activities in all parts of the nuclear fuel cycle. The complete fuel cycle for nuclear fuel includes uranium enrichment and the recycling of spent nuclear fuel.

David Albright alleged that Saudi Arabia was employing technical experts capable of constructing the centrifuge cascades required to enrich uranium:

> "They view the developments in Iran very negatively. They have money, they can buy talent, they can buy training. The Saudis are thinking through how do you create a deterrent through capability."
>
> "We don't worry about the Saudis learning to operate a reactor, *I worry that they will learn the skills needed to master the fuel cycle*."

Mike Urban, diplomatic and defense editor at the British Broadcasting Corporation (BBC) Newsnight, alleged the following unsubstantiated claims about a fictitious deal between Saudi Arabia and Pakistan [9]:

> "Saudi Arabia has invested in Pakistani nuclear weapons projects, and believes it could obtain atomic bombs at will, a variety of sources have told BBC Newsnight.
>
> While the Kingdom's quest has often been set in the context of countering Iran's atomic program, it is now possible that the Saudis might be able to deploy such devices more quickly than the Islamic Republic (Iran).
>
> Earlier this year (2014), a senior NATO decision maker told me that he had seen intelligence reporting that nuclear weapons made in Pakistan on behalf of Saudi Arabia are now sitting ready for delivery.
>
> Last month (January 2014) Amos Yadlin, a former head of Israeli military intelligence, told a conference in Sweden that if Iran got the bomb, 'the Saudis will not wait one month. They already paid for the bomb, they will go to Pakistan and bring what they need to bring.'
>
> Since 2009, when King Abdullah of Saudi Arabia warned visiting USA special envoy to the Middle East Dennis Ross that if Iran crossed the threshold, 'we will get nuclear weapons', the kingdom has sent the Americans numerous signals of its intentions.
>
> Gary Samore, until March 2013 President Barack Obama's counter-proliferation adviser, has told Newsnight: 'I do think that the Saudis believe that they have some understanding with Pakistan that, in extremis, they would have claim to acquire nuclear weapons from Pakistan.'
>
> The story of Saudi Arabia's project - including the acquisition of missiles capable of delivering nuclear warheads over long ranges - goes back decades.
>
> In the late 1980s they secretly bought dozens of CSS-2 ballistic missiles from China.
>
> These rockets, considered by many experts too inaccurate for use as conventional weapons, were deployed 20 years ago.
>
> This summer experts at defense publishers IHS Jane's reported the completion of a new Saudi CSS-2 base with missile launch rails aligned with Israel and Iran.

It has also been clear for many years that Saudi Arabia has given generous financial assistance to Pakistan's defense sector, including, western experts allege, to its missile and nuclear labs.

Visits by the then Saudi defense minister Prince Sultan bin Abdul Aziz Al Saud to the Pakistani nuclear research center in 1999 and 2002 underlined the closeness of the defense relationship.

Saudi Arabia's undisclosed missile site defense and security intelligence provider IHS Jane's revealed the existence of Saudi Arabia's third and undisclosed intermediate-range ballistic missile site, approximately 200 km southwest of Riyadh.

In its quest for a strategic deterrent against India, Pakistan co-operated closely with China which sold them missiles and provided the design for a nuclear warhead.

The Pakistani scientist Abdul Qadeer Khan was accused by western intelligence agencies of selling atomic know-how and uranium enrichment centrifuges to Libya and North Korea.

Abdul Kadeer Khan is also believed to have passed the Chinese nuclear weapon design to those countries. This blueprint was for a device engineered to fit on the CSS-2 missile, i.e. the same type sold to Saudi Arabia.

Because of this circumstantial evidence, allegations of a Saudi-Pakistani nuclear deal started to circulate even in the 1990s, but were denied by Saudi officials.

They noted that their country had signed the Non-Proliferation Treaty, and called for a nuclear-free Middle East, pointing to Israel's possession of such weapons.

The fact that handing over atom bombs to a foreign government could create huge political difficulties for Pakistan, not least with the World Bank and other donors, added to skepticism about those early claims.

In 'Eating the Grass,' his semi-official history of the Pakistani nuclear program, Major General Feroz Hassan Khan wrote that Prince Sultan's visits to Pakistan's atomic labs were not proof of an agreement between the two countries. But he acknowledged, 'Saudi Arabia provided generous financial support to Pakistan that enabled the nuclear program to continue.'

Whatever understandings did or did not exist between the two countries in the 1990s, it was around 2003 that the kingdom started serious strategic thinking about its changing security environment and the prospect of nuclear proliferation.

A paper leaked that year by senior Saudi officials mapped out three possible responses - to acquire their own nuclear weapons, to enter into an arrangement with another nuclear power to protect the kingdom, or to rely on the establishment of a nuclear-free zone in the Middle East.

It was around the same time, following the USA invasion of Iraq, that serious strains in the USA/Saudi relationship began to show themselves, says Gary Samore.

The Saudis resented the removal of Saddam Hussein, had long been unhappy about USA policy on Israel, and were growing increasingly concerned about the Iranian nuclear program.

In the years that followed, diplomatic chatter about Saudi-Pakistani nuclear cooperation began to increase.

In 2007, the USA mission in Riyadh noted they were being asked questions by Pakistani diplomats about USA knowledge of 'Saudi-Pakistani nuclear cooperation.'

The unnamed Pakistanis opined that 'it is logical for the Saudis to step in as the physical 'protector' of the Arab world by seeking nuclear weapons, according to one of the State Department cables posted by WikiLeaks.

By the end of that decade Saudi princes and officials were giving explicit warnings of their intention to acquire nuclear weapons if Iran did.

Having warned the Americans in private for years, last year (2013) Saudi officials in Riyadh escalated it to a public warning, telling a journalist from the Times: 'it would be completely unacceptable to have Iran with a nuclear capability and not the Kingdom'.

But were these statements bluster, aimed at forcing a stronger USA line on Iran, or were they evidence of a deliberate, long-term plan for a Saudi bomb? Both, is the answer I have received from former key officials.

One senior Pakistani, speaking on background terms, confirmed the broad nature of the deal - probably unwritten - his country had reached with the kingdom and asked rhetorically 'what did we think the Saudis were giving us all that money for? It wasn't charity.'

Another, a one-time intelligence officer from the same country, said he believed 'the Pakistanis certainly maintain a certain number of warheads on the basis that if the Saudis were to ask for them at any given time they would immediately be transferred.'

As for the seriousness of the Saudi threat to make good on the deal, Simon Henderson, Director of the Global Gulf and Energy Policy Program at the Washington Institute for Near East Policy, told BBC Newsnight 'the Saudis speak about Iran and nuclear matters very seriously. They don't bluff on this issue.'

Talking to many serving and former officials about this over the past few months, the only real debate I have found is about how exactly the Saudi Arabians would redeem the bargain with Pakistan.

Some think it is a cash-and-carry deal for warheads, the first of those options sketched out by the Saudis back in 2003; others that it is the second, an arrangement under which Pakistani nuclear forces could be deployed in the kingdom.

Gary Samore, considering these questions at the center of the USA intelligence and policy web, at the White House until earlier this year (2014), thinks that what he calls, 'the NATO model', is more likely.

However, 'I think just giving Saudi Arabia a handful of nuclear weapons would be a very provocative action', says Gary Samore.

He adds: ‘I've always thought it was much more likely - the most likely option if Pakistan were to honor any agreement would be for be for Pakistan to send its own forces, its own troops armed with nuclear weapons and with delivery systems to be deployed in Saudi Arabia.’

This would give a big political advantage to Pakistan since it would allow them to deny that they had simply handed over the weapons, but implies a dual key system in which they would need to agree in order for Saudi Arabian ‘nukes’ to be launched.

Others I have spoken to think this is not credible, since Saudi Arabia, which regards itself as the leader of the broader Sunni Islamic 'Ummah' or community, would want complete control of its nuclear deterrent, particularly at this time of worsening sectarian confrontation with Shia Iran.

And it is Israeli information - that Saudi Arabia is now ready to take delivery of finished warheads for its long-range missiles - that informs some recent USA and NATO intelligence reporting. Israel of course shares Saudi Arabia's motive in wanting to worry the USA into containing Iran.

Amos Yadlin declined to be interviewed for our BBC Newsnight report, but told me by email that ‘unlike other potential regional threats, the Saudi one is very credible and imminent.’

Even if this view is accurate there are many good reasons for Saudi Arabia to leave its nuclear warheads in Pakistan for the time being.

Doing so allows the kingdom to deny there are any on its soil. It avoids challenging Iran to cross the nuclear threshold in response, and it insulates Pakistan from the international opprobrium of being seen to operate an atomic cash-and-carry.

These assumptions though may not be safe for much longer. The USA diplomatic thaw with Iran has touched deep insecurities in Riyadh, which fears that any deal to constrain the Islamic republic's nuclear program would be ineffective.

Earlier this month the Saudi intelligence chief and former ambassador to Washington Prince Bandar announced that the kingdom would be distancing itself more from the USA.

While investigating this, I have heard rumors on the diplomatic grapevine, that Pakistan has recently actually delivered Shaheen mobile ballistic missiles to Saudi Arabia, minus warheads.

These reports, still unconfirmed, would suggest an ability to deploy nuclear weapons in the kingdom, and mount them on an effective, modern, missile system more quickly than some analysts had previously imagined.

In Egypt, Saudi Arabia showed itself ready to step in with large-scale backing following the military overthrow of President Mohammed Mursi's government.

There is a message here for Pakistan, of Riyadh being ready to replace USA military assistance or World Bank loans, if standing with Saudi Arabia causes a country to lose them.

Newsnight contacted both the Pakistani and Saudi governments. The Pakistan Foreign Ministry has described our story as ‘speculative, mischievous and baseless’.

It adds: ‘Pakistan is a responsible nuclear weapon state with robust command and control structures and comprehensive export controls.’

The Saudi embassy in London has also issued a statement pointing out that the Kingdom is a signatory to the Non-Proliferation Treaty and has worked for a nuclear-free Middle East.

But it also points out that the UN's ‘failure to make the Middle East a nuclear free zone is one of the reasons the Kingdom of Saudi Arabia rejected the offer of a seat on the UN Security Council’.

It says the Saudi Foreign Minister has stressed that this lack of international action ‘has put the region under the threat of a time bomb that cannot easily be defused by maneuvering around it’.”

Zakary Keck, associate editor of “The Diplomat” in turn debunked and disproved Mark Urban’s inflated claims [10]:

“Much of the soul-searching since the Iraq War has focused on the intelligence failures that produced the faulty WMD (Weapons of Mass Destruction) assessment. Less attention has been paid to the more puzzling question of why so many people readily accepted the argument that Saddam would arm Al Qaeda with nuclear weapons, despite the obvious absurdity of the claim.

It is this latter question that also seems most relevant amidst new concerns about a Saudi nuclear weapon. Earlier this month, in the run-up to the Iran-P5+1 talks, the BBC’s Mark Urban wrote a lengthy piece claiming that Pakistan has built nuclear weapons ‘on behalf of Saudi Arabia [that] are now sitting ready for delivery.’

The article attracted considerable attention and alarm, although it’s not clear why. Concerns about a secret Saudi-Pakistani nuclear pact date back to the 1970s and 1980s, and have become especially prevalent over the past decade.

Nonetheless, despite decades of suspicions, the existence of a Saudi-Pakistan nuclear pact is based almost entirely on speculation. Moreover, like the alleged Saddam-AQ nuclear nexus, the notion that Pakistan would supply Saudi Arabia with nuclear weapons defies common sense.

As noted above, concerns about a Saudi-Pakistan nuclear pact emerged in the 1970s and 1980s as Saudi aid to Pakistan increased rapidly. Many in Western foreign-policy circles feared that some of the Kingdom’s aid was being used to fund Pakistan’s nuclear program, with Riyadh expecting some of the final products in return.

However, the increase in Saudi aid during the 1980s was due to other factors, such as Pakistan basing some fifteen thousand troops in the Kingdom, and the Saudi government financing of over half of the Afghan jihad against the Soviet Union. If Saudi money directly funded Pakistan’s nuclear program,

it was almost certainly because, as a Saudi advisor once explained, 'We gave money and [the Pakistanis] dealt with it as they saw fit.'

Similar Western speculation centers on Saudi defense minister Prince Sultan bin Abdulaziz's trip to Pakistan in 1999. During the trip, Pakistani prime-minister Sharif gave Sultan a tour of the Khan Research Laboratories, which produce highly enriched uranium, and an adjacent ballistic missile factory. He was believed to be the first foreign dignitary to view the highly secretive, military-run KRL, although he denied being given access to the secret parts of the complex.

It's not exactly clear why giving the Saudi defense minister a tour of the facilities would be necessary for the two sides to forge a nuclear pact, or even how it would advance it. Furthermore, if the tour was part of a covert nuclear deal, it seems unlikely the two sides would have publicized it. Instead, the highly publicized nature of the tour suggests it was intended to symbolize the closeness of the Saudi-Pakistani relationship.

The timing of the trip supports this view. Specifically, after India's nuclear tests the year before, Riyadh empowered PM Sharif to respond with his own nuclear tests by assuring him the Kingdom would help offset the international sanctions that were almost certain to follow.

Beyond pure speculation, suspicions of a Saudi-Pakistan nuclear pact also stem from the testimony of Mohammed Khilewi, the number two at the Saudi UN Mission until he defected in 1994. In seeking asylum in the USA, Khilewi made a string of allegations to FBI agents, including that Saudi Arabia had a secret nuclear-weapons program and had helped fund Pakistan and Iraq's nuclear programs. According to the UK Sunday Times, Khilewi claimed that in return for this funding, the two sides had signed a pact pledging that 'if Saudi Arabia were attacked with nuclear weapons, Pakistan would respond against the aggressor with its own nuclear arsenal.'

The FBI agents who debriefed Khilewi did not put much stock into his claims. As his lawyer later complained, the two FBI agents 'dismissed them as marginal and walked out of the meeting, refusing to take Khilewi into custody or give him protection.'

They were almost certainly right to do so. To begin with, Khilewi had a clear motivation for lying, given that his livelihood depended on being granted USA asylum. The USA, however, had little reason to strain its alliance with Saudi Arabia on Khilewi's account, unless of course he could be useful to USA interests.

His testimony all around appeared aimed at demonstrating his usefulness to the United States. Unfortunately, a central part of it would be proven unfounded a decade after he gave. Specifically, although Khilewi mentioned the Pakistani program, the overwhelming majority of his allegations were about the Kingdom's alleged funding of Saddam Hussein's nuclear weapons program in the 1980s. In Khilewi's telling, Saudi Arabia gave Saddam at least $5 billion from 1985 through the Gulf War, in return for promises that it would receive nuclear weapons in return. Khilewi also claimed that Saudi nuclear scientists were regularly trained by their Iraqi counterparts

in Baghdad. These allegations were seen as particularly damaging in the USA because of the still recent Gulf War.

After toppling Saddam Hussein in 2003, however, the USA gained extensive access to Iraqi documents and nuclear scientists, and conducted a large investigation into the history of Saddam's nuclear-weapons program. None of what they found appears to have corroborated Khilewi's claims about Saudi funding and scientific training. Nonetheless, he continues to be cited by reports claiming that there is a secret Pakistani-Saudi nuclear pact.

Khilewi's allegations are notable, however, in demonstrating that he understood how deeply the USA fears nuclear weapons spreading, particularly to the Middle East, and his willingness to use this to his advantage. Whatever other differences Khilewi may have with the Saudi family, they share this in common. Indeed, for years now Saudi rulers have repeatedly threatened to go nuclear if the USA doesn't stop Iran from gaining nuclear weapons.

But for their threat to be effective, it has to be credible. And to be credible, Riyadh has to be capable of making good on it. This puts Saudi officials in a difficult bind as it would take decades for them to build a nuclear weapon from scratch, if they were ever able to do so at all. As Jacques Hymans has noted, of the ten states that have begun dedicated nuclear weapons programs since 1970, only three have been successful (India, Pakistan and North Korea), with the jury still out on Iran. Of the three success stories, building the bomb took an average of 17 years. Not counting the Shah's nuclear activities, the Iranian case has stretched 30 years and counting.

Saudi Arabia is far less capable of building a nuclear weapon than Pakistan or Iran. Furthermore, threatening to acquire nuclear bombs twenty five years from now is not likely to cause undue alarm among USA officials. Thus, Saudi leaders need a way to make their threats seem more urgent.

Enter the secret nuclear pact with Pakistan. For the past decade, periodic and often well-timed reports have surfaced claiming that if Iran goes nuclear, Pakistan has nuclear weapons waiting for Saudi Arabia to claim. Alternatively, others suggest that Pakistan might deploy nuclear weapons to the Kingdom under the guardianship of Pakistani troops, much like the USA bases nuclear weapons in NATO countries.

The first of these reports was published by The Guardian in September 2003. The article's two reporters-—who were based out of Vienna (where the International Atomic Energy Agency's headquarters is based)—said that they had 'learned' of a recent strategic review Saudi Arabia had undertaken in which it considered building nuclear weapons or forming a new alliance with a nuclear armed power. The reporters speculated that Pakistan might be the potential new nuclear ally Saudi Arabia would seek out.

This report is one of the only ones that focuses on specific details rather than general speculation. Nonetheless, the authors provide little details about how they learned of the strategic review, though it doesn't appear they saw the alleged document. It's worth noting that Saudi Arabia isn't a government that is particularly well known for (unplanned) leaks of high-level security documents, especially to a London newspaper.

The timing of the report is crucial here. Iran's nuclear program had first been exposed publicly a year earlier. Then, in March 2003, the USA invaded Iraq despite Saudi reservations that it would create a vacuum that Iran would fill. The Bush administration is believed to have tried to assuage Saudi concerns by suggesting that Saddam Hussein would only be the first regime it would topple. As The Guardian report discusses in great detail, in the months after the invasion, the Saudis had become increasingly concerned about America's commitment to them.

In this context, the leak about the strategic review was almost certainly intended to force the USA to renew its focus on Iran and its nuclear program. The timing of the report is also notable because the month after The Guardian article was published, Crown Prince Abdullah bin Abdulaziz led a Saudi delegation on a trip to Pakistan.

Many are the numerous reports since then, including the one last week, have been based on even more shaky grounds. First, they all seem to surface during times when there is heightened concern about Iran's nuclear program, and/or strains in the USA-Saudi relationship. Secondly, almost none add any new kind of evidence, usually just citing a couple unnamed officials. Interestingly, the reports often cite NATO or Western officials who appear to only to be voicing their suspicions about the existence of a pact. The rest of the space is usually filled by reciting the long history of speculation about a secret nuclear pact, conveniently papering over the lack of evidence supporting these fears.

Another flaw that almost all the news accounts share is that they analyze the pact solely from the perspective of Saudi Arabia, and ignore Pakistan's interests almost entirely. They note, for example, that the Kingdom fears a nuclear-armed Iran and point out that Saudi officials have regularly threatened to go nuclear if Iran isn't prevented from building the bomb. Although one can imagine some reasons the Saudis might not want Pakistani bombs, particularly if they were under the command of Pakistani soldiers, it's not altogether difficult to believe Riyadh would accept a readymade nuclear deterrent.

But it's downright preposterous to think that Pakistan would take the unprecedented step of selling Saudi Arabia nuclear weapons, given that it would have nothing to gain and everything to lose by doing so.

To begin with, Pakistani officials are exceptionally paranoid about the size of their nuclear arsenal, and take extraordinary measures to reduce its vulnerability to an Indian or USA first strike. Providing the Saudis with their nuclear deterrent would significantly increase Islamabad's vulnerability to such a first strike. It defies logic to think that Islamabad would accept this risk simply to uphold promises former Pakistani leaders might have made.

It is similarly hard to imagine that past Saudi economic assistance could purchase future nuclear weapons. After all, the USA has provided Pakistan with billions of dollars to fight terrorism since 9/11, and it found bin Laden living in an off-campus mansion outside Pakistan's military academy. The Saudis have similarly struggled to use (and) turn their financial assistance

to Pakistan into influence. For example, in the late 1990s and early 2000s, a time when international sanctions left Pakistan highly dependent on Saudi aid, Riyadh unsuccessfully attempted to persuade Pakistan to force the Taliban to hand over bin Laden.

If current aid in the 1990s couldn't buy Saudi Arabia bin Laden, how can aid from the 1980s be expected to purchase a nuclear arsenal in the future? Unlike with bin Laden, Pakistan has compelling strategic incentives not to sell Saudi Arabia nuclear weapons. Such a move would, of course, result in immediate and severe backlash from the USA and the West, who would organize international sanctions against Islamabad. They would also use their influence in the International Monetary Fund to end its aid package to Islamabad, which currently serves as Pakistan's lifeline. Pakistan's nuclear sales would also force Washington to end any pretense of neutrality between Pakistan and India, and significantly strengthen ties with the latter.

Pakistan's all weather friendship with China would also be jeopardized. In fact, it's quite possible China would be more infuriated than the USA because the Kingdom supplies about 20 percent of China's oil imports, and Beijing's dependence on Persian Gulf oil is expected to grow in the coming years. By opening Saudi Arabia up to a conventional or nuclear attack, Pakistan would be threatening China's oil supplies, and through them the stability of the Communist Party. This is a sin Beijing would not soon forgive.

No country would be more enraged by Pakistan's intransigence than its western neighbor, Iran. It is this fear of alienating Tehran that would be the biggest deterrent to selling Saudi Arabia a nuclear bomb. To begin with, Tehran would immediately halt natural-gas sales to energy-starved Pakistan. More importantly, it would finally embrace India wholeheartedly, including a large Indian presence along its border with Pakistan.

Thus by selling Saudi nuclear weapons, Pakistan would have guaranteed it is surrounded by India on three sides, given that Delhi uses Iran as its main access point to Afghanistan. India's presence in Iran would also be detrimental to Pakistan, because Iran borders on Pakistan's already volatile Baluchistan province. This would allow India and Iran to aid Baluch separatist movements, conjuring up memories of Bangladesh in the minds of Pakistani leaders. Finally, Iran could give the Indian Navy access to Chabahar port, which Delhi has invested millions in upgrading. Aside from being encircled on land, Pakistan's navy would now be boxed in by the Indian and Iranian navies.

For a country as obsessed with strategic depth as Pakistan, this situation would be nothing short of a calamity. The notion that Pakistan would resign itself to this fate simply to honor a promise it made to Saudi Arabia is no less farfetched than believing Saddam would arm Al Qaeda with nuclear weapons. That may be why three decades of speculation has turned up no evidence of a Saudi-Pakistani nuclear pact."

SAUDI AND USA HISTORICAL STRATEGIC TIES

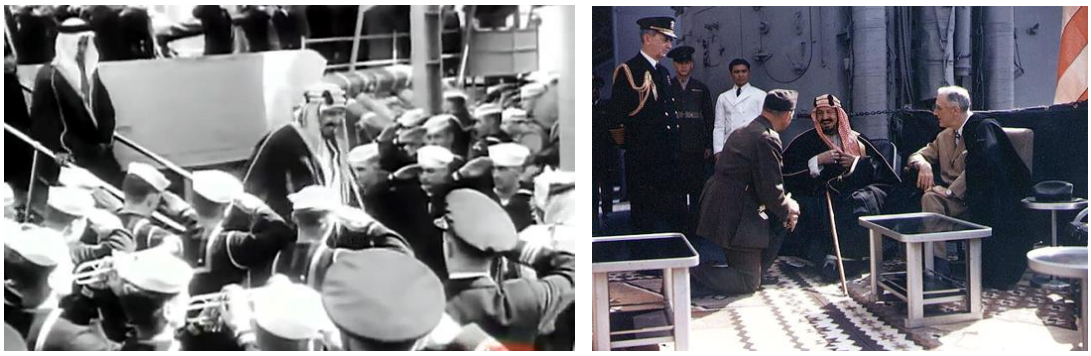


Figure 42. King Abdul Aziz Ibn Al Saud and President Franklin D. Roosevelt (FDR) met after the Yalta, Crimea Conference and established a long enduring alliance between the USA and Saudi Arabia [12].

A close strategic relationship was started when King Abdul Aziz (Ibn Saud): "The Lion of the Desert," and President Franklin D. Roosevelt (FDR) met after the Yalta, Crimea Conference [12]. The meeting was set to negotiate the post-war world order and the creation of the United Nations with Winston Churchill of the UK and the Soviet leader Josef Stalin. The meeting on the USA cruiser USS Quincy (CA-71) on February 14, 1945, established a long-lasting Saudi Arabian and USA alliance initiated by the establishment of the Standard Oil of California, then Aramco (Arabian American Oil Company). The USS Murphy destroyer had been sent to Jeddah, Saudi Arabia's port on the Red Sea, to provide transportation for Saudi Arabian King Abdul Aziz Ibn Saud to the Great Bitter Lake at Ismailia, Egypt for his forthcoming conference with FDR. King Abdul Aziz Ibn Saud traveled more than 800 miles to meet FDR. It was the first time that he had ever left his country.

He returned on a British destroyer rather than an American vessel at the insistence of Winston Churchill. According to Thomas Lippman [12]:

> "Whereas Roosevelt had respected the king's wishes and refrained from smoking in his presence, Churchill did the opposite. As he wrote in his memoirs, 'If it was the religion of His Majesty to deprive himself of smoking and alcohol I must point out that my rule of life prescribed as an absolutely sacred rite smoking cigars and also drinking alcohol before, after, and if need be during all meals and in the intervals between them.' He puffed cigar smoke in the King's face."

On how to deal with the Iraqi insurgents, around 1920, Winston Churchill offered the advice to use chemical weapons: "… against recalcitrant Arabs as an experiment. I am strongly in favor of using poisoned gas against uncivilized tribes to spread a lively terror." In his 1899 book "The River War," he expresses a distorted contemptuous and arrogant view about the Islamic faith.

The King, FDR, and their respective parties exchanged gifts and presented gifts to King Farouk of Egypt and Emperor Haile Selassie of Ethiopia. Princes Faisal and Khalid, sons of King Abdul Aziz Ibn Saud, and both future kings, were invited in September 1943 to Washington D. C. and met with then Vice President, and later President Harry Truman, quoted

as: “I’m sorry, gentlemen, but I have to answer to hundreds of thousands who are anxious for the success of Zionism; I do not have hundreds of thousands of Arabs among my constituents.”

NUCLEAR WEAPONS FREE ZONE IN THE MIDDLE EAST

The USA State Department has been intermittently working towards the longstanding USA-stated goal of a Nuclear-Weapons-Free Middle East. There have been three meetings of Arab countries and Israel in an attempt to set up a conference in Helsinki on how to pursue a Middle East without Weapons of Mass Destruction (WMDs). Both Israeli Prime Ministers: Yitzhak Rabin “martyr of peace”, and Ehud Olmert supported the concept of a Middle-East nuclear weapons free zone as part of a generalized peace agreement. Israel attended as an observer a meeting about the topic at the IAEA, Vienna Austria.

Saudi Arabian Prince Turki Al Faisal proposed that the five permanent members of the United Nations Security Council (USA, France, UK, China and Russia) and Germany (the P5+1 group) would provide guarantees, inspections and a nuclear umbrella to the signatories to such a regional treaty. However, an agreement on an agenda and a conference remains elusive.

MEETING THE” GOLD STANDARD,” ATOMIC ENERGY ACT OF 1954

The government of Saudi Arabia felt anxious over the outcome of the nuclear talks between the USA and Iran agreeing to Iran’s developing a closed nuclear fuel cycle including uranium fuel enrichment and recycling. As Iran received international recognition for its nuclear program, Saudi Arabia’s own peaceful nuclear aspirations were stalled. A proposed USA-Saudi Arabian nuclear agreement remained at a standstill for many years.

The nuclear issue poses a problem for Saudi Arabia, which wants to keep pace with Iran on technological advancements and regional prestige. It is also a problem for the USA, which cannot afford to be estranged from Saudi Arabia at a time when it requires its assistance in resolving conflicts in Iraq, Israel, and Syria.

The USA-Saudi Arabian nuclear talks were initiated in 2008, when Secretary of State Condoleezza Rice and her Saudi Arabian counterpart, Prince Saud Al Faisal, signed a Memorandum of Understanding (MOU) on Nuclear Energy Cooperation. Many observers expected that the two countries were forging a new pillar for their 80-year-long strategic partnership. Consequently, Saudi Arabia announced its intention to build 16 nuclear power plants at an estimated cost of $112 billion, which would have made it the world’s largest civilian nuclear program and generated tens of thousands of high-paying jobs for the kingdom’s growing young population.

Saudi Arabia justified its nuclear vision by pointing to the country’s dependence on oil and gas exports, which constitute 80 percent of national revenue. Saudi Arabia could meet its own growing energy demands through nuclear energy and would not have to curtail its sale of oil on the international market.

Before Saudi Arabia enjoys the benefits of nuclear energy, it needs to find partners who are willing to help build its nuclear infrastructure. The USA does not seem willing to play that role. It said that it would first need to reach an agreement with Saudi Arabia on adherence to the Atomic Energy Act of 1954, a USA law that regulates nuclear commerce, and those efforts have stalled over the question of whether Saudi Arabia would be subject to the so-called “Gold

Standard" provision that would proscribe Saudi Arabia from enriching uranium or recycling nuclear fuel, hence developing a complete closed nuclear fuel cycle as allowed to member nations by the Non Proliferation Treaty (NPT).

Saudi Arabia is understandably incensed at any suggestion that it would not be accorded the same right to enrich uranium that the USA effectively granted to Iran under the interim agreement between those two countries. It argued that the Gold Standard represents an unacceptable infringement on its national sovereignty, emphasizing that the NPT, of which Saudi Arabia is a signatory, stipulates that countries have a right to develop a closed nuclear fuel cycle.

The USA has been reluctant to offer any compromise. President Barack Obama avoided addressing the issue entirely during a visit to Riyadh. His hesitancy may stem from a desire to avoid a backlash in Congress similar to one in 2006 after President George W. Bush's administration proposed selling a major port to a company based in the United Arab Emirates (UAE). Saudi Arabia has avoided airing its concerns publicly for the same reasons. Israel is likely to oppose any nuclear deal with Saudi Arabia that does not adhere to the Gold Standard and will pressure its allies and supporters in the USA to do the same. Incidentally, Israel tacitly approved the 2009 nuclear deal between the USA and the UAE, which was compliant with the Gold Standard.

Should Saudi Arabia fail to reach an understanding with the USA, it might instead choose to partner with willing partners such as Canada, France, Russia, South Korea, or China to develop its nuclear program. In January 2014, during a state visit by French President François Hollande to Saudi Arabia, the French company Areva, the world's largest nuclear firm, signed a Memorandums of Understanding with five Saudi Arabian companies that aim to develop the industrial and technical skills of local companies. The Chief Executive Officer (CEO) of Russia's Rosatom, Sergei Kiriyenko, announced in July 2014 that Russia and Saudi Arabia expect to sign an agreement on civilian nuclear cooperation. If Saudi Arabia follows through on these agreements, it would be to the detriment of USA companies as well as the enduring USA-Saudi Arabian strategic partnership.

THE "SILVER STANDARD," VIETNAM AND INDIA'S TEMPLATES

To push the nuclear talks with Saudi Arabia out of their rut, a basic template, the USA could look to the nuclear deals it struck a decade earlier with Vietnam and India. A middle ground can be considered that would be acceptable to both sides.

A notable precedent is the USA-Vietnam nuclear agreement of 2014, which allowed Vietnam to obtain any nuclear reactor fuel that it needs for its reactors from the international market, rather than produce the material itself. Such a model that was dubbed the "Silver Standard." This arrangement is consistent with the agreement that Secretary of State Condoleezza Rice and Prince Saud Al Faisal signed in 2008. It is not clear that it would be acceptable to USA Congress politicians who are unlikely to accept anything short of the Gold Standard.

The USA-India nuclear agreement of 2008 could be another template. Under this agreement, India agreed to separate its civil and military nuclear facilities and to place all of its civil nuclear facilities under International Atomic Energy Agency (IAEA) safeguards. In exchange, the USA agreed to provide assistance to India's civilian nuclear energy program and expand cooperation in energy and space satellite technology.

The USA could make assurances that it would assist Saudi Arabia with its nuclear program in exchange for IAEA monitoring of its civilian facilities. It must be emphasized that, unlike India, Saudi Arabia is not planning any nuclear installations with military purposes. Like the India deal, such an agreement would allow the USA to share its state-of-the-art technologies and safety best practices, even if it included provisions that would prohibit the transfer of particularly sensitive equipment and technologies.

The USA ambassador to Riyadh, Joseph W. Westphal, broached the subject of renewed talks in July 2014. Saudi Arabia appears not to be planning to move ahead without the USA's participation, as an anticipated bidding process in the spring of 2014 has been postponed indefinitely, prompting speculation about the viability of the program. Saudi Arabia has yet to make any long-term commitments to either France or Russia, suggesting that it is still uncomfortable with pursuing its civilian nuclear program without the backing of the USA as its long-standing strategic partner.

8.23 PAKISTAN'S NUCLEAR PROGRAM

Pakistan identified eight sites for the installation of 32 nuclear power plants, which will generate a total of 40,000 MWe electricity according to Pakistan Atomic Energy Commission (PAEC) chairman Dr. Ansar Parvez: "Our future plans are to have nuclear power plants supply one-fourth of our total required capacity. On the directives of the prime minister, we are selecting eight sites for installing more nuclear power plants. Each site will feature a total of four plants – having a capacity of producing 1,100 MWe each – which will be built in two phases. [11]"

China has agreed to finance 82 percent of the total cost for two Karachi Nuclear Power Plants (KANUPP-2 and KANUPP-3) and will be providing a loan of $6.5 billion for the same. The agreement went through despite objections from the Nuclear Supplier Group – the international body that regulates nuclear power trade. China has rebuffed a call from the body saying that its nuclear exchange with Pakistan predates the group's charter and is thus exempt from it. The remaining 18 percent of cost will be borne by Pakistan: "Since the government will be providing its share in rupees, it won't need to arrange foreign exchange for the K-2 and K-3 plants." The government has also selected a site at Muzaffargarh for installing a 1,100 MWe plant [11].

Despite a severe energy crisis, Pakistan's civil nuclear ambitions have always been stymied by the nexus of the International Atomic Energy Agency, the Nuclear Suppliers Group and the USA government. Since Pakistan has not signed on to the Non-Proliferation Treaty and the supply of uranium, the basic fuel for generating electricity, is subject to severe global restrictions, historically, Pakistan has had no option but to comply.

The intercession by the USA to grant a civil nuclear cooperation deal to India in 2005 rankled Pakistan, which put in a similar request. This was shot down on the basis of fears regarding the security of the country's nuclear assets at a time Islamabad is grappling with Islamic militancy. While the USA government has offered to help Pakistan meet its energy needs through hydroelectric power and thermal projects, energy experts in Pakistan dismiss as these as inadequate [11].

Depriving Pakistan of uranium fuel at a time when many other countries, including India, are getting uranium from Australia is hard to justify. Pakistan has inserted a clause in its agreement with China for ensuring lifetime fuel supply for its nuclear power plants. The design

lifetime of the Chashma-1 and 2 plants was 40 years. It would be 60 years for the K-2 and K-3 plants. Karachi Nuclear Power Plant (Kanupp) has already outlived its design lifetime.

In the 1970s, Pakistan's Prime Minister Zulfikar Ali Bhutto said: "Even if we have to eat grass, we will make nuclear bombs." This was a reflection of the rivalry between Pakistan and India. The Pakistani nuclear program was led by Abdel Qadeer Khan. As a child, Abdel Qadeer Khan witnessed the partition of British India in 1947. His father, a Moslem teacher, decided to leave the Indian city of Bhopal and move to Pakistan, "The Land of the Pure." Abdel Qadeer Khan, 16 years of age at the time, gets caught in the turmoil of the partition. He watches soldiers robbing, raping and killing women and children. A border guard steals a ballpoint pen from him, which was a cherished gift from his brother.

After attending school in Karachi, he earned his doctorate in metallurgy in the Belgian city of Leuven. He takes a job with a supplier to the centrifuge builder Urenco, where he gains access to the centrifuge technology developed in Germany.

Abdel Qadeer Khan returned to Pakistan in January 1976 to lead its nuclear enrichment program. In 1983, a court in Amsterdam, The Netherlands convicts him of industrial espionage and sentences him in absentia to a four-year prison term in an attempt to extradite him. By 1985, Pakistan successfully enriched uranium using the centrifuge process. The nuclear research institute at Kahuta, 40 kilometers or 25 miles south of the capital Islamabad, previously named as the Kahuta Research Laboratories it is commonly referred to as the Khan Research Laboratories (KRL), in honor of its previous director.

On May 28, 1998, Pakistan conducted several successful nuclear tests and Abdel Qadeer Khan becomes a national hero, helped in large part by a Swiss family of equipment suppliers. He is reported to have provided the technology to Iran and Lybia through intermediaries in Dubai. In the summer of 2009, Abdel Qadeer Khan said: "Iran was interested in acquiring nuclear technology. Since Iran was an important Moslem country, we wished Iran to acquire this technology. Western countries pressured us unfairly. If Iran succeeds in acquiring nuclear technology, we will be a strong bloc in the region to counter international pressure. Iran's nuclear capability will neutralize Israel's power."

The security of Pakistan's nuclear warheads and fissile materials stockpile has been of concern to the USA, which has developed plans in conjunction with the Pakistan military to seize the devices and the special nuclear materials from Pakistani nuclear facilities if they believed terrorist groups were closing on the country's nuclear facilities.

INDIA'S PROGRAM, NO-FIRST-USE DOCTRINE

India has enunciated a "no-first-use" nuclear weapons doctrine, which committed it to refrain from any pre-emptive nuclear strike. The signature policy was instigated by India's Prime Minister, Atal Bihari Vajpayee, who ordered its 1998 nuclear tests. India is not a signatory to the nuclear Non Proliferation Treaty. It tested its first nuclear weapon in 1974, provoking leaky international sanctions meant to temporarily bar it from importing nuclear technology and materials. The 1998 nuclear tests drew a response from Pakistan, triggering an arms race between the two neighbors, who have fought three wars since independence in 1947.

A civil nuclear cooperation deal with the USA, sealed in 2008, provided India with access to know-how and fuel in return for an unfulfilled pledge to collaborate with USA firms to expand India's civilian nuclear power generation capacity. The pact exempts Indian military facilities and stockpiles of nuclear fuel from scrutiny by the International Atomic Energy

Agency. The exemption, granted by the administration of President George W. Bush, faced opposition from China and Pakistan, India's regional rivals, and European nations who said it would undermine efforts to control the spread of nuclear weapons.

India has a covert centrifuge uranium enrichment plant meant to support a nuclear naval propulsion program as well as a potential thermonuclear weapons program, as part of its arms race with China and Pakistan. India's new Arihant class of submarine is assessed to have an 80-MWth onboard reactor that uses around 65 kg of highly enriched uranium. One submarine is operational, a second is being built and a third is planned.

Nuclear safeguards on India and Brazil lack, while Iran faces scrutiny and sanctions from the USA and European Union powers over its nuclear program. The Washington-based Institute for Science and International Security (ISIS), in a December 2013 report, identified the construction of the new gas centrifuge plant. The Mysore fuel enrichment plant is not subject to IAEA safeguards.

The enrichment nits at the Indian “Rare Metals Plant” would boost India's ability to produce weapons-grade uranium to twice the amount needed for its planned nuclear-powered submarine fleet. The facility, located near Mysore in southern India, would becoe operational by 2015. The plant is able to produce a surplus of around 160 kgs / year a year of uranium enriched to 90 percent. The amount is double the needs of its planned nuclear submarine fleet that India is developing to supplement its land-based missile arsenal and reported to be enough to make five thermonuclear devices per year. By combining the highly enriched uranium with its existing stockpile of weapons-grade plutonium, India could develop thermonuclear weapons that have a more complex detonation process and greater yield than simpler weapons. This adds to India’s already far greater advantage over Pakistan in terms of nuclear weapons production potential, and brings India closer to matching China’s nuclear weapons capability.

The Stockholm International Peace Research Institute (SIPRI) estimates that the Mysore facility could signify India's intent to move towards thermonuclear weapons. India is estimated by SIPRI to hold 90 to 110 nuclear weapons in its arsenal by 2014.

8.23 TRAFFICKING IN NUCLEAR MATERIALS:

Unauthorized and uncontrolled movement of nuclear materials can lead to radiation hazards and proliferation risks, depending on the kinds and quantities of these materials. Sovereign nations are not involved in these activities, but individuals acting outside the confines of the laws of these nations could get involved.

Improved surveillance at airports and customs checks at borders can control such trafficking. In the USA, police and Department of Transportation and State Police authorities routinely check highway traffic for gamma rays emissions characteristic of nuclear materials.

5 

Figure 43. Nuclear materials proportional counter monitors for pedestrians and cars at Astrakhan on the Caspian Sea.

Figure 44. Nuclear materials radiation detector proportional counters portal system for trains.

Trains and vehicles in European and Asian countries pass through highly sensitive gamma ray detectors at borders checkpoints. Figure 43 shows pedestrian and vehicle monitoring portals at Astrakhan, a major seaport on the Caspian Sea for shipments to Iran. Figure 44 shows a radiation portal system for monitoring rail cars.

The most publicized case involves the interception by Russian border guards trained by USA Customs in 1999 of 10 grams of weapons grade uranium hidden inside a car traveling to Bulgaria. This is a trivially useless amount, considering that a critical mass of U^{235}, is about 54 kgs, or 54,000 gms.

A reported case involves a state trooper in the State of Illinois routinely scanning for gamma ray emissions from a truck carrying cast steel table pedestals destined to the Chicago area. Upon investigation, it was determined that the table pedestals were cast in a Mexico foundry. The foundry used scrap steel from a recycling plant in Mexico using a medical radiation instrument containing pellets of $Cesium^{137}$ previously used in cancer treatment and illegally disposed of.

There were unsubstantiated reports of attempted sales of Pu^{238} used in heart pacers, space probes, and smoke detectors in some Eastern European nations. $Plutonium^{238}$ is totally unusable

as a weapon material, and even if it were, the quantities involved are meaningless for weapons purposes. However, the traffickers tried to pass it to uninformed naïve and unsuspecting buyers for the Pu^{239} isotope suitable for weapons manufacture.

Out of the fear of the possibility of nuclear materials trafficking, over the period 1992-2000, the USA's Energy Department has spent about $1.2 billion on various programs related to protecting nuclear materials. To be specific, it is not American nuclear material being protected here: it is Russian nuclear material that the USA's Energy Department was protecting. Among the previously unthinkable justifications for these programs are: helping Russian nuclear scientists find jobs, improving physical safeguards at Russian nuclear facilities and reducing the stockpile of weapons-grade uranium and plutonium in Russia.

The USA's year 2001 budget, with an enormous surplus produced by a booming economy, had a sum of $1 billion allocated for the purchase of highly enriched uranium from Russia. This sum was also earmarked for stepping out efforts to consolidate more than 1,000 tons of plutonium and uranium now scattered in 300 buildings and 50 sites across Russia. Russia has an estimated 40,000 nuclear weapons and more than 1,000 metric tons of nuclear material including highly enriched uranium and plutonium scattered at facilities across Russia.

USA's spending on nuclear security in Russia totaled about $900 million annually. About a third of that sum was in Energy Department programs to help Russia secure nuclear materials, safeguard nuclear facilities and retrain and support nuclear scientists facing hard economic times. A panel of former federal officials in the USA recommended a $30 billion program to help Russia secure its nuclear stockpile.

Nuclear accounting methods and controls, in the nations possessing these materials is presently the perceived appropriate approach to control such traffic.

8.24 NON-NATIONAL GROUPS

After the September 11, 2001 attacks on the World Trade Center and the Pentagon in the USA, the possibility of access of non-national groups to fissile or radioactive materials became an area of intensive debate. Those considering these possibilities present three separate scenarios:

1. The suitcase device.

In this case, it is suggested that a non-national group could obtain a miniature portable nuclear device. These were known as “small atomic demolition munitions’” and were intended for destroying bridges and railways in Europe in case of a NATO–Warsaw pact confrontation. A few hundred of these devices may have been manufactured by the USA and the previous Soviet Union. This alternative is considered as outright imagination since the USA intelligence services have expressed very high confidence that Russia has accounted for all its nuclear weapons. Even if a portable device were acquired, nuclear weapons are equipped with safety devices that would self-destruct and disperse the weapon’s material the without causing a nuclear reaction in case of unauthorized initiation.

2. Smuggled nuclear material device.

The IAEA reported 18 cases of fissile smuggling since 1993, and numerous cases of attempted trafficking in radioactive substances. The fissile materials cases involved gram

quantities probably stolen from research laboratories, with quantities that are not in any way sufficient to attain supercriticality. About 18 countries possess various amounts of fissile material that is jealously guarded or under international safeguards. The largest amount exists in Russia with 1,300 metric tons of plutonium and highly enriched uranium. Since 1992, USA agencies have spent 5 billion dollars upgrading Russia's security at the laboratories and the weapons sites where they are stored, and providing employment and financial aid to the weapons scientists, with the intention of preventing them from marketing their expertise to clandestine weapons programs in other nations. The Russians welcomed wholeheartedly this new form of trade that helped their economy based on the newly arisen paranoid fears in the USA.

3. Radiation dispersal device.

There have been concerns that a non-national group could obtain stolen radioactive nuclear material and construct a radiological dispersal device where the objective is, through a chemical explosion, to disperse the radioactivity in a given area. Assuming that the individuals involved do not get severely sickened and eventually killed by the emitted unshielded radiation, and pass undetected through multiple safeguards, the emitted radiation itself would not cause major harm upon dilution. So, beyond the damage caused by the chemical explosive, what is left is only the psychological effect of the event.

8.25 THE OBSOLESCENCE OF NUCLEAR WEAPONS

OVERVIEW

The USA policy on nuclear deterrence has evolved since the first use of nuclear weapons in the Second World War. The perceived usefulness of nuclear weapons has also decreased significantly among the nuclear weapons states, even though they may remain a practically unattainable goal for rogue states and non national groups. The evolution of nuclear deterrence policy in the USA is shown in Table 4. Beyond the year 2002, many options were being debated, including keeping nuclear weapons in trust for any possible future need, for instance for protecting Earth against incoming stellar invaders as asteroids or comets. A decision has been taken to develop an anti missile defense system and to withdraw from the Anti Ballistic Missile (ABM) defense treaty. Fissile materials from dismantled aged weapons are not to be burned for power production in nuclear reactors, but be held in trust for any future uses by humanity. A Weapons Stewardship program assures the viability of existing devices through a laboratory-testing program and through numerical computer simulations.

The fact still remains that many wars have been fought without nuclear weapons being used, which suggests that their use was neither possible nor practicable.

Table 4. Evolution of USA's Nuclear Deterrence Policy.

Date	USA Nuclear Deterrence Policy
1945	End of World War Second.
1947	Single Nuclear Power State.
1954	Massive retaliation
1963	Flexible response, escalation dominance.

1965	Assured destruction of opponent.
1967	Mutual Assured Destruction (MAD).
1969	Sufficiency.
1974	Essential equivalence.
1976	Rough equivalence.
1979	Countervailing strategy; Presidential directive 59.
1981	Peace through strength: National Security Defense directive 13.
1983	Strategic defense Initiative (SDI.)
1989	Weapons of last resort.
1994	Nuclear posture review.
1997	Post cold War deterrent with hedge.
2001	Deterrence, Assurance, Dissuasion, Defense.
2002	Missile defense system development. Withdrawal from Anti Ballistic Missile (ABM) defense treaty. Weapons Stewardship program. Nuclear weapons held in trust for humans. Reconstitution as a safeguard. Sustained deterrent. Flexible deterrent. Responsible hedge deterrent. Minimal deterrent. Recessed deterrent. Virtual deterrent. Undeterrence.
2003	Pre-emptive Unilateral Intervention. Regime change. Shock and Awe. Denial of nuclear and dual use technologies.
2005	Counter proliferation. Proliferation Security Initiative.
2006-2011	Global Nuclear Energy Partnership, GNEP. Control of nuclear fuel trade.

New technology in weapons systems, including those based on the Global Positioning System (GPS) has lead to precision guided munitions and made nuclear weapons practically obsolete and unusable in present warfare. This is occurring in the same way as mobile warfare in the 1940s in the Second World War using tanks had replaced static trench warfare of 1914-18 First World War. In 1940 it took the German Wehrmacht only six weeks to roll from Germany and the river Rhine to Paris and the Seine River. Some French military leaders thought that oil is dirty, while horses dung was not. Others thought that tanks would need mechanics that would be susceptible as non elite working class individuals to communist influences.

In World War Second, the target kill probability of bombs was 1 in 400 or 0.24 percent. In the Afghan War in 2001, the kill probability has been enhanced with precision munitions to 90 percent. Real time intelligence from unmanned drones and satellites, precision munitions guided by the space based global positioning system, and stealthy aircraft turn smaller smarter forces into effective agile and flexible overwhelming forces, capable of killing from a safe distance without their being reachable by their opponents.

As outlined by George Will, four main characteristics now cover modern military doctrine in the USA, in view of preserving its status as the single world hyperpower with significant asymmetric force, and the arbiter of last resort for the foreseeable future:

1. Protection of the information networks

This is based on real time satellite photography in the visible and infrared regions allowing monitoring in day and night, as well as space radar allowing the detection of underground installations. These are the cornerstones of precision warfare, protecting friendly forces from attack, while being able to attack those of the adversaries.

2. Enhancement of joint forces operational capabilities

This is to be achieved through leveraged information technology, and the optimal use of different forces at the appropriate places and times.

3. Maintenance of unhindered access to space

The ultimate high ground is outer space. Protection of the infrastructure that supports the space capabilities that allow the projection of military power to any point on the Earth's surface becomes of paramount importance. It will be soon feasible for space technology to identify, illuminate and destroy targets both above and under ground. It is known that radar can penetrate the ground and identify from outer space underground structures. Those targets could be stationary like missile silos or command posts, or mobile such as planes, cruise missiles, submarines and ballistic missiles.

4. Decapitation of opponents' leadership

This involves extending the conflict to destroy the enemy's leadership rather than the more economical expediting the quickest cessation of hostilities. This 19-th century non technological and aspect of military doctrine has been also been designated as a policy of "extermination" or "eradication" of the enemy, particularly its leadership. This includes dividing the opponents and turning its factions against each other, then eliminating them one a time. As discussed by George Will, the policy dates back to the USA's Civil War, in the scorched Earth policy of General William Tecumseh Sherman who believed in what he called "the awful fact" … that victory required "that the present class of men who rule the South must be killed outright." He believed that the army's goal is not to occupy territory, but to destroy enemy personnel. Hence, after the torching of Atlanta, Georgia in 1864, he proclaimed: "I fear the world will jump to the wrong conclusion that because I am in Atlanta the work is done. Far from it. We must kill three hundred thousand I have told you of so often, and the further they run the harder for us to get them." The eerie success of this policy can be glimpsed from a letter written after the Civil war by the Confederate general D. H. Hill to another Confederate general Jubal Early: "Why has the South become so toadyish and sycophantic? I think because the best and noblest were killed off during the war."

Several new technologies have been developed to reach the threshold of destructiveness of nuclear weapons through electronic, mechanical and chemical processes without the burden of nuclear weapons and their widespread indiscriminate destructiveness and resulting radioactivity.

DEPLETED URANIUM MUNITIONS AND ARMOR

Depleted Uranium is a very dense material approximately twice the density of lead. It has the capability of penetrating armor, and can also be used itself as armor for tank and personnel carriers. Because of its high density it is used as ballast in ships and aircrafts. Depleted uranium munitions were first used during the Gulf War in 1991, leading to devastation of the Iraqi army. It has been later used in the Bosnian, Kosovo, Afghanistan and the Iraq conflicts.

DAISY CUTTER 15,000 LBS DEVICE

This large weapon designated as BLU-82 is capable of incinerating everything within a 600 yards radius. It is a high blast device used effectively in the Afghan war against mine fields and congregations of ground forces in the open or protected by building structure. Figure 45 shows a daisy cutter device on its parachuted pallet.

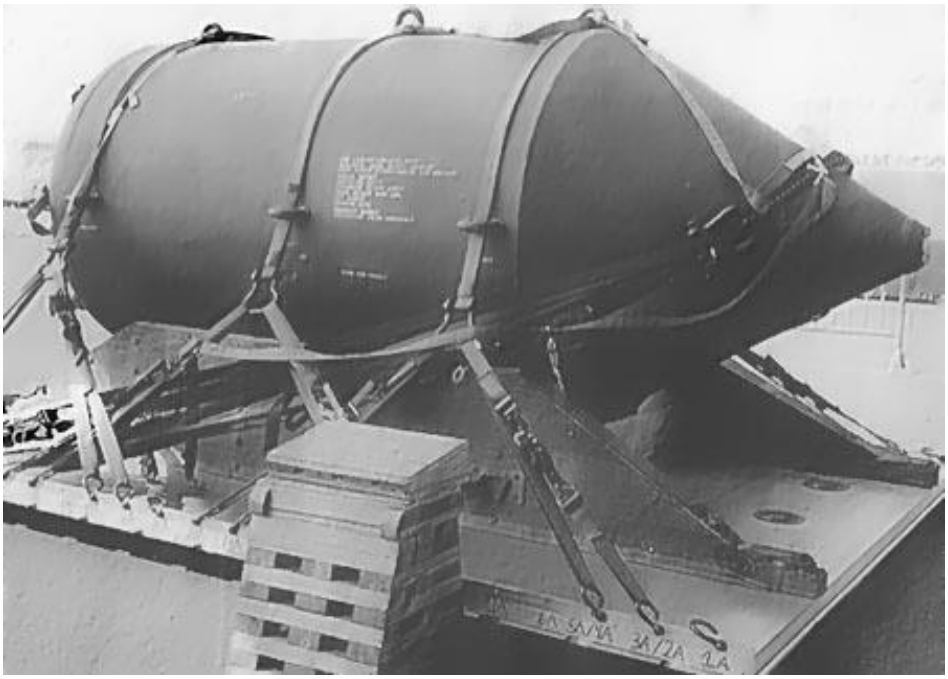


Figure 45. A 15,000 pounds Daisy-Cutter BLU-82 device on its parachute-dropping pallet.

FUEL-AIR MIXTURE EXPLOSIVES

This weapon was developed during the Vietnam War. It depends on creating a mist of liquid fuel in the air, which is then detonated. Explosions of different yields can be created depending on the size of the droplets produced, wind speed and other factors. The inability to predict the yield makes them hard to use. The explosion depletes the air from all traces of oxygen within its explosion radius, leading to death by suffocation of any oxygen breathing life forms in its effective radius.

THERMOBARIC AND VACUUM WEAPONS

This device generates both heat (thermo) and blast pressure (baric) with a yield at thelevel of tactical nuclear device without the radioactive emissions. This weapon, designated as the BLU-118b, is an evolution of the earlier Fuel-Air Mixture explosives and can be used in several configurations. It generates explosions based on the same principle as dust explosions that occur frequently in grain elevators in the USA's grain belt, or methane explosions. These explosions occur when fine dust or methane gas is generated in grain handling operations or methane gas in coal mines. The dust offers a large surface area to oxygen in the air. Powerful explosions and

destructive shock waves can be initiated in the finely dispersed dust by a spark from starting an electrical motor, or an employee clandestinely smoking a cigarette.

Such devices generally detonate in two stages. First a small blast disperses a main load of explosive slurry material into a cloud at an optimal height around 500 feet to create a horizontally moving mach stem, which then either spontaneously ignites in air or is set off by a second charge. This explosion generates a pressure wave that reaches much further than that from a conventional explosive. The consumption of gases in the blast also generates a partial vacuum that can compound damage and injuries caused by the explosion itself.

The main destruction is inflicted by an ultrasonic shockwave and a high temperature causing all that is alive to merely evaporate. The heat and pressure effects are formidable. Humans caught in the blast could have the air sucked from their bodies and even their internal organs catastrophically destroyed.

Thermobaric weapons are closely related to the fuel-air explosives, where the explosive cloud is provided by a volatile gas or liquid.

Figure 46. Views of Russian and USA thermobaric devices and comparison of Russian and USA devices.

Figure 47. Explosion of Russian thermobaric device. It is characterized by three separate and distinct explosions. The earlier explosion consume the oxygen needed for the subsequent ones and allows the gaseous fuel to expand into the created vacuum before detonating.

In September 2007, Russia announced the development of a new bomb that is more powerful than the USA GBU-38/B 21,700 lbs Massive Ordnance Air Blast Bomb (MOAB), also known under its name "Mother of All Bombs". The Russian designers called their new weapon "Father of All Bombs." It is four times more powerful at 44 metric tons of TNT equivalent than its USA satellite guided 11 tonnes of TNT equivalent counterpart and the temperature at the epicenter of its blast was two times higher. It has a blast radius of 300 feet or 990 feet, twice as large as the USA design destroying all human life within three miles and causing deaths within up to four miles in diameter. Portable versions of this weapon are suspected to have been used by Russia to level off the capital city of Grozny in Chechnya.

The thermobaric devices create a cloud of explosive particles such as aluminum powder, or explosive slurries with a shock wave of higher strength and duration than generated by conventional explosives. The generated shock waves can be directed and amplified in enclosed spaces such buildings, bunkers, tunnels and caves. An interesting characteristic is that this allows the destruction of the contents of the enclosed space without destroying its access entrance. These weapons are dropped from airplanes and directed to their targets using their fins and the coordinates of the target fed into the Global Positioning System by ground special or clandestine special forces. The weapon can also be guided to its target through illuminating it by special lasers invisible to the opponents. They are exploded near the entrance of the enclosed structure directing the generated blast wave to its interior.

Those USA's AH-1W Apache helicopters and the Predator drones are armed with thermobaric weapons as a Force Multiplier:

> "The Hellfire thermobaric warhead using a metal augmented explosive charge is used primarily in urban warfare, against bunkers, buildings caves and other concealed targets. This warhead is designed to inflict greater damage in multi-room structures, compared to the Hellfire's standard or blast-fragmentation warheads. The Metal Augmented Charge or MAC (Thermobaric) Hellfire, designated AGM-114N, has completed rapid development cycle in 2002 and was deployed during OIF by US Marines Helicopters in Iraq. The new warhead contains a fluorinated aluminum powder that is layered between the warhead casing and the PBXN-112 explosive fill. When the explosive detonates, the aluminum mixture is dispersed and rapidly burns. The resultant sustained high pressure is extremely effective against enemy personnel and structures. The AGM-114N is designed for deployment from helicopters such as the AH-1W or UAVs such as the Predator drones."

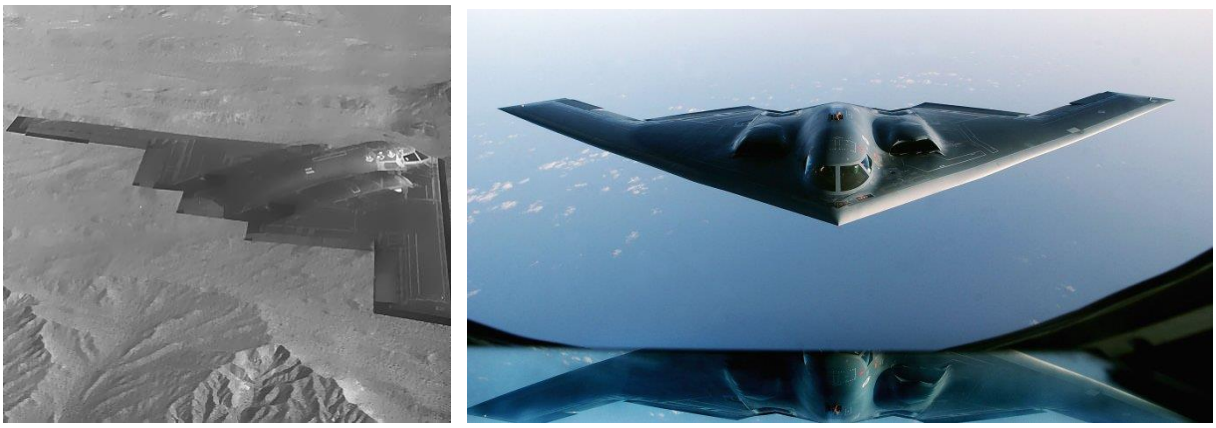


Figure 48. Stealth bomber, Northrup B-2A.

STEALTH AIRCRAFT TECHNOLOGY

Radar evading stealth technology has been applied to both fighter and bomber aircraft, and even surface ships. The designs involve sharp angle deflecting radar waves rather than reflecting them, and materials and coatings absorbing radar waves. The technology has been instrumental in defeating air defenses and quickly achieving air superiority and control in most of the recent conflicts: the Gulf War, Bosnia, Kosovo, Afghanistan and Iraq. Figure 48 shows the Northrup B2-A, which is the ultimate of what bombardment platform should be. These became operational on December 17, 1993. This was the first anniversary of the Wright Brothers' first powered air flight.7

GUNSHIPS, THE US AIR FORCE AC-130U

These are slow moving but they offer pinpoint accuracy against targets. The aircraft can cruise at low altitude over a target area and fire side mounted guns as shown in Fig. 49. The guns could use depleted uranium munitions against armor. The latest versions have radar to detect targets at long range, as well as satellite guided navigational systems.

Figure 49. A Special Forces gunship equipped with cannon and heavy machine guns, the US air Force AC-130U.

UNMANNED AIRCRAFT AND SENSOR NETWORKS

Stealth and unmanned aerial vehicles (UAV) can fly over combat areas and transmit visual video, infrared, and radar information to controllers who would direct naval, artillery or aircraft fire. They come in two versions, the Vertical Take-off and Landing (VTOL) shown in Figs. 50, 51, and the stealth Predators in Fig. 52. Some of the latter are have been outfitted with missiles that have been remotely shot at ground targets.

The unmanned aircraft can be used to position, maintain and operate correlated sensors networks in rough terrain as shown in Fig. 53. The sensors can be permanently deployed in sensitive locations or deployed on demand. They can be self-powered using solar arrays or batteries or they could clandestinely tap their energy from existing power sources such as telephone networks. Data fusion algorithms generate continuous online information from communication links. These sensors can detect the presence of fissile material, biological agents, and ordinary troop movements. The array of sensors could form a reconfigurable and self-healing network relaying the information to the unmanned aircraft.

Figure 50. Unmanned Vertical Take Off and Landing (VTOL) aerial vehicle.

Figure 51. Honeywell observation and monitoring drone with a range of 6 miles.

Figure 52. Unmanned Aerial Vehicle, UAV Predator aircraft. Source: USAF

Figure 53. Unmanned Predator aircraft with a correlated sensor network.

PREDATOR UAV

The Predator UAV flies at up to 25,000 feet for around 20 hours at a time. The drone was initially supposed to be a pure surveillance aircraft. Starting in late 2000, the President Bill Clinton and George W. Bush administrations decided to outfit the Predator with Hellfire missiles to reduce the lag time between identifying Osama bin Laden in Afghanistan and attempting to take him out.

Bureaucratic wrangling delayed the armament, but in November 2002, a CIA-operated armed Predator blew up a Jeep carrying some of bin Laden's associates The age of the

Predator; an age of remotely piloted air war and extra-judicial clandestine assassinations had begun.

REAPER UAV

The Reaper came into use in 2007 and is built by the General Atomics Company like The Reaper. It flies twice as fast: 150-170 knots cruising, 260 maximum, at higher altitudes around 50,000 feet, and carries ten times the payload of over 2 tons as the Predator.

This allows it to strap on the AGM-114 Hellfire missiles, as well as GBU-12 and GBU-38 precision bombs.

As a surveillance aircraft, it has more electrical power than the Predator, which means that new or improved sensors can be integrated on the aircraft.

As of 2010, the USA Air Force owns 57 of the drones and plans to buy another 272, for a total buy of 329 planes. Many of the drones were deployed in Afghanistan. Air Force officers pilot them remotely from Creech Air Force Base in the state of Nevada.

The CIA operates an unacknowledged drone program over the Pakistani tribal areas an Yemen. The Air Force supplies the CIA with its drones which used it for 108 strikes in 2009 alone..

The lethality of that program drew the attention of other countries wanting the same weapons. WikiLeaks revealed that USA allies such as the United Arab Emirates and Turkey attempting to buy armed Reapers from the USA almost as soon as the Predator upgrade came online.

Armed drone sales to non-NATO allies are probably still years off, but General Atomics has USA State Department approval to sell the unarmed version of the Predator as surveillance aircraft to non-NATO countries like Pakistan, Egypt and the UAE.

AVENGER UAV

China, Iran and Israel are some of the countries that have their own indigenous drone programs. The Reaper is getting an upgrade by General Atomics a faster, stealthier Avenger.

Even as the Reaper replaces the Predator in the USA, the global proliferation of drone technology is the path-breaking plane's real legacy.

Figure 54. Predator C Avenger.

As of 2011 the USA military had 6,000 unmanned drone aircraft in its arsenal that can be piloted remotely from a base in Nevada. Figures from the New America Foundation show there were nine USA drone strikes in Pakistan between 2004 and 2007. In 2008, the number jumped to 33. The numbers continue to accelerate under President Barack Obama: 53 in 2009 and 118 last year in 2010.

The Predator C Avenger can cruise at 53,000 feet for up to 20 hours, carrying 3,000 pounds of precision munitions. Drones are now in use in the covert wars in the Yemen and Somalia. Unarmed surveillance drones keep an eye on the USA Mexico border.

PRECISION LASER AND GLOBAL POSITIONING SYSTEM (GPS) MUNITIONS

Using small portable lasers and the Global Positioning System (GPS), ground forces infiltrating behind enemy lines under disguise, for instance as local populations, aid workers or news reporters can locate targets in a way that airline pilots are incapable of. The lasers are invisible to the human eye, yet sensors in the bombs can see them. Special operating forces carry portable radios that can intercept the opponent's side's radio communications and mobile telephone communications. They operate with local friendly groups who would designate buildings, caves, installations or vehicles that are to be hit. Besides night vision goggles, distributed to all troops, some special forces have high technology sniper rifle scopes that are so sensitive that they can spot a person miles away in total darkness using ambient light amplification methods, or infrared sensors. Two approaches to precision munitions were being used:

1. Laser Guided Munitions

An air force specialist called forward air controllers illuminates the target with an invisible laser. The pilot receives the information and drops the bomb, which sees the target and steers itself with its tail fins to strike the target. Figure 55 shows a five hundred pounds Joint Direct Attack Munition (JDAM) on its cart, showing the directional finning. The advantage of this approach is that pilots do not need to identify the targets reducing their exposure to enemy fire. In addition, the bombs can follow a moving target as long as it remains illuminated by the laser. Some Special Forces troops carry a "Modular Target Identification and Acquisition" unit, which combine a laser range finder with a laser pointer. The only flaw in its usage occurs if a cloud of dust or smoke would absorb the laser and obscures the target from the laser beam. This approach found its widest application in the Gulf War.

2. Global Positioning System (GPS) Munitions

A forward air controller in this case aims a laser range finder to measure the target's distance. Coupled with the soldier's GPS data, the target's coordinates are determined. Using encrypted radio signals, the bombers crew receives the data, and the satellite-guided bomb is programmed with the coordinates. Some devices can transmit the coordinates directly to the bomber. Others allow the controllers to send more detailed information, including digital photographs or videos to pilots or commanders. Once dropped, it steers itself with its fins to the target's coordinates. The advantage here is that it cannot be obscured by smoke or dust like in the laser approach. The possible flaw is that if the coordinates are not correct, the bomb will miss the

target, possibly coming very close to friendly positions. This approach found its widest application in the Afghan war.

Figure 55. Five hundred pounds Joint Direct Attack Munition (JDAM) on its cart, showing the directional steering and control fins.

Figure 56. Defense Advanced Research Projects Agency (Darpa) Falcon Project, Hypersonic Vehicle Technology 1 (HTV1) ramjet missile.

Figure 57. NASA Waverider hypersonic X43b plane artist depictions.

Figure 58. Lockheed Martin X35C bomber.

HYPERSONIC RAMJET AND SCRAMJET MISSILES

The supersonic ramjet missile, shown in Fig. 56, and under development by the USA, Russia, Japan, Germany, France and India, can escape being downed by conventional missiles, and can outmaneuver slower moving aircraft as well as antiaircraft missiles. It is considered for unmanned aircraft.

Pratt and Whitney Rocketdyne is developing the X-2 hypersonic scramjet engine hoping to best the X-1 engine which produced Mach 6 levels of thrust, fast enough for a flight on a projected X-51 Waverider from New York to Tokyo of two hours.

Commercial jet engines use fast rotating fans to generate thrust. A scramjet engine has no moving parts. A solid fuel rocket propels the aerial vehicle to Mach 5, and air is compressed and heated as it speeds into the confined space inside the engine cavity. Fuel is injected into the superheated air sparking a small controlled explosion that fires out of the exhaust duct and propels the vehicle forward.

AERIAL AND SATELLITE IMAGING

Some military spy satellites are reputed to achieve a five-inch resolution. Commercial satellites have a resolution of 1 meter like the photograph of Fig. 59 taken by the Ikonos satellite. The Ikonos satellite orbits from the North Pole to the South Pole at a height of 423 miles and at a slight angle so that it passes in three days over every spot on Earth. The Space Imaging Company has received a license to operate a satellite by 2005 with a half-meter resolution.

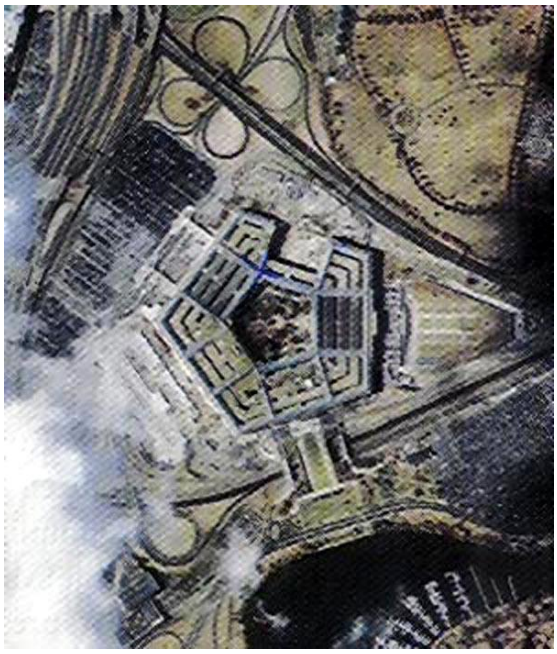


Figure 59. A one-meter resolution photograph taken by the Ikonos satellite showing a wing under reconstruction at the Pentagon building.

During the Afghan war, the Pentagon signed an exclusive license to purchase all its pictures of Afghanistan to prevent other parties from tracking USA operations.

The Ikonos satellite uses a telescope where the incoming light bounces between mirrors that focus it onto a Charge Coupled Device (CCD) dense sensor array. The mirrors in the telescope shown in Fig. 60 are perfectly polished using sophisticated diamond-cutting technology. If the mirrors had a 100 miles diameter, the highest bump would rise less than 0.08 inch. The alignment error is measured in terms of Angstroms, the unit used for measuring the wavelength of light. Each one of the thousands of glass pixels on the CCD device is coated with 66 thin film filters each with a thickness at the Angstrom level.

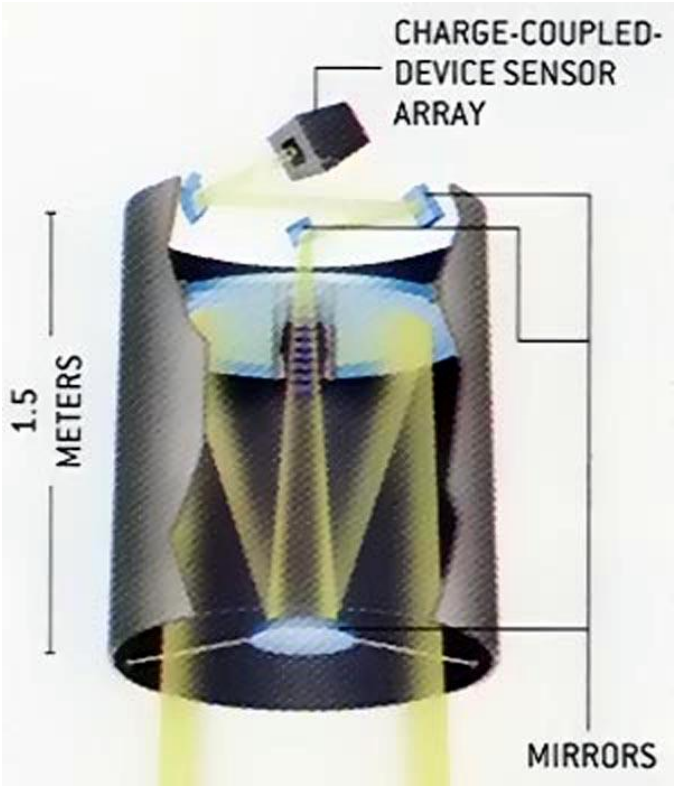


Figure 60. Telescope structure in imaging satellite.

EARTH PENETRATING BUNKER BUSTER MUNITIONS, MASSIVE ORDNANCE PENETRATOR, MOP, GBU-57

INTRODUCTION

During World War II, attacking heavily protected targets like submarine pens and rocket facilities in occupied France and Germany was a challenge to the Allied air forces. A British engineer, Barnes Wallis, contributor to the dam busting bouncing bomb, designed a 12,000 lb weapon designated as Tallboy; a streamlined, spin stabilized device with a terminal velocity of over Mach 3.5 when dropped from 20,000 feet. Carrying 5,200 lbs of Torpex D1 explosive, it made a crater 80 ft deep and 100 ft across. By 1945, another 22,000 lbs design was built designated as the Earthquake Bomb or Grand Slam.

These weapons temporarily went out of fashion with the advent of nuclear weapons, but they are back in production with new features such as Global Positioning System, GPS guidance. The B61-11 penetrating nuclear bomb which was typically reserved for such missions lost its appeal because of its radioactive as well as political fallouts complications.

Air-burst and surface-burst weapons may be inadequate to destroy very hard underground targets since very little of their energy release actually reaches the target. An Earth Penetrator-Weapon (EPW), by exploding underground, couples a much larger fraction of its energy into ground motion and would be more effective than a surface burst weapon.

Ground shock is the determining factor in destroying underground targets. An EPW can be much lighter than a surface device that would generate the same level of ground shock

to a target of interest. The geology around a target affects its susceptibility to damage. If a water table or a material interface intersects a buried structure, the resulting discontinuity in the material properties increases the bending strains in the structural walls.

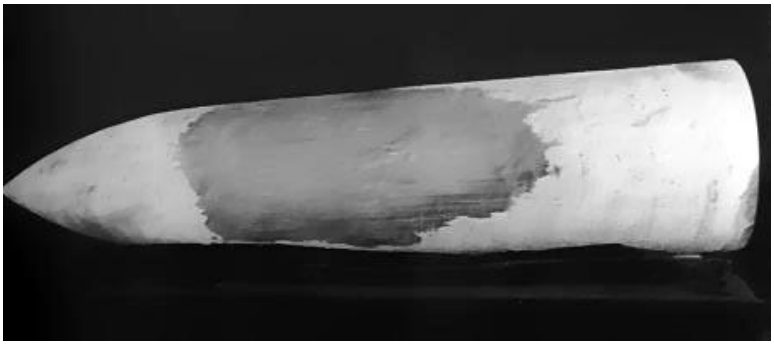


Figure 61. Earth penetrator casing made out of depleted uranium dug out of rock.

Figure 62. Earth penetrator bunker buster munition consists of a shaped charge front component followed by a hardened case penetrator.

Penetrator cases are designed in a shape that permits it to penetrate stably into soil, concrete and rock. They must be strong enough to withstand the bending forces from high velocity impacts. In addition to safety and reliability requirements, the warhead for an EPW and the fusing and firing components must withstand the very large decelerations that the case does.

Earth penetrating weapons offer advantages above surface burst devices for most relevant figure of merit of effectiveness against buried structures.

EARTH PENETRATION

A deep underground tunnel facility in a rocky geology poses a significant challenge for conventional non-nuclear weapons. Such a target is difficult to penetrate and the likelihood of damaging critical functional components deep within the facility from an energy release near an adit or opening is low. Experience has shown that 2,000 lb penetrators carrying 500 lbs. of high explosive are relatively ineffective against tunnels, even when skipped directly into the tunnel entrance.

Several thousand pounds of high explosives coupled to the tunnel are needed to blow down blast doors and propagate a lethal air blast throughout a typical tunnel complex. This can be achieved either by an accurate blast weapon situated in front of the tunnel entrance or a penetrator that has burrowed directly into the tunnel. In both cases, the munition must be on the order of 20,000-30,000 lbs to couple a sufficient amount of energy to the tunnel.

The penetrator requires the weight for penetration and the blast weapon requires the weight for carrying high explosives. Optimized penetrators of this size may penetrate about 5 to 8 times farther than an existing 2,000 lb class weapon and may also be suitable for housing a clean low yield nuclear weapon.

Using the tactic of optimal dual delivery, where a second penetrator follows immediately behind the first, and boosting the penetrator velocity with a rocket motor, a depth of up to 40 meters can be achieved in moderately hard rock. This sort of accuracy could be achieved only by the use of laser guidance, GPS steered weapons would not suffice.

THE MASSIVE ORDNANCE PENETRATOR, MOP

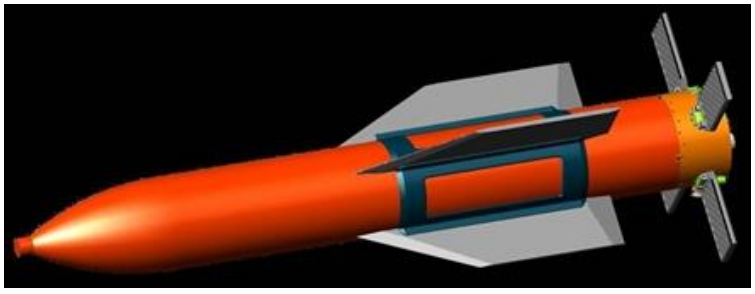
The USA Defense Threat Reduction Agency has stepped out of its usual verification and Weapons of Mass Destruction, WMD detection and destruction programs to fund a project called the Massive Ordnance Penetrator, MOP. It is also called “Big BLU” or “Direct Hard Target Strike Weapon.”

This 30,000 lbs weapon is approximately 31.5 in in diameter and 20.5 ft long, with about 5,300 lbs of explosive loading. It is not the largest bomb the USA has ever built: the 44,000 pound T12 holds the title, but it could become the biggest conventional bomb ever used. The so-called Mother Of All Bombs, MOAB GBU-43 fuel-air explosive bomb weighs 21,000 lbs.

In 2004, a Pentagon science board task force issued a report: "Future Strategic Strike Forces." In it, the task force said that existing non-nuclear weapons were too weak and recommended that a new weapon be developed:

> “To improve conventional attack effectiveness against deep, expansive, underground tunnel facilities.
>
> Our past test experience has shown that 2,000-pound penetrators carrying 500 pounds of high explosive are relatively ineffective against tunnels, even when skipped directly into the tunnel entrance.
>
> Instead, several thousand pounds of high explosives coupled to the tunnel are needed to blow down blast doors and propagate a lethal air blast throughout a typical tunnel complex.”

Figure 63. Massive Ordnance Penetrator (MOP) in aircraft bomb bay.



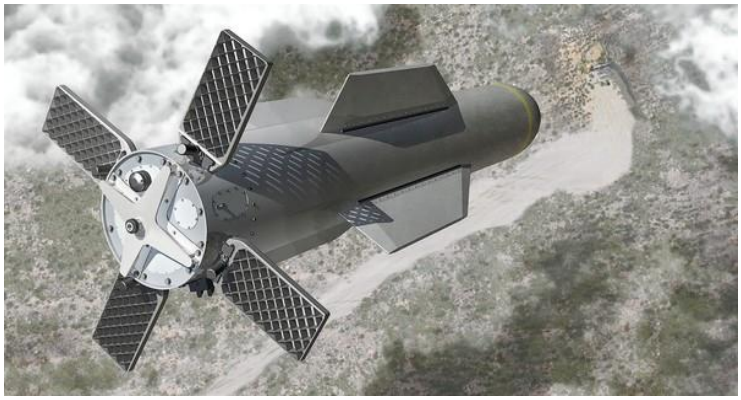


Figure 64. Massive Ordnance Penetrator (MOP) showing its lateral and tail fins. Source: Boeing.

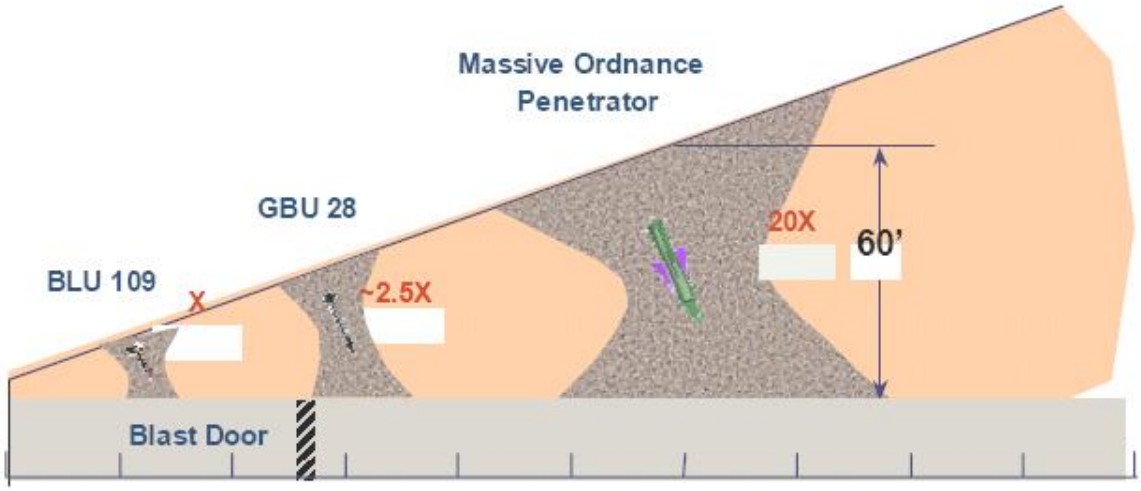


Figure 65. Concrete penetration of 20,000-30,000 lbs of blast, penetrator and parafoil deployed vehicle variants of earth penetrator munitions.

Unlike the MOAB, the MOP is a GPS guided, penetrating weapon that can be carried aboard B-52 Strato-fortress or B-2 Spirit bombers platforms to defeat "a specialized set of hard and deeply buried targets" like bunkers and tunnel facilities. The B-2 will be able to carry 2 MOPs: one in each bay, mounted to the existing forward and aft mounting hardware.

The expectation is of over 60 ft of concrete destroyed, with the bomb was meant to penetrating 200 feet underground before exploding.

The Northrop Grumman Company is the B-2A prime contractor, and leads the MOP integration effort. The Boeing Company is the prime contractor to produce the MOP, and will also be the B-52 fleet integrator. The B-2, developed by Los Angeles, California-based Northrop Grumman Corporation has a skin capable of evading radar and is the only USA

bomber capable of penetrating air defenses such as those believed in use by North Korea and Iran. The B-2 bombed targets in the early days of NATO's Kosovo air campaign and in the Afghanistan and Iraq wars.

The MOP is approximately 20.5 feet long, with a 31.5-inch diameter and a total weight of slightly less than 30,000 pounds. It has a hardened-steel casing that is designed to reach targets up to 200 feet underground before exploding. The weapon will carry over 5,300 pounds of explosive material and will deliver more than 10 times the explosive power of its predecessor, the BLU-109. It is nearly five tons heavier than the 22,600-pound GBU-43 MOAB surface bomb, sometimes called the "mother of all bombs." Guided by Global Positioning System navigation, the MOP has cropped wings for improved agility and storable grid fin controls that also facilitate internal carriage.

The MOP is designed to permit carriage inside both the USAF B-52 and B-2 bombers. The giant bunker-busting bombs were tested at the White Sands Missile Range in New Mexico. The Boeing Company developed and built the massive bomb at its Phantom Works facilities in St. Louis, Missouri.

Table 5. Massive Earth Penetrator, MOP Technical Specifications.

Weight, total	13,600 kgs, about 30,000 lbs
Weight, high explosive	2,700 kgs, 6,000 lbs, > 5,300 lbs
Length	6 m, 20.5 ft
Guidance	
Diameter	31.5 in
Penetration	60 m, 200 ft, 5,000 psi* reinforced concrete 40 m, 125 ft, moderately hard rock, 8 m, 25 ft, 10,000 psi reinforced concrete
Contractors	Boeing, Northrop Grumman
Sponsors	Air Force Research Laboratory's Munitions Directorate, Defense Threat Reduction Agency.
Platforms	B-52, B-2
Guidance	Global positioning System, GPS guidance. Short span cropped wings for high speed stability Lattice or trellis tails, folded forward for storage. GPS aided INS for adverse weather guidance. Precision accuracy will be attained by using differential GPS (DGPS) technology demonstrated on programs such as Enhanced Differential GPS for Guidance Enhancement (EDGE) and Miniature Munition Technology Demonstration (MMTD).

* psi is a rating of concrete strength

The warhead was to be a 20,000 lb. penetrator with dense metal ballast. This concept uses the Hard Target Smart Fuze (HTSF), an accelerometer based electronic fuze which allows control of the detonation point by layer counting, distance or time. The accelerometer senses

G loads on the bomb due to deceleration as it penetrates through to the target. The fuze can distinguish between earth, concrete, rock and air.

FIELD ARTILLERY RADAR

A new development in warfare that could make field artillery obsolete is the use of an array of field radars to identify the trajectory of an incoming mortar, artillery round or projectile, and using an inverse mathematical technique to pinpoint its origination point. Using the global positioning system (GPS), a rocket is promptly sent to within five meters of the artillery or tank crew that fired the round, obliterating the location by day or night.

SUTER SYSTEM

What enabled the Israelis to slip past Syria's air defenses during the September 6, 2007 raid, is a system that has been used in Iraq to detect transmissions from terrorist communications and zap the triggering systems of Improvised Explosive Devices (IED) detonation systems. This system is referred to as Suter.

The USA-developed Suter airborne network attack system was developed by BAE Systems and integrated into USA unmanned aerial vehicle operations by L-3 Communications. Israel has long been adept at using unmanned systems to provoke and spoof Syrian Surface to Air Missile (SAM) systems, as far back as the Bekka Valley engagement in 1982.

The basic elements of Suter are powerful sensors, for detecting all manner of electronic emissions. This is coupled with fast computers, and a large database of known emitters. The computer software quickly identifies the emitters, and potential entry points into enemy communications networks. Suter transmitters can shut down some or all enemy emitters, just monitor them, or inject misleading information.

USA Air Force officials will often talk about jamming, but the term now involves increasingly sophisticated techniques such as network attack and information warfare. The USA version of the system has been at the very least tested operationally in Iraq and Afghanistan against insurgent communication networks. The technology allows users to invade communications networks, see what enemy sensors see and even take over as systems administrators so sensors can be manipulated into positions where approaching aircraft cannot be seen. The process involves locating enemy emitters with great precision and then directing data streams into them that can include false targets and misleading messages that allow a number of activities including control.

The Kuwaiti newspaper Al Watan reported that USA jets provided aerial cover for the Israeli strike aircraft during the attack on Syria. Similar statements of American involvement were made by Egyptian officials after the 1967 and 1973 wars with Israel. The Al Watan newspaper suggested that: “Russian experts are studying why the two state-of-the-art Russian-built radar systems in Syria did not detect the Israeli jets entering Syrian territory,” and: “Iran reportedly has asked the same question, since it is buying the same systems and might have paid for the Syrian acquisitions.”

AIR BURST SMART GUN, XM25

The USA Army has developed the ATK XM25 airburst 25mm grenade launcher Individual Semi-Automatic Airburst System (ISAAS) also designated as Individual Airburst Weapon System (IAWS

The XM25's developers have stated that the 12-12.5-pound, 29.5-inch weapon will "change the rules of warfare as we know them."

The XM25would give USA infantry a capability that they currently do not enjoy, thanks to the XM25's precision-defilade capability provided by its Counter Defilade Target Engagement (CDTE) system, consisting of the weapon itself, a "fully-integrated" L-3 Brashear XM104 ruggedized Target Acquisition and Fire Control (TAFC) system with targeting laser for measuring distance to target, and time-fused High Explosive Airburst (HEAB) 25mm projectiles (grenades) that explode in proximity to the target (above or beside the target), instead of via a kinetic strike.

The XM25 is essentially a box magazine-fed semi-auto 25mm grenade launcher capable of firing 25mm HEAB rounds accurately up to a reported distance of 2,300 ft. or 767 yards. The XM25 magazine capacity is 4 rounds.

The XM-25's High Explosive Airburst/defilade capability means that USA military soldiers can engage enemy combatants fighting from behind walls, from trenches, or from inside buidings.

The Army is also developing an armor-piercing/armor-penetrating (AP) 25mm grenade round that penetrates the hardened target and detonates on the other side of the barrier, once penetration is achieved.

Upon muzzle exit, the intelligent fuse, using a turns-counting approach, determines the distance traveled, and bursts precisely over the engaged target at the programmed range.

The weapon incorporates advanced, high-tech composites like carbon fiber in its construction, and these materials are not cheap.

The cost is $277,777.78 cents per weapon. The Army wants to produce and field 12,500 XM25's, starting in early 2014. That is enough for one XM25 system per general infantry squad and Special Forces team.

Figure 66. Infantry ATK XM-25 Game-Changer, semi-automatic 25 mm air burst grenade launcher / Individual Airburst Weapon System, IAWS. Photo: DoD.

LONG RANGE SNIPER RIFLE XM2010

The snipers are being outfitted with the XM2010 rifle, capable of hitting a target from a 3,937-foot distance; about three quarters of a mile.

The current sniper rifle, the M-24, has a range of 2,625 feet. The Remington Company got an open-ended contract to revamp the M-24s into longer-range XM2010s, with an eye to making 3,600 guns in all, about 1100 more of them than the Army has snipers.

The XM2010's scoping allows for snipers to see further than the M-24 does, and it has add-ons to stifle the heat and noise it gives off, which can tip off a sniper's position to an enemy.

Figure 67. Special Forces' long range sniper rifle XM2010. Photo: DOD.

MICROWAVE AND LASER "AREA DENIAL" NON-LETHAL WEAPONS

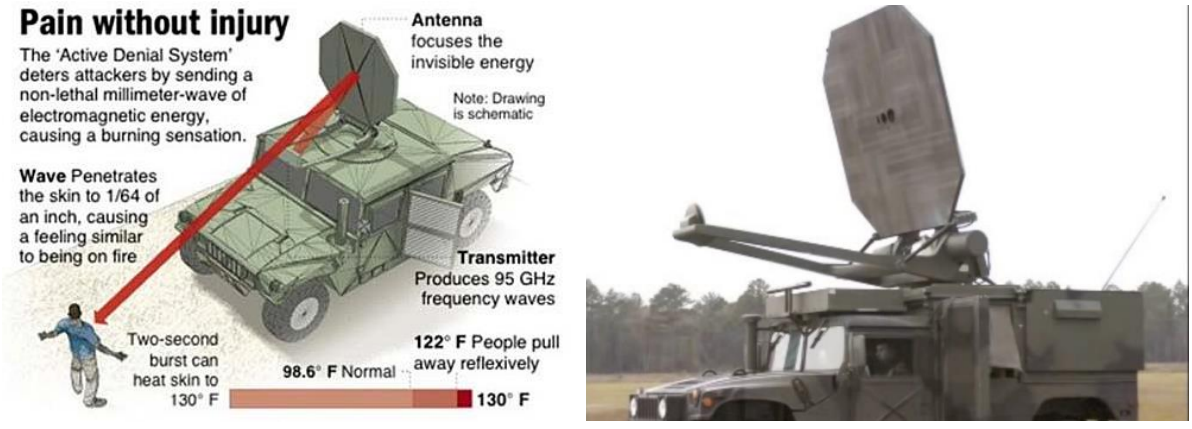


Figure 68. Active Denial microwave weapons.

Figure 69. Trucked Active Area Denial units, Reno, Nevada.

The idea of a microwave weapon may sound farfetched, but is in fact a reality. Multiple different types of laser beam technology, also known as directed energy weapons, are currently being manufactured for the military.

KINETIC ENERGY WEAPONS, RODS FROM GOD, PROJECT CROWBAR

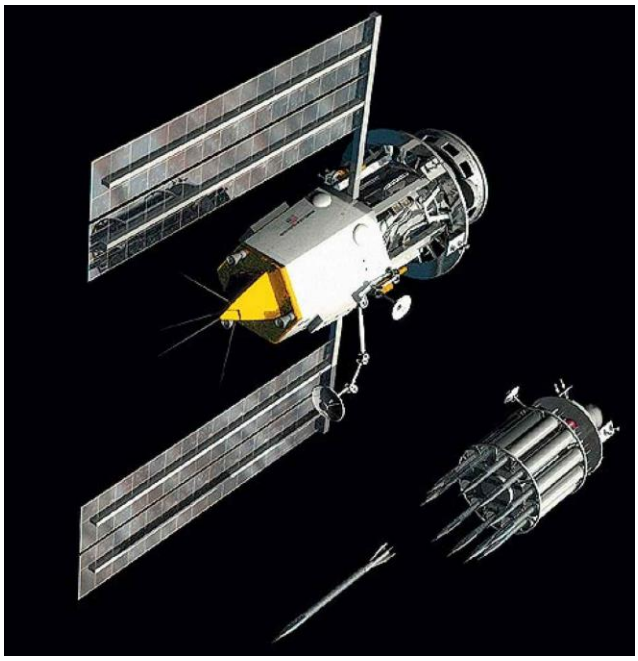


Figure 70. Kinetic energy device launched from satellites. Source: Popular Science.

They are a kinetic energy device like the railgun, but instead of using electricity to achieve destructive velocities, gravity is used. The system would be comprised of two satellites in orbit around the Earth. One would house the communications and targeting hardware, while the other would house the rods themselves, each up to a foot in diameter and twenty feet long. To fire, they would simply be released and allowed to fall back to Earth with a remote guidance. By the time they reach the surface, they would be traveling at a speed of 36,000 feet per second and carry the destructive force of a nuclear warhead, with none of the radioactive fallout.

Dropping on targets has a 15 minutes' notice. The guided rods enter the atmosphere, protected by a thermal coating, traveling at 36,000 feet per second, comparable to the speed of a meteor. The result: complete devastation of the target, even if it is buried deep underground. The two-platform configuration permits the weapon to be reloaded by just launching a new set of rods, rather than replacing the entire system.

Project Crowbar grew from 2" diameter by 4' long projectiles for anti-tank use made of Tungsten or depleted uranium, and a 6" diameter by 6' long for antishipping uses, to 1' x 20' objects that would be way too heavy to put into orbit. Each 20' long tungsten bar would weigh 75,000 lb, compared to the 53,000 lb capacity of the shuttle, far above that of any heavy lift rocket in use.

It is conceived as a mass drop weapon, as originally envisioned. They would be dropped in waves on advancing soviet armor columns, from expendable satellites. The larger anti-ship version was planned to have had some sort of terminal guidance. Launching heavy tungsten rods into space will require substantially cheaper rocket technology than exists today. The rods' speed would be so high that they would vaporize on impact, before the rods could penetrate the Earth's surface.

NEUTRON BOMBS, PURE FUSION DEVICES, ENHANCED RADIATION WEAPONS (ERWs)

A tungsten rod up to 20 feet in length and 1 foot in diameter has a hollow core down the middle 2 inches in diameter and 2 - 10 ft long, filled with a DT or DD fuel mix and lined with a neutron source would be launched into space and guided back into the atmosphere at a target. As it enters the Earth's atmosphere at a speed of 36,000 ft / sec, as fast as a meteorite, the friction creates so much heat and pressure that the DD or DT mix is suggested to enter a pure fusion state of a thermonuclear device without using a fission trigger. Pre-detonation, like what happens to meteorites entering the Earth's atmosphere, would have to be controlled by adjusting the reentry speed possibly by retro-rockets.

A 600 cGy (rad) absorbed dose of radiation from neutron activation is lethal and a neutron bomb delivers an 8,000 cGy (rad) absorbed dose to the crew of an armored vehicle. In addition, an irradiated armored vehicle will remain lethally radioactive for 24-48 hrs making re-crewing the vehicle impossible.

The use of mercury as a salting agent would deliver a radiation dose from ultra-violet radiation. The use of isotopically-tailored $Zinc^{64}$ would interdict an area for a few years as a result of the activation into $Zinc^{65}$, a gamma emitter with a 243.8 days half-life. The use of $Cobalt^{59}$ would render an area uninhabitable for decades from the Co^{60} gamma emissions with a 5.27 years half-life.

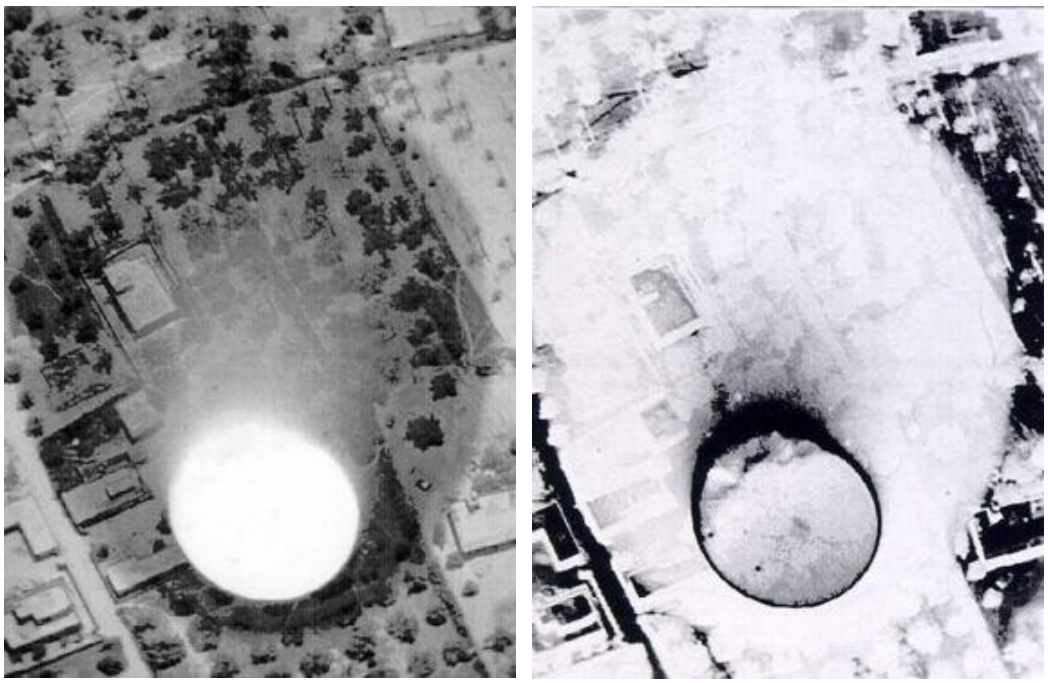


Figure 71. Far-end of the visible spectrum approaching the ultraviolet spectrum a few hundreds of a microsecond (left) at its brightest, and one millisecond later (right) into the detonation of a low-yield 1 kT of TNT equivalent Enhanced Radiation Device (ENRD, neutron bomb) device dropped from 10,000 ft and exploded at 3,000 ft. Fireball is 200-300 ft across. An un-symmetric directed configuration can be noticed with a fireball dome visible and the pattern of the neutron impacting the ground. It is rumored that the test involved cooperation between the USA and China in 1995-1996.

8.26 NEW NON-NUCLEAR THREATS

The possibility of a global nuclear war is recognized to have significantly receded. Even the possibility of regional nuclear conflict is eliminated as long as asymmetry among the possible opponents does not exist. Some political scientists even argue that the threat of nuclear force conflict provides a source of stability against enlarging a local conflict. They cite as an example the conflict about Kashmir between India and Pakistan, which are both nuclear power states. The control of nuclear arsenals by radical factions becomes the major concern. According to Fouad Agami: "But rest assured, America is already acting covertly to secure Pakistan's nuclear sites. In all likelihood, they are under USA supervision even now. And we have plans to defend the nuclear arsenal if Pakistan is overwhelmed by political chaos. That could pull us into a messy conflict, to be sure, but it is a risk we would bee willing to take."

As stated by retired USA Air Force Col. John Warden, the USA is presently a "hyperpower," and with new technology can deliver weapons to any place at any chosen time. It is positioned to be the world's arbiter of last resort for the foreseeable future. This concept of "asymmetric power," the "hammer and anvil," and knowing when to quit and avoid mission creep precludes the utility and usage of nuclear weapons for power projection.

Precision weapons have taken the place of atomic weapons as the most revolutionary development in the history of warfare. In the Second World War neither side had an asymmetric

advantage until the end of the war when the Allies had air superiority over Germany, and later the atomic bomb against Japan.

Precision weapons are extremely cost effective. A single plane nowadays with a crew of two persons can hit up to 15 targets on a single mission. During the Second World War, to get a 90 percent kill probability of a target, 9,000 bombs had to be dropped on it requiring the use of 1,000 B-17 bombers employing a crew of 10,000 troops.

In today's "hammer and anvil" military doctrine, bombing is the hammer, and the ground troops are the Anvil. In the Gulf War and in the Iraq War such an approach cut the strength of the Iraqi's troops from 360,000 to 200,000 before the ground war even began. As suggested by Barry Posen from MIT, such an approach places a potential enemy in a catch-22 situation. If the enemy concentrates his troops to stand up to ground forces, air power comes down and destroys his concentration. If the enemy disperses to avoid the bombing, then the ground forces can come in and destroy its diluted strength.

In the new technological world new threats other than global and regional nuclear war have arisen:

1. Regional Force Asymmetry.

Due to technological advance, a local power acquiring real or perceived superior conventional or unconventional capability over its neighbors, its government, or its own population, would be tempted to exercise its asymmetry in settling a local conflict to its advantage. From a Game Theory perspective this is a two-dimensional game between two opponents. The game would be settled rapidly to a stable solution to the advantage of the superior power, which would apply from the "might makes right" concept.

If the opponents have equal strength, the game may not have a solution, and the conflict could continue for a long time. Considering a 3 dimensional game where the hyper power would play the arbiter's role, the game would reach a solution depending on which side the hyper power would lean. If the hyper power is unable or unwilling to take side with one opponent or oscillates in its support for one side or the other, no solution would be reached, leading to a stalemate and a prolonged conflict.

In such a three dimensional game, an interesting situation can arise, whereas an opponent such as an unpopular local government, endeavors to portray itself as being allied with the hyper power against its political opponents, dissenters or insurrections. In this case it would try to pull the hyper power on its side of the conflict.

A dangerous situation can arise if one of the players can mislead the hyperpower to act against the third player, even against its own interest. Disinformation can be used to great advantage to convince the hyperpower to act against a local opponent. The Iraqi War is a clear example of this case. Falsification of documents about uranium acquisition from Niger, planted news items about meetings between Iraqi intelligence and September 11, 2001 terrorist organizers, anthrax attacks falsely attributed to Iraq and false information about nuclear, biological and chemical programs helped push the hyperpower to act against a player to the advantage of the third player or coalition of players.

When more than two players are involved in the game, the system can become multidimensional, the small players role would not significantly affect the evolution of the game unless they form a coalition, and a solution could probably only be found only according to the objective function of the hyper power and its favored small players.

2. Emerging or reemerging natural and manufactured pathogens.

Large populations that are not immunized are vulnerable to smallpox and antibiotic-resistant tuberculosis. New diseases are emerging with biotechnology providing the means to modify and combine disease elements to tailor their effects. There are rumors about doomsday biological weapons already developed in the Middle East by Israel that would affect only the opponent's genotype. The means to design, manufacture, and disperse microbes are relatively simple, yet difficult to detect.

The World Health Organization, WHO, has been monitoring about 40 emerging infectious diseases which have been around for only a few decades. These include: Acquired Immune Deficiency Sydrome (AIDS), Ebola virus, Dengue hemorrhagic fever, Lassa fever, N ipah, Hendra, hantavirus, Marburg virus, monkeypox, mad cow disease or Bovine Spongiform Encephalopathy (BSE), Severe Acute Respiratory Syndrome (SARS), West Nile Virus, Lyme disease, Legionnaire's disease and the cyclospora parasite.

These pathogens have either mutated or genetically recombined to become new strains or novel microbes, or they may have existed for millennia but were only identified in recent years.

At least one new infectious disease has emerged each year since 1980, with many of them escaping traditional therapies and having no vaccine nor cure. There are more virulent and difficult to treat infectious diseases than there were 20-3- years ago.

Old infectious diseases once believed to be controlled such as cholera, tuberculosis, staphylococcus, hepatitis, influenza and diphtheria are reemerging as deadly new strains that are often drug resistant or are appearing in new regions of the world.

In April 2009, the never seen before A/H1N1 variant of the swine flu was detected in Mexico and the USA causing the first pandemic of the 21st century. This virus replicates in the lungs, whereas the normal flu virus does not, creating the risk of causing pneumonia. In that regard, it bears resemblance to the 1918 Spanish flu virus pandemic that caused the death of 40-100 million people.

With modern fast transportation the virus spread rapidly with 125,000 confirmed cases and 140 deaths in 73 countries, it was declared by the WHO on June 11, 2009 as the first global flu pandemic in 41 years. Surveillance measures were put in place measuring the facial temperature of travelers at airports and quarantining them. Pharmaceutical companies stepped up the production of antiviral drugs such as Tamiflu by Hoffman-LaRoche AG in Switzerland and Relenza by Glaxo-Smith-Kline in the UK and doses of them stockpiled by governments for use by their first responders, health organizations, police, military forces and government officials. Schools were closed and face masks were distributed in large cities. Large public gatherings such as sport events and concerts were cancelled. Shopping malls, restaurants and public places were emptied.

Infectious diseases have become the leading cause of death in the world; a situation that has not been the case since the pre-antibiotic era of the early 1990s. Of the estimated 57 million deaths/year globally, about 15 million of them or 15/57 = 0.263 or 26 percent of them are directly caused by infectious diseases. Millions of extra deaths are caused by the secondary effects of infection.

Close to 200, with possibly another 1,000 out there, bacterial, viral, parasitic and fungal pathogens have been identified as linked to emerging and reemerging infections among humans. About 75 percent of these pathogens are zoonoses transmitted between animals and people, which

makes them more problematic since it is not possible to eliminate all the animal reservoirs or vectors that might be carrying the zoonosis. Transmission can occur through direct contact with the infected animals blood, saliva, urine, feces or via an intermediate vector as an insect such as fleas or rodent that carries the pathogen from the infected animal reservoir to people.

The bubonic plague or black death pandemic was transmitted by fleas and rodents as vectors from human to human and killed tens of millions in three great waves during the middle ages.

Many factors created by humans reside behind the occurrence and transmission of contemporary pandemics. Feeding rendered diseased cow tissue is recognized as a cause for the spread of BSE. People eating exotic animals caused the spread of the Ebola virus. Air travel spreads dengue fever around the world.

3. Genetic recombination, human control of future biological forms.

New biological forms developed with the best of intentions may have possible unintended consequences and side effects. This includes biological creations to manufacture organs or medicines for human use, or seeds containing transplanted genes. These life forms are ecologically untested and can cause significant ecological and human disruptions.

Changes in the environment and lifestyles are causing the emergence and spread of disease. These include new agricultural practices and consumption of exotic animals through genetic recombination. This occurs when two or more animal species come in contact with each other and exchange the viruses that each carries.

When different viruses infect the same cell, the genomes get mixed and a totally new virus emerges which contains genetic material from both the parent strains.

In north America a practice exists of feeding chicken farms feces, containing a significant amount of feed, to other animals such as cows or swine.

This also occurs particularly through a newly practiced farming method practiced in Asia. Birds such as ducks or chicken are kept in cages hung above pigs kept in pens directly above water fish and shrimp ponds in which other water fowl can swim and eliminate their own waste. Farmers save money on pigs feed and increase the yield of shrimp and fish. The pigs feed on the ducks droppings and their own manure fertilizes the fish and shrimp ponds. This places ducks and other waterfowl which are major reservoirs of the influenza viruses, although it does not affect them, in direct contact with swine which may also be harboring influenza viruses. This is how the AH1N1 influenza virus was conceived as a mixture of avian, swine and human viruses. Migrating water fowl such as geese can them spread new strains of the virus globally.

Recombination can also occur when humans feed on exotic non domesticated animals. For instance, in China, civet cats, coral snakes, tree shrew, flying squirrels, badgers, martens and pangolins are considered as delicacies. In Africa, monkeys, apes, aardvarks and rats are popular. In Central and South America guinea pigs, capybaras and armadillos are commonly consumed.

This is how HIV, the virus that causes AIDS in humans may have emerged. HIV is a fusion of the simian immunodeficiency virus (SIV) which infects monkeys and apes, and a similar type of virus that infects people. SIV was transferred to humans as a result of monkeys being eaten or their blood getting into cuts or wounds on their hunters.

Secretary of Defense William Cohen attended a counterterrorism conference at the University of Georgia in Athens, Georgia, as sponsored by former USA Senator Sam Nunn on April

28, 1997. At the "Conference on Terrorism, Weapons of Mass Destruction, and USA Strategy," he responded to a question about a false threat on the use of anthrax:

> "Well, it points out the nature of the threat. It turned out to be a false threat under the circumstances. But as we have learned in the intelligence community, we had something called -- and we have James Woolsey here to perhaps even address this question about "phantom moles." The mere fear that there is a mole within an agency can set off a chain reaction and a hunt for that particular mole which can paralyze the agency for weeks and months and years even, in a search. The same thing is true about just the false scare of a threat of using some kind of a chemical weapon or a biological one. There are some reports, for example, that some countries have been trying to construct something like an Ebola Virus, and that would be a very dangerous phenomenon, to say the least.
>
> Alvin Toeffler has written about this in terms of some scientists in their laboratories trying to devise certain types of pathogens that would be ethnic specific so that they could just eliminate certain ethnic groups and races; and others are designing some sort of engineering, some sort of insects that can destroy specific crops. Others are engaging even in an eco-type of terrorism whereby they can alter the climate, set off earthquakes, volcanoes remotely through the use of electromagnetic waves.
>
> So there are plenty of ingenious minds out there that are at work finding ways in which they can wreak terror upon other nations. It is real, and that is the reason why we have to intensify our efforts, and that is why this is so important."

4. Gained and lost control of nature.

The increased understanding of weather, ocean currents and geological events such as tornadoes, hurricanes, earthquakes and volcanoes for long term prediction, offers methods of possible control of these events. The use of Tsunamis or a giant tidal wave by the destruction of the continental shelf can be used by one nation against another, while disguising it a natural event. Directing stellar objects from outer space against an opponent's industrial and population centers may also become possible. Human activities in adding greenhouse gases and ozone depleting chemicals are affecting the global climate. Their consequences can be either beneficial or harmful in different parts of the world in ways that may not be predictable.

Ecological changes such as deforestation, dam projects, irrigation, road construction, and extensive agriculture lead to disease emergence. The remote wilderness areas are home to unique microbes, parasites or viruses not found elsewhere. When humans invade these ecosystems they encounter these life forms for the first time. Human contact with the Ebola virus in the late 1970s occurred when humans started clearing the rain forest in Ddemocratic Republic of Congo.

Once forests are cleared, the wildlife that used to live there has no choice than to move the human areas ending up in suburbs and farming communities where they make contact with people spreading any diseases they carry.

5. Cyber malfeasance

Simple intrusions and denial of service attacks by national or non-national groups can destroy financial activities, and can cause retaliation by other means and start major conflicts.

A dark aspect of it is that the attack can be made to appear as originating from as source other than the one effectively initiating it, so as to induce retaliation against the intended source. This would be in line with the anthrax scare that was initiated in the U.S., which killed 5 people and sickened 13 others. It was made to appear as coming from a dismantled Iraqi anthrax-manufacturing program, to encourage retaliation against it. Scientists at the Institute for Genetic Research in Rockville, Maryland have noticed subtle genetic variations between two anthrax samples, one used in Florida and the other held by a British biodefense laboratory that originally received its sample from the USA Army laboratory at Fort Detrick, Maryland. Genetic mapping suggested that the source of the anthrax spores used in Washington D. C. are similar to the "Ames, Iowa Bacillus strain" that could have been procured from about a dozen laboratories that had it at hand, and used by subcontractors in the USA.

There exist two subcategories of Cyber Space threats:

1. The physical infrastructure threat: This involves compromising critical systems to severely affect critical infrastructures such as electrical power grids, water and sewer systems, dams, hospitals, pipelines, communications, global positioning satellites, air traffic systems or any networked systems, which would result in death or destruction.
2. The critical data threat: This involves the compromising of critical computer systems to irreversibly damage or steal vital data, such as credit cards information, social security numbers, driver licenses data, medical records, financial institutions records or secret military documents, resulting in death destruction or catastrophic economic turmoil.

Information attacks could take different forms with increasing levels of threat to national security:

1. Cyberhooliganism: Use of computers for digital vandalism and low- evel destruction. This includes web sites defacement, viruses propagation or "hacktivism," which refers to using these tools to get a message across.
2. Cybercrime: Stealing money, credit card data, and personal information using computers. The objective is to use these in extortion schemes or just to gain notoriety as a hacker.
3. Information Vendettas: Sabotaging an organization, creating public embarrassment or to gain at the expense of the organization. This would be done by an insider to the organization or would be sanctioned by an insider.
4. Cyber Organized Crime: Cartel groups and mafias using computers to steal and traffic in commodities or money, from vulnerable sources. Some of these crimes could remain undiscovered for long periods of time, when they remain small, yet affect large flows of the target.
5. Cyber Terrorism: Causing terror, death, destruction or massive economic turmoil using computers. A non-national group would cause this, or a party not affiliated with a state.
6. Information Counter intelligence: This would be a state sponsored use of computers to gain knowledge and possibly destroy an enemy.
7. Information Warfare: This is the most serious form of information attacks where a state-sponsored use of computers can be used in military action. Examples would be to embed in computers at the time of their assembly and manufacture, before being provided to a potential adversary, devices that could receive a signal to disable radar systems, communications systems, electrical utilities and transportation systems such as railroads and airlines, and causing a collapse of a banking or financial system.

6. Blunting of Force Projection.

New technologies can emerge to counter existing air defense and air combat technologies. These include sensors to defeat aircraft infrared countermeasures, decoys that fool heat seeking missiles, dome optics giving aircraft missiles greater speed and range, passive radar systems using cellular phone tower networks that can lessen the effectiveness of stealth aircraft and antiradar missiles, visible light sensors that would lessen the effectiveness of cruise missiles, improved infrared systems to increase the effectiveness of night operations, and stealth naval systems, cruisers, and frigates. This would decrease the degree of force asymmetry that gives the USA its hyper power and arbiter of last resort status. The emergence of more than a single hyper-power can lead to instability, and to the dominance of the "might makes right" doctrine in global relations.

7. Cosmic Collisions and Stellar Invaders.

Earth has been regularly bombarded in its geological history by cosmic bodies in the form of comets and asteroids. Depending on the sizes of these stellar objects local damage, temporary weather and climate changes and major extinctions of species have occurred. The most notable one is the stellar impact at the K-T geological age boundary, which is thought to have led to well-documented massive species extinction and the end of the age of the dinosaurs. It is most interesting that the knowledge acquired by humanity about nuclear weapons may be its salvation in these cases, since it would be the only alternative possessing sufficient energy density to deflect or fragment these objects, and avert a catastrophic destruction of life on Earth.

8.27 USA'S NUCLEAR POSTURE

As the world's hyper-power for the foreseeable future, the USA's nuclear posture merits careful consideration, since the largest likelihood of use of nuclear weapons could come from this direction. The USA is the only country to use nuclear weapons; against Japan during the Second World War. Under stressful situations, their use was contemplated by the USA in the Korean War and in Vietnam, and by Israel against Egypt in the October 1973 War.

President Nixon raised the idea of using nuclear weapons against North Vietnam on April 25, 1972. A few weeks before ordering a major escalation, he addressed Henry Kissinger, then his national security adviser: "I'd rather use the nuclear bomb." Kissinger responded: "That, I think, would be too much." Nixon responded: "The nuclear bomb. Does that bother you? I just want you to think big." He is reported to have said: "I don't give a damn" about civilian casualties.

During the Afghanistan War, The USA Navy nearly ran out of satellite and precision guided munitions, particularly the ship-launched Tomahawk missiles and laser-guided bombs manufactured by the Raytheon Corporation. According to Adm. Robert J. Natter, tapping Air Force stocks saved the situation, as well as "maxing-out" an existing production line and starting a new one. It could be envisioned that running out of "smart" munitions in a future conflict could become an incentive for the use of nuclear weapons.

A "Nuclear Posture Review" report sent to the USA Congress in January 2002, suggested that the Pentagon is developing plans for using nuclear weapons against countries that are developing weapons of mass destruction. The report identifies seven such nations: China, Iran, Iraq, Libya, DPRK (North Korea), Russia and Syria.

National security adviser Condoleezza Rice responded to questions about their use stating: "We all want to make the use of weapons of mass destruction less likely. The way that you do that is to send a very strong signal to anyone who might try to use weapons of mass destruction against the United States that they'd be met with a devastating response."

Secretary of State Colin Powell said the United States has never ruled out using nuclear weapons against a nuclear-armed enemy, a policy he said would deter any attacker: "We think it is best for any potential adversary out there to have uncertainty in his calculus."

Arms control experts suggest that this posture could make the USA more likely to use such weapons. Daryl Kimball executive director of the Arms Control Association says: "By targeting these seven countries, some of which are new targets, the USA is increasing, not decreasing, the possibility of using nuclear weapons in its policy." This is countered by defense Department officials suggesting that over the next decade, it should be "far less likely" that the USA or other countries will rely on nuclear weapons. It has been USA policy in the past not to consider using nuclear weapons except for retaliation for a nuclear strike or in exceptional cases during wartime.

A posture review included President's George W. Bush's plans to slash the United States' ready nuclear stockpiles by about two-thirds over a decade. Existing warheads were being modified by the military to destroy underground bunkers and other "hardened" targets. These include suspected underground weapons factories as well as command centers. A missile defense system is also under development, and conventional weapons that can be used over longer ranges and with more precision, and better intelligence. A non-proliferation by product of the policy is also proposed by Douglas J. Feith, undersecretary of defense: "If we have an effective military, our allies are not going to feel that they are under any compulsion to develop their own nuclear weapons."

The posture review suggests that nuclear weapons would be used by the USA under three types of situations:

1. Against targets able to withstand nuclear attack,
2. In retaliation for attack with nuclear, biological or chemical weapons,
3. In the event of surprising military developments.

8.28 THE NEW COLD WAR, NUCLEAR ARMS RACE

Nuclear war can still happen through hardware failure or through human error. William Perry, USA Secretary of Defense from 1994 to 1997 in his book "My Journey at the Nuclear Brink," points out that in November 1979, a NORAD computer reported a full-scale Russian sneak attack with land and sea-based missiles, which led to scrambling USA bombers and alerting USA missile silos to prepare to launch. It turned out there was no Soviet attack but an errant test tape. Six months later NORAD computers erroneously announced that Soviet submarines had launched 220 missiles at the USA. This time the cause was a defective computer chip that cost 49 cents, resulting in scrambling interceptors and putting the silos on alert. Nuclear weapons in existence endanger the world's security, contrary to the prevalent thinking by NATO operatives that it enhances it through being a deterrent to war.

During the 1962 Cuban missile crisis that is generally represented as a dangerous standoff resolved by diplomacy, the fact is that a single man, Russian submarine commander Vasili Arkhipov, who defied an order to launch a nuclear torpedo at an American destroyer that could have set off a nuclear exchange between the Soviet Union and the USA.

Today, the destructive capability of nuclear weaponry is hard to understand. The yield 15 -20 kT of TNT equivalent nuclear devices that destroyed the cities of Hiroshima and Nagasaki pale in comparison to modern nuclear devices. If the Hiroshima device represented 27 train freight cars loaded with TNT, a one-megaton device corresponds to a train 300 miles in length. Each Russian RS-20V Voevoda intercontinental ballistic missile carries 10 Mt of TNT equivalent.

Human miscalculation is a dominant human trait, considering that 50 percent of Americans' choices of marriage partners are miscalculations as proven by the divorce rate. President Bill Clinton abrogated a 1990 agreement with the Soviet Union not to push NATO further east after the reunification of Germany or to recruit former members of the defunct Warsaw Pact. NATO has reneged on a 1997 pledge not to install "permanent" and "significant" military forces in former Warsaw Pact countries. In July 2016, NATO decided to deploy four battalions on or near the Russian border, arguing that since the units will be rotated, they are not "permanent" or large enough to be "significant." It's a linguistic sleight of hand that is not swallowed by Russia.

The 1999 USA and NATO intervention in the Yugoslavian civil war and the forcible dismemberment of Serbia and the creation pf Kosovo, encouraged Russia to do the same by using force to "redraw borders in Europe" by annexing the Crimea Peninsula. The USA subsequently built Camp Bond Steel, Washington's largest base in the Balkans.

President George W. Bush's unilaterally withdrew from the Anti-Ballistic Missile Treaty and President Barack Obama administration decided to deploy anti-missile systems in Romania and Poland, as well as Japan and South Korea.

Lately, the USA is to spend upwards of $1 trillion over three decades upgrading its nuclear weapons arsenal, which includes building nuclear devices with smaller-yield, stealthy and precise devices, a move that many critics argue blurs the line between conventional and nuclear weapons.

Figure 72. The B61 Model 12, small-yield, stealth and precise nuclear munition. It has a "dial-a-yield" feature whose lowest setting is only 2 percent as powerful as the bomb dropped on Hiroshima in 1945. Source: Sandia Laboratory.

The Yugoslav civil war and NATO's move east convinced Russia that the USA-led coalition was surrounding Russia with potential adversaries, and the deployment of Anti-Ballistic Missile systems (ABMs) supposedly aimed at Iran's non-existent nuclear weapons, was seen as a threat to Russia's nuclear deterrent.

When the USA endorsed the 2014 coup against the pro-Russian government in the Ukraine, it ignited a crisis that has led to several dangerous incidents between Russian and NATO forces. NATO does not intends to attack Russia, but the power differential between the USA and Russia is such a "colossal asymmetry," that the Russians have abandoned their "no first use" of nuclear weapons pledge. The Russians have said they would consider using small tactical nukes if "the very existence of the state" was threatened by an attack.

The USA and Russia are developing a long-range cruise missile that can be armed with conventional or nuclear warheads. The idea of no "specific nuclear thresholds" is one of the most extraordinarily dangerous and destabilizing concepts to come along since the invention of nuclear weapons.

After disappearing from the radar screen for several decades, nuclear weapons are back, and a decision to modernize the USA arsenal is kicking off a nuclear arms race with Russia and China. Russia is already replacing its current ICBM force with the more powerful and long range "Sarmat" ICBM, and China is loading its own missiles with multiple warheads. The missile will replace the most powerful RS-20V Voevoda (according to NATO classification SS-18 Satan) ballistic complexes. Each missile is able to deliver 10 Mt nuclear warheads at a distance of 11,000 kilometers.

In Prague in 2009, President Barack Obama pledged that he would take concrete steps toward a nuclear-free world and "reduce the role of nuclear weapons in our national security strategy." The Nobel Prize committee cited the pledge that year in awarding him the Peace Prize. A modest arms reduction treaty with Russia seemed like a first step. In 2010, the administration released a plan to rearrange old components of nuclear arms into revitalized weapons. The resulting hybrids would be far more reliable, meaning the administration could argue that the nation would need fewer weapons in the far future. American allies and adversaries see that refurbishing weapons in their existing configurations could keep them in service for decades. The plan is to merge four old B61 models into a single version Model 12 that greatly reduced their range of destructive power. It would have a "dial-a-yield" feature whose lowest setting was only 2 percent as powerful as the bomb dropped on Hiroshima in 1945.

The bomb's new tail section and steerable fins allowing high accuracy and low destructive settings meant military commanders might press to use the bomb in an attack, knowing the radioactive fallout and collateral damage would be limited. The overall modernization plan might change how military commanders looked at the risks of using nuclear weapons.

The new cruise missile might sway a future president to contemplate "limited nuclear war." Because the missile comes in nuclear and non-nuclear varieties, a foe under attack might assume the worst and overreact, initiating nuclear war.

A Cold War standby called the B83, a powerful city buster is to be scrapped. The modernization plan may cost upward of a trillion dollars if future presidents go the next step and order new bombers, submarines and land-based missiles, and upgrades to eight factories and laboratories.

8.29 SHOCK AND AWE, GAME THEORY AND LANCHESTER LAW

It is clear that the USA acquisition of the position of hyper power and its success in the latest conflicts is based on superior knowledge and understanding of the quantitative fundamental strategic and tactical principles of conflict and war. These include the principles of Sun Tzu, the maxims of Napoleon, and the doctrines of Clausewitz. At some time or the other these have been qualitatively expressed as slogans such as:

1. Divide and conquer.
2. Get there fastest with the mostest.
3. Take the high ground.

The American military was introduced to and has mastered Decision Theory and the Theory of Games under a mathematically oriented former Secretary of Defense from 1994 to 1997: William Perry. One particular aspect is the application of a theory developed by the English engineer Frederick Lanchester. His theory is based on the study of air battles in the First World War. It was applied in the two "Shock and Awe" campaigns against Iraq - even though initially meant to be used against the Warsaw Pact nations during the Cold War - in which its efficacy was spectacularly demonstrated.

Lanchester's model of warfare considers two opposing forces shooting at each other without any particular advantage in accuracy, weapons or force multipliers. In this case the firepower F of a fighting force is proportional to the total number of units N_1 that it can muster or:

$$F \alpha_{\ell} N_1 \tag{9}$$

The units N_1 could be troops, airplanes, ships, tanks, etc. The number of targets T that a force presents to its opponent to distribute its firepower resources against is also proportional to N_1:

$$T \alpha_{\ell} N_1 \tag{10}$$

Assuming also that the shooting from one side on the other is random with an equal probability of scoring a hit, three important consequences of these simple assumptions can be deduced.

The strength of the force S with N_1 units is proportional to both its firepower F and the number of targets T it presents to its opponent's firepower:

$$S \alpha_{\ell} F.T \tag{11}$$

Substituting from Eqns. 9 and 10 into 11, we get:

$$S \alpha_{\ell} F.T = cN_1^2 \tag{12}$$

where: c is a proportionality constant replacing the proportionality symbol α.

The first consequence is that the square law in Eq. 12 reveals that the strength of a force S is proportional to the square of its number of units N_1. If an army can gather twice the number of units of its opponent, its strength is not just twice its opponent's, but the square of two or four times its opponent's. It pays to go against an opponent with overwhelming force or "Shock and Awe." It pays to go with a large number of cheap units rather than a small number of expensive units. It also pays to gather allies and "coalition partners" forces and paid mercenaries, even without their fighting; as they would draw away the fire and the losses from one's own troops.

During the Second World War, the advanced-technology small number of German V2 rockets targeting London, were eliminated by an overwhelming larger number of lower-technology bomber aircraft conducting continuous day and night raids on their manufacture and launching sites.

A constant of motion M exists that does not change as a result of the mutual fighting and the ensuing losses on both sides. Considering the absolute value of the difference between the square of one's own units N_1 and the opponents' square of the number of units N_2:

$$M = \left|(N_1^2 - N_2^2)\right| \tag{13}$$

The square root of M can be considered as the expected outcome O or the mean value of the remainder number of units after the confrontation:

$$O = \sqrt{M} = \sqrt{\left|(N_1^2 - N_2^2)\right|} \tag{14}$$

The second important consequence of Eqn. 12 is that a force with a larger number than its opponent, can wipe out or exterminate the opponent while still being relatively intact. For instance, if a force of 5 units faces a force of 3 units the expected outcome is according to Eqn. 14:

$$O = \sqrt{M} = \sqrt{\left|\left(5^2 - 3^2\right)\right|} = \sqrt{\left|(25-9)\right|} = \sqrt{16} = 4$$

The expected outcome 4 of the confrontation is thus that the smaller force of 3 is totally wiped out losing 100 percent of its units. On the other hand the larger force would still have 4 out of 5 units left and would have lost just:

$$\frac{5-4}{5} \times 100 = \frac{1}{5} \times 100 = 20 \; \textit{percent}$$

of its units.

A third important consequence of this law is that it provides a way for a small force to prevail over a force that outnumbers it. The insight is that this can be achieved by splitting the enemy forces and dealing with their divided forces one divided group at a time; the old qualitative maxim of divide and conquer, penetration or concentration principle. As a numerical example, suppose that one has 20 units confronting 25 units. A head on confrontation according to Eqn. 14 would lead to an expected outcome of:

$$O = \sqrt{M} = \sqrt{\left|(20^2 - 25^2)\right|} = \sqrt{\left|400 - 625\right|} = \sqrt{225} = 15$$

which means that one's inferior force would be wiped out, leaving 15 units of the opponents 25 units still intact. The opponent would have lost:

$$\frac{25-15}{25} \times 100 = \frac{10}{25} \times 100 = 40 \; percent$$

of his force, a significant loss, but would have totally wiped us out.

Suppose that by some stratagem, maybe exploiting a defensive posture by the opponent, one is able to divide the opponent's force into two groups of 15 and 10 units each. Confronting the first group with our total force leads to the expected outcome:

$$O_1 = \sqrt{M_1} = \sqrt{\left|(20^2 - 15^2)\right|} = \sqrt{\left|400 - 225\right|} = \sqrt{175} \approx 13$$

which wipes out the enemy's group of 15, and leaves 13 of one's troops intact. These could be used against his remaining group of 10 with expected outcome:

$$O_2 = \sqrt{M_2} = \sqrt{\left|(13^2 - 10^2)\right|} = \sqrt{\left|169 - 100\right|} = \sqrt{69} \approx 8$$

which means that an inferior force can totally exterminate a superior force while keeping:

$$\frac{8}{20} \times 100 = 40 \; percent$$

of its initial force intact.

Multiple players' games can also be envisioned. In the case of three players two situations arise. If the three parties are shooting at each other, the situation favors the largest force that would encourage the situation since the two other parties will be drawing fire away from it and onto each other. Eventually the smaller force is wiped out and the field is left to the two largest forces, which could settle their differences or continue the conflict to the detriment of the smaller force which would eventually be wiped out.

The second situation is an alliance of convenience where the two smaller forces ally themselves against the largest force knowing well that they would have to settle their differences after defeating the largest force.

Examples of three or more players' games are the Serbs, Croats and Bosnians in the old Yugoslavia, and the Shiites, Sunnis and Kurds in the partitioned Iraq. An example of two forces allied against a third is the Western Alliance with the Soviet Union against Germany. It was a tepid alliance of convenience and was in fact followed by the cold war where the Soviet Union was later dismantled. In three-way contests it is logically best for two players to ally themselves against the third.

This idealized situation can be affected by force multipliers such as superior motivation, morale, weaponry, positions, intelligence and even pure luck, but the general principles still apply.

It is well known that an army surrenders not necessarily when it is defeated, but when it thinks it is defeated. It is possible to make an army perceive defeat and surrender even it were the superior force.

Mastering these decision and game theory notions and principles is behind the present hyper-power status of the USA, obviously for as long as its competitors have not yet grasped them. A hyper-power dominance will eventually lead to the formation of alliances and coalitions of those who do not want to fall under its influence, against it. This explains the eventual fall and decay of the great empires throughout history. The alliance between France, Germany, China and Russia, with commercial interest in Iraqi oil, in the United Nation's Security Council against the USA's interest in controlling the largest known oil reserves in the world in Iraq, may be a harbinger of future conflicts. Interestingly enough, a violation by Iraq of the NPT was used as a pretext for its invasion and control of its oil wealth.

CONDITIONING THE OPPONENT

It is human nature that people will get used and conditioned to almost anything if it goes on for long enough. The conditioning process does not take too long if it is something that people do not understand well and that they cannot experience directly.

The British military excelled at using this human cognitive feature during the period of Empire, and particularly during World War II. The British Royal Air Force (RAF) undertook a plan of disinformation to facilitate the undetected approach of a squadron of bombers to an important unspecified target in Europe. The target, possibly the hydroelectric dams in the Ruhr Valley, was so well protected that destroying it would require great surprise.

The RAF was equipped to electronically jam the existing radar at the time along the route to the target. However, the jamming by itself is an alert the defending forces. The smart approach was to condition, train, and misinform the defending German personnel into believing in something that was not true. The intended German personnel were operating novel and unreliable electronic equipment. The operators were trying to interpret radar signals without the benefit of direct observation.

This is how the RAF proceeded: at sunrise on every day, the RAF would broadcast a jamming signal for just a short period of time. On every subsequent day, just before sunrise, the jamming signal would last a little longer. The conditioning proceeded for about three months. The German radar personnel interpreted the signals their equipment gave them in just the way the British intended: They reached a conclusion that their equipment operates poorly in the atmospheric conditions present at sunrise and that the problem grows as the season progresses. The mistaken inference allowed an RAF squadron to fly undetected at sunrise far enough into Europe to reach the target and destroy it.

8.30 DISCUSSION

On Januray 25, 1995, Norwegian and American researchers fired a rocket in northwestern Norway to study the Aurora Borealis phenomenon. The four-stage rocket flew inadvertently through the same corridor that American Minuteman III missiles, equipped with nuclear warheads, would use to travel from the USA to Russian targets. The rocket's speed and flight pattern matched what the Russians expected from a Trident missile that would be fired from a USA submarine and detonated at high altitude. The ensuing Electro-Magnetic Pulse (EMP) would blind the Russian

early-warning system to prepare for a large-scale nuclear attack by the USA. The Russian military declared a high alert. Russian President Boris Yeltsin activated the keys to launch nuclear weapons against the USA. He had less than 10 minutes to decide whether to issue the launching order. President Boris Yeltsin wisely left the Russian missiles in their silos, because relations between Russia and the USA were relatively friendly in 1995. If a similar incident occurred in 2015 with the tensions between NATO and Russia concerning the Ukraine and the Crimean Peninsula, the situation could have been uncontrollable [14].

In the age where a single hyper power prevails nuclear weapons have become obsolete. Their continued obsolescence depends on a continued successful implementation of the NPT. A successful continued implementation of nuclear safeguards in the future will be hinged on two provisions in Article VI of the NPT. The first provision calls upon the parties "… to pursue negotiations in good faith on effective measures relating to the nuclear arms race at an early date and to nuclear disarmament." The second provision places an obligation on all parties to the treaty to: "… facilitate and promote peaceful nuclear activities."

Disarmament agreements between the USA and Russia have released large amounts of fissile materials obtained from unsafe aging weapons. The USA has expressed the intention, not yet made irrevocable; to place some of these materials under safeguards in relation to a voluntary Safeguards offer agreement. Experiments are carried out in Canadian CANDU power reactors on burning such weapons-origin material as fuel for electricity generation. This is tested in the form of a Mixed Oxide (MOX) of UO_2 and PuO_2. This approach is not conducive to nonproliferation since the uranium in the mixed oxide is still being converted into plutonium. Another possible approach that would decrease the possibility of proliferation is the use of a thorium plutonium mix, a possibility worth exploring.

The General Assembly of the United Nations has called for a "cut-off agreement" involving a non-discriminatory ban on the production of fissile material.

A Comprehensive Test Ban Treaty agreement has been signed but not ratified by the USA. Arguments still exist about its verification measures. The treaty is complementary to the NPT and calls for 173 non-nuclear weapons states parties to the NPT to be bound not to use any nuclear material for the testing of nuclear weapons or other nuclear explosives.

New developments in weapons and military doctrine, based on information technology and space based systems, are in fact making nuclear weaponry obsolete and is eliminating over time the ignominious relation between peaceful and military nuclear applications. This does not totally eliminate the small likelihood of the use of nuclear weapons by the hyper power or any alliances or coalitions formed against it, particularly under unforeseen conflict situations or under conditions of extreme force asymmetry. This requires vigilance in the continued enforcement of the safeguards and nonproliferation agreements.

The tremendous energy release in nuclear weapons will be sublimated in the future in planetary engineering like terra forming Mars and Venus, restoring the Earth's global equatorial current in response to global warming or civil nuclear engineering projects. Space travel within and beyond the solar system would have to depend on nuclear energy for propulsion and for power in space or on bases on the moon or Mars. In them might be the salvation of life on Earth in deflecting or shattering undesirable stellar invaders in the form of comets or asteroids. For humans to spread all of life throughout the Milky Way galaxy and beyond in the known universe, nuclear energy will be their most valuable tool.

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APPENDIX I

TREATY ON THE NON-PROLIFERATION OF NUCLEAR WEAPONS, NPT

Significant dates:

Signed at Washington, London, and Moscow, July 1, 1968
Ratification advised by U.S. Senate, March 13, 1969
Ratified by U.S. President, November 24, 1969
U.S. ratification deposited at Washington, London, and Moscow, March 5, 1970
Proclaimed by U.S. President, March 5, 1970
Entered into force, March 5, 1970

Text of Treaty:

The States concluding this Treaty, hereinafter referred to as the "Parties to the Treaty",

Considering the devastation that would be visited upon all mankind by a nuclear war and the consequent need to make every effort to avert the danger of such a war and to take measures to safeguard the security of peoples,

Believing that the proliferation of nuclear weapons would seriously enhance the danger of nuclear war,

In conformity with resolutions of the United Nations General Assembly calling for the conclusion of an agreement on the prevention of wider dissemination of nuclear weapons,

Undertaking to cooperate in facilitating the application of International Atomic Energy Agency safeguards on peaceful nuclear activities,

Expressing their support for research, development and other efforts to further the application, within the framework of the International Atomic Energy Agency safeguards system, of the principle of safeguarding effectively the flow of source and special fissionable materials by use of instruments and other techniques at certain strategic points,

Affirming the principle that the benefits of peaceful applications of nuclear technology, including any technological by-products which may be derived by nuclear-weapon States from the development of nuclear explosive devices, should be available for peaceful purposes to all Parties of the Treaty, whether nuclear-weapon or non-nuclear weapon States,

Convinced that, in furtherance of this principle, all Parties to the Treaty are entitled to participate in the fullest possible exchange of scientific information for, and to contribute alone or in cooperation with other States to, the further development of the applications of atomic energy for peaceful purposes,

Declaring their intention to achieve at the earliest possible date the cessation of the nuclear arms race and to undertake effective measures in the direction of nuclear disarmament,

Urging the cooperation of all States in the attainment of this objective,

Recalling the determination expressed by the Parties to the 1963 Treaty banning nuclear weapon tests in the atmosphere, in outer space and under water in its Preamble to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time and to continue negotiations to this end,

Desiring to further the easing of international tension and the strengthening of trust between States in order to facilitate the cessation of the manufacture of nuclear weapons, the liquidation of all their existing stockpiles, and the elimination from national arsenals of nuclear weapons and the means of their delivery pursuant to a Treaty on general and complete disarmament under strict and effective international control,

Recalling that, in accordance with the Charter of the United Nations, States must refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any State, or in any other manner inconsistent with the Purposes of the United Nations, and that the establishment and maintenance of international peace and security are to be promoted with the least diversion for armaments of the worlds human and economic resources,

Have agreed as follows:

Article I

Each nuclear-weapon State Party to the Treaty undertakes not to transfer to any recipient whatsoever nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices directly, or indirectly; and not in any way to assist, encourage,

or induce any non-nuclear weapon State to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or control over such weapons or explosive devices.

Article II

Each non-nuclear-weapon State Party to the Treaty undertakes not to receive the transfer from any transferor whatsoever of nuclear weapons or other nuclear explosive devices or of control over such weapons or explosive devices directly, or indirectly; not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices; and not to seek or receive any assistance in the manufacture of nuclear weapons or other nuclear explosive devices.

Article III

1. Each non-nuclear-weapon State Party to the Treaty undertakes to accept safeguards, as set forth in an agreement to be negotiated and concluded with the International Atomic Energy Agency in accordance with the Statute of the International Atomic Energy Agency and the Agencys safeguards system, for the exclusive purpose of verification of the fulfillment of its obligations assumed under this Treaty with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices. Procedures for the safeguards required by this article shall be followed with respect to source or special fissionable material whether it is being produced, processed or used in any principal nuclear facility or is outside any such facility. The safeguards required by this article shall be applied to all source or special fissionable material in all peaceful nuclear activities within the territory of such State, under its jurisdiction, or carried out under its control anywhere.

2. Each State Party to the Treaty undertakes not to provide:

(a) source or special fissionable material, or

(b) equipment or material especially designed or prepared for the processing, use or production of special fissionable material, to any non-nuclear-weapon State for peaceful purposes, unless the source or special fissionable material shall be subject to the safeguards required by this article.

3. The safeguards required by this article shall be implemented in a manner designed to comply with article IV of this Treaty, and to avoid hampering the economic or technological development of the Parties or international cooperation in the field of peaceful nuclear activities, including the international exchange of nuclear material and equipment for the processing, use or production of nuclear material for peaceful purposes in accordance with the provisions of this article and the principle of safeguarding set forth in the Preamble of the Treaty.

4. Non-nuclear-weapon States Party to the Treaty shall conclude agreements with the International Atomic Energy Agency to meet the requirements of this article either individually or together with other States in accordance with the Statute of the International Atomic Energy Agency. Negotiation of such agreements shall commence within 180 days from the original entry into force of this Treaty. For States depositing their instruments of ratification or accession after the 180-day period, negotiation of such agreements shall commence not later than the date of such deposit. Such agreements shall enter into force not later than eighteen months after the date of initiation of negotiations.

Article IV

1. Nothing in this Treaty shall be interpreted as affecting the inalienable right of all the Parties to the Treaty to develop research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with articles I and II of this Treaty.

2. All the Parties to the Treaty undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy. Parties to the Treaty in a position to do so shall also cooperate in contributing alone or together with other States or international organizations to the further development of the applications of nuclear energy for peaceful purposes, especially in the territories of non-nuclear-weapon States Party to the Treaty, with due consideration for the needs of the developing areas of the world.

Article V

Each party to the Treaty undertakes to take appropriate measures to ensure that, in accordance with this Treaty, under appropriate international observation and through appropriate international procedures, potential benefits from any peaceful applications of nuclear explosions will be made available to non-nuclear-weapon States Party to the Treaty on a nondiscriminatory basis and that the charge to such Parties for the explosive devices used will be as low as possible and exclude any charge for research and development. Non-nuclear-weapon States Party to the Treaty shall be able to obtain such benefits, pursuant to a special international agreement or agreements, through an appropriate international body with adequate representation of non-nuclear-weapon States. Negotiations on this subject shall commence as soon as possible after the Treaty enters into force. Non-nuclear-weapon States Party to the Treaty so desiring may also obtain such benefits pursuant to bilateral agreements.

Article VI

Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a Treaty on general and complete disarmament under strict and effective international control.

Article VII

Nothing in this Treaty affects the right of any group of States to conclude regional treaties in order to assure the total absence of nuclear weapons in their respective territories.

Article VIII

1. Any Party to the Treaty may propose amendments to this Treaty. The text of any proposed amendment shall be submitted to the Depositary Governments which shall circulate it to all Parties to the Treaty. Thereupon, if requested to do so by one-third or more of the Parties to the Treaty, the Depositary Governments shall convene a conference, to which they shall invite all the Parties to the Treaty, to consider such an amendment.

2. Any amendment to this Treaty must be approved by a majority of the votes of all the Parties to the Treaty, including the votes of all nuclear-weapon States Party to the Treaty and all other Parties which, on the date the amendment is circulated, are members of the Board of Governors of the International Atomic Energy Agency. The amendment shall enter into force for each Party that deposits its instrument of ratification of the amendment upon the deposit of such instruments of ratification by a majority of all the Parties, including the instruments of ratification of all nuclear-weapon States Party to the Treaty and all other Parties which, on the date the amendment is circulated, are members of the Board of Governors of the International Atomic Energy Agency. Thereafter, it shall enter into force for any other Party upon the deposit of its instrument of ratification of the amendment.

3. Five years after the entry into force of this Treaty, a conference of Parties to the Treaty shall be held in Geneva, Switzerland, in order to review the operation of this Treaty with a view to assuring that the purposes of the Preamble and the provisions of the Treaty are

being realized. At intervals of five years thereafter, a majority of the Parties to the Treaty may obtain, by submitting a proposal to this effect to the Depositary Governments, the convening of further conferences with the same objective of reviewing the operation of the Treaty.

Article IX

1. This Treaty shall be open to all States for signature. Any State which does not sign the Treaty before its entry into force in accordance with paragraph 3 of this article may accede to it at any time.

2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the United States of America, the United Kingdom of Great Britain and Northern Ireland and the Union of Soviet Socialist Republics, which are hereby designated the Depositary Governments.

3. This Treaty shall enter into force after its ratification by the States, the Governments of which are designated Depositaries of the Treaty, and forty other States signatory to this Treaty and the deposit of their instruments of ratification. For the purposes of this Treaty, a nuclear-weapon State is one which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to January 1, 1967.

4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Treaty, it shall enter into force on the date of the deposit of their instruments of ratification or accession.

5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or of accession, the date of the entry into force of this Treaty, and the date of receipt of any requests for convening a conference or other notices.

6. This Treaty shall be registered by the Depositary Governments pursuant to article 102 of the Charter of the United Nations.

Article X

1. Each Party shall in exercising its national sovereignty have the right to withdraw from the Treaty if it decides that extraordinary events, related to the subject matter of this Treaty, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other Parties to the Treaty and to the United Nations Security Council three months in advance. Such notice shall include a statement of the extraordinary events it regards as having jeopardized its supreme interests.

2. Twenty-five years after the entry into force of the Treaty, a conference shall be convened to decide whether the Treaty shall continue in force indefinitely, or shall be extended for an additional fixed period or periods. This decision shall be taken by a majority of the Parties to the Treaty.

Article XI

This Treaty, the English, Russian, French, Spanish and Chinese texts of which are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Treaty shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.

IN WITNESS WHEREOF the undersigned, duly authorized, have signed this Treaty.

DONE in triplicate, at the cities of Washington, London and Moscow, this first day of July one thousand nine hundred sixty-eight.

APPENDIX II

OUTER SPACE TREATY

TREATY ON PRINCIPLES GOVERNING THE ACTIVITIES OF STATES IN THE EXPLORATION AND USE OF OUTER SPACE, INCLUDING THE MOON AND OTHER CELESTIAL BODIES

Bureau of Arms Control, Verification, and Compliance

Signed at Washington, London, Moscow, January 27, 1967
Entered into force October 10, 1967

Narrative

The Outer Space Treaty, as it is known, was the second of the so-called "nonarmament" treaties; its concepts and some of its provisions were modeled on its predecessor, the Antarctic Treaty. Like that Treaty it sought to prevent "a new form of colonial competition" and the possible damage that self-seeking exploitation might cause.

In early 1957, even before the launching of Sputnik in October, developments in rocketry led the United States to propose international verification of the testing of space objects. The development of an inspection system for outer space was part of a Western proposal for partial disarmament put forward in August 1957. The Soviet Union, however, which was in the midst of testing its first ICBM and was about to orbit its first Earth satellite, did not accept these proposals.

Between 1959 and 1962 the Western powers made a series of proposals to bar the use of outer space for military purposes. Their successive plans for general and complete disarmament included provisions to ban the orbiting and stationing in outer space of weapons of mass destruction. Addressing the General Assembly on September 22, 1960, President Eisenhower proposed that the principles of the Antarctic Treaty be applied to outer space and celestial bodies.

Soviet plans for general and complete disarmament between 1960 and 1962 included provisions for ensuring the peaceful use of outer space. The Soviet Union, however, would not separate outer space from other disarmament issues, nor would it agree to restrict outer space to peaceful uses unless U.S. foreign bases at which short-range and medium-range missiles were stationed were eliminated also.

The Western powers declined to accept the Soviet approach; the linkage, they held, would upset the military balance and weaken the security of the West.

After the signing of the Limited Test Ban Treaty, the Soviet Union’s position changed. It ceased to link an agreement on outer space with the question of foreign bases. On September 19, 1963, Foreign Minister Gromyko told the General Assembly that the Soviet Union wished to conclude an agreement banning the orbiting of objects carrying nuclear weapons. Ambassador Stevenson stated that the United States had no intention of orbiting weapons of mass destruction, installing them on celestial bodies or stationing them in outer space. The General Assembly unanimously adopted a resolution on October 17, 1963, welcoming the

Soviet and U.S. statements and calling upon all states to refrain from introducing weapons of mass destruction into outer space.

The United States supported the resolution, despite the absence of any provisions for verification; the capabilities of its space-tracking systems, it was estimated, were adequate for detecting launchings and devices in orbit.

Seeking to sustain the momentum for arms control agreements, the United States in 1965 and 1966 pressed for a Treaty that would give further substance to the U.N. resolution. On June 16, 1966, both the United States and the Soviet Union submitted draft treaties. The U.S. draft dealt only with celestial bodies; the Soviet draft covered the whole outer space environment. The United States accepted the Soviet position on the scope of the Treaty, and by September agreement had been reached in discussions at Geneva on most Treaty provisions. Differences on the few remaining issues -- chiefly involving access to facilities on celestial bodies, reporting on space activities, and the use of military equipment and personnel in space exploration -- were satisfactorily resolved in private consultations during the General Assembly session by December.

On the 19th of that month the General Assembly approved by acclamation a resolution commending the Treaty. It was opened for signature at Washington, London, and Moscow on January 27, 1967. On April 25 the Senate gave unanimous consent to its ratification, and the Treaty entered into force on October 10, 1967.

The substance of the arms control provisions is in Article IV. This article restricts activities in two ways:

First, it contains an undertaking not to place in orbit around the Earth, install on the moon or any other celestial body, or otherwise station in outer space, nuclear or any other weapons of mass destruction.

Second, it limits the use of the moon and other celestial bodies exclusively to peaceful purposes and expressly prohibits their use for establishing military bases, installation, or fortifications; testing weapons of any kind; or conducting military maneuvers.

After the Treaty entered into force, the United States and the Soviet Union collaborated in jointly planned and manned space enterprises.

Treaty Text

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies

Signed at Washington, London, Moscow, January 27, 1967
Ratification advised by U.S. Senate April 25, 1967
Ratified by U.S. President May 24, 1967
U.S. ratification deposited at Washington, London, and Moscow October 10, 1967
Proclaimed by U.S. President October 10, 1967
Entered into force October 10, 1967

The States Parties to this Treaty,

Inspired by the great prospects opening up before mankind as a result of man’s entry into outer space,

Recognizing the common interest of all mankind in the progress of the exploration and use of outer space for peaceful purposes,

Believing that the exploration and use of outer space should be carried on for the benefit of all peoples irrespective of the degree of their economic or scientific development,

Desiring to contribute to broad international co-operation in the scientific as well as the legal aspects of the exploration and use of outer space for peaceful purposes,

Believing that such co-operation will contribute to the development of mutual understanding and to the strengthening of friendly relations between States and peoples,

Recalling resolution 1962 (XVIII), entitled "Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space," which was adopted unanimously by the United Nations General Assembly on 13 December 1963,

Recalling resolution 1884 (XVIII), calling upon States to refrain from placing in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction or from installing such weapons on celestial bodies, which was adopted unanimously by the United Nations General Assembly on 17 October 1963,

Taking account of United Nations General Assembly resolution 110 (II) of 3 November 1947, which condemned propaganda designed or likely to provoke or encourage any threat to the peace, breach of the peace or act of aggression, and considering that the aforementioned resolution is applicable to outer space,

Convinced that a Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, will further the Purposes and Principles of the Charter of the United Nations,

Have agreed on the following:

Article I

The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.

Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.

There shall be freedom of scientific investigation in outer space, including the moon and other celestial bodies, and States shall facilitate and encourage international co-operation in such investigation.

Article II

Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.

Article III

States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the moon and other celestial bodies, in accordance with international law,

including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding.

Article IV

States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.

The Moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes. The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military maneuvers on celestial bodies shall be forbidden. The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited. The use of any equipment or facility necessary for peaceful exploration of the Moon and other celestial bodies shall also not be prohibited.

Article V

States Parties to the Treaty shall regard astronauts as envoys of mankind in outer space and shall render to them all possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas. When astronauts make such a landing, they shall be safely and promptly returned to the State of registry of their space vehicle.

In carrying on activities in outer space and on celestial bodies, the astronauts of one State Party shall render all possible assistance to the astronauts of other States Parties.

States Parties to the Treaty shall immediately inform the other States Parties to the Treaty or the Secretary-General of the United Nations of any phenomena they discover in outer space, including the Moon and other celestial bodies, which could constitute a danger to the life or health of astronauts.

Article VI

States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty. When activities are carried on in outer space, including the Moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization.

Article VII

Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the Moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies.

Article VIII

A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth. Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.

Article IX

In the exploration and use of outer space, including the Moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including the Moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty. States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, may request consultation concerning the activity or experiment.

Article X

In order to promote international co-operation in the exploration and use of outer space, including the Moon and other celestial bodies, in conformity with the purposes of this Treaty, the States Parties to the Treaty shall consider on a basis of equality any requests by other States Parties to the Treaty to be afforded an opportunity to observe the flight of space objects launched by those States.

The nature of such an opportunity for observation and the conditions under which it could be afforded shall be determined by agreement between the States concerned.

Article XI

In order to promote international co-operation in the peaceful exploration and use of outer space, States Parties to the Treaty conducting activities in outer space, including the Moon and other celestial bodies, agree to inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the nature, conduct, locations and results of such activities. On receiving the said information, the Secretary-General of the United Nations should be prepared to disseminate it immediately and effectively.

Article XII

All stations, installations, equipment and space vehicles on the Moon and other celestial bodies shall be open to representatives of other States Parties to the Treaty on a basis of reciprocity. Such representatives shall give reasonable advance notice of a projected visit, in order that appropriate consultations may be held and that maximum precautions may be taken to assure safety and to avoid interference with normal operations in the facility to be visited.

Article XIII

The provisions of this Treaty shall apply to the activities of States Parties to the Treaty in the exploration and use of outer space, including the Moon and other celestial bodies, whether such activities are carried on by a single State Party to the Treaty or jointly with other States, including cases where they are carried on within the framework of international intergovernmental organizations.

Any practical questions arising in connection with activities carried on by international inter-governmental organizations in the exploration and use of outer space, including the Moon and other celestial bodies, shall be resolved by the States Parties to the Treaty either with the appropriate international organization or with one or more States members of that international organization, which are Parties to this Treaty.

Article XIV

1. This Treaty shall be open to all States for signature. Any State which does not sign this Treaty before its entry into force in accordance with paragraph 3 of this article may accede to it at any time.
2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the United States of America, the United Kingdom of Great Britain and Northern Ireland and the Union of Soviet Socialist Republics, which are hereby designated the Depositary Governments.
3. This Treaty shall enter into force upon the deposit of instruments of ratification by five Governments including the Governments designated as Depositary Governments under this Treaty.

4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Treaty, it shall enter into force on the date of the deposit of their instruments of ratification or accession.
5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification of and accession to this Treaty, the date of its entry into force and other notices.
6. This Treaty shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

Article XV

Any State Party to the Treaty may propose amendments to this Treaty. Amendments shall enter into force for each State Party to the Treaty accepting the amendments upon their acceptance by a majority of the States Parties to the Treaty and thereafter for each remaining State Party to the Treaty on the date of acceptance by it.

Article XVI

Any State Party to the Treaty may give notice of its withdrawal from the Treaty one year after its entry into force by written notification to the Depositary Governments. Such withdrawal shall take effect one year from the date of receipt of this notification.

Article XVII

This Treaty, of which the English, Russian, French, Spanish and Chinese texts are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Treaty shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.

IN WITNESS WHEREOF the undersigned, duly authorized, have signed this Treaty.

DONE in triplicate, at the cities of Washington, London and Moscow, this twenty-seventh day of January one thousand nine hundred sixty-seven.

APPENDIX III

GENERALIZED SOLUTIONS OF LANCHESTER LAWS

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"He who knows when he can fight and when he cannot, will be victorious."

Sun Tzu

ABSTRACT

The dynamic theory developed by the English engineer Frederick William Lanchester [1] based on the study of air battles in the First World War is presented in simple dynamic and static interpretations. Its implications are discussed based on a description initially suggested by Lewis [1]. It was recently successfully applied in the two Shock and Awe campaigns against Iraq, even though it was initially meant to be used against the Warsaw Pact nations during the Cold War. The strategy raises new interest and is worthy of investigation in the management, understanding and mitigation of the effects of current conflicts. It is being increasingly adopted by global world competitors leading to new multi-players Game Theory configurations and asymmetric warfare. Its application potentially enables a small force to overwhelm a superior force in numbers. The application of the theory can be expanded from defense applications to risk management, safeguards, business, management, sports, politics, video games design and other socio-economic realms.

INTRODUCTION

It has become evident that the USA acquisition of the position of hyper power and its dominance in the latest major conflicts is based on superior knowledge and understanding of the quantitative fundamental strategic and tactical principles of conflict and war. These include the principles of Sun Tzu, the maxims of Napoleon, and the doctrines of Clausewitz. At some time or the other these have been qualitatively expressed as slogans such as [1]: Divide and conquer and take the high ground.

The USA military was introduced to, and has mastered Decision Theory and the Theory of Games under the mathematically-oriented Secretary of Defense William Perry. One particular aspect is the application of the theory developed by the British Air Force English engineer and mathematician Frederick William Lanchester. His 1916 theory involves a set of differential equations solvable by using the Laplace's Transformation that are based on the study of air battles in the First World War [2]. He introduced a Linear Law describing ancient combat and a Square Law applying to modern combat and his Principle of Concentration. He initially considered two opponents with a strength of $N_1(t)$ and $N_2(t)$ each. The rate at which the members of one group are reduced in magnitude is proportional to the number of their opponents, leading to the set of first order coupled ordinary rate equations:

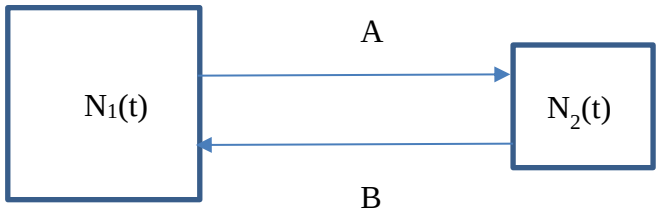

Figure 1. Lanchester' model of combat between two homogeneous forces $N_1(t)$ and $N_2(t)$ and fighting effectiveness A and B respectively.

$$\frac{dN_1(t)}{dt} = -BN_2(t), \quad N_1(0) = N_{10}, \ \forall N_1(t) > 0$$
$$where \frac{dN_1(t)}{dt} = 0 \ for \ N_1(0) \tag{1}$$

$$\frac{dN_2(t)}{dt} = -AN_1(t), \quad N_2(0) = N_{20}, \ \forall N_2(t) > 0$$
$$where \frac{dN_2(t)}{dt} = 0 \ for \ N_2(0) \tag{2}$$

where: $A, B > 0$, are the fighting effectiveness coefficients,
N_{10}, N_{20}, are the initial troop strengths.

GENERAL SOLUTION

Differentiating Eq. 1 with respect to the time variable yields:

$$\frac{d^2N_1(t)}{dt^2} = -B\frac{dN_2(t)}{dt}$$

Substituting for the first derivatives from Eq. 2 yields:

$$\frac{d^2N_1(t)}{dt^2} = +ABN_1(t) \tag{3}$$

Defining the radial frequency ω as:

$$\omega^2 = AB$$
$$\omega = \sqrt{AB} = 2\pi f$$
where f $[Hz]$, *is a frequency characteristic of the process*

We can write:

$$\frac{d^2 N_1(t)}{dt^2} = +\omega^2 N_1(t). \qquad (3)'$$

This equations is of the general form:

$$\ddot{x}(t) = +\omega^2 x(t)$$

The solution is a negative and positive exponential decay and growth given by either of:

$$x(t) = A^{"} \cosh(\omega t) + B^{"} \sinh(\omega t)$$
$$x(t) = A^{"'} e^{+\omega t} \quad + B^{"'} e^{-\omega t}$$

where cosh(x) and sinh(x) are the hyperbolic cosine and sine functions, with:

$$e^{+\omega t} = \cosh(\omega t) + \sinh(\omega t)$$
$$e^{-\omega t} = \cosh(\omega t) - \sinh(\omega t)$$

or:

$$\cosh(\omega t) = \frac{e^{+\omega t} + e^{-\omega t}}{2}$$
$$\sinh(\omega t) = \frac{e^{+\omega t} - e^{-\omega t}}{2}$$
$$\frac{d}{dt}\cosh(\omega t) = \frac{\omega e^{+\omega t} - \omega e^{-\omega t}}{2} = \omega \sinh(\omega t)$$
$$\frac{d}{dt}\sinh(\omega t) = \frac{\omega e^{+\omega t} + \omega e^{-\omega t}}{2} = \omega \cosh(\omega t)$$

Thus we can write as a solution:

$$N_1(t) = R\cosh(\omega t) + S\sinh(\omega t)$$
$$= Te^{+\omega t} \quad + Ue^{-\omega t} \qquad (4)$$

The form of the solution and the constants of integration are to be determined by the nature of the problem at hand and its initial conditions.

INTEGRATION CONSTANTS

As an initial condition at t = 0,

$$N_{10} = N_1(0) = Te^{+\omega 0} + Ue^{-\omega 0} = T + U$$

Another initial condition is:

$$\frac{dN_1(0)}{dt} = -BN_2(0) = -BN_{20} = [T\omega e^{\omega 0} - U\omega e^{-\omega 0}] = \omega(T - U)$$

These are two equations in two unknowns:

$$T + U = N_{10},$$

$$T - U = -\frac{B}{\omega} N_{20}$$

Adding the two equations yields:

$$T = \frac{1}{2}(N_{10} - \frac{B}{\omega} N_{20})$$

Subtracting the two equations yields:

$$U = \frac{1}{2}(N_{10} + \frac{B}{\omega} N_{20})$$

The solution becomes:

$$N_1(t) = \frac{1}{2}(N_{10} - \frac{B}{\omega} N_{20})e^{+\omega t} + \frac{1}{2}(N_{10} + \frac{B}{\omega} N_{20})e^{-\omega t} \qquad (5)$$

This solution can be written in terms of hyperbolic sines and cosines as:

$$
\begin{aligned}
N_1(t) &= \frac{1}{2}(N_{10} - \frac{B}{\omega}N_{20})e^{+\omega t} + \frac{1}{2}(N_{10} + \frac{B}{\omega}N_{20})e^{-\omega t} \\
&= N_{10}\frac{e^{+\omega t} + e^{-\omega t}}{2} - \frac{B}{\omega}N_{20}\frac{e^{+\omega t} - e^{-\omega t}}{2} \\
&= N_{10}\cosh\omega t - \frac{B}{\omega}N_{20}\sinh\omega t
\end{aligned} \qquad (5)'
$$

From Eq. 1 we can write:

$$
\begin{aligned}
N_2(t) &= -\frac{1}{B}\frac{dN_1(t)}{dt} \\
&= -\frac{1}{B}\frac{d}{dt}[(N_{10}\cosh\omega t - \frac{B}{\omega}N_{20}\sinh\omega t)] \\
&= -\frac{1}{B}(N_{10}\omega\sinh\omega t - BN_{20}\cosh\omega t) \\
&= \frac{1}{B}(-N_{10}\omega\sinh\omega t + BN_{20}\cosh\omega t)
\end{aligned} \qquad (6)
$$

Another form of the solution would be:

$$
\begin{aligned}
N_2(t) &= -\frac{1}{B}\frac{dN_1(t)}{dt} \\
&= -\frac{1}{B}\frac{d}{dt}[\frac{1}{2}(N_{10} - \frac{B}{\omega}N_{20})e^{+\omega t} + \frac{1}{2}(N_{10} + \frac{B}{\omega}N_{20})e^{-\omega t}] \\
&= -\frac{\omega}{B}[(\frac{1}{2}(N_{10} - \frac{B}{\omega}N_{20})e^{+\omega t} - \frac{1}{2}(N_{10} + \frac{B}{\omega}N_{20})e^{-\omega t}]
\end{aligned} \qquad (6)'
$$

STALEMATE

One can deduce a condition for reaching a stalemate by equating the troops strength as:

$$
\begin{aligned}
&N_1(t) = N_2(t) \\
&\frac{1}{2}(N_{10} - \frac{B}{\omega}N_{20})e^{+\omega t} + \frac{1}{2}(N_{10} + \frac{B}{\omega}N_{20})e^{-\omega t} = -\frac{\omega}{B}[(\frac{1}{2}(N_{10} - \frac{B}{\omega}N_{20})e^{+\omega t} - \frac{1}{2}(N_{10} + \frac{B}{\omega}N_{20})e^{-\omega t}] \\
&\frac{1}{2}(N_{10} - \frac{B}{\omega}N_{20})e^{+\omega t} + \frac{\omega}{B}(\frac{1}{2}(N_{10} - \frac{B}{\omega}N_{20})e^{+\omega t} = -\frac{1}{2}(N_{10} + \frac{B}{\omega}N_{20})e^{-\omega t} - \frac{1}{2}\frac{\omega}{B}(N_{10} + \frac{B}{\omega}N_{20})e^{-\omega t}] \\
&[(N_{10} - \frac{B}{\omega}N_{20}) + \frac{\omega}{B}(N_{10} - \frac{B}{\omega}N_{20})]e^{+2\omega t} = -[(N_{10} + \frac{B}{\omega}N_{20}) + \frac{\omega}{B}(N_{10} + \frac{B}{\omega}N_{20})]
\end{aligned}
$$

ATTRITION TIME

The time to attrition is obtained by setting the solution for the forces to zero and solving for the time.

$$N_1(t_{a1}) = \frac{1}{2}(N_{10} - \frac{B}{\omega}N_{20})e^{+\omega t_{a1}} + \frac{1}{2}(N_{10} + \frac{B}{\omega}N_{20})e^{-\omega t_{a1}} = 0$$

$$\frac{1}{2}(N_{10} - \frac{B}{\omega}N_{20})e^{+\omega t_{a1}} = -\frac{1}{2}(N_{10} + \frac{B}{\omega}N_{20})e^{-\omega t_{a1}}$$

$$(N_{10} - \frac{B}{\omega}N_{20})e^{+\omega t_{a1}}e^{+\omega t_{a1}} = -(N_{10} + \frac{B}{\omega}N_{20})e^{-\omega t_{a1}}e^{+\omega t_{a1}}$$

$$\ln e^{+2\omega t_{a1}} = 2\omega t_{a1} = \ln - \frac{(N_{10} + \frac{B}{\omega}N_{20})}{(N_{10} - \frac{B}{\omega}N_{20})}$$

$$t_{a1} = \frac{1}{2\omega}\ln - \frac{(N_{10} + \frac{B}{\omega}N_{20})}{(N_{10} - \frac{B}{\omega}N_{20})}$$

$$N_2(t_{a2}) = \frac{\omega}{B}[-(\frac{1}{2}(N_{10} - \frac{B}{\omega}N_{20})e^{+\omega t_{a2}} + \frac{1}{2}(N_{10} + \frac{B}{\omega}N_{20})e^{-\omega t_{a2}}] = 0$$

$$\ln e^{+2\omega t_{a2}} = \ln \frac{(N_{10} + \frac{B}{\omega}N_{20})}{(N_{10} - \frac{B}{\omega}N_{20})}$$

$$t_{a2} = \frac{1}{2\omega}\ln \frac{(N_{10} + \frac{B}{\omega}N_{20})}{(N_{10} - \frac{B}{\omega}N_{20})}$$

EXAMPLE

We consider an example introduced by Joyner [3] who used the Laplace Transformation for a solution of the Lanchester equations:

$$\frac{dN_1(t)}{dt} = -4N_2(t),\ N_{10} = 150$$

$$\frac{dN_2(t)}{dt} = -1N_1(t),\ N_{20} = 90$$

$$A = 1, B = 4, \omega = \sqrt{AB} = 2$$

According to the derived generalized solutions, for troops 1:

$$\begin{aligned} N_1(t) &= \frac{1}{2}(N_{10} - \frac{B}{\omega}N_{20})e^{+\omega t} + \frac{1}{2}(N_{10} + \frac{B}{\omega}N_{20})e^{-\omega t} \\ &= \frac{1}{2}(150 - \frac{4}{2}\times 90)e^{+2t} + \frac{1}{2}(150 + \frac{4}{2}\times 90)e^{-2t} \\ &= -15e^{+2t} + 165e^{-2t} \end{aligned}$$

Alternatively:

$$\begin{aligned} N_1(t) &= N_{10}\cosh\omega t - \frac{B}{\omega}N_{20}\sinh\omega t \\ &= 150\cosh 2t - \frac{4}{2}90\sinh 2t \\ &= 150\cosh 2t - 180\sinh 2t \end{aligned}$$

According to the generalized solution, for troops 2:

$$\begin{aligned} N_2(t) &= -\frac{\omega}{B}[(\frac{1}{2}(N_{10} - \frac{B}{\omega}N_{20})e^{+\omega t} - \frac{1}{2}(N_{10} + \frac{B}{\omega}N_{20})e^{-\omega t}] \\ &= -\frac{2}{4}[(\frac{1}{2}(150 - \frac{4}{2}90)e^{+2t} - \frac{1}{2}(150 + \frac{4}{2}90)e^{-2t}] \\ &= -\frac{1}{4}[(150 - 180)e^{+2t} - (150 + 180)e^{-2t}] \\ &= \frac{1}{4}[30e^{+2t} + 330e^{-2t}] \\ &= 7.5e^{+2t} + 82.5e^{-2t} \end{aligned}$$

Alternatively:

$$\begin{aligned} N_2(t) &= \frac{1}{B}(-N_{10}\omega\sinh\omega t + BN_{20}\cosh\omega t) \\ &= \frac{1}{4}(-150\times 2\sinh 2t + 4\times 90\cosh 2t) \\ &= -75\sinh 2t + 90\cosh 2t \end{aligned}$$

For t > 0, the troops 2 solution can only be positive, hence troops 2 survives troops 1 which has an attrition time of:

$$N_1(t_{a1}) = -15e^{+2t_{a1}} + 165e^{-2t_{a1}} = 0$$

$$e^{+2t_{a1}} e^{+2t_{a1}} = \frac{165}{15} e^{-2t_{a1}} e^{+2t_{a1}}$$

$$\ln e^{+4t_{a1}} = \ln \frac{165}{15}$$

$$\ln e^{+4t_{a1}} = 4t_{a1} = \ln 11$$

$$t_{a1} = \frac{1}{4} \ln 11 = \frac{2.3979}{4} = 0.5995$$

The number of survivors in unit 2 is given by:

$$\begin{aligned} N_2(t_{a2}) &= 7.5e^{+2t_{a1}} + 82.5e^{-2t_{a1}} \\ &= 7.5e^{+2\times 0.5995} + 82.5e^{-2\times 0.5995} \\ &= 7.5e^{+1.119} + 82.5e^{-1.119} \\ &= 7.5\times e^{+1.119} + 82.5\times e^{-1.119} \\ &= 7.5\times 3.062 + 82.5\times \frac{1}{3.062} \\ &= 22.965 + 26.943 \\ &= 49.9 \\ &\simeq 50 \end{aligned}$$

The example demonstrates that a smaller size (N_{20} = 90) better prepared and trained troops ($4N_2$) compared with less effective troops ($1.N_1$), can annihilate a larger troop size (N_{10} = 150), while retaining more than half its initial size (50 out of 90).

THE SQUARE LAW

Instead of considering the time behavior of $N_1(t)$ and $N_2(t)$ separately, one could be interested in their behavior against each other. Dividing the two rate equations 1 and 2 eliminates *dt* as:

$$\begin{aligned} &\frac{\dfrac{dN_1(t)}{dt}}{\dfrac{dN_2(t)}{dt}} = \frac{-BN_2(t)}{-AN_1(t)}, \\ &AN_1(t)dN_1(t) = BN_2(t)dN_2(t) \end{aligned} \qquad (7)$$

Limit integration yields a solution to this equation as:

$$A\int_{N_{10}}^{N_1(t)} N_1(t)dN_1(t) = B\int_{N_{20}}^{N_2(t)} N_2(t)dN_2(t)$$

$$A[N_1^2(t) - N_{10}^2] = B[N_2^2(t) - N_{20}^2]$$

This is usually expressed as:

$$A[N_{10}^2 - N_1^2(t)] = B[N_{20}^2 - N_2^2(t)] \tag{8}$$

since: $N_{10} > N_1(t), N_{20} > N_2(t)$.

It can be noticed that the "Relative Fighting Strength" is a constant of motion of the process:

$$AN_1^2(t) - BN_2^2(t) = AN_{10}^2 - BN_{20}^2 = \text{Constant} \tag{9}$$

Lanchester lived from the middle 19th century through the end of World War II, building the first British gasoline-powered cars, invented power steering and disc brakes, and studied aerodynamics. His theory was applied in the two Shock and Awe campaigns against Iraq; even though initially meant to be used against the Warsaw Pact nations during the Cold War; in which its efficacy was spectacularly demonstrated. Defense Secretary Rumsfeld during USA President George W. Bush's administration successfully used small but heavily armed units in the second Iraq war instead of the traditional large forces assumed to be needed for a military invasion.

The strategy is worthy of investigation as it is being adopted by world competitors which is leading to new multi-players Game Theory configurations, rather than a single player situation, as can be observed in new theaters. The application of the theory can be expanded from defense applications to business, sports, politics, risk management, video games design, Operations Research and other socio-economic realms.

MATHEMATICAL DESCRIPTION

Expanding on a simpler static, rather than Lanchester's dynamic description, initially suggested by Lewis [1], the concept is developed in detail, and applied to specific situations that show its potential usefulness in the context of Risk assessment, Safeguards, Nonproliferation and Peaceful Nuclear Energy [3].

Lanchester's model of warfare considers two opposing forces shooting at each other without any particular advantage in accuracy, weapons or force multipliers. In this case the firepower F of a fighting force is proportional to the total number of units N that it can muster; or:

$$F = c_1 N \tag{2}$$

where: c_1 is a proportionality constant.

The units N could be troops, airplanes, ships, tanks, submarines, etc. The number of targets *T* that this force presents to its opponent to distribute its firepower resources against is also proportional to its own size N ; thus it also follows that:

$$T = c_2 N \tag{3}$$

where: c_2 is a proportionality constant.

Assuming also that the shooting from one side on the other follows a uniformly distributed random pattern with an equal probability of scoring a hit, three important static consequences of these two simple assumptions can be deduced.

First, the strength of the force *S* with *N* units is proportional to both its firepower *F* and the number of targets *T* it presents to its opponent's firepower:

$$S = c_3 F.T \tag{4}$$

where: c_3 is a proportionality constant.

Substituting from Eqns. 2 and 3 into Eqn. 4, yields:

$$S = c_1 c_2 c_3 N^2 \tag{5}$$

Equation 5 can be rewritten as:

$$S = c.N^2 \tag{6}$$

where: $c = c_1 c_2 c_3$ is a proportionality constant.

The first consequence of Lanchester's Laws is that the square law in Eq. 6 reveals that the strength of a force *S* is proportional to the square of its number of its units *N*. If an army can gather twice the number of units of its opponent, its strength is not just twice its opponent's, but the square of 2 or 4 times its opponent's.

The implication is that it is advantageous to go against an opponent with overwhelming force or Shock and Awe. It also can be inferred that it pays to go with a large number of cheap units rather than a small number of expensive units. It also pays to gather allies, proxies and coalition-partner forces and paid-mercenaries, even without their being involved in the fighting; as they would draw away the fire and the losses from one's own troops.

During World War II, the advanced-technology, but small number of German V2 rockets targeting London and the Messerschmitt advanced jet fighters, were effectively countered by an overwhelming larger number of lower-technology bomber aircraft conducting continuous day and night raids on German manufacture and launching sites. It is necessary to acquire an expensive N^2 factor increase in quality to make up for a cheaper N factor increase in quantity. This implies the necessity of maintaining a large manufacturing and industrial capability, as well as a young dynamic draftable or recruitable population to produce and man the large number of units' base.

THE CONSTANT OF MOTION *M*

A constant of motion *M* exists that does not change as a result of the mutual fighting and the ensuing losses on both sides [2]. This constant of motion is expressed as the absolute value of the difference between the square of one's own units N_1^2 and the opponent's square of the number of units, N_2^2, assuming comparatively prepared and equipped troops with A = B:

$$M = \left|(N_1^2 - N_2^2)\right| \tag{7}$$

The square root of *M* can be considered as the expected outcome *O* or the mean value of the remainder number of units after a confrontation:

$$\begin{aligned} O &= \sqrt{M} \\ &= \sqrt{\left|(N_1^2 - N_2^2)\right|} \end{aligned} \tag{8}$$

The second important consequence of Lanchester's Laws from Eqn. 8 is that a force with a larger number than its opponent, can wipe out or exterminate the opponent while still being relatively left intact.

EXAMPLE 1

For instance, if a force of 5 units faces a force of 3 units the expected outcome is according to Eqn. 8:

$$\begin{aligned} O &= \sqrt{M} \\ &= \sqrt{\left|(5^2 - 3^2)\right|} \\ &= \sqrt{\left|(25 - 9)\right|} \\ &= \sqrt{16} \\ &= 4 \end{aligned}$$

The expected outcome 4 of the confrontation is thus that the smaller force of 3 is totally wiped out losing 100 percent of its units. On the other hand the larger force would still have 4 out of 5 units left and would have lost just:

$$\begin{aligned} \frac{(5-4)}{5} \times 100 &= \frac{1}{5} \times 100 \\ &= 20 \text{ percent} \end{aligned}$$

of its units.

SMALL FORCE PREVAILING OVER LARGE FORCE, DIVIDE AND CONQUER

A third important consequence of Lanchester's Laws is that it provides a way for a small force to prevail over a force that outnumbers it [1]. The insight is that this can be achieved by splitting the enemy forces and dealing with their divided forces one divided group at a time; this corresponds to the old qualitative maxim of divide and conquer, or penetration or concentration principle.

EXAMPLE 2

As a numerical example, suppose that an A group with 20 units is confronting another B group with 25 units. A head-on confrontation according to Eqn. 8 would lead to an expected outcome of:

$$\begin{aligned} O &= \sqrt{M} \\ &= \sqrt{\left|(20^2 - 25^2)\right|} \\ &= \sqrt{\left|(400 - 625)\right|} \\ &= 15 \end{aligned},$$

which means that the A group's inferior force of 20 would be totally wiped out, leaving 15 units of the B opponent's 25 units still intact. The opponent B would have lost:

$$\begin{aligned} \frac{25-15}{25} \times 100 &= \frac{10}{25} \times 100 \\ &= 40 \,\text{percent} \end{aligned}$$

of his force, a significant loss, but would have totally wiped the A group out.

Suppose that by some stratagem, maybe inducing or exploiting a defensive posture by the B opponent, the A group is able to divide the opponent's force into two subgroups of 15 and 10 units each. Confronting the first group with A's total force leads to the expected outcome:

$$\begin{aligned} O_1 &= \sqrt{M_1} \\ &= \sqrt{\left|(20^2 - 15^2)\right|} \\ &= \sqrt{\left|(400 - 225)\right|} \\ &= \sqrt{175} \\ &\simeq 13 \end{aligned}$$

which wipes out the B's group of 15, and leaves 13 of A's troops intact. These could then be used against B's remaining group of 10 with the expected outcome:

$$\begin{aligned} O_2 &= \sqrt{M_2} \\ &= \sqrt{\left|(13^2 - 10^2)\right|} \\ &= \sqrt{\left|(169 - 100)\right|} \\ &= \sqrt{69} \\ &\simeq 8 \end{aligned}$$

which means that an inferior force A with 20 units can totally exterminate a superior force B with 25 units while still keeping:

$$\frac{8}{20} \times 100 = 40 \,\text{percent}$$

of its initial force intact.

MULTIPLAYERS GAMES

Multiple-players' games based on Lanchester's Laws can be envisioned, and are in fact occurring. In a three players game we can write:

$$\begin{aligned} \frac{dN_1(t)}{dt} &= -BN_2(t) - CN_3(t), N_1(0) = N_{10}, \\ \frac{dN_2(t)}{dt} &= -AN_1(t) - CN_3(t), N_2(0) = N_{20}, \\ \frac{dN_3(t)}{dt} &= -AN_1(t) - BN_2(t), N_3(0) = N_{30}, \end{aligned}$$

In the case of a three players game two situations arise [2]. If the three parties are shooting at each other, the situation favors the largest force that would encourage the situation since the two other parties will be drawing fire away from it and onto each other. Eventually the smaller force is wiped out and the field is left to the two largest forces, which could settle their differences or continue the conflict to the detriment of the smaller force which would eventually be wiped out. The second situation is an alliance of convenience where the two smaller forces ally themselves against the largest force knowing well that they would have to eventually settle their differences after defeating the largest force.

Another example of multiple-players games is British Admiral Nelson's victory at the Battle of Trafalgar in which he divided the Spanish and French fleets combined superior force into defeatable smaller groups before they could reunite.

Examples of three or more players' games are the Serbs, Croats and Bosnians in the previous united Yugoslavia. The Shiites, Sunnis and Kurds in the partitioned Iraq, are another

example. An example of two forces allied against a third is the Western Alliance with the Soviet Union against Germany during World War II. It was an alliance of convenience and was in fact followed by the Cold War where the old Soviet Union was later dismantled. In three-way contests it is logically best for two players to ally themselves against the third, such as Russia and China allying themselves against the USA and the North Atlantic Treaty Organization (NATO) alliance.

DISCUSSION

A limitation of Lanchester's Laws is that they apply to battles of attrition, whereas victory or defeat may be defined based on other criteria. For instance, French Napoleon Bonaparte and German Adolf Hitler were defeated by losing most of their respective armies without causing strategic surrenders in their invasions during Russia's winters.

This idealized situation can be affected by force multipliers such as superior technology, motivation, morale, weaponry, positions, terrain, weapons range, movement and maneuver, surprise, weather, intelligence gathering and even pure luck [1]. The general mathematical principles nevertheless still apply. It is well known that an army surrenders not necessarily when it is defeated, but when it thinks it is defeated. It is possible to make an army perceive of defeat and surrender even it were the superior force.

Mastering these decision and game theory notions and principles is behind the present hyper-power status of the USA, obviously for as long only as its global competitors have not yet grasped them. A hyper-power dominance can be eventually expected to face the formation of alliances and coalitions of those who do not want to fall under its influence, against it. This partly explains the previous rise then fall and collapse of the great empires throughout history.

The alliances between the North Atlantic Treaty Organization (NATO) nations, the UK, the USA and the Ukraine against Russia; the USA and Israel with a coalition of Sunni Islam against a coalition of Shiite Islam and Russia appear to be harbingers of hopefully-avoidable multi-faceted geo-political, confessional and ideological painful chaotic contexts that contemporary humanity ought to understand, de-escalate and peacefully resolve.

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