EGYPT'S NUCLEAR PROGRAM: ASSESSING SUPPLIER-BASED AND OTHER DEVELOPMENTAL CONSTRAINTS

by Barbara M. Gregory

Barbara M. Gregory is Deputy Manager of the Weapons Proliferation Analysis Division of Science Applications International Corporation (SAIC) in McLean, Virginia. The views expressed in this article are those of the author and do not necessarily represent those of SAIC or any of its sponsors.[1]

Egyptian officials have periodically made statements suggesting that Egypt's nuclear energy development efforts, like those of other developing countries, have been stymied by supplier restrictions on the transfer of technology, materials, and equipment. These restrictions, they contend, represent a discriminatory breach of supplier state commitments under Article IV of the nuclear Non-Proliferation Treaty (NPT), which calls on states parties to "facilitate...the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy...with due consideration for the needs of the developing areas of the world." Egypt's foreign minister, in an address to the Third NPT Review Conference in 1985, cited restrictions on the supply of nuclear fuel as among the "obstacles which hinder the smooth execution" of his country's planned nuclear power program.[2] Noting that Egyptians are "alarmed when supplier countries...impose...limitations on their exports beyond those required by the...safeguards system" of the International Atomic Energy Agency (IAEA), he called on those countries to faithfully implement NPT Article IV.[3]

Such criticisms were renewed in connection with the more recent controversy over extension of the NPT. At a Washington, D.C., symposium held in January 1995, an official of Egypt's Ministry of Foreign Affairs explicitly cited export controls as a constraining influence on his country's unrealized nuclear power plans.[4] The contentious nature of the debate over supplier restraints, perceived by Egypt and other developing nations (notably Iran) as a discriminatory impediment to peaceful nuclear development, suggests that a closer examination of the record is in order.

This article explores the impact of export controls on Egyptian nuclear policies and seeks to shed light on the extent to which other factors may have constrained Egypt's nuclear development. A lack of specific and detailed information makes an assessment of the correlation between export controls and Egypt's slow progress in the nuclear field a somewhat uncertain endeavor. However, available information suggests that export controls have had at most a limited impact on Egypt's nuclear activities, Egyptian official pronouncements notwithstanding. Other factors, including inadequate financial resources, a lack of sustained political support, and environmental concerns appear to have played more pivotal roles than export controls in inhibiting Egyptian nuclear research and development. This article begins by examining Egypt's early nuclear ambitions and the course to its 1981 decision to join the NPT. It then surveys the current state of Egypt's nuclear fa-

cilities. Finally, it discusses factors that have inhibited the growth of the program.

EGYPT'S PAST INTEREST IN NUCLEAR WEAPONS

Prior to 1981, there were several indicators of possible Egyptian interest in nuclear weapons, some quite explicit, others less so. Egypt is reported to have requested nuclear arms in 1965 and 1967 from the Soviet Union and China, respectively.[5] Both requests were turned down. Failing to secure assistance from China, Cairo approached India, presumably with hopes of gaining access to sensitive nuclear technology. Both countries signed a nuclear cooperation agreement in 1970, which anticipated joint research in the production of heavy water, nuclear fuels, and raw materials prospecting.[6] Very little assistance was forthcoming from the Indians, and the Egyptians reportedly cooled to the idea of working with them after the United States entered into discussions with Egypt in 1974 on bilateral nuclear cooperation. Supplier restraint clearly played a role in frustrating Egypt's somewhat naive hopes of gaining easy access to sensitive, nuclear-weapons related technology from the Soviet Union, China, and possibly, India.[7]

That Egypt may have toyed with the idea of acquiring a nuclear weapons capability is more strongly suggested by its efforts to develop a plutonium-based fuel cycle. According to Shyam Bhatia, Salah Hedayat, who served as President Nasser's science advisor from 1965 to 1970, is reported to have recommended that Egypt develop an independent nuclear fuel cycle.[8] In a series of proposals made to the government after 1965, he urged self-sufficiency in all stages of the fuel cycle and recommended that a plutonium production reactor and a reprocessing plant be built in Egypt. Hedayat envisioned that his own nuclear engineering consulting firm, Design Consultants Association (DCA), would serve as the organization with lead responsibility for the planning and execution of these proposals.[9]

Motivated in part by concerns that Israel was involved in nuclear weapons development, he apparently felt it was incumbent upon Egypt to try to match Israel's nuclear capabilities. Hedayat's plans reportedly received the personal backing of Nasser and his defense minister, Abdel Hakim Amer. His proposals, however, never achieved fruition for a number of reasons. Among them were mounting political tensions in the early 1970s between Cairo and Tripoli, which had initially expressed support for Hedayat's goals. As a result of the prevailing atmosphere of distrust (aggravated no doubt by an alleged Libyan-backed plot to kill Sadat), Egypt was unable to obtain the necessary funding from Libya.[10]

According to Yair Evron, Egypt failed to purchase a natural uranium fueled, heavy water reactor because the donor states wished to ensure control over the plutonium produced in the reactor.[11] Egypt's apparent reluctance to accept conditions on the disposition of the reactor's spent fuel suggested a possible interest in nuclear weapons development.[12] That Egyptian officials were unhappy over NPT-based supplier restrictions was noted by an Australian official Justice Fox, who, in 1977, was appointed ambassador-at-large with the principal role of representing Australia in international nonproliferation endeavors. Following an overseas tour, Ambassador Fox briefed a group of senior Australian officials on foreign responses to U.S. and Canadian nuclear nonproliferation and export control policies. A record of this briefing states the following:

> [T]here was general opposition...to the proposition that there could be no reprocessing of American-supplied material without United States' consent. Mr. Justice Fox had encountered this sentiment in discussions he had held in Vienna and New York with representatives of developing countries such as Egypt.... [R]estraints on reprocessing and breeders were seen as constituting interference with national energy programs and as undermining the force of the NPT as a non-proliferation instrument.[13]

Before 1981, therefore, supplier constraints may have limited Cairo's proliferation potential by prompting its decision to forego the development of a nuclear fuel cycle based on plutonium production reactors.

The Argentine light water research reactor currently under construction (discussed below) provides an important new impetus to Egypt's program and appears to represent a stronger commitment by Egypt's political leadership to the country's nuclear development. It is noteworthy that Egypt's contract with Argentina for the reactor provides for eventual construction of a fuel fabrication facility, strongly suggesting that a reprocessing facility and the development of a complete fuel cycle may once again figure into Egypt's nuclear development plans.[14] Although there is no current evidence of Egyptian interest in nuclear weapons, such indications that Cairo may

once again be contemplating the development of a complete nuclear fuel cycle bear watching.

THE HISTORY AND CURRENT STATUS OF EGYPT'S NUCLEAR FACILITIES

The Inchas Reactor: Limited Peaceful Nuclear Research

Although Egypt has been engaged in peaceful nuclear research since the 1950s, the country has made only modest strides in the nuclear field. Its present nuclear capabilities, resources, and infrastructure are extremely limited. Despite prior indicators of possible Egyptian interest in acquiring a nuclear weapons capability, Egypt is now committed by its NPT membership to foreswear nuclear weapons development.

The country's sole nuclear reactor is a small, two megawatt thermal (MWt) research reactor located at Inchas, 40 kilometers northeast of Cairo. Construction on the Soviet-supplied light water reactor began in March 1958, and it went critical in February 1961.[15] The Soviet Union provided the initial fuel load of 3.2 kilograms (kg) of 10 percent enriched uranium. No other country is known to have refueled the reactor, which, according to the IAEA, operates only 20 weeks out of the year on the original fuel load.[16] The reactor's small capacity has limited its use to modest neutron physics experiments, the production of radioisotopes for medical and agricultural purposes, and training. Under IAEA safeguards since Egypt ratified the NPT in 1981, the Inchas reactor does not generate enough plutonium to make its spent fuel a proliferation threat.[17]

In the early 1980s, Egypt requested assistance from the IAEA to modernize the reactor's aging systems and to improve its safety. Through two special missions in the mid-1980s and subsequent technical assistance programs, the IAEA has provided a variety of equipment and technical advice.[18] For example, between 1987 and 1989, a new radiation monitoring system and a measuring system were installed to improve the reactor's safety. An IAEA expert visited Egypt in 1989 and assisted the local staff in the design and manufacture of a neutron radiography system.[19] An Egyptian specialist was sent to France and Yugoslavia the following year to receive training in the technology and application of neutron radiography. To optimize radioisotope and radiopharmaceutical production, various items of equipment were installed at Inchas in 1990, including in-cell equipment for producing Iodine-131 and a line for Technetium-99m production.[20] Agency experts are currently reviewing the Safety Analysis Report (SAR) for the Soviet-supplied reactor.[21]

Egypt reached an agreement with Argentina in September 1992 for the purchase of a 22 MWt research reactor, which is expected to replace the Soviet-supplied reactor at Inchas when it goes on line approximately two years from now in 1997.[22] The reactor, currently under construction, will be fueled with 20 percent enriched uranium, moderated and cooled with light water like other reactors exported by Argentina. Argentina's National Commission for Atomic Energy (CNEA) reported that the reactor will be used for "nuclear medicine, material radiation, basic scientific research,...and personnel training."[23] The Argentine firm Investigaciones Aplicadas (INVAP) won the tender for construction of the plant over rival bids from General Atomics of the United States and a Franco-German consortium of Siemens and Framatome. The cost of the project has been estimated at $44.5 million, plus $16.6 million for locally subcontracted construction and manufacture of components.[24]

The reactor will be subject to IAEA safeguards. It poses several theoretical proliferation risks. Like any research reactor, it could be used to irradiate nuclear materials, such as slugs of natural uranium, to produce plutonium.[25] The other risk lies in the possibility that Egypt could recover the enriched uranium and use it as feedstock for further enrichment. However, the diversion of fuel elements to this purpose would be readily detectable by IAEA inspectors. Egypt's lack of a spent fuel reprocessing capability and a uranium enrichment capability would further limit any proliferation risk associated with the reactor.

Egyptian Nuclear Fuel Cycle Activities

Egypt does not have, and is far from attaining, an independent nuclear fuel cycle capability. However, it has taken modest steps which suggest an interest in gaining mastery over aspects of the fuel cycle.

1. **Uranium Exploration and Prospecting.** Egypt does not report any conventional uranium resources. However, exploration activities (begun in the 1950s) have revealed uranium occurrences in sandstone deposits in the Bahariyah

Oasis, and areas of the Western and Eastern Deserts and the Sinai Peninsula, indicating the possible presence of conventional uranium resources. Unconventional uranium resources have been discovered in phosphate deposits in areas of the Western Desert, the Nile Valley, and the Red Sea coast. The uranium content of all phosphate deposits is estimated at 33,000 tons.[26]

The Egyptian Nuclear Materials Authority, established in 1977, oversees Egypt's uranium exploration program. It was reported in 1989 that 250 researchers, some with masters and doctorate degrees, were involved in uranium exploration activities.[27] The capabilities of the Nuclear Materials Authority have been strengthened by the acquisition of a gamma spectrometer-equipped aircraft and diamond drilling and laboratory equipment.

The Egyptian press has occasionally published reports on government plans to begin uranium mining operations. As early as 1985, Egypt was reportedly ready to open its first uranium mine at a cost of $2.1 million.[28] A 1989 report stated that Egypt's Ministry of Electricity had signed technical cooperation agreements with Australia, Canada, and Niger for "advanced technology transfer in the fields of mining and uranium ore development...."[29] Despite such reporting, no mining activities have been initiated.

2. **Uranium Ore Processing and Enrichment.** For the past several years, reports have surfaced in the Egyptian and Arab press on plans by the Egyptian Nuclear Materials Authority to produce uranium as a byproduct of the manufacture of phosphate fertilizers.[30] In 1991, it was reported that this body would "oversee the installation and operation of a uranium production line in the Abu Za'bal [Company for Fertilizers and Chemicals]," which is engaged in phosphate mining and the manufacture of phosphate fertilizers.[31] However, these plans to develop uranium ore processing capability have never been attained. Egypt has no facilities for uranium enrichment.

3. **Fuel Fabrication.** Egypt's metallurgical laboratory at Inchas, supplied with equipment by West Germany, reportedly can produce nuclear fuel on a small, laboratory scale. Reports in the Egyptian media suggest that the country attained this fledgling nuclear fuel production capability between 1988 and 1989.

4. **Reprocessing.** The hot cells at Inchas are the only facilities that currently provide Egypt the wherewithal to separate plutonium from irradiated reactor fuel. Hot cells are shielded rooms with remote handling equipment used for examining radioactive materials and producing radioisotopes. Since they may be used to reprocess spent reactor fuel, they may have some significance from a proliferation standpoint.

In 1964, the Egyptians requested Soviet assistance in setting up a radiochemistry laboratory at Inchas, to include hot cells. The facility was reportedly intended to give Egyptian scientists laboratory experience in reprocessing and management of the spent fuel expected to be produced by a power reactor to be built by Siemens.[32] However, none of these plans achieved fruition. Two hot cells were finally installed at Inchas in 1982 by the French engineering company Robatel reportedly to provide Egyptian scientists with experience in nuclear waste management.[33]

REASONS FOR THE SLOW PROGRESS OF EGYPT'S NUCLEAR PROGRAM

Restricted access to nuclear items and technology appears to have had a limited, but by no means decisive, influence on Egypt's nuclear activities. Cairo's decision to finally ratify the NPT in 1981, 13 years after signing it, was reportedly based in part on its realization that joining the treaty was the only way of obtaining the technology needed to launch a civilian nuclear power program designed to alleviate the country's chronic energy shortage. Fathi 'Ali Husayn notes that, after a comprehensive assessment of Egyptian energy needs was made at the outset of the 1980s, the People's Assembly recommended that Egypt launch a nuclear power program as soon as possible and sign "whatever international agreements were necessary to allow Egypt to acquire the [requisite] nuclear material, equipment, and technology...."[34] According to Husayn, "the first step taken to achieve this goal was the political decision that Egypt join the NPT in February 1981."[35]

That gaining access to nuclear-related goods and technology played a part in Egypt's decision to ratify the NPT was noted in March 1995 by Mohamed Shaker, Egypt's ambassador to the United Kingdom. Shaker stated that:

> [t]owards the end of 1980, and as a result of Egypt's interest in investing heavily in nuclear power for generating electricity...as well as the adoption for the first time that year of a consensus resolution at the U.N. General Assembly on the establishment of a nuclear-weapon-free zone in the

> Middle East, in which Israel had participated, Egypt decided to ratify the NPT.[36]

Becoming a party to the NPT, therefore, should have helped Egypt gain access to nuclear materials, equipment, and technology, and provided a boost to its nuclear program. In fact, Egypt's decision to join the NPT and sign a full-scope safeguards agreement with the IAEA did allow it to enter into an agreement for peaceful nuclear cooperation with the United States. The agreement, which was signed on June 29, 1981, and became effective on January 1, 1982, represented the culmination of discussions begun with Egypt in 1974. The "Agreed Minute" to the agreement noted that it would:

> permit the transfer from the United States to the Arab Republic of Egypt of technology and equipment for nuclear electric power generation, including at the outset the transfer of technology and equipment for nuclear electric generating capacity of about 2000 megawatts electric and enriched uranium necessary to support that capacity.[37]

A U.S. State Department official, testifying before the U.S. House of Representatives about the agreement, affirmed that the United States considered "Egypt's expectation that its adherence to the NPT would facilitate nuclear cooperation to be fully justified and in conformity with the similar expectations of the other NPT parties."[38]

However, even after joining the Treaty, the pace of Egypt's nuclear progress remained slow, suggesting that supplier restrictions were not, in fact, the main impediment to Egypt's nuclear development. Other factors, discussed in greater detail below, appear to account for Egypt's slow progress in the nuclear field and best explain why the Western technology desired at the time Egypt ratified the NPT (and earlier) has not been forthcoming.

Lack of Political Support

The lack of a sustained political commitment appears to have been a key brake on Egypt's nuclear development. In contrast to other developing countries like India, Pakistan, North Korea, and Iraq, where the political leadership has personally taken the lead in supporting nuclear development efforts, Egyptian Presidents Nasser, Sadat, and Mubarak all seem to have refrained from giving their personal stamp of approval to a more aggressive nuclear development strategy.

Examples of inadequate political support and equivocation at the political decisionmaking level abound. For instance, despite President Nasser's concerns over Israeli nuclear activities at Dimona, he appears not to have considered the possibility of backing a crash nuclear weapons development program similar to the missile development program that was underway with German assistance.[39] Although he reportedly endorsed his science advisor's proposal that Egypt should develop an independent nuclear fuel cycle with a view to a possible nuclear weapons option, he apparently refrained from active or direct intervention on Hedayat's behalf in moving these proposals forward. Unlike President Bhutto of Pakistan, Nasser is not known to have personally lobbied the oil-rich Arab states for financial assistance with a nuclear weapons development program. Such personal intervention might also have been crucial in putting an end to some of the bureaucratic infighting that helped to undermine Hedayat's plans.

Egypt's long-standing plans to embark on a large-scale nuclear power program to meet the country's energy needs have likewise met with little success. Egyptian scientists have expressed frustration with the apparent lack of political commitment to these goals. Dr. 'Ali al-Sa'idi, former president of the Nuclear Power Plants Authority, has been a blunt critic of government inaction. In a 1989 interview, he stated that "we used to have an Egyptian nuclear program, but now we do not have any vision...with regard to this vital issue." He further complained that, despite recommendations by the People's Assembly and the Shura Council for immediate implementation of a nuclear power program, "so that we would not lag behind, as usual,...we are still waiting for the political decision to begin implementation now that the experts have had their say."[40] The head of the Nuclear Materials Authority, Dr. Husayn 'Abd al-Muhsin, echoing some of the same frustrations, complained that, although sizeable deposits of uranium have been discovered in Egypt's deserts, "they have not gone into production, waiting for the long-awaited political decision."[41]

Funding Difficulties

A lack of money has also constrained Egypt's nuclear development. Beginning in the 1960s, Egypt devised ambitious plans to launch a large-scale civilian nuclear power program. Although these plans remained "on the books" for nearly 30 years, they were never realized, primarily due to a lack of adequate funds.

In the early 1960s, Egypt's Nuclear Power Plants Authority and Ministry of Electricity reportedly drew up a master plan for the construction of a 200 megawatt electric (MWe) nuclear power plant by 1972 at one of five selected sites.[42] Egypt approached a number of European and American firms regarding the purchase of a natural uranium fueled, heavy water reactor and reportedly reached an agreement with Siemens to build such a reactor. The Siemens deal was cancelled following Cairo's decision to sever diplomatic relations with Bonn as a result of the sale of German tanks to Israel.

More elaborate plans in the 1980s envisaged the construction of eight 1,000 MWe units by the year 2000. An international bid invitation for the turnkey supply of a nuclear plant consisting of two 1,000 MWe units at Al Dabaa was issued on behalf of Egypt's Nuclear Power Plants Authority in April 1983. The provision of a financing offer to cover the import portion of the construction work was made a condition of the bid.[43] Two U.S. vendors (Bechtel/Combustion Engineering and a Westinghouse/Mitsubishi consortium headed by Westinghouse) submitted bids based on the belief that the Export-Import (EXIM) Bank would provide competitive financing for approximately $250 million worth of American technology as part of the U.S. Government's longstanding pledge to facilitate its transfer. The EXIM Bank, however, refused to provide the expected financing, asserting that the proposal did not offer reasonable assurances of repayment.[44] On several occasions between 1984 and 1987, the bidders (those short listed include Kraftwerk Union, Westinghouse and a Franco-Italian consortium headed by Framatome) were asked to extend the validity of their bids. Framatome finally withdrew in 1986 due to an inability to obtain export credit guarantees.[45] After further delays and tortuous negotiations, Egypt canceled its invitation of nuclear plant tenders in 1987.

Egypt's long dormant nuclear power program appeared to receive renewed consideration in 1992. At an IAEA seminar in Vienna on September 16, 1992, the head of Egypt's Nuclear Power Plants Authority stated that his country intended to build a 600 MWe plant of advanced design at the Al Dabaa site 160 miles west of Alexandria.[46] Egypt reportedly approached Beijing regarding the purchase of 300 MWe power reactors modeled on China's first online nuclear plant.[47] However, the effort to enlist Chinese assistance likewise seemed to falter due to financial constraints.

In July 1992, in response to a question from a faculty member of Alexandria University as to why the country had not yet embarked on a nuclear power program, President Hosni Mubarak emphasized the overwhelming costs of doing so:

> If we set up a network of three or four stations, we would start with $2 billion, but this figure would reach $5-6 billion by the time it was finished; that is, the final figure would be between $18-20 billion. Frankly, I would be leaving a debt for the citizens, a burden on the people. I cannot do this....I do not want to add more burdens than the people can endure.[48]

The following month, Egypt's minister of electricity indicated that, "for the time being," Egypt did not intend to buy nuclear power plants from China or any other country.[49] According to an official with Egypt's Ministry of Foreign Affairs, Egypt's nuclear power program "did not materialize for lack of funding" and is "no longer under active consideration."[50]

Environmental Impediments

Environmental and safety concerns, too, have played a role in hindering progress. For example, Egypt's nuclear program reportedly faced increased domestic opposition after the accident at Three Mile Island in 1979, forcing the government to abandon Sidi Kuraryr as the site for Egypt's first power plant in favor of Al Dabaa.[51] Further delays in the Al Dabaa project were precipitated by the April 1986 Chernobyl accident. Egypt announced in May 1986 that construction on Al Dabaa would be postponed until the causes and consequences of the accident could be determined.[52] Ambassador Mohamed Shaker noted in March 1995 that "as a result of the Chernobyl accident...[Egypt] decided to suspend" its ambitious nuclear power program.[53] Concerns over public safety and the environment, and the political repercussions of a major accident, may still figure prominently in the Egyptian leadership's reluctance to revive the country's dormant nuclear power program. Egypt's plan to set up an elaborate network of radiation monitoring stations throughout the country underscores these concerns.[54]

Other national security-related considerations might also have been weighed by Egypt's political leadership. The possibility that Egyptian nuclear installations might be the target of preemptive Israeli military actions, similar to Israel's June

1981 airstrike on Iraq's Osirak reactor, appears to have played a role in limiting Egypt's nuclear ambitions. The importance of this issue to the Egyptians was underscored at the 1985 NPT Review Conference, when the Egyptian delegation submitted a working paper which dealt with the subject of attacks on peaceful nuclear installations.[55] The Egyptian paper linked attacks on safeguarded facilities to the purposes of the conference by arguing that such attacks interfered with the rights of all states parties to the NPT (under Articles III and IV) to engage in peaceful nuclear activities. The Egyptian paper further characterized such attacks as "a direct challenge to the credibility and validity of the IAEA safeguards system" and recommended that NPT parties "should commit themselves to provide or support immediate assistance to the Party...whose...safeguarded nuclear activities are subject to an attack, or threat of an attack."[56]

CONCLUSION

Statements by Egyptian officials contending that their country's nuclear progress has been stymied by lack of access to the requisite technology, materials, and equipment do not square with a closer examination of the record. Supplier restraints do appear to have been successful in thwarting Egypt's efforts to obtain nuclear weapons and nuclear weapons-related technology in the 1960s and 1970s. However, they cannot be said to represent a major stumbling block to Egyptian nuclear development since Egypt joined the NPT as a non-nuclear weapon state in 1981. Rather, Cairo's slow progress in the nuclear field appears to be more closely tied to factors examined here, including inadequate political support, an inability to obtain funding, and environmental concerns. Egypt's continued complaints of lack of access to Western nuclear technology may thus be motivated less by fact than by a desire to raise Egypt's status in the Non-Aligned Movement.

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[1] The author wishes to thank Joseph A. Yager for his thoughtful comments on an earlier draft of this study.

[2] His Excellency Dr. Ahmad Esmat Abdel-Maguid, statement delivered to the Third Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons, held in Geneva, Switzerland, August 30, 1985, p. 19 of prepared text. Dr. Abdel-Majid's reference to nuclear fuel is somewhat puzzling, since Egypt, lacking a nuclear power reactor, would not appear to need nuclear fuel. As a member of the NPT, Egypt would certainly not be precluded from obtaining nuclear power reactors and the fuel to operate them, provided that the fuel was subject to safeguards administered by the International Atomic Energy Agency. This issue is discussed in greater detail below.

[3] *Ibid*., p. 21.

[4] Dr. Mahmoud Karem, panelist in session on "NPT Extension and the Middle East," at "Nuclear Non-Proliferation in 1995: Renewal, Transition, or Decline?," symposium held in Washington, D.C., sponsored by the Carnegie Endowment for International Peace, January 30-31, 1995.

[5] See Ernest Lefever, *Nuclear Arms in the Third World: U.S. Policy Dilemma* (Washington, D.C.: The Brookings Institution, 1979), p. 73. See also Bhatia, who reports that concerns over Israel's activities at Dimona prompted Nasser to approach Beijing after 1967 for "help in acquiring sensitive nuclear know-how that would give Egypt a nuclear military option." Shyam Bhatia, *Nuclear Rivals in the Middle East* (London & New York: Routledge, 1988), p. 59.

[6] Bhatia, p. 59.

[7] Another indication of possible nuclear weapons intent is an unsubstantiated report that Egypt may have clandestinely sought to acquire enriched uranium. In the late 1980s, an Egyptian army colonel, who was involved in an operation to smuggle ballistic missile technology (related to the now defunct Condor II program) to Egypt from the United States, is reported to have found a source in France for 100 kg of uranium, which he hoped to ship to Pakistan for enrichment. The report does not specify what form of uranium. See Joseph S. Bermudez, Jr., "Ballistic Missile Development in Egypt," *Jane's Intelligence Review*, October 1992, p. 458.

[8] Hedayat held a number of important positions within the government from 1961 to 1965, including chairman of the Atomic Energy Authority and minister of scientific research. Bhatia, pp. 52-53.

[9] Hedayat reportedly believed that there were several advantages to using a firm like DCA as a vehicle to maintain and expand the momentum of research at Inchas, including the fact that a private entity might attract less attention from the outside. Further, if properly funded, it could serve as a sort of autonomous Arab nuclear group that would be less vulnerable to political changes in the Arab world. Bhatia, pp. 56-57, 65-67.

[10] Bhatia, p. 66

[11] Yair Evron, "The Arab Position in the Nuclear Field: A Study of Policies up to 1967," *Cooperation and Conflict*, No. 1, (1973), p. 20.

[12] It is worth noting that, during the same approximate timeframe, Iraq appeared interested in a plutonium-based nuclear fuel cycle presumably to support a bomb program. In 1975, the Iraqi government approached French authorities regarding the purchase of a 500 MWe natural uranium/gas-graphite reactor. This type of plutonium production reactor had been used in the French nuclear weapons program, but its manufacture had been discontinued in favor of more efficient light water reactors. France refused Iraq's request and built instead the Osirak, a 40 MWt light water reactor. As a member of the Nuclear Suppliers Group, France may have been prompted by proliferation concerns in its decision not to supply Iraq with a plutonium production reactor. However, there is persuasive evidence to suggest that nonproliferation considerations played only a minor role, at best, in the decision. To begin, the French atomic construction company Framatome had ceased manufacturing this type of reactor in favor of pressurized light water reactors built under license from Westinghouse. Filling the Iraqi order would have required Framatome to disrupt ongoing work and reassemble a costly new production team. Practical industrial and economic considerations, therefore, may have been the primary factors underlying France's refusal to supply the reactor. This view is supported by Dr. Bertrand Goldschmidt, a senior figure in the French Atomic Energy Commission familiar with the French policy debate at the time, who maintained that the sale was disapproved for "internal French reasons that had nothing to do with nuclear proliferation." See Steve Weissman and Herbert Krosney, *The Islamic Bomb: The Nuclear Threat to Israel and the Middle East* (New York: New York Times Books, 1981), p. 92.

[13] Text of Justice Fox's Briefing of Senior Government Officials on Nuclear Non-Proliferation, 29 September 1977, in *Sydney Morning Herald*, November 3, 1977, p. 4, cited by Desmond J. Ball, "Australia and Nuclear Non-Proliferation," in Jae Kyu Park, ed., *Nuclear Proliferation in Developing Countries*, (Seoul: The Institute for Far Eastern Studies, Kyungnam University, 1979), p. 114.

[14] See Richard Kessler, "Argentina Denies Reports of Nuclear Commerce with Iraq," *Nucle-*

onics Week, April 26, 1990, p. 13, which references Egypt and Argentina's "15-year nuclear fuel cycle cooperation agreement" signed in 1988.

[15] *Nuclear Research Reactors in the World*, International Atomic Energy Agency, IAEA-RDS-3/08, December 1994, p. 13.

[16] *Ibid*., p. 75.

[17] Such a threat is further mitigated by Egypt's lack of a reprocessing capability.

[18] See *A Special Evaluation Review of the Agency's Assistance to Developing Member States in Research Reactor Related Activities, 1980-1991*, International Atomic Energy Agency, IAEA-SER-91/19, November 22, 1991, pp. 32-38.

[19] *Ibid*.

[20] *Ibid*.

[21] A Safety Analysis Report, which often follows an outline set forth by the IAEA, evaluates the potential safety hazards associated with a reactor based on a variety of considerations, including environmental, seismic, siting, and radiation protection

[22] MENA, September 19, 1992; in FBIS-NES-92-187 (25 September 1992), p. 7.

[23] MENA, September 19, 1992, p. 14; in JPRS-TND-92-035 (23 September 1992), p. 14.

[24] Fergus Nicoll, "Egyptian Reactor Deal for Argentina," *Financial Times*, September 23, 1992, p. 8.

[25] It is worth noting that exemption from safeguards of special fissionable material (i.e., Pu-239, U-235 and U-233) is allowed under the model IAEA safeguards agreement provided the amount does not exceed one kilogram. It should be recalled that Iraq availed itself of this privilege to gain experience in spent fuel reprocessing. After repeated requests to the Agency from 1982 to 1988, Iraq succeeded in gaining IAEA agreement to exempt five fuel pins for its IRT-5000 reactor. Following the Gulf War, U.N. inspectors discovered that Iraq had irradiated one of these fuel pins in the reactor and then, using three hot cells, separated 2.26 grams of plutonium. The inspections uncovered three additional grams of plutonium that Iraq had separated in violation of its safeguards agreement with the IAEA.

[26] *Uranium: 1993 Resources, Production and Demand*, Joint Report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency, 1994, p. 133.

[27] *Mayu* (Cairo), September 25, 1989, p. 4; in JPRS-TND-89-022 (29 November 1989), p. 18.

[28] See *Nuclear Engineering International*, November 1985, p. 10, citing an August 1985 report in Egypt's semi-official daily, *al-Ahram*.

[29] *Al-Jumhuriyah* (Cairo), August 2, 1989, p. 6; in JPRS-TND-89-018 (18 September 1989), p. 24.

[30] See *Al-Musawwar* (Cairo), March 3, 1989, pp. 38-41; in JPRS-TND-89-009 (5 May 1989), p. 17; *Al-Jumhuriyah* (Cairo), August 2, 1989, p. 6; in JPRS-TND-89-018 (18 September 1989), p. 24; and *Mayu* (Cairo), September 25, 1989, p. 4; in JPRS-TND-89-022 (29 November 1989), p. 18.

[31] *Al-Sharq al-Awsat* (London), November 14, 1990, p. 10; in JPRS-TND-91-003 (25 February 1991), p. 26.

[32] Bhatia, p. 55.

[33] *Ibid*., 61.

[34] Fathi 'Ali Husayn, "*al-Ab'ad al-Amniyah wa al-Siyasiyah li Qadiyat al-Taqah al-Nawawiyah fi Misr*" ["The Political and Security Aspects of Egypt's Nuclear Energy Dilemma"], *al-Siyasah al-Dawliyah* (Cairo), October 1987, p. 157. See also Bhatia, p. 61.

[35] *Ibid*.

[36] Mohamed Shaker, "The Middle East, Israel and Iraq," paper delivered to conference, "Issues at the 1995 NPT Conference," held at Arden House Conference Centre, Harriman, New York, sponsored by the Programme for Promoting Nuclear Non-Proliferation, March 10-12, 1995, pp. 2-3.

[37] See G. Henry M. Schuler, "Egypt and Nuclear Technology: The 'Peace Dividend," Significant Issues Series, (Washington, D.C.: Center for Strategic and International Studies, 1983), pp. 11-12.

[38] U.S. Congress, House, Committee on Foreign Affairs, *Proposed United States-Egyptian Agreement for Peaceful Nuclear Cooperation: Hearing and Markup before the Committee on Foreign Affairs*, 97th Cong., 1st sess., September 10 and 17, 1981, p. 3. Statement of Harry R. Marshall, Jr., principal deputy assistant secretary, Bureau of Oceans and International Environmental and Scientific Affairs, Department of State.

[39] Egypt's efforts to produce missiles indigenously date back to the late 1950s and early 1960s, when Cairo embarked on a crash missile development program with German assistance. Three rockets were under development at that time: the 370-km range al-Zafir; the 600-km range al-Qahir; and the al-Ra'id, a two-stage rocket with a projected range of 1500 km. Although approximately 100 al-Zafir and al-Qahir missiles were produced, none reached operational service due to guidance system problems and mismanagement of the project, which was cancelled prior to the June 1967 War with Israel.

[40] *Mayu* (Cairo), September 25, 1989, p. 4; in JPRS-TND-89-022 (29 November 1989), p. 17.

[41] *Ibid*., p. 18.

[42] Bhatia, p. 55.

[43] "The Long and Winding Road to El Dabaa," *Nuclear Engineering International*, April 1987, p. 22.

[44] *Ibid*., p. 12.

[45] *Nuclear Engineering International*, June 1987, p. 30.

[46] Margaret L. Ryan, "Egypt Is again Considering Construction of Nuclear Plant," *Nucleonics Week*, September 2, 1992, p. 18.

[47] "China Tells of Possible Nuclear Plant Sales," *Washington Times*, July 31, 1992, p. A9. China's first on-line nuclear plant, the Qinshan, is a 300 MWe pressurized water reactor, which began commercial operations in May 1993.

[48] ESC Television (Cairo), July 18, 1992; in FBIS-NES-92-139 (20 July 1992), p. 11.

[49] MENA, August 23, 1992; in FBIS-NES-92-164 (24 August 1992), p. 13.

[50] Ramzy Ezzeldin Ramzy, Deputy Chief of Mission, Embassy of Egypt, Washington, D.C., telephone conversation with author, March 23, 1995.

[51] *Al-Majallah* (London), July 3, 1989, p. 35; in JPRS-TND-89-017 (29 August 1989), p. 12.

[52] "The Long and Winding Road to El Dabaa," *Nuclear Engineering International*, April 1987, p. 23. Egypt also approached the IAEA for "information on the effect of the accident on Western safety systems." See *Nuclear Engineering International*, June 1986, p. 3.

[53] Shaker, p. 2.

[54] MENA, June 9, 1990; in FBIS-NES-90-113 (13 June 1990), p. 13; and MENA, February 20, 1993; in FBIS-NES-93-035 (24 February 1993), pp. 9-10.

[55] Egypt, Working Paper on Articles III and IV of the Non-Proliferation Treaty, Non-Proliferation Treaty Conf. Doc. NPT/CONF.III/30 (1985).

[56] *Ibid*., para. 6(b). The Conference's Final Declaration did not ultimately incorporate the above language. However, it did include a statement, based on another recommendation in the Egyptian proposal, recognizing that "an armed attack on a safeguarded nuclear facility...would create a situation in which the Security Council would have to act immediately in accordance with provisions of the United Nations Charter." *Final Declaration*, Annex I, Non-Proliferation Treaty Conf. Doc. NPT/Conf.III/64/I (1985), in U.N. Department of Disarmament Affairs, Disarmament Fact Sheet No. 43, The Third Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons 14, 19 (1985).