Notes

North Korea's Nuclear Programme

[1] Reactors use a variety of substances as moderators, which slow neutrons to the lower speeds necessary to effectively fission or split uranium. Typically, reactors fuelled by enriched uranium use light water as a moderator, while reactors fuelled by natural uranium often use heavy water or graphite as a moderator. Cooling – to help contain the heat produced by fission – can be achieved with a variety of substances, typically water or carbon dioxide.

[2] All reactors fuelled by uranium (natural or enriched) produce different isotopes of plutonium that can be used in nuclear explosions, but Plutonium 239 is the most desirable for weapons purposes. The other plutonium isotopes, such as Plutonium 238, 240 and 241 present certain complications for the design and operation of nuclear weapons because they emit heat and neutrons, which can cause premature detonation and reduce reliability. In general, the longer fuel is irradiated (that is, the higher the 'burn up'), the more these undesirable plutonium isotopes accumulate in it. 'Weapons-grade' plutonium commonly refers to plutonium with a P239 content of 90% or more, which is the grade most suitable for a first generation nuclear device.

[3] For additional technical details on the Yongbyon facilities, see Albright, D. and O'Neill, K., *Solving the North Korea Nuclear Puzzle* (Washington, DC: The Institute for Science and International Security (ISIS), 2000) and May, M. (ed), *Verifying the Agreed Framework*, (Livermore, CA: Center for Global Security Research (CGSR), Lawrence Livermore National Laboratory, April 2001).

[4] For a first hand description of the 5MW(e) reactor by an American physicist see Alvarez, Robert, 'North Korea: No bygones at Yongbyon', *Bulletin of American Scientists*, July / August 2003.

[5] The amount of radiation or 'burn up' that each fuel rod is exposed to, and, therefore, the amount of plutonium produced in each rod, depends on its location in the core. In general, rods in the centre of the core are exposed to much higher levels of irradiation than those situated on its periphery. The estimate of 7.5kg of weapons-grade plutonium produced each year is based on a discharge of the most heavily irradiated ten tonnes of fuel from the centre of the core. The remaining 40 tonnes of fuel would also contain small amounts of plutonium, but not enough to warrant reprocessing. In normal practice, fuel from the core's periphery would be moved to the centre to replace the spent fuel that has been removed and fresh fuel would be loaded into the vacant areas on the periphery.

[6] Typically, Purex reprocessing plants fail to separate 10–20% of the plutonium in the spent fuel, which remains in the waste streams. However, since the IAEA found evidence that North Korea had engaged in additional reprocessing campaigns, the claimed North Korean loss rate may not be accurate. While it is plausible that North Korea's reprocessing plant would be less efficient than Purex-based plants in the West, doubt about the actual loss rate contributes to overall uncertainty about North Korea's potential plutonium inventory.

[7] At the time, there was no hard data to test the proposition. In 1994, though, North Korea demonstrated that it could indeed unload the entire 5MW(e) reactor core in less than two months.

[8] For more technical details and alternative scenarios, see Dreicer, J., 'How Much Plutonium Could Have Been Produced in the DPRK IRT Reactor?', *Science and Global Security*, vol. 8, no. 3, 2000.

[9] Over the past decade, there have been periodic reports in the media that North Korea purchased plutonium or nuclear weapons from the former Soviet Union in the early 1990s. None of the reports can be confirmed, however, and some of the more sensational accounts provided by various North Korean defectors are generally discounted.

[10] For further details, see a series of annual reports by the IAEA Director General to the IAEA General Conference. 'Implementation of the Agreement Between the Agency and the Democratic People's Republic of Korea for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons', GC (40)/16, 20 August 1966 and GC (41)/17, 18 August 1977. Available at www.iaea.org

[11] Sanger, D., 'North Korean Site an A-Bomb Plant, US Agencies Say', *The New York Times*, 17 August 1998.

[12] Exactly when North Korea began receiving centrifuge technology from Pakistan is unknown. Dates in public literature range from 1995–1998.

[13] Central Intelligence Agency (CIA) Report to US Congress, 19 November 2002; Warrick, J., 'US Followed the Aluminum: Pyongyang's Effort to Buy Metal was Tip to Plans', *The Washington Post*, 18 October 2002; Hibbs, M., 'Customs Intelligence Data Suggest DPRK Aimed at G-2 Type Centrifuge', *Nuclear Fuel*, vol. 28, no. 11, 26 May 2003.

[14] 'Defector Leaked Details of North Korean Nuclear Program', *Yomiuri Shimbun*, 18 December 2002.

[15] CIA report to US Congress, 19 November 2002; Frantz Douglas, 'North Korea's Nuclear Success is Doubted', *The Los Angeles Times*, 9 December 2003.

[16] Hibbs, M., 'Customs Intelligence Data Suggest DPRK Aimed at G-2 Type Centrifuge', *Nuclear Fuel*, vol. 28, no. 11, 26 May 2003.

[17] As a rule of thumb, 235 SWUs per annum are required to produce one kilogram of uranium enriched to 93% U-235. Since each G-2 machine is theoretically capable of achieving five SWUs per annum, about 50 machines of the G-2 type are needed to produce one kilogram of

weapons-grade uranium per year. Using this formula, between 1,000 and 1,250 machines would be necessary to produce 20–25kg of weapons-grade uranium a year, roughly enough for one nuclear weapon based on an implosion design. In theory, 3,500 machines could produce 75kg of weapons-grade uranium per annum, roughly enough for three weapons based on a first-generation implosion design.

[18] 'Firm Raided Over N-Part Export', *Yomiuri Shimbun*, 9 May 2003.

[19] See *Yonhap*, 19 October 2002; *Choson Ilbo*, 21 October 2002. For a comprehensive compilation of open-source information on suspect nuclear sites in North Korea, see the map on the Nuclear Threat Initiative website, www.nti.org/e_research/profiles/NK/201.html

[20] See *Korean Central News Agency*, 3 October 2003.

[21] At the time that the IAEA inspectors were expelled, the reprocessing plant's vent stack was not equipped with a filter system that could reduce emissions of krypton-85. Whether such equipment was subsequently installed after the inspectors were expelled is not known.

[22] Since the 5MW(e) reactor has historically experienced technical difficulties in operating at full power for sustained periods, a more realistic maximum production output is probably in the region of 6–7kg per year, which would yield some 4–6kg of separated plutonium, assuming a reprocessing loss of 10–30%. Presuming that each first generation implosion device requires 5–8kg of plutonium, the 5MW(e) reactor is able to produce annually about enough plutonium for one such weapon.

[23] Assuming a reprocessing loss of 10–30%, the annual yield of separated plutonium would be approximately 38.5–49.5kg per year, which could produce some five to ten nuclear weapons per year, assuming that between 5–8kg of plutonium is needed for each weapon based on a first generation implosion design.

[24] The text of the leaked KGB memo was printed in *Izvestiya* on 24 June 1994.

[25] 'Seoul Says North Korea Reprocessing Nuclear Rods', *Reuters*, 9 July 2003.

[26] See US Senate Select Committee on Intelligence, Unclassified Responses to the Questions for the Record from the Worldwide Threat Hearing of 11 February 2003, 18 August 2003, reprinted in www.fas.org/irp/congress/2003_hr/021103qfr-cia.pdf

[27] Hersh, Seymour, 'The Cold Test: The Pakistan–North Korea Nuclear Axis', *The New Yorker*, 27 January 2003.

[28] 'North Korea Holds Five Nuclear Bombs', *Agence France Presse*, 16 April 1999, quoting Japanese daily *Sankei Shimbun*. Interestingly, in November 2000, Hwang was also quoted as saying that North Korea 'has been aiming at continuing to produce nuclear weapons using uranium 235 in cooperation with a certain nation in West Asia since 1996'. See 'N. Korea defector warns of war plans', *United Press International*, 22 April 1997.

[29] 'North Korea has Dozens of Nukes, Top Defector tells Magazine', *Agence France Presse*, 14 May 2003, quoting Japanese magazine *Gekkan Gendai*.

North Korea's Chemical and Biological Weapons Programmes

[1] Parts of this analysis are drawn from research presented at a meeting on North Korea's WMD programmes at the Carnegie Endowment for International Peace in November 2003. See Harris, Elisa D., 'North Korean Chemical and Biological Weapons Activities: Deconstructing the Threat' (Carnegie Endowment for International Peace, 7 November 2003).

[2] Oehler, Gordon, *Senate Governmental Affairs Committee Hearing to Examine Nuclear, Biological and Chemical Weapons Proliferation Threats of the 1990s* (Washington DC, 24 February 1993); Russian Foreign Intelligence Service Report, *Proliferation of Weapons of Mass Destruction* (Moscow, 1993); Republic of Korea, Ministry of National Defense, *Defence White Paper 1994* (Seoul, 1994).

[3] Bermudez, Joseph S. Jr., 'CW: North Korea's growing capabilities', *Jane's Defence Weekly*, vol. 11, no. 2, 14 January 1989, p. 54.

[4] See the Nuclear Threat Initiative, North Korea Chemical Chronology, at www.nti.org/e_research/profiles/NK/Chemical

[5] For a history of the North Korean chemical industry, see Kim Yong-yun, 'North Korean Chemical Industry', *Pukhan*, 1 December 1998, FBIS translated text, FTS19981230001322.

[6] Republic of Korea, Ministry of National Defense, *Defense White Paper 2000* (Seoul, 2000), available at www.mnd.go.kr/

[7] US Department of Defense, *Proliferation: Threat and Response*, (Washington DC, April 1996), available at www.defenselink.mil/pubs/prolif/ne_asia.html

[8] See the Nuclear Threat Initiative, North Korean Chemical Profile, www.nti.org/db/profiles/dprk/chem/over/NKC_OGo_bg.html

[9] See the Nuclear Threat Initiative, North Korea Chemical Profile, www.nti.org/db/profiles/dprk/chem/over/NKC_OGo_bg.html

[10] 'North Korea Said to have Chemical and Biological Weapons Capabilities', *United Press International*, 23 October 1992.

[11] See Kim Kyoung Soo, 'North Korea's CB Weapons: Threat and Capability', *The Korean Journal of Defense Analysis*, vol. 14, no. 1, Spring 2002, pp. 69–95.

[12] Choi Ju Hwal, North Korean Missile Proliferation Hearing before the US Senate, Governmental Affairs Subcommittee on International Security, Proliferation and Federal Services, 21 October 1997.

Notes

[13] 'Defector claims North completed nuclear weapons development', *KBS Radio*, 22 March 1994.
[14] North Korean Missile Proliferation Hearing before the US Senate, Governmental Affairs Subcommittee on International Security, Proliferation and Federal Services, 21 October 1997.
[15] 'Korea Defectors', *Voice of America*, 26 February 1998.
[16] See 'N. Korea defector warns of war plans', *United Press International*, 22 April 1997.
[17] 'North Korea: Defector says Uranium Facilities Maintained in Pakchon', *Global News Wire*, 17 October 2002, and 'A Physicist Defector's Account of North Korea's Nuke Labs', comments by Lee Wha Rang, available at www.ku.edu/~ibetext/korean-war-l/2002/10/msg00166.html
[18] See the Nuclear Threat Initiative, North Korea Chemical Chronology, www.nti.org/e_research/profiles/NK/ Chemical
[19] Republic of Korea, Ministry of National Defense, *Handbook on DPRK Chemical, Biological Warfare Capabilities*, 10 December 2001; and Republic of Korea, Ministry of National Defense, *Defence White Paper 2000* (Seoul, 2000), available at www.mnd.go.kr/
[20] US Department of Defense, *Proliferation: Threat and Response* (Washington DC, January 2001).
[21] Statement of General Thomas A. Schwartz, Commander in Chief United Nations Command/ Combined Forces Command and Commander, United States Forces in Korea, before the 107th Congress, Senate Armed Services Committee, 5 March 2002, p. 8.
[22] The Nuclear Threat Initiative website contains a complete catalogue of these reports, available at www.nti.org/db/profiles/dprk/chem/fac/fac_list.html. Also, See Kim Kyoung Soo, 'North Korea's CB Weapons: Threat and Capability', *The Korean Journal of Defense Analysis*, vol. 14, no. 1, Spring 2002.
[23] Bermudez, Joseph S. Jr., and Richardson, Sharon A., 'The North Korean View of the Development and Production of Strategic Weapons Systems', in Sokolski, Henry (ed.), *Planning for a Peaceful Korea*, (Strategic Studies Institute, 2001), available at www.carlisle.army.mil/ssi/pubs/2001/peackora/peackora.htm
[24] US Department of Defense, *Proliferation: Threat and Response*, (Washington DC, January 2001).
[25] Pak Tong-sam, 'How Far has the DPRK's Development of Strategic Weapons Come?', *Pukhan*, January 1999, pp. 62-71, FBIS translated text, FTS19990121001655.
[26] See the Nuclear Threat Initiative, North Korea Chemical Profile, www.nti.org/db/profiles/dprk/bio/chron/ NKB_CHGO_bg.html
[27] Republic of Korea, Ministry of National Defense, *Defense White Paper 1998*, (Seoul, 1998), available at www.mnd.go.kr/
[28] Russian Foreign Intelligence Service Report, *Proliferation of Weapons of Mass Destruction* (Moscow, 1993).
[29] Pak Tong-sam, 'How Far Has the DPRK's Development of Strategic Weapons Come?', *Pukhan*, January 1999, pp. 62–71, FBIS translated text, FTS19990121001655.
[30] US Department of Defense, *Proliferation Threat and Response*, (Washington DC, November 1997).
[31] Statement by Carl W. Ford Jr., Assistant Secretary of State for Intelligence and Research before the Senate Committee on Foreign Relations Hearing on Reducing the Threat of Chemical and Biological Weapons, 19 March 2002.
[32] Republic of Korea, Ministry of National Defense, *Defense White Paper 2000* (Seoul, 2000), available at www.mnd.go.kr/
[33] Republic of Korea, Ministry of National Defense, *Handbook on DPRK Chemical, Biological Warfare Capabilities*, 10 December 2001.
[34] US Department of Defense, *Proliferation: Threat and Response* (Washington DC, January 2001).
[35] See *The New York Times*, June 1999.
[36] North Korean Missile Proliferation Hearing before the United States Senate, Governmental Affairs Subcommittee on International Security, Proliferation and Federal Services, 21 October 1997.
[37] Kim Kyoung Soo, 'North Korea's CB Weapons: Threat and Capability', *The Korean Journal of Defense Analysis*, vol. 14, no. 1, Spring 2002, pp. 69-95.
[38] 'Korea Defectors', *Voice of America*, 26 February 1998.
[39] See Federation of American Scientists, www.fas.org/nuke/guide/dprk/bw/index.html
[40] Bermudez, Joseph S. Jr., 'Case Study 5: North Korea', *Chemical and Biological Arms Control Institute, the Deterrence Series*, p. 12.
[41] See the Nuclear Threat Initiative, North Korea Biological Chronology, www.nti.org/db/profiles/dprk/bio/ chron/NKB_CHGO_bg.html
[42] US House of Representatives, Speaker's North Korea Advisory Group, *Report to the Speaker*, November 1999, available at www.fas.org/nuke/guide/dprk/nkag-report.htm

North Korea's Ballistic Missile Programme

[1] See Bermudez, Joseph S. Jr., *The Armed Forces of North Korea* (New York: I.B. Taurus, 2001), pp. 240–245.
[2] Lewis, John W. and Hua, Di, 'China's Ballistic Missile Programs: Technologies, Strategies, Goals', *International Security*, vol 17, fall 1992, p. 32.
[3] CEP, or circular error probability, is a measure of the accuracy of the missile. It is the radius of a circle that would contain half of the impact points of a large number of missiles fired at the same point.
[4] For descriptions of North Korea's missile production

facilities, see the Nuclear Threat Initiative, North Korea Country Profile, available at www.nti.org

[5] See Bermudez, Joseph S. Jr., 'A History of Ballistic Missile Development in the DPRK', *Monterey Institute of International Studies, Center for Nonproliferation Studies, Occasional Paper No. 2*, November 1999, available at www.cns.miis.edu/pubs/opapers/op2/

[6] 'Pyongyang Pig Factory Produces Missiles', *Chosun Ilbo*, 12 February 2001.

[7] Daniel A. Pinkston, interview with Kim Il Son, Monterey Institute of International Studies, Center for Nonproliferation Studies, 10 April 2001.

[8] 'Commercial Images Detail North Korean Missile Site', *Aviation Week & Space Technology*, 17 January, 2000.

[9] Bermudez, Joseph S. Jr., 'A History of Ballistic Missile Development in the DPRK', *Monterey Institute of International Studies, Center for Nonproliferation Studies, Occasional Paper No. 2*, November, 1999, available at www.cns.miis.edu/pubs/opapers/op2/

[10] 'N. Korea Expanding Missile Programs', *The Washington Post*, 20 November 1998.

[11] 'North Korea Continues Secret Build-up Including Construction of Three Underground Bases in Rear Area', *Choson Ilbo*, 1 March 2001.

[12] 'North Korea Building New Missile Site, South Says', *The Washington Post*, 7 July 1999.

[13] Facing a similar need for a longer-range missile during the Iran–Iraq War, Iraq modified its existing *Scud*-B missiles by extending the airframe, expanding the fuel and oxidizer tanks, modifying engine performance, and reducing payload in half, producing the *al-Hussein* missile with a range of almost 650km. The *al-Hussein* missile was aero-dynamically unstable and tended to break up on re-entry, significantly reducing accuracy.

[14] Wright, David and Kadyshev, Timur, 'An Analysis of the North Korean Nodong Missile', *Science and Global Security*, vol. 4, 1994, p. 129–160, available at www.princeton.edu/~globsec/publications/pdf/4_2wright.pdf

[15] According to some reports, North Korea may have built a *Scud*-D variant with a 700km range and 500 kg payload.

[16] McCarthy, Timothy, 'North Korean Ballistic Missile Programs: Soviet and Russian Legacies', in Michael Barletta (ed.), *WMD Threats 2001: Critical Choices for the Bush Administration*, Monterey Institute of International Studies, Center for Nonproliferation Studies, Occasional Paper No. 6, p. 9–11, available at www.cns.miis.edu/pubs/opapers/op6/index.htm

[17] China's earliest ballistic missiles were heavily influenced by technology transfers from the Soviet Union. See Norris, Robert, Burrows, Andrew and Fieldhouse Richard, *British, French, and Chinese Nuclear Weapons* (Boulder: Westview Press 1994), pp. 359–362.

[18] US Marine Corps, *North Korea Country Handbook* (Washington DC, 1997).

[19] IISS, *The Military Balance 2003/2004* (Oxford: Oxford University Press for the IISS, 2003), p. 160.

[20] US Secretary of Defense, *2000 Report to Congress: Military Situation on the Korean Peninsula*, 12 September 2000, available at www.defenselink.mil/news/Sept2000/korea09122000.html

[21] Bermudez, Joseph S. Jr., *The Armed Forces of North Korea* (New York: I.B. Taurus, 2001).

[22] For details or reported missile deployment sites, see the Nuclear Threat Initiative, North Korea Country Profile, www.nti.org

[23] 'New Missile Reported in North Korea; California is within its Range, a Defector tells South Koreans', *The Herald Tribune*, 19 February 2000, and 'A Tale of Two Defectors', *The Washington Times*, 16 March 2000.

[24] 'Defector: North Korea has capability to put satellite in orbit', *Associated Press*, 7 September 1998.

[25] 'South Korea: Defector Provides 'Unique' Opportunity for Arms Information', *Yonhap*, 27 August 1997.

[26] 'North Korea aims missiles at Tokyo: defector', *United Press International*, 6 June 1997, and 'North Korea arms target Tokyo: defector', *Courier Mail*, 10 June 1997.

[27] Hearing on Drugs, Counterfeiting, and Weapons Proliferation: The North Korean Connection, the Financial Management, the Budget, and International Security, Subcommittee of the US Senate Governmental Affairs Committee, 20 May 2003.

[28] 'Report: North Korea would not launch pre-emptive attack on Japan, defector says', *Associated Press*, 28 May 2003; 'North Korea Imports 90 Percent of Missile Parts from Japan says Defector', BBC, 16 May 2003.

[29] 'North Korea – Defector Claims Pyongyang has Dozens of Nukes', *IAC (SM) Newsletter Database*, 15 May 2003, and 'North Korea has Dozens of Nukes, Top Defector Tells Magazine', *Agence France Presse*, 14 May 2003.

[30] 'North Korea has Pak-Made Nukes, Says Defector', *The Economic Times of India*, 28 November 2002.

[31] 'Defector says 1991 missile plant explosion killed 200', *BBC Summary of World Broadcasts*, 21 March 1994.

[32] North Korean Missile Proliferation Hearing before the US Senate, Governmental Affairs Subcommittee on International Security, Proliferation, and Federal Services, 21 October 1997.

[33] Ko Young Hwan, North Korean Missile Proliferation Hearing before the US Senate, Governmental Affairs Subcommittee on International Security, Proliferation, and Federal Services, 21 October 1997.

[34] See the Nuclear Threat Initiative, www.nti.org/e_research/profiles/NK/Missile/64_750.html

[35] 'Ballistic Missile Program, Defense and Foreign Affairs', *Strategic Policy*, December, 1999.

Notes

[36] www.nti.org/e_research/profiles/NK/Missile/64_750.html

[37] www.nti.org/e_research/profiles/NK/Missile/64_754.html

[38] North Korean defector's press conference, *KBS Television*, 11 November 1996.

[39] 'North Korea's Scuds said capable of carrying chemicals', *Kyodo News International*, 28 April 1994.

[40] There may be some variations on the range and payload of the different *No-dong* models. Some accounts report a *No-dong*-1 and *No-dong*-2.

[41] See IISS, *Iraq's Weapons of Mass Destruction: A Net Assessment* (London, 2002), pp 59–60.

[42] See Monterey Institute of International Studies, Center for Nonproliferation Studies, Chronology of North Korea's Missile Trade and Developments: 1992–93, available at cns.miis.edu/iiop

[43] Pakistan *Ghauri* missiles were successfully tested in April 1998, April 1999, and May 2002. Iran's *Shahab*-3 tests in July 1998 and September 2000 are reported to have failed, while tests in July 2000 and May 2002 are believed to have been successful.

[44] Wright, David and Kadyshev, Timur, 'An Analysis of the North Korean Nodong Missile', *Science and Global Security*, vol. 4, 1994, available at www.princeton.edu/~globsec/publications/pdf/4_2wright.pdf

[45] Republic of Korea, Ministry of National Defense, *Defence White Paper, 2000* (Seoul, 2000), available at www.mnd.go.kr/

[46] See IISS, *The Military Balance 2003/2004* (Oxford: Oxford University Press for the IISS, 2003), p. 160; 'N. Korea has Up to 750 Ballistic Missiles: U.S. Source', *Jiji Press Ticker Service*, 12 May 2003.

[47] For further information on reported missile deployment sites, see the Nuclear Threat Initiative, North Korean Country Profile, www.nti.org

[48] Smith, Jeffrey R., 'N. Korea and the Bomb: High Tech Hide-and-Seek; US Intelligence Key In Detecting Deception', *The Washington Post*, 18 March 1994.

[49] *Paektusan* means Mount Paektu (literally White Head Mountain), the highest mountain in Korea and redoubt of Kim Il-Sung during his guerrilla struggle against the Japanese in the late 1930s and legendary birth place of Kim Jong Il.

[50] Details of the launch, including the timing of the staging of the booster, were given in the initial North Korean press reports of the launch, 'Successful Launch of First Satellite in DPRK', *Korean Central News Agency*, 4 September 1998, available at www.kcna.co.jp/item/1998/9809/news09/04.htm#1

[51] National Intelligence Council, *Foreign Missile Developments and the Ballistic Missile Threat Through 2015*, September 1999, available at www.cia.gov/nic/pubs/other_products/foreign_missile_developments.htm

[52] National Intelligence Estimate, *Emerging Missile Threats to North America During the Next 15 Years*, November 1995, available at www.fas.org/spp/starwars/offdocs/nie9519.htm

[53] Report of the Commission to Assess the Ballistic Missile Threat to the United States, 15 July 1998. Available at www.access.gpo.gov/su_docs/newnote.html

[54] National Intelligence Estimate, *Emerging Missile Threats to North America During the Next 15 Years*, November 1995, available at www.fas.org/spp/starwars/offdocs/nie9519.htm

[55] The NIEs do not specify what 'several hundred kilograms' means, but presumably it is meant to include at least 500kg, the standard defined by the Missile Technology Control Regime (MTCR) as the minimum necessary for a first generation nuclear weapon and heat shield. Of course, it is not known whether North Korea is capable of producing a nuclear warhead of this class, and a larger payload would significantly reduce the range of the missile. For example, a missile of the size of a TD-2 that could carry a 500kg payload 12,000km could reach only 7,000–8,000km with a 1,000kg payload.

[56] National Intelligence Council, *Foreign Missile Developments*, December 2001.

[57] See, for example, Sessler, Andrew, *Countermeasures : A Technical Evaluation of the Operational Effectiveness of the Planned US National Defense System* (Cambridge, MA: Union of Concerned Scientists and MIT Security Studies Program, 2000).

[58] Federation of American Scientists, No-dong Launch Facility, available at www.fas.org/nuke/guide/dprk/facility/Nodong.htm; Bermudez, Joseph Jr., 'North Korea's Musudan-Ri Launch Facility', available at www.cdiss.org/spec99aug.htm

[59] See Monterey Institute of International Studies, Center for Nonproliferation Studies, Chronology of North Korea's Missile Trade and Developments: 1999–2002, available at cns.miis.edu.htm

[60] See 'Russia: N. Korea Unable to Advance in Missile Development', *Middle East Newsline*, vol. 3, no. 248, 26 June 2001, www.menesline.com

[61] See Kniazkov, Maxim, 'North Korea has new intermediate range missile', *Agence France Presse*, 11 September 2003; 'Missile Watch as N. Korea turns 55', CNN, 8 September 2003.

[62] Cochran,Thomas, Arkin, William, Norris, Robert and Sands, Jeffrey, *Soviet Nuclear Weapons* (New York: Ballinger, 1989), pp. 143–144.

[63] The usual estimate of the number of missiles exported by North Korea is 400, but this is only a rough estimate that dates back to 1996 and so it is probably out of date. For details on North Korea's missile exports to particular countries, see the Nuclear Threat Initiative, North Korea Country Profile, www.nti.org

[64] 'Pakistan's Missile 'Was a Nodong'', *Jane's Missiles & Rockets*, vol. 2, no. 5, May 1998, pp. 1–2.

[65] Yi Kyo-kwan, 'How Does North Korea Export Missiles?', *Chosun Ilbo*, 5 March 2002, in *DPRK Said to Export Body, Main Parts of Missiles Separately*, FBIS translated text, KPP20020305000112; Lee Kyo-kwan, 'NK Missile Exports Diversified in Technique', *Chosun Ilbo*, 7 March 2002, available at nk.chosun.com/english

Conventional Military Balance

[1] Hodge, Homer T., 'North Korea's Military Strategy', *Parameters, US Army War College Quarterly*, Spring 2003, available at carlisle-www.army.mil/usawc/Parameters/03spring/hodge.pdf; Kongdan, Oh and Hassig, Ralph C., *North Korea Through the Looking Glass* (Washington DC: Brookings, 2000); Oberdorfer, Don, *The Two Koreas* (Reading: Mass: Addison-Wesley, 1997).

[2] Quantities for North Korean military formations and its inventory of weapons are not known exactly. This chapter draws from the IISS, *The Military Balance 2003/2004* (Oxford: Oxford University Press for the IISS, 2003), for slightly different figures, see Republic of Korea, Ministry of National Defense, *Defense White Paper 2000* (Seoul, 2000), available at www.mnd.go.kr/; and US Department of Defense, *2000 Report to Congress: Military Situation on the Korean Peninsula* (Washington DC, 12 September 2000), available at www.defenselink.mil/news/Sep2000/korea09122000.html

[3] See O'Hanlon, Michael, 'Stopping a North Korean Invasion: Why Defending South Korea is Easier than the Pentagon Thinks', *International Security*, vol. 22, no. 4, Spring 1998.

[4] Office of Naval Intelligence, *Worldwide Submarine Proliferation in the Coming Decade* (Washington DC: US Department of Defense, May 1995).

[5] Quantities for ROK military structure and inventory are drawn from the IISS, *The Military Balance 2003/2004* (Oxford: Oxford University Press for the IISS, 2003).

[6] US Department of Defense, *2000 Report to Congress: Military Situation on the Korean Peninsula* (Washington DC, 12 September 2000), p. 8, available at www.defenselink.mil/news/Sep2000/korea09122000.html

[7] Statement of General Thomas A. Schwartz, Commander in Chief, United Nations Command/Combined Forces Command, and Commander, United States Forces Korea, before the Senate Armed Services Committee, 5 March 2002, available at www.defenselink.mil

[8] See O'Hanlon, Michael, 'Stopping a North Korean Invasion: Why Defending South Korea is Easier than the Pentagon Thinks', *International Security*, vol. 22, no. 4, Spring 1998.

[9] See, for example, Mangold, Tom and Goldberg, Jeff, *Plague Wars: The Terrifying Reality of Biological Warfare* (London: Macmillan, 1999), pp. 325–327, for an account of a US military exercise in 1996 that began with the projected use of biological weapons, delivered by North Korean Special Forces.

[10] Statement of General Thomas A. Schwartz, Commander in Chief, United Nations Command/Combined Forces Command, and Commander, United States Forces Korea, before the Senate Armed Services Committee, 5 March 2002, available at www.defenselink.mil