



Nuclear Programs of Arab and Islamic States: Capabilities, Strategies, and Implications

Gerald M. Steinberg and Aharon Etengoff

The proliferation of nuclear weapons technology in the radical states of the Middle East, Persian Gulf, and south Asia has been steadily accelerating since the 1970s. Under Saddam Hussein, Iraq spent billions of dollars on acquiring and developing ballistic missiles and weapons of mass destruction. In 1991, at the time of the U.S.-led counterattack following the invasion of Kuwait, the totalitarian Iraqi dictator was only a few months away from being able to fabricate a nuclear weapon. Iran has been working steadily to follow this lead, as have Libya, Algeria, and other states. In May 1998, Pakistan followed India in officially entering the nuclear weapons club.

The threats to security and stability posed by the spread of nuclear weapons in the Islamic world go beyond the impacts of the individual national programs and constitute a much wider regional and global threat. These are highly unstable areas, in which terrorism, sponsored, used, and sheltered by states, is endemic, and the concept of *jihad* (holy war) is central. In much of this region, the

degree of hostility toward perceived enemies (“Israel,” “the West,” the “Great Satan”) is extremely high,¹ and the global strictures against the acquisition and use of weapons of mass destruction are ignored.

In addition, despite the many sectarian and nationalist conflicts among groups, the shared element of Islam is seen as providing a basis for cooperation in obtaining these weapons and technologies, and perhaps even the transfer of nuclear arms in times of crisis and conflict.² Pan-Islamic ideology is quite powerful, if often violated (as in the case of the Iran-Iraq war, Saddam Hussein’s invasion of Kuwait, etc). In many cases, the development of an “Islamic bomb” is often understood “to be a nuclear weapon acquired for broad ideological reasons — a weapon that supposedly belongs collectively to the Muslim *ummah* or community and, as such, is the ultimate expression of Islamic solidarity.”³

This concept has been stated explicitly by a number of Islamic leaders. Before he was executed, deposed President Zulfikar Ali Bhutto, the architect of Pakistan’s nuclear program, wrote, “We know that Israel and South Africa have full nuclear capability. The Christian, Jewish, and Hindu civilizations have this capability. The Communist powers also possess it. Only the Islamic civilization was without it, but that position was about to change.”⁴ Similarly, in an address before an Islamic conference in Teheran in 1992, Iranian Vice President Sayed Ayatollah Mohajerani declared, “The Muslims, must cooperate to produce an atomic bomb, regardless of UN efforts to prevent proliferation.”⁵

Echoing similar sentiments, many Palestinians cheered the Pakistan nuclear tests as part of the extension of a wider Islamic military capability. The Palestinian newspaper *Al-Quds* printed an illustration of the nuclear mushroom cloud, with an Islamic crescent above it.⁶ Pakistan’s image and influence in the Islamic world rose significantly as a result of the nuclear tests. As Pervez Hoodbhoy noted in an article in the *Bulletin of Atomic Scientists* (1993):

The bomb looms large in the popular Muslim consciousness as a symbol of Islamic unity, determination, and self-respect. It is seen by many as a guarantee against further humiliating defeats, as the sure sign of a reversal of fortunes, and as a panacea for the ills that have plagued

Muslims since the end of the Golden Age of Islam. Such sentiments are echoed by Muslims from Algeria to Syria, and from Iraq to Pakistan. A country that could turn this symbolism into reality would have the support of hundreds of millions of Muslims the world over. It is therefore natural that Pakistan, a Muslim country that is now a de facto nuclear state, should indeed enjoy considerable financial and political benefits from oil-rich Arab countries.⁷

While, for the most part, the nuclear weapons programs (and, in the case of Pakistan, capabilities) are primarily national, rather than “Islamic,” in the sense of being made available to groups and causes that extend beyond national boundaries, this situation is likely to evolve. In the meantime, the threats to the United States, Israel, Europe, and other potential targets that will be posed by acquisition of nuclear weapons in Iraq, Iran, Libya, Algeria, Syria, and perhaps Egypt are very serious.

In this chapter, we will describe and analyze the 1) nuclear weapons capabilities and technologies, 2) development and acquisition plans and programs, and 3) statements on strategy and goals for Iran, Pakistan, Libya, Syria, Egypt, Saudi Arabia, and Algeria. For each country, we will present information based on a detailed study of the sources, including U.S. government and other official reports, the academic literature, and press reports. The country assessments will also include analysis of technological acquisitions (include dual-use systems, materials, and facilities), delivery systems such as ballistic missiles, and cooperation with third countries, including Russia, China, and North Korea, and well as between themselves. Because of the United States’ destruction of Saddam Hussein’s Baathist regime, our discussion of Iraqi nuclear capabilities will consist of historical background, with Iraq, at the present time, no longer considered a threat in the context of other regimes.

On this basis, the implications of the proliferation of nuclear weapons and technology in the Arab and Islamic world will be analyzed. In the case of Pakistan, this section will focus on the impact of the nuclear weapons capability on the balance of power in the region (including the Persian Gulf), on the nuclear ambitions and

programs of the other states in the region, and the potential for transfer of technology and experienced personnel. Regarding the Iranian nuclear acquisition program, we will examine the security implications for the region (including Israel), and for future deployment of U.S. and NATO forces and interests in the region. We will also consider the implications of the accelerating nuclear proliferation process in this region for European security interests.

IRAQ

Iraq's efforts to acquire nuclear weapons began many years ago, and continued despite wars, attacks, and international sanctions imposed following the invasion of Kuwait in August 1990, and the war that followed.

In the early 1970s, Iraq attempted, unsuccessfully, to purchase a plutonium production reactor that was similar to the one France utilized in its nuclear weapons program.⁸ In 1976, France and Iraq reached an agreement on the construction of the Osirak and Isis reactors — which were part of Iraq's sizeable nuclear research complex at Tuwaitha in Baghdad. This led to greater vigilance by outside powers, including Israel, leading to a series of setbacks in the Iraqi effort. However, Khidhir Hamza, a former physicist who worked on Iraqi nuclear weapons since 1970 (and defected in 1994), reports that in 1979 (when Saddam became president), the project was accelerated.⁹ In June 1981, after efforts to gain international cooperation in stopping the flow of nuclear weapons technology to Iraq failed, Israel launched an air strike against the Osirak nuclear reactor, just before its first fuel was to be loaded.

Following the destruction of the reactor, the central effort was shifted to the production of highly enriched uranium, and Iraqi scientists investigated many different techniques for uranium enrichment. However, Iraq still maintained an interest in acquiring plutonium as fissile material for weapons, albeit on a lower level. Following the end of the war with Iran, more resources were made available for the acquisition of nuclear technology, and in 1988, Iraq attempted to obtain the components and technology for the URENCO gas-centrifuge process. During this period, Saddam Hussein increased the priority of acquiring a nuclear weapons capability, and accelerated the rate of development and acquisition

of technology, materials, and expertise.¹⁰ A wide acquisition network was formed, with branches in many countries around the world. In 1990, Iraq initiated a crash program to divert reactor fuel (highly enriched uranium) under IAEA safeguards, to the production of nuclear weapons.

At the time of the Gulf War (January 1991), Iraq maintained a sophisticated and wide-ranging nuclear weapons development program, which was supported by at least 16 primary and supporting facilities.¹¹ The program employed 10,000 people, and had a multi-year budget of approximately \$10 billion.¹² According to Hamza, the project was close to completion at the time of the Gulf War.¹³ (The prototype bomb was a "hulking, blimp-shaped, stainless steel device minus, of course, its uranium core," that would not fit on a missile.)

IRAN

Iran's nuclear program began in 1967, with the delivery of a U.S.-supplied 5 megawatt (MW) research reactor at Tehran University.¹⁴ In 1974, Iran established the AEOI — the Atomic Energy Organization of Iran. Iran maintains two operational (5 MW and 30 kilowatt [KW]) research reactors, as well as a .01 KW critical assembly at Esfahan and Tehran.¹⁵

A third reactor, named Bushehr, is the core of the Iranian nuclear program. Construction was initiated by Germany (Siemens) in the 1970s, suspended in 1979 (due to the Islamic revolution¹⁶), and subsequently revived based on Russian assistance. The initial agreement (estimated to be worth \$1 billion) was signed in 1995, but work on the 1,000 MW reactor did not begin until February 1998.¹⁷ In March 1998, Iranian and Russian officials agreed in principle on construction of two more reactors for the Bushehr complex,¹⁸ and in November 1998, Russia and Iran announced that they were studying the possibility of building three more nuclear reactors at Bushehr.¹⁹

Iran also turned to China for assistance, and in 1990, the two countries signed a ten-year nuclear cooperation agreement.²⁰ In 1994, a contract was signed with China's National Nuclear Corporation for the construction of two 300 MW power reactors,²¹ but the contract was cancelled in 1997.

Although the U.S. administration initiated a series of high-level dialogues (the Gore-Chernomyrdin Commission) with the Russian government in the effort to slow the flow of Russian assistance, these efforts had little or no impact. In 1995, Iran attempted to purchase a uranium enrichment plant from Russia,²² and in April 1998, Russia and Iran held talks regarding the construction of a research reactor utilizing 20 percent enriched uranium.²³ In May 1998, the head of the Iranian Atomic Energy Organization visited Russia, to discuss further cooperation and purchases.²⁴

In October 1998, Western intelligence reported that Iran (led by the AEOI) was attempting to acquire equipment for laser enrichment of nuclear materials.²⁵ According to the American officials “there is no question that the turn-key facility was intended for” Iran’s nuclear weapons program.²⁶ Laser enrichment is considered to be uneconomical for producing the low-enriched uranium used in civilian power reactors.²⁷ The official Russian response has been that Moscow did not know of the contract until early last year because the Science and Technology Center of Microtechnology (a unit of the government’s D.V. Efremov Institute of St. Petersburg), had not sought an export permit, on the grounds that no sensitive technology was involved.²⁸ A senior U.S. official said that some Russian laser-related equipment theoretically could be cleared for export to Iran but that the U.S. government believed that, “taken as a whole package,” the laser facility clearly “was intended and designed for weapons-grade enrichment.”²⁹

In April 1999, the Russian Izhorskiye Zavod (machine-building company in St. Petersburg) began producing equipment for the primary circuit at Bushehr.³⁰ This included the reactor vessel, steam generator casing, and internals.³¹ In January 2000, Iran’s President Muhammad Khatami sent a message to acting president of the Russian Federation Putin, stating the expectation that ties between the two states would be extended further. In mid-January, Russia’s Foreign and Defense Ministers met with the Secretary of Iran’s Supreme National Security Council, and declared that Moscow intended to fulfill its obligations under the relevant agreements. Atomic Affairs Minister Adamov denied reports that Russia had agreed to stop nuclear collaboration with Iran.³²

In February 2000, the U.S. Senate approved legislation imposing sanctions on entities that assisted Iran’s chemical, biological, and nuclear weapons programs.³³ In June 2000, the U.S. government reported that a nuclear research center in Tehran was importing tritium from Russia. Tritium is a radioactive gas used primarily to enhance the explosive power of nuclear warheads. One American nuclear specialist noted that “This is an issue of concern and one would expect Iran to be very forthcoming in providing assurances about what it is being used for.”³⁴

Russian construction and engineering crews continued to work on the Bushehr nuclear power reactor project. In May 2000, Iran’s ambassador to Russia, Mehdi Safari, declared that the nuclear power station was 40 percent complete, and would become operational in 2002.³⁵ However, work on the complex has been somewhat delayed due to American sanctions.³⁶ As such, the date of completion remains highly speculative.³⁷

Assessments of progress in the Iranian nuclear sphere vary considerably. In 1993, the Central Intelligence Agency (CIA) stated that Iran was eight to ten years away from acquiring nuclear weapons; foreign assistance was said to be critical.³⁸ However, in 1999 the CIA warned that Iran might soon be able to produce a nuclear weapon.³⁹

Clearly, Russian and Chinese assistance has accelerated the rate of Iranian nuclear development significantly. According to Marine General Anthony Zinni, former head of U.S. Central Command, “I would say they are on track, within five years, they would have the capability [by then].”

Iranian officials formally deny that they are pursuing a military nuclear path. Dr. Amrollahi (of the AEOI) declared, “We would like to tell the world community that if our activities were not peaceful, the IAEA would have said so.”⁴⁰

Yet, an earlier statement by President Ali Khamene’i, in a February 1987 address to Iran’s Atomic Energy Organization, sharply contrasted Iran’s policy of denying military nuclear intentions:

Regarding atomic energy, we need it now. . . . Our nation has always been threatened from outside. The least we can do to face this danger is to let our enemies know that

we can defend ourselves. Therefore, every step you take here is in defense of your country and your evolution. With this in mind, you should work hard and at great speed.⁴¹

Missiles

- Approximately 150 Scud-Cs — 500 km range, 700 kg payload.⁴²
- Up to 200 Scud-Bs — 300 km range, 985 kg payload.⁴³
- Approximately 25 CSS-8s — 150 km range, 190 kg payload.⁴⁴
- Unknown quantity of indigenous-manufactured *Mushak* missiles — range from 120 km to 200 km, payload from 150 kg to 500 kg.⁴⁵
- Currently developing *Shihab-3*, over 1,000 km range, over 700 kg payload; the *Shihab-4*, 2,000 km range, 1,000 kg payload; and the *Shihab-5*, which will have a range of 10,000 km.⁴⁶ On July 15, Iran successfully conducted the second test of its *Shihab-3* missile, reportedly using one of a dozen North Korean rocket motors supplied to Teheran in 1999.⁴⁷ (The first test was conducted in July 1998, but the missile did not complete a full trajectory.)⁴⁸

In a report to the Subcommittee on Space and Aeronautics, Kenneth Timmerman stated that Iran is developing a new missile, named “*Kosar*.” The *Kosar* is structured around the Soviet SS-5 missile, uses the same RD-216 liquid fuel rocket motor, and has a range of 4,250 km. There are reports that the *Kosar* is the basis for Iran’s space launch vehicle.⁴⁹

PAKISTAN

Although relatively removed from the conflicts in the Middle East, Pakistan clearly represents a major threat to India, as well as to other states in the region. The increasing political instability, as reflected in the military coup in October 12, 1999, that ousted the government of Muhammad Nawaz Sharif, and the role of radical Islam, are causes for growing concern, particularly given Pakistan’s status as a de-facto nuclear weapons state.

On May 28, 1998 (a short while after five Indian nuclear tests), Pakistan announced that it had successfully completed five nuclear tests, which were reportedly carried out over a two-hour period in Balochistan.⁵⁰ According to the Pakistan Atomic Energy Commission, the nuclear tests measured up to 5.0 on the Richter scale, and had a (reported) yield of up to 40 kilotons (KT) (equivalent TNT).⁵¹ One of the tested nuclear devices was said to be a boosted uranium device, while the other tests were (low yield) sub-KT devices.⁵² On May 30, 1998, Pakistan tested an additional nuclear warhead (with a yield of 12 KT), bringing the total amount of Pakistani nuclear tests to six.⁵³

Pakistan’s nuclear program has reportedly progressed considerably following the successful nuclear tests in 1998.⁵⁴ Although the Pakistani government declared a moratorium on further nuclear weapons tests in June 1998,⁵⁵ two nuclear reactors, along with a plutonium processing facility, have since become operational. In addition, reports indicated that Pakistan may now be able to produce enough plutonium to manufacture one atomic bomb per year.⁵⁶

In addition, concerns regarding Pakistani nuclear and missile cooperation with other states in the region are increasing. In 1999, the Saudi Arabian defense minister, Prince Sultan, visited Pakistan’s secret nuclear facilities at Kahuta and a missile factory.⁵⁷

History

The Pakistan Atomic Energy Commission (PAEC) was established in 1955, and in 1965, Pakistani Prime Minister Zulfikar Ali Bhutto declared: “If India builds the bomb, we will eat grass or leaves, even go hungry. But we will get one of our own.”⁵⁸ In 1972, Bhutto assembled Pakistan’s top scientists at Multan, and ordered them to build an atomic bomb.⁵⁹ In 1974, after India conducted a nuclear test, Bhutto declared that Pakistan must develop its own “Islamic bomb.”⁶⁰

Following Bhutto’s statement, Pakistan’s nuclear program accelerated considerably. In October 1974, Pakistan signed a contract with France for the design of a reprocessing facility for the fuel from its power plant at Karachi and others.⁶¹ However, in response to pressure from the United States, the import of key components became more difficult.⁶² China provided assistance in the development of gas

centrifuges,⁶³ and the uranium enrichment facility began operation in the early 1980s.

In 1989, Pakistan tested a short-range missile, capable of carrying a nuclear payload. In 1990, the United States suspended military aid to Pakistan, after President Bush stated that he could not certify that Pakistan did not possess nuclear weapons.⁶⁴ In 1992, Pakistani Foreign Minister, Shahryar Khan, declared that Pakistan possessed the components and knowledge to manufacture at least one nuclear explosive “device.”⁶⁵ In 1994, German officials announced the seizure of preforms for gas centrifuge scoops intended for use in Pakistan.⁶⁶

However, by the mid-1990s, reports indicated that Pakistan’s nuclear arsenal consisted of at least ten nuclear warheads based on a Chinese design.⁶⁷ In February of 1996, British custom officials seized a shipment of Swedish laser measuring equipment slated for a Pakistani company that was well known to be a “front” for Pakistan’s nuclear weapon program.⁶⁸ In addition, the CIA revealed that China clandestinely sold 5,000 ring magnets to Pakistan’s A.Q. Khan Research Laboratories.⁶⁹ In September 1996, reports indicated that China had sold (in 1996) an industrial furnace and high-tech diagnostic equipment, with military applications, to an unsafeguarded nuclear facility in Pakistan.⁷⁰

The Pakistani nuclear program is based on enriched uranium weapons, using the fissile material produced at the Kahuta enrichment facility⁷¹ and utilizing centrifuge technology based on *Urenco* G-1 and G-2 designs stolen by Dr. A.Q. Khan.⁷² The plant⁷³ has an estimated 3,000 centrifuges in operation — generating a capacity of 9,000–15,000 SWU, and is capable of producing 55-95 kg of HEU per year.⁷⁴ Kahuta also houses the Dr. A.Q. Khan Research Laboratory, which began operating in 1984, and has the ability to produce centrifuge components.⁷⁵

Pakistani officials also claim to be independent in the production of heavy water, enriched uranium, zirconium, and spare parts for its nuclear industry, and able to fabricate a nuclear weapon of any type or size, including a neutron bomb.⁷⁶ However, according to U.S. government sources, Pakistan acquired nuclear-related and dual-use equipment and materials from Western Europe and other sources.⁷⁷

Among its goals, Pakistan is seeking to develop the capability to produce plutonium for potential weapons use.⁷⁸ A 50-70 MW heavy-water moderated plutonium reactor located at Khashab, and constructed with Chinese assistance, became operational in 1998.⁷⁹ A U.S. official was quoted as stating that Khashab is: “being operated as a dedicated weapons plutonium production reactor.”⁸⁰ In March 2000, *Nucleonics Week* reported that Pakistan had successfully obtained (through smuggling) components, as well as equipment, for a heavy water production plant at Khashab.⁸¹ Another non-safeguarded heavy water production facility supplied by Belgium in 1980 (with a yearly capacity of 13 MT) is located at Multan.⁸²

The Pakistan Institute of Nuclear Science and Technology (PINSTECH) site with Pakistan’s New Laboratories (also known as New Labs) includes an experimental-scale plutonium re-processing plant, capable of re-processing 10-20 kg of plutonium on a yearly basis.⁸³ Construction of New Labs (based on French design) began in 1976, and, according to reports, has been completed.⁸⁴ Apparently, both “cold”⁸⁵ and “hot”⁸⁶ tests have been conducted at the facility. PINSTECH also hosts a small-scale reprocessing laboratory that utilizes a solvent extraction method in addition to the Nuclear Track Detection Laboratory, an entity that carries out exploration for uranium.⁸⁷ The Center for Nuclear Studies, also based at PINSTECH, is Pakistan’s primary nuclear training school.⁸⁸ (PINSTECH contains two small reactors, named Pakistan Atomic Research Reactor — also known as PARR.⁸⁹)

There is also a partially built plutonium reprocessing plant at Chashma. Construction of the plant was begun by the French, but was subsequently halted in 1978.⁹⁰ According to U.S. intelligent reports, either Pakistan or China may be re-building the plant.⁹¹

In 1987, Pakistan received a tritium purification and production facility (with a daily production capability of 5–10 grams of tritium) from West Germany.⁹² PARR-1 is a 10 MW high flux, (upgrade from its original 5 MW capacity) pool type research reactor supplied by the United States in 1965.⁹³ PARR-1 is under IAEA safeguards, and originally utilized uranium enriched up to 90 percent, but has since been converted to use 20 percent enriched uranium.⁹⁴ According to reports, Lithium-6 targets were irradiated on a test basis, for later use in tritium separation.⁹⁵

Missiles

Pakistan's efforts to develop and manufacture long-range ballistic-missiles capable of carrying nuclear warheads is part of a strategy to counter India's military capabilities.⁹⁶

Pakistan's missile arsenal includes:

- The *Ghauri* MRBM (Pakistani developed and manufactured) is a medium-range ballistic missile using liquid propellant, based on North Korea's *No Dong* MRBM, (range 1,500 km; payload 700 kg. However, it is more likely that its range is similar to the North Korean *No Dong* — 1,300 km.⁹⁷
- The *Shaheen-1* SRBM (Pakistani developed and manufactured) solid-fueled, 750 km range.⁹⁸
- The *Hatf-1* is a Pakistani developed and manufactured solid propellant missile with an 80 km range.⁹⁹
- The M-11 SRBM is a (mobile) Chinese manufactured missile with a 290 km range, and is capable of carrying an 800 kg warhead.¹⁰⁰ According to reports, the M-11 is a single-stage, solid-propellant missile, with an inertial mid-course guidance system.¹⁰¹ Reportedly, Pakistan's HATF III will be based on this model.¹⁰²

According to Pakistani officials, Pakistan is currently developing two new missiles, the *Ghaznavi*, and the *Shaheen-II*. Both have a (intended) range of 2,000 km — a range sufficient to reach any location in India.¹⁰³

LIBYA

Libya has attempted to obtain nuclear material and technology from Pakistan, China,¹⁰⁴ the Soviet Union (now Russia), Argentina,¹⁰⁵ India, and Belgium. Libya's December 2003 pledge to dismantle its weapons programs are encouraging, but we will still consider the country's weapons-development history.

Currently, Libya's basic nuclear program includes a small research reactor (which was provided by the Soviet Union in the mid-1970s at the Tajura nuclear research center¹⁰⁶), and could be operating several minor nuclear research facilities. According to

Gordon C. Oehler, "Persistent efforts to deny Libya access to nuclear, BW, and delivery system technology have hobbled Qadhdhafi's programs and forced him to turn to less advanced technologies and less reliable sources available in the gray and black markets of the developing world."¹⁰⁷

However, a CIA report notes that:

Libya continues to develop its nascent and still rudimentary nuclear research and development program but still requires significant foreign assistance to advance to a nuclear weapons option. In the latter half of 1999, Tripoli and Moscow resumed discussions on cooperation at the Tajura Nuclear Research Center¹⁰⁸ and on a potential power reactor deal. Should this civil-sector work come to fruition, Libya could gain opportunities to conduct weapons related R&D.¹⁰⁹

Libya ratified the NPT treaty in 1975, which had been signed earlier by the Idris regime in 1969, but has not signed the CTBT.¹¹⁰ In 1980, Libya reached an agreement with the IAEA to place (all of) Libya's nuclear infrastructure under international inspection. However, despite the accord with the IAEA, Qadhdhafi has continually stated Libya's desire to acquire nuclear weapons.¹¹¹

In 1977, Qadhdhafi embarked on a program of nuclear (and other) cooperation with Pakistan. For a while, it appeared as if this program had produced tangible results. Libya provided financial aid and delivered uranium "yellow cakes" (that originated in Niger), hoping that it would be compensated in the form of weapons from Pakistan.¹¹² However, Pakistan ended its nuclear relations with Libya before the success of Pakistan's atomic bomb — leaving Qadhdhafi without any nuclear gains.¹¹³

Nevertheless, despite reports of nuclear cooperation between Pakistan and Libya, Qadhdhafi (in 1986) stated that Libya would never help Pakistan acquire an atomic bomb. He said, "We consider nuclear weapons production a great mistake against humanity."¹¹⁴

In 1979, the Soviet Union supplied Libya with a 10 MW nuclear reactor, which was installed at a Libyan research center. The center was staffed with 750 Libyan specialists and technicians. Nevertheless, many students were sent abroad for additional training, and

200 Libyans studied nuclear science materials in the United States until 1983 — when training nuclear training for Libyans was prohibited.¹¹⁵

In the early 1980s, Libya considered buying a power station from the Soviet Union, but displeased with Soviet technology, turned to the Belgian firm Belgonucleaire to take over the engineering contract and supply equipment. The United States objected to the deal, and Belgium decided, (in 1984) to refuse the United States \$1 billion contract. Subsequently, Libya re-confirmed their agreement with Moscow to construct an 880 MW power station to be located in the Surt region. The total cost of the power station was over \$4 billion.¹¹⁶

In 1983, the Tajura nuclear research center became operational.¹¹⁷ The research center includes a small research reactor, (provided by the Russians in the 1970s¹¹⁸) and, as noted above, in 1999, Libya and Russia and Moscow resumed discussions about resuming cooperation and discussed a potential power reactor deal.¹¹⁹

Missiles and Other Delivery Systems

- Scud-C variant — 550 km range, 500 kg payload.¹²⁰
- 100+ Scud-B missiles — 300 km range, 985 kg payload.¹²¹
- SS-21 Scarab — 70 km range, 480 kg payload.¹²²
- Current program to develop Al Fatah (Iltisslat) missile with 950 km. range — 500 kg payload. Has been under slow development for over 15 years.¹²³

SYRIA

Syria does not have an active and advanced nuclear program, but following the pattern in a number of other states in the Middle East and elsewhere, the Syrians have been slowly building a foundation in both missile and nuclear technology. This foundation is largely based on civil research and dual-use applications, including a small 30 KW neutron research reactor in Damascus, which is operated under IAEA safeguards.¹²⁴ The fertilizer plant at Homs is owned and operated by the Atomic Commission of Syria, and this plant is being prepared for recovering uranium from phosphates.

According to the Federation of American Scientists, in 1979, Syria reportedly initiated a military nuclear program — and has not provided the IAEA with complete information regarding these activities.¹²⁵

The Russian government has been seeking to expand its influence in the region through the export of sensitive and dual-use technologies (see the discussion of the Iranian case), and this process included the re-establishment of traditional ties between Moscow and Damascus. On February 23, 1998, the two countries signed an agreement regarding the “peaceful” use of nuclear energy, and in July 1998, a memorandum was signed regarding the construction of a 25 MW light water nuclear research center in Syria, which included the participation of Russia’s Atomstroyeksport and Nikiet.¹²⁶ On May 19, Russia and Syria signed a cooperative agreement, in the fields of scientific, technical, and economic cooperation in the peaceful application of nuclear energy.¹²⁷

In its 2000 report on WMD proliferation, the CIA stated: “As to Syria’s embryonic nuclear research and development program, we will continue to monitor the potential for this program to expand. Moscow and Damascus agreed in 1999 to cooperate on peaceful uses of nuclear energy in a wide area of disciplines.”¹²⁸

Missiles and other delivery systems

- 60-120 Scud-C — 500 km range, 500 kg payload.¹²⁹
- Up to 200 Scud-B missiles — 300 km range, 985 kg payload.¹³⁰
- 200 SS-21 Scarab — 70 km range, 480 kg payload.¹³¹
- In the process of developing indigenous production capability for M-9 [CSS-6 or DF-15] missiles – 600 km range, 500 kg payload.¹³²

EGYPT

Egypt continues to play a primary role in the Arab world, and has sought to maintain advanced military capabilities, including ballistic missiles, chemical, and, to a lesser degree, biological weapons as well. However, Egyptian policy in the area of nuclear weapons development is somewhat exceptional, and has been relatively dormant for some

time. The major cause for concern is the possibility that following regional developments, and the India and Pakistani nuclear tests of 1998, the Egyptian pursuit of nuclear weapons may resume.

Egypt's nuclear program began in 1954, and significantly progressed in 1961, following the acquisition of a 2 MW research reactor from the Soviet Union.¹³³ Following the 1967 War, however, Egypt's nuclear program declined, after many of its nuclear experts emigrated abroad and economic difficulties increased.¹³⁴ Nevertheless, serious work in the nuclear sphere continued.

In the mid 1970s, as part of the realignment away from the Soviet Union and the beginning of peace negotiations with Israel, the United States agreed to provide Egypt with eight nuclear power plants. The U.S. proposal required accession to the NPT, and Egypt ratified the treaty in 1981. However, following the Israeli decision to forgo the American plan, the U.S. offer to Egypt lapsed. In September 1992, Egypt signed a contract with Invap, Argentina's nuclear organization, to build a 22 MW research reactor at Inshas.¹³⁵ Construction began in March 1993,¹³⁶ and became operational in 1998.¹³⁷ Egypt also continued to seek ways to expand its nuclear development capabilities, through a joint project with Canada.¹³⁸

In addition to the two nuclear reactors, Egypt operates a hot cell complex¹³⁹ for plutonium extraction research, and a pilot nuclear fuel factory that is utilized to process natural uranium mined in Egypt.¹⁴⁰ Egypt is also striving to develop uranium fuel independently. Egypt has reportedly signed contracts with Australia, Canada, and Niger to buy mining technology — and aid in processing uranium ore.¹⁴¹ Egypt also maintains scientific projects under the tutelage of the IAEA,¹⁴² and has bilateral agreements regarding the peaceful use of atomic energy with Germany, the United States, Russia, India, China, and Argentina. The UK and India provide assistance to Egypt in scientific research training, and atomic projects as well.¹⁴³

Although the evidence indicates that Egypt dropped its nuclear weapons efforts in the 1960s, some Egyptians have called for a renewed effort toward this goal. Officials and journalists often argue that Israel's nuclear capability is a justification for Arab nations to build atomic bombs.¹⁴⁴ Apparently, Egyptian rhetoric has given way to action — and Egypt is currently building ballistic missiles capable of carrying a nuclear payload.¹⁴⁵ Following the 1998 Indian

and Pakistani tests, reports of Egyptian-Syrian and Saudi Arabian cooperation in this area increased.¹⁴⁶

SAUDI ARABIA

Although Saudi Arabia is a signatory to the NPT and is not generally viewed as a country of concern in the area of nuclear proliferation,¹⁴⁷ a number of reports and allegations of Saudi efforts to acquire nuclear weapons have been published over the past years. In 1994, news reports indicated that Saudi Arabia had tried to acquire nuclear weapons from Iraq. These reports were based on the allegations of a former Saudi diplomat, Mohammed Khilewi, who later sought asylum in the United States. According to Khilewi, Saudi Arabia provided \$5 billion for Iraq's nuclear program during the 1980s, in return for a nuclear weapon. Khilewi also alleged that Saudi Arabia possessed two (undeclared) nuclear research reactors. However, these claims were never corroborated — and U.S. officials have stated that they have no evidence of Saudi assistance to Iraqi nuclear development.¹⁴⁸

In 1999, Saudi Defense Minister, Prince Sultan bin Abdul-Aziz, visited Pakistan's Kahuta uranium enrichment plant and missile factory.¹⁴⁹ Aziz denied the allegations, stating:

Saudi Arabia is a signatory of the nuclear non-proliferation treaty and is committed to its international pledges. . . . [The visit did not] exceed the first entrances of the site and did not include secret facilities as was reported. . . . We are proud that our relations with Pakistan are always friendly and strong and they should not be interpreted as something else.¹⁵⁰

The Saudi acquisition of long-range strategic missiles is also seen as an indication of intentions in this area. The missiles include 40 to 60 Chinese CSS-2[DF-3] missiles with 2,400 km range and 2,500 kg payload, deployed at al-Sulaiyil and al-Joffer, 500 km and 100 km south of Riyadh, respectively. Each site includes four-to-six concrete launch pads.¹⁵¹

ALGERIA

In 1984, Algeria purchased 150 tons of uranium concentrate from Niger, and there are numerous reports of cooperation with Iraq

in this area dating from the 1980s.¹⁵² Attention to Algeria's nuclear efforts was drawn in the early 1990s, when an unreported thermal heavy water moderated 15 MW nuclear reactor (with the potential for upgrading to 40 MW) was discovered via space imaging. The Es Salam reactor was supplied by China and apparently became operational in 1992 or 1993.¹⁵³ (In addition, Algeria operates a one MW Argentinian pool-type research reactor, which first went critical in 1989.¹⁵⁴) Both nuclear reactors are now under IAEA safeguards.¹⁵⁵ The Es Salam nuclear is estimated to have the capability to produce three to five kilograms of plutonium per year.¹⁵⁶ In addition, reports claim that the nuclear facility includes a Chinese-supplied hot cell that can be used to separate plutonium, albeit on a small scale,¹⁵⁷ and a facility for the production of radioisotopes.¹⁵⁸

The construction of this reactor in an isolated part of Algeria was kept secret for a number of years, until the construction activity and telltale security perimeter were discovered using satellite imaging.¹⁵⁹ A large, heavy-walled building nearby may have been intended as a full-scale plutonium plant, and a Soviet-made SA-5 surface-to-air missile battery was located at the site.¹⁶⁰ When it was first discovered, Algerian officials claimed that the reactor was designed for "peaceful purposes," such as electrical power generation and production of radioactive isotopes for medical research.¹⁶¹ However, as analysts noted, "There are no electrical-power generation facilities at the reactor and no electric-power transmission lines are nearby. . . . This is clearly a military nuclear reactor for weapons production."¹⁶²

China is also reported to have supplied Algeria with nuclear weapons technology, as well as expertise on matching nuclear weapons to various aerial and missile delivery systems.¹⁶³ Under pressure from the United States, Algeria accepted IAEA safeguards in 1992, joined the Nuclear Non-Proliferation Treaty (NPT) in 1995, and signed the CTBT on October 15, 1996.

As in the cases of Iraq, Iran, and other would-be proliferators, the capability for developing nuclear weapons continues, as does the concern regarding Algerian intentions. As Spanish government analysts noted in 1998:

. . . the knowledge obtained by an impressive staff of experts and scientists, as well as the availability of the

installations which it will have at the end of the century, will place this country in an advantageous position to restart a military program if the corresponding political decision is taken.¹⁶⁴

Similarly, David Albright concluded that Algeria "might have the facilities necessary to produce military plutonium, the key element in nuclear weapons" in two years.¹⁶⁵

In addition, Algeria has been a transfer point for nuclear materials, and there is evidence that uranium dioxide purchased from Argentina was delivered to Iran.¹⁶⁶

With regard to weapons delivery, the Algerian armed forces possess a variety of bombers, including the Su-24 Fencer, as well as short-range missiles and launchers, and (Soviet-manufactured) rockets.¹⁶⁷

IMPLICATIONS

Despite the efforts of the United States government during the past decade, the proliferation of weapons of mass destruction and ballistic missile technology in the Middle East has accelerated. Most other countries and leaders around the world did not share these concerns, and even when they did, their actions were very limited.

The U.S.-led sanctions and export limitations may have slowed but did not prevent this process, particularly with respect to Iran. In the case of Iraq, the unprecedented degree of intrusion established in the UNSCOM inspection and verification regime, as well as ten years of sanctions, did not force Saddam Hussein to halt efforts to preserve and acquire new WMD and missile capabilities. Following the Iraqi lead, additional states will pursue such weapons without fear of censure or stigma.

For Israel, as well other countries in the region, and also for the United States and Western Europe, these developments require major adjustments in military strategy. The deterrence and defense against WMD threats has become the primary focus of Israeli security policy,¹⁶⁸ and in the United States, the need for greater attention to these threats was emphasized by the report of the Rumsfeld Commission and in other strategic planning frameworks. In NATO, the WMD and missile threats from the Middle East are also gaining

increased attention,¹⁶⁹ as reflected in discussions of joint approaches and responses. Unless there is a radical change in the implementation of policies designed to slow or prevent proliferation, within the next decade, the number of states in the Middle East with a nuclear weapons capability, as well as biological weapons and long-range delivery systems, is likely to increase dramatically. In the Middle East, the emergence of a multipolar WMD environment in the next decade is increasingly likely.¹⁷⁰

Endnotes

- 1 Samuel Huntington, *The Clash of Civilizations* (New York: Simon and Schuster, 1997).
- 2 Herbert Krosney and Steven Weismann, *The "Islamic Bomb"* (New York: Times Books, 1981), also the BBC documentary series of the same name; D.K. Palit and P.K.S. Namboodiri, *The Islamic Bomb* (Asia Book Corporation of America, 1979).
- 3 Pervez Hoodbhoy, "Myth-Building: The 'Islamic' Bomb," *Bulletin of the Atomic Scientists* (June 1993).
- 4 Ibid.
- 5 Ibid.
- 6 Danny Rubinstein, "The Islamic Bomb and the Palestinians," *Ha'aretz*, June 1, 1998, p. B1.
- 7 The combination of religious and ethnic hatreds, reactionary internal forces, and failed leadership in Muslim society grasping to achieve nuclear weapons capabilities are also major sources for criticism. One critic in the region has argued that it is difficult to recall a more demoralized and corrupt community in the annals of history. Each of the 30-odd "Islamic" governments are dominated by self-serving rulers. . . . All are addicted to armaments and to dependence on suppliers. All are littered with machines but command no technology. Not one is home to a university or research center of repute. They lack the will no less than the know-how to transform wealth into capital, importance into influence, resource into power.
Hoodbhoy, "Myth-Building: The 'Islamic' Bomb."
- 8 Office of the Secretary of Defense, *Report of the Quadrennial Defense Review*, Washington, DC: U.S. Department of Defense, 1997, <http://www.defenselink.mil/pubs/prolif/me_na.html>.
- 9 Khidhir Hamza with Jeff Stein, *Saddam's Bombmaker: The Terrifying Inside Story of the Iraqi Nuclear and Biological Weapons Agenda* (New York: Simon and Schuster, 2000).
- 10 "Iraq-Early Western Assessments: What Did We Know and When Did We Know It?" *FAS*, <<http://www.fas.org/nuke/guide/iraq/nuke/when.htm>>.
- 11 The majority of the facilities were in Baghdad, and the periphery of the city, but others were located in Mosul in the north, and Al Qaim and Akashat, in the west near the Syrian border, Office of the Secretary of Defense, *Report of the Quadrennial Defense Review*.
- 12 "Weapons of Mass Destruction in the Middle East," Monterey Institute Center for Nonproliferation Studies, <<http://cns.mii.edu/research/wmdme/iraq.htm>>.
- 13 A.H. Joffe, "Serious Talk About 'The Gang that Couldn't Bomb Straight,'" *Forward*, November 24, 2000.
- 14 "Iran Nuclear Milestones," *Risk Report*, vol. 6, no. 4, (July-August 2000), <<http://www.wisconsinproject.org/countries/iran/nuke-miles.htm>>.
- 15 "Weapons of Mass Destruction In The Middle East," Monterey Institute Center for Nonproliferation Studies, <<http://cns.mii.edu/research/wmdme/iran.htm>>.
- 16 *Risk Report*, vol. 6, no. 4, (July-August 2000), <<http://www.wisconsinproject.org/countries/iran/nuke-miles.htm>>.
- 17 *Risk Report*, vol. 6, no. 4, (July-August 2000): In January 1997, 200 Russian engineers laid the groundwork for the construction of a light-water VVER-1000 reactor in Bushehr.
- 18 "Nuclear and Missile Trade Developments," *NonProliferation Report*, vol. 6, no. 1 (Fall 1998): p. 167.
- 19 "Russia May Build Reactors in Iran," Associated Press, November 26, 1998. A detailed report on recruitment of Russian scientists and engineers for the Iranian missile program was published in the Russian newspaper *Novaya Gazeta* and summarized in the *Washington Post*, March 23, 1998, and in the *Washington Times*, April 8, 1998.
- 20 "Iran Nuclear Milestones," *Risk Report*, vol. 6, no. 4, (July-August 2000), <<http://www.wisconsinproject.org/countries/iran/nuke-miles.htm>>.
- 21 Ibid.
- 22 Ibid.
- 23 Ibid.
- 24 "Iran Nuclear Team To Visit Russia, China — Paper," Reuters, May 11, 1998.
- 25 "Iran Nuclear Milestones," *Risk Report*, vol. 6, no. 4, (July-August 2000), <<http://www.wisconsinproject.org/countries/iran/nuke-miles.htm>>.
- 26 Judith Miller, "Russia Sends Mixed Signals on Laser System to Iran," *New York Times*, September 20, 2000.
- 27 Walter Pincus, "Russia: Laser Deal With Iran Blocked," *Washington Post*, September 20, 2000, p. A25.
- 28 Miller, "Russia Sends Mixed Signals on Laser System to Iran."
- 29 Pincus, "Russia: Laser Deal With Iran Blocked," p. A25.
- 30 "Iran Nuclear Milestones," *Risk Report*, vol. 6, no. 4, (July-August 2000), <<http://www.wisconsinproject.org/countries/iran/nuke-miles.htm>>.
- 31 Ibid.
- 32 Programme for Promoting Nuclear Non-Proliferation (PPNN), Newsbrief No. 49, 1st Quarter 2000, p.4, <<http://www.soton.ac.uk/~ppnn/newsbriefs/htm>>.

- 33 "Iran Nuclear Milestones," *Risk Report*, vol. 6, no. 4, (July-August 2000), <<http://www.wisconsinproject.org/countries/iran/nuke-miles.htm>>.
- 34 Bill Gertz, "Russia Sells Missile Technology to North Korea," *Washington Times*, June 30, 2000.
- 35 According to Russian Atomic Power Minister Yevgeny Adamov, Tehran plans to place orders for three more reactors at Bushehr. Adamov also stated that the Russian leadership had to "occupy a more active position on the world arena." "Moscow To Supply 8 Atomic Reactors To India and Iran," *DPA*, April 2, 2000; "Iranian Nuclear Reactor 40 Percent Complete Says Ambassador," *Agence France Presse*, May 23, 2000.
- 36 Indeed, U.S. sanctions have played some part in slowing construction of Iran's nuclear reactor. Acceding to a U.S. request, the Czechoslovakian Parliament and government approved a law banning all Czech exports to the Bushehr nuclear power plant, including particularly the air conditioning ducts that were to be purchased from ZVVZ Milevsko company. In addition, Ukraine decided (as a result of American pressure) not to provide the turbines for the Bushehr reactors. Instead, Russia will provide Iran with the turbines — but this will delay the project and increase costs, "Czech Parliament Bans Exports for Nuclear Plant in Iran," *Associated Press*, April 5, 2000; NEB/AK/GE/RAE 08-Mar-2000 13:32 PM EDT (08-Mar-2000 1832 UTC) Source: Voice of America, <<http://www.fas.org/news/iran/2000/000308-iran1.htm>>; Michael R. Gordon, "Against US Wishes, Russia Will Sell Reactors to Iran," *New York Times*, March 7, 1998; "Iran Condemns Ukraine for Scrapping Nuclear Deal," *Reuters*, March 7, 1998; Gerald Steinberg, "Arms Control and Non-Proliferation Developments in the Middle East: 1998-1999," *BESA Security and Policy Studies*, No. 44, August 2000, <http://faculty.biu.ac.il/~steing/conflict/1999_Middle_East_Report.html>; Op. Cit., Programme for Promoting Nuclear Non-Proliferation (PPNN) Newsbrief No. 51, 3rd Quarter 2000, p. 4–5.
- 37 In October of 1999, Iran threatened to withhold further nuclear contracts from Russia for failing to complete the Bushehr plant in time. In February 2000, Russia's Ministry of Atomic Energy acknowledged that the project was running 18 months behind schedule, and in June 2000, Russia's deputy minister for atomic energy stated that the Bushehr plant would be completed in 2002. Although the date of completion remains highly speculative, press reports note that Bushehr is expected to be online by 2003, *Risk Report*, vol. 6, no. 4 (July-August 2000), <<http://www.wisconsinproject.org/countries/iran/nuke-miles.html>>; Modher Amin, "Iran Nuclear Power Plant to be Operational by 2003," *UPI*, January 31, 2001.
- 38 "Iran Nuclear Milestones," *Risk Report*, vol. 6, no. 4, (July-August 2000).
- 39 Programme for Promoting Nuclear Non-Proliferation (PPNN) Newsbrief No. 49, 1st Quarter, 2000, p. 16.
- 40 "Iran: Nuclear Suspicion Grows," *Risk Report*, vol. 1, no. 7 (September 1995): p. 3-4, <<http://www.wisconsinproject.org/countries/iran/nuke.html>>.

- 41 "Nuclear Weapons-Iran," *FAS*, <<http://www.fas.org/nuke/guide/iran/nuke/index.html>>.
- 42 "Weapons of Mass Destruction in the Middle East," Monterey Institute Center for Nonproliferation Studies, <<http://cns.miis.edu/research/wmdme/iran.htm>>.
- 43 Ibid.
- 44 Ibid.
- 45 Ibid.
- 46 Ibid.; W. Seth Carus, "Iran And Weapons Of Mass Destruction," *American Jewish Committee* (June 2000): p. 9–10, citing testimony of Kenneth R. Timmerman, President, Middle East Data Project, Inc., before the Subcommittee on Space and Aeronautics, Hearing on H.R. 1883, Iran Non-Proliferation Act of 1999, July 13, 1999, as found at <www.house.gov/science>; see also "Iran Preparing Bigger Missile Launch," *Reuters*, July 15, 1999.
- 47 The Shihab-3 is believed to be based on North Korea's *No Dong* ballistic missile. "Iran Tests Ballistic Missile," *Reuters*, July 15, 2000; W. Seth Carus, "Iran And Weapons Of Mass Destruction," *American Jewish Committee* (June 2000): p. 9.
- 48 Gerald Steinberg, "Arms Control and Non-Proliferation Developments in the Middle East: 1998-1999," *BESA Security and Policy Studies*, no. 44 (August 2000), <http://faculty.biu.ac.il/~steing/conflict/1999_Middle_East_Report.htm>.
- 49 W. Seth Carus, "Iran and Weapons of Mass Destruction," *The American Jewish Committee*, June 2000, p. 9–10, citing testimony of Kenneth R. Timmerman, President, Middle East Data Project, Inc., before the Subcommittee on Space and Aeronautics, Hearing on H.R. 1883, Iran Non-Proliferation Act of 1999, July 13, 1999, as found at <www.house.gov/science>; see also "Iran Preparing Bigger Missile Launch," *Reuters*, July 15, 1999.
- 50 The tests were carried out despite U.S. efforts (which included an offer of economic and military benefits) to convince Pakistan not to go ahead with the tests. Earlier U.S. efforts to curb Pakistan's nuclear program were apparently unsuccessful — limited sanctions were leveled at Pakistan in 1990, because of the uncertainty over whether or not Pakistan possessed a nuclear device. Following the Indian and Pakistani tests in 1998, the Clinton administration slapped economic sanctions on the two states — but did not sever ties. The Clinton sanctions halted economic aid, loans, and military sales, but significantly did not ban loans to non-government companies, or investment by U.S. companies. However, sales of dual-use items were stopped, and banks were prohibited from lending money to either government. It should be noted that the majority of other countries, i.e., Britain, France, and Russia, chose not to impose any sanctions. "Pakistan Nuclear Weapons," *FAS*, <<http://www.fas.org/nuke/guide/pakistan/nuke/index.html>>; "India-Pakistan: Nuclear Weapons Update 1998," *Risk Report*, vol. 4, no. 6, November–December 1998, <<http://www.wisconsinproject.org/countries/pakistan/nuke98.html>>.

- 51 It must be noted that Pakistani data regarding the nuclear tests cannot be confirmed seismically by outside sources. Indeed, Indian sources have suggested that only two nuclear weapons were detonated — and had lower yields than Pakistan claimed. Nonetheless, seismic information indicated at least two, and perhaps a third, test in the initial round of tests, and one on May 30th, “Pakistan Nuclear Weapons,” *FAS*, <<http://www.fas.org/nuke/guide/pakistan/nuke/index.html>>.
- 52 Ibid.
- 53 Ibid. However, Pakistani sources have claimed that at least one nuclear device, (originally slated to be tested on May 30th) remains underground, and is ready for detonation.
- 54 Nonetheless, Pakistan has stated that it will not assemble or deploy its nuclear warheads, nor will it resume testing unless India does so first. . . . In addition, Pakistan has agreed to enter into negotiations to complete a fissile material cutoff agreement — but has not agreed to halt production of fissile material before signing the treaty. Office of the Secretary of Defense, *Proliferation: Threat and Response*, (Washington, DC: U.S. Department of Defense, January 2001), <<http://www.defenselink.mil>>.
- 55 “Pakistan Nuclear Milestones,” *Risk Report*, vol. 6, no. 5, September–October 2000, <<http://www.wisconsinproject.org/countries/pakistan/nuke-miles.htm>>.
- 56 Ibid.
- 57 Ibid.
- 58 Ibid.
- 59 Ibid.
- 60 “Pakistan Nuclear Weapons,” *FAS*, <<http://www.fas.org/nuke/guide/pakistan/nuke/index.html>>.
- 61 Ibid.
- 62 Ibid.
- 63 In 1996, reports indicated that the A.Q. Khan Research Laboratory had received 5,000 ring magnets, which could be used in gas centrifuges, from a Chinese nuclear company, “Pakistan Nuclear Weapons,” *FAS*, <<http://www.fas.org/nuke/guide/pakistan/nuke/index.html>>.
- 64 “Pakistan Nuclear Milestones,” *Risk Report*, vol. 6, no. 5, September–October 2000, <<http://www.wisconsinproject.org/countries/pakistan/nuke-miles.htm>>.
- 65 Ibid.
- 66 Ibid.
- 67 It should be noted that China’s nuclear aid to Pakistan began long before the 1986 Sino-Pakistani atomic cooperation agreement. Indeed, important Sino-Pakistan transfers occurred during the period of 1980–1985. Reportedly, China provided Pakistan with the design of one of its warheads, as well as enough HEU for a small amount of weapons, “Pakistan Nuclear Weapons,” *FAS*, <<http://www.fas.org/nuke/guide/pakistan/nuke/index.html>>.

- 68 “Pakistan Nuclear Milestones,” *Risk Report*, vol. 6, no. 5, September–October 2000, <<http://www.wisconsinproject.org/countries/pakistan/nuke-miles.htm>>.
- 69 Ibid.
- 70 Ibid.
- 71 Andrew Koch and Jennifer Topping, “Pakistan’s Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet,” *Non-Proliferation Review*, vol. 4, no. 3, 1997.
- 72 Ibid.
- 73 The Kahuta enrichment plant may be the location where highly enriched uranium is formed into weapons cores. Koch and Topping, “Pakistan’s Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet,” citing Col. S. Bakov, “Nuclear Ambitions,” *Krasnaya zvezda*, May 23, 1990, p. 3; in JPRS-TND-90-011 (June 28, 1990), p.21; Indranil Banerjee, “The Secrets Of Kahuta,” *Sunday*, April 24, 1993, p. 34–38; in JPRS-TND-93-014 (May 18 1993), p. 12–15.
- 74 Koch and Topping, “Pakistan’s Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet,” citing David Albright, Frans Berkhout, and William Walker, *Plutonium And Highly Enriched Uranium 1996: World Inventories, Capabilities, And Policies* (Oxford: Oxford University Press, 1997), p. 275.
- 75 Koch and Topping, “Pakistan’s Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet,” citing David Albright and Mark Hibbs, “Pakistan’s Bomb: Out of the Closet,” *Bulletin of the Atomic Scientists* 48 (July/August 1992): p. 38–43; Koch and Topping, “Pakistan’s Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet.”
- 76 “Pakistan Nuclear Update,” *Risk Report*, vol. 6, no. 5, September–October 2000, <<http://www.wisconsinproject.org/countries/pakistan/nuke2000.htm>>; “Pakistan Nuclear Milestones,” *Risk Report*, Vol. 6, No. 5, September–October 2000, <<http://www.wisconsinproject.org/countries/pakistan/nuke-miles.htm>>; Office of the Secretary of Defense, *Proliferation: Threat and Response*, Washington, DC: US Department of Defense, January 2001, <<http://www.defenselink.mil>>.
- 77 In July 1999, British custom officials intercepted 20 tons of crucial components used in the manufacture of nuclear weapons, including high-grade aluminum — destined for Pakistan, “Pakistan Nuclear Milestones,” *Risk Report*, vol. 6, no. 5, September–October 2000, <<http://www.wisconsinproject.org/countries/pakistan/nuke-miles.htm>>.
- 78 Office of the Secretary of Defense, *Proliferation: Threat and Response*, Washington, DC: US Department of Defense, January 2001, <<http://www.defenselink.mil>>; Office of the Secretary of Defense, *Report of the Quadrennial Defense Review*.
- 79 Koch and Topping, “Pakistan’s Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet,” citing R. Jeffery Smith and Thomas W. Lippman, “Pakistan Building Reactor that May Yield Large Quantities of Plutonium,”

- Washington Post*, April 8, 1995, p. A20; "Pakistan Nuclear Update, 2000," *Risk Report*, vol. 6, no. 5, September–October, 2000, <<http://www.wisconsinproject.org/countries/pakistan/nuke2000.htm>>.
- 80 Ibid., *Risk Report*, "Pakistan Nuclear Update, 2000."
- 81 It should be noted that there is a disagreement between U.S. officials as to whether or not China supplied the heavy water plant. "Pakistan Nuclear Update, 2000," *Risk Report*, vol. 6, no. 5, September–October, 2000, <<http://www.wisconsinproject.org/countries/pakistan/nuke2000.htm>>.
- 82 Koch and Topping, "Pakistan's Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet," citing Aroosa Alam, *Muslim*, July 3, 1996, p. 1; FBIS-TAC-96-008, July 3, 1996; Indranil Banerjee, "The Secrets Of Kahuta," *Sunday*, April 24, 1993, p. 34–38; JPRS-TND-93-014, May 18, 1993, p. 12–15.
- 83 Koch and Topping, "Pakistan's Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet," citing Indranil Banerjee, "The Secrets Of Kahuta," *Sunday*, April 24, 1993, p. 34–38; JPRS-TND-93-014, May 18, 1993, p. 12–15; J.N Dixit, "India's Nuclear Options," *Indian Express*, August 30, 1994; "In the Aisles," *Der Spiegel*, June 26, 1989, p. 87–89; JPRS-TND-89-014, July 14, 1989, p. 39–40; "Hot Laboratories," *Der Spiegel*, February 27, 1989, p. 87–89, 113; JPRS-TND-89-006, March 28, 1989, p. 33–34; Koch and Topping, "Pakistan's Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet," citing U.S. State Department, The Pakistani Nuclear Program, Washington: GPO, June 23, 1983.
- 84 Koch and Topping, "Pakistan's Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet," citing David Albright and Mark Hibbs, "Pakistan's Bomb: Out of the Closet," *Bulletin of the Atomic Scientists*, vol. 48 (July/August 1992): p. 38–43.
- 85 Koch and Topping, "Pakistan's Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet," citing V.D. Chopra, *Patriot*, November 10, 1986, p. 4; *World Wide Report*, January 2, 1987, p. 63–64.
- 86 Koch and Topping, "Pakistan's Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet," citing "Hot Laboratories," *Der Spiegel*, February 27, 1989, p. 113; JPRS-TND-89-006, March 28, 1989, p. 33–34.
- 87 Koch and Topping, "Pakistan's Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet," citing "Pakistan: PINSTECH Fabricates Sensitive Track Detecting Material," *Nucleonics Week* (February 19, 1987), and U.S. State Department, "The Pakistani Nuclear Program," Washington: GPO, June 23, 1983; *Patriot*, August 23, 1989, p. 5; JPRS-TND-89-020, October 26, 1989, p. 30–31.
- 88 Koch and Topping, "Pakistan's Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet," citing *Dawn*, April 7 1985, p. 7; JPRS-TND-85-009, May 23, 1985, p. 78–79; "Twenty-Five Years of Research and Development at PINSTECH," *Muslim*, May 25, 1992, p. 10; JPRS-TND-92-020, June 25, 1992, p. 14–17.

- 89 Koch and Topping, "Pakistan's Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet."
- 90 Ibid.
- 91 Koch and Topping, "Pakistan's Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet," citing Bill Gertz, "China Aids Pakistan Plutonium Plant," *Washington Times*, April 3, 1996, p. A4.
- 92 Koch and Topping, "Pakistan's Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet," citing Michael Schneider, "Paris: Hub for Pakistani Nuclear Traffic," *Politis-Le Cityoen* (February 22–28, 1990): p. 50–55; JPRS-TND-90-021, July 18, 1990, p. 27–29; Mark Hibbs, "Illegal Export Charges May Spur Tighter German Export Controls," *Nucleonics Week* (January 5, 1989): p. 3–5; Heinz Vielan, "First Confessions — Pakistan's A-Bomb with German Help?" *Welt Am Sonntag*, December 25, 1988, p. 1–2; JPRS-TND-89-001, January 13, 1989, p. 25–26.
- 93 Koch and Topping, "Pakistan's Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet," citing "Research Reactors," *Nuclear Review* (April 1996): p. 18; "Pakistan," *Nuclear Europe Worldscan* (July/August 1991): p. 51; "PARR's New Lease Of Life," *Nuclear Engineering International*, vol. 36 (December 1991): p. 3.
- 94 Koch and Topping, "Pakistan's Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet," citing "Datafile: Pakistan," *Nuclear Engineering Informational*, vol. 36 (May 1991): p. 52–54; Shahid-ur-Rehman Khan and Rauf Siddiqi, "PAEC Plans To Expand And Extend The Life Of Kanupp," *Nucleonics Week* (November 7, 1991): p.10.
- 95 Koch and Topping, "Pakistan's Nuclear-Related Facilities, Center for Non-Proliferation Fact Sheet."
- 96 After the successful 1999 tests of the *Ghauri* and *Sha-been-1* missiles, Pakistan announced the conclusion ("for now") of "the series of flight tests involving solid-and liquid-fuel rocket motor technologies." Pakistan also asked India to participate in a "strategic restraint regime" that would limit the development of missile and nuclear weapons technology, as well as deployment, Office of the Secretary of Defense, *Proliferation: Threat and Response*, Washington, DC: U.S. Department of Defense, January 2001, <<http://www.defenselink.mil>>.
- 97 Last tested in April 1999. "Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, July 1 through December 31, 1999," <http://www.cia.gov/cia/publications/bian/bian_aug2000.htm#10>; Office of the Secretary of Defense, *Proliferation: Threat and Response*, Washington, DC: U.S. Department of Defense, January 2001, <<http://www.defenselink.mil>>.
- 98 Last tested in April 1999. "Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, July 1, Through December 31, 1999," <http://www.cia.gov/cia/publications/bian/bian_aug2000.htm#10>.

- 99 Office of the Secretary of Defense, *Proliferation: Threat and Response*, Washington, DC: U.S. Department of Defense, January 2001, <<http://www.defenselink.mil>>.
- 100 Shirley A. Kan, Foreign Affairs and National Defense Division, "Chinese Missile and Nuclear Proliferation: Issues for Congress," CRS Report for Congress, October 20, 1993, <<http://www.fas.org/spp/starwars/crs/93-10-20.htm>>.
- 101 Ibid., citing *Jane's Defence Weekly*, April 9, 1988.
- 102 Office of the Secretary of Defense, *Proliferation: Threat and Response*, Washington, DC: U.S. Department of Defense, January 2001, <<http://www.defenselink.mil>>.
- 103 Ibid.
- 104 In 1970, Qadhdhafi attempted to purchase an atomic bomb from China. "Libya Has Trouble Building the Most Deadly Weapons," *Risk Report*, vol. 1, no. 10 (December 1995): p. 1–4, <<http://www.wisconsinproject.org/countries/libya/trouble.html>>.
- 105 In 1974, Libya and Argentina finalized a deal, under which Argentina would provide Tripoli with equipment for uranium mining and processing. Apparently, Argentina had already extracted plutonium from spent reactor fuel, although it remains uncertain if the agreement with Libya provided any assistance in this area. However, in 1982, during the war over the Falkland Islands, Libya provided Argentina with \$100 million in anti-aircraft and air-to-air missiles. It has been suggested that Argentina may have provided nuclear information or technology to Libya. Indeed, according to a May 1983 report, Argentina and Libya continued nuclear contacts after the war, during which discussions about reprocessing and enrichment technologies probably occurred. In 1985, reports indicate that Argentina planned on selling a hot cell facility to Libya — but pressure from the United States prevented the sale. Rodney W. Jones, Mark G. McDonough, Toby F. Dalton, and Gregory D. Koblenz, "Argentina," from *Tracking Nuclear Proliferation, Carnegie Endowment for International Peace, July 1998*, <<http://www.ceip.org/programs/npp/nppargn.htm>>.
- 106 Office of the Secretary of Defense, *Report of the Quadrennial Defense Review*.
- 107 Gordon C. Oehler, National Intelligence Officer for Science, Technology, and Proliferation, Central Intelligence Agency, "The Proliferation of Weapons of Mass Destruction in the Middle East," *Washington Institute For Near East Policy*, Soref Symposium, April 27, 1992, <<http://www.washingtoninstitute.org/pubs/oehler.htm>>.
- 108 The research center is under IAEA safeguards. "Weapons of Mass Destruction in the Middle East," Monterey Institute Center for Nonproliferation Studies, <<http://cns.miis.edu/research/wmdme/libya.htm>>.
- 109 "Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, July 1 through December 31, 1999," <http://www.cia.gov/cia/publications/bian/bian_aug2000.htm#6>.

- 110 "Weapons of Mass Destruction in the Middle East," Monterey Institute Center for Nonproliferation Studies, <<http://cns.miis.edu/research/wmdme/libya.htm>>, "Libya Special Weapons," *FAS*, <<http://www.fas.org/nuke/guide/libya/index.html>>.
- 111 "Libya Special Weapons," *FAS*, <<http://www.fas.org/nuke/guide/libya/index.html>>.
- 112 Ibid.
- 113 "Libya Has Trouble Building the Most Deadly Weapons," *Risk Report*, vol. 1, no. 10 (December 1995): p. 1, 3–4, <<http://www.wisconsinproject.org/countries/libya/trouble.html>>.
- 114 "Libya Special Weapons," *FAS*, <<http://www.fas.org/nuke/guide/libya/index.html>>.
- 115 Ibid.
- 116 Ibid.
- 117 "Libya's Nuclear Research Is Centered at Tajura," *Risk Report*, vol. 1, no. 10 (December 1995): p. 10, <<http://www.wisconsinproject.org/countries/libya/tajura.html#top>>.
- 118 Office of the Secretary of Defense, *Report of the Quadrennial Defense Review*.
- 119 "Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, July 1 through December 31, 1999," <http://www.cia.gov/cia/publications/bian/bian_aug2000.htm#6>.
- 120 "Weapons of Mass Destruction In The Middle East," Monterey Institute Center for Nonproliferation Studies, <<http://cns.miis.edu/research/wmdme/libya.htm>>.
- 121 Ibid.
- 122 Ibid.
- 123 Ibid.
- 124 30 KW nuclear research reactor, along with almost one kilogram of highly enriched uranium, was purchased from China in 1991. Both the reactor and enriched uranium are now under IAEA safeguards, "IAEA Annual Report for 1999 (annex), IAEA, October 31, 2000, <<http://www.iaea.org/worldatom/Documents/Anrep/Anrep99/>>; Michael Eisenstadt, *Jane's*, 1993, p. 169, cited by Lesser and Tellis, p. 70.
- 125 "Syria-Special Weapons," *FAS*, <<http://www.fas.org/nuke/guide/syria/index.html>>, "Weapons of Mass Destruction In The Middle East," Monterey Institute Center for Nonproliferation Studies, <<http://cns.miis.edu/research/wmdme/syria.htm#2>>.
- 126 "Syria-Special Weapons," *FAS*, <<http://www.fas.org/nuke/guide/syria/index.html>>.
- 127 "Russia, Syria Sign Nuclear Power Agreement," RFE/RL Newline, May 20, 1999, <<http://www.rferl.org/newline/1999/05/200599.html>>.
- 128 "Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions,

- July 1 through December 31, 1999," <http://www.cia.gov/cia/publications/bian/bian_aug2000.htm#7>.
- 129 "Weapons of Mass Destruction In The Middle East," Monterey Institute Center for Nonproliferation Studies, <<http://cns.miis.edu/research/wmdme/syria.htm>>.
- 130 Ibid.
- 131 Ibid.
- 132 Ibid.
- 133 The 2 MW research reactor was supplied by the Soviets, and began operating in 1961. It was shut down for renovation during the 1980s, but re-opened in 1990. The reactor runs on 10%-enriched uranium fuel. "Egypt's Budding Nuclear Program," *Risk Report*, vol. 2, no. 5 (September–October 1996), <<http://www.wisconsinproject.org/countries/egypt/nuke.html>>.
- 134 "Nuclear Weapons Program — Egypt," *FAS*, <<http://www.fas.org/nuke/guide/egypt/nuke/index.html>>.
- 135 "Egypt's Budding Nuclear Program," *Risk Report*.
- 136 Ibid.
- 137 Shawn Twing, "Egypt Opens Nuclear Power Plant," *Washington Report on Middle East Affairs* (April 1998): p. 38–42, <<http://www.washington-report.org/backissues/0498/9804038.html>>.
- 138 "Egypt's Budding Nuclear Program," *Risk Report*.
- 139 Ibid. Supplied by France.
- 140 Ibid.
- 141 Ibid.
- 142 In addition, both Egyptian nuclear reactors operate under IAEA safeguards, "Weapons of Mass Destruction in the Middle East," Monterey Institute Center for Nonproliferation Studies, <<http://cns.miis.edu/research/wmdme/egypt.htm>>.
- 143 "Nuclear Weapons Program — Egypt," *FAS*, <<http://www.fas.org/nuke/guide/egypt/nuke/index.html>>.
- 144 "Egypt's Budding Nuclear Program," *Risk Report*.
- 145 Egypt's missile capability and developments: 100+ SS-1 (Scud-B) with 300 km range and 985 kg payload; approximately 90 Project T missiles with 450 km range and 985 kg payload; developing Scud-C variant production capability with DPRK assistance; with 550 km range and 500 kg payload; developing Vector missile with 800 km to 1,200 km range and 450–1,000 kg payload. It has been alleged by U.S. and Israeli intelligence that Egyptian government companies are acquiring and exporting U.S. (and Western) technology to N. Korea for alterations — which is then returned to Egypt as advanced missile components. Egypt is also suspected of working with China and (N. Korea) to develop missiles and non-conventional weapons. "Egypt's Budding Nuclear Program," *Risk Report*, vol. 2, no. 5 (September–October 1996), <<http://www.wisconsinproject.org/countries/egypt/nuke.html>>; "Weapons of Mass De-

- struction In The Middle East," Monterey Institute Center for Nonproliferation Studies, <<http://cns.miis.edu/research/wmdme/egypt.htm>>.
- 146 "Nuclear Weapons Program — Egypt," *FAS*, <<http://www.fas.org/nuke/guide/egypt/nuke/index.html>>.
- 147 "Weapons of Mass Destruction in the Middle East," Monterey Institute Center for Nonproliferation Studies, <<http://cns.miis.edu/research/wmdme/saudi.htm>>.
- 148 Ibid.
- 149 "Saudi Arabia Denies Nuclear Link with Pakistan," Reuters, August 5, 1999.
- 150 Ibid.
- 151 "Weapons of Mass Destruction in the Middle East," Monterey Institute Center for Nonproliferation Studies, <<http://cns.miis.edu/research/wmdme/saudi.htm>>.
- 152 "Algeria Special Weapons," *FAS*, <<http://www.fas.org/nuke/guide/algeria/index.html>>, Bill Gertz, "China Helps Algeria Develop Nuclear Weapons," *Washington Times*, April 11, 1991.
- 153 "Weapons of Mass Destruction in the Middle East," Monterey Institute Center for Nonproliferation Studies, <<http://cns.miis.edu/research/wmdme/algeria.htm>>; *World Nuclear Industry Handbook, 1993* (Surrey, England: Nuclear Engineering International, 1993), p. 120 (cited by Lesser and Tellis, p. 45); "Algeria Special Weapons," *FAS*, <<http://www.fas.org/nuke/guide/algeria/index.html>>; Bruce W. Nelan, "China: For Sale: Tools of Destruction," *Time* magazine (April 22, 1991).
- 154 Rodney W. Jones, Mark G. McDonough, Toby F. Dalton, and Gregory D. Koblentz, "Argentina," *Tracking Nuclear Proliferation, Carnegie Endowment for International Peace*, July 1998, <<http://www.ceip.org/programs/npp/nppargn.htm>>.
- 155 "Weapons of Mass Destruction in the Middle East," Monterey Institute Center for Nonproliferation Studies, <<http://cns.miis.edu/research/wmdme/algeria.htm>>.
- 156 "Algeria Special Weapons," *FAS*, <<http://www.fas.org/nuke/guide/algeria/index.html>>.
- 157 Ibid.
- 158 *Eurasian Politician's World Report*, no. 2, October 31, 2000, <<http://www.the-politician.com/issue2/wr2.htm#mideast>>, quoting "The Middle East," *ISIS* (June 2000).
- 159 Vipin Gupta, "Algeria's Nuclear Ambitions," *Nuclear Engineering International* (March 1992): p. 6; Vipin Gupta, "Algeria's Nuclear Ambitions," *International Defense Review*, no. 4 (1992): p. 329–330.
- 160 "Algeria Special Weapons," *FAS*, <<http://www.fas.org/nuke/guide/algeria/index.html>>.
- 161 Ibid.
- 162 Bill Gertz, "China Helps Algeria Develop Nuclear Weapons," *Washington Times*, April 11, 1991.