# CHAPTER 3

# THE NUCLEAR CAPABILITIES AND AMBITIONS OF IRAN'S NEIGHBORS

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## INTRODUCTION

The Islamic Republic of Iran has been suspected of pursuing nuclear weapons since the mid-1980s. Over the past 2 years, these suspicions have intensified due to revelations about Tehran's past failures to inform the International Atomic Energy Agency (IAEA) of significant nuclear activities and facilities. The most serious failures have involved neglecting to declare extensive work on uranium enrichment and plutonium separation—the two routes to producing weapons-grade material for nuclear weapons.

Iran's failure to live up to the both the letter and spirit of its Safeguards Agreement with the IAEA has prompted a serious deterioration in assessments of when Tehran could acquire nuclear weapons. It has been suggested that the time frame for Iran "going nuclear" could now be as early as 2005-07.[1] Such assessments have not gone unnoticed in Iran's immediate neighborhood, and concern is growing about the potential response of some of its neighbors, in particular whether Tehran's behavior could prompt other regional actors to consider acquiring nuclear weapons. Four countries, Saudi Arabia, Egypt, Turkey, and Syria, stand out in this respect due to their relative proximity to Iran and because there are suspicions that they have all, at one time or another, been interested in acquiring nuclear weapons. Although beyond the scope of this chapter, it is recognized that if one or more of these countries acquired, or came close to acquiring, a nuclear weapons capability, then this would influence nuclear deliberations in other countries, both within and beyond the Middle East and North Africa. If Egypt went nuclear, for example, this probably would influence nuclear decisionmaking in Algeria. Moreover, although the chapter does not examine the current case of

Iraq in relation to Iran, it is recognized that, in the long-term, a post-Saddam government could feel sufficiently vulnerable to consider acquiring nuclear weapons to counteract a future nuclear-armed Tehran.

Drawing purely on open sources, this chapter seeks to cast some light on the nuclear capabilities and ambitions of Saudi Arabia, Egypt, Turkey, and Syria. In addition to generally available sources, the authors utilize original Arabic and Turkish language sources and information derived from various scientific and technical journals/proceedings. For each country, an assessment is made of current nuclear capabilities, including various elements of the fuel cycle that could potentially be used to support the development of nuclear weapons. Attention is also given to the drivers of potential nuclear and other weapons of mass destruction (WMD) programs in the countries concerned, and potential nuclear delivery systems.

An analysis of available open sources revealed relatively little about national intentions regarding the acquisition of nuclear weapons—both in general terms and, more specifically, in response to the current Iranian nuclear crisis. The lack of pertinent information in this respect appears to stem primarily from the political sensitivity of the issue and the relatively closed and nontransparent nature of the societies involved, with the exception of Turkey. In contrast, it did prove possible to develop a fairly detailed picture of the various elements of the fuel cycle currently in existence or being developed in the four countries, as well as their potential nuclear delivery options. Although it is assessed that each country currently lacks the technical capacity to build a nuclear weapon, it is essential to note that open sources rarely will provide the complete picture. This is particularly the case with regard to the most sensitive aspects of nuclear weapons development—uranium enrichment, plutonium separation, and weaponization—which are subject to the greatest secrecy. Moreover, revelations throughout 2004 about the role of Pakistani scientist A. Q. Khan in illicitly supplying nuclear technology to Libya and Iran, raise the concern that other countries also may have benefited from this clandestine proliferation network. For example, Libya's acquisition of technology and assistance via the network prior to December 2003 had enabled Pakistan to begin to initiate a step change in its nuclear

weapon program. Moreover, Khan is known to have made business trips to numerous other countries including Egypt, Saudi Arabia, and Syria, although it is not known what the Pakistani scientist actually did on these visits.[2]

## SAUDI ARABIA

Saudi Arabia does not possess a nuclear weapons capability and, based on an assessment of available open sources, the Kingdom does not appear to possess the necessary technical infrastructure to develop one indigenously, bar significant infusions of external assistance. However, there are some suspicions that Saudi Arabia has considered the nuclear option and even sought to purchase nuclear weapons from abroad, notably from Pakistan. This despite the country's non-nuclear weapon status and commitments under the Nonproliferation Treaty (NPT) which Riyadh signed in 1988.[3] However, the Kingdom has yet to conclude a comprehensive safeguards agreement with the IAEA.[4]

Beyond the nuclear realm, there is "no confirmed evidence" that Saudi Arabia has a chemical or biological weapons program.[5] Indeed, the Kingdom long has denied any intention to acquire WMD of any type and, similar to Egypt, has called for an agreement to make the Middle East a WMD-free zone.[6] In Autumn 2002 Prince Naef bin Ahmed Al-Saud, a colonel in the Saudi Armed Forces with responsibilities for strategic planning, noted that "Proliferation must be seen in terms of regional realities: the Israeli monopoly in nuclear weaponry, defiance by Pakistan and India of nonproliferation regimes, and reported efforts by both Iraq and Iran to develop nuclear capabilities."[7] At least one Saudi newspaper has expressed concern about Iran's nuclear intentions by noting that, "the danger will include countries such as Saudi Arabia, Oman, Iraq, Afghanistan, Turkmenistan, and Azerbaijan."[8]

Speculation about the Kingdom's potential interest in acquiring nuclear weapons goes back to the 1980s. Saudi Arabia originally signed the NPT in 1988 to address concerns that it wanted to arm its newly acquired DF-3 (CSS-2) intermediate range ballistic missiles (IRBM) with nuclear warheads. The missiles had been acquired from China at some point between 1986 and 1988. The transfer

was significant because it provided the Kingdom with the longest-range ballistic missiles (2,700-2,800km) outside the Permanent Five members of the United Nations (UN) Security Council. Indeed, the DF-3 gave Saudi Arabia the capability to strike targets throughout and beyond the Middle East. Moreover, the missiles had been withdrawn from Chinese service as nuclear delivery systems, although they reportedly were modified prior to shipment as non-nuclear capable systems.[9] Despite suspicions that Saudi Arabia planned to arm the missiles with unconventional warheads, Riyadh claimed it had no intention to do so.

In early September 2002, Israeli Prime Minister Ariel Sharon said that "there might be Saudi money involved" in Libya's nuclear weapons program, but this had not been confirmed.[10] There has been much greater speculation about a potential nuclear link with Pakistan. Since the 1980s, there have been suspicions that Saudi Arabia has paid, or wanted to pay, Pakistan to conduct research and development of nuclear weapons. These suspicions have been based in part on the history of defence cooperation between the two countries including, for example, the training of Saudi pilots and naval collaboration. In recent years, suspicions have been fed by several visits to Pakistan by Saudi officials. In 1999, a team of defence officials visited Pakistan's enrichment and missile assembly facilities at Kahuta where they were briefed by A. Q. Khan, the father of the Pakistani nuclear weapons program.[11] In 2002, the son of Crown Prince Abdullah was reportedly an invited guest at the test firing of Pakistan's 950-mile range *Ghauri* nuclear-capable missile.[12] More recently in October 2003, it was alleged that Abdullah visited Pakistan and concluded a secret agreement on "nuclear cooperation" to cover nuclear technology in return for cheap oil. However, Saudi Arabia has denied this allegation.[13] Recent revelations about the role of Khan in proliferating nuclear technology to several states of concern has further fueled suspicion about the Saudi-Pakistan nuclear connection.[14] Indeed, Khan has travelled to Saudi Arabia in the past, although it is not known what he actually did during his time in the Kingdom.[15]

Prince Naef argued in 2002 that, "Saudi Arabia does not accept the notion that a Pakistani bomb is an Islamic bomb. Instead, national interest is regarded as the most likely factor affecting how nuclear

capabilities will be used. Nevertheless, regional competition increases concern among Saudis over the spread of WMD and ballistic missiles. Moreover, despite the lack of evidence that Riyadh may be pursuing a nuclear option, some speculate on the possibility."[16] Indeed, it was reported in September 2003 that Saudi Arabia was conducting a strategic review including deliberations related to the potential acquisition of nuclear weapons. The review appears to be the result of a growing perception of strategic vulnerability prompted by several interrelated factors, including: the crisis over Iran's nuclear program and intentions, the lack of international pressure to address Israel's nuclear arsenal, general regional instability in the Middle East, and the deterioration of relations with the United States since September 11, 2001 (9/11), including concerns about the reliability of U.S. security guarantees and the American nuclear umbrella. Although it is not known whether a decision has yet been made, the strategic review reportedly is considering three potential options on the nuclear front: (1) acquiring nuclear weapons for deterrent purposes; (2) maintaining an alliance or entering into a new alliance with an existing nuclear weapon power; and (3) seeking an agreement for a Middle East free of nuclear weapons.[17]

**Nuclear Capabilities.**

The national nuclear authority in Saudi Arabia is the King Abdul Aziz City for Science and Technology (KACST) in Riyadh.[18] KACST describes itself as "an independent scientific organization of the Saudi Arabia Government"[19] which provides "scientific and technological advice" and conducts "applied research programs and joint research activities with other international scientific institutions." KACST assists the private sector in applied research for promoting agricultural and industrial development and funds research projects in universities such as studies of alternative energy resources and sewage water treatment.[20]

The Atomic Energy Research Institute (AERI) was established within KACST in 1988 with the aim of adapting the nuclear sciences and technologies and utilizing them "in support of the economic, industrial and agricultural plans of the Kingdom." The objectives of

AERI include drafting a national atomic energy plan and supervising its implementation; conducting research in the field of nuclear technologies; identifying manpower requirements in the area of atomic energy research; and training and developing manpower in the area of atomic energy research."[21] To do this, the institute has several departments: a Radiation Protection Department; an Industrial Applications Department; a Nuclear Reactors and Safety Department; and a Materials Department.[22] The institute has programs that focus on industrial applications of radiation and radioactive isotopes, nuclear power and reactors, nuclear materials, and radiation protection.

A review of available open sources generated the following observations related to Saudi Arabia's nuclear capabilities.

*Uranium Resources*. The U.S. Geological Survey makes no reference to uranium resources in its 2001 report on Saudi Arabia's mineral sector.[23] However, it is evident that the Kingdom has conducted research into uranium prospecting, mining, and milling. In 1986, the IAEA approved a technical cooperation agreement with KACST and the Nuclear Engineering Department of King Abdul Aziz University to provide "training for the application of neutron capture techniques in in-situ mineral exploration." The agreement covered prospecting, mining and analyzing raw nuclear materials.[24]

Saudi Arabia does not appear to be involved in the recovery of uranium from phosphate rock. However, relevant research has been conducted in this area in the past. In 1987, for example, an academic currently at King Abdul Aziz University wrote a Ph.D. thesis on "The Separation and Determination of Rare Earths in Phosphate Deposits from the North of the Kingdom of Saudi Arabia."[25] Saudi Arabia's phosphate mines are operated by the Ma'aden mining company,[26] which was founded in 1997 to become the focal point of the country's minerals sector. Ma'aden operates mines at Al Hajar, Al Sukhaybarat, and Bulgah which produce gold and silver. A mine at Mahad Ad Dabab produces copper, gold, and silver; and a mine at Al Amar produces copper, zinc, and gold. The company is carrying out exploration programs in the Al-Jalamid and Umm Wu-al areas.[27]

*Nuclear Power*. Saudi Arabia does not possess a nuclear power reactor. However, the Kingdom has certainly demonstrated an

interest in nuclear power since at least the late 1970s. The IAEA approved a technical cooperation project in 1978 on nuclear energy planning with the Atomic Energy Department, Ministry of Petroleum and Mineral Resources, in Saudi Arabia. The aim was to establish "training and research institutions with regard to the introduction of nuclear power in the country."[28] It is evident that the Kingdom's interest in nuclear power has focused, at least partially, on its potential application in the desalination of seawater.[29] Indeed, researchers from AERI and the Nuclear Engineering Department of King Abdul Aziz University recently conducted research into the role of nuclear desalination in Saudi Arabia.[30] In 2001, the IAEA approved a technical cooperation agreement with AERI on transferring and enhancing national capabilities and skills "in modern forecasting techniques for the development and regular updating of future energy demands and optimal expansion plans for the power sector."[31]

*Reprocessing, Spent Fuel and Waste Storage*. Although Saudi Arabia does not appear to possess a reprocessing capability, the AERI has four laboratories of potential relevance in this field. These include laboratories for physical separation, chemical separation, radio chemistry, and radioactive isotopes and chemical separation.[32]

Saudi Arabia does not have a spent fuel and waste storage capability. However, AERI is responsible for controlling radioactive waste disposal "in all installations that use radioactive material" and is reported to be preparing national regulations for radioactive waste disposal.[33] In 1995, the IAEA approved a technical cooperation agreement with AERI to establish a "comprehensive radioactive waste management program covering regulations, storage, and treatment." The agreement covered safety issues and technologies related to radioactive waste management.[34]

*Research Reactor*. Saudi Arabia does not have a research reactor. However, it should be noted that the IAEA has provided extensive assistance to develop nuclear research and applications in the Kingdom.[35] According to one source, Saudi Arabia opened a nuclear research centre in a desert military complex at Al-Suleiyel, near Al-Kharj in 1975.[36]

*Delivery Capabilities*. Saudi Arabia's potential nuclear delivery capabilities include both ballistic missiles and aircraft. Saudi Arabia

possesses 40-60 DF-3 (CSS-2) IRBMs, which can carry payloads of up to 2,500kg. The DF-3 is a single stage missile with a circular error probable of 1km. The missiles are reportedly deployed at two sites located 500km (al-Sulaiyil) and 100km (al-Joffer) south of Riyadh.[37] The missiles had been withdrawn from Chinese service as nuclear delivery systems, although they reportedly were modified prior to shipment as non-nuclear capable systems.[38] Their current status is unknown. According to one recent report, Saudi Arabia and Pakistan "have arranged a deal by which Pakistan will provide Saudi Arabia with nuclear technology in return for cheap oil," and the Kingdom will also acquire a new generation of Chinese-supplied long-range missiles with a range of 4,000-5,000km.[39] In terms of fighter and ground attack aircraft, Saudi Arabia is reported to possess 50 F-15s (with 75 on order), 91 F-15C/D *Eagles*, 24 *Tornado* ADVs (F Mk3), 92 *Tornado* IDs, approximately 64 F-5E/Fs and 10 RF-5Es.[40]

**EGYPT**

Egypt acceded to the NPT in 1981 and its comprehensive Safeguards Agreement entered into force in 1982 (INFCIRC 302).[41] However, the country has been critical of the nuclear nonproliferation regime primarily because of Israel's possession of nuclear weapons. In a debate at the UN General Assembly in late September 2003, Egyptian Foreign Minister Ahmed Maher said, "It is unacceptable that Israel's possession of such weapons should remain a reality that some prefer to ignore or prevent the international community . . . from facing it squarely and frankly."[42] According to the Wisconsin Project, Egypt strongly opposed efforts to extend the NPT indefinitely in 1995.[43] Despite this lack of faith in the nonproliferation regime, Egyptian President Hosni Mubarak frequently has proposed the creation of a WMD-free zone in the Middle East as a way to address the nuclear threat posed by Israel and the wider challenge of proliferation.[44]

Throughout 2003-04, it appears that Egypt has, in its public statements, continued to be much more concerned about Israel's nuclear arsenal than Iran's recent nuclear activities. As the Egyptian Foreign Minister said after John Bolton visited Egypt in June 2003, "Talks with the American official dwelt on Israel's nuclear

arms."[45] Moreover, Egyptian-Iranian relations appeared to improve significantly in late 2003 when negotiations were initiated over the resumption of diplomatic relations between the two countries.[46]

In 2004 and early 2005, several media reports claimed that Egypt has been working on a clandestine nuclear program. These have included a few reports about potential "Egyptian links" to Libya's nuclear program in the past. One report even referred to "evidence uncovered by a British-U.S. team of nuclear inspectors" working in Libya which confirmed "an exchange of nuclear and missile technology between Libya and Egypt in late 2003."[47] Officials reportedly stated that the evidence confirmed suspicions of a 3-year-long secret trade between Cairo and Tripoli in strategic weapons obtained from North Korea.[48] Egyptian links with Libya in the nuclear field are believed to go back to the early 1970s. According to Shyam Bhatia writing in 1988, a link developed between Libya and high calibre Egyptian nuclear scientists in the early 1970s. This link reportedly resulted in the transfer of manpower and ideas to Libya. Bhatia wrote that Egypt explored the possibility of using Libyan money to keep up the momentum of research and development at Egypt's nuclear center at Inshas and other locations, and both Qadhafi and Nasser reportedly gave this project their personal backing. However, Libyan-Egyptian cooperation was short-lived because relations between the two countries deteriorated in the mid-1970s when it emerged that Libya had backed a plot against Egyptian President Sadat.[49] Relations between the two countries later had recovered sufficiently to enable joint research in nuclear-related fields including personnel exchanges.[50]

In addition to the alleged link with Libya, it was reported in November 2004 that the IAEA was looking into why plutonium particles had been discovered near a nuclear facility in Egypt.[51] This was followed in January 2005 by a report that, according to diplomats, the IAEA "has found evidence of secret nuclear experiments in Egypt that could be used in weapons programs."[52] A report by the IAEA Director General to the Agency's Board of Governors dated February 16, 2005, and leaked into the public domain shortly thereafter, subsequently confirmed that Egypt, indeed, had possessed undeclared materials and conducted undeclared activities

at its Inshas Nuclear Centre near Cairo. The materials and activities related to uranium extraction and conversion, the irradiation of uranium targets, and reprocessing. The key findings of these IAEA investigations related to Egypt are included in the sections below.

**Nuclear Capabilities**.

The Egyptian Atomic Energy Authority (AEA) is at the center of the country's civilian nuclear program and the main AEA nuclear research center is located at Inshas near Cairo. Egypt has conducted a considerable amount of nuclear relevant research. A review of available open sources generated the following observations related to Egypt's nuclear capabilities.

*Uranium Resources*. The AEA Nuclear Materials Authority has undertaken various technical co-operation projects with the IAEA on uranium exploration since 1989.[53] However, Egypt appears to have placed an emphasis on extracting uranium from phosphates as opposed to mining uranium itself. For example, IAEA investigations in 2004 revealed that Egypt's Nuclear Materials Authority (NMA) had conducted a project to separate uranium at a Phosphoric Acid Purification Plant at Inshas, although "it was never able to work as designed for the separation of uranium." It was also discovered that the NMA currently has "a program for heap leaching of uranium ore in the Sinai and Eastern deserts." The Egyptian authorities have claimed that "none of the uranium ore concentrate produced as a result of its leaching activities has been of a purity and composition that required it to be reported" to the IAEA.[54] In 1990, the AEA began a technical cooperation program with the IAEA titled, "Potential for yellowcake production." The objective was to provide expert services to undertake a prefeasibility study to assess the potential of two sites for a pilot plant.[55]

*Conversion, Enrichment, and Fuel Fabrication*. The IAEA noted in February 2005 that investigations in 2004-05 had revealed that, prior to Egypt's Safeguards Agreement taking force in 1982, it imported nuclear material and conducted uranium conversion activities, using some of this material at Laboratories in the Nuclear Chemistry Building at Inshas.[56] According to the Egyptian

authorities, the experiments were designed within the "framework of staff development for the front end of the fuel cycle." Initial IAEA investigations have discovered that Egypt failed to include in its first report to the Agency in 1982 "approximately 67 kg of imported UF4, 3 kg of uranium metal (some of which had been imported, and some of which had been produced from imported UF4), approximately 9.5 kg of imported thorium compounds, and small amounts of domestically produced UO2, UO3 and UF4."[57]

In January 2005 it had been reported that, according to diplomats, the IAEA "has found evidence of secret nuclear experiments in Egypt" involving the production of "various components of uranium." The Egyptians reportedly have produced "several kilograms of uranium metal and of uranium tetrafluoride—a precursor to uranium hexafluoride gas." According to the diplomats, the work appears "to have been sporadic, involved small amounts of material, and to have lacked a particular focus," indicating that it was "laboratory scale" and "not directly geared toward creating a full-scale program to make nuclear weapons."[58] The experiments reportedly were conducted mainly during the 1980s and 1990s, but there may also be evidence suggesting that some experiments "were as recent as a year ago."

Egypt does not appear to have an established enrichment program but research has been performed on relevant processes. For example, scientists at Cairo University have researched the chemical exchange process as a method of uranium isotope enrichment.[59] Moreover, research has been conducted at the University of Alexandria on multicomponent isotope separation in asymmetric cascades, which could potentially be used in uranium enrichment using aerodynamic methods.[60]

The AEA has a Fuel Manufacturing Plant to produce the nuclear fuel necessary for the operation of the Agency's multipurpose reactor. According to the AEA: "The starting material is uranium hexafluoride ($UF_6$) gas, 19.75 percent enrichment. This is converted into $U_3O_8$ through treatment with ammonia and water in special chemical reactors. This is followed by filtration and thermal treatment to get the appropriate particle size of $U_3O_8$. The oxide powder is mixed with aluminium powder and cold-pressed under 4.5 tons/$cm^2$ into compacts, which are then cladded with sheets of aluminium 6061

alloy, and sealed by welding all around."[61] The plant can produce two fuel elements per month, which is sufficient for the continuous operation of the reactor. According to the Wisconsin project, Egypt had plans to build a larger fuel fabrication plant in the mid 1990s with help from Germany.[62] However, these plans do not yet appear to have come to fruition.

*Nuclear Power*. Egypt does not have any nuclear power reactors. The Egyptian government has shown interest in starting a civilian nuclear power program since the 1960s. The Federation of American Scientists states that in the mid-1970s, the United States pledged to provide Egypt with eight nuclear power plants, and the necessary cooperation agreements were signed. This project was cancelled in the late 1970s after the United States unilaterally revised the bilateral agreements and introduced new conditions that were unacceptable to the Egyptian government.[63]

Interest in nuclear power reactors has continued, and Egypt has carried out several relevant research programs. In 2001, the AEA began a technical cooperation project with the IAEA entitled, "Human Resource Development for Nuclear Power Project Preparation and Project Management." The project's objective was to "transfer knowledge, information, and experience related to the development of human resources for planning and implementing a nuclear power project for electricity generation and/or desalination."[64] It was reported in September 2002 that an Egyptian government minister had announced the country's intent to build a nuclear power plant on the north coast of Egypt, although no details of the plan were available.[65] Indeed, initial negotiations reportedly were underway in 2001 with Russia, after Egypt requested information about Russia's atomic energy industry. According to General Director of Russia's *Atomenergostroi* Viktor Kozlov, contracts may be signed as early as 2006.[66] Although new plans have not yet been announced, the media reported that Egypt has held negotiations with both China and Russia over the construction of nuclear power plants.[67] However, it was reported later in 2004 that the likely site for a nuclear power plant, Dabba, was about to be turned into a tourist resort.[68]

*Reprocessing, Spent Fuel, and Waste Storage*. It has emerged as a result of recent IAEA investigations that in the late 1970s, Egypt concluded a number of contracts with a foreign company to construct

a laboratory (the Hydrometallurgy Pilot Plant) for conducting "'bench scale radiochemistry experiments' involving the separation of plutonium and uranium from irradiated fuel elements of the 2 MW research reactor." According to Egyptian authorities, the experiments were motivated by plans to construct eight nuclear power plants and to develop expertise in the nuclear fuel cycle.[69]

In 1987, Egypt subsequently performed "acceptance tests using unirradiated uranyl nitrate in chemical reagents" at the Hydrometallurgy Pilot Plant. The uranyl nitrate had been blended with a solution acquired from the dissolution of domestically produced scrap UO2 pellets (estimated total weight of 1.9 kg of uranium compounds). However, Egypt failed to report to the IAEA both the materials and their use in test.[70]

The reason offered by Egypt for not including the Hydrometallurgy Pilot Plant in its initial declaration to the IAEA in 1982 is that it "had not considered it to be a facility since it was being constructed only to carry out bench scale radiochemistry experiments." The IAEA believes the plant constituted a nuclear facility, given its intended purpose and design capabilities, and Egypt should have informed the Agency "as early as possible prior to the introduction of nuclear material into the facility." [71]

Further undeclared activities took place between 1990 and 2003. Egypt informed the IAEA in December 2004 that, between 1990 and 2003, 16 experiments had been performed, "involving the irradiation of small amounts of natural uranium in its reactors to test the production of fission product isotopes for medical purposes." Twelve experiments involving a total of 1.15g of natural uranium compounds took place at the 2MW research reactor between 1990 and 2003. Four experiments involving 0.24g of natural uranium compounds took place at the 22MW reactor between 1999 and 2000. Nine thorium samples also were irradiated in the 2MW reactor. Moreover, the irradiated targets "had been dissolved in three laboratories located in the Nuclear Chemistry Building" although Egypt claims that "no plutonium or U-233 was separated during these experiments." According to the Egyptian authorities, similar experiments were performed before its Safeguards Agreement took force, and between 1982 and 1988, but that it has been unable thus far to locate relevant source documentation with respect to such experiments." [72]

Egypt also informed the IAEA in December 2004 that it had not included in its initial Safeguards report imported "unirradiated fuel rods containing uranium enriched to 10% U-235 and some of which had been used in experiments" at the Nuclear Chemistry Building prior to its Safeguards Agreement taking force. The experiments were reported to have involved "laboratory scale testing of fuel dissolution in anticipation of the development of a reprocessing laboratory."[73]

Egypt currently is constructing a new Radioisotope Production Facility at Inshas for the separation of radioisotopes from uranium enriched to 19.7 percent in U-235 to be irradiated at the 22MW reactor. However, the Egyptian authorities have informed the IAEA that no nuclear relevant equipment yet has been acquired for the facility. According to the IAEA, the decision to construct the facility should have been conveyed to Vienna "no later than 1997 when it undertook to provide early design information for new facilities."[74]

*Research Reactors*. Egypt commissioned its first research reactor, the 2MW Soviet-supplied ET-RR-1 in 1961.[75] A second, the 22MW open pool Multi-Purpose Reactor (MPR), was commissioned in 1997. The MPR, supplied by the Argentine company, INVAP, is designed to produce radioisotopes for industrial and medical applications, as well as research on neutron physics and training personnel.[76] Both reactors are located at Inshas and are under IAEA safeguards.

It is reasonable to assume that, based on standard operating levels, the MPR will produce about 22g of plutonium per day of operation. Assuming that the MPR runs for 300 days a year (if in heavy service), it would produce 6.6kg of plutonium per year. The Fatman nuclear bomb used by the United States in 1945 used 6.5kg of plutonium.[77]

**Delivery Capabilities**.

Egypt's potential nuclear delivery capabilities include both ballistic missiles and aircraft. Egypt has a range of ballistic missiles both in its inventory and under development. Egypt is reported to have nine *SCUD*-B launchers[78] and slightly over 100 *SCUD*-B missiles. The inventory also reportedly includes approximately 90 Project T missiles, with a range of 450km and a payload of 985kg.[79] Other

ballistic missiles apparently are being developed. There are reports that Egypt has developed an enhanced *SCUD*-C missile, with a range of 550km and a 500kg payload. Furthermore, Egypt reportedly signed an agreement with North Korea in 2001 to purchase the 1000km-range *Nodong* system. [80] These reports have not been confirmed. It is also reported that Egypt is developing the Vector missile with a range of 800-1,200km and a 450-1,000kg payload.[81] In March 2004, it was reported that evidence was uncovered by a British-U.S. team of nuclear inspectors working in Libya that, "an exchange of nuclear and missile technology between Libya and Egypt" took place "in late 2003."[82] Egypt possesses seven squadrons of fighter-ground attack aircraft (including *Mirage* 5E2) and 22 squadrons of fighter aircraft (including F-16A and D, *Mirage* 2000C and 5D/E, and *MiG*-21).[83] It would appear that the range of combat aircraft available to Egypt would provide Cairo with a theoretical capability to deliver nuclear weapons.

## TURKEY

Turkey's ratification of numerous nonproliferation agreements commits the country to the application of nuclear technology for purely peaceful purposes. These commitments include the NPT, IAEA Safeguards (including the Additional Protocol) and the Comprehensive Test Ban Treaty (CTBT).[84] Although the country does not possess a nuclear power reactor, the Turkish Atomic Energy Authority (TAEK) conducts a considerable amount of research in the nuclear field and operates one research reactor.[85]

In the recent past, Turkey has shown considerable interest in establishing a civil nuclear power sector to alleviate energy shortfalls. The country is a net energy importer because it is not rich in energy resources. For example, Turkey imported 62 percent of its energy requirements in 2001. Turkish government officials believe this figure will increase by about 8-10 percent annually up to 2010, which will necessitate an installed power production capacity of approximately 46GW.[86] In 2002 and 2003 there were calls from national newspapers,[87] and even the head of the TAEK,[88] for Turkey to initiate a nuclear power program in order to reduce energy

imports. The Turkish government demonstrated a renewed interest in nuclear power in 2004. In November 2004, Turkish Minister of Energy and Natural Resources Hilmi Guler said Turkey should be producing 4,500MW of nuclear power beginning in 2012[89] with three nuclear power plants.[90]

There is no evidence in available open sources that suggests Turkey has a nuclear weapons program. Indeed, given the openness of Turkey's nuclear research program, small uranium reserves, and lack of enrichment and reprocessing capabilities, it is difficult to believe that Ankara could develop a weapons program in the near future. Although some allegations have been made about the potential proliferation threat posed by Turkey, it is important to note that most have been voiced by Greek officials and focused on alleged nuclear cooperation between Turkey and Pakistan. For example, following a military coup in Turkey in September 1980, military leaders of Turkey and Pakistan reportedly exchanged a series of official visits, which prompted Greek Prime Minister Papandreou to accuse Pakistan of expecting Turkey "to act as a trans-shipper of material for a nuclear bomb" and likely to "reciprocate by proudly sharing the nuclear bomb technology with Turkey."[91] Moreover, following the Indian and Pakistani nuclear tests an article in the Turkish daily "Radical" reported that then Pakistan Prime Minister Nawaz Sharif offered Turkey cooperation on nuclear weapons by stating, "Let's work together on nuclear weapons."[92]

Ankara certainly has reacted with concern to Iran's recent activities in the nuclear field. Defense Minister Vecdi Gonul noted in November 2003 that Iran's efforts to export its own revolution, its contradictory attitude towards terrorism, and its policies towards Armenia and Azerbaijan are not in line with Turkey's interests, and make it difficult for Ankara to develop bilateral relations with Tehran. Moreover, he noted that Iran might be working on the production of nuclear, biological, and chemical weapons, which would threaten the whole region.[93] As Larabee and lesser note, a nuclear-armed Iran "could dramatically change the security equation for Turkey and could have broader consequences for military balances elsewhere on Turkey's borders."[94] However, it was reported on November 19, 2004, that Turkish Foreign Minister Abdullah Gul had told

journalists in Ankara that Turkey wanted the Middle East to be a region free of nuclear weapons. With regard to American concerns over Iran's nuclear activities, Gul said he expected caution on both sides, adding that Iran had a "long-standing place in the region. It would probably be very cautious. So we expect the problem to be resolved eventually."[95] It would appear, then, that there may be a substantial difference of opinion between the Foreign and Defence ministries in Turkey in terms of threat perceptions related to Iran.

Although Turkish and Israeli military and civilian officials appear to have discussed "joint threats" as part of their strategic cooperation,[96] it is not known to what extent Iran and its nuclear ambitions have featured in their discussions.

**Nuclear Capabilities.**

It appears that almost all aspects of the nuclear fuel cycle have been examined in Turkey except uranium enrichment. The Çekmece Nuclear Research and Training Centre is in charge of these activities, which are conducted by a network of nuclear-related research centers and laboratories based at government facilities and universities.

*Uranium Resources.* It was reported in November 2004 that Hilmi Guler had said that Turkey has 230,000 tons of thorium reserves and 9,200 tons of uranium reserves. Moreover, Guler noted that, while current technology in Turkey was more suited to uranium, thorium would be considered in the future.[97] Indeed, preliminary work has been conducted to survey, analyze, and determine the feasibility of using the country's natural thorium resources to fuel a future nuclear power industry in Turkey. Moreover, TAEK initiated a feasibility study on uranium extraction from phosphoric acid in the early 1980s, with assistance from the IAEA. According to the IAEA database on technical cooperation, this work is still active and may not yet be complete.[98] TAEK is working with ETI Holding and the Directorate General of Mineral Research and Exploration (MTA) on rare soil elements and the development of thorium extraction/purification technology.[99]

*Conversion, Enrichment, and Fuel Fabrication.* Turkey appears to have one facility capable of engaging in conversion activities, a fuel pilot plant at the Çekmece Nuclear Research and Training Centre.

The extent of the facility's work remains unclear.[100] Moreover, while Turkey does not appear to have any enrichment capabilities, some potentially relevant research has been conducted at Turkish universities.[101]

Turkey has experimented with nuclear fuel fabrication on a laboratory scale. Relevant experiments have been conducted at several universities in Turkey, with research undertaken to understand the properties of nuclear fuel and the process of fuel fabrication. Dr. Gungor Gunduz, Department of Chemical Engineering, Middle East Technical University (METU), has participated in numerous projects with the TAEK and supervised student projects in this field.[102] Fuel fabrication experiments and uranium analysis studies have also been conducted in the Department of Chemistry, Cumhuriyet University.

*Nuclear Power*. Although Turkey does not have a nuclear power plant, the country has shown an interest in nuclear power ever since U.S. President Dwight Eisenhower's Atoms for Peace speech in December 1953. However, it was not until the mid-1990s that Turkey made its most definite attempt to initiate a civil nuclear power program. In 1996, following additional feasibility and exploration work conducted by the Korean Atomic Energy Institute (KAERI), Turkey invited bids to construct a nuclear power plant at Akkuyu. By the end of 1997, three competing vendors were negotiating with Turkey for the deal: AECL (Canada), Nuclear Power International (NPI)—which included Germany's Siemens and France's Framatome—and the U.S. Westinghouse Electric Co. However, Turkish Prime Minister Bulent Ecevit announced in July 2000 that the Akkuyu project had been cancelled, blaming it on the International Monetary Fund's demands on Turkey with regard to its domestic economic policies. The country's nuclear power program was shelved indefinitely, and TAEK recommended Turkey's concentration on the development of natural gas and hydroelectric options until at least 2015.[103]

The Turkish government began to demonstrate a renewed interest in nuclear power in 2004. In May 2004, Guler reportedly said that technical studies continued on nuclear power plants, Turkey would "soon get in touch with the countries producing such power plants," and that things are at the specifications of contract stage. According

to Guler, the government wants to involve the private sector in all kinds of investment in the energy sector, but the government could invest itself where necessary.[104] During a visit to Brazil in October 2004, Turkish Finance Minister Kemal Unakitan was due to hold talks with officials in Sao Paolo and Rio de Janeiro on economic relations. The meetings were expected to focus in part on cooperation in many fields including nuclear energy.[105]

Guler said in November 2004 that Turkey should be producing 4,500MW of nuclear power from 2012.[106] The Turkish Ministry of Energy and Natural Resources also issued a statement in November 2004 noting that nuclear power was one of the most important alternative energy sources for Turkey. According to the ministry, Turkey is one of the few developing countries that possesses the infrastructure to transfer and to develop nuclear technology.[107] According to a report dated November 19, 2004, Guler said Turkey was planning to construct three nuclear power plants, and they would be on-line after 2011. Guler said that domestic resources were insufficient to meet the country's energy requirements, and an energy shortage could occur if no measures are taken. According to Guler, Turkey plans three nuclear plants to prevent such a shortage. The goal is to generate 8-10 percent of the country's energy needs using nuclear power plants. Guler said that the plan is to fuel the plants with uranium, and that current technology in Turkey was more suited to uranium, altough thorium would be considered as a fuel in the future.[108]

*Reprocessing, Spent Fuel, and Waste Storage.* Since the late 1980s, academics and government scientists in Turkey have worked both at home and abroad on studies to determine the most effective method for reprocessing spent fuels.[109] For example, a research project involving the Nuclear Engineering Department of Hacettepe University and the TAEK Nuclear Safety Department established feasible flow sheet calculations for using the solvent extraction process to reprocess thorium based spent fuel.[110] The project was carried out in anticipation that Turkey may eventually build a thorium-based HTR reactor.

The majority of Turkey's radioactive waste classified as low-level is produced by the country's single research reactor, several research centers, and radiological sources in universities, hospitals,

and industries. The waste is collected, treated, and stored at the Radioactive Waste Processing and Storage Facility of the Çekmece Nuclear Research and Training Centre.[111]

During negotiations to build a power reactor at Akkuyu, Turkey started to plan for an interim storage facility to accommodate spent fuel. Negotiations were initiated with Bulgaria and Hungary in 1997 to establish a regional interim storage facility or repository in south Eastern Europe—potentially in a remote location in Turkey. The site would have served as an interim storage facility or potential repository for spent fuel from the planned Akkuyu power reactor and reactors in Bulgaria and Hungary.[112] Given the cancellation of the Akkuyu project, negotiations with these countries are not likely to continue.

*Research Reactors.* Turkey has one operational research reactor. The ITU-TRR is a 250 kw *TRIGA* Mk II reactor, which was supplied by General Atomics and went critical in 1979.[113] The reactor is located at the Istanbul Technical University, operated by the Institute for Nuclear Energy, and licensed by TAEK. Turkey's first research reactor, the 1MW TR-1 located at Çekmece Nuclear Research and Training Centre, was shut down in 1977.[114] The country's second research reactor, the TR-2, a 5MWth upgrade of the TR-1, was shutdown in 1995.[115]

**Delivery Capabilities.**

Turkey's potential nuclear delivery capabilities include both ballistic missiles and aircraft. Turkey is reported to be developing a satellite launch vehicle (SLV) similar to the French *Ariane* SLV, which could potentially form the basis of a theoretical nuclear missile. The project is scheduled for completion by 2010 at the earliest, if the rocket and the satellite are completed simultaneously. The Rocketan Corporation has begun production activities related to the rocket under the supervision of the Turkish Aviation Institution. Other organizations involved include the Turkish Armed Forces, the Middle East Technical University, Istanbul Technical University, and the Turkish Scientific and Technical Research Institution. No decision yet has been reached on the location of the launch site, which is expected to be situated on the Turkish coast.[116] Turkey is believed to have 120

MGM-140 Army Tactical Missile Systems (ATACMS), with a range of 160km and a payload capability of 450kg.[117] The Turkish Air Force has a range of combat aircraft including 223 F-16 fighter aircraft (193 F-16C and 30 F-16D); 87 F/NF-5A/B fighter ground attack aircraft; and 170 F-4E aircraft (88 fighter ground attack, 47 fighters, and 35 recce).[118] In addition, the air force now has some 100 Israeli *Popeye*-1 air-launched standoff missiles, with a range of 100km and a payload of 360kg. One hundred more may be delivered by Israel, and there are plans to co-produce, with the Israeli firm, Rafael, *Popeye*-2 air-launched standoff missiles, with a 350km range and a payload of 360kg.[119]

**SYRIA**

Syrian President Bashar Assad effectively admitted in an interview published in January 2004 that his country has developed chemical and biological weapons as a last resort defence against Israel.[120] Indeed, it has long been known that Damascus possesses a substantial chemical warfare capability and a more limited biological weapons capability.[121] From a review of available open sources, however, it does not appear that Syria is pursuing seriously the development of nuclear weapons. Moreover, it appears that Syria does not currently possess the infrastructure and personnel necessary to establish a nuclear weapons program, bar significant infusions of external assistance.[122] This assessment reflects Syria's non-nuclear weapons status under the NPT,[123] which has been subject to IAEA verification since the country's Safeguards Agreement (INFCIRC 407) took force in 1992.[124] Syria has not concluded an Additional Protocol with the IAEA or signed the CTBT.[125]

The U.S. National Intelligence Council noted in December 2001 that the American intelligence community "remains concerned about Syria's intentions regarding nuclear weapons."[126] The country's limited infrastructure includes a nuclear research center at Dayr Al Hajar[127] and a small Chinese-supplied research reactor under IAEA safeguards. In May 1999, Damascus signed a "broad nuclear cooperation agreement" with Russia covering the construction of a small light-water research reactor, which will be subject to IAEA safeguards.[128] Syria and Russia have also approved "a draft

cooperative program on cooperation in the civil nuclear power field." It has been assessed by U.S. intelligence that, "In principle, broader access to Russian expertise provides opportunities for Syria to expand its indigenous capabilities, should it decide to pursue nuclear weapons."[129] In 2004, there were reports alleging that Syria may have acquired centrifuge enrichment technology from the A. Q. Khan network.

In March 2004 an agreement reportedly was signed between Syria and Iran on defense and military cooperation.[130] Both Syria and Iran confront a similar strategic situation and appear to recognize that they have a vested interest in cooperating with each other to retain their political independence. Both countries are united against Israel in support of the Palestinians, Hezbollah, and Lebanon. Moreover, they were both rivals of the Iraqi Ba'athist regime of Saddam Hussein, and both currently fear American hegemony and intentions in the region due to their own WMD ambitions and support for terrorism.[131]

**Nuclear Capabilities.**

The Atomic Energy Commission (AEC) is at the center of Syria's civilian nuclear program. A review of available open sources generated the following observations related to Syria's nuclear capabilities.

*Uranium Resources*. Syria has conducted significant work to examine the feasibility of exploiting phosphatic rock to recover uranium. The country is rich in phosphatic rock deposits and produces around one-fifth of the phosphate rock mined in the entire Middle East.[132] In 2001, Syria mined over 2.04 million tons of phosphate.[133]

Syria operates a uranium recovery micro-pilot plant at Homs.[134] The plant was designed to be the precursor for a pilot plant and an industrial scale plant, with potential operations such as refining, conversion, enrichment, and fuel fabrication.[135] However, a study, conducted to determine whether the technology used for extracting uranium from phosphoric acid produced at Homs could be industrialized, found that it was not feasible financially.[136] Damascus signed a tripartite contract with the IAEA and an unnamed entity in 1996 to improve its technical capabilities to recover uranium from triple superphosphate.[137]

Several Syrian experts reportedly have spent time at Ranstad Mineral in Sweden, a facility that extracted uranium for enrichment purposes between 1997 and 2002. Although the IAEA reportedly sponsored some of the visits, according to the facility's owner, Bengt Lillja, the Syrians made additional trips "on their own."[138]

*Conversion, Enrichment, and Fuel Fabrication*. Syria does not appear to have conversion, enrichment, or fuel fabrication capabilities. However, there were various reports in 2004 related to Syria's potential acquisition of enrichment related technology from the A. Q. Khan network. According to one report in August 2004, American officials believe that Syria received "an unspecified number" of P1 centrifuge components "in what could be the most significant step" in the country's "nascent nuclear weapons program." According to the officials, Firas Tlas, son of Syrian Defence Minister Mustafa Tlas, became a customer of A. Q. Khan in 2001. The components and other nuclear equipment reportedly were ordered by the Saddam regime in Iraq via Syria, and deliveries may have continued after Saddam's fall in April 2003.[139] In May 2004, however, it was reported that the U.S. intelligence community was divided on the issue of whether Syria had received technology from the clandestine network.[140] Moreover, a January 2004 report in *The Washington Post* noted that, although network middlemen from South Africa, Germany, the Netherlands, Sri Lanka, and elsewhere allegedly offered their services to Syria, the deals never apparently transpired.[141]

Moving beyond the centrifuge allegations, Syria does operate a *Cyclon*-30 cyclotron which was provided by Belgium's Ion Beam Applications (IBA).[142] IBA also supplied a cyclotron of the same model to Iran, which analysts suspect may have been used to research uranium enrichment.[143] The AEC had asked for IAEA assistance in 1996 to build a cyclotron facility at its Nuclear Medicine Centre. The project was approved by the IAEA, and construction of the facility began in 1997. The stated aim is to produce radioisotopes for medical purposes.[144] It should be noted that personnel at the AEC are also conducting research on $CO_2$ lasers, which could potentially be applied to laser isotope separation and therefore enrichment.[145]

*Nuclear Power*. Although Syria does not have a nuclear power reactor, it has long viewed nuclear energy as a viable source to meet Syria's future energy needs. Damascus performed a feasibility study

in the early 1980s with help from the IAEA to identify the requirements for a potential power program,[146] and since the late 1980s has actively sought to acquire a nuclear power capability. Syria initiated a plan in 1988 to build six nuclear power reactors by the late 1990s capable of producing 6,000MW at a cost of $3.6 billion. Although Belgium, the Soviet Union, and Switzerland were approached for assistance, the plan came to nothing as a result of financial and technical issues.[147] In 1990, for example, Syria asked the Soviet Union if it could buy up to four VVER-1000 power reactors and the associated fuel.[148]

Russia and Syria signed a Comprehensive Cooperation Agreement in 1997 under which Russia reportedly will build two nuclear reactors in Syria, although it is unclear whether they will be for research or power production.[149] Syria's continuing interest in nuclear power was demonstrated in 2001 when the IAEA agreed to provide assistance for another project to assess the potential role of nuclear power in the country.[150]

One potential application of nuclear power in Syria is desalination. The AEC is involved with Damascus University in a program to develop desalination technologies in conjunction with the Scientific National Commission for Water Desalination, based at the Higher Institute of Applied Science and Technology, Damascus.[151]

It was subsequently reported in 2003 that Russia and Syria had entered negotiations for the construction of a $2 billion nuclear facility in Syria. Russia's Ministry of Atomic Energy confirmed that discussions were underway to supply a nuclear power plant and a nuclear desalination plant, but no agreement had been reached.[152] However, the Russian Foreign Ministry denied that such discussions had taken place.[153]

*Spent Fuel and Waste Storage*. There do not appear to be any spent fuel storage facilities in Syria, although the AEC is currently planning to construct a waste processing facility. To this end, the AEC recently established a Radioactive Waste Management Division to collect, treat, and store naturally occurring radioactive waste from Syria's mining, oil, and natural gas sectors.[154]

*Research Reactor*. Syria's single 30kw research reactor—the SRR-1 (Syrian Research Reactor, Syrian Miniature Neutron Source Reactor)—was provided by China along with 90 percent enriched uranium fuel. The reactor is located at the Der Al-Hadjar Nuclear

Research Centre near Damascus, and went critical in 1996. It is used for basic and applied research and training reactor operators.[155] Syria and Russia have reportedly signed an agreement for the provision of a 25MW light-water pool-type research reactor to be housed in a new research centre.[156]

**Delivery Capabilities.**

Syria's potential nuclear delivery capabilities include missiles and aircraft. Syria has several hundred *SCUD*-B, *SCUD*-C and SS-21 missiles, according to *The Military Balance*[157] and the U.S. Department of Defense (DoD).[158] DoD states that Syria continues to acquire *SCUD*-related equipment and materials from Iran and North Korea, including considerable assistance from Pyongyang in producing *SCUD*-C missiles. According to *Jane's Defence Weekly*, Syria may have some *SCUD*-D missiles with a range of 650km.[159] Syria allegedly has tested a *SCUD*-B with a warhead designed to disperse VX nerve agent."[160] Damascus is also said to be attempting to develop a capability to arm ballistic missiles with biological warheads, although this has not been verified.[161] Since 1999, it is thought that Syria has worked on establishing a solid-propellant rocket motor development and production capability with external assistance from abroad, including Iran. In addition, DoD claims that foreign equipment and assistance for Syria's liquid-propellant missile program has come from North Korean entities, as well as Chinese and Russian firms. According to DoD, these developments are part of Syria's efforts to acquire a modern, solid-fueled, short-range missile.[162] Syria possesses 10 squadrons of fighter-ground attack aircraft (including Su-24, Su-22 and *MiG*-23 BN) and 16 squadrons of fighter aircraft (including *MiG*-21, *MiG*-23, *MiG*-25 and *MiG*-29A, and Su-27), according to *The Military Balance 2003-2004*.[163] The combat aircraft available to Syria would provide Damascus with a theoretical capability to deliver nuclear weapons.

**CONCLUSION**

The Iranian nuclear crisis has resulted in concerns about the potential response of some of Iran's neighbours, in particular

whether Tehran's behavior could prompt other regional actors to consider acquiring nuclear weapons. Within this context, the chapter sought to shed some light on the nuclear capabilities and ambitions of four key countries in Iran's immediate neighbourhood: Saudi Arabia, Egypt, Turkey, and Syria. These countries were singled out due to their relative proximity to Iran and because there have been suspicions that they have all been interested, at one time or another, in acquiring nuclear weapons. For each country, an assessment was made of current capabilities, including the various elements of the fuel cycle that could potentially be used to support nuclear weapons development and potential nuclear delivery systems. Attention also was given to the drivers of potential nuclear and other WMD programs in the countries concerned.

An analysis of available open sources revealed relatively little about national intentions in Saudi Arabia, Egypt, Turkey, and Syria regarding the acquisition of nuclear weapons—both in general terms and more specifically with regard to the current Iranian nuclear crisis. The lack of pertinent information in this respect appears to stem primarily from the political sensitivity of the issue and the relatively closed and nontransparent nature of the societies involved, with the exception of Turkey. In contrast, it was possible to develop a fairly detailed picture of the various elements of the fuel cycle currently in existence or being developed in the four countries, as well as their potential nuclear delivery options. It is assessed that each country currently lacks the technical capacity to build a nuclear weapon, barring significant infusions of external assistance. However, the recent exposure of Egypt's undeclared materials and activities is a significant cause for concern—not just in its own right, but in terms of whether it is indicative of a broader trend in the region already demonstrated by the Iran and Libya cases. Indeed, given that A. Q. Khan has previously visited Egypt, Saudi Arabia, and Syria, it is quite possible that, in addition to Iran and Libya, these countries also may have secretly acquired sensitive nuclear technology and expertise from this clandestine proliferation network in the past.

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