PAKISTAN'S NUCLEAR WEAPONS PROGRAM: A STATUS REPORT

by Andrew Koch and Jennifer Topping

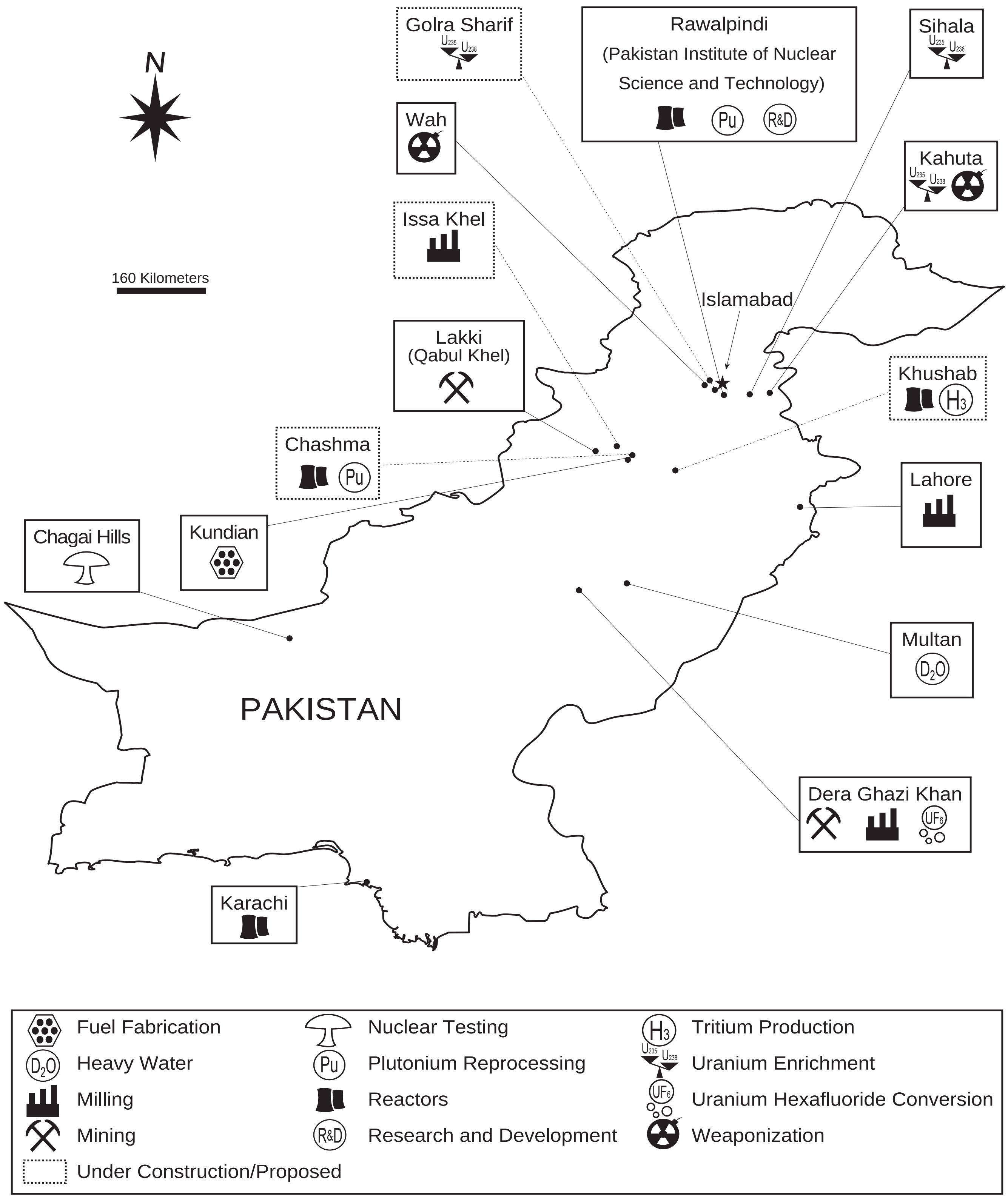
Andrew Koch is a Senior Research Associate and Jennifer Topping is a Research Assistant for the Monitoring Proliferation Threats Project at the Center for Nonproliferation Studies, Monterey Institute of International Studies.

Now that a Comprehensive Test Ban Treaty (CTBT) has been concluded, the Clinton administration is likely to turn its attention toward negotiating a Fissile Material Cut-off Treaty (FMCT). Discussion regarding the negotiation of a FMCT occurred at the Conference on Disarmament in Geneva throughout 1994-96, though no progress was made. The issue was also discussed at the April 1997 NPT (Treaty on the Non-Proliferation of Nuclear Weapons) Prepcom, which recommended that the issue be discussed at its next session in 1998. To engage in serious negotiations and eventually conclude a treaty, states will need to have an accurate picture of each other's nuclear fuel cycle capabilities. Without such information, developing and implementing an effective verification regime will be difficult. When looking at a country's nuclear program, the primary concerns are how much fissile material (consisting of either highly enriched uranium (HEU) or plutonium) they possess, and where such materials are produced and/or stored. Also of concern, but not addressed by the FMCT, are steps a country took toward weaponizing its nuclear capabilities. In the case of Pakistan, there is a lack of transparency and a paucity of publicly available information about its nuclear capabilities and stockpile. This report attempts to address that shortfall by providing a comprehensive analysis of the open-source data on Pakistan's nuclear weapons program.

FUEL CYCLE FACILITIES

Pakistan has unsafeguarded indigenous facilities throughout its nuclear fuel cycle that are capable of feeding uranium enrichment facilities and providing fuel for the country's reactors. Islamabad's uranium development efforts are overseen by the Pakistan Atomic Energy Commission's Atomic Energy Minerals Center in Lahore (see Figure 1), which houses a pilot-scale mill.[1] At the beginning of the fuel cycle, Dera Ghazi Khan province is home to the Baghalchar uranium mine, as well as a mill—which can produce up to 30 metric tons (MT) of yellowcake per year.[2] Although the Baghalchar mine has a reported capacity of 23 MT of uranium per year, the uranium deposits there may be nearing exhaustion.[3] A uranium mine at Qabul Khel, near Lakki in the North West Frontier Province, may meet Pakistan's uranium ore needs when the Baghalchar mine is closed.[4] A proposed milling site at Issa Khel in the nearby Mianwali district of Punjab province lies near a railway connecting to the Qabul Khel mine.[5] Other efforts by Islamabad to increase its uranium production capacity include spending $7.18 million on uranium exploration in Nangar Ani, Khura-Murghan Zai, and Pitok-Sori Gorakh, all in Dera Ghazi Khan province.[6] The exploration efforts are assisted by the Nuclear Track Detection Laboratory at the Pakistan Institute of Nuclear Science and Technology (PINSTECH) in Rawalpindi.

Figure 1: Pakistan's Nuclear-Related Facilities



The yellowcake is then either fed into a uranium hexaflouride (UF6) conversion plant and sent to one of Pakistan's centrifuge facilities, or is fabricated into heavy water reactor fuel. The country's only UF6 conversion facility, located at Dera Ghazi Khan, is not safeguarded and has a yearly production capacity of 200 MT.[7] An unsafeguarded fuel fabrication facility, which can process 24 MT of natural uranium per year and which manufactures fuel for the Karachi nuclear power plant, is located at Kundian near the Chashma reactor.[8] The site may also house a small zirconium oxide and Zircaloy-4 production plant, which produces the cladding for reactor fuel.

Pakistan's capability to produce fissile material rests on its ability to enrich uranium. This is centered at the uranium enrichment facility at Kahuta. Kahuta is home to the A.Q. Khan Research Laboratory (KRL), formerly called the Engineering Research Laboratory (also known as the Project 706 Engineering Research Laboratory), which began operations in 1984.[9] The facility is the hub of Islamabad's nuclear weapons program and contains an unsafeguarded uranium enrichment plant using centrifuge technology based on Urenco G-1 and G-2 designs stolen by A.Q. Khan.[10] The plant has an estimated 3,000 centrifuges in operation with a total capacity of 9,000 to 15,000 separative work units (SWU), and can produce 55 to 95 kilograms (kg) of HEU per year.[11] Although much of the equipment and technology for its centrifuge program was imported, KRL does have some ability to produce centrifuge components. Aside from the enrichment activities, it is believed that Kahuta may also be the site where HEU is formed into weapon cores.[12]

In addition to Kahuta, Pakistan has two smaller centrifuge facilities: at Golra and at Sihala. Neither of these are subject to International Atomic Energy Agency (IAEA) safeguards, due to Pakistan's non-membership in the NPT. Western intelligence sources are reported to have claimed in 1987 that a uranium enrichment facility was being constructed at Golra.[13] It is not clear, however, that the facility was ever completed or became operational. The Golra facility may be used to test advanced centrifuge designs before they are installed at Kahuta. The small centrifuge pilot-plant located at Sihala has a reported 54-centrifuge cascade and could be used for testing and training.[14]

Islamabad has also indicated that it is interested in obtaining access to weapons-grade plutonium and has experimented with extracting plutonium from spent fuel.[15] The "New Laboratories" [New Labs] experimental-scale plutonium reprocessing plant, located at PINSTECH, can reprocess 10 to 20 kg of plutonium per year.[16] Based on a French design, construction of the unsafeguarded facility began in 1976. "Cold" tests were conducted as early as 1982, and in 1987 West German intelligence said the facility previously conducted "hot" tests.[17] PINSTECH also houses a small-scale reprocessing laboratory that conducts experiments in the solvent extraction method.[18] In addition to the smaller, research-sized reprocessing facilities at PINSTECH, there is a partially built plutonium reprocessing plant at Chashma that was started by France, but abandoned in 1978. Some U.S. intelligence officials believe the facility is being completed, either indigenously or with Chinese assistance, and may be part of activities undertaken by staff at New Labs.[19] However, China could be working on a fuel fabrication facility at Chashma instead. The Chashma-1 contract stipulates that China will provide Pakistan with a fuel fabrication facility, which would be under safeguards.[20]

In order to reprocess significant amounts of plutonium, a country needs access to large quantities of spent fuel, preferably unsafeguarded. The most obvious future source of spent fuel in Pakistan is from a 40 megawatt thermal (MWt) heavy water reactor being built with clandestine Chinese assistance at Khushab.[21] Aside from providing spent fuel for a plutonium reprocessing plant, the unsafeguarded Khushab reactor may also be the site of a tritium production facility.[22] In support of the Khushab reactor, Pakistan reportedly has an unsafeguarded heavy water production facility with a 13 MT per year capacity at Multan.[23] The Multan plant could supply the Khushab reactor with heavy water, although Pakistan allegedly imported 40 MT of heavy water from the China National Nuclear Corporation.[24]

Spent fuel also could be extracted from the country's other research or commercial reactors, although they are under IAEA safeguards. The two small research reactors, called the Pakistan Atomic Research Reactor (PARR), at PINSTECH, are the centerpiece of Pakistan's open nuclear research and development program. PARR-1 is a 10 MW pool-type research reactor that was supplied by the United States in 1965 and has been converted to burn 20 percent enriched uranium fuel.[25] PARR-2 is a Chinese-supplied 27 kilowatt thermal (kWt) pool-type research reactor that is fueled by one kg of HEU.[26]

Pakistan's only operating commercial reactor is the Karachi nuclear power plant, a fully safeguarded 137 megawatt electric (MWe) CANDU pressurized heavy water reactor supplied by Atomic Energy of Canada, Ltd. Finally, a 300 MW pressurized water reactor is being built by the China National Nuclear Corporation at Chashma. The Chashma reactor is expected to be commissioned in October 1998 and will be placed under IAEA safeguards.

FISSILE MATERIAL STOCKPILE

Pakistan's stockpile of fissile material presently consists of weapons-grade uranium. Although there is some disagreement on the particulars, it is generally accepted that Islamabad agreed to "cap" its uranium enrichment program in 1991, meaning that it would not enrich uranium above five percent. It is possible to estimate Pakistan's nuclear stockpile, assuming that the country's sole capacity to enrich uranium is at the Kahuta facility. By using its estimated stockpile of low-enriched uranium (LEU) (7,493 to 12,480 kg) to feed the Kahuta plant, it would take one year for Pakistan to replace all the HEU forgone by capping its enrichment program.[27] The amount of HEU Pakistan could produce within one year using LEU as feed (308 to 516 kg of HEU), plus the stockpile of HEU produced prior to the reported capping date (157 to 263 kg of HEU), is approximately equal to the amount of HEU Pakistan would have possessed had it not capped its enrichment program (460 to 785 kg of HEU). Assuming that a Pakistani nuclear device uses 20 kg of HEU, Pakistan would have had enough HEU for 23 to 39 nuclear weapons if it had not capped its program. If Pakistan did cap its enrichment program, during a crisis, Islamabad could enrich enough HEU for seven to 12 nuclear weapons within six months, in addition to the eight to 13 weapons worth of HEU stockpiled prior to capping.

WEAPONIZING ITS NUCLEAR STOCKPILE

Any attempt by Islamabad to weaponize its stockpile of fissile material would require several steps. First, the trigger and other non-nuclear components of a nuclear device would have to be manufactured or acquired. Such work would most likely occur in and around the military-run Pakistan Ordnance Factory at Wah. A large machine tool complex, called the Heavy Mechanical Complex (HMC), is at Taxila, as are the Heavy Rebuild Factory (HRF) and the Heavy Forge Factory (HFF).[28] A unit for developing a nuclear device was reportedly established at one of these facilities.[29] Such a unit would likely be the location for any weaponization work, especially the trigger and high explosive packages, due to the factory's expertise in fuzing, high explosives, and heavy machining.

Pakistan has taken other steps to increase its ability to weaponize. In 1987, Islamabad acquired a West German tritium purification and production facility, which can produce up to five to 10 grams of tritium per day.[30] The equipment may have been tested in 1987 at a secret location 150 kilometers (km) south of Rawalpindi (Khushab is located 150 km to the southwest), using lithium-6 targets irradiated in the PARR-1 research reactor.[31] Tritium can be produced by irradiating lithium-6 targets in a reactor and then processing those targets in a separate plant. Tritium can be used as a booster in advanced fission designs and as a neutron initiator.

Were Islamabad to move to develop nuclear weapons openly, it would probably conduct one or more nuclear tests to certify its weapon design. Such tests would likely be conducted at a site in Chagai Hills, where "cold" tests of a nuclear implosion device were held in 1986.[32] An airbase in the area allegedly contains a facility for storing nuclear weapons-related material, possibly for protection from a pre-emptive Indian airstrike.[33]

CONCLUSION

If an FMCT were to enter into force, the IAEA would likely be tasked with enforcing the agreement as part of its safeguards efforts. To date, the government of Pakistan has provided little information on its nuclear program, closely guarding it as a vital state secret. The provision of open-source data, as called for under the IAEA's 93 + 2 program, is a valuable supplement to the data from participating states' national intelligence organizations. The available open-source data indicates that Pakistan possesses at least 160 to 260 kg of unsafeguarded HEU, which could be subject to eventual elimination under the treaty. The data also indicate that Pakistan has at least one, and as many as three, facilities with the capability to enrich uranium to weapons grade that would have to be declared and inspected under the new regime. Additionally, Islamabad evidently is pursuing the capability to reprocess plutonium at one or more facilities, and is building one unsafeguarded and one commercial reactor that could provide spent fuel to these reprocessing facilities. At the least, these sites would have to be brought under some form of safeguards in order to make the FMCT verifiable.

[1] P.B. Sinha and R.R. Subramanian, *Nuclear Pakistan: Atomic Threat to South Asia* (New Delhi: Vision Books, 1980), p. 35.
[2] "Nuclear Profile: Pakistan," *The Risk Report* 1 (July/August 1995), p. 3; Shahid-ur-Rehman Khan, "Pakistanis Tell of Indigenous U Mining and Milling Effort," *NuclearFuel*, December 1, 1986, pp. 6-7.
[3] Khan, "Pakistanis Tell of Indigenous U Mining and Milling Effort;" "Uranium Mining Project Launched," *Khaleej Times*, October 20, 1995; in *Strategic Digest*, February 1996, pp. 250-251.
[4] "Nuclear Profile: Pakistan," *The Risk Report*; "Uranium Mining Project Launched," *Khaleej Times*.
[5] Shahid-ur-Rehman Khan, "PAEC Head Denies Report That U.S., Money Ills Derail Chashma-2," *Nucleonics Week*, July 6, 1995, p. 5; Nuclear Engineering International, *World Nuclear Industry Handbook 1996* (London: Reed Business Publishing, 1995), p. 111.
[6] "Bureau Report," *Dawn*, August 24, 1996; in FBIS-NES-96-168 (24 August 1996); "Pakistan Might Increase U Exploration," *NuclearFuel*, September 9, 1996, pp. 15-16.
[7] "Nuclear Profile: Pakistan," *The Risk Report*; U.S. State Department, *The Pakistani Nuclear Program*, (Washington: Government Printing Office, June 23, 1983) (obtained by the National Security Archive, Washington, D.C. under the Freedom of Information Act).
[8] U.S. State Department, *The Pakistani Nuclear Program*; Shahid-ur-Rehman Khan, "Chashma Vessel Manufacture Said To Be Underway in China," *Nucleonics Week*, November 30, 1995, p. 6.
[9] David Albright and Mark Hibbs, "Pakistan's Bomb: Out of the Closet," *The Bulletin of the Atomic Scientists* 48 (July/August 1992), pp. 38-43.
[10] *Ibid*., pp. 38-43. Khan worked at the Dutch engineering firm FDO, which collaborated with the Urenco consortia, from 1972 to 1975. In 1975, he fled to Pakistan, taking with him centrifuge uranium enrichment designs.
[11] David Albright, Frans Berkhout, and William Walker, *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities, and Policies* (Oxford: Oxford University Press, 1997), p. 275.
[12] Col. S. Bakov, "Nuclear Ambitions," *Krasnaya zvezda*, May 23, 1990, p. 3; in JPRS-TND-90-011 (28 June 1990), p. 21.
[13] R. R. Subramanian, "Time to Call Pak Bluff," *The Hindustan Times*, December 18, 1987, p. 11; in JPRS-TND-88-003 (25 February 1988), pp. 17-18; "Pakistan's A-Bomb Potential," *The Risk Report* 1 (July/August 1995), p. 5.
[14] Indranil Banerjee, "The Secrets of Kahuta," *The Sunday*, April 24, 1993, pp. 34-38; in JPRS-TND-93-014 (18 May 1993), pp. 12-15.
[15] Andrew Koch, "Pakistan Persists with Nuclear Procurement," *Jane's Intelligence Review* 9 (March 1997), pp. 131-133.
[16] U.S. State Department, *The Pakistani Nuclear Program*; Banerjee, "The Secrets of Kahuta."
[17] Albright and Hibbs, "Pakistan's Bomb: Out of the Closet"; and "Hot Laboratories," *Der Spiegel*, February 27, 1989, p. 113; in JPRS-TND-89-006 (28 March 1989), pp. 33-34.
[18] U.S. State Department, *The Pakistani Nuclear Program*.
[19] Bill Gertz, "China Aids Pakistan Plutonium Plant," *The Washington Times*, April 3, 1996, p. A4**.**
[20] Khan, "Chashma Vessel Manufacture Said To Be Underway in China."
[21] R. Jeffrey Smith and Thomas W. Lippman, "Pakistan Building Reactor That May Yield Large Quantities of Plutonium," *The Washington Post*, April 8, 1995, p. A20.
[22] John J. Fialka and Thomas F. O'Boyle, "West German Forms Admit Supplying Nuclear-Weapons Material to Pakistan," *The Wall Street Journal*, April 21, 1989, p. A12.
[23] Banerjee, "The Secrets of Kahuta."
[24] All India Radio Network, April 19, 1996; in FBIS-NES-96-078 (19 April 1996).
[25] "PARR's New Lease of Life," *Nuclear Engineering International* 36 (December 1991) p. 3.
[26] Albright and Hibbs, "Pakistan's Bomb: Out of the Closet;" "China and Pakistan Collaborate on PARR-2," *Nuclear Engineering International* 35 (December 1990) pp. 46-47.
[27] Figures in this section are derived from Albright, Berkhout, and Walker, *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities, and Policies*, pp. 272-278; Zia Mian and Abdul H. Nayyar, "Pakistan's Uranium Stockpile," *INESAP-Information Bulletin* 7 (October 1995), pp. 8-9.
[28] Swaran Singh, "Pakistan-China Defence Cooperation," *Sapra India Monthly* (April/May 1996) (http://www.subcontinent.com/sapra); "Heavy Engineering Industry—Its Role and Status," *Economic Review* 21 (August 1990), pp. 63-70.
[29] Marcus Warren, "Pakistan Nuclear Program at a 'Screwdriver Level'," *The Washington Times*, February 20, 1996, pp. A1, A16.
[30] Michel Schneider, "Paris: Hub for Pakistani Nuclear Traffic," *Politis-Le Citoyen*, February 22-28, 1990, pp. 50-55; in JPRS-TND-90-012 (18 July 1990), pp. 27-29; Heinz Vielan, "First Confessions—Pakistan's A-Bomb with German Help?" *Welt Am Sonntag*, December 25, 1988, pp. 1-2; in JPRS-TND-89-001 (13 January 1989), pp. 25-26.
[31] Mark Hibbs, "Prosecutors Link Tritium Plant to Pakistan Weapons Program," *NuclearFuel*, May 1, 1989, pp. 12-13; Fialka and O'Boyle, "West German Firms Admit Supplying Nuclear-Weapons Material to Pakistan."
[32] R. Jeffrey Smith, "Pakistan Has Plan for Nuclear Blast, U.S. Officials Say," *The Washington Post*, March 6, 1996, p. A12; Harold Hough, "Pakistan's Nuclear Status—Confusion or Strategy," *Jane's Intelligence Review* 7 (June 1995), pp. 270-272.
[33] Syed Alamdar Raza, "Pakistan's External Security Environment," *The Muslim*, March 19, 1994, p. 7; in JPRS-TND-94-008 (1 April 1994), pp. 34-36.