

Proliferation Rings

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New Challenges to the Nuclear Nonproliferation Regime

The nuclear programs of the Democratic People's Republic of Korea (DPRK), Iran, and Pakistan provide the most visible manifestations of three broad and interrelated challenges to the nuclear nonproliferation regime. The first is so-called latent proliferation, in which a country adheres to, or at least for some time maintains a façade of adhering to, its formal obligations under the Nuclear Nonproliferation Treaty (NPT) while nevertheless developing the capabilities needed for a nuclear weapons program.¹ That country can then either withdraw from the NPT and build actual weapons on short notice, or simply stay within the NPT while maintaining the latent capability for the rapid realization of nuclear weapons as a hedge against future threats. This was the path followed by the DPRK with its plutonium program and one that is likely being followed by Iran and more subtly by others. The second broad challenge is first-tier nuclear proliferation, in which technology or material sold or stolen from private companies or state nuclear programs assists nonnuclear weapons states in developing illegal nuclear weapons programs and delivery systems.² The third challenge—the focus of this article—is second-tier nuclear proliferation, in which states in

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1. For a discussion of latent proliferation in the context of Iran, see George Perkovich, "Dealing with Iran's Nuclear Challenge" (Washington, D.C.: Carnegie Endowment for International Peace, April 28, 2003), <http://www.ceip.org/files/projects/npp/pdf/Iran/iraniannuclearchallenge.pdf>. In January 2004 President Mohammad Khatami of Iran gave public assurances that Iran's nuclear program is peaceful, stated that Iran "vehemently" opposed production of nuclear arms, and denied that Iran had received nuclear material from the DPRK. See "Iran Denies Receiving Nuclear Material from North Korea," Agence France-Presse, Davos, Switzerland, January 21, 2004, <http://www.spacewar.com/2004/040121200135.i5cph0v8.html>.

2. First-tier or primary proliferation may be defined as the spread of nuclear weapons-relevant material from states or private entities within states that are members of the formal nuclear exporters groups, the Nuclear Exporters Committee (or Zangger Committee) or the Nuclear Suppliers Group. Second-tier suppliers are other states or private entities within states that may be supplying nuclear weapons-relevant material on the international market.

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the developing world with varying technical capabilities trade among themselves to bolster one another's nuclear and strategic weapons efforts.

In the DPRK, Iranian, and Libyan uranium programs, and possibly other national programs, second-tier proliferation centered on Pakistan has exacerbated the threat of latent proliferation. In the Iranian, Libyan, and Pakistani missile programs, and possibly other national programs, missile proliferation activities emanating from the DPRK have further raised the stakes. All three proliferation challenges are interrelated, and the missile and nuclear weapons clandestine supply rings have been intertwined. These issues must be addressed if the nonproliferation regime is to survive. Here we analyze, in light of recent revelations out of Iran, Libya, Malaysia, Pakistan, South Africa, Turkey, and other nations, the dynamics of second-tier proliferation of nuclear technologies, weapons designs, and delivery systems, and their interactions with latent and first-tier proliferation. Second-tier proliferation, in particular, poses a strong challenge to the supply-side approaches that have traditionally been central to the existing nonproliferation regime.

Evidence for the exchange of nuclear weapons-related and missile technologies among several developing countries suggests that we are entering a world in which a growing number of such countries will be able to cut themselves free from the existing nonproliferation regime. We dub these networks of second-tier proliferators "proliferation rings." The full development of such proliferation rings, unless checked, will ultimately render the current export control regimes moot, as developing countries create nuclear-weapons and delivery systems technologies and manufacturing bases of their own, increasingly disconnect from first-tier state or corporate suppliers, and trade among themselves for the capabilities that their individual programs lack. Along the way, technology transfer among proliferating states will also cut the cost of and the period to acquisition of nuclear weapons and missile capabilities, as well as reduce the reaction time of the overall nonproliferation regime.

Concern over second-tier proliferation is hardly new.³ What is new is that the modalities of the proliferation routes are much more extensive than previ-

3. Analyses of second-tier proliferation prior to the 1990s include those in Joseph Pilat and William Potter, eds., *The Nuclear Suppliers and Nonproliferation* (Lexington, Mass.: Lexington Books, 1985); Leonard Spector, with Jacqueline Smith, *Nuclear Ambitions: The Spread of Nuclear Weapons, 1989–1990* (San Francisco, Calif.: Westview, 1990), pp. 29–48; and William Potter, ed., *International Nuclear Trade and Nonproliferation: The Challenge of Emerging Suppliers* (Lexington, Mass.: Lexington Books, 1990).

ously recognized; the spread of technological know-how and manufacturing capabilities is wider than hitherto believed; and such proliferation has undeniably had a major impact on the nuclear weapons and missile programs of several developing countries. In 1990 it was still possible to argue that second-tier suppliers' capabilities were at the lower end of the nuclear export spectrum, and that the export actions these suppliers did undertake were for the most part cautious.⁴ Both claims manifestly no longer apply. We now find that proliferation ring members support one another either directly at the state-to-state level or indirectly through once-removed private sector supplier networks. In addition, "rings" of clandestine exchanges of technologies have begun to interact and support one another.

An effective response to the proliferation challenge must address both the supply and demand sides of the problem. Addressing the supply side continues to require limiting the transfer of nuclear weapons-grade material or nuclear weapons technology from first-tier suppliers to potential proliferators, in addition to addressing second-tier proliferation. Addressing the demand side necessitates confronting the balance of factors that states take into consideration when deciding their nuclear-weapons and missile delivery systems policies.⁵

Supply-side action requires increasing the security of nuclear weapons-grade material in the former Soviet Union (FSU) and elsewhere. If continuing efforts in the Cooperative Threat Reduction (CTR) program are successful, and with the expansion of this program to include other poorly protected fissile material, the challenge of nuclear theft and smuggling should recede over time, provided an ongoing commitment of the Group of Eight (G-8) countries,

4. See Lewis Dunn, "The Emerging Nuclear Suppliers: Some Guidelines for Policy," in Potter, *International Nuclear Trade and Nonproliferation*, p. 398. Dunn notes the exception of China to his statement that "the emerging suppliers have so far acted relatively cautiously as nuclear exporters."

5. There is an extensive literature on the reasons countries choose to develop nuclear weapons, including Mitchell Reiss, *Bridled Ambition: Why Countries Constrain Their Nuclear Capabilities* (Baltimore, Md.: Johns Hopkins University Press, 1995); Scott D. Sagan, "Why Do States Build Nuclear Weapons? Three Models in Search of a Bomb," *International Security*, Vol. 21, No. 3 (Winter 1996/97), pp. 54–86; George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation* (Los Angeles: University of California Press, 1999), pp. 444–468; Peter Liberman, "The Rise and Fall of the South African Bomb," *International Security*, Vol. 26, No. 2 (Fall 2001), pp. 45–86; Ariel Levite, "Never Say Never Again: Nuclear Reversal Revisited," *International Security*, Vol. 27, No. 3 (Winter 2002/03), pp. 59–88; and Kurt M. Campbell, Robert J. Einhorn, and Mitchell B. Reiss, *The Nuclear Tipping Point: Why States Reconsider Their Nuclear Choices* (Washington, D.C.: Brookings, 2004).

the FSU, and other states.⁶ In addition to a robust and successful CTR program, the various export control regimes must also be strengthened and deepened.⁷ Yet second-tier proliferation may nevertheless increase in scope and sophistication, as members of proliferation rings acquire the resources for, and master the technologies of, weapons manufacture and delivery systems production among themselves. If networks (or rings) of third world nations able to swap nuclear weapons-relevant and missile systems-relevant technologies expand, nonproliferation policies focused on first-tier supply will become less relevant, and demand-side approaches will correspondingly increase in importance.

In addition to the supply-side “push” to proliferation, proliferation “pull” involves a number of demand-side factors. These include regional security and national prestige, requiring responses that go well beyond the NPT itself. Nevertheless, the nonproliferation regime plays an important role in framing the balance of factors that states consider when determining their nuclear weapons policies. As currently structured, however, the regime presents potential proliferators with a skewed set of positive and negative inducements regarding compliance versus noncompliance. If the nuclear nonproliferation regime is to be preserved, a better balance must be struck: one that increases the benefits of adhering to the regime, decreases the negative consequences of adherence, makes clear the negative impact of abandoning the regime, and reassures adherents that the regime protects them against adversaries’ nuclear ambitions.

In this article we explore, to the extent possible from sources in the open literature, the interactions among the DPRK, Iranian, Libyan, and Pakistani nuclear technologies, weapons, and missile programs, and discuss the implications of these interactions for the nuclear nonproliferation regime. In this light, we then consider policy options to address second-tier proliferation, beginning with needed incremental improvements to the current regime, an analysis of the more ambitious proposals made in 2003 and 2004 by U.S. President George

6. For a review of CTR programs, see Matthew Bunn, Anthony Wier, and John P. Holdren, *Controlling Nuclear Warheads and Materials: A Report Card and Action Plan* (Cambridge, Mass.: Nuclear Threat Initiative and Project on Managing the Atom, Belfer Center for Science and International Affairs, John F. Kennedy School of Government, Harvard University, 2003); for an update, see Matthew Bunn and Anthony Wier, *Securing the Bomb: An Agenda for Action* (Cambridge, Mass.: Nuclear Threat Initiative and Project on Managing the Atom, Belfer Center for Science and International Affairs, John F. Kennedy School of Government, Harvard University, 2004).

7. For a summary and evaluation of export control regimes, see U.S. General Accounting Office (GAO), *Nonproliferation Strategy Needed to Strengthen Multilateral Export Control Regimes* (Washington, D.C.: U.S. GAO, October 2002), <http://www.state.gov/documents/organization/14867.pdf>.

W. Bush and by Director General Mohamed ElBaradei of the International Atomic Energy Agency (IAEA), as well as further supply-side and demand-side measures.

Intersecting Missile and Uranium Enrichment Rings

Evidence for significant interactions among the DPRK, Iranian, and Pakistani nuclear and missile programs has accumulated in the past several years, and details of links with Libya and other countries have recently also come to light. Any discussion of how the nonproliferation regime might better respond to second-tier proliferation in the future must begin with an understanding, albeit imperfect, of the actions taken by and motivations of the proliferating state and substate actors that have brought the regime to the crisis it currently faces.

THE NORTH KOREAN PLUTONIUM PROGRAM

The North Koreans began reprocessing plutonium in 1989, using their 5 MW(e) graphite-moderated reactor and “radiochemical laboratory”—a medium-size reprocessing plant located at the Yongbyon nuclear center about 100 kilometers north of Pyongyang.⁸ The DPRK reactors are thought to be based on the British 1950s’ Calder Hall-type reactors that the DPRK built using information available in the technical literature. IAEA inspections of the Yongbyon site in 1992 uncovered the diversion of several kilograms of plutonium following the reprocessing of spent fuel.⁹

The signing of the Agreed Framework between the United States and the

8. The abbreviation MW(e) stands for “megawatt electric.” A megawatt, or 1 million watts, is a unit of power; 1,000 MW(e) is a typical electrical power output for a large commercial power reactor. MW(e) measures the electrical power output of the plant, as opposed to MW(th), or “megawatt thermal,” which measures the plant’s thermal power. The plant’s thermal output is converted, at an efficiency cost, into electrical power. For terminology and basic reactor physics, see Richard L. Garwin and Georges Charpak, *Megawatts and Megatons: A Turning Point in the Nuclear Age?* (New York: Alfred A. Knopf, 2001).

9. For descriptions of the DPRK plutonium program, see David Albright and Kevin O’Neill, eds., *Solving the North Korean Nuclear Puzzle* (Washington, D.C.: Institute for Science and International Security Press, 2000); Michael M. May, Chaim Braun, George Bunn, Zachary Davis, James Hassberger, Ronald Lehman, Wayne Ruhter, William Sailor, Robert Schock, and Nancy Suski, *Verifying the Agreed Framework*, CGSR-CISAC report (Stanford, Calif.: Center for Global Security Research and Center for International Security and Cooperation, Stanford Institute for International Studies, Stanford University, April 2001), <http://cisac.stanford.edu/publications/12020/>; and Jonathan Pollack, “The United States, North Korea, and the End of the Agreed Framework,” *Naval War College Review*, Vol. 56, No. 3 (Summer 2003), pp. 11–49.

DPRK in October 1994 froze the DPRK's ability to further reprocess the spent fuel from the 5 MW(e) reactor, but not before the DPRK extracted adequate plutonium for at least two nuclear weapons, according to published CIA estimates.¹⁰ Whether the DPRK has successfully manufactured nuclear warheads from this extracted plutonium remains uncertain.¹¹

In December 2002 the DPRK withdrew from the NPT, removed the monitoring devices installed by the IAEA on the Yongbyon facilities, and dismissed the IAEA's safeguards inspectors.¹² The DPRK restarted the 5 MW(e) reactor in March 2003 and prepared for the restart of the radiochemical laboratory, facilitated, according to unnamed U.S. officials, by the acquisition of twenty tons of tributylphosphate organic solvent from a Chinese company.¹³

At the time of the signing of the Agreed Framework, the DPRK had a total of 8,000 spent fuel rods that would be subject to IAEA monitoring. Reprocessing this stockpile would provide adequate plutonium for perhaps six additional nuclear warheads.¹⁴ In January 2004 an unofficial U.S. delegation visited the DPRK and saw that the 8,000 rods had been removed from their storage pond; DPRK scientists claimed that these had been entirely reprocessed during a six-month work campaign.¹⁵

Operation of the 5 MW(e) reactor will produce enough plutonium for one additional weapon per year. Were the DPRK to complete construction of two

10. Central Intelligence Agency, *Unclassified Report to Congress on the Acquisition of Technology Related to Weapons of Mass Destruction and Advanced Conventional Munitions, 1 July through 31 December 2001*, http://www.nti.org/e_research/official_docs/cia/cia_cong_wmd.pdf. See also David Albright, "North Korea's Current and Future Plutonium and Nuclear Weapons Stocks," *ISIS Issues Brief* (Washington, D.C.: Institute for Science and International Security, January 15, 2003).

11. For a discussion of inconsistencies in recent unclassified intelligence assessments of whether the DPRK has produced nuclear warheads from its extracted plutonium, see Pollack, "The United States, North Korea, and the End of the Agreed Framework." A.Q. Khan, a key figure in the Pakistani nuclear program, reportedly told Pakistani authorities that he was shown what he believed to be three nuclear warheads during a visit to the DPRK in 1999. See David E. Sanger, "Pakistani Tells of North Korean Nuclear Devices," *New York Times*, April 13, 2004.

12. IAEA, "Fact Sheet on DPRK Nuclear Safeguards" (Vienna: IAEA, May 2003).

13. See "Allies Discuss N. Korea Nuke Move," *CNN.com*, <http://www.cnn.com/2002/WORLD/asiapcf/east/12/22/n.korea.nukes/>; and John Pike, "Yongbyon," <http://www.globalsecurity.org/wmd/world/dprk/yongbyon.htm>.

14. For periodically updated reviews of the DPRK nuclear program, see Larry A. Niksch, "North Korea Nuclear Weapons Program," Congressional Research Service (CRS) Issue Brief for Congress, IB 91141 (Washington, D.C.: CRS, August 23, 2003); and Sharon A. Squassoni, "North Korea's Nuclear Weapons: How Soon an Arsenal?" Congressional Research Service Report for Congress, RS21391 (Washington, D.C.: CRS, February 2, 2004).

15. See Siegfried S. Hecker, "Visit to the Yongbyon Nuclear Scientific Research Center in North Korea," statement before the Senate Committee on Foreign Relations, 108th Cong., 2d sess., January 21, 2004.

other partially built reactors—a 50 MW(e) reactor at Yongbyon and a 200 MW(e) reactor at Taechon—these could produce adequate plutonium for thirty to fifty nuclear weapons per year, depending on North Korea’s reprocessing capacity.¹⁶ The January 2004 U.S. delegation reported, however, that the larger Yongbyon reactor seemed to be in a state of extensive disrepair; this might also hold for the Taechon reactor. One of the U.S. fears about the DPRK’s weapons stockpile is that, while a few warheads might be held in reserve as an ultimate guarantee of regime survival, a larger number of warheads could be viewed by the regime as sufficient to permit it to conduct nuclear testing or to sell nuclear material (or even warheads) on the black market.¹⁷ Currently it seems most probable, though hardly certain, that the DPRK plutonium-based stockpile will increase at only one warhead per year. The remaining source of uncertainty is the status of the DPRK’s clandestine uranium enrichment program.

PAKISTAN AND THE NORTH KOREAN URANIUM ENRICHMENT PROGRAM

The Bush administration stated in October 2002 that the DPRK had acknowledged having a uranium enrichment program.¹⁸ Evidently, subsequent to the

16. For the potential rate of accumulation of fissile materials within the DPRK nuclear program, see Henry Sokolski, “Beyond the Agreed Framework: The DPRK’s Projected Atomic Bomb Making Capabilities, 2002–2009” (Washington, D.C.: Nonproliferation Education Center, December 3, 2002), <http://www.npec-web.org/pages/fissile.htm>; and Jon B. Wolfsthal, “Estimates of North Korea’s Unchecked Nuclear Weapons Production Potential,” write-up (Washington, D.C.: Carnegie Endowment for International Peace, August 2003).

17. According to unnamed U.S. officials, a DPRK delegate to talks with the United States in Beijing in April 2003 threatened (in a corridor conversation outside the meeting) that North Korea might export or test a nuclear weapon. See Glenn Kessler, “N. Korea Says It Has Nuclear Arms: At Talks with U.S. Pyongyang Threatens ‘Demonstration’ or Export of Weapon,” *Washington Post*, April 25, 2003. Two different unnamed officials, however, warned that the North Korean official’s words were vague. “No one talked about testing directly, or selling,” one official stated. Rather, “there was language about ‘taking physical actions.’” Quoted in David E. Sanger, “North Korea Says It Now Possesses Nuclear Arsenal,” *New York Times*, April 25, 2003. For an analysis of mistranslations and misunderstandings of North Korean assertions, see Daniel A. Pinkston and Phillip C. Saunders, “Seeing North Korea Clearly,” *Survival*, Vol. 45, No. 3 (Autumn 2003), pp. 79–102. See also Marina Malenic, “North Korea Could Give Nuclear Weapons to Terrorist Groups, U.S. Military Officials Warn,” NTI Global Security Newswire, April 1, 2004.

18. See Peter Slevin and Karen DeYoung, “N. Korea Admits Having Secret Nuclear Arms; Stunned U.S. Ponders Next Steps,” *Washington Post*, October 17, 2002. The DPRK has denied having such a program, however, and a senior Chinese official said in June 2004 that “the U.S. has not presented convincing evidence” that a DPRK uranium program exists. See Joseph Kahn and Susan Chira, “Chinese Official Challenges U.S. Stance on North Korea,” *New York Times*, June 9, 2004. See also Paul Kerr, “N. Korea Uranium Enrichment Efforts Shrouded in Mystery,” *Arms Control Today*, Vol. 33, No. 4 (May 2003), p. 25; and Dipali Mukhopadhyay and Jon Wolfstahl, “Carnegie Analysis: Ten Questions on North Korea’s Uranium Enrichment Program” (Washington, D.C.: Carnegie Endowment for International Peace, January 7, 2003), <http://www.ceip.org/files/nonprolif/templates/article.asp?NewsID=3871>.

signing of the Agreed Framework, the DPRK decided to accelerate its low-level uranium enrichment research effort into an alternative route to nuclear weapons material acquisition.¹⁹ The DPRK appears to have turned to Pakistan, with its fully developed uranium enrichment program, for help.²⁰ This apparently led to a missiles-for-enrichment-technology barter deal between Pakistan and the DPRK, a benchmark event in the global proliferation enterprise. According to unnamed Pakistani, Republic of Korea, and U.S. officials, this relationship began as early as 1993 with plans for the Nodong missile provided to Pakistan by the DPRK.²¹ In April 1998, Pakistan successfully tested the Ghauri-1 missile, its version of the Nodong. The Pakistani government's lack of hard currency putatively coincided with the DPRK's desire for a uranium route to nuclear weapons, and in that same year the Khan Research Laboratory (KRL) reportedly began to provide Pyongyang with blueprints and components for gas centrifuges for uranium enrichment, compensating for the DPRK's frozen (due to the Agreed Framework) plutonium program. Pakistani officials denied this trade until April 2004, when it made public portions of the confession of Abdul Qadeer (A.Q.) Khan attesting to the transfer of Pakistani enrichment technology to the DPRK. Khan was director of KRL in Kahuta, Pakistan, and leader of the Pakistani uranium centrifuge enrichment program.²²

19. The history of the DPRK's uranium centrifuge program remains poorly understood, although a rough timeline can be pieced together. See Kerr, "N. Korea Uranium Enrichment Efforts Shrouded in Mystery."

20. Central Intelligence Agency, untitled CIA estimate for Congress, November 19, 2002, <http://www.fas.org/nuke/guide/dprk/nuke/cia111902.html>. See also David E. Sanger and James Dao, "U.S. Says Pakistan Gave Technology to North Korea," *New York Times*, October 17, 2002; and Carla Anne Robbins and Zahid Hussain, "North Korea Had Russian Parts Suppliers," *Wall Street Journal*, October 21, 2002.

21. For accounts of the missiles-for-centrifuges deal, see Gaurav Kampani, "Second Tier Proliferation: The Case of Pakistan and North Korea," *Nonproliferation Review*, Vol. 9, No. 3 (Fall/Winter 2002), pp. 107–116; Mark Hibbs, "CIA Assessment on DPRK Presumes Massive Outside Help on Centrifuges," *Platts Nuclear Fuel*, November 25, 2002, pp. 1, 12–13; International Institute for Strategic Studies, "Pakistan and North Korea: Dangerous Counter-Trades," *IISS Strategic Comments*, Vol. 8, No. 9 (November 2002), pp. 1–2; Daniel A. Pinkston, "When Did WMD Deals between Pyongyang and Islamabad Begin?" (Monterey, Calif.: Center for Nonproliferation Studies, Monterey Institute for International Studies, December 2002); David E. Sanger, "In North Korea and Pakistan, Deep Roots of Nuclear Barter," *New York Times*, November 24, 2003; David E. Sanger "U.S. Widens View of Pakistan Link to Korean Arms," *New York Times*, March 14, 2004; and Christopher Clary, "Dr. Khan's Nuclear WalMart," *Disarmament Diplomacy*, No. 76 (March/April 2004), pp. 31–36. DPRK assistance to the Ghauri program was affirmed by the U.S. National Intelligence Council in December 2001, in *Foreign Missile Developments and the Ballistic Missile Threat through 2015*, http://www.cia.gov/nic/PDF_GIF_otherprod/missilethreat2001.pdf.

22. See David E. Sanger and William J. Broad, "From Rogue Nuclear Programs, Web of Trails Leads to Pakistan," *New York Times*, January 4, 2004; and George Jahn, "AP: Pakistan Knew of Nuclear Black Market," *Washington Times*, March 7, 2004. For reports on Khan's admissions, see David

A.Q. Khan seems to have been the central figure in the DPRK deal. According to Khan's reported testimony, his network provided the DPRK with centrifuge designs based on Pakistani versions of both early- and second-generation centrifuges developed at the Urenco company enrichment plants in Almelo, Netherlands, and Gronau, Germany. Famously, Khan had been employed in the Almelo plant and took design information and listings of component suppliers with him to Pakistan in 1975.²³ Based on that information, the KRL laboratory developed and built two centrifuge models, the P-1 and the more sophisticated and more capable P-2.²⁴

By 2001 the DPRK development of centrifuge enrichment capabilities had progressed to the point where the DPRK apparently started shopping for the large-scale supply of machine components required to construct about 4,000 centrifuges. North Korean procurement agents reportedly bought British-manufactured high tensile-strength aluminum tubes from a German company and shipped a consignment of those tubes with freight papers indicating their destination to be the Shenyang Aircraft Corporation in China. The shipment was tracked and halted in Egypt while en route.²⁵ Were those 4,000 rotor tubings and other centrifuge components obtained by the DPRK, and the enrichment plant completed, it could produce one or two weapons' worth of highly enriched uranium (HEU) per year, depending on the design.²⁶

Rhode and David E. Sanger, "Key Pakistani Is Said to Admit Atom Transfers," *New York Times*, February 2, 2004; John Lancaster and Kamran Khan, "Pakistani Scientist Apologizes," *Washington Post*, February 5, 2004; and Peter Edidin, "Dr. Khan Got What He Wanted, and He Explains How," *New York Times*, February 15, 2004.

23. For reviews of Khan's activities, see Douglas Frantz, "Iran Closes In on Ability to Build a Nuclear Bomb," *Los Angeles Times*, August 4, 2003; and Maggie Farley and Bob Drogin, "1 Man, 3 Nations, a World of Peril," *Los Angeles Times*, January 6, 2003.

24. Using Urenco data, the KRL built the P-1 centrifuge, which uses aluminum tubes and has a capacity of 2–3 separative work units (SWUs) per year. By 1995 the KRL had switched to the P-2 centrifuge, which is based on a maraging steel rotor and rated at twice the SWU capacity of the P-1. See David Albright and Corey Hinderstein, "The Centrifuge Connection," *Bulletin of the Atomic Scientists*, Vol. 60, No. 2 (March/April 2004), pp. 61–66.

25. Mark Hibbs, "DPRK Sought Enough Aluminum Tubing in Germany for 4,000 Centrifuges," *Platts Nuclear Fuel*, May 12, 2003, pp. 1, 16–17; Joby Warrick, "U.S. Followed the Aluminum," *Washington Post*, October 18, 2003; and Mark Hibbs, "DPRK Enrichment Not Far Along, Some Intelligence Data Suggest," *Nucleonics Week*, October 24, 2003, pp. 1, 12–14.

26. According to Richard Garwin and Georges Charpak, *Megawatts and Megatons*, p. 59, the gun-type Hiroshima weapon contained about 60 kilograms of HEU. According to Leonard Spector and Jacqueline Smith, *Nuclear Ambitions*, appendix A, more difficult implosion designs require 25 kilograms of HEU, or as little as 15 kilograms or less for increasingly sophisticated designs. According to David Albright and Mark Hibbs, citing an unnamed U.S. official interviewed in 1991, the nuclear warhead design provided to Pakistan by China used about 15 kilograms of HEU. See Albright and Hibbs, "Pakistan's Bomb: Out of the Closet," *Bulletin of the Atomic Scientists*, Vol. 48, No. 4 (July/August 1992), pp. 38–43. It requires about 200 SWUs to make 1 kilogram of HEU. Thus

In this pursuit, as in 1992, the DPRK appears to have underestimated the technical capabilities of the nonproliferation control regime. In 1992 the DPRK seems not to have foreseen that swipes of surfaces by IAEA inspectors in buildings within the Yongbyon complex would provide data on its recent reprocessing activities.²⁷ In 2001 the DPRK seems to have hoped that it could procure large quantities of dual-use items related to centrifuge manufacturing in the global metal markets without alerting the export control regimes. It was wrong both times, and in that sense the control regimes were effective and performed as designed. In each case, however, the DPRK substantially advanced the technical scope of its proliferation efforts prior to being discovered.

PAKISTAN, EUROPE, LIBYA, AND THE PRIVATE SECTOR PROLIFERATION NETWORK
Libyan President Muammar Qaddafi decided in December 2003 to break with his past proliferation activities, renounce Libya's nuclear and chemical weapons programs, disclose and dismantle them, and forswear missiles that do not conform to 1987 Missile Technology Control Regime (MTCR) guidelines.²⁸ His decision followed years of negotiations intended to lift sanctions imposed on Libya because of its ties to terrorism and its own proliferation program; a Libyan approach to Britain in March 2003 at the outset of the second Gulf War; and the interdiction in Italy's Taranto Harbor in October 2003 of the German-owned ship *BBC China*, which proved to be carrying the components for several thousand P-2 centrifuges for the Libyan uranium enrichment program.²⁹

it will require about 3,000 SWUs to produce one weapon's worth of HEU, or 1,000 to 1,500 P-1 centrifuges operating for one year. For the production capability goal of the DPRK enrichment plant, see Central Intelligence Agency, *Unclassified Report to Congress on the Acquisition of Technology Related to Weapons of Mass Destruction and Advanced Conventional Munitions, 1 January through 30 June 2002*, http://www.fas.org/irp/threat/bian_apr_2003.htm.

27. See May et al., *Verifying the Agreed Framework*; and Albright and O'Neill, *Solving the North Korean Nuclear Puzzle*.

28. Robin Wright and Glenn Kessler, "Analysis—Two Decades of Sanctions, Isolation Wore Down Gaddafi," *Washington Post*, December 20, 2003; and "Iran, Libya, and Pakistan's Nuclear Supermarket," *Disarmament Diplomacy*, No. 75 (January/February 2004), pp. 39–42. Libya's efforts to meet its obligations to the IAEA are given in IAEA Board of Governors, "Implementation of the NPT Safeguards Agreement of the Socialist People's Libyan Arab Jamahiriya," IAEA Report GOV/2004/12, Vienna, Austria, February 20, 2004. See also Paul Kerr, "U.S. Says Libya Implementing WMD Pledge," *Arms Control Today*, Vol. 34, No. 2 (March 2004), pp. 28–29.

29. Stephen Fidler, Mark Huband, and Roula Khalaf, "Comment: Return to the Fold: How Gaddafi Was Persuaded to Give Up His Nuclear Goals," *Financial Times*, January 27, 2004; Ray Takeyeh, statement before the Committee on International Relations, U.S. House of Representatives, 108th Cong., 2d sess., March 10, 2004; and "Qaddafi's Son Says Libya Was Promised Economic, Military Gains for WMD Disarmament," NTI Global Security Newswire, March 10, 2004.

The revelations flowing from President Qaddafi's decision are remarkable. Evidently Pakistan's A.Q. Khan and a few of his senior associates at KRL were at the center of a private sector proliferation network for the clandestine export of centrifuge uranium enrichment technology.³⁰ Besides the DPRK and Libya, it appears that Iran, Iraq, possibly Syria, and perhaps other countries were approached with offers of nuclear weapons-related deals.³¹ The network used a firm, Scomi Precision Engineering, in a third-party country, Malaysia, to manufacture centrifuge components whose ultimate destination was hidden by transshipment through Dubai. The network also reportedly used the Turkish electrical components firm Elektronik Kontrol Aletleri (EKA) to purchase motors and frequency converters for the centrifuges. These components were also shipped on the *BBC China* and were discovered only when the ship docked in Tripoli in March 2004.³² These transshipments were facilitated by the Dubai-based Sri Lankan businessman Buhary Syed Abu Tahir, the controlling shareholder of Gulf Technical Industries, whom President Bush has described as the "chief financial officer and money launderer" of the Khan network.³³ The net-

30. See Peter Slevin, John Lancaster, and Kamran Khan, "At Least 7 Nations Tied to Pakistani Nuclear Ring," *Washington Post*, February 8, 2004; William J. Broad, David E. Sanger, and Raymond Bonner, "A Tale of Nuclear Proliferation: How Pakistani Built His Network," *New York Times*, February 12, 2004; and Clary, "Dr. Khan's Nuclear WalMart." For official Malaysian investigation results, see Polis Diraja Malaysia, "Press Release by Inspector General of Police in Relation to Investigation on the Alleged Production of Components for Libya's Uranium Enrichment Programme," February 20, 2004, http://www.rmp.gov.my/rmp03/040220scomi_eng.htm. According to this document, European participants allegedly involved in the Malaysian/Libyan centrifuge efforts included Heinz Mebus and Gotthard Lerch from Germany, Friedrich Tinner and his son Urs Friedrich Tinner from Switzerland, Gunas Jireh and Selim Alguadis from Turkey, and Peter Griffen from the United Kingdom.

31. See David Albright and Corey Hinderstein, "Documents Indicate A.Q. Khan Offered Nuclear Weapons Designs to Iraq in 1990. Did He Approach Other Countries?" ISIS Issue Brief (Washington, D.C.: ISIS, February 4, 2004), <http://www.isis-online.org>; and Douglas Frantz, "Nuclear Ring May Have Aided Syria," *Los Angeles Times*, June 25, 2004. Possible nuclear links between Pakistan and Saudi Arabia are discussed in Simon Henderson, "Towards a Saudi Nuclear Option: The Saudi-Pakistani Summit," Policy Watch Report No. 750 (Washington, D.C.: Washington Institute for Near East Policy, April 22, 2003); and "Pakistan, Saudi Arabia Reach Secret Nuclear Weapons Deal, Pakistani Source Says," NTI Global Security Newswire, October 21, 2003. An offer of "nuclear power" to Nigeria by a visiting senior Pakistani military officer was asserted, then rescinded. See "Nigerian Military Asserts, Then Denies, Interest in Acquiring Pakistani Nuclear Technology," NTI Global Security Newswire, March 4, 2004.

32. Stephen Fidler and Mark Huband, "Turks and South Africans Helped Libya's Secret Nuclear Arms Project," *Financial Times*, June 10, 2004; and Stephen Fidler, "Turkish Businessman Denies Nuclear Goods Claim," *Financial Times*, June 11, 2004.

33. Quoted in Rohan Sullivan and Patrick McDowell, "AP: Nuclear Financier Has Ties to Malaysia," *TheState.com*, February 18, 2004, <http://www.thestate.com/mid/thestate/news/world/7977621.htm>; and Raymond Bonner, "Salesman on Nuclear Circuit Casts Blurry Corporate Shadow," *New York Times*, February 18, 2004.

work relied on a group of European former colleagues of Khan who worked as engineers in technology and components supply companies serving Urenco, and later branched out to form their own consulting companies specializing in centrifuge technologies; a South African company was also involved.³⁴ Even more disturbing, Khan's network evidently sold the design of a workable nuclear weapon to Libya, reportedly offered to provide a design to Iraq in 1990, and possibly made similar offers to other nations.³⁵

The support effort for the Libyan nuclear program was likely the most ambitious and elaborate activity undertaken by Khan's network. The Libyan purchases alone are estimated to have netted the network about \$100 million; the support for Libya was almost on a turnkey basis, proposing to provide Libya with a workable centrifuge enrichment plant.³⁶ There is nothing to prevent a European engineering consultant from offering services to a Dubai-based engineering company or a Malaysian precision-equipment manufacturing firm, provided that the end use of the products is sufficiently well disguised to baffle intelligence and export control agencies. But how a collection of private European consultants and equipment suppliers was allowed to continue operating in support of Khan's network over many years is obviously an important inquiry.

34. See Michael Wines, "South African Is Charged with Making Nuclear Components," *New York Times*, September 4, 2004; Slevin, Lancaster, and Khan, "At Least 7 Nations Tied to Pakistani Ring"; and Broad, Sanger, and Bonner, "A Tale of Nuclear Proliferation." For estimates of the network's earnings, see David E. Sanger and William J. Broad, "Pakistan's Nuclear Earnings: \$100 Million," *New York Times*, March 16, 2004; and Clary, "Dr. Khan's Nuclear WalMart."

35. The warhead is thought to be based on a design tested by the Chinese and later provided to Pakistan in the 1980s. See John Pike, "Pakistan Nuclear Weapons," *GlobalSecurity.com*, <http://www.globalsecurity.org/wmd/world/pakistan/nuke.htm>. See also William J. Broad, "Libya's A-Bomb Blueprints Reveal New Tie to Pakistani," *New York Times*, February 9, 2004; "Libyan Inspections Find Evidence of Collaboration with Egypt," *World Tribune.com*, March 29, 2004, http://216.26.163.62/2004/me_egypt_03_29.html. The possibility that a package of centrifuge technology, uranium hexafluoride, and nuclear warhead designs was provided by the Pakistani network to the DPRK, citing a CIA assessment, is reported in David E. Sanger, "U.S. Widens View of Pakistan Link to Korean Arms," *New York Times*, March 14, 2004. According to that assessment, a similar package was reportedly sold by Dr. Khan's network to Libya for \$60 million.

36. The scope of the Libyan nuclear and chemical programs is discussed in Mark Huband, Roula Khalaf, and Stephen Fidler, "Libya Nuclear Deal Exposes Black Market," *Financial Times*, January 21, 2004; Raymond Bonner and Craig Smith, "Pakistani Said to Have Given Libya Uranium," *New York Times*, February 21, 2004; Judith Miller, "Libya Discloses Production of 23 Tons of Mustard Gas," *New York Times*, March 6, 2004; and George Jahn, "Japan Company Sold Atomic Plant to Libya," *Guardian*, March 12, 2004. Reportedly, in February 2001 the DPRK transferred 1.7 tons of uranium hexafluoride to Libya in support of the uranium centrifuges provided by the Khan network. See David E. Sanger and William J. Broad, "Evidence Is Cited Linking Koreans to Libya Uranium," *New York Times*, May 23, 2004.

IRAN AND PAKISTAN

Iran has been a party to the NPT since 1970, but in 1996 congressional testimony, Director of Central Intelligence John Deutch stated: "We judge that Iran is actively pursuing an indigenous nuclear weapons capability. . . . Specifically, Iran is attempting to develop the capability to produce both plutonium and highly enriched uranium."³⁷ In August 2002 the media reported the existence of a pilot uranium enrichment centrifuge plant in Natanz; in February 2003 Iran informed the IAEA director general of work on two enrichment facilities at Natanz, a pilot plant nearing completion and a commercial-scale fuel enrichment plant under construction.³⁸ Iran stated that more than 100 of the 1,000 planned centrifuge casings had been installed at the pilot plant. The commercial enrichment facility was described as being planned to contain more than 50,000 centrifuges, with installation beginning in early 2005.³⁹ In June 2003 Iran introduced gaseous uranium hexafluoride into the first centrifuge for testing purposes, and in August 2003 a ten-machine small cascade started test operations.⁴⁰ Reportedly, a French government document provided to the Nuclear Suppliers Group (NSG) in May 2003 concluded that Iran was concealing a military program within its civilian nuclear program, stating that "Iran appears ready to develop nuclear weapons within a few years."⁴¹ The Iranian foreign ministry has denied that Iran is concealing a nuclear weapons program.⁴²

According to unnamed Western intelligence sources cited in January 2003, design information and component parts for the pilot facility were provided to Iran by Pakistan,⁴³ possibly with support from other states.⁴⁴ A.Q. Khan's pri-

37. CIA Director John Deutch, 1996 congressional testimony, quoted in "Iran" (Washington, D.C.: Carnegie Endowment for International Peace, n.d.), <http://www.ceip.org/programs/npp/iran.htm>.

38. Mohamed ElBaradei, "Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran," report by the director general to the IAEA board of governors, GOV/2003/40, Vienna, Austria, June 6, 2003, p. 2.

39. *Ibid.*, p. 6.

40. Mohamed ElBaradei, "Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran," IAEA Report GOV/2003/63, Vienna, Austria, August 26, 2003, p. 7.

41. Reported by Frantz, "Iran Closes In on Ability to Build a Nuclear Bomb."

42. Iranian foreign ministry spokesman Hamid Reza Asefi has called these allegations "poisonous and disdainful rumors" spread by the United States. Quoted in *ibid.*

43. Mark Hibbs, "Pakistan Believed Design Data Source for Centrifuges to Be Built by Iran," *Platts Nuclear Fuel*, January 20, 2003, pp. 1, 14–16.

44. See Joby Warrick and Glenn Kessler, "Iran's Nuclear Program Speeds Ahead," *Washington Post*, March 10, 2003; and David Albright and Corey Hinderstein, "Furor over Fuel," *Bulletin of the Atomic Scientists*, Vol. 60, No. 3 (May/June 2003), pp. 12–15.

vate sector associate, B.S.A. Tahir, has admitted to selling two containers of surplus Pakistani centrifuge equipment to Iran in 1994 and 1995 for a payment of \$3 million.⁴⁵ These shipments and other components purchased abroad or manufactured in Iran reportedly allowed the Iranians to assemble 500 operable P-1 centrifuges by 1995.⁴⁶

The Iranian government reported the existence of an enrichment test-bed facility in the Kalaye Electric Company's workshop in February 2003, but it refused permission for environmental sampling at the site until August 2003, when significant modifications to site facilities were noted.⁴⁷ IAEA inspectors found traces of HEU at the Natanz plant in June 2003 and in the Kalaye workshop in September 2003. Iranian officials have stated that these traces had been on the equipment when it was purchased from another country, thus denying the production of HEU at the plants but admitting to outside help in their construction.⁴⁸ Evidence collected in Iran by the IAEA reportedly implicates Pakistan as a supplier of critical technology and parts,⁴⁹ and the IAEA is said to suspect Pakistan as the source of the 90 percent HEU found on some samples.⁵⁰ Assistance has allegedly also been obtained from other nations, reportedly including China, the DPRK, and Russia.⁵¹ The IAEA has identified two other Iranian facilities engaged in development work on P-2 centrifuges; in March 2004 the Iranian military acknowledged having produced P-1 type centrifuges in a facility located at the Doshen-Tappen air base near Tehran.⁵²

The scope of the P-2 centrifuge program may be larger than the Iranians

45. Polis Diraja Malaysia, "Press Release by Inspector General of Police"; and Bonner, "Salesman on Nuclear Circuit Casts Blurry Corporate Shadow."

46. Albright and Hinderstein, "The Centrifuge Connection."

47. ElBaradei, "Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran," IAEA Report GOV/2003/63, pp. 6–8.

48. Felicity Barringer, "Traces of Enriched Uranium Are Reportedly Found in Iran," *New York Times*, August 27, 2003; and Joby Warrick, "Iran Admits Foreign Help on Nuclear Facility; U.N. Agency's Data Point to Pakistan as the Source," *Washington Post*, August 27, 2003.

49. Warrick, "Iran Admits Foreign Help on Nuclear Facility."

50. Joby Warrick, "Nuclear Program in Iran Tied to Pakistan," *Washington Post*, December 21, 2003; and Craig S. Smith, "Alarm Raised over Quality of Uranium Found in Iran," *New York Times*, March 11, 2004.

51. According to an unnamed non-U.S. intelligence officer and an unnamed former Iranian intelligence officer, the DPRK is providing help to Iran on nuclear warhead design. See Frantz, "Iran Closes In on Ability to Build a Nuclear Bomb." For claims of other nations' participation in the Iranian program, see Glen Kessler, "Group Alleges New Nuclear Site in Iran," *Washington Post*, February 20, 2003; and Leonard S. Spector, "Iran's Secret Quest for the Bomb," *YaleGlobal Online*, May 16, 2003, <http://yaleglobal.yale.edu/article.print?id=1624>.

52. "IAEA Inspectors Find Centrifuge Equipment at Iranian Air Base," NTI Global Security Newswire, February 19, 2004; and "Iran Talks Quiet in Vienna, but High-Grade Uranium Reportedly Found," NTI Global Security Newswire, March 11, 2004.

originally reported. Iranian representatives have apparently inquired through European middlemen about purchasing “tens of thousands” of magnets for P-2 centrifuges. A centrifuge cascade of this size would be enough to produce several warheads’ worth of HEU a year.⁵³

Two other enrichment facilities are alleged to have begun operations in 2000 near the villages of Lashkar-Abd and Ramandeh, about 40 kilometers west of Tehran.⁵⁴ The Lashkar-Abd site was found by the IAEA to contain an active laser program that could be used for uranium enrichment.⁵⁵

Another element of the Iranian nuclear program is a planned heavy-water reactor and its ancillary facilities in Arak, a city close to Esfahan. Iran declared to the IAEA in May 2003 its intention to build a 40 MW(th) heavy-water moderated and cooled, and natural-uranium fueled, Iran Nuclear Research Reactor (IR-40). The stated purpose of that reactor is radioisotopes production, as well as reactor research development and training.⁵⁶ A radioisotopes production facility referred to as the Molybdenum, Iodine, and Xenon facility is currently in operation at the Tehran nuclear research center.⁵⁷ There is a heavy-water production plant in Khondab, near the Arak site. A related facility is Iran’s fuel-manufacturing plant in Esfahan, which will fabricate the fuel elements for the IR-40 and perhaps ultimately for the Bushehr nuclear power plant; construction began in 2003.⁵⁸

The Iranian nuclear program is technologically broad based, includes redundant facilities, and is well dispersed across many different sites. The latter attribute is a particular advantage of a centrifuge enrichment-based program for any country pursuing a covert capability. In contrast to plutonium production reactors, centrifuge facilities can be built as small-scale distributed facilities that are especially difficult to detect. It is the associated conversion facilities at

53. Louis Charbonneau, “UN Sees Signs of Massive Iran Nuke Plans—Diplomats,” Reuters, June 10, 2004; Mohamed ElBaradei, “Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran,” IAEA Report GOV/2004/34, Vienna, Austria, June 1, 2004.

54. Sheryl Gay Stolberg, “Group Says Iran Has 2 Undisclosed Nuclear Laboratories,” *New York Times*, May 27, 2003.

55. ElBaradei, “Implementation of the NPT Safeguards,” GOV/2003/63, p. 8.

56. “Iran Set to Announce Work on Heavy Water Reactor; Nuclear Inspections Timetable Set,” NTI Global Security Newswire, April 9, 2004.

57. ElBaradei, “Implementation of the NPT Safeguards,” GOV/2003/40, pp. 5–7.

58. Since a heavy-water reactor operates with natural uranium fuel, plutonium can be produced without a uranium enrichment facility. India and Israel based their nuclear weapons programs on such reactors. A description of the Iranian facilities may be found in ElBaradei, “Implementation of the NPT Safeguards,” GOV/2003/40, pp. 5–8; and GOV/2003/71, November 10, 2003, “Heavy Water Reactor Programme” section.

the front and back ends of the enrichment process, required to produce gaseous uranium hexafluoride or metallic uranium, respectively, that are more difficult to conceal.

The IAEA board of governors at its September 2003 annual meeting set a deadline of October 31, 2003, for Iran to provide extensive additional information on its nuclear activities and to suspend all further uranium enrichment-related activities.⁵⁹ In October 2003 Iran promised to freeze all uranium enrichment and reprocessing activities, provide full information to the IAEA, and open all requested facilities to IAEA inspectors; in December 2003 it signed the Additional Protocol to the NPT that strengthens IAEA inspection rights.⁶⁰ But Iran's compliance was grudging and characterized by attempts to limit the scope of the agreement and threats to cancel it. Indeed, in June 2004 Iran announced that it would resume centrifuge production in response to an IAEA resolution critical of its cooperation with the agency.⁶¹

MISSILE AND URANIUM PROLIFERATION RINGS

Iran's missile program has also received help from China, the DPRK, and Russia.⁶² Additional support has been obtained from companies in Taiwan, Macedonia, and Belarus, according to U.S. Undersecretary of State John Bolton.⁶³ Israeli sources have claimed that a follow-on missiles-for-centrifuges technical exchange barter deal was struck between Pyongyang and Tehran.⁶⁴ Under this putative arrangement, in exchange for Iranian assistance with uranium enrich-

59. Joby Warrick, "Iran Given Deadline to Lay Bare Nuclear Program," *Washington Post*, September 13, 2003.

60. Christine Hauser and Nazila Fathi, "Iran Signs Pact Allowing Inspections of Its Nuclear Sites," *New York Times*, December 18, 2003; and ElBaradei "Implementation of the NPT Safeguards," GOV/2004/11, sec. B.5, p. 10.

61. Dafna Linzer, "Iran Says It Will Renew Nuclear Efforts," *Washington Post*, June 25, 2004.

62. Joseph Cirincione, with Jon Wolfsthal and Miriam Rajkumar, *Deadly Arsenals: Tracking Weapons of Mass Destruction* (Washington, D.C.: Carnegie Endowment for International Peace, 2002), pp. 262–264; Donald H. Rumsfeld, Barry M. Blechman, Lee Butler, Richard L. Garwin, William R. Graham, William Schneider, Larry D. Welch, Paul D. Wolfowitz, and R. James Woolsey, "Executive Summary of the Report of the Commission to Assess the Ballistic Missile Threat to the United States," July 15, 1998, <http://www.fas.org/irp/threat/bm-threat.htm>.

63. John R. Bolton, "Iran's Continuing Pursuit of Weapons of Mass Destruction," testimony before the U.S. House of Representatives, International Relations Committee, Subcommittee on the Middle East and Central Asia, 108th Cong., 2d sess., June 24, 2004.

64. See Ze'ev Schiff, "North Korea Got Nuclear Know-How from Iran," *Ha'aretz English Edition*, November 21, 2002; and Ze'ev Schiff, "Weapons of Mass Destruction and the Middle East: The View from Israel" (Houston, Tex.: James A. Baker III Institute for Public Policy, Rice University, March 2003).

ment, the DPRK provided Iran with engines for the Nodong missiles (the precursors of the Iranian Shahab-3 missile) and worked out Shahab-3 manufacturing problems in Iran. The Shahab-3 successfully completed its test program in July 2003, and is thought to be able to carry a 1,000-kilogram payload for 1,500 kilometers.⁶⁵

The DPRK has proved willing to sell its missile technologies worldwide. Because the DPRK and its customers are not members of the MTCR, these sales are not in violation of any agreement. The DPRK network of missile sales can be pictured as the hub and spokes of a wheel, with the DPRK at the center. DPRK missile sales to Pakistan and Iran correspond to spokes in this wheel. The DPRK has also sold missiles to Egypt, Iraq, Libya, Syria, and Yemen, and approached other nations.⁶⁶ It is a reminder of the importance of export controls to recall that the entire DPRK missile development and export program was initiated in the late 1970s, when the DPRK purchased several Soviet-supplied Scud-B missiles from Egypt and then proceeded to reverse engineer and further develop them.⁶⁷

An analogous group of countries that trade among themselves in uranium centrifuge enrichment technologies appears to have evolved during the 1990s, centered on Pakistan. China was the major historical supporter of the Pakistani nuclear program, putatively providing Pakistan with a complete design of one of its early uranium nuclear warheads; sufficient quantities of HEU for two such weapons; short-range ballistic missiles and construction blueprints; assistance in developing a medium-range missile; support in developing second-generation uranium enrichment centrifuges, including the provision of 5,000 ring magnets in 1994–95; and a 40 MW(th) heavy-water plutonium and tritium production reactor located at Khushab.⁶⁸ Smuggling from a number of Western nations, and in particular the acquisition of an entire plant for converting uranium powder to uranium hexafluoride from West Germany between 1977 and

65. Barringer, "Traces of Enriched Uranium Are Reportedly Found in Iran."

66. Cirincione, with Wolfsthal and Rajkumar, *Deadly Arsenals*, pp. 250–251. DPRK offers of missile sales to Myanmar and Nigeria are reported in "Intelligence Officials Suspect North Korean WMD Exports to Myanmar," NTI Global Security Newswire, November 18, 2003; and Nicholas Kralev, "North Korea Offers Nigeria Missile Deal," *Washington Times*, January 29, 2004.

67. Cirincione, with Wolfsthal and Rajkumar, *Deadly Arsenals*, pp. 250–251. See also Federation of American Scientists, Weapons of Mass Destruction—WMD around the World—North Korea Missiles—Hwasong 5/SCUD B, <http://www.fas.org/nuke/guide/dprk/missile/hwasong-5.htm>.

68. Cirincione, with Wolfsthal and Rajkumar, *Deadly Arsenals*, pp. 148–150, 152, 212–215. China's supply of HEU to Pakistan has been called unconfirmed by one unnamed U.S. official. See Albright and Hibbs, "Pakistan's Bomb."

1980, also played an important role in the development of Pakistan's nuclear program.⁶⁹

Links among these missile and uranium enrichment technology rings accelerate technology transfer within each ring; reduce the total development cost; and if not disrupted, potentially shorten the time period needed for the successful development of the technology. Dating the origin of the DPRK gas centrifuge program is difficult; an unclassified CIA estimate suggests that North Korea began developing this program in 2000 and that its HEU production could be fully operational by mid-decade; this suggests that the DPRK was on course to halve the development time required in other third world states.⁷⁰ Pakistan's program, for example, was launched in 1972, was expedited by A.Q. Khan's arrival from the Urenco plant in the Netherlands in 1975, and only in 1985–86 seems to have begun producing HEU.⁷¹ Similarly, foreign assistance has telescoped the timescale for ballistic missile development and production.⁷² Obviously, obtaining the blueprints for a working HEU warhead could also greatly reduce the time required to complete a nuclear weapons program. Nuclear and missile proliferation rings could provide a package of uranium enrichment technology, warhead design, and missile delivery system, thereby potentially reducing the time needed to achieve an integrated weapons system. The relationships between the DPRK and Khan networks show the shifting roles that ring members may play, with the DPRK acting on different occasions as a buyer, seller, and supplier to mutual partners.

WHY PROLIFERATE?

Determining the motives that drive nuclear proliferation is difficult, with reasons of national security, national prestige, organizational politics, international pressure, and others all playing a role.⁷³ Even in the case of the South African nuclear program, where the trajectory of the construction and destruction of its six-warhead nuclear stockpile is known, and dozens of interviews with nuclear policymakers have been undertaken, it is difficult to determine

69. Spector and Smith, *Nuclear Ambitions*, p. 91. Uranium hexafluoride is the gaseous form of uranium needed for uranium centrifuge enrichment.

70. See untitled CIA estimate for Congress, November 19, 2002, <http://www.fas.org/nuke/guide/dprk/nuke/cia111902.html>.

71. Cirincione, with Wolfsthal and Rajkumar, *Deadly Arsenals*, pp. 210–211.

72. Duncan Lennox, "Co-operation Boosts Missile Proliferation," *Jane's Intelligence Review*, January 2002, pp. 39–41; and Rumsfeld et al., "Executive Summary of the Report of the Commission to Assess the Ballistic Missile Threat to the United States."

73. Sagan, "Why Do States Build Nuclear Weapons?"

the relative importance of various motivating factors.⁷⁴ Case studies for a number of countries, however, suggest that security concerns provide an especially important motive for pursuing the nuclear option.⁷⁵

Here our concern is more specific: we are interested in measures that could help prevent, and therefore in the motives that might help foster, second-tier proliferation. Why did the Pakistani Khan network provide assistance to the DPRK and, evidently, Iranian, Libyan, and other nuclear programs? What calculations were being made? These questions too are hard to answer; it is difficult enough on the basis of open sources, largely relying on unnamed officials who may be pursuing their own agendas, to sketch what physically has occurred in these exchanges. Going from these already sketchy results to conclusions about motivations is especially challenging. Moreover, the extent to which certain proliferators should be seen as unitary actors is unclear. The authority of successive Pakistani heads of government, for example, has varied vis-à-vis the Pakistani military, intelligence, and nuclear bureaucracies.⁷⁶ (Yet cooperation with other nations in centrifuge enrichment has evidently been carried out under three Pakistani governments.) Officials in President Bill Clinton's administration were reportedly concerned "about whether the Pakistani government was sufficiently in control of its nuclear labs and certain nuclear scientists."⁷⁷ The rivalry between the KRL and the Pakistani Atomic Energy Commission (PAEC) may also have played a significant role in the nuclear and missile programs' development trajectories in Pakistan.⁷⁸ Given the gravity of the Pakistan-DPRK exchanges, however, including decisions regarding the acquisition of particular nuclear-strike systems, it would seem surprising if Khan and the KRL were acting independent of higher authorities, although the effect of the covert nature of the Pakistani nuclear weapons

74. Liberman, "The Rise and Fall of the South African Bomb"; and Helen E. Purkitt and Stephen F. Burgess with reply by Peter Liberman, "Correspondence: South Africa's Nuclear Decisions," *International Security*, Vol. 27, No. 1 (Summer 2002), pp. 186–194.

75. See, for example, Liberman, "The Rise and Fall of the South African Bomb"; Perkovich, *India's Nuclear Bomb*, pp. 446–455; and Perkovich, "Dealing with Iran's Nuclear Challenge."

76. For a discussion of this issue during the 1970s and 1980s, see Spector and Smith, *Nuclear Ambitions*, pp. 89–112.

77. Unnamed Clinton administration official, quoted in Dan Stober and Daniel Sneider, "Bush Knew About North Korea's Nuclear Program for More Than a Year," *San Jose Mercury News*, October 25, 2002.

78. Relations between Khan's KRL and the PAEC in the context of the Pakistani weapons program are discussed in Simon Henderson, "Pakistan's Nuclear Proliferation and U.S. Policy," *Policy Watch* No. 826 (Washington, D.C.: Washington Institute for Near East Policy, January 12, 2004); and Pervez Hoodbhoy, "Pakistan: Inside the Nuclear Closet," *Open Democracy*, March 3, 2004, <http://www.opendemocracy.net/debates/article-2-95-1767.jsp>.

program and the role and authority of civilian government remain less clear.⁷⁹ Understanding how Khan obtained the warhead design he evidently shared with Libya and possibly others might shed light on these issues, although there are objections to both end-member scenarios—deep Pakistani government involvement and Khan as an independent “rogue actor”—that have been suggested.⁸⁰

Pakistani Prime Minister Zulfikar Ali Bhutto appears to have decided to pursue nuclear weapons development in the year after Pakistan’s devastating loss in the 1971 Indo-Pakistani war.⁸¹ Pakistan’s relationship with the DPRK may have been driven by a desire to secure appropriate nuclear weapons delivery systems.⁸² In the mid-1980s the United States provided forty F-16 aircraft to Pakistan. With appropriate modifications, these aircraft could serve as nuclear delivery vehicles, though unlike ballistic missiles they are vulnerable to air defenses. In 1985, however, the U.S. Congress passed the Pressler amendment to the Foreign Assistance Act, requiring the president to certify annually “that Pakistan does not possess a nuclear explosive device.”⁸³ Presidents Ronald Reagan and George H. W. Bush made these annual certifications to Congress, but with increasing discomfort and caveats in successive years. In 1989 the Soviet army completed its withdrawal from Afghanistan. In October 1990 the Pressler amendment was finally invoked, terminating most military aid to Islamabad, including the transfer of additional F-16s that were on order. In 1989 Pakistan, through PAEC connections, had agreed with China to buy thirty-four solid-fueled M-11 ballistic missiles having a 300-kilometer range with a 500-kilogram payload. By the early 1990s, however, Beijing was under increasing U.S. pressure to comply with the MTCR restrictions on missile transfers,⁸⁴ and Pakistan evidently diversified its missile suppliers, apparently

79. The hypothesis that Khan was acting on his own is criticized by Kampani, “Second Tier Proliferation”; and in IISS, “Pakistan and North Korea.” Kampani also discusses the bureaucratic rivalry between the KRL and the PAEC, and its possible effects. The U.S. State Department determined that DPRK-Pakistani cooperation in missile technology violated the MTCR and imposed sanctions on the KRL and the DPRK’s Ch’anggwang Trading Company.

80. Clary, “Dr. Khan’s Nuclear WalMart”; and Sharon Squassoni “Closing Pandora’s Box: Pakistan’s Role in Nuclear Proliferation,” *Arms Control Today*, Vol. 34, No. 3 (April 2004), pp. 8–13.

81. Spector and Smith, *Nuclear Ambitions*, p. 90.

82. For details, see *ibid.*, pp. 107–112; Cirincione, with Wolfsthal and Rajkumar, *Deadly Arsenals*, pp. 207–216; Kampani, “Second Tier Proliferation”; and IISS, “Pakistan and North Korea.”

83. The texts of the 1985 Pressler amendment, as well as the 1976 Symington and Glenn amendments, are given in the appendices to Richard N. Haass and Morton H. Halperin, *After the Tests: U.S. Policy toward India and Pakistan* (New York: Council on Foreign Relations, 1998).

84. Cirincione, with Wolfsthal and Rajkumar, *Deadly Arsenals*, p. 152; and Dinshaw Mistry, “Beyond the MTCR: Building a Comprehensive Regime to Contain Ballistic Missile Proliferation,” *International Security*, Vol. 27, No. 4 (Spring 2003), pp. 119–149.

negotiating the deal with the DPRK for liquid-fueled Nodong missiles having a range of 1,000–1,300 kilometers with a payload of 700–1,000 kilograms. This permitted Pakistan to threaten a much larger set of targets deeper in India than was possible with the M-11. Finally, there has been speculation of cooperation between Pakistan and the DPRK involving the use of DPRK plutonium in the fifth Pakistani nuclear test in May 1998.⁸⁵

Pakistan's decision to share centrifuge enrichment technology with the DPRK may have been driven by a perceived strategic need to acquire a less vulnerable longer-range nuclear warhead delivery system with which to hold Indian targets at risk, as well perhaps as by internal bureaucratic infighting. Pakistan's interests in assisting the Iranian nuclear program would be much harder to understand, although one analyst has speculated that this help may have been a way to reassure Tehran that Islamabad's nuclear capabilities were directed against India or to manage tensions over Afghanistan.⁸⁶ In this scenario, the assistance would represent a peculiar kind of negative security assurance. It has also been suggested that Pakistan was attempting either to prevent the emergence of improved Indian-Iranian relations or to foster a common front against the Russian presence in Afghanistan.⁸⁷

Determining the intentions of the DPRK is notoriously daunting, but its motives in the centrifuge-missile exchange with Pakistan would seem easier to discern. The acquisition of uranium centrifuge technology provided the DPRK with an alternative pathway to producing nuclear weapons after its plutonium program had attracted world attention. The deal would have been reached sometime between 1993 and 1997.⁸⁸ The DPRK has stated that it will seek a negotiated settlement over its nuclear programs on three conditions: "Firstly, if the U.S. recognizes the DPRK's sovereignty, secondly, if it assures the DPRK of non-aggression and thirdly, if the U.S. does not hinder the economic development of the DPRK."⁸⁹ The DPRK nuclear program may serve as either an ultimate guarantor of the regime or as a bargaining chip, but even in the latter role its utility is putatively as a security guarantee.

Iranian leaders' motivations for pursuing nuclear weapons are not easily ac-

85. See David E. Sanger and William J. Broad, "Pakistan May Have Aided North Korea A-Test," *New York Times*, February 27, 2004; and Paul Watson and Mubashir Zaidi, "Death of N. Korean" Woman Offers Clues to Pakistani Nuclear Deals," *Los Angeles Times*, March 1, 2004.

86. Perkovich, "Dealing with Iran's Nuclear Challenge."

87. Sultan Shahin, "Iran, Nukes, and the South Asian Puzzle," *Asia Times*, September 8, 2003.

88. Pinkston, "When Did WMD Deals between Pyongyang and Islamabad Begin?" But see CIA estimate that the DPRK began developing its centrifuge-based enrichment program in 2000. Untitled CIA estimate for Congress, November 19, 2002.

89. DPRK foreign ministry statement, October 25, 2002, <http://www.kcna.co.jp/index-e.htm>.

cessible to outsiders. It is not even clear who the decisionmakers are, although a small group with little technological or strategic background has been suggested.⁹⁰ At least two motives seem to be involved: security concerns vis-à-vis Israel, the United States, and possibly Pakistan (and, in the past, Iraq and the Pakistani-supported Taliban); and nationalism and nationalist-fueled resentment of other nations' perceived hypocrisy on the nuclear issue.⁹¹

Buttressing the Existing Nonproliferation Regime

The previous section sketched the rise in second-tier proliferation in the form of what we have dubbed "proliferation rings." First-tier proliferation has also played an important role in the establishment of nuclear weapons capabilities among proliferators, including the rings members themselves. We are entering a period, however, in which more states in the developing world will acquire sufficient knowledge and technological and manufacturing capabilities to allow them to disconnect from first-tier suppliers and fill technological gaps in their nuclear and missile programs by trading among themselves. Opportunities for cooperative development and even "latent proliferation by proxy" (one country participating in proliferation ring activities on behalf of another country that wishes to hide its true intentions) will be enhanced. Moreover, increases in secondary proliferation in turn increase the risk of proliferation to terrorist groups.

A critical issue is the extent to which the discovery of second-tier proliferation networks represents the unraveling of a uniquely ambitious set of proliferation relationships that are currently being terminated, or whether such discoveries should instead be thought of as harbingers of what is to come, driven by continuing regional instabilities and abetted by the spread of technological know-how throughout the world. If indeed the nuclear warhead plans revealed in Libya were "copies of copies of copies" as one analyst claims,⁹² it

90. Perkovich, "Dealing with Iran's Nuclear Challenge."

91. *Ibid.*; Perkovich assesses the scant evidence available for the different motives fueling Iran's nuclear demand. For a discussion of the utility of Iranian nuclear weapons in meeting its national security needs, see Sharam Chubin, "Iran's Strategic Environment and Nuclear Weapons," in Geoffrey Kemp, ed., *Iran's Nuclear Weapons Options: Issues and Analysis* (Washington, D.C.: Nixon Center, 2001), pp. 17–34. For a discussion of the public debate over nuclear weapons within Iran, see Farideh Farhi, "To Have or Not to Have: Iran's Domestic Debate on Nuclear Options," in *ibid.*, pp. 45–63. See also "Iran's Nuclear Ambitions: Full Steam Ahead?" *IISS Strategic Comments*, Vol. 9, No. 2 (March 2003).

92. Clary, "Dr. Khan's Nuclear WalMart."

would be foolish to think that even rolling up the programs of all the countries known so far to have directly traded with Pakistan would eliminate the possibility that copies of the uranium implosion warhead design are currently floating around the world.⁹³ The operational answer is clear: the international community must act as if the proliferation rings described here are the shape of the future, while taking steps to increase the chances that history will conclude that these particular rings were a final challenge to nonproliferation due to a few last hard cases. The current networks must be shut down, and measures should be put in place to prevent or detect their rise elsewhere.

In the following sections, we consider various incremental approaches to improving the nonproliferation regime and assess the extent to which they respond to the proliferation rings issue.

COOPERATIVE THREAT REDUCTION

Steps taken to prevent latent, first-tier, or second-tier proliferation will be moot if nuclear weapons or nuclear weapons–usable material may be stolen and directly provided to either a state or terrorist program. To buttress the nuclear nonproliferation regime, therefore, member states must first prevent it from being circumvented through theft and smuggling. The IAEA reportedly traced at least some of the 36 percent–enriched HEU discovered on centrifuges in Iran to Russia.⁹⁴ If true, then nuclear smuggling and second-tier proliferation may have already played synergistic roles.

Stealing and smuggling a complete warhead from a state program would seem far more difficult, but cannot be ruled out.⁹⁵ Stealing nuclear explosive material in the form of plutonium or HEU is a threat for which there are already anecdotal examples; at least kilogram quantities of HEU (including 90

93. For example, the IAEA is reportedly trying to determine whether Egypt may have received the Pakistani nuclear warhead designs from Libya. See “Libyan Inspectors Find Evidence of Collaboration with Egypt,” *World Tribune.com*, March 29, 2004.

94. William J. Broad, “Uranium Traveled to Iran Via Russia, Inspectors Find,” *New York Times*, February 28, 2004.

95. See Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials*, p. 70. Evaluation of the security of warheads against insider and outsider threats in the Pakistani or Indian programs is more difficult. Pakistani Gen. Khalid Kidwai stated in January 2002 that Pakistani warheads do not have permissive action links (or PALs, devices designed to prevent the explosion of the warhead by an unauthorized user), although the bombs are kept in a disassembled state. See Paolo Cotta-Ramusino and Maurizio Martellini, *Nuclear Safety, Nuclear Stability, and Nuclear Strategy in Pakistan* (Como, Italy: Landau Network, Centro Volta, February 11, 2002), <http://lxmi.mi.infn.it/~landnet/Doc/pakistan.pdf>. Garwin and Charpak state that PALs on a stolen weapon could eventually be overcome, but this would be challenging for a nonstate group or unsophisticated state program. Garwin and Charpak, *Megawatts and Megatons*, p. 342.

percent HEU, ideal for making the lowest-mass uranium warheads) have been stolen from Russian facilities in the past.⁹⁶ By the end of fiscal year 2002, neither comprehensive nor even interim, rapid security upgrades had been completed for 63 percent of the 600 metric tons of vulnerable weapons-usable nuclear material outside of Russian warheads.⁹⁷ A terrorist group or unsophisticated state program could conceivably produce a working fission warhead with either stolen weapons-grade plutonium or HEU, but the former would prove extremely challenging because plutonium warheads require spherical explosive compression with precise timing.⁹⁸ Assembling a gun-type HEU weapon would be less demanding.⁹⁹ If there is a spherical implosion design available to terrorists or proliferators, it would likely be the Chinese/Pakistani uranium-based design, once again indicating that HEU is of the greatest concern.

The first line of defense is therefore to protect and deter against theft, and detect it should it occur. This must be done globally, given that substantial quantities of poorly safeguarded HEU exist outside the FSU.¹⁰⁰ In this context, CTR programs are central. If fully implemented, the June 2002 “10 plus 10 over 10” agreement reached by the G-8 at the Kananaskis summit in Canada should increase available funding, distribute the total funding more equitably (even while committing the United States to do more), and ensure that the G-8 will continue to address this problem throughout the coming decade.¹⁰¹ If these

96. See Lyudmila Zaitseva and Kevin Hand, “Nuclear Smuggling Chains: Suppliers, Intermediaries, and End-Users,” *American Behavioral Scientist*, Vol. 46, No. 6 (February 2003), p. 822; and Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials*, app. A.

97. Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials*, p. 66.

98. See Garwin and Charpak, *Megawatts and Megatons*, pp. 347–350.

99. Francesco Calogero, “The Risk of Nuclear Terrorism,” paper presented to the Second Pugwash Workshop on Terrorism: Consequences of the War on Terrorism, Como, Italy, October 9–12, 2003, <http://www.isodarco.it/courses/andalo04/paper/andalo04-Calogero.pdf>.

100. A “global cleanup” campaign of the most vulnerable sites is required, as is the conversion of HEU research reactors worldwide to run on LEU fuel so that the number of sites where HEU can be stolen is minimized. See Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials*, pp. 71–72. The reactor conversion program is discussed in “Reduced Enrichment for Research and Test Reactors,” n.d., <http://www.nnsa.doe.gov/na-20/retrtr.shtml>. On May 26, 2004, U.S. Department of Energy Secretary Spencer Abraham during a visit to the IAEA announced the launch of a Global Threat Reduction Initiative to expedite these goals. See http://www.energy.gov/engine/content.do?BT_CODE=PR_SPEECHES.

101. The agreement is formally called the Global Partnership against the Spread of Weapons and Materials of Mass Destruction. Under 10 plus 10 over 10, U.S. commitments of \$10 billion for nonproliferation cooperation programs with Russia and other former Soviet states will be matched by \$10 billion from the other G-8 nations, spread over ten years. See “The G8 Global Partnership against the Spread of Weapons and Materials of Mass Destruction,” statement by the Group of Eight leaders, Kananaskis, Canada, June 27, 2002, <http://www.state.gov/e/eb/rls/othr/11514>

continuing and expanded efforts in CTR are successful, the danger posed by poorly secured fissile material stocks should recede over time, meaning that other measures are not moot.

THE IAEA ADDITIONAL PROTOCOL

Under article 3 of the NPT, the IAEA implements a safeguards and inspections regime intended to ensure that nonnuclear weapons states meet their treaty obligations not to use their nuclear programs to develop nuclear weapons. A measure taken to strengthen the safeguards regime, the so-called Additional Protocol, should make latent proliferation by this route more difficult, and also make it more difficult for countries to build illegal programs through second-tier proliferation.

Starting in 1972, the IAEA safeguards regime under article 3 was codified by IAEA information circular 153 (INFCIRC/153), whose stated goal was the timely detection of the diversion of significant quantities of nuclear material from permitted peaceful nuclear activities to nuclear weapons programs.¹⁰² But monitoring and inspections under INFCIRC/153 were typically applied only to facilities declared by the nation being inspected. By the early 1990s, the cases of the DPRK and Iraq had shown that the INFCIRC/153 safeguards could be sidestepped through the use of covert facilities.¹⁰³ Under the INFCIRC/153 oversight regime, IAEA access to undeclared facilities for the purpose of inspections could be refused.¹⁰⁴ More recently, but exemplary of the limitations of INFCIRC/153, Iranian authorities refused to allow IAEA sample collection at two centrifuge enrichment sites.¹⁰⁵

In reaction to the DPRK and Iraq experiences, in 1993 the IAEA embarked on a two-year project, known as Program 93 + 2, to strengthen the existing safe-

.htm. For analyses of subsequent progress, see Bunn, Wier, and Holdren, *Controlling Nuclear Warheads and Materials*, pp. 54–55.

102. IAEA, “The Structure and Content of Agreements between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons,” IAEA Information Circular, INFCIRC/153 (corrected), June 1972.

103. The IAEA did, under INFCIRC/153, request a “special inspection” of the DPRK after its inspectors found reason to believe that a violation may have occurred. The DPRK declined the request. The IAEA reported this to the UN Security Council, precipitating the DPRK’s threat to withdraw from the NPT and the Agreed Framework. See IAEA, “The Evolution of IAEA Safeguards,” IAEA International Verification Series No. 2 (1998), pp. 21–22.

104. See Ephraim Asculai, *Verification Revisited: The Nuclear Case* (Washington, D.C.: Institute for Science and International Security, 2002), pp. 13–18.

105. “Iran: IAEA Inspectors Turned Away from Nuclear Site, Leave Iran,” NTI Global Security Newswire, June 12, 2003; and Craig S. Smith “Iran Postpones a Visit by U.N. Inspectors until April,” *New York Times*, March 13, 2004.

guards system. Measures considered were divided into two parts, depending on whether they could be implemented under existing IAEA authority (so-called part 1 measures) or would require additional legal authority (part 2 measures). The additional legal authority for part 2 was provided by the IAEA board of governors in 1997 in the form of an Additional Protocol, INFCIRC/540.¹⁰⁶ As the IAEA explains, “While the chief object of safeguards under INFCIRC/153 is to verify that declared nuclear material was not diverted, the chief object of the new measures under INFCIRC/540 is to obtain assurance that the State has no undeclared activities.”¹⁰⁷ Under INFCIRC/540, states are required to make expanded, comprehensive declarations of all their nuclear material and nuclear-related activities; the IAEA may conduct environmental sampling wherever it has access; and the IAEA shall have access to any location to check for undeclared nuclear material or activities.¹⁰⁸ Acceptance of the Additional Protocol by member states is voluntary.¹⁰⁹

So far, too few states have ratified the Additional Protocol, though steady progress is being made.¹¹⁰ While eighty-four states plus Euratom had signed the protocol, and fifty-eight had ratified it as of June 2004 (including the United States, which ratified it in April 2004), among Middle East and Persian Gulf states the only signatories were Iran, Jordan, Kuwait, Libya, and Turkey.¹¹¹ Indeed, even though every nonnuclear weapons state signatory to the NPT is obliged under article 3 to conclude a safeguards agreement with the IAEA, some states such as Saudi Arabia have not even concluded this basic agreement—to which the Additional Protocol would need to be subsequently added.

States’ slowness in ratifying the Additional Protocol goes to the heart of the

106. IAEA, “Model Protocol Additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the Application of Safeguards,” IAEA Information Circular, INFCIRC/540 (corrected), September 1997.

107. IAEA, “The Evolution of IAEA Safeguards.”

108. For a summary of both part 1 and part 2 provisions, see Ming Shih Lu, “The IAEA Strengthened International Safeguards Systems,” Sixth ISODARCO Beijing Seminar on Arms Control, October–November 1998.

109. George Bunn argued that the Additional Protocol could legally have been interpreted to be compulsory for all NPT members; this argument did not prevail. See Bunn, “Inspection for Clandestine Nuclear Activities: Does the Nuclear Non-Proliferation Treaty Provide Legal Authority for the International Atomic Energy Agency’s Proposals for Reform?” *Nuclear Law Bulletin*, No. 57 (June 1996), pp. 9–22.

110. For a list of signatories with dates of signature and entry into force, see “Strengthened Safeguards System: Status of Additional Protocols” (as of September 29, 2003), http://www.iaea.org/worldatom/Programmes/Safeguards/sg_protocol.shtml.

111. See Chen Zak, *Iran’s Nuclear Policy and the IAEA: An Evaluation of Program 93 + 2* (Washington, D.C.: Washington Institute for Near East Policy, 2002).

bargain of the NPT. The Additional Protocol represents a greater intrusion into a country's sovereignty than does INFCIRC/153. Adherents to the Additional Protocol must provide ten-year fuel-cycle research and development plans to the IAEA, the activities and identities of persons or entities carrying out this R&D, export/import information, and descriptions of facilities. The signatories may also be subject to far more intrusive inspections. All of these are clearly negatives from the point of view of the signatory. What does it gain in return?

This question emphasizes the point that pushing for full adherence to the Additional Protocol must be accompanied by steps to ensure that states view their adherence to the protocol, or indeed to the NPT itself, as worth the price they have to pay. Multilateral demand-side inducements to this end are not necessarily inconsistent with influence the United States or others may unilaterally bring to bear to delay, stop, or roll back a particular state's nuclear program.¹¹² Increasingly onerous reporting and inspection requirements, as well as the *prima facie* inequalities of these requirements in comparison to those imposed on the nuclear weapons states (including those outside of the NPT), may be mitigated with appropriate inducements. One important inducement is that the adoption and implementation of the Additional Protocol should make countries less fearful of the nuclear ambitions of their neighbors, which in turn should make them feel more secure. This is the primary argument for the Additional Protocol given by the Bush administration,¹¹³ which claims strong U.S. support for the NPT.¹¹⁴ In the following discussion, we propose ways of linking the Additional Protocol to other measures to provide further inducements.

Effective implementation of the Additional Protocol faces budgetary obstacles. IAEA member states applied a policy of zero real growth to the IAEA from 1985 to 2003, despite an increase in its responsibilities.¹¹⁵ The agency's 2004 regular budget was less than \$269 million; within this, nuclear verifica-

112. A taxonomy of these approaches with historical examples is presented in Levite, "Never Say Never Again," pp. 76–85.

113. Statement by Deputy Assistant Secretary of State Andrew K. Semmel, alternate representative of the United States of America to the Second Session of the Preparatory Committee for the 2005 NPT Review Conference, Geneva, Switzerland, May 5, 2003, <http://www.us-mission.ch/press2003/0505IAEASafe.htm>.

114. The statement declares, "The United States remains firmly committed to its obligations under the NPT. We are pursuing a number of avenues that promote the goal of nuclear disarmament." Message from U.S. Secretary of State Colin Powell to the 2003 Preparatory Committee Meeting for the 2005 NPT Review Conference, quoted in John S. Wolf, "Remarks to the Second Meeting of the Preparatory Committee," Geneva, Switzerland, April 28, 2003, <http://www.state.gov/t/np/rls/rm/20034.htm>.

115. IAEA, "How Much Do Safeguards Cost?" n.d., <http://www.iaea.org/Publications/Booklets/Safeguards2/part8.html>.

tion received about \$102 million, the largest single budget category. With U.S. support, the IAEA board of governors accepted a budget increase of \$25 million to be phased in from 2004 to 2007.¹¹⁶ Given the centrality of IAEA safeguards and inspections to the nonproliferation regime, as well as the IAEA's expanding responsibilities, it is extraordinary and self-defeating that the IAEA's budget saw no growth for so long. An underfunded IAEA risks a catch-22 of limited means available to verify safeguards compliance. A robust IAEA should be a high-priority foreign policy objective of the United States.

STRENGTHENING OF EXPORT CONTROL REGIMES

Proliferation rings have benefited from both first- and second-tier proliferation. More robust inspections following broad adoption of the Additional Protocol should help to curtail these routes. Export control regimes are examples of supply-side measures that first-tier nuclear supplier states have adopted. These regimes must be extended to capture second-tier exporters as well. Yet it is also necessary to strengthen controls on first-tier suppliers. Progress in both regards may appear to be in some tension with article 4 of the NPT, which declares the "inalienable right of all the Parties to the Treaty to develop research, production and use of nuclear energy for peaceful purposes without discrimination"; the sentence continues, however, "in conformity with articles I and II of this Treaty." (Under article 1, nuclear weapons state parties agree not to assist nonnuclear weapons state parties in acquiring nuclear weapons; under article 2, nonnuclear weapons states undertake not to receive any assistance in the manufacture of nuclear weapons or seek to build their own.) For this reason, export controls that act to ensure that nuclear weapons technology does not spread are consistent with the NPT.

The export restrictions most relevant to the NPT are those of the NSG and the MTCR.¹¹⁷ The U.S. General Accounting Office (GAO) has assessed for the U.S. Congress the strengths and weaknesses of these two regimes, along with regimes for chemical and biological weapons (the Australia Group) and conventional weapons (the Wassenaar agreement), which do not so directly concern us here.¹¹⁸ The GAO recommends a number of commonsense steps that we endorse: (1) improve the completeness and timeliness of members' infor-

116. *IAEA Programme and Budget for 2004–2005*, n.d., <http://www.iaea.org/About/budget.html>. For U.S. support, see Statement by Deputy Assistant Secretary of State Semmel.

117. For the current memberships and guidelines of the NSG and MTCR, see <http://www.nuclearsuppliersgroup.org/> and <http://www.mtc.info/english/>, respectively.

118. U.S. GAO, *Nonproliferation Strategy Needed to Strengthen Multilateral Export Control Regimes*. See also <http://www.australiagroup.net/> and <http://www.wassenaar.org/>.

mation sharing regarding their export licensing decisions, including denials and approvals of exports; (2) decrease the length of time taken by members to adopt agreed-upon changes to control lists;¹¹⁹ (3) reconcile differences in how regime members implement agreed-upon controls; and (4) ensure that new members joining regimes have effective export control systems in place at the time they become members.¹²⁰

Item (1) in particular emphasizes how in some cases intelligence related to the actions and, by inference, intentions of some countries of concern could be improved by better capturing and sharing existing information among export control regime members. Some members have never reported any denials of export licenses. The reasons for this have not been evaluated systematically; it is possible that some countries provide “informal denials” to would-be exporters prior to formal applications for export licenses. If these are not reported, other regime members are not necessarily alerted that potential proliferators may be seeking particular items, and a chance to add to a fuller picture of those countries’ actions or intentions may be lost.¹²¹

The MTCR should be considered an integral part of the nuclear non-proliferation regime. First, the text of the MTCR itself recognizes that restrictions on exports of missile technology “is to limit the risks of proliferation of weapons of mass destruction [WMD] (i.e., nuclear, chemical and biological weapons), by controlling transfers that could make a contribution to delivery systems (other than manned aircraft) for such weapons.”¹²² Ballistic missiles are enabling technologies for WMD. In fact, there is little conventional utility for a 1,500-kilometer range missile in the absence of “smart” targeting ability. Damage effectiveness calculations will favor the quest for nonconventional warheads for such vehicles. Second, the expansion of long-range missile capability is a key psychological driver for the acquisition and expansion of strategic missile defenses; yet missile defenses may serve to spur an increase in offensive delivery vehicles and warheads on the part of some nuclear weapons states. Finally, and as we have seen, missile technology has apparently been a key element in some of the swaps involved in the proliferation of nuclear

119. *Ibid.* This process can take as long as a year for some members.

120. CIA Director Tenet reported in 2001 that Russia did not have an effective export control system, due to weak enforcement and insufficient penalties for violations. See Central Intelligence Agency, *Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, 1 January through 30 June 2001*.

121. U.S. General Accounting Office, *Nonproliferation Strategy Needed to Strengthen Multilateral Export Control Regimes*.

122. *Missile Technology Control Regime*, par. 1, <http://projects.sipri.se/expcon/mtrguidelines.htm>.

weapons technology. For all these reasons, better control of missile technology should decrease the missile-technology driver of nuclear proliferation.

NECESSARY BUT INSUFFICIENT

While the steps endorsed or advocated so far are important, they represent incremental improvements in the current regime. But there are limits to how far incremental improvements can go, and more ambitious measures will likely need to be implemented. For example, consider improvements in the control of nuclear weapons-relevant exports under the NSG. The roles of the Malaysian firm Scomi Precision Engineering and the Turkish EKA electrical equipment company in producing centrifuge technology for shipment to Libya underscore the need to expand export controls (including controls for dual-use equipment) beyond the first-tier suppliers of the NSG, though the immediate benefits to third world states in adopting dual-use export controls may be unclear.

In some cases, the answer will be to bring additional members into the NSG. Indeed, Estonia, Lithuania, Malta, and the People's Republic of China joined the NSG in May 2004.¹²³ Some analysts have suggested that the NSG should be globalized, with the body moved away from consensus decisionmaking to majority rule.¹²⁴ Widening the NSG, however, could push its decisions toward the lowest common denominator, and it could prove difficult to globalize by majority vote the strengthening of export restrictions, especially for dual-use items. Even the Nuclear Exporters Committee (or Zangger Committee) was bypassed by the NSG in part because of the committee's failure to cover these items.¹²⁵ Yet as the Scomi and EKA examples demonstrate, not all exporters of relevant dual-use nuclear equipment are within countries that are members of the Zangger Committee or the NSG. (Malaysia and Turkey are members of neither.) Moreover, effective export controls need to be implemented by all three of the nuclear non-NPT states (i.e., India, Israel, and Pakistan) as well.¹²⁶

123. "The NSG—Strengthening the Nuclear Non-proliferation Regime," NSG plenary meeting, Göteborg, Sweden, May 27–28, 2004, <http://www.nuclearsuppliersgroup.org/PRESS/2004-05-goteborg.pdf>.

124. See, for example, Michael Beck and Seema Gahlaut, "Creating a New Multilateral Export Control Regime," *Arms Control Today*, Vol. 33, No. 4 (April 2003), pp. 12–18.

125. A history of the Nuclear Exporters Committee and the NSG may be found in Leonard S. Spector and Mark G. McDonough, with Evan S. Medeiros, "Appendix D: Nuclear Supplier Organizations," in *Tracking Nuclear Proliferation: A Guide in Maps and Charts* (Washington, D.C.: Carnegie Endowment for International Peace, 1995), pp. 179–183.

126. See Anupam Srivastava and Seema Gahlaut, "Curbing Proliferation from Emerging Suppliers: Export Controls in India and Pakistan," *Arms Control Today*, Vol. 33, No. 9 (September 2003), pp. 12–16.

Bush and ElBaradei Supply-Side Proposals

The incremental approaches to improving the nonproliferation regime just described are important but not sufficient to the challenge posed by proliferation rings. More ambitious proposals were made in 2003–04 by both the Bush administration and the director general of the IAEA.

The heart of the Bush administration's approach to the nonproliferation threat has been to improve enforcement of the supply-side strictures (articles 2 and 3) of the NPT and to close what administration officials see as NPT loopholes that can allow proliferation under the guise of good standing with the treaty (article 4). The administration has not pursued global treaty-based approaches to these ends; rather it has assembled specific coalitions to pursue particular objectives according to mutually agreed criteria for which it would be challenging to gain universal acceptance. In a remarkable move, the administration has also worked through the UN Security Council to impose global nonproliferation measures via resolution. Some of its proposals are substantively similar to recommendations made by Director General ElBaradei, although his proposals are consistent with a global treaty-based approach to these issues. The administration's proposals carry the sense that progress toward the objective takes precedence over allegiance to particular approaches, especially slow ones requiring global consensus.

An important issue is the extent to which these less-than-global supply-side approaches can achieve their objectives in the long term, and whether other approaches could strengthen them or prolong their effectiveness. In the following sections, we present a chronological sketch of the Bush and ElBaradei proposals, then turn to where these proposals fall short and what else could be done.

THE PROLIFERATION SECURITY INITIATIVE

President Bush announced the Proliferation Security Initiative (PSI) in Krakow, Poland, on May 31, 2003.¹²⁷ The initiative initially brought together eleven nations to agree to practical steps to interdict shipments of missiles, chemical and biological agents, and nuclear components traveling through their national territories.¹²⁸ These countries' formal Statement of Interdiction Princi-

127. White House, "Remarks by the President to the People of Poland," Krakow, Poland, May 31, 2003, <http://www.whitehouse.gov/news/releases/2003/05/20030531-3.html>.

128. The original PSI countries are Australia, France, Germany, Italy, Japan, the Netherlands, Poland, Portugal, Spain, the United Kingdom, and the United States.

ples in September 2003 called on all states to (1) undertake such interdiction measures; (2) streamline procedures for rapid exchange of relevant information; (3) strengthen their national legal authority to accomplish these objectives; and (4) take a series of specific actions in support of interdiction efforts, including not only interdicting craft in their own territory but also to “seriously consider” providing consent to the boarding of a signatory’s own flag vessels “by other states.”¹²⁹ The PSI has expanded to fifteen core members, including Russia; the United States claims that more than sixty other states support the initiative.¹³⁰ The United States has also signed boarding agreements with the leading flag states, Liberia and Panama, to allow their vessels to be stopped and searched.¹³¹

The PSI is a supply-side measure that, unlike traditional export-control suppliers’ regimes, directly addresses second-tier as well as first-tier proliferation. The success of the PSI will depend strongly on intelligence; its best-known success claimed by U.S. officials is the interdiction and seizure by German and Italian authorities of centrifuge parts aboard the BBC *China*, the German-owned ship bound for Libya that originated in Malaysia, via Dubai.¹³² All the same, the PSI’s limitations should be recognized: some high-consequence types of nuclear smuggling could involve small-volume packages that are either transported by means not inspected by the PSI members or that could prove very hard to detect and track; despite U.S. efforts to expand the initiative to include more members, important countries along the transfer routes may choose not to participate; intelligence is imperfect, and timely “actionable” intelligence may be scarce. The PSI is but one supply-side component in what must be a web of measures to counter proliferation, but by speaking directly to second-tier proliferation, it represents an important new step.

129. “Proliferation Security Initiative, Statement of Interdiction Principles,” Paris, France, September 4, 2003.

130. The additional adherents are Canada, Norway, and Singapore. See Jofi Joseph, “The Proliferation Security Initiative: Can Interdiction Stop Proliferation?” *Arms Control Today*, Vol. 34, No. 5 (June 2004), pp. 6–13. Russia joined the PSI in May 2004. See George Jahn, “U.S. Welcomes Russia Arms Security Effort,” Associated Press, June 1, 2004, <http://www.ransac.org/Projects%20and%20Publications/News/Nuclear%20News/2004/612004123906PM.html#1C>.

131. Flag states permit foreign-owned ships to operate under their national flag, often for reasons of lower costs or more lenient operating rules. See Wade Boese, “U.S., Panama Agree on Boarding Rules for Ships Suspected of Carrying WMD,” *Arms Control Today*, Vol. 34, No. 5 (June 2004), pp. 38–39.

132. See White House, “President Announces New Measures to Counter the Threat of WMD,” Fort Lesley J. McNair, National Defense University, Washington, D.C., February 11, 2004, <http://www.whitehouse.gov/news/releases/2004/02/20040211-4.html>.

DIRECTOR GENERAL ELBARADEI'S PROPOSALS

In October 2003, IAEA Director General ElBaradei called for a new non-proliferation framework "more suited to the threats and realities of the 21st century."¹³³ Criticizing the behavior of both the nuclear weapons states and the nonnuclear weapons states party to the NPT, ElBaradei focused on the dangers of latent proliferation. The director general made three proposals: (1) limit the production of separated plutonium or HEU to facilities under multilateral control; (2) convert existing HEU facilities to low-enriched uranium and deploy only new systems that are proliferation resistant; and (3) consider multinational approaches to spent fuel and radioactive waste disposal. In addition, he called for renewed attention to the Fissile Material Cutoff Treaty (FMCT). In an editorial published on February 12, 2004, in response to President Bush's speech on related topics, ElBaradei also called for greater adherence to the Additional Protocol, suggested that "no country should be allowed to withdraw" from the NPT, and urged that the export control system be universalized with the enactment of "binding, treaty-based controls."¹³⁴ The combination of these measures would make it more difficult for countries to use civilian nuclear capacity acquired under article 4 of the NPT to create a de facto nuclear weapons capability, and then withdraw from the treaty (with only three-months' notice required under the NPT's article 10) to produce them.

With respect to the challenge of proliferation rings, the implementation of ElBaradei's recommendations could increase the difficulty of constructing an illicit program, however supplied, so that the export of nuclear weapons-related material for that end would be discouraged. The dilemma is not so much one of goals as of implementation. A number of ElBaradei's recommendations would have the effect of placing further restrictions on nonnuclear weapons states and even limiting their sovereignty. A global treaty-based approach to these objectives would first have to convince such states that it was in their interest to pursue these objectives. Experience suggests that negotiating a global treaty with tough enforcement measures could take a long time. Alternatively, these objectives could be sought through other means. This has been the approach of the Bush administration.

133. Mohamed ElBaradei, "Towards a Safer World," *Economist*, October 16, 2003, pp. 48–50.

134. Mohamed ElBaradei, "Saving Ourselves from Self-Destruction," *New York Times*, February 12, 2004.

PRESIDENT BUSH'S SEVEN PROPOSALS

In his speech at the National Defense University on February 11, 2004, President Bush announced seven proposals "to strengthen the world's efforts to stop the spread of deadly weapons."¹³⁵ These are (1) expansion of the PSI; (2) quick passage by the UN Security Council of a U.S. proposal from fall 2003 "requiring all states to criminalize proliferation, enact strict export controls, and secure all sensitive materials within their borders"; (3) broadening of CTR beyond the FSU; (4) NSG denial of enrichment and reprocessing equipment and technologies "to any state that does not already possess full-scale, functioning enrichment and reprocessing plants," while ensuring that states renouncing enrichment and reprocessing have reliable access at reasonable cost to civilian reactor fuel; (5) denial of civilian nuclear reactor-program equipment to states that have not signed the Additional Protocol; (6) creation of a safeguards and verification committee of the IAEA board of governors; and (7) prohibition of membership on this committee or the IAEA board to any state "under investigation for proliferation violations."

These proposals cluster into several groups. Proposals (1) and (2) endeavor to prevent or interdict nuclear weapons-related shipments, and thus speak directly to the proliferation rings issue. Proposal (3) speaks to the primordial need to prevent nuclear theft. Proposals (4) and (5) parallel ElBaradei's suggestions, and if successfully implemented would hamper the ability of countries to pursue illicit nuclear programs, however supplied. Proposals (6) and (7) are less action oriented but would presumably make violations of the NPT more difficult. The proposals are striking for their lack of appeal to universally negotiated approaches. The PSI is a coalition of the willing, and nuclear suppliers' export controls would be improved through the actions of the limited-membership NSG. How to enforce a requirement that only signatories to the Additional Protocol be allowed to import civilian reactor equipment is not specified. The immediately preceding part of the speech, however, leads one to assume that this would be by NSG decision.

SECURITY COUNCIL LAWMAKING

The Bush administration's second proposal, the expansion of export controls to all countries of the world, was to be imposed by vote of the UN Security Council, rather than be the product of a negotiated treaty or agreed reinterpretation

135. White House, "President Announces New Measures to Counter the Threat of WMD."

of article 3 of the NPT. President Bush first proposed such a Security Council resolution in his address to the UN General Assembly on September 23, 2003.¹³⁶ A draft resolution began circulating in December 2003; subsequent negotiations among the Permanent Five led in March 2004 to a P-5-supported draft resolution that the United States and United Kingdom presented to the ten elected Security Council members. The Security Council adopted Resolution 1540 in April 2004.¹³⁷

There are twelve points listed in Resolution 1540; of these, many “call upon” states to take certain steps, but points (1) through (3) represent Security Council lawmaking, a remarkable new approach to global enforcement of non-proliferation requirements.¹³⁸ Point (2) requires states to adopt internal legislation, announcing that the Security Council “decides also that all States . . . shall adopt and enforce appropriate effective laws which prohibit any non-State actor to manufacture, acquire, possess, develop, transport, transfer or use nuclear, chemical or biological weapons and their means of delivery.” Point (3) states that the Security Council “decides” that states will “(a) develop and maintain appropriate effective measures to account for and secure” nuclear, chemical, or biological weapons and materials; “(b) develop and maintain appropriate effective physical protection measures; (c) develop and maintain appropriate effective border controls and law enforcement efforts” to prevent illicit trafficking in these materials; and “(d) establish, develop, review and maintain appropriate effective national export and trans-shipment controls over such items, including appropriate laws and regulations to control export, transit, trans-shipment and re-export” of such items along with appropriate penalties for violations. The P-5 have imposed a requirement for supply-side measures against proliferation on every other nation of the world.

Beyond the Bush and ElBaradei Responses

Both President Bush and Director General ElBaradei see the importance of confronting the challenge of latent proliferation, incrementally through the univer-

136. White House, “President Bush Addresses United Nations General Assembly,” United Nations, New York, September 23, 2003, <http://www.whitehouse.gov/news/releases/2003/09/20030923-4.html>.

137. UN Security Council Resolution 1540 (2004), http://www.un.org/Docs/sc/unsc_resolutions04.html.

138. We are grateful to George Bunn for emphasizing this aspect of Resolution 1540 in discussions with us.

sal adoption of the Additional Protocol and more radically through limits on HEU production and plutonium reprocessing. Both appeal to supply-side measures to address first- and second-tier proliferation. ElBaradei calls for “treaty-based” universalization of export controls. But as we have argued, universalizing the NSG risks reducing its effectiveness, even as it expands; negotiating a universal regime within the NPT will not directly capture India, Israel, and Pakistan; and negotiating a new universal regime to include all the nations of the UN would be a labor of many years—yet the problem is urgent. Not surprisingly, the Bush administration favors either a Security Council resolution (for export controls) or a coalition of willing states (for the PSI), with neither leading to a new global treaty-based regime.

There is precedent for this approach in the creation of the NSG, largely at the initiative of the United States, subsequent to India’s first nuclear test explosion in 1974. But unlike the NSG, which established consensus export controls for participating states, Resolution 1540 requires all nations to adhere to export controls. The resulting tension—global requirements without first reaching global consensus—is evident in the criteria to which the resolution appeals with respect to implementation. Resolution 1540 declares that the Security Council decides that states shall develop and maintain “appropriate” export controls “to prevent the proliferation of nuclear, chemical, or biological weapons and their means of delivery,” and that it recognizes the need for “effective national export and trans-shipment controls.” But the resolution is silent on whether certain countries are to be prohibited from receiving certain items, and by what criteria.

The PSI bears greater resemblance to the NSG. The September 2003 PSI Statement of Interdiction Principles, for example, declares that PSI members agree to interdict WMD transfer “to and from states and non-state actors of proliferation concern,” a phrase that it says “generally refers to those countries or entities that the PSI participants involved establish should be subject to interdiction activities because they are engaged in proliferation.”¹³⁹ Similarly, in 1994 the NSG agreed that a nuclear supplier should authorize a transfer of trigger list items only when it is satisfied that the transfer would not contribute to nuclear weapons proliferation, recognizing that formal adherence to the NPT may not in itself be a guarantee that a recipient state in fact shares a commitment to nonproliferation.¹⁴⁰ The PSI is more ambitious than the NSG in that

139. Proliferation Security Initiative, “Statement of Interdiction Principles,” Paris, France, September 4, 2003.

140. INFCIRC/539 (attachment), “The Nuclear Suppliers Group: Its Origins, Role, and Activities,” n.d., http://projects.sipri.se/expcon/infirc_539_1.htm.

PSI countries are pressuring flag carrier states to agree to the boarding of their ships on the high seas. Under the agreements reached with Liberia and Panama, permission will be granted on a case-by-case basis, but failure to respond to a specific request within a two-hour period will be treated as consent to act.¹⁴¹

There are three challenges facing the Bush administration proposals. The first two are challenges of effectively universalizing their initiatives. The third concerns the incompleteness of a supply-side response.

UNIVERSALIZATION OF EXPORT CONTROLS AND THE PROLIFERATION SECURITY INITIATIVE

Security Council Resolution 1540 preempts Director General ElBaradei's proposal to universalize export controls. Perhaps the Security Council will ultimately promulgate and update a trigger list of items that would fall under every nation's export controls. This and other steps might come within the purview of the Security Council committee created by Resolution 1540 to report on implementation, should the committee lead to a standing body. But what criteria are to be used for determining which nations are to be trusted as nuclear export recipients? PSI- or NSG-like decisions by a small number of nations will be impossible, unless the Security Council anticipates regularly reaching ad hoc agreement on particular nations that are viewed as unacceptable recipients. Yet every country will have a stake in export controls being effectively implemented by each UN member.

One solution that could be broadly acceptable and useful would be a global requirement that exports can be made only to countries that have concluded Additional Protocol agreements with the IAEA, had these agreements enter into force, and remained in good standing with these commitments. The NSG would continue to exist in addition to this universal export regime, as a first-tier body that could exercise stricter controls that would not have to achieve Security Council approval.

If the Security Council wished to universalize the PSI in a similar fashion, it could also rely on good standing with the Additional Protocol to separate those countries that were "of proliferation concern" from those that were not. The strictest export controls would be applied universally to countries of concern under this definition. The countries of the original PSI, analogously to those of the NSG, could continue to apply their own criteria as well, drawing in part on their own intelligence and suspicions.

141. Boese, "U.S., Panama Agree on Boarding Rules for Ships Suspected of Carrying WMD."

THE NEED FOR DEMAND-SIDE STEPS

The PSI and Resolution 1540 suggest that the United States and the P-5 do not view the current situation as one in which the state proliferation dilemma will be solved after a small number of “hard cases” in the world is addressed. Rather, these efforts seek to establish measures with global reach that will, by all appearances, continue indefinitely. This long-term perspective is wise, but it must also be recognized that the technological trajectory of many traditionally nuclear nonsupplier states is such that nuclear weapons-relevant technology will become increasingly available, either by illicit trade within proliferation rings (at least the trade that is not interdicted) or by the creation of indigenous capability. The manufacture of centrifuge-relevant components by Scmi Precision Engineering in Malaysia and EKA in Turkey emphasizes that, even though the PSI may successfully intercept equipment shipments, it will not be effective in interdicting the globalization of technology and know-how. More and more companies and countries will learn to manufacture these components for themselves, especially because most of the required items represent dual-use technologies with legitimate civilian applications. Therefore, in the long run, supply-side steps will not be enough, and demand-side measures must be given greater attention.

In fact, the proposals considered so far all have the effect of tightening the article 2 and article 3 requirements under the NPT for the nonnuclear weapons states. To be fair, they also restrict business opportunities for the nuclear weapons states, an article 1 measure. Nevertheless, for the long-term viability of the NPT, these additional burdens must be balanced by advantages of adherence to the NPT regime. For some states, this will be the advantage, under article 2, of an assurance that similar proliferation restraints are imposed on their neighbors, at times reinforced by positive security assurances from the United States or other countries. However, for those states that suspect their neighbors of having engaged in long-term clandestine or semi-overt nuclear or other so-called WMD acquisition programs,¹⁴² the basic elements of the NPT agreement will not seem to be met. Their adherence to the NPT will entail a degree of uncertainty regarding their long-term security against potentially WMD-armed neighbors.

If the mix of economic benefits expected under article 4 of the NPT, and the security benefits under article 2, are insufficient to compensate for this uncer-

142. For a discussion of the confusion and misleading analogies that the use of the blanket term “WMD” encourages, see Christopher F. Chyba, “Toward Biological Security,” *Foreign Affairs*, Vol. 81, No. 3 (May/June 2002), pp. 123–127.

tainty, the likelihood of covert defection from the regime will increase. Moreover, to the extent that nations that have successfully proliferated appear to have gained in prestige and security, the more it may seem that defection from the nonproliferation regime, carefully pursued, can bring considerable benefits. In this light, defection is not an irrational decision explained by a nation's "rogue" status, but rather a rational response to an unfavorable balance of incentives and disincentives.

Supply-side measures remain crucial to nonproliferation, but are not sufficient answers to the exchanges of technological know-how that occur within proliferation rings. They will become more difficult to monitor and enforce as the capability to manufacture uranium centrifuges becomes increasingly widespread. Nor will it be easy for supply-side measures to address what occurs on the territory of states with especially weak governments; even the calls in Resolution 1540 for assistance with legal and regulatory infrastructure cannot extend a government's authority into territory it does not de facto control.

Demand-side measures to accompany the new supply-side steps will involve blending, and in some cases strengthening and extending, traditional approaches. Security guarantees and the imposition, or lifting, of economic sanctions will continue to play important roles. These have been deployed in varying ways, and with varying success, in the case of most countries that have been part of the proliferation rings described here. The easing of regional security concerns will also be a crucial objective even as supply-side steps slow a state's ability to develop a nuclear arsenal. All these must be pursued on a case-by-case basis. But a broadly relevant sweetener for many countries could be a program to provide energy support in return for appropriate behavior with respect to weapons development. This would be consistent with, but would expand, the bargain implicit in article 4 of the NPT: that the benefits of nuclear technology be available, under controls, to the nonnuclear weapons states.

AN ESI TO COMPLEMENT THE PSI

A major benefit of the NPT, made explicit in article 4, was supposed to be preferred access to presumed abundant and low-cost nuclear electricity supplies, as also envisioned in President Dwight Eisenhower's Atoms for Peace program of 1953.¹⁴³ It has become clear, however, that nuclear power is not a low-cost energy option, but rather a very demanding technology in its con-

143. For a description and critique of this program, see Henry Sokolski, *Best of Intentions: America's Campaign against Strategic Weapons Proliferation* (Westport, Conn.: Praeger, 2001), pp. 25–37.

struction and operation. The hope of utilizing the nuclear energy option for “bootstrapping” a national economy to a higher technical development level, and for raising national standards of living through the supply of low-cost power, has at best only partially been met. And now states are being asked to accept even more intrusive and costly safeguards on their nuclear activities, if not an outright ban on their development of indigenous nuclear fuel-cycle facilities, while in some cases having neighbors that are pursuing, openly or clandestinely, nuclear weapons programs.

The NSG guidelines for nuclear transfers call on suppliers to “encourage” recipients to accept, “as an alternative to national plants,” supplier involvement or multinational participation (or possibly both) in their enrichment or reprocessing facilities.¹⁴⁴ The nonproliferation benefits of the resulting transparency are clear; such an approach, however, should be mated with incentives to make the bargain more appealing to recipient countries. A menu of possible energy-related benefits could be clustered under a new Energy Security Initiative (ESI) that would parallel and compensate for the burdens that would be imposed on nonnuclear weapons states by the PSI, the Additional Protocol, and universalized export controls.

In particular, this approach can be tied to fuel-leasing arrangements in which countries with good NPT standing (including with respect to the Additional Protocol) could lease subsidized, lower-cost fuel for their nuclear plants, with the subsidy costs borne by the nuclear weapons or NSG states. Subsidized fuel leasing should be coupled with spent fuel take-back programs and could also, at a later stage, be coupled with the storage of that fuel at regional spent fuel storage facilities to be run by regional organizations and monitored by their own participating members, as well as by the IAEA. Such suggestions have recently been made regarding the DPRK and Iran.¹⁴⁵ Finally, even though article 4 of the NPT speaks exclusively of nuclear energy, consideration should

144. Section 6 of the NSG part 1 guidelines reads in part: “If enrichment or reprocessing facilities, equipment or technology are to be transferred, suppliers should encourage recipients to accept, as an alternative to national plants, supplier involvement and/or other appropriate multinational participation in resulting facilities. Suppliers should also promote international (including IAEA) activities concerned with multinational regional fuel cycle centers.” See IAEA INFCIRC/254/Rev.6/Part 1 (corrected), “Communications Received from Certain Member States Regarding Guidelines for the Export of Nuclear Material, Equipment, and Technology,” May 16, 2003, <http://www.nsg-online.org/guide.htm>.

145. William J. Perry and Ashton B. Carter, “The Crisis Last Time,” *New York Times*, January 19, 2003; Daniel Poneman and Robert Gallucci, “U.S. Should Offer a Better Deal to N. Korea,” *Los Angeles Times*, May 24, 2004; and Brent Scowcroft, “A Critical Nuclear Moment,” *Washington Post*, June 24, 2004.

be given to expanding its scope to nonnuclear energy alternatives under appropriate commercial terms, as well as to electric transmission grid enhancements, for demonstrable adherence to NPT obligations. Some indications of this approach can be identified in proposals to improve the Iranian oil and gas industries as part of the ultimate solution to Iran's energy supply situation and an acceptable outcome for its nuclear program.¹⁴⁶ A similar approach has been proposed as part of the resolution of the DPRK nuclear standoff, most recently in the six-party talks held in Beijing in June 2004,¹⁴⁷ an approach that in this respect seems to parallel efforts reportedly pursued by the United States and United Kingdom vis-à-vis Libya.¹⁴⁸ The intent of the ESI would be to present an international policy declaration up front, providing a menu of potential incentives to be tailored to the needs of particular countries. In this way the two sides of the NPT bargain would be visibly brought into closer balance.¹⁴⁹

Cooperation under article 4 need not be limited to energy; indeed the IAEA's Technical Cooperation Program also funds public health and environmental assistance efforts that have a nuclear component.¹⁵⁰ The total 2004 budget for the IAEA technical cooperation program is about \$75 million.¹⁵¹ Further incentives along these lines could be explored as well.

A FISSILE MATERIAL CUTOFF TREATY

Pulling those nuclear weapons states outside of the NPT into a system of constraints on their nuclear programs would have the benefit of increasing the evident equity of the nuclear nonproliferation regime. One way to pursue this approach is through the Fissile Material Cutoff Treaty. The FMCT was sup-

146. For a discussion on Iran's oil and gas reserves and their role vis-à-vis a proposed nuclear power program, see John R. Bolton, "U.S. Efforts to Stop the Spread of Weapons of Mass Destruction," testimony before the U.S. Congress, House International Relations Committee, 107th Cong., 2d sess., June 4, 2003.

147. For a discussion of proposed deals to resolve the DPRK standoff, including energy supply assistance, see Selig S. Harrison, "Turning Point in Korea—New Dangers and New Opportunities for the U.S.," report of the Task Force on U.S. Korean Policy (Chicago: Center for East Asian Studies, University of Chicago, February 2003); and Michael O'Hanlon and Mike Mochizuki, "Towards a Grand Bargain with North Korea," *Washington Quarterly*, Vol. 26, No. 4 (Autumn 2003), pp. 7–18.

148. See, for example, "Qaddafi's Son Says Libya Was Promised Economic, Military Gains for 'WMD' Disarmament."

149. Chaim Braun, "Energy Security Initiative (ESI): A New Opportunity to Enhance the Nonproliferation Regime," Center for International Security and Cooperation and Institute for International Studies, Stanford University, August 25, 2004.

150. For example, the sleeping sickness-carrying tsetse fly was eliminated from Zanzibar through the release of radiation-sterilized male flies. See IAEA, "Campaign Launched to Eliminate Tsetse Fly," WorldAtom press release, PR2002/0219, February 2002.

151. IAEA *Programme and Budget for 2004–2005*.

ported by a consensus resolution of the UN General Assembly in 1993, which calls for the negotiation of a “non-discriminatory multilateral and internationally and effectively verifiable treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices.”¹⁵² An FMCT would apply an arms control measure to both the nuclear as well as the nonnuclear weapons states within the NPT. It would also, if it could be globally applied, rein in the nuclear programs of India, Israel, and Pakistan, and thereby begin to reduce the sense that these nations have gained unfair advantages by remaining outside the NPT. The nuclear weapons states promised an FMCT in 1995 as one of the considerations for the indefinite extension of the NPT.¹⁵³ At the 2000 NPT Review Conference, one of the “13 steps” related to article 6 obligations agreed upon by consensus was the achievement of an FMCT within five years.¹⁵⁴ Linkage of the FMCT at the Conference on Disarmament in Geneva to the Prevention of an Arms Race in Outer Space initiative delayed progress for years, but there may now be an opportunity to revive the FMCT negotiations.¹⁵⁵

Were it realized, an FMCT would help in several ways: (1) it would demonstrate further nuclear weapon–state movement under article 6 of the NPT; (2) by putting a cap on Israel’s and Pakistan’s nuclear weapons material production, it would start to address Iran’s security concerns vis-à-vis these two nations; and (3) by placing a cap on India’s nuclear weapons material production, it would begin to tackle Pakistan’s and even China’s security concerns vis-à-vis India. Moreover, the United States has a strong interest in pursuing restraints on the nuclear programs of India, Israel, and Pakistan. For all these reasons, the United States should vigorously pursue an FMCT. In July 2004, however, the Bush administration announced a major shift in U.S. policy to-

152. United Nations General Assembly, “Prohibition of the Production of Fissile Materials for Weapons or Other Nuclear Explosive Devices,” UNGA 48/75L, December 16, 1993.

153. Paragraph 4(b) of “Principles and Objectives for Nuclear Non-Proliferation and Disarmament,” adopted by consensus by the parties to the NPT at the May 1995 extension conference, called for “the immediate commencement and early conclusion of negotiations on a non-discriminatory and universally acceptable convention banning the production of fissile material for nuclear weapons or for other nuclear explosion devices.”

154. *2000 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons: Final Document*, May 2000, par. 15.3. The United States has stated that it “no longer supports all 13 steps.” See, for example, U.S. Department of State Fact Sheet Provided to the Second Session of the Preparatory Committee for the 2005 NPT Review Conference, “Article VI of the Non-Proliferation Treaty,” May 1, 2003, <http://www.state.gov/t/np/rls/fs/20288pf.htm>.

155. See “Statement by Mr. Hu Xiaodi, Ambassador for Disarmament Affairs of China, at the Plenary of the 2003 Session of the Conference on Disarmament,” Geneva, Switzerland, August 7, 2003, <http://www.china-un.ch/eng/53991.html>.

ward the FMCT, declaring that it would oppose verification provisions for the treaty.¹⁵⁶

THE ROLE OF U.S. NUCLEAR WEAPONS POLICY

U.S. nuclear weapons policy has historically played an important role on the demand side of controlling proliferation.¹⁵⁷ For example, the United States has used positive security assurances in the past to convince nonnuclear allies considering nuclear weapons that the protection of the U.S. defense umbrella spared them the need for their own nuclear weapons program. Negative security assurances—reassurances against a nuclear first strike—were originally provided under President Jimmy Carter’s administration, but have been weakened by a number of recent Bush administration policy statements. According to excerpts leaked to the press, the Bush administration’s 2002 Nuclear Posture Review states that “North Korea, Iraq, Iran, Syria, and Libya are among the countries that could be involved in immediate, potential, or unexpected contingencies.” As reported, this statement appears shortly after the same document’s assertion that “in setting requirements for nuclear strike capabilities, distinctions can be made among the contingencies for which the United States must be prepared. Contingencies can be categorized as immediate, potential or unexpected.”¹⁵⁸ Policy-level statements such as these, along with “axis of evil” rhetoric, may be taken by the DPRK and Iran to mean that they risk nuclear attack by the United States. The United States should instead seek to undermine the security rationale for these states’ demand for nuclear weapons, even if certain regional security concerns will nevertheless remain.

Further nuclear policy statements by the Bush administration, such as its December 2002 National Strategy to Combat Weapons of Mass Destruction, its opposition to ratification of the Comprehensive Test Ban Treaty, and its desire to fund research into new-generation nuclear weapons intended for preventive attacks on underground national command centers or biological or chemical weapons bunkers,¹⁵⁹ signal to other nations that nuclear weapons may play a growing, not diminishing, role in U.S. security decisions. They also undermine

156. Dafna Linzer, “U.S. Shifts Stance on Nuclear Treaty,” *Washington Post*, July 31, 2004.

157. For a review, see Levite, “Never Say Never Again.”

158. For excerpts from the *Nuclear Posture Review*, see *GlobalSecurity.org*, <http://www.globalsecurity.org/wmd/library/policy/dod/npr.htm>.

159. *National Strategy to Combat Weapons of Mass Destruction*, December 2002, <http://www.whitehouse.gov/news/releases/2002/12/WMDStrategy.pdf>. See also Carl Hulse and James Dao, “Cold War Long Over, Bush Administration Examines Steps to a Revamped Arsenal,” *New York Times*, May 29, 2003.

the impression of progress by the United States to meet its obligations under article 6 of the NPT “to pursue negotiations in good faith on effective measures related to cessation of the nuclear arms race at an early date and to nuclear disarmament,” despite the reductions in the size of the U.S. and Russian nuclear arsenals.¹⁶⁰

In its 2002 National Security Strategy, the Bush administration emphasized that the United States will engage in preventive (which it calls “preemptive”) attacks to counter emerging threats.¹⁶¹ But as the case of the DPRK shows, it is possible for even small third-world nations to deter the United States from military action, either by conventional threats (e.g., artillery aimed at Seoul) or, should they succeed in developing nuclear weapons, nuclear ones. Therefore options for preventive war will remain limited, though not excluded. Moreover, preventive wars will carry very significant costs and unforeseen consequences for the United States. It is exactly to reduce the need or perceived need for such wars that new means of strengthening the nonproliferation regime must be found, and the emergence and expansion of proliferation rings prevented or disrupted.

Conclusion

Latent proliferation and proliferation rings represent two major and broad challenges to the survival of the nuclear nonproliferation regime. Proliferation rings exacerbate the latent proliferation challenge and illustrate the inadequacy of current export controls. The full development of such proliferation rings will ultimately render export control regimes limited to the traditional nuclear suppliers moot, as a set of third world countries (or their substate actors) develop nuclear weapons technology and manufacturing bases, disconnect from first- or second-world suppliers, and trade among themselves for the capabilities that their individual programs lack. Technology transfer among proliferating states could cut the cost and time period to acquisition of nuclear weapons capabilities, and even to deployment of integrated weapons and delivery systems, thus reducing the reaction time available to the overall non-

160. The Bush administration asserts that reductions agreed under the Moscow Treaty are strong evidence of its fulfillment of its article 6 obligations. See Wolf, “Remarks to the Second Meeting of the Preparatory Committee.”

161. *The National Security Strategy of the United States of America*, September 2002, p. 15.

proliferation regimes. Worse, the possibility that nuclear weapons would be intentionally transferred or lost to terrorist groups cannot be discounted.

Addressing the challenge of proliferation requires action on both the supply and demand sides of the nonproliferation equation. However, a strategy to limit future proliferation rings must rely more strongly on demand-side approaches than nonproliferation regimes have in the past, precisely because of the disconnect they represent from the first and second worlds. The PSI and the Security Council's Resolution 1540 are supply-side steps that speak directly to this problem. But universal implementation of the latter is far from guaranteed, and the former will be increasingly challenged as relevant nuclear know-how and capacity spreads. Therefore, in addition to these supply-side measures, the balance of factors evaluated by states considering proliferation must be shifted back in favor of adherence to the nonproliferation regimes.

While preventive wars against some proliferators may play their role in the future, the United States will likely often find itself strongly deterred from exercising such options except as a last resort, and in the face of high costs. The United States should therefore place an extremely high priority on maintaining the strongest reasonable nonproliferation regimes. But of course no single proposal is a solution. The "silver bullet fallacy," which disdains useful measures that are less than total solutions, must be resisted. Rather, each step must be recognized as but one strand in a web of a multifaceted nonproliferation strategy.

Indeed, the development of proliferation rings and their detachment from traditional nuclear supplier export controls is a reminder that in the long term, any control regime that relies on restricting the diffusion of technology may well fail.¹⁶² One purpose of the existing regimes is therefore to provide the time during which alternative approaches may be found to limit the perceived need for nuclear weapons or other WMD for confronting regional security dilemmas, and to encourage the evolution of governments that do not see WMD programs as useful or wise diversions of their society's resources. U.S. policy, including nuclear weapons policy, should be made with these long-term objectives in constant view.

162. Physicist Wolfgang K.H. Panofsky comments, "All new technologies have become dual-use . . . and . . . all new technologies have, in time, spread around the globe." Panofsky, "Nuclear Proliferation Risks, New and Old," *Issues in Science and Technology Online*, Summer 2003, <http://www.nap.edu/issues/19.4/panofsky.html>.