Appendix 12D. Suppliers of ballistic missile technology

SIEMON T. WEZEMAN

I. Introduction

The proliferation of ballistic missiles has been viewed by Western countries as a problem for over 20 years. Their use in the 1991 Gulf War, in particular the threat of chemical warheads mounted on them, and the possession of nuclear-capable missiles by India and Pakistan since 1998 have emphasized the problem of ballistic missiles becoming available to what many Western governments regard as irresponsible states.

This appendix examines recent information about the exporters of ballistic missiles and ballistic missile technology. Its focus is limited to missiles with a range of over 300 kilometres. Its scope is also limited to transfers of complete missiles and *major* components.[1] Any public assessment of ballistic missile transfers is based on fewer sources than is often the case for transfers of other weapons. For this reason, many of the reported transfers of ballistic missiles are not included in SIPRI's statistics on arms transfers.[2] Furthermore, while a number of sources might report a transfer, they often rely on a single, not necessarily reliable, primary source—often a government agency which may have released selective information.

In many cases it is obvious that a country has developed ballistic missiles, especially when the missiles are tested. Most countries with reportedly active missile programmes display and test their missiles in public. However, it is extremely difficult, even for governments with extensive means, to monitor foreign programmes. It is even more difficult for independent research organizations, such as SIPRI, to assess reports about transfers of missiles, components or related technology. Several of the major and most problematic suppliers and recipients, such as China, Iran, the Democratic People's Republic of Korea (DPRK, North Korea) and Syria, are among the most secretive countries in the world. Most reports of their activities are based on Israeli, US or other Western intelligence sources and are virtually impossible to ver-

[1] For reasons of space, this appendix discusses missiles with a range of 300 km or more. The 300-km limit is used by the Missile Technology Control Regime (MTCR). For participating states see the glossary in this volume. There has been strong criticism of the MTCR limit since it ignores the geographical context of missiles. A shorter-range missile may in specific contexts still be a strategic weapon. Ballistic missiles with ranges of less than 300 km are frequently transferred, often for use with multiple rocket launchers with ranges of less than 50 km. Such transfers, as well as transfers of guided anti-aircraft and anti-ship missiles and of technology in the framework of cooperation on civilian and military space launch vehicles, could also be seen as a problem because the technology used in these missiles can be used to develop longer-range ballistic missiles. However, they also are not considered here for reasons of space. For an overview of ballistic missile technology see Karp, A., SIPRI, *Ballistic Missile Proliferation: The Politics and Technics* (Oxford University Press: Oxford, 1996); for an overview of these and other technology transfers and of criticisms of the MTCR, see Mistry, D., *Containing Missile Proliferation* (University of Washington Press: Seattle, Wash., and London, 2003).

[2] To be included in the SIPRI statistics, a transfer has to be identified in several independent sources considered generally reliable by researchers. See appendix 12C.

ify using independent sources. Western intelligence services were apparently proved quite wrong, in 2003, about weapon programmes and missile capabilities in Iraq. This highlights the paucity of good information even for governments, as well as the possibility of biased interpretations of circumstantial evidence.[3]

The fact that several countries have produced ballistic missiles that look very similar to each other might support allegations of links between countries of concern. However, this could also be coincidence since ballistic missiles tend to look similar, at least externally, because the principles of aerodynamics leave little room for alternative designs.

The secretive nature of most ballistic missile programmes makes details about their development, including the name of the programme or weapon system, hazy and often contradictory—adding more confusion to reports and analysis.[4] For example, the Indian Agni-I is reported to have either an 800-km or a 1500-km range, while many statements by the Iranian authorities seem either over-optimistic about their achievements or confusing because the missiles are known by several names.[5]

II. Ballistic missile suppliers

When ballistic missile transfers were last discussed in detail in the SIPRI Yearbook, in 1991, at least four suppliers were identified: China, North Korea, Russia and the United States.[6] Today, only two countries (and possibly a third, although the status of China is unclear) are both willing and able to supply complete ballistic missiles—North Korea and the United States. All three countries supply components and technology for ballistic missiles.

The USA is the only supplier that is known to have transferred long-range ballistic missiles for use with nuclear warheads (to the United Kingdom). Other US transfers of complete missiles involve the MGM-140 Block-1 ATACMS, which have a range of only 300 km and a small conventional warhead. In the case of the ATACMS, missiles are supplied with strong controls to prevent the technology leaking into indigenous ballistic missile programmes.

North Korea

North Korea is undoubtedly the main exporter of ballistic missiles. Reports indicate strong cooperation between Iran, North Korea, Libya, Pakistan and Syria in the

[3] See the Introduction and chapter 2 in this volume. According to Hans Blix, Head of the United Nations Monitoring, Verification and Inspection Commission in Iraq in 2000–2003, regarding the US vision of Iraq's weapons of mass destruction 'everything was interpreted as if one believed in witches. If one saw a broom it was evidence of the existence of witches'. 'Blix: invasion av Irak var byggd på fel diagnos' [Blix: invasion of Iraq was based on the wrong diagnosis], *Metro* (Stockholm), 4 Mar. 2004, p. 10.

[4] Some designations for ballistic missiles, e.g., the North Korean Rodong or Nodong, are invented by foreign sources to identify certain missiles when the real name is unknown. See Karp (note 1), pp. 6–7.

[5] Iran appears to be quite open about most weapon development and production programmes. However, its reports are often contradictory or claim successes that do not exist, e.g., reports about frigate production that turn out to be small patrol vessels or reports of the production of an indigenous combat aircraft that are later contradicted by reports of delayed production linked to serious structural design problems. Jackson, P., *Jane's All the World's Aircraft 2003–2004* (Jane's Information Group: Coulsdon, 2003), p. 269.

[6] Karp, A., 'Ballistic missile proliferation', *SIPRI Yearbook 1991: World Armaments and Disarmament* (Oxford University Press: Oxford, 1991), pp. 317–43.

development and production of missiles. How strong these links are may become clearer when the full details of Abdul Qadeer Khan's dealings with North Korea (see below) and of the Libyan ballistic missile programme become available.[7] North Korea, the most advanced in this group at developing ballistic missiles, supplies missile factories, components and complete missiles. US Under Secretary for Arms Control and International Security John Bolton has called North Korea 'the world's foremost peddler of ballistic missile-related equipment, components, materials and technical expertise'.[8]

North Korea's ballistic missile programme is based on the 300-km range Scud-B missile acquired in the 1980s from Egypt and the Soviet Union.[9] The Scud-B was copied by North Korea as the Scud Mod-B, and further development produced the 500- to 600-km range Scud Mod-C.[10] It is thought that by the late 1980s North Korea was no longer dependent on foreign inputs and had built up an indigenous missile programme consisting of versions of the Scud. In 1993 it tested the 1300-km range Scud Mod-D, or Rodong, partly based on copied Scud technology. The programme may also be partly dependent on Chinese technology and components (see below).

North Korea produces ballistic missiles not only for its own armed forces but also for export to earn foreign currency.[11] The US Central Intelligence Agency (CIA) regards North Korean missile exports as 'one of the North's major sources of hard currency'.[12] However, the importance of arms exports for North Korea is disputed. In 2002 an unnamed 'US military official in Seoul' estimated the value of North Korean missile sales at $560 million per year.[13] However, this figure is contradicted by South Korean sources. According to a 2003 South Korean report, missile exports from North Korea amounted to only $30 million in 1999, $20 million in 2001 and $60 million in 2002.[14] The South Korean Unification Ministry put a value of $6.44 billion on total North Korean exports for the period 1990–95, of which weapons accounted for $300 million. South Korean officials claimed in 1999 that North Korean missile exports to the Middle East for the period 1987–92 were valued at $580 million, or just under $100 million per year.[15] In 1998 North Korea reportedly demanded $500 million from the USA in return for abandoning its ballistic missile programme, a demand rejected by the USA.[16]

[7] Libya abandoned its ballistic missile programme in Dec. 2003. See chapter 16 in this volume.

[8] Kirk, D., 'US assails North Korea's arms sales', *International Herald Tribune*, 30 Aug. 2002, p. 8.

[9] North Korean Scud missiles and later developed versions are also known as Scud Mod-A, Mod-B and Mod-C or as Hwasong V or Hwasong VI or, occasionally, the Rodong-1 and Rodong-2. Confusingly, the original Soviet Scud missiles are also known as Scud A–E. This text therefore uses the 'Mod' designation.

[10] 'Nodong-1', *Missile Forecast* (Forecast International), Feb. 2004, p. 4.

[11] Karp (note 1), p. 18.

[12] US Central Intelligence Agency, 'Unclassified report to Congress on the acquisition of technology relating to weapons of mass destruction and advanced conventional munitions, 1 July through 31 December 2001', Jan. 2003, p. 4, URL <http://www.cia.gov/cia/reports/721_reports7_july_dec2001.html>.

[13] Ward, A., 'North Korea involved in narcotics trade, says US', *Financial Times*, 4 Dec. 2002, p. 6; and Lague, D. and Hiebert, M., 'Pressure politics', *Far Eastern Economic Review*, 17 July 2003, p. 22.

[14] Yong-won, Y., 'Pyongyang keeps up weapons purchases', *Chosun Libo* (Internet edn), 23 Oct. 2003, URL <http://english.chosun.com/w21data/html/news/200310/200310230005.html>.

[15] 'Missile export: North Korea earns $100m per year, says paper', *Dawn*, 3 Apr. 1999.

[16] 'DPRK defense industry said suffering from reduced exports', *Korea Times* (Internet edn), 30 Aug. 1998, in Foreign Broadcast Information Service, *Daily Report–East Asia (FBIS-EAS),* FBIS-EAS-98-242, 30 Aug. 1998.

In early 2003 the USA embargoed a state-owned North Korean company after North Korea allegedly delivered four to six Rodong-1 missiles to *Pakistan* in August 2002. It also embargoed the Pakistani nuclear research company KRL for buying them.[17] The sanctions ban these companies from doing business with the USA and, in the case of North Korea, are mainly symbolic. Pointedly, the USA did not impose sanctions on the North Korean Government or the Pakistani Government, in the last case probably because Pakistan is still considered more important as an ally in the fight against terrorism than as a ballistic missile proliferator. At the same time, an unnamed US official was quoted as saying that North Korea had also delivered some 10 Scud Mod-B missiles to Pakistan.[18]

North Korean technology is widely believed to have been instrumental in the development of Pakistan's ballistic missiles, which are often regarded as no more than copies of North Korea's. Early in 2004, Abdul Qadeer Khan, the 'father' of the Pakistani nuclear weapon and ballistic missile programmes and Director-General of KRL, admitted what had long been suspected—that he had illegally transferred nuclear technology to a number of countries, including North Korea. According to the USA, these transfers were partly paid for with North Korean missiles and missile technology.[19] In 1998 and 2001 the USA had embargoed a North Korean company, Changgwang Sinyoung Corporation, for sales of missile technology to Pakistan.[20] These links date from 1993, when Pakistan Prime Minister Benazir Bhutto visited North Korea. A final agreement on Rodong deliveries is believed to have been signed in November 1995. The 1500-km range Ghauri-I (also known as the Hatf-V), test-fired for the first time in April 1998, is believed to be the result of this agreement.[21] The Ghauri-III is believed to be based on the Taepo Dong-1 (possibly identical to the North Korean missile identified as Rodong-2 or Scud Mod-E). North Korean Taepo Dong-1 and Taepo Dong-2 technology has also reportedly been used in different longer-range (over 2000 km) Pakistani missiles (such as the Abdali, Ghaznavi and 4000-km range Tipu).[22] North Korea has admitted to selling 12 Rodong-1 missiles in 1998 but denies that Rodong technology was used in the Ghauri. Pakistan has only admitted 'foreign inputs in the Ghauri development'.[23]

Iran has been a faithful customer of North Korea's, as well as China's, since 1980, importing *inter alia* artillery rockets and technology for the Iranian development of several rockets. The Iranian Fadjr-5 (or Fajr-5) 333-mm multiple rocket launcher (MRL) system, with a 75-km range, is thought to be based at least partly on North

[17] Hiebert, M., 'Spotlight: punishing Kim', *Far Eastern Economic Review*, 10 Apr. 2003, p. 11; 'Vajpayee's offer: the US needs to make Pakistan keep its promise', *Far Eastern Economic Review*, 1 May 2003, p. 8; and Agence France-Presse, 'US says Pakistan imported missile technology from North Korea', 2 Apr. 2003, URL <http://www.defense-aerospace.com/afp/defense/030402114414.mv2zvtfi.html>.

[18] Agence France-Presse, 'N. Korea exported Scud missiles to Pakistan in March: Japanese report', 2 Apr. 2003, URL <http://www.defense-aerospace.com/afp/defense/030402021241.8i8tjmet.html>.

[19] Suspicions about a missiles for nuclear technology deal were raised in the mid-1990s. Bermudez, J. S., 'Lifting the lid on Kim's nuclear workshop', *Jane's Defence Weekly*, 27 Nov. 2002, p. 21; and Rashid, A., 'The bomb traders', *Far Eastern Economic Review*, 12 Feb. 2004, p. 16.

[20] Crispin, A. W. and Lintner, B., 'Dangerous bedfellows', *Far Eastern Economic Review*, 20 Nov. 2003, p. 24.

[21] Bermudez (note 19), p. 21.

[22] 'Ghauri', *Missile Forecast* (Forecast International/DMS), Jan. 2004, p. 2.

[23] 'Ghauri' (note 22), p. 4.

Korean technology.[24] Iran has been involved in the North Korean ballistic missile programme since the early 1980s, mainly by providing finance but also by supplying North Korea with parts from Iraqi Al Hussein missiles salvaged from those used against Iran in the 1980–88 Iraq–Iran War.[25] Iran assembles North Korean Scuds from kits.[26] North Korean technology is also reportedly used in Iran's ballistic missile development. The latest Iranian ballistic missile, the 1300- to 1500-km range Shahab-3, is thought to be based to a large extent on the North Korean Rodong and uses North Korean liquid-fuel engines, about 20 of which were imported in 1999.[27] The missile was tested in July 2003. According to Israel, Iran is developing longer-range missiles, reportedly including the 2000-km range Shahab-4 and a 5000-km range Shahab-5, some of which are based on North Korean technology.[28] As part of their cooperation, Iran apparently allows North Korea to conduct missile tests in Iran.[29]

North Korea was also reportedly involved in the now defunct *Libyan* ballistic missile programme. In recent years there have been several reports of the interception of shipments of Scud missile parts from North Korea to Libya, including components to extend the range of Libyan Scud missiles, a large number of which were delivered in the late 1970s and early 1980s from the Soviet Union.[30] Libya reportedly produced North Korean Scud Mod-C missiles from 1994 and tested modified Scud missiles in recent years, but with poor results.[31] The Libyan programme may also have included the North Korean Rodong missile, either by using Rodong technology in a Libyan missile or importing complete missiles.[32] Other sources claim that Libya did not acquire the Scud Mod-C until 1999 and maintain that Libya was developing a ballistic missile based on the Rodong in 2002, but with a range of only 900 to 1200 km.[33] In recent years, Israel took the Libyan Rodong threat seriously enough to include a sea-based anti-ballistic missile (ABM) system in its procurement plans.[34]

Syria has also received the Scud Mod-C from North Korea. The missiles are reportedly assembled in Syria and, according to the USA, China and North Korea have assisted with the production of Scud Mod-C missiles in Syria since 1993.[35]

As noted above, *Egypt* has been involved in the North Korean ballistic missile programme by providing Scud-B missiles for reverse-engineering and further develop-

[24] This fires a 915-kg unguided rocket powered by solid fuel to a maximum range of 75 km carrying a 175-kg warhead. *Jane's Armour and Artillery 2003–2004* (Jane's Information Group: Coulsdon, 2003), p. 859.

[25] 'Nodong-1' (note 10), pp. 4–5; Lennox, D., 'Iran's ballistic missile projects: uncovering the evidence', *Jane's Intelligence Review*, vol. 10, no. 6 (June 1998), p. 24.

[26] 'Nodong-1' (note 10), pp. 1–4.

[27] Hughes, R., 'Iran denies Shahab-4 development', *Jane's Defence Weekly*, 12 Nov. 2003, p. 19; and Hughes, R., 'Iran claims "success" with latest missile test', *Jane's Defence Weekly*, 5 June 2002, p. 12.

[28] Hughes, R., 'Interview: Arieh Herzog, Director, Israel Missile Defense Organization', *Jane's Defence Weekly*, 22 Oct. 2003, p. 32.

[29] 'Nodong-1' (note 10), p. 1.

[30] *Jane's Defence Weekly*, 13 Feb. 2002, p. 16; and *Air & Cosmos*, 21 Jan. 2000, p. 7. The interceptions were legal because Libya was under a binding UN arms embargo at the time.

[31] 'Nodong-1' (note 10), p. 1; and Sirak, M., 'Faux reform', *Jane's Defence Weekly*, 3 Sep. 2003, p. 21.

[32] Kneissl, K., 'Internationale Rundschau: Libyen' [International round-up: Libya], *Österreichische Militärische Zeitschrift*, Nov./Dec. 2002, p. 787; and Hughes (note 28), p. 32.

[33] 'Libya increases investment in medium-range missiles', *Middle East Newsline*, 3 Mar. 2002, URL <http://www.menewsline.com/stories/2002/march/03_01_2.html>.

[34] Ben-David, A., 'Israel Navy seeks to bolster surface fleet', *Jane's Defence Weekly*, 3 Dec. 2003, p. 5.

[35] 'Chinese ICBM', *Missile Forecast* (Forecast International/DMS), Jan. 2004, p. 6; and 'Nodong-1' (note 10), p. 1.

ment. Since 1993 there have been repeated reports of North Korean sales of Scud Mod-Cs to Egypt, all of which have been denied by Egypt.[36] The reports include a Swiss claim, made in 1998, that several Scuds, which were being smuggled from North Korea to Egypt, had been intercepted. In 2001 Israel and the USA accused Egypt of a purchase involving up to 50 Rodongs.[37] In 2002–2003 the Slovakian authorities investigated New World Trading—a company in Slovakia with links to North Korea. The company acted as a broker for dual-use chemicals and equipment between *inter alia* China, Russia and Ukraine and the state-owned Egyptian company, Kader. In 1999 Kader had been accused by the USA, along with two other Egyptian companies, of involvement in missile deals with North Korea.[38]

In August 2002 the USA imposed sanctions on the Changgwang Sinyoung Corporation and, in contrast to the Pakistan case mentioned above, also against the North Korean Government for selling Scud components to *Yemen*.[39] In December 2002 Spanish and US forces intercepted a North Korean cargo ship that was carrying 15 Scud Mod-C missiles. Israeli sources claimed that the missiles were bound for Iraq.[40] However, the cargo was later released when it became clear that the Scuds were bound for Yemen. Two batches had already been delivered to Yemen in 2001.[41]

Some evidence emerged in 2003 that Deasong, a North Korean company with links to Changgwang Sinyoung Corporation, had established contacts with *Myanmar* (Burma)—leading to rumours that Myanmar had an interest in ballistic missiles. However, it was not clear that the contacts with Deasong had any link with ballistic missiles and Myanmar denied any missile-related purchases.[42]

The United States

The USA has been involved in several transfers of ballistic missiles and related technology, most of which are either historical or mainly related to civilian space programmes. The long-range component of the *Indian* ballistic missile programme, the Agni-II, is partly based on technology from the civilian SLV-3 launcher programme, which in turn is partly based on civilian US technology acquired over 20 years ago. This highlights the issue of technology for civilian space programmes being diverted to military programmes.[43] More recent and relevant is the supply of 58 Trident long-range submarine-launched ballistic missiles to *the United Kingdom* in

[36] *Defense News*, 29 July 1996, p. 3; and 'Additional worldwide missile programs', *Missile Forecast* (Forecast International/DMS), Jan. 2004, p. 16.

[37] 'En bref: soupçons sur L'Egypt' [In brief: missiles for Egypt], *Air & Cosmos*, 30 Nov. 2001, p. 32; and 'Ägypten kauft 24 Raketen' [Egypt buys 24 missiles], *Soldat und Technik*, vol. 45, no. 3 (Mar. 2002), p. 61.

[38] Lintner, B., 'Nordkoreaner styr hemliga vapenaffärer' [North Koreans steer secret weapon deals], *Svenska Dagbladet* (Stockholm), 6 Feb. 2003, pp. 14–15.

[39] Gordon, M. R., 'North Korea incurs US penalty for sale of missile parts to Yemen', *International Herald Tribune*, 24–25 Aug. 2002, p. 2.

[40] Dan, U., 'Yemen Scuds Baghdad-bound', *New York Post*, 27 Dec. 2002, p. 4.

[41] Lague and Hiebert (note 13), pp. 22–23.

[42] Crispin and Lintner (note 20), pp. 22–24; and Dickerson, L., 'Myanmar denies purchasing missile from North Korea', Forecast International, World Aerospace and Defense Intelligence Newsletter, Washington, DC, 18 Nov. 2003.

[43] The head of the Indian Space Research Organization, which developed the SLV-3, opposed the use of technology developed by his organization for military purposes. 'Agni', *Missile Forecast* (Forecast International/DMS), Jan. 2004, p. 3.

the 1990s, for which logistical support is continuing.[44] The Trident transfer is part of a long-standing arrangement between the USA and the UK, where the USA supplies the missiles for use with British nuclear warheads.[45]

In 2001 *South Korea* signed a contract for 111 MGM-140 Block-1A ATACMS, which have a range of 250–320 km.[46] The 150-km range version of this missile was delivered to several countries. The main difference between this version and the Block-1A is that the payload of the Block-1A has been reduced in order to increase its range. Several other countries are interested in the ATACMS, although which version they are interested in is unclear.[47] South Korea might be trying to develop its own ballistic missiles, but may also be hoping that the USA will release some technology. In the late 1990s South Korea announced plans to procure or produce surface-to-surface missiles with a range of up to 500 km and asked the USA for support. The USA was reported in 2000 to have suspended exports of some core missile parts to South Korea, presumably intended for earlier South Korean ballistic missiles with a range of less than 300 km. It is possible that this was an attempt to gain leverage with South Korea in discussions of these plans.[48]

Taiwan has on several occasions been reported to be developing or even producing a ballistic missile with a range of 300 km or more. Anonymous Taiwanese sources maintain that key components for a medium-range missile have been obtained from the USA and that Taiwanese or former Taiwanese scientists in the USA have offered their assistance. The sources give no detail about whether Taiwan has procured or developed 300-km or 1000-km range missiles.[49] Taiwan denies the existence of a medium-range ballistic missile programme.[50] However, in August 2003, Taiwan reported an unsuccessful test of the Difeng missile, possibly based on the Taiwanese Tien Kung (Sky Bow) surface-to-air missile, which has a range of 600–900 km. The test may have been carried out in response to Chinese deployments of surface-to-surface missiles capable of being used against Taiwan.[51]

There have also been accusations that the US company Loral has illegally transferred guidance technology to *China*.[52]

[44] See appendix 15B in this volume.

[45] The UK received US ballistic missiles in the 1950s but ceased the indigenous development of ballistic missiles in 1962 in return for US Polaris missiles under what is generally known as the 'Nassau Agreement'. The order for the Tridents was agreed in 1980 as a follow-on to the Polaris. Federation of American Scientists, 'WMD around the world: Polaris A-3P', URL <http://www.fas.org/nuke/guide/uk/slbm/a-3.htm>; and Norris, R. S., Burrows, A. S. and Fieldhouse, R. W., Natural Resources Defense Council, *Nuclear Weapons Databook*, vol. 5, *British, French and Chinese Nuclear Weapons* (Westview Press: Boulder. Colo., 1994).

[46] Agence France-Presse, 'South Korea's new missiles put most of North Korea within range', 4 Jan. 2002, URL <http://www.defense-aerospace.com/afp/defense/020104093859.kwk1sbv2.hyml>.

[47] 'MGM-140 ATACMS', *Missile Forecast* (Forecast International/DMS), Jan. 2004, p. 6.

[48] Matthews, R. and Chul-Whan, Kim, 'Self-reliance still ultimate goal of South Korea's defence Industry', *Asia–Pacific Defence Reporter*, vol. 29, no. 6 (Sep. 2003), pp. 32–35.

[49] 'Taiwan: progress on domestic surface-to-surface missiles slow', *Taipei Times* (Internet edn), 3 Apr. 2004, in Foreign Broadcast Information Service, *Daily Report–China (FBIS-CHI),* FBIS-CHI-2004-0405, 6 Apr. 2004.

[50] 'CNA: Defense Ministry denies developing offensive missiles', Taipei Central News Agency, 1 Apr. 2004, FBIS-CHI-2004-0401, 2 Apr. 2004.

[51] 'Highlights', *Missile Forecast* (Forecast International/DMS), Dec. 2003, p. 1; 'Taiwan quiet over missile plans', *Australian Herald Sun* (Internet edn), 29 Oct. 2003, URL <http://www.heraldsun.news.com.au/common/story_page/0,5478,7705870%255E1702,00.html>; and 'In brief: Taiwanese missile test failed', *Jane's Defence Weekly*, 26 Nov. 2003, p. 18.

[52] 'Chinese ICBM', *Missile Forecast* (Forecast International/DMS), Jan. 2004, p. 1.

III. Suppliers of ballistic missile technology

In addition to countries that supply complete missiles, several countries have exported components or expertise for ballistic missile programmes. In some cases the transfers include technology specifically for ballistic missiles, while in others the technology may be more of a dual-use nature. Transfers can be illegal and may involve non-state actors, as in some European and Russian cases. In the past 10–15 years, the involvement of West European, especially German, entities in developing countries' ballistic missile programmes has diminished significantly. This is partly linked to the diminishing market for ballistic missiles after development programmes were dismantled in Argentina, Brazil and South Africa, and partly because West European countries have restricted technology exports related to ballistic missiles.[53]

China

Since the early 1990s, China has been accused by the USA of supplying complete ballistic missiles and related technology to Iran and to Pakistan, its closest ally. While not a participant in the Missile Technology Control Regime (MTCR),[54] China has on several occasions since 1991 promised to abide by the MTCR. In November 2000 China and the USA agreed that China would put in place new export regulations for ballistic missiles and related technology. However, according to the USA, such assurances and the 2000 agreement have had little effect.[55] As a result of continued exports to Iran the USA imposed sanctions on NORINCO, a state-owned exporter. NORINCO was barred from exporting to the USA, losing an estimated $100 million per year.[56]

Among the items sold by China to *Iran* in the 1990s were artillery rockets and ballistic missiles, reported to include the 120- to 300-km range M-11[57] (also known as DF-11 or CSS-7), and possibly the production technology for its solid-fuel and guidance systems.[58] Some sources suggest that the Chinese mobile 1700-km range DF-25 missile was a joint development programme with Iran. However, development ceased in 1996 because of a lack of funding.[59] More recently, China has been linked to the Iranian development of longer-range missiles—possibly the 2000-km range Shahab-4 or the 5000-km range Shahab-5—the existence of both of which is denied by Iran.[60] According to the USA, China remains a key source of ballistic missile technology for Iran, including solid-fuel rocket engines.[61]

[53] For these earlier programmes see Karp (note 6), pp. 317–43; and Mistry (note 1).

[54] See note 1.

[55] Rowan, J., 'China spurns nonproliferation efforts', *Taiwan Journal*, 2 Apr. 2004, p. 6.

[56] Lawrence, S. V., 'Ties that bind: costly sanctions against Chinese conglomerate don't seem set to damage Sino-US relations', *Far Eastern Economic Review*, 5 June 2003, p. 26. The USA did not impose direct sanctions on the Chinese Government, which owns NORINCO. For an overview of China's MTCR commitments, see the Internet site of the Nuclear Threat Initiative, URL <http://www.nti.org/db/china/mtcrorg.htm>.

[57] According to official US sources, the range of the M-11 is over 300 km. Koch, A. and Lennox, D., 'Pakistan's tests: warning for India', *Jane's Defence Weekly*, 5 June 2002, p. 2.

[58] 'Chinese ICBM' (note 52), p. 4.

[59] 'Chinese ICBM' (note 52), p. 6.

[60] Hughes (note 27), p. 19; and Hughes (note 28), p. 32.

[61] 'CIA: China remains key missile supplier to Iran', *Middle East Newsline*, 4 Apr. 2002, URL <http://www.menewsline.com/stories/2002/april/04_18_3.html>.

Chinese transfers to *Pakistan* have been another controversial issue. The USA has accused China of delivering ballistic missiles and technology since the late 1980s. China has denied any delivery of ballistic missiles that would contravene the MTCR. However, according to the USA, China has delivered 34 M-11s since 1993 and equipment and technology to produce the M-11, as well as its fuel and guidance systems. The Pakistani 300-km range Shaheen (or Hatf-3) may actually be a Pakistan-produced M-11.[62] China also assisted Pakistan to develop ballistic missiles, including through deliveries of the 600-km range M-9 (also known as CSS-6 or DF-15) which is thought to have been used in the development of Pakistani Hatf (or Shaheen-I and Shaheen-II) ballistic missiles. According to India, the Ghauri is no more than a Pakistani assembly or copy of the Chinese 2800-km range DF-3 (also known as CSS-2) or mobile 1700-km range DF-25 (rather than a copy of the North Korean Rodong, as alleged above).[63] Saudi Arabia bought some 36 DF-3s in 1988, and there have been suggestions that a number of these were either transferred to Pakistan or that Saudi Arabia gave Pakistan access to the technology.[64] In either case there would be some continued Chinese involvement because the Saudi DF-3s are reportedly operated by Chinese technicians. India also accused China of providing a nuclear warhead design for the M-11 to Pakistan.[65] According to the CIA, Pakistan's ballistic missile programme, including the solid-fuel Shaheen-I and Hiader-I missiles, 'continues to benefit from significant Chinese entity assistance'. Development of the two-stage Shaheen-II would not have been possible without Chinese (or other) help.[66]

Since the early 1990s there have also been allegations that China has provided *Syria* with the 600-km range M-9 (also known as DF-15 and CSS-6), giving Syria access to two-stage technology, and the M-11. In addition, according to the USA, since 1990 China and North Korea have helped Syria to set up missile production and have trained Syrian engineers.[67]

There are some indications that China has previously provided and continues to provide *North Korea* with help to design ballistic missiles such as the Rodong and with some components and liquid and solid rocket engine fuels.[68]

Russia and Ukraine

There have been reports that *China* has obtained technology for intercontinental ballistic missiles (ICBMs) from Russia and Ukraine and has used this in the development of the 8000-km range DF-31 and the DF-41 ICBM.[69] Reports claim that the DF-31 (in service since about 2002) and its submarine-based version the JL-2 are

[62] Koch and Lennox (note 57).

[63] 'Ghauri' (note 22), pp. 3–4.

[64] 'Chinese ICBM' (note 52), p. 4; and 'Ghauri' (note 22), p. 4.

[65] 'Chinese ICBM' (note 52), pp. 6–7.

[66] US Central Intelligence Agency (note 12).

[67] 'Chinese ICBM' (note 52), p. 6.

[68] China developed the 600-km range DF-61 for North Korea between 1975 and 1978. Cancellation of the DF-61 spurred the North Korean indigenous programme. 'Nodong-1' (note 10), pp. 1–3.

[69] Zulkarnaen, I., 'Russia–China defence technology cooperation and her emerging military capability', *Asian Defence Journal*, no. 7–8 (July/Aug. 2003), p. 5. Chinese missiles are also known by their NATO codenames—the DF-31 as the CSS-9, the DF-41 as the CSS10, and the JL-2 as the CSS-N-4 or the CSS-NX-5.

'largely' based on Russian technology, and that the 7500–12000-km range DF-41 ICBM (in development) 'may incorporate' Russian SS-18 technology.[70]

Russian links to the *Iranian* ballistic missile programme have been reported but the details are unclear. The Shahab-4 is reported to be based on Soviet SS-4 technology from the 1950s, but when and how this technology came into Iranian hands is also unclear.[71] The USA imposed sanctions on several Russian companies in 1998 and 1999 for alleged transfers of ballistic missile technology to Iran.[72] According to the CIA, Russian 'entities' have supplied Iran with equipment and technology for ballistic missiles, specifically for the Shahab-3, and are 'likely' to support further Iranian ballistic missile development.[73]

Earlier Soviet technology, mainly the Scud-B missile, had an important impact on the development of North Korean ballistic missiles as well as on Egyptian, Libyan and Syrian programmes. Russia has claimed ownership of all copyrights on former Soviet weapons, but has lost control of Scud technology.[74] Russia was linked to the *Libyan* ballistic missile programme in 1993 when Ukraine intercepted a shipment of an oxidizer used in rocket engines, which originated in Russia.[75] In 2001 Russia strengthened its arms export laws with new control lists for weapons of mass destruction (WMD) and missile-related materials.[76]

Other suppliers

Much has been written about European involvement, mainly through private individuals and German companies, in ballistic missile programmes in Argentina, Brazil, Egypt, Libya and other countries.[77] Most of these programmes have now been dismantled and European states have extended controls to prevent future involvement. Nonetheless, there have been several reports about recent activity. The development of the Indian Prithvi may have been assisted by European technology, but sources are not specific about which country allegedly supplied the technology.[78] Before the US-led invasion of Iraq in 2003, the exact status of the Iraqi missile programme, much of which was forcibly dismantled after the Iraqi defeat in 1991, was uncertain. Since 1991, Iraq had been limited to ballistic missiles with a range of less than 150 km, but most sources agree that some development was continuing on missiles with longer ranges.[79] Some sources predicted that Iraq would possess several ballistic missiles with a range of around 2000 km by 2015. These would have been based on the Argentine Condor-2 missile, presumably with help from countries, companies or persons involved in the original Condor-2 programme, which was dismantled by

[70] 'Chinese ICBM' (note 52), p. 4.
[71] Hughes (note 27), p. 19.
[72] Mistry (note 1), p. 72.
[73] US Central Intelligence Agency (note 12), p. 3.
[74] See also chapter 12 in this volume.
[75] Karp (note 1), p. 1.
[76] US Central Intelligence Agency (note 12), p. 3.
[77] See, e.g., Mistry (note 1).
[78] Lennox, D. (ed.), *Jane's Strategic Weapon Systems* (Jane's Information Group: Coulsdon, 2003), pp. 84–85.
[79] E.g., there have been allegations of transfers of components for Scud missiles from the Czech Republic via Syria to Iraq, which have been denied by the Czech Government. Piper, G., 'USA: der nächste Angriff auf den Iraq' [USA: the next attack on Iraq], *Antimilitarismus Information*, July/Aug. 2002, p. 49.

Argentina in the 1990s.[80] Despite extensive investigations after the defeat of Iraq in 2003, little evidence has been found of the existence of a development programme for ballistic missiles with ranges of more than 150 km.

Israel was linked with the Indian ballistic missile programme in 2003 when it was reported that India was seeking Israeli assistance with developing missiles, including the 3500-km range Agni-III and the submarine-launched version of the 150- to 250-km range Dhanush ballistic missiles.[81] Israel has become an important supplier of military technology to India in the past five years and cooperation on ballistic missiles may be linked to other Indian procurements of weapons and military technology from Israel. The Israeli involvement may, however, be limited to surface-to-air missile systems, the development of which was in serious trouble by late 2003, when India sought Israeli help and the Indian Aksah and Trishul surface-to-air missile programmes were revived.[82] Israel has also been trying to sell the Arrow-2 ABM to India and, in early 2004, was waiting for US agreement to the sale. Such a sale would be controversial since the Arrow-2 would technically come under the MTCR because the missile is capable of carrying a 500-kg warhead over 300 km.[83]

Several other countries have imported ballistic missiles or related technology and later re-transferred some of it. From early data available from the Libyan inspections it seems that Libya has transferred ballistic missile data or technology to Egypt.[84]

IV. Conclusions

There are two main reasons for exporters to supply ballistic missiles, components or technology. For some they are mainly financial.[85] North Korean export-related income is limited but arms sales provide an important part of it. Most North Korean weapons are outdated and uncompetitive, but the country has found a niche market for its ballistic missiles. Giving up such exports, which are not illegal, would be a big economic sacrifice. In addition to hard currency, North Korea has sold missile technology to Pakistan in return for Pakistani nuclear technology for use in North Korea's nuclear weapon programme. Companies and persons from former Soviet republics are trading their products and knowledge for commercial reasons, but generally without state involvement or permission. For other exporters the reasons may be political.

[80] Piper (note 79).

[81] Bedi, R., 'India courts missile help from Israel', *Jane's Defence Weekly*, 1 Oct. 2003, p. 4; 'Highlights' (note 51), p. 2; and 'Agni' (note 43), pp. 4–5. The Agni-III or a follow-on Agni-IV may also be designated Surya. The status of the Dhanush is uncertain. According to most reports, the Dhanush is a version of the Prithvi, but other reports also give it an anti-ship capability, which would be difficult to achieve with the Prithvi.

[82] Bedi, R., 'Israeli help boosts Indian missile project', *Jane's Defence Weekly*, 21 Jan. 2004, p. 16.

[83] See Ahlström, C., 'Arrows for India?: technology transfers for ballistic missile defence and the Missile Technology Control Regime', *Journal of Conflict and Security Law*, vol. 9, no. 1 (spring 2004), pp. 103–25.

[84] Dickerson, L., 'Libya may have traded missile data with Egypt', 31 Mar. 2004, URL <http://emarketalerts.forecast1.com/mic/eabstract.cfm?recno=104357>. The article quotes Middle East Newsline as the source for this allegation.

[85] Data on the prices of complete ballistic missiles are difficult to find. E.g., Forecast International estimates the price of the Agni at $2–3 million but notes that other sources quote up to $17 million per missile. It estimates the price of the more powerful Chinese DF-5 at $1.7 million, the price of North Korean Scud Mod-C at $890 000 and the price of the Rodong-1 at $1.4 million, but notes that other sources give prices as high as $2–2.5 million for the Scud Mod-C and nearly $7 million for the Rodong-1. *Missile Forecast* (Forecast International/DMS), Feb. 2004.

Chinese technology exports to Pakistan are related more to supporting an ally, as are US exports to the UK.

Exporters are aware that most ballistic missiles have proven ineffective in conventional roles.[86] In the 1980s Iran and Iraq attacked each other's cities, and the Soviet Union and its Afghan allies bombarded rebel positions with hundreds of missiles. After the Soviet withdrawal the Afghan Government and rebels used these missiles against each other. Iraq used ballistic missiles against Israel and coalition forces in 1991, and again on a limited scale in 2003. While some of these uses were spectacular, they were not particularly effective. The missiles used were inaccurate and carried only small, simple conventional warheads. With such warheads, especially single conventional warheads, ballistic missiles have proved to be a relative waste of resources if the lack of power is not compensated for by extreme accuracy.[87]

Ballistic missiles may be acquired as a symbol of power and advanced technology and therefore be more of a psychological and propaganda weapon where military utility is less important. Some countries, such as Iran and Syria, may hold the view that a ballistic missile would be the only weapon able to penetrate enemy defences and that, even with a limited conventional payload and a low probability of hitting a militarily significant target, the satisfaction of 'hitting back' could be seen as an important psychological boost. There may also be steps in the direction of the development of highly accurate ballistic missiles that could use conventional warheads more effectively. New navigation systems may dramatically improve accuracy without adding exceptional additional costs. Global Positioning System technology is widespread, and other systems not dependent on signals from foreign satellites are also being developed.[88]

However, the main worry and urgency in the debate about missile proliferation concerns those missiles intended to deliver warheads armed with biological, chemical or nuclear payloads, with nuclear warheads being the most problematic.[89] These would not require the same level of accuracy as missiles carrying conventional warheads. Even the threat of such warheads changes the ballistic missile into an effective weapon of disruption, as demonstrated in the 1991 Gulf War when a large part of the coalition air campaign was directed at the small number of Iraqi ballistic missile launchers.

When ballistic missile programmes go hand-in-hand with WMD programmes there is cause for concern about ballistic missile proliferation.[90] The Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technolo-

[86] The exceptions are missiles with highly accurate guidance systems, e.g., the US ATACMS.

[87] The widespread Scud-B missiles have a circular error of probability (CEP) of several hundred metres. The Rodong has a reported CEP of 700–4000 metres. Most ballistic missiles carry warheads of less than 1000 kg.

[88] Ben-David, A., 'IMI concludes rocket system tests', *Jane's Defence Weekly*, 8 Oct. 2003, p. 15.

[89] Ballistic missiles are less effective than cruise missiles or aircraft at delivering chemical and biological weapons. International Institute of Strategic Studies, *Strategic Survey 2002–2003* (Oxford University Press: Oxford, 2003); and US Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction* (US Government Printing Office: Washington, DC, 1993), p. 9.

[90] Similar concerns could also apply to other means of delivery, such as aircraft armed with cruise missiles or new technologies, even including unpowered glide-bombs. The new US 130-kg 'Small Diameter Bomb' can be fitted with simple foldable wings that give it a range of over 100 km, a GPS guidance system and an optional terminal guidance system. Sirak, M., 'Small Diameter Bomb may get seeker, datalink', *Jane's Defence Weekly*, 14 Jan. 2004, p. 10.

gies[91] and, since 1987, the MTCR therefore specifically target missile proliferation and have been successful in limiting the number of suppliers of ballistic missiles and related technology. This success is partly linked to the fact that ballistic missiles, especially if they have ranges of over 1500 km, when problems of multiple stages and warhead re-entry are encountered, are fairly complicated systems which often require foreign help.[92] The fact that many of the key technologies required for ballistic missiles (e.g., fuel, warhead re-entry vehicles and engines) are quite distinct has also helped to control proliferation.

What is problematic, from an arms control point of view, is that North Korea, the main source of ballistic missiles and related technology, has been shown to be unscrupulous in its arms exports and unconcerned about the fact that most ballistic missile programmes are closely linked to WMD programmes. It is also a country that is not sensitive to pressure from abroad.[93] Concern about North Korea as an irresponsible exporter is so strong that in 2003 the USA and 'like-minded states' organized the Proliferation Security Initiative (PSI) to monitor and intercept ships and aircraft suspected of transporting WMD or delivery systems such as missiles and components, establishing a de facto blockade of North Korea.[94] North Korea, on the other hand, argues that there is nothing illegal about selling ballistic missiles or related technology because no international agreement prohibits this. North Korea plays no role in regimes such as the MTCR. Countries such as Iran and Syria do not regard themselves as obliged to cease their acquisitions of ballistic missiles. Even countries with better relations with the USA hold similar views, as indicated by Yemen in 2002, when it complained to the USA about the interception of Scuds bound for Yemen from North Korea and pointed out that it was not acting illegally.[95]

Importantly, some of the uncertainty about ballistic missile programmes, transfers and links between countries may soon be reduced. Several sources of information have recently become available. The 'war on terrorism' has increased controls on financial transactions and on the transfer and transportation of weapons and related materials. At the same time, Khan's revelations and Western access to the Libyan and Iraqi ballistic missile programmes will increase understanding of the sources and mechanisms of ballistic missile proliferation. This may lead to improved controls and regulations, further limiting proliferation even while the trade in ballistic missiles remains legal.

[91] The Wassenaar Arrangement (WA) is discussed in chapter 18 in this volume. For the participants in the WA see the glossary in this volume.

[92] See Karp (note 1).

[93] According to US Under Secretary of state for Arms Control and International Security John Bolton, North Korea has shown 'few if any signs of getting out of the business of proliferation', even after US pressure. Kirk, D., 'US assails North Korea's arms sales', *International Herald Tribune*, 30 Aug. 2002, p. 8.

[94] The PSI, which is informal, included by May 2004 Australia, Canada, France, Germany, Italy, Japan, the Netherlands, Norway, Poland, Portugal, Russia, Singapore, Spain, the UK and the USA. The legal basis for any interception is unclear. Lague and Hiebert (note 13), pp. 22–23; and Valencia, M. J., 'Why interdiction could fail', *Far Eastern Economic Review*, 28 Aug. 2003, p. 23. For a discussion of the other factors behind its inception, with regard to WMD and delivery systems, see chapter 14 in this volume.

[95] Bermudez, J., 'Yemen continues ballistic missile procurement programme', *Jane's Intelligence Review*, vol. 15, no. 4 (Apr. 2003), p. 28–29.