CHAPTER 13

Israel

Nuclear Weapon Capability

Israel has an advanced nuclear weapon capability and is thought to possess enough nuclear material for between 98 and 172 nuclear weapons.[1] Israel is not a party to the Non-Proliferation Treaty and has not acknowledged that it has nuclear weapons. It is, however, indisputably regarded as a de facto nuclear-weapon state. The exact number of weapons Israel has assembled is unknown but is more likely on the lower end of the possible range. In all, Israel is thought to have produced between 391 and 687 kilograms of weapons-grade plutonium since its nuclear research reactor at Dimona started its operation in early 1964. Plutonium separated from the fuel rods in the reactor allowed Israel to complete the development of its first nuclear device by late 1966 or 1967, becoming the sixth nation in the world to do so.[2] It remains the only nation in the Middle East with nuclear weapons.

Missile and Aircraft Capability

The most capable military power in the region, Israel fields both short-range Jericho I (500 kilometers, with a 500-kilogram payload) and medium-range (1,500 kilometers) Jericho II missiles. Both missiles use solid propellant and are nuclear-capable. Israel's successful satellite launches using the Shavit space launch vehicle directly suggest that Israel could quickly develop missile platforms with much longer ranges then the Jericho II has. Development of the single-stage Jericho I missile began in the early 1960s with French assistance (a contract with the French firm Marcel Dassault for the development of the missile, under the code name MD 620) and was first deployed in 1973. Development of the two-stage Jericho II began in the mid-1970s, with first deployment in 1990. The extended range and 1,000-kilogram payload of the Jericho II makes it a likely nuclear delivery vehicle. Both missiles are land- and rail-mobile. In all, Israel is believed to have deployed 100 Jericho missiles. Israel could also deliver nuclear weapons using its F–4E Phantoms and F–16 Falcons and may also possess artillery-launched nuclear munitions. Israel also has a sizable inventory of cruise missiles that includes the U.S.-origin Harpoon, which can be launched from an aircraft, ship, or submarine. The Harpoons can travel up to 120 kilometers with a payload of 220 kilograms. In May 2000 Israel reportedly carried out a test of a new sea-launched nuclear-capable cruise missile off Sri Lanka. The missiles are said to have hit targets at a range of 1,500

kilometers.[3] It may be a variant on the Israeli Popeye Turbo air-launched cruise missile under development for possible deployment in 2002.[4]

A New Development: Sea-Launched Capability

Probably the most important nuclear-related development in Israel is the formation of its sea-based nuclear arm. By July 2000 Israel completed taking delivery of all three of the Dolphin-class submarines it had ordered at the Thyssen-Nordseewerke shipyard in Kiel, Germany. In doing so, it is widely believed, Israel moved significantly toward acquiring a survivable second-strike nuclear capability. All indications are that Israel is on the way to finalizing a restructuring of its nuclear forces into a triad, like the United States.[5]

Since the early 1980s (and probably even earlier) the Israeli navy (jointly with other governmental agencies) lobbied hard for the notion that Israel should build a small fleet of modern diesel submarines for "strategic purposes," an Israeli euphemism for a sea-launched nuclear capability. Because no American shipyard had the appropriate expertise in building modern diesel, electrical-powered, large submarines, Israel sought a German shipyard as a contractor for the project. After a complex series of negotiations, when a deal was almost signed in early 1990, it was vetoed by Gen. Ehud Barak, then Israel's chief of staff, because of cost. In 1991, in the wake of Iraqi Scud attacks against Israel during the Gulf War, the German government offered to finance the purchase of two submarines fully and to share in the financing of the third to compensate for the role that the German industry played in the development of Iraq's nonconventional weaponry. Israel immediately accepted the German offer for the first two submarines. Shortly after (apparently in a response to alarming reports on Iranian nuclear and missiles projects), it decided to purchase the third one as well. The cost of each submarine is estimated to be about $300 million dollars.

The details of the specific capabilities of the submarines, named *Dolphin*, *Leviathan*, and *Tekumah*, remain highly classified. German leaks indicate that the three 1,900-metric-ton submarines are equipped with ten 21-inch multipurpose tubes, capable of launching torpedoes, mines, and cruise missiles. While under construction in Kiel, Germany, Israel maintained tight security measures and technological oversight on the project. Many of the navigating, communication, and weapon systems in those submarines were reportedly developed, built, and assembled by the Israeli defense industries. It is also believed (but not confirmed) that the most sensitive aspect of the project, the cruise-missile technology that renders the diesel submarines nuclear-capable launching platforms, was developed and built in Israel; the submarines would have to have been assembled only after their arrival in Israel. Speaking at the ceremony for the arrival of the third submarine at its Haifa base in July 2000, the commander of the Israeli navy, Rear Adm. Yedidya Yaari, referred to the new submarine as the finest conventional submarine of its class in the world.[6] It is reported that the Israeli-made cruise missiles have the capability of hitting targets in a range of more than 900 miles.[7]

According to one report in the London *Sunday Times*, by early 2000 Israel had carried out the first launching tests of its cruise missiles, less than two years after the first submarine, *Dolphin*, was delivered to Israel. According to that report, "Elite crews have assembled to man [the submarines]. . . . Five specially selected officers solely responsible for the warheads will be added to each vessel once the missiles are operational."[8]

A strong indication that the acquisition of a sea-launched nuclear capability may be at the center of Israel's nuclear agenda are the recent key appointments in the Israeli nuclear and defense bureaucracy. In 2000 a former deputy commander of the Israeli navy, Brig. Gen. (reserve) Shaul Horev, was recruited to serve as the deputy director general of the Israel Atomic Energy Commission. Horev had previously served as a deputy director of Israel's Defense Ministry "special measures" directorate, reportedly the top-secret organization in charge of nonconventional weaponry. In early 2001, however, having served in the post of deputy director general for five months, Horev was brought back to the Defense Ministry to head the special measures directorate. The changes may also indicate the organizational friction involved.[9]

A fleet of three submarines is believed to be the minimum that Israel needs to have a deployment at sea of one nuclear-armed submarine at all times. Such a survivable deterrent is perceived as essential because of Israel's unique geopolitical and demographical vulnerability to nuclear attack, and one that no potential nuclear enemy of Israel could ignore.

Biological and Chemical Weapon Capability

Israel possesses advanced chemical and biological weapon capabilities, although it is not known what type or how many offensive agents it currently has. Israel is believed to have had sophisticated chemical and biological weapon programs for several decades, centered at the Israel Institute for Biological Research (IIBR) at Ness Ziona, 10 kilometers south of Tel Aviv. There, Israel has reportedly conducted advanced research on both chemical and biological warfare.

Lacking authoritative information, non-Israeli publications have made many claims about Israel's CBW capabilities, from the trivial to the most sensationalist.[10] The government of Israel, as part of its traditional and deliberate policy of ambiguity, has neither confirmed nor denied those reports. Acknowledging the difficulty of assessing Israel's CBW programs and capabilities, Avner Cohen recently characterized them thus: "A near-consensus exists among experts—based on anecdotal evidence and intelligence leaks—that Israel developed, produced, stockpiled, and maybe even deployed chemical weapons at some point in its history."[11] As to biological weapons, however, Cohen appears to be more cautious and tentative: "It would be logical—given the experience with Iraq—that Israel has acquired expertise in most aspects of weaponization, with the possible exception of testing. Although it is probable that Israel has maintained some sort of production capability, it is highly doubtful that Israel engages in the ongoing production or stockpiling of BW agents."[12]

A 1990 DIA study reported that Israel had an operational chemical warfare testing facility. In an oblique reference to Israel, the authoritative *Middle East Military Balance*, which is produced by the Jaffee Center for Strategic Studies in Tel Aviv, notes, "The chemical and biological capabilities of Syria, Iraq, and Iran are matched, according to foreign sources, by Israel's possession of a wide range of such weapons."[13] Israel has signed but not yet ratified the Chemical Weapons Convention and is not a party to the Biological Weapons Convention.

Nuclear Analysis

Unclassified estimates of Israel's nuclear capabilities are based in large part on former Israeli nuclear technician Mordechai Vanunu's revelations in October 1986.[14] Based on Vanunu's information about Israeli plutonium production, the London *Sunday Times* projected that Israel might have as many as 200 nuclear devices.[15] However, most experts who have attempted to harmonize Vanunu's testimony with other relevant information concluded that, given the small size of Israel's only plutonium-producing reactor, located at the Dimona research complex, Israel's nuclear inventory probably contained far fewer weapons. David Albright, Frans Berkhout, and William Walker calculated that, depending on the power level of the Dimona reactor, Israel could have produced 370–650 kilograms of weapons-grade plutonium by the end of 1999.[16] The reactor can produce between 10.6 and 18.6 kilograms of plutonium a year, thus increasing the plutonium supply by the end of 2001 to 391–687 kilograms. Assuming 4 kilograms of plutonium for each warhead, Israel could have enough material for 98–172 weapons at the beginning of 2002, with enough new material for an additional 2–4 new weapons a year. Assuming a more conservative 5 kilograms for each warhead would mean that Israel has enough material for 78–137 weapons.

Vanunu also indicated that Israel had produced tritium and lithium deuteride, suggesting that Israel may have developed "boosted" nuclear weapons, i.e., weapons that use a nuclear-fusion reaction to increase their efficiency. Since Israel is not known to have conducted any nuclear tests (with the possible exception of the 1979 "flash" off South Africa), it is assumed that it has not advanced to the point of producing thermonuclear weapons (hydrogen bombs). Israel is likely to rely on simple, proven designs that would require larger amounts of plutonium than the sophisticated U.S. or Russian designs.

Some experts, however, make different assumptions. A 1991 book by American investigative journalist Seymour Hersh argued that Israel's arsenal was considerably larger and more advanced than even Vanunu's information suggested. Relying largely on interviews with U.S. intelligence analysts and Israelis knowledgeable about the country's nuclear program, Hersh concluded that Israel possessed "hundreds" of low-yield, enhanced-radiation, "neutron"-type warheads, many in the form of artillery shells and land mines, as well as full-fledged thermonuclear weapons.[17]

A 1994 report alleged plausible new details about Israel's nuclear weapon infrastructure, identifying Nahal Soreq as the installation where Israel conducts

research on nuclear weapon design. It claimed that Israel's nuclear weapons are assembled at a facility in Yodefat, that Israel's nuclear missile base and bunker for storing nuclear gravity bombs is near Moshav Zekharya, a few kilometers from the town of Beit Shemesh, and that tactical nuclear weapons are stored at Eilabun.[18]

History

Israel's interest in establishing a national nuclear infrastructure, aimed at both security and energy, is as old as the state itself.[19] By 1955, in the wake of David Ben Gurion's return to power in Israel, Shimon Peres (then the director general of the Ministry of Defense) started to explore in earnest the feasibility of a nuclear weapon project. In 1956–1957, out of the forming of the French–Israeli military alliance that reached its climax during the Suez crisis, the Israeli nuclear weapon program was born.[20] At the time, France's socialist government, led by Guy Mollet, was deeply committed to Israel's survival. The two states confronted dangers stemming from Arab nationalism, Israel because of its isolated position in the Middle East and France because of growing unrest in French Algeria. France secretly pledged to assist Israel in developing nuclear arms and agreed to supply a sizable plutonium-producing reactor to be built at Dimona, in the Negev, 40 miles from Beersheba.[21]

In mid-1957, with French Atomic Energy Commission approval, Israel signed an agreement with the French firm of St. Gobain Techniques Nouvelles for the construction of several additional facilities at the Dimona site, including the key installation (where Vanunu would subsequently work) for extracting plutonium from the Dimona reactor's spent fuel. Soon thereafter, France also gave Israel important information on the design and manufacture of nuclear weapons themselves. Francis Perrin, the scientific head of the French Atomic Energy Commission from 1951 to 1970, was intimately involved with the French–Israeli nuclear program. In an on-the-record 1986 interview with the London *Sunday Times*, Perrin acknowledged that France had supplied the Dimona reactor and the plutonium extraction plant and that, for at least two years during the late 1950s, France and Israel had collaborated on the design and development of nuclear weapons.[22]

Recent research by Avner Cohen has revealed that the June 1967 war had an important nuclear dimension. He concludes that by late 1966 Israel had successfully completed the research and development stage of its program. During the tense days of the crisis in late May 1967, just days before the Six-Day War, Israel improvised the assembly of two deliverable nuclear devices and placed them on "operational alert."[23]

No conclusive proof exists that Israel has ever conducted a full-scale nuclear test. Its nuclear arsenal is thought to have been developed in part through the testing of non-nuclear components and computer simulations, and through the acquisition of weapon design and test information from abroad. Israel is thought, for example, to have obtained data from France's first nuclear test, which took place in 1960.[24] It may also have obtained data from U.S. nuclear

tests at approximately that time. According to a May 1989 U.S. television documentary, Israel was able to gain access to information concerning U.S. tests from the 1950s and early 1960s. The test data could have included the results of tests of U.S. boosted and thermonuclear weapons that were being developed at the time.[25]

There has been speculation, however, that a signal detected on September 22, 1979, by a U.S. VELA monitoring satellite orbiting over the South Atlantic was in fact the flash from a low-yield nuclear explosive test, possibly from a tactical nuclear weapon or from the fission trigger of a thermonuclear device. Although the official U.S. government scientific review concluded that the most likely explanation was that it was a non-nuclear event, the readings have been attributed by some to a nuclear test conducted by South Africa, and by others to Israel.

Seymour Hersh reports that "according to Israeli officials whose information about other aspects of Dimona's activities has been corroborated," the September 1979 event was indeed an Israeli nuclear weapon test and was the third of a series of tests conducted at that time.[26] The first two tests, Hersh's sources stated, were obscured by storm clouds. The claim that clouds would prevent the detection of an atmospheric nuclear detonation by a VELA satellite has been challenged, however, since the satellite is said to rely in part on infrared sensors that can penetrate cloud cover. Thus, this critical matter remains unresolved.

Motivation and Policy

Israel's pursuit of the nuclear deterrent option as the basis of national survival has been founded primarily on two factors: Israel's lack of territorial strategic depth, which makes it difficult to absorb a conventional attack and respond effectively; and the "preponderance of men and equipment" enjoyed by its Arab neighbors, almost all of whom have been hostile adversaries throughout its history. At the same time, Israel has sought to maintain a margin of qualitative conventional military superiority that would both discourage its foes from resorting to force and ensure victory without the use of nuclear arms in the event of conflict.[27]

Out of this predicament Israel's policy of nuclear ambiguity or nuclear opacity originated. It was first enunciated in a 1963 meeting of Shimon Peres, as Israel's deputy minister of defense, and President John F. Kennedy. Questioned about Israel's nuclear capabilities and intentions, Peres responded that "Israel would not be the first country to introduce nuclear weapons in the [Middle East]."[28]

Beginning in the early 1960s there was continuous friction between the United States and Israel over the question of Israel's nuclear development, culminating in Israel's refusal to join the NPT in 1968.[29] In September 1969, during an official state visit to the United States, Israeli Prime Minister Golda Meir and President Richard Nixon for the first time reached a secret understanding on this sensitive issue that brought an end to the friction. Meir explained to Nixon why Israel had developed nuclear weapons—and hence could not sign

the NPT—and why a policy of nuclear opacity (using the old formulation that "Israel will not be the first nation to introduce nuclear weapons to the Middle East") would best serve the interests of both countries. Israel also pledged not to test nuclear weapons or publicly admit to possessing them. Nixon accepted the Israeli position, recognizing that the Israeli bomb was a fait accompli, and ended American pressure on Israel to sign the NPT.[30]

The agreement put an end to a decade of unsuccessful (and at times half-hearted) U.S. efforts to halt the Israeli nuclear program. Since then all Israeli governments have adhered to the agreement. Likewise, while publicly calling on all states to sign the NPT, all subsequent U.S. administrations have not pressured Israel to give up its nuclear weapons. Israeli nuclear opacity was born and cultivated as a symbiotic U.S.–Israeli policy. Over the years, nuclear opacity has become Israel's most distinct contribution to the nuclear age.[31]

A refinement in Israel's defense posture was the Begin doctrine, which became official policy after Israel's air attack on June 7, 1981, on Iraq's plutonium-producing Osiraq research reactor. Israeli Prime Minister Menachem Begin then declared that Israel would block any attempt by adversaries to acquire nuclear weapons.[32]

During the 1980s the strategic balance in the Middle East underwent significant changes. Some Arab states undertook or accelerated programs to develop or acquire weapons of mass destruction as well as delivery systems. By the end of the decade, Saddam Hussein was boasting about Iraq's extensive ballistic missile forces and chemical weapon capabilities by declaring (in April 1990) that, if Israel attacked any Iraqi nuclear installations, he would destroy "half of Israel" with chemical weapons. (Iraq had already used chemical weapons in the Iran–Iraq war.)[33] At the same time, Iran, Libya, and Syria were expanding their chemical weapon capabilities, and some of Israel's adversaries were also pursuing the development of biological weapons.

While suspicion of Iraq's nuclear weapon program existed before the 1991 Gulf War, the scale and range of its efforts were not known. It was subsequently revealed that Iraq had embarked not only on a multi-faceted nuclear weapon development program, but also, after its invasion of Kuwait, on a crash program to develop a single nuclear device by April 1991. The emerging WMD threat was demonstrated during the 1991 Gulf War when Israeli cities and sites in Saudi Arabia were attacked by Iraqi extended-range Scud missiles. Although the attacking Scud missiles carried conventional warheads, it was later disclosed that Iraq had stockpiled chemical and biological warheads for such missiles. It is believed that some of the hidden Scud missiles were so armed. Iraq launched a total of 39 Scud missiles against Israel, causing two deaths and hundreds of injuries.[34]

The 1991 Gulf War also demonstrated the difficulties of identifying and striking facilities involved in clandestine proliferation programs. In spite of a massive air campaign, much of Iraq's nuclear weapon infrastructure remained intact. Several nuclear installations had not been identified by the United States or its partners. In some cases, attacked nuclear-related facilities suffered only slight damage, allowing the Iraqis to remove and hide equipment. It was left to

the IAEA to discover, in a painstaking effort, the magnitude of the Iraqi nuclear program. The case of Iraq raises important questions over the practicality of the Begin doctrine in the future if potential nuclear infrastructure targets are too distant, hidden too well, and too numerous to be destroyed by air attacks.[35]

Strategic Analysis: A Perspective on Arms Control

The "tacit collaboration between Israel and the Arab members of the anti-Iraq coalition" before and during the Gulf War provided an impetus for the initiation of a peace process in the region, raising the prospect of a transition to arms control.[36] The Middle East Peace Conference, which opened in Madrid on October 30, 1991, under the sponsorship of the United States and the Soviet Union, began sets of bilateral talks between Israel and its neighbors aimed at a comprehensive peace in the region. An additional multi-lateral component of this process was the establishment of five working groups to address regional issues of common interest, one being the Arms Control and Regional Security (ACRS) working group. However, major Israeli antagonists in the region, such as Iran and Syria, did not participate in the talks. The talks were suspended in early 1995 with very limited, if any, concrete accomplishments.

In the context of the April 1995 NPT Review and Extension Conference, the Arab states, led by Egypt, attempted but failed to pressure Israel into renouncing its nuclear option. At the fourth Preparatory Committee (PrepCom) session of the Review and Extension Conference in January 1995, Egypt, as well as Algeria, Libya, and Syria, issued statements indicating that they would consent to an indefinite extension of the NPT only after Israel had agreed to accede to the treaty.[37] Israel's response was embodied in Foreign Minister Shimon Peres' exchange with Egyptian Foreign Minister Amr Mussa: Peres explained that Israel would agree to a nuclear-weapon-free zone (NWFZ) in the Middle East two years after the conclusion of a comprehensive peace accord between all states in the region, including Iran.

From Israel's point of view, security conditions deteriorated rapidly both internally and regionally from 1995 to the end of 2001. During that period, as ballistic missile threats increased, Israel accelerated its development of active ballistic missile defenses. Deploying missile defenses will require an adaptation of Israel's traditional doctrine of "offensive defense." Israel's postulated threat was amplified by Syrian tests of advanced 600-kilometer Scud–C missiles, a system capable of striking Israeli sites from deep within Syria, and possibly with chemical and biological weapons. Iran also posed an increasingly serious threat. In addition to its stockpile of chemical weapons, substantial biological warfare program, and efforts to acquire nuclear weapons, information surfaced that Iran was developing Shahab missiles, with ranges of up to 2,000 kilometers, that would enable Iran to target Israel for the first time (see chapters 5 and 15). Moreover, Israel believed that it continued to face missile threats from Libya, Egypt, Saudi Arabia, and possibly Iraq.

At the same time, the collapse of the peace process established by the 1993 Oslo accords not only undermined efforts to resume the regional arms control

talks but also created a deeply pessimistic mood among the Israeli public about peace with anyone. Efforts by Israeli Prime Minister Ehud Barak and Palestinian Authority Chairman Yasser Arafat to negotiate an accord showed promise throughout 1999 but stalled at the end of 2000. A provocative visit by Likud party leader Ariel Sharon to the Temple Mount in September 2000 ignited a new intifada. Since then, hundreds of Palestinians and Israelis have been killed, with only faint prospects in sight for a peaceful resolution to the conflict.

Israel signed the Comprehensive Nuclear Test Ban Treaty on September 25, 1996, the only one of the three non-NPT nuclear-weapon states to do so. From the Israeli perspective, its adherence to the CTBT and its earlier signing of the Chemical Weapons Convention demonstrated Israel's interest in arms control regimes with reliable verification systems that are not subject to abuse or frivolous requests. According to this view, Israel's arms control credentials and policies were also reflected in the active role it played in the negotiations of the CTBT as a primary participant in the drafting of the accord; in its co-sponsorship of the United Nations resolution that opened the CTBT for signature; and in the fact that it was one of its first signatories.[38]

In the early 1990s, both the Bush administration in 1991 and subsequently the Clinton administration in 1993 made proposals to ban the further production of fissile materials for weapons both in the Middle East and globally. The impetus for the 1991 Bush regional proposal was the perception that the "fissban" idea, in addition to the effort to disarm Iraq, could be an important milestone toward an eventual nuclear free zone in the Middle East. In the wake of the Gulf War, it was evident that Israel had to be a part of any effort to reduce the nuclear threat in the Middle East. In this context, advocates of a fissban argued that it offered a realistic compromise: a limited but real constraint on the Israeli nuclear program, coupled with an implicit legitimization of Israel's nuclear status. In 1993 the Clinton administration modified the Bush proposal, calling for a global fissile material cut-off treaty that would ban the further production of plutonium and highly enriched uranium for nuclear weapons as well as the production of such materials outside IAEA safeguards. The cut-off proposal would permit the five nuclear-weapon states and the three de facto nuclear powers (India, Israel, and Pakistan) to retain their existing stocks of unsafeguarded fissile material.[39]

In the early 1990s the Israel government refrained from making an official and public response to the Bush and Clinton initiatives to limit the production of weapons-grade fissile material. Unofficially, however, Israeli officials expressed reservation about the proposals but were careful not to reject them outright. The main concern was that the constraints imposed by the fissban, together with the associated verification modalities, would put Israel on a slippery slope leading to the demise of nuclear opacity and to increased pressure to abandon its nuclear arsenal entirely.[40]

By the mid-late 1990s, following the collapse of ACRS, Israeli opposition to the fissban proposal grew firmer. In 1998 Prime Minister Netanyahu told (and wrote to) President Clinton in unequivocal language that Israel cannot accept

the fissban proposal. According to Aluf Benn, *Ha'aretz*'s diplomatic correspondent, in two letters and several conversations Netanyahu told Clinton: "We will never sign the treaty, and do not delude yourselves, no pressure will help. We will not sign the treaty because we will not commit suicide."[41]

Despite India's and Pakistan's declarations of nuclear weapons in 1998, it is unlikely that Israel will follow suit or change its policy of nuclear ambiguity. It appears that only a dramatic change in the nuclear status of Iran or Iraq could trigger a change in the Israeli position. Israeli decision makers will also continue to hold the view, however, that for as long as adversaries in the Middle East region maintain the capability to mount large-scale military attacks against Israel or to threaten Israeli cities with missiles carrying chemical or biological warheads, Israel will need to maintain the nuclear deterrence option. In some respects, one Israeli observer argues, Israel's nuclear posture may have been better understood internationally as a result of its controversy with Egypt before and during the course of the 1995 Review and Extension Conference. In his view, the conflict forced Rabin, Peres, and other Israeli leaders to articulate for the first time "links between the maintenance of the nuclear capability and the continued threats to national survival, linked to the military, geographic and demographic asymmetries in the region."[42]

From the Israeli perspective, a substantive discussion of regional arms control issues is inextricably linked to the achievement of a comprehensive Middle East peace settlement. Such a settlement, however, is unlikely any time soon.

Missile Analysis

Israel currently deploys two nuclear-capable ballistic missile systems: the Jericho I and Jericho II. Up to 50 Jericho I solid-fuel, two-stage missiles with an approximate range of 660 kilometers are thought to be deployed in shelters on mobile launchers, possibly at a facility located midway between Jerusalem and the Mediterranean. The Jericho II solid-fuel, two-stage missile can travel an estimated 1,500 kilometers. Commercial satellite photos indicate that the missile base between Jerusalem and the Mediterranean was enlarged between 1989 and 1993 to allow for Jericho II deployment. Furthermore, a Lawrence Livermore Laboratory study indicates that Israel's Shavit space launch vehicle could be modified to carry 500 kilograms over 7,800 kilometers, in effect giving it the capability of an intercontinental ballistic missile.[43]

Israel now deploys the Arrow II anti-ballistic missile system in a missile battery about 30 miles south of Tel Aviv. The $1.6 billion Arrow system will attempt to intercept short-range Scud-type missiles just as they start reentering the atmosphere after reaching the highest point of their flight trajectory. The program is a joint U.S.–Israeli undertaking begun in 1988 and now sponsored by the U.S. Ballistic Missile Defense Organization. Israel would like to have a fully operational system by 2005, deploying another battery in northern Israel and one more in the south. The system would link operations with Patriot air-defense units.

Israel is also experimenting with another missile interceptor, the Moab, funded in part by the U.S. Ballistic Missile Defense Organization. This system

will try to intercept Scud-like missiles soon after launch with an air-to-air missile fired from an unmanned aerial vehicle flying at high altitude. Israel is also developing jointly with the United States the Nautilus, a fixed-site high-energy laser capable of shooting down short-range artillery rockets. This system is intended for deployment, in the near term, in Israel's northern regions to help protect against Hezbollah-directed Katyusha rocket attacks on Israel from southern Lebanon. The follow-on mobile version would be the tactical high-energy laser (THEL) system.

Israel's unmanned aerial vehicle program has been extended to cover cruise missile development, including land-attack cruise missiles (LACM). Reportedly, Israel has three platforms: the Popeye 1, with a range of 100 kilometers and carrying a payload of 360 kilograms; the Delilah, with a 400-kilometer range and a 450-kilogram payload; and the Popeye 3, with a 350-kilometer range and a 360-kilogram payload. The Delilah is said to have been developed with Chinese cooperation, and Israel's armament industries are believed to have extensive ties, including projected cruise missile cooperation with China, India, South Korea, and Turkey.

Notes

1. Extrapolated from David Albright, Frans Berkhout, and William Walker, *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities, and Policies* (Oxford: Oxford University Press for Stockholm International Peace Research Institute, 1997), p. 263.
2. Avner Cohen, *Israel and the Bomb* (New York: Columbia University Press, 1998), pp. 239 and 273–276.
3. Uzi Mahnaimi and Matthew Campbell, "Israel Makes Nuclear Waves with Submarine Missile Test," *Sunday Times* (London), June 18, 2000.
4. Federation of American Scientists web site, *Israel Special Weapons Guide*, www.fas.org/nuke/guide/israel/missile/popeye-t.htm.
5. See Reuven Pedatzure, "Completing the Deterrence Triangle," Carnegie Proliferation Brief, vol. 3, no.18, June 29, 2000. Available at www.ceip.org/npp.
6. *Ha'aretz*, July 26, 2000.
7. Mahnaimi and Campbell, "Israel Makes Nuclear Waves."
8. Ibid.
9. Aluf Benn, "An Open and Shut Case: Should Israel's Nuclear Policy Continue To Be Kept under Wraps?" *Ha'aretz*, September 26, 2001 (English Internet edition).
10. Many of these sensationalist stories appeared in the *Sunday Times* (London). One of these stories cites a biologist who once held a senior post in the Israeli intelligence as saying that "there is hardly a single known or unknown form of chemical or biological weapon, which is not manufactured at the Institute." Uzi Mahnaimi, "Israeli Jets Equipped for Chemical Warfare," *Sunday Times* (London), October 4, 1998. See also, "Israel's Secret Institute," *Foreign Report*, August 20, 1998; "Israel's Nes[s] Ziona Mystery," *Foreign Report*, February 5, 1998.
11. Avner Cohen, "Israel and CBW: History, Deterrence, and Arms Control," *Nonproliferation Review*, fall 2001, pp.1–20.
12. Ibid.
13. Shai Feldman and Yiftah Shapir, eds., *The Middle East Military Balance 2000–2001*, Jaffee Center for Strategic Studies, Tel Aviv University (Cambridge: MIT Press, 2001), p. 67.
14. "Revealed: The Secrets of Israel's Nuclear Arsenal," *Sunday Times* (London), October 5, 1986.

15. In light of what is known about Israel's nuclear infrastructure, it has long been assumed that its weapons use plutonium rather than highly enriched uranium for their cores.
16. This extrapolation is based on the assumption that the Dimona reactor has been operating reliably at a power level of between 40 and 70 MWt and has not experienced any significant shutdowns nor extended operation at its theoretical upper limit of 150 MWt. See Albright, Berkhout, and Walker, *Plutonium and Highly Enriched Uranium 1996*, pp. 259 and 262; the authors assume in their calculations that Israel uses 5 kg of plutonium for each warhead. The authors of this volume assume that Israel uses 4 kg for each warhead.
17. Seymour Hersh, *The Samson Option* (New York: Random House, 1991), pp. 291, 312, and 319.
18. Harold Hough, "Israel's Nuclear Infrastructure," *Jane's Intelligence Review*, November 1994, p. 508.
19. Cohen, *Israel and the Bomb*, pp. 9–31.
20. Ibid., pp. 41–55.
21. Cohen, *Israel and the Bomb*, chapter 4, pp. 57–68; Leonard Spector, *The Undeclared Bomb* (Cambridge: Ballinger, 1988), pp. 165–187; Pierre Pean, *Les Deux Bombes* (Paris: Fayard, 1981), chapters 5, 7, and 8.
22. "France Admits It Gave Israel A-Bomb," *Sunday Times* (London), October 12, 1986.
23. Cohen, *Israel and the Bomb*, pp. 273–276.
24. Steven Weissman and Herbert Krosney, *The Islamic Bomb* (New York: Times Books, 1981), p. 114.
25. "Israel: The Covert Connection," *Frontline*, PBS Network, May 16, 1989.
26. Hersh, *The Samson Option*, p. 271.
27. Cohen, *Israel and the Bomb* (esp. chapters 1, 12, and 17); Gerald Steinberg, "The Future of Nuclear Weapons: Israeli Perspectives," paper presented at the Ninth Amaldi Conference on Security Questions at the End of the Twentieth Century, Geneva, Switzerland, November 21–23, 1996; revised November 25, 1996.
28. Cohen, *Israel and the Bomb*, pp. 118–119; Barbara Opall, "Peres: Keep Nuclear Details Secret," *Defense News*, July 29–August 4, 1996, p. 3.
29. Cohen, *Israel and the Bomb* (chaps. 5–7, 9–11, and 16–17).
30. Ibid., pp. 336–338; Aluf Benn, "Open Secrets: The Struggle To Keep Nuclear Capabilities Secret," *Ha'aretz*, September 14, 1999 (English Internet edition).
31. Ibid., pp. 341–344; Benn, "Open Secrets."
32. Leonard Spector, with Jacquelin Smith, *Nuclear Ambitions* (San Francisco: Westview Press, 1990), pp. 167 and 188.
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Table 13.1: **Israel: Nuclear Infrastructure**

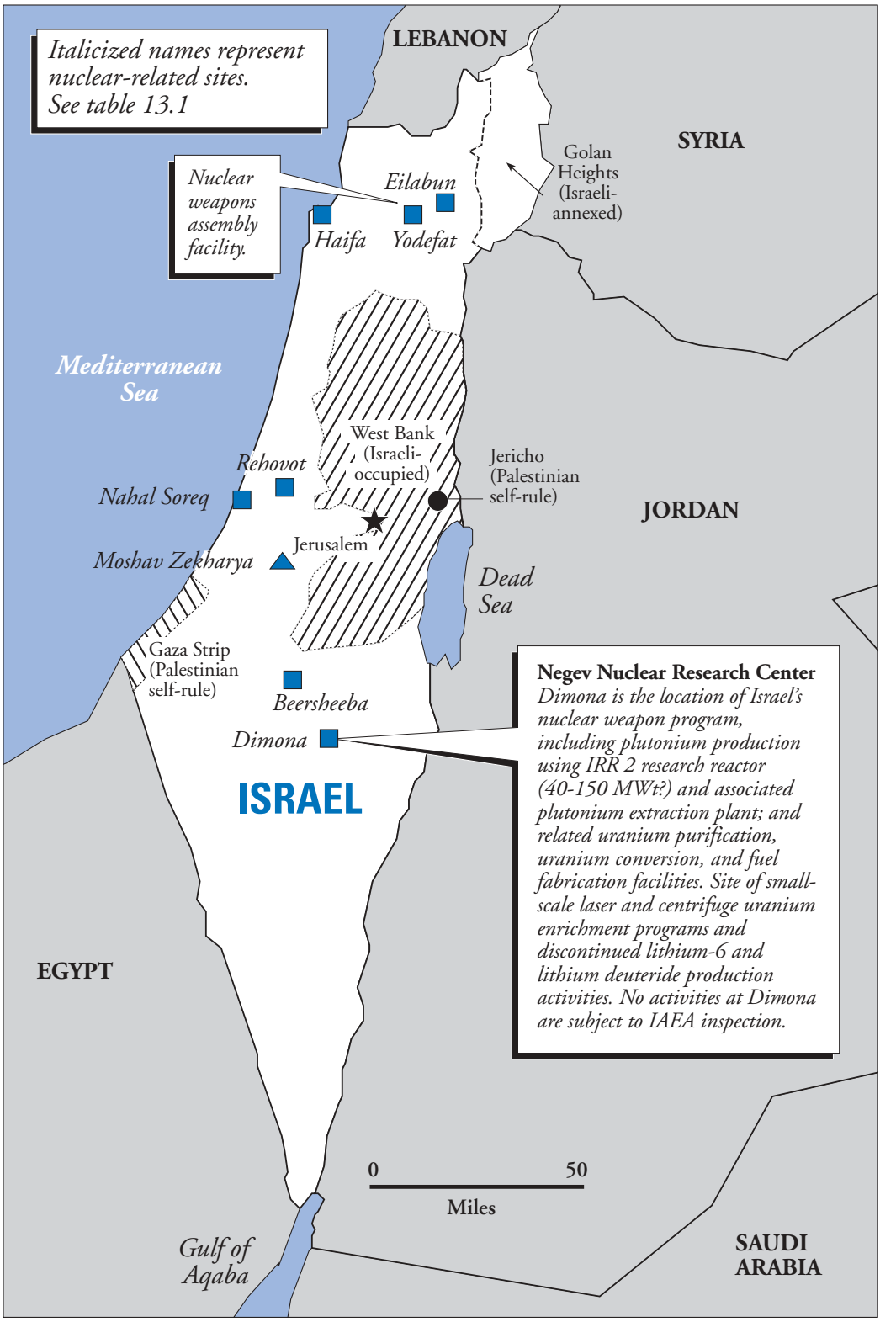
Name/Location of Facility	Type/ Status	IAEA Safeguards
NUCLEAR WEAPONS COMPLEX		
Negev Nuclear Research Center, Dimona	Plutonium production research reactor and plutonium extraction facilities (see below) and other weapon-related infrastructure	No
Moshav Soreq	Nuclear weapon research and design facility	No
Yodefat	Nuclear weapon assembly facility	No
Moshav Zekharya	Nuclear missile base and gravity bomb storage facility	No
Eilabun	Tactical nuclear weapon storage facility	No
RESEARCH REACTORS		
IRR 1, Nahal Soreq	Light-water, pool, HEU, 5-MWt; operating	Yes
IRR 2, Dimona	Heavy-water, nat. U, 40–150-MWt; No operating*	
URANIUM ENRICHMENT		
Dimona	Experimental/pilot-scale (?) laser and centrifuge-enrichment programs; operating	No
REPROCESSING (PLUTONIUM EXTRACTION)		
Dimona	Operating	No
Nahal Soreq	Pilot-scale; operating	No
URANIUM PROCESSING		
Negev area, near Beersheeba	Uranium phosphate mining; operating	N/A
Haifa	Yellowcake produced in two phosphate plants; operating	N/A
Southern Israel	Yellowcake produced in phosphate plant; operating	N/A
Dimona	Uranium purification (UO_2), uranium conversion (UF_6), and fuel-fabrication facility; all operating	No
HEAVY–WATER PROCESSING		
Rehovot	Pilot-scale plant; operating	No
TRITIUM, LITHIUM DEUTERIDE		
Dimona	Lithium–6 production, allowing the production of both tritium and lithium deuteride; decommissioned	No

Abbreviations

HEU	highly enriched uranium	MWt	millions of watts of thermal output
LEU	low-enriched uranium	kWt	thousands of watts of thermal output
nat. U	natural uranium	N/A	not applicable
MWe	millions of watts of electrical output		

NOTE

* Estimates of the reactor's capacity varies widely. For a good discussion of the reactor power mystery, see David Albright, Frans Berkhout, and William Walker, *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities, and Policies* (Oxford: Oxford University Press, 1997), pp. 257–264.



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