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A History of Ballistic Missile Development in the DPRK

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Monitoring Proliferation Threats Project

MONTEREY INSTITUTE OF INTERNATIONAL STUDIES

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FOREWORD

During the early afternoon of August 31, 1998, North Korea tested what is known in the West as the Taep'o-dong space launch vehicle; flying a ballistic trajectory, this rocket can reach intercontinental ranges. The launch clearly changed the terms of the debate over a number of missile proliferation issues, including the long-running and contentious argument over deployment of national missile defenses in the United States. Indeed, the August test demonstrated that the direct threat to the United States posed by developing country missiles was no longer a theoretical possibility, but rather a demonstrated technical fact. Tipped with a nuclear warhead, North Korea's missiles would inevitably change the strategic landscape.

But disquiet over P'yongyang's missile program does not lie solely with its march to an intercontinental strike capability. Equally disturbing is North Korea's willingness to sell its missile technology to a number of states whose interests are often in conflict with those of the United States and its allies. There is, therefore, no country more central to ongoing concerns over missile proliferation than the Democratic People's Republic of Korea (DPRK).

That said, hard knowledge about the DPRK missile program appears to be in inverse proportion to the concern it generates; hardly surprising given that North Korea is the most insular nation on earth. Nevertheless, in order to respond appropriately to the military and proliferation threats the program poses, we must have a better grasp of how it has evolved during the past four decades.

No other proliferation analyst is better equipped to meet this challenge than Joseph S. Bermudez Jr. He has been closely following North Korea for almost 20 years, with a publication record on P'yongyang's missile program unmatched by any other author. This body of work comes amid his prolific contribution to the missile proliferation literature on a variety of other topics, including analyses of developments in Iran, Syria, Egypt, and Iraq.

The present text—a version of which will appear in Bermudez's forthcoming book, tentatively titled *The Armed Forces of North Korea* (Sydney, Australia: Allen & Unwin)—brings together more than a decade of his work on this important problem. With his dogged research—including interviews with American, Korean, and other officials—Bermudez provides the reader with unique insight into how P'yongyang developed its missiles. The paper does not aim to make policy prescriptions or predictions. Instead, it provides the historical research necessary to set aside misconceptions and clarify how the DPRK's missile program has actually evolved. By presenting the facts as best they can be determined, this Occasional Paper will provide a stronger basis for understanding the dynamics of missile proliferation in North Korea and elsewhere and for identifying policy options.

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INTRODUCTION

The Democratic People's Republic of Korea (DPRK) has pursued a ballistic missile capability for over 30 years. In the late 1970s, the missile program became a national priority equal to that of the nuclear program; consequently, over the past decade it has achieved consistent progress and a number of successes despite economic collapse and famine. Today, P'yongyang fields the largest ballistic missile force in the Third World—comprising some 36 launchers and 700 missiles—and stands on the verge of deploying ballistic missiles that could threaten the continental United States. This is an ominous development since there is little doubt that the DPRK perceives the ballistic missile to be the delivery system of choice for nuclear weapons.[1]

The DPRK not only builds ballistic missiles but sells them as well. Twenty years of success in marketing complete systems, components, and production technologies have established P'yongyang as the world's leading ballistic missile proliferator. The DPRK has exported missiles or missile technology to a range of countries including Egypt, Iran, Libya, Pakistan, Syria, and the United Arab Emirates. These exports make a significant contribution to the capabilities and development programs of the receiving states and serve to increase tension in regions already characterized by political and military instability.

The most impressive attribute of the DPRK's missile program is the speed at which it has grown, particularly the rapid expansion of capabilities over the last decade. Given the known levels of science, technology, and industrial infrastructure within the DPRK, it is difficult to believe that it has reached such an advanced status of missile proficiency (especially in the areas of guidance and engines) without significant external assistance. The questions then become "Who provided this assistance and when?" and "What was the nature of the assistance?" Although a complete picture remains elusive, what is known is that the DPRK has: (1) engaged in missile technology exchanges with Egypt, Iran, Libya, Pakistan, Syria, and possibly Iraq; (2) both openly and covertly obtained—and is continually seeking to obtain—ballistic missile technologies, components, and materials from Europe, Japan, Russia, and the People's Republic of China (PRC); and (3) over the years, acquired the services of small numbers of foreign missile designers, engineers, and specialists. Indeed, the DPRK's acquisition of missile services may be a key—though difficult to quantify—factor in its missile success. That said, it would be imprudent to underestimate the dedication and abilities of the DPRK's own missile designers, engineers, and specialists. The ballistic missile program has long been a national development priority and has consistently received the high level of resources and attention that this designation implies.

This paper details the roots and history of P'yongyang's ballistic missile program. It traces the distinct chronological stages of the DPRK's development effort, moving from artillery rockets, to short-range ballistic missiles, to medium-range ballistic missiles, and finally to longer range systems. The analysis incorporates discussions of

[1] Important sources used in the preparation of this paper include: Joseph S. Bermudez Jr., "Taepo-dong Launch Brings DPRK Missiles Back Into the Spotlight," *Jane's Intelligence Review* 10 (October 1998), pp. 30-32; Joseph S. Bermudez Jr., "North Koreans Test Two-stage IRBM Over Japan," *Jane's Defence Weekly*, September 9, 1998, p. 28; Joseph S. Bermudez Jr., "A Silent Partner," *Jane's Defence Weekly*, May 20, 1998, pp. 16-17; Ministry of National Defense, Republic of Korea, *Defense White Paper 1998* (Seoul: 1999), pp. 66-67; Joseph S. Bermudez Jr., "N. Korea Set for More Ballistic Missile Tests," *Jane's Defence Weekly*, October 23, 1996, p. 5; Joseph S. Bermudez Jr., "Special Report Number 3 - North Korea's Ballistic Missile Programme," *Jane's Intelligence Review* 6 (April 1994); Joseph S. Bermudez Jr., "Ballistic Missiles in Egypt," *Jane's Intelligence Review* 4 (September 1992), pp. 452-458; Joseph S. Bermudez Jr., "Ballistic Missiles in the Third World—Iran's Medium-Range Missiles," *Jane's Intelligence Review* 4 (April 1992), pp. 147-152; Joseph S. Bermudez Jr., "Afghanistan: Ballistic Missiles in the Third World," *Jane's Intelligence Review* 4 (February 1992), pp. 51-58; Joseph S. Bermudez Jr., "Egypt: Ballistic Missiles in the Third World," *Jane's Intelligence Review* 3 (December 1991), pp. 531-537; Joseph S. Bermudez Jr., "N. Korea on Way to 'Decisive' Weapon," *Jane's Defence Weekly*, October 12, 1991, p. 653; Joseph S. Bermudez Jr., "Syria's Acquisition of North Korean SCUDs," *Jane's Intelligence Review* 3 (June 1991), pp. 249-251; and Joseph S. Bermudez Jr., "New Developments in North Korean Missile Programme," *Jane's Soviet Intelligence Review* 2 (July 1990), pp. 343-345. In addition to these published sources, the author received the support of numerous people and organizations who granted interviews and provided valuable information. Due to the nature of their work, these people and organizations have requested anonymity. Wherever information obtained from these sources has been used it is cited as "author interview data" in the footnotes.

DPRK missile exports, as well as development of other systems relevant to the ballistic missile program.

EARLY DEVELOPMENTS, 1960-1979

The first significant step towards a DPRK missile capability occurred during the latter part of 1960 within the area of surface-to-air missiles (SAM). At that point, a long-term agreement was concluded with the Soviet Union to modernize the DPRK's military arsenal. This included provisions for delivery of what would be the DPRK's first missile system, the V–75 Dvina (SA–2a GUIDELINE) SAM.[2] This acquisition distinguished the DPRK as the third non–Warsaw Pact country (after the PRC and Cuba) to operationally deploy the SA–2.[3]

In late 1962 or early 1963, the first battalion of SA-2s arrived and was deployed near the capital city of P'yongyang.[4] Included within the SA-2 agreement were provisions for the Soviets to establish a rudimentary capability to assemble, maintain, and test these systems. Delivery of the SA-2s, however, came just as DPRK-Soviet relations began to deteriorate: in late 1962 Moscow suspended all negotiations for future military aid in response to the DPRK's support for Beijing in the worsening Sino-Soviet split. Despite this suspension, Moscow did honor commitments made in late 1960 for aid to the DPRK through 1964. On at least one occasion during the arms moratorium, the DPRK approached the Soviet Union seeking missile-related assistance. On August 3, 1963, Brigadier General Kang Hyong-su, the Korean People's Army (KPA) military attaché in Moscow, contacted First Deputy Minister of Defense Andrey A. Grechko to discuss possible cooperation in manpower training and acquisition of missile development technology.[5] The results of this effort are unknown; however, the Soviet arms moratorium continued until 1965 and seriously damaged DPRK-Soviet relations.

During 1965, Premier Kim Il-song laid the basis of the DPRK's missile infrastructure by establishing the Hamhung Military Academy (a.k.a., Hamhung Defense Academy or Military Academy of Hamhung) to support development of modern weapons, including missiles. The Hamhung Academy was made directly subordinate to the Ministry of Defense (now Ministry of People's Armed Forces).[6] In establishing the new organization Kim stated:

> If war breaks out, the US and Japan will also be involved. In order to prevent their involvement, we have to be able to produce rockets which fly as far as Japan. Therefore it is the mandate of the Military Academy to nurture those personnel which are able to develop mid- and long-range missiles.[7]

Within the academy, the First Department was the Department of Missile Engines. This department closely studied the German V-1 (Fieseler Fi 103) and V-2 (A4) and Soviet Free Rocket Over Ground (FROG), among other topics. Other departments are believed to include Missile Design (including anti-ship and surface-to-air), Physics (i.e., nuclear), and Chemical (i.e., chemical and biological warfare). Following the DPRK's capture of the US surveillance ship *Pueblo* in 1968, P'yongyang feared a retaliatory US attack on its strategic sites and many facilities relocated to isolated parts of the country. The academy was moved to Kanggye, where it became known as the Kanggye Military Academy (a.k.a., National Defense College, Kanggye Defense College, Kanggye Defense Academy, or Military Academy

[2] Throughout this paper the national designator for a missile system will be used when it is known. With the first use of a national designator the US reporting name, along with common variations, will follow the designator within parentheses. When no national designator is known the US reporting name will be used followed by common variations within parentheses. For a detailed analysis concerning Soviet SAMs and their development see, Steven J. Zaloga, *Soviet Air Defence Missiles* (London: Publishing Company Ltd., 1989).

[3] Joseph S. Bermudez Jr., "North Korea's Air Defense Missile Forces," *Defense Asia-Pacific* (May 1988), pp. 37-43; and Joseph S. Bermudez Jr.,"North Korea's Air Defense Expansion," *Jane's Defence Weekly*, June 25, 1988, pp. 1289-90.

[4] Defense Intelligence Agency, "USSR Continues Military Aid to North Korea," *Defense Intelligence Digest* (June 1963), p. 43.

[5] Sok-hwan Kim , "North Korea Attempted To Dispatch Manpower To Learn Missile Technology From Former Soviet Union in 1963," *Chungang Ilbo*, August 29, 1999, <http://english.joongang.co.kr/>.

[6] Author interview data; and US Senate, Subcommittee on Governmental Affairs, *Statement of Colonel Joo-hwal Choi and Young-hwan Ko, Before the Senate Committee on Governmental Affairs Subcommittee on International Security, Proliferation and Federal Services*, October 21, 1997.

[7] Ibid.

of Kanggye).[8]

Following the removal of Soviet Premier Nikita Khrushchev from office in October 1964, P'yongyang's relations with Moscow improved and negotiations for further aid re-opened. Military aid subsequently resumed under agreements made in May 1965 and March 1967. This renewed assistance had considerable impact on missile development within the DPRK, as the Soviets agreed to provide the S-2 Sopka (SSC-2b SAMLET) coastal-defense cruise missile, P-20 (SS-N-2 STYX) anti-ship missile, and the 3R10 Luna-2 (FROG-5) artillery rocket.[9] The first consignment of SSC-2b SAMLETs apparently consisted of two launch batteries, target acquisition radars, and support equipment. US intelligence first observed this consignment in September 1965.[10] Additional SSC-2b deliveries brought the total to eight launchers and 32 missiles that were organized into a single regiment of four batteries. The first SS-N-2 STYX probably arrived during 1967-1968 with the delivery of four KOMAR-class fast attack craft.[11] The first FROG-5 transporter-erector-launchers (TEL) probably arrived in 1968.[12]

As with the SA-2s, the Soviets provided training that allowed the DPRK to assemble, test, and maintain SS-N-2 STYX and SSC-2b SAMLETs. This training—along with experience gained in producing multiple-rocket launchers (MRL) and operating the FROG-5 and SA-2a—provided the foundation upon which the DPRK subsequently developed an indigenous missile production capability.

PRC Assistance

In the late 1960s, DPRK–Soviet relations began to sour once again. Moscow declined to provide additional missile systems or upgrades for those already delivered, forcing the DPRK to seek other means to modernize its rudimentary assembly and maintenance capabilities. As a result, the DPRK turned to the PRC to facilitate expansion of its missile efforts.

In September 1971, the DPRK signed a wide-ranging military agreement with the PRC for the acquisition, development, and production of modern weapon systems. The agreement included acquisition of PRC missiles, transfer of PRC missile research-and-development technology, and training of DPRK personnel within the PRC. The first tangible result of this cooperation was the PRC's assistance in reorganizing the Soviet-established assembly and maintenance programs for the SA-2, SS-N-2 STYX, and SSC-2b SAMLET.[13] Interestingly, the Soviet Union continued to provide SS-N-2 STYX and SSC-2b SAMLET missiles during the early 1970s at irregular rates in fulfillment of previous contracts.

Soon after the PRC's reorganization assistance, the DPRK acquired PRC-produced HQ-1 and HQ-2 (CSA-1) SAMs and SY-1 (CSS-N-1 SCRUBBRUSH) anti-ship cruise missiles.[14] The HQ-1 is a PRC reverse-engineered version of the SA-2, the HQ-2 is an enhanced version of the HQ-1 with improved range and guidance, and the SY-1 is a license-produced version of the Soviet SS-N-2 STYX. Initial examples of these systems are believed to have been delivered directly from People's Liberation Army and Navy stocks.[15]

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[8] Ibid.

[9] It is probable that several 3R9 (FROG-3) artillery rockets were also provided. Such a practice would not be unusual for the Soviets, with the earlier variants being utilized for familiarization and training. A January 1989 statement by Secretary of Defense Frank C. Carlucci indicated that the KPA has nine "FROG 3-5" launchers. *Report of the Secretary of Defense Frank C. Carlucci to the Congress on the FY 1990/FY 1991 Biennial Budget and FY 1990-94 Defense Programs*, January 17, 1989. The Soviet index number and name for the FROG-3 are 3R9 and Luna-2, respectively.

[10] Author interview data; and Benjamin Welles, "North Korean Militancy Linked to 1966 Meeting," *New York Times*, February 1, 1968, p. 15.

[11] By 1971 the Korean People's Navy had four OSA-class and 10 KOMAR-class combatants. Defense Intelligence Agency, "North Korean Navy: Compact, Capable, Growing," *Defense Intelligence Digest*, November 1971, pp. 4-7.

[12] Defense Intelligence Agency, "North Korean Armed Forces Modernization," *Defense Intelligence Digest*, December 1968, pp. 15-16; Defense Intelligence Agency, "North Korea, The USSR, Communist China: Operation Tightrope," *Defense Intelligence Digest*, September 1968, pp. 37-40; Department of State, "Arms Suspension: A Big Stick or a Weak Reed," INR-22, November 12, 1969; and Central Intelligence Agency, "The Threat of the Guided Missile Patrol Boat," *Weekly Review (Special Report)*, 17 November 1967, p. 4.

[13] It is interesting to note that the PRC never produced the SSC-2b SAMLET and only deployed it in limited numbers as they believed it was an obsolete system with limited effectiveness. Author interview data.

[14] HQ stands for Hong Qian ("Red Leader") and SY stands for Shui Ying ("Water Eagle").

[15] Bradley Hahn, "The Democratic People's Republic of

During the mid-1970s, the DPRK also began to acquire the HY-1 in both its coastal defense version (CSSC-2 SILKWORM) and later in its ship-launched version (CSS-N-2 SAFFLOWER).[16] System deliveries were accompanied by a PRC-supported effort to expand the DPRK's existing missile programs to include the assembly, upgrade, and eventually the production of both the HQ-2 and HY-1.[17] As the programs developed, this effort proceeded from technical assistance to the provision of complete missile systems, to "knocked-down" kits, and then to sub-assemblies.

The DPRK probably achieved an indigenous HQ-2 and HY-1 production capability sometime during the late 1970s, although it was most likely still heavily dependent on the PRC for critical sub-components.

Establishment of a Ballistic Missile Program

Available evidence strongly suggests that the DPRK initiated a multifaceted ballistic missile program in 1975. One of the primary factors precipitating this move was the establishment of a Republic of Korea (ROK) program to develop a short-range ballistic missile—the Paekkom ("White Bear").[18] The ROK program was itself a response to the threat posed by the DPRK's FROG-5 capability—P'yongyang could strike Seoul but the ROK had no missile system capable of reaching P'yongyang. The Paekkom prototype was developed from the US-supplied Nike-Hercules SAM and was first successfully flight tested on September 26, 1978. Paekkom, however, never entered production due to political pressure from the United States, which feared it would lead to an escalation of tension and an arms race in the region.[19]

Aside from the Paekkom program, factors that contributed to the DPRK's decision to establish a ballistic missile program included: the continued instability in DPRK-Soviet relations and the Soviet refusal to provide additional missiles and FROG-5 rockets; the solidification of the internal situation within the DPRK as embodied in *Chu'che* (self-reliance) and the national military policies of "Fortress Korea" and "Four Military Lines"; the growing military and economic strength of the ROK; and the Egyptian and Syrian use of tactical ballistic, coastal-defense, and anti-ship cruise missiles during the October 1973 War.[20]

As best as can be presently determined, the ballistic missile program established by the DPRK in 1975 consisted of three discrete though concurrent efforts—FROG-5/6/7, HQ-2, and the DF-61.[21] The intent appears to have been for the FROG and HQ-2 (in a surface-to-surface role) to provide a modest, near-term improvement in ballistic missile capabilities, while the DF-61 would provide a highly capable, short-range ballistic missile in the longer term. The DF-61 program was the primary effort; the FROG and HQ-2 programs provided the "fall-back" position. Because information concerning this period is especially scarce, many of the details concerning the FROG and HQ-2 programs presented in the following sections should be considered tentative.

FROG-5 (Luna-2) and FROG-7B (Luna-M)

As part of the military assistance agreements

Korea: Maritime Power—A Political and Economic Weapon?" *Combat Craft* 3 (January/February 1985), pp. 10-19.

[16] HY stands for Hai Ying ("Sea Eagle").

[17] For an overview of PRC naval missiles see Bradley Hahn, "China's Tactical Naval Missiles," *Navy International* (June 1988), pp. 308-312.

[18] The Chinese character "Paek" is white, while the Korean "Kom" is bear. Paekkom can also be translated as "Polar Bear."

[19] Author interview data; Kim Chae-hong, "What is the 'Yulgok' Project," *Tong-a Ilbo*, April 26, 1993, p. 2, in FBIS-EAS-93-078; Yu Yong-won, "We Too Must Develop a Long Range Surface-to-Surface Missile (SSM)," *Wolgan Choson*, April 1991, pp. 378-93, in FBIS-EAS-91-191; John J. Fialka, "Fighting Dirty: Chemical Weapons Spread in Third World, Pose Challenge to West," *Wall Street Journal*, September 15, 1988, pp. 1, 26; David C. Isby, "Weapons and Tactics of the Republic of Korea Army," *Jane's Defence Review* 3 (1982), pp. 55-61; Frederick P. Weichel, "The Last to Leave," *Air Defense Magazine* (July-September 1982), pp. 31-32; and Pete Roming, "Partners in Defense," *Air Defense Magazine* (July-September 1977), pp. 6-9.

[20] For information regarding the Arab use of tactical ballistic missiles during the 1973 War see Joseph S. Bermudez Jr., "Egypt's Missile Development," in William Potter and Harlan Jencks, eds., *The International Missile Bazaar* (Boulder, CO: Westview Press, 1994), pp. 23–46; Joseph S. Bermudez Jr., "The Syrian Missile Threat," *Marine Corps Gazette* 69 (January 1985), pp. 54-62; and Saad El-Shazly, *The Crossing of the Suez* (San Francisco: American Mideast Research, 1980), pp. 79-80, 198, 268, 309.

[21] DF stands for Dong Feng ("East Wind").

concluded with the Soviet Union in 1965 and 1967, the DPRK received approximately 27 to 63 FROG-5 (3R10 Luna-2) artillery rockets, nine TELs, and associated equipment. The weapon systems were delivered in 1968, along with approximately 12 FROG-6 trainer vehicles. Although numerous sources indicate that the DPRK also received a number of 3R9 (FROG-3) rockets, this has yet to be confirmed.[22] The Soviet Union may have provided a small number of these rockets for training or, alternatively, the similar appearance of the 3R9 and 3R10 may be a source of confusion.

The FROG-5 consists of a transporter-erector-launcher (TEL) based upon the PT-76 chassis and the 3R10 artillery rocket. The 3R10 is a solid-fuel, unguided, spin-stabilized rocket with a maximum range of 55 km and a 408-kg high-explosive (HE) warhead (the Soviet Union provided only HE warheads). It has a circular error probable (CEP) of approximately 880 m at a range of 40 km.[23] Reaction time from arrival at a pre-surveyed site is 15 to 30 minutes.[24] Associated equipment includes a ZIL-157V rocket transloader, K-51 crane, and a RVS-1 Malakhit (BREAD BIN) meteorological data receiver. The FROG-6 is a training system with a non-operational dummy rocket and launch rail that is mounted on a modified ZIL-157 wheeled vehicle.[25]

[22] Author interview data; Steven J. Zaloga, "Luna-M: A Source of Third World Thunder," *Jane's Intelligence Review* 8 (June 1996), pp. 249-253; Gordon Jacobs, "North Korea's Arms Industry: Development and Progress," *Asian Defense Journal* (March 1989), pp. 28-35; Defense Intelligence Agency, *North Korean Armed Forces Handbook* (Washington, DC: Defense Intelligence Agency, July 1977), pp. 2-13, 2-67 and 2-69; and United Nations Command, United States Forces Korea, United States Army, *1976 Annual Historical Report*, HIST-S-77-6, 1977, pp. 50-51.

[23] CEP is a measure of accuracy. It is the radius of a circle drawn around the intended target point in which 50 percent of the rounds fired will impact. The smaller the CEP, the greater the accuracy.

[24] Reaction time is that period of time in which an average missile crew can prepare and launch a missile.

[25] At least one source states that the FROG-6 trainer vehicle consisted of a dummy missile permanently fixed to the launch rail. Author interview data.

Table 1. FROG Artillery Rocket Characteristics[26]

	3R10 Luna-2	9M21E Luna-M
	(FROG-5)	(FROG-7B)
Weight (tonnes)	1.9	2.5
Warhead weight (kg)	400–450	420-457
Length (m)	9.1	9.4
Diameter (m)	0.4	0.544
Maximum range (km)	55	65
Minimum range (km)	15	15
CEP (m)	800	400
Warhead types	HE, chemical	HE, chemical

The FROG-5s were initially organized into three battalions subordinate to the Artillery Command and deployed near P'yongyang, within the III Corps. Each battalion had three TELs, approximately 167 personnel, and was organized into a headquarters and three firing batteries. Headquarters consisted of a small staff; technical, communications, and rear services platoons; and meteorological and survey sections. Each firing battery consisted of a launcher section with one TEL. During this period, the standard Soviet organization for a FROG battalion called for meteorological and survey sections to be included in each launch battery. It appears, however, that since radars were in short supply, the KPA may have established meteorological and survey sections within the battalion headquarters, or independent target-acquisition batteries that served both the FROG battalions and multiple-rocket-launcher units.

This structure did not change until the late 1980s. At that time, each firing battery added an air defense section and the RMS-1 (END TRAY) may have replaced the BREAD BIN meteorological data receiver.

With the establishment of a ballistic missile program, it appears that P'yongyang made a decision to enhance and expand the FROG force. This effort is believed to have consisted of three sub-components: acquisition of the 9M21E Luna-M (FROG-7B) or, failing that, additional FROG-5s; reverse-engineering the FROG-5 and possibly the FROG-7B; and development of chemical warheads for the systems.

Due to the poor state of relations between Moscow and P'yongyang, the DPRK was not able to secure the FROG-7B directly from the Soviet Union. Attempts to acquire the FROG-7B were therefore limited to those countries that had previously received the system from the Soviet Union; were on good terms with the DPRK; and were willing to incur Moscow's displeasure by selling or transferring the systems to the DPRK. At the time only a few countries met all of those conditions, including Egypt, Romania, and Syria.

As a result of the precipitous decline in Egyptian-Soviet relations and in return for the DPRK's assistance during the October 1973 War, Egypt's President Anwar el Sadat transferred a small number of Soviet-supplied FROG-7B TELs and rockets to the DPRK and agreed to cooperate in the field of missile development. This transaction may have been repayment for DPRK assistance during the 1973 War, or for spare parts and weapons acquired after the war. Approximately 24 to 56 9M21E Luna-M (FROG-7B) rockets, six to eight TELs, and six to eight rocket transporter vehicles were delivered in 1975 and 1976. Syria may have been involved in this particular

[26] Zaloga, "Luna-M," pp. 249-253.

transfer or Damascus may have, in a separate move, provided a small number of its own FROG-7B rockets. This, however, remains unconfirmed.[27]

The FROG-7B consisted of a new TEL (based upon the Soviet eight-wheeled ZIL-135LM vehicle) and the 9M21E artillery rocket. Like the 3R10, the 9M21E is a solid-fuel, unguided, spin-stabilized rocket. However, it has a longer maximum range (65 km) and a larger HE warhead (450 kg) than its 3R10 predecessor. Reaction time from arrival at a pre-surveyed site is 15 to 30 minutes.

Upon arrival in the DPRK, these systems were organized into two battalions subordinate to the Artillery Command that were modeled on those of the existing FROG-5 battalions. Possible differences include two instead of three firing batteries (each with two TELs) and the END TRAY radar may have been substituted for the BREAD BIN meteorological data receiver in the meteorological section.[28]

Following receipt of the Egyptian FROG-7Bs, the program to reverse-engineer or acquire additional FROG-5s was probably refocused to the FROG-7B. Defectors report that by the end of the 1970s, the DPRK was producing a reverse-engineered FROG (presumably the FROG-7B) at the January 18th Machine Factory in P'yongyang, P'yongyang-si.[29] Numbers produced and the length of the production run are unknown. It is probable, however, that low-rate production continued at least into the mid-1980s.

The Soviets provided only HE warheads for the FROG-5s transferred to the DPRK. Similarly, the FROG-7Bs provided to Egypt (and subsequently to the DPRK) had only HE warheads. However the DPRK was apparently successful in developing chemical warheads for both the FROG-5 and FROG-7B.[30]

[27] Author interview data.

[28] Ibid.

[29] *Statement of Colonel Joo-hwal Choi and Young-hwan Ko*.

[30] Ibid. The Soviet chemical warhead for the FROG-7 weighs 436 kg with 216 kg of VX agent. Conference on Disarmament, *Information on the Presentation at the Shikhany Military Facility of the Standard Chemical Munitions and of Technology for the Destruction of Chemical Weapons at a Mobile Unit*, CD/789, December 16, 1987, pp. 24-26.

HQ-2/SA-2 Surface-to-Surface Missile (SSM)

The DPRK "mirrored" the ROK's Paekkom program (which developed a ballistic missile from the Nike-Hercules SAM) by either assigning the surface-to-surface mission to a small number of its HQ-2/SA-2 units, or by establishing a project to develop a dedicated SSM version of the HQ-2/SA-2. It is conceivable that both paths were pursued for a short time.[31]

Almost all early Soviet (e.g., SA-2, SA-3, and SA-5) and US (e.g., Nike-Hercules) SAMs were designed with the capability to conduct surface-to-surface fires as a secondary mission.[32] SAMs employed in this role generally have their fuzing systems changed, self-destruct sub-systems deactivated, and the timer for thrust termination reset. Once launched, they are actively guided to a specific point in the sky and then allowed to fly a ballistic path to their ground targets. In this role, the missiles have surprisingly good range (for example an HQ-2/SA-2 has a range of approximately 150 to 200 km, compared to the FROG-7B's 65 km). Because of their small HE charge and fragmentation rather than blast warheads (190 kg in the SA-2, compared to the FROG-7B's 420 to 457 kg) they have limited destructive effect, however. The KPA's rudimentary target acquisition capabilities did not diminish the HQ-2/SA-2's potential as a surface-to-surface weapon, since its likely mission was to attack high-value fixed targets (e.g., Seoul, airfields, radar installations, etc.).

DF-61[33]

The DF-61 program was the primary—and

[31] Author interview data.

[32] Steven J. Zaloga, "Back-Door BMs: The Proliferation Threat Posed by Converted SAMs," *Jane's Intelligence Review* 11 (April 1, 1999), pp. 51–53; Zaloga, *Soviet Air Defence Missiles*, pp. 36-109; and Chuck Hansen, *US Nuclear Weapons: The Secret History* (Arlington, TX: Aerofax, 1988), pp. 187–189. The Nike-Hercules could use the W-31 nuclear warhead, with yields up to 40 kilotons, in the surface-to-surface role.

[33] Author interview data; Hua Di, "China's Case: Ballistic Missile Proliferation," in Potter and Jencks, eds., *The International Missile Bazaar*, pp. 163-164; Ling Yu, "Latest Development of CPC Missiles and Nuclear Weapons," *Xuang Chiao Ching*, November 16, 1993, pp. 16-19, in FBIS-CHI-93-221; and John W. Lewis and Hua Di, "China's Ballistic Missile Programs: Technologies, Strategies, Goals," *International Security* 17 (Fall 1992), pp. 5-40.

most sophisticated—component of the DPRK's early ballistic missile program. At Mao Zedong's invitation, Kim Il-song traveled to Beijing in April 1975. Beijing saw the visit as an opportunity to continue its policy of pulling the DPRK away from the Soviet orbit, while P'yongyang saw the trip as an opportunity to elicit greater PRC political and military support for its struggle against the ROK.[34] During this nine-day state visit, DPRK Defense Minister O Jin-u asked if the PRC could equip the KPA with short-range ballistic missiles. The PRC did not have such missiles in its arsenal but the request coincided with internal interests, and later that year the PRC initiated feasibility studies on tactical ballistic missile development. The following year, General Chen Xilian from the PRC's Central Military Commission authorized a full-scale development project for a liquid-fuelled tactical ballistic missile to be designated the DF-61.

Two versions of the DF-61 were intended for production—domestic and export (i.e., for the DPRK). The export version was designed with a 600-km range and a 1,000-kg conventional warhead, while the domestic version was to have a 1,000-km range with a 500-kg nuclear warhead. The 600-km range was an important requirement for the DPRK: it would provide the capability to strike targets anywhere within the ROK, including the southernmost island of Cheju-do. Conventional warheads considered for the export DF-61 included high explosive, fuel-air explosive, and cluster. Sub-munitions for the latter warhead were given varying aerodynamic properties; once the ballistic windshield was released, the sub-munitions would all travel with slightly different trajectories. Guidance was to be provided by a new, PRC-developed inertial strap-down system (CEP is currently unknown). The liquid rocket engine relied on a high-pressure turbo pump, but the fuel itself was not pressurized. The production missile was to be approximately 9 m in length, 1 m in diameter, and constructed with a relatively thick-gauge steel skin (this would allow the DF-61 to be transported without fear of damage—a requirement for both the PRC and the DPRK).

Development of the DF-61 progressed for approximately one year; then, for internal PRC political reasons, it was suspended. In 1978 the project was cancelled after General Chen Xilian was removed from office.

The extent to which the DPRK was involved in the design of the DF-61 is unknown. A small number of DPRK personnel were apparently allowed access to the PRC design bureau and were kept abreast of most DF-61 developments. Possible exceptions to this access were in the areas of guidance system and warhead (especially nuclear) development.

Other Missile Systems

The DPRK was involved in a number of smaller missile-related projects during this period. In 1975, P'yongyang began to manufacture a reverse-engineered version of the Soviet PUR-61 Shmel (AT-1 SNAPPER) anti-tank guided missile (ATGM). This development is regarded by some as the first missile system in the DPRK to be totally manufactured with indigenous components.[35] During 1974, both the DPRK and the PRC are believed to have acquired examples of the Soviet PUR-64 Malyutka (AT-3 SAGGER) ATGM and 9K32 Strela-2 (SA-7 GRAIL) SAM from Egypt. These systems were subsequently reverse-engineered by the DPRK and placed in service with the KPA in the late 1970s.[36]

FIRST BALLISTIC MISSILES, 1979-1989

While cancellation of the DF-61 program was a considerable setback, the DPRK did not abandon its pursuit of a ballistic missile capability. Direct paths to this goal, however, were limited: the PRC and the Soviet Union were seemingly the only two countries that could conceivably provide assistance. Cancellation of the DF-61 meant the PRC was not able to export the required missile systems, while the Soviet Union, for political reasons, refused to provide what the DPRK wanted. These circumstances left the DPRK with only one real choice: to produce ballistic missiles

[34] Wayne S. Kiyosaki, *North Korea's Foreign Relations: The Politics of Accommodation, 1945-1975* (New York: Praeger Publishers, Inc., 1976), pp. 102-105; "Kim Il-song Bids US Get Out of Korea," *New York Times*, April 20, 1975, p. 26; "North Korea's Kim Leaves Peking," *New York Times*, April 27, 1975, p. 7; and "North Korea Gets Peking's Support," *New York Times*, April 29, 1975, p. 35.

[35] Author interview data.

[36] Author interview data.

indigenously. In 1979 the existing, though incipient, ballistic missile program was reorganized into an ambitious effort to achieve this goal.[37] With this reorganization, both the FROG and HQ-2/SA-2 programs appear to have been refocused. The FROG program began to concentrate solely on maintenance of existing systems, while the HQ-2/SA-2 program focused on production and improvement of the SAM versions of these systems.[38]

Significant obstacles stood in the way of an indigenous capability to design and produce ballistic missiles. Most importantly, the DPRK did not have the skilled manpower or technology to design a ballistic missile from the ground up, as all its relevant expertise was confined to SAM, anti-ship cruise missile, and artillery rocket programs. To overcome these limitations, the DPRK again turned to Egypt, and the two countries concluded a series of new agreements to cooperate in missile development. The central focus of this cooperation was a program to reverse-engineer the Soviet R-17E (the version of the Scud B exported to Egypt) as an interim step towards future production of indigenously designed ballistic missiles with greater ranges and improved accuracies. Part of this agreement called for the exchange of scientists and technicians between the two countries. Egypt had long desired to produce long-range ballistic missiles, and shortly after the October 1973 War, it had initiated several feasibility studies for an improved Scud B.[39] Cairo viewed cooperation with P'yongyang as a means to advance its own ballistic missile ambitions while conserving its resources. In addition to this expanded cooperation with Egypt, the DPRK apparently requested and received PRC assistance in the areas of rocket engine design/production, metallurgy, and airframe technology.

Although ROK ballistic missile developments during this period would strongly influence the overall direction of the DPRK's ballistic missile program, any effects upon the contemporaneous R-17E and Hwasong 5 programs appear to have been minimal. The primary ROK activity during this period was the development of the Hyonmu ("Black Weapon") SSM—a follow-on to the Paekkom.[40] Development of the Hyonmu began in 1984, its test-launch phase was successfully completed in 1987, and the system was deployed shortly afterwards. When the United States became aware of the Hyonmu, it applied considerable pressure on the ROK to limit both the range of the system and the number produced. The United States feared that a long-range missile, built in large numbers, would be perceived as a threat to the PRC. The ROK bowed to US pressure and limited the range of the Hyonmu to 180 km (instead of 250 km) and deployed only a single unit (with 12 TELs). In return for these concessions, the United States provided greater military aid and the US Army announced, in November 1986, its decision to return tactical ballistic missiles to the ROK with the redeployment of the B/6–32nd Field Artillery Regiment equipped with the MGM-52 Lance SSM.[41] Although the range of the Lance was only 120 km (i.e., unable to reach P'yongyang), it possessed a CEP of 120 m and was capable of delivering the W70 nuclear warhead.[42]

Against this background the DPRK acquired its first ballistic missile—the R-17E—and subsequently initiated production of its first

[37] The exact date of this reorganization is presently unknown. The 1979 date used here represents the best estimate currently available.

[38] Some HQ-2/SA-2 units undoubtedly retained a secondary surface-to-surface mission.

[39] Due to both monetary and political restraints Egypt was unable to act upon these studies until 1984 when the Badr-2000 program was initiated. Bermudez, "Egypt's Missile Development," pp. 23–46; Bermudez, "Ballistic Missiles in Egypt," pp. 452-458; and US House of Representatives, Subcommittee on Oversight, Committee on Ways and Means, *Administration and Enforcement of US Export Control Programs: Hearings Before the Subcommittee on Oversight of the Committee on Ways and Means*, 102nd Cong., 1st sess., April 18 and May 1, 1991, pp. 134–153.

[40] Hyonmu is a mythical Chinese animal with the body of a turtle and a head of a dragon. The Chinese character "Hyon" is translated as black, while the Chinese character "mu" is weapon.

[41] The United States withdrew its last tactical ballistic missiles from the ROK in 1978 when the 4th Missile Command was deactivated.

[42] Author interview data; Yong-won Yu, "We Too Must Develop a Long Range Surface-to-Surface Missile (SSM)," pp. 29-37; "Lance Back in South Korea," *Jane's Defence Weekly*, November 22, 1986, p. 1203; and "Lance Missiles to South Korea," *Bulletin of the Atomic Scientists*, May 1987, p. 56.

ballistic missile, the Hwasong 5.[43]

R-17E (a.k.a., Scud B)[44]

The most significant aspect of the DPRK's new agreements with Egypt was the transfer in 1979 or 1980 to the DPRK of a small number of Soviet R-17E missiles, MAZ-543 TELs, support vehicles, and equipment.[45] The agreements also provided for a limited exchange of engineers, technicians, and military personnel.

With the R-17E in hand, the DPRK began to reverse-engineer the missile. Available evidence suggests that none of the Egyptian-supplied missiles were ever test launched but instead were used as "models" for reverse-engineering and to train a cadre of engineers, technicians, and KPA personnel. In 1981 or 1982 this cadre was used to form a special missile test-and-evaluation unit to conduct flight tests and to prepare for the introduction of ballistic missiles into KPA service. It is unclear whether this unit was established or equipped as a combat unit. Regardless, it provided the DPRK with its first true, albeit contingency, ballistic missile capability.

Concurrent with these efforts, the DPRK began to assemble the industrial infrastructure required to support an indigenous ballistic missile program. This program involved construction or conversion of: the 125 Factory (P'yongyang); a military research-and-development facility at Sanum-dong (25 km north of P'yongyang); the Musudan-ri Launch Facility located on the northeast coast (30 km southeast of Kilchu); and a variety of other related facilities.

Hwasong 5 Prototype (a.k.a., Scud Mod. A)

The reverse-engineered version of the R-17E was assigned the name Hwasong 5.[46] The primary organizations involved in this project—as well as all missile development within the DPRK—were the Guided Missile Division of the Academy of Defense Sciences and the Fourth Machine Industry Bureau. Both of these organizations were subordinate to the Second Economic Committee.

Work proceeded steadily on Hwasong 5 throughout 1982 and 1983, and by early 1984, DPRK engineers completed the first prototypes. The missile is believed to have been an exact (or near) copy of the R-17E and was built in small numbers. Prototypes represented "proof-of-concept" systems intended to: provide training and experience for those involved in design and manufacture; identify problems in both the design and production processes; and identify areas in which production could be tailored to best suit DPRK manufacturing capabilities. As such, it is probable that none of these missiles was ever intended to be an operational weapon and none was deployed.

During this development period, the Iranian government approached the PRC and the DPRK for tactical ballistic missiles and missile technology.[47] In October 1983, Iranian Prime Minister Husayn Musavi and Defense Minister Colonel Mohammad Salimi traveled to P'yongyang. It is believed that the DPRK's Hwasong 5 program was a major topic of discussion during this trip.[48]

In April and September 1984, the DPRK conducted a minimal flight-test program for Hwasong 5 prototypes with three known

[43] There is considerable confusion concerning the national designators for the DPRK's missiles. One defector claims that the first DPRK produced copy of the R-17E is identified as the Hwasong 1, while the No-dong 1 and Taep'o-dong 1 are Hwasong 5 and Hwasong 6, respectively. Another defector identifies the Hwasong 1, 2, and 3 as surface-to-air, surface-to-surface, and air-to-surface missiles respectively. Usually reliable non-DPRK sources identify the DPRK produced "Scud B" as Hwasong 5 and the "Scud C" as the Hwasong 6. This paper will use these latter designations.

[44] For a detailed description of the R-17 and its development see Steven J. Zaloga, "Ballistic Missiles in the Third World, Scud and Beyond," *International Defense Review*, November 1988, pp. 1423–1427.

[45] There is some debate as to the exact year in which the DPRK received the Scud B missiles from Egypt. This transfer may actually have been a DPRK purchase, or part of an Egyptian barter agreement for DPRK arms and spare parts. Author interview data; "Merchants of Death: How to Curb the Weapons Trade," *Moscow News*, November 19, 1990, p. 13; and Yong-chin Nam, "DPRK Advanced Weapons," *Korea Times*, February 8, 1991, p. 8, in FBIS-EAS-91-090 (May 9, 1991), pp. 30-32.

[46] Hwasong means Mars.

[47] For details concerning the early Iranian missile program see Joseph S. Bermudez Jr., "Iran's Missile Development," in Potter and Jencks, *Missile Bazaar*, pp. 47-74.

[48] "Iranian Prime Minister Arrives in North Korea," Reuters, October 24, 1983.

successful launches and three failed launches.[49] All flight tests are believed to have been Hwasong 5 prototypes and were conducted from the Musudan-ri Launch Facility, with flight trajectories southeast over the East Sea.[50] It is reasonable to assume that these first prototypes consisted of DPRK-produced airframes and fuel tanks, but utilized engines and guidance systems taken from original R-17Es. An Iranian presence during the flight-test program is also probable. No additional flight tests of the Hwasong 5 are known to have been conducted within the DPRK.[51] The timing of this test-launch program may have been in response to the ROK Hyonmu test program.

Hwasong 5 (a.k.a., Scud Mod. B, Scud B)

The Hwasong 5 was the first ballistic missile to reach true production status within the DPRK. In comparison to the prototypes, it was modified slightly to conform to DPRK production practices and capabilities, and probably included a small number of more modern components. While the external dimensions of the Hwasong 5 are "almost identical" to the R-17E, it has a 10 to 15 percent increase in operational range compared to the original—approximately 320 km versus 280 km with a 1,000-kg warhead.[52] The CEP of the Hwasong 5 is not known with any certainty, but it is believed to be similar to that of the original R-17E (e.g., 500 to 800 m). Over the course of its production, numerous changes were apparently incorporated into the Hwasong 5 design. For example, earlier models were equipped with a copy of the R-17E strap-down guidance system (or original guidance sets covertly obtained from the Soviet Union or, more likely, from other countries with Scud inventories), while later models used an improved indigenous guidance system. It is likely that the DPRK also incorporated minor changes to its copy of the Isayev 9D21 rocket engine. Concurrent with Hwasong 5 production, DPRK engineers worked to develop new warheads for the system, including HE, cluster, chemical, and possibly biological.[53] These changes undoubtedly resulted in various sub-models, but the designations and details of these are not known.

Low-rate series production of the Hwasong 5 is believed to have begun in 1985, followed by full-scale production some time in 1986. The production rate for the Hwasong 5 is believed to have averaged four to five per month during the early years of the program. Given, however, the number of missiles exported and those required for KPA usage, the production rate probably reached eight to ten per month during 1987 to 1988. The Hwasong 5 provided the KPA with the ability to strike targets throughout the northern two-thirds of the ROK. In 1989, Hwasong 5 production was probably phased out in favor of the Hwasong 6.[54]

Details of the establishment of operational Hwasong missile units within the KPA are unclear. It is believed that some time during 1984 or 1985, the Ministry of People's Armed Forces (MPAF) established a Hwasong missile regiment subordinate to the Artillery Command. Personnel for this new unit were apparently drawn from the special missile test-and-evaluation unit established earlier. It is probable that this regiment was initially deployed near P'yongyang and was later moved south to the area of Chiha-ri (south-southeast of P'yongyang and approximately 50 km

[49] Author interview data.

[50] Author interview data; Nam, "DPRK Advanced Weapons"; and Yin-taek Yu, "North's Military Reorganization, Mobilization," *Pukan* 6 (June 1985), pp. 132-141, in JPRS-KAR-85-070 (October 31, 1985), pp. 1-9.

[51] Press reports during January 1987 report ROK Defense Minister Lee Ki-Baek as stating that the DPRK had recently conducted a "secret test" of a long-range guided missile. While this suggests a test launch in 1986, subsequent information indicates that Minister Lee was referring to the 1984 tests. Author interview data; "North Korea Deploys Romeo-class Submarine in East Sea: Min. Lee," *Korea Herald*, January 29, 1987, p. 1; and "Asia: North Korea Launches Submarine/Tests Missile," *Defense & Foreign Affairs Weekly*, February 9-15, 1987, p. 2.

[52] Author interview data; "DPRK Developing Improved Scud Missile," *Kyodo*, September 20, 1991, in FBIS-EAS-91-183 (September 20, 1991), pp. 2-3; David B. Ottaway, "Egypt Drops Out of Missile Project," *Washington Post*, September 20, 1989, p. A32; and David B. Ottaway, "State Department Official Offers No Details on Iraqi Program," *Washington Post*, September 20, 1989, p. A32. The latter article indicates it has "a 190-mile [306 km] range and is capable of carrying an 1,100-pound [500 kg] warhead."

[53] There is some speculation that there is a biological warhead, but this remains unconfirmed.

[54] Nam, "DPRK's Advanced Weapons Analyzed;" "Measures Against Possible Scud Attack," *Yonhap*, April 12, 1991, in FBIS-EAS-91-071; and "Merchants of Death: How to Curb the Weapons Trade."

north of the Demilitarized Zone [DMZ]). Additional reports of an operational Hwasong unit stationed in the Kilchu–Ch'ongjin area (i.e., Hamgyong-bukto Province) suggest one of several possibilities:[55]

- the Hwasong missile regiment deployed independent battalions to operating locations in different parts of the country;
- the initial deployment of Hwasong missile units was by battalion, not regiment; or
- the special missile test-and-evaluation unit in the Musudan-ri area also served as an operational missile unit.

From March through June 1985, Iran and Iraq engaged in what became known as the first "War of the Cities," as Iran struck Baghdad with missiles and aircraft while Iraq responded against Tehran with air attacks. In response to this intensified combat, Iran concluded an agreement with the DPRK calling for the bilateral exchange of missile technology, financing for the DPRK's missile program, and an Iranian option to purchase the Hwasong 5. Part of this agreement may have also included delivery of DPRK SA-2, HQ-1, and HQ-2 SAMs.[56]

In June 1987 the two countries concluded a $500 million arms agreement which included the Iranian purchase of 90 to 100 Hwasong 5s and, apparently, DPRK assistance in establishing a missile assembly facility in Iran. Hwasong 5 deliveries are believed to have begun in July 1987 and continued through early February 1988. Within Iran, the Hwasong 5 is known as the Shehab 1.[57]

These Hwasong 5s played a significant role in the second "War of the Cities" in 1988. Over a 52-day period, the Iranians fired approximately 77 of the DPRK-produced missiles at Iraqi cities. The majority of missile attacks (61) were against Baghdad, while the remainder were aimed at Mosul (nine), Kirkuk (five), Takrit (one), and Kuwait (one).[58] Also during the "War of the Cities" reports emerged concerning Iran's development of chemical warheads for its missiles. Although the Iranian chemical warfare capability had been developing for several years (with PRC and European assistance), it is believed that the DPRK facilitated the missile-related effort by providing Iran with chemical weapons technology and, possibly, a small number of Hwasong 5 chemical warheads.[59]

In 1989 the DPRK concluded an arms sales agreement with the United Arab Emirates (UAE). The $160 million deal included 25 Hwasong 5 missiles, self-propelled artillery, multiple-rocket launchers, and munitions. The UAE was not pleased with the quality of the Hwasong 5; the systems were never operational in UAE service and were quickly placed in storage. UAE officials view the missiles as a "problem" and are currently discussing how to dispose of them. As of 1998, they were still sitting in storage.[60]

Foreign Assistance and Cooperation[61]

Throughout the Hwasong programs, the DPRK exchanged technical information, documentation (e.g., blueprints, specifications, etc.), and personnel with Egypt. This missile relationship was somewhat of a paradox in light

[55] Author interview data; and "Measures Against Possible Scud Attack Detailed."

[56] "N Korea Denies Tehran Reports," *Jane's Defence Weekly*, October 19, 1985, p. 857; and Clarence A. Robinson, Jr., "Iraq, Iran Acquiring Chinese-Built Fighters," *Aviation Week & Space Technology*, April 11, 1983, pp. 16-18.

[57] Shehab means "meteor" in Farsi. Author interview data; Pejamn Peyman, "International News: Iran," UPI, September 18, 1987; "P'yongyang Missile Sale to Tehran Reported," *Washington Times*, June 1, 1988, p. A2; John M. Broder, "Five Key Nations Sold Arms to Iran," *Los Angeles Times*, January 20, 1988, p. 5; and "Ramadan Interviewed," *Al-Musawwar*, May 20, 1988, pp. 20-21, in FBIS-NES-88-100 (May 24, 1988), p. 18.

[58] Joseph S. Bermudez Jr., "Iraqi Missile Update," *Jane's Soviet Intelligence Review* 2 (July 1990), p. 329; Joseph S. Bermudez Jr. and Seth W. Carus, "Iraq's al-Husayn Missile Programme, Part II," *Jane's Soviet Intelligence Review* 2 (June 1990), pp. 242-248; Joseph S. Bermudez Jr. and Seth W. Carus, "Iraq's al-Husayn Missile Programme, Part I," *Jane's Soviet Intelligence Review* 2 (May 1990), pp. 204-209; and Joseph S. Bermudez Jr. and Seth W. Carus, "Iran's Growing Missile Forces," *Jane's Defence Weekly*, July 23, 1988, pp. 126-131.

[59] For information on Iranian missile chemical warfare capabilities during this period see Farzad Bazoft and Allan George, "Missiles Armed With Chemical Warheads 'in Sight'," *Observer*, March 13, 1988, p. 23.

[60] Author interview data. Some sources suggest that the total number of missiles supplied was less than 25. Others have speculated that the UAE arms purchase agreement was, in part, a covert intelligence operation by the United States to acquire a number of the DPRK's latest weapons systems.

[61] Author interview data.

of Egypt's staunch support of Iraq during the ongoing Iran-Iraq War and, conversely, the DPRK's support of Iran.[62] These technical exchanges were so extensive that when the DPRK achieved a Hwasong 5 production capability, Egypt possessed all the documentation necessary to undertake its own production, should it desire to do so. Beginning in late 1984 or early 1985, the DPRK extended a similar level of cooperation to Iran. The DPRK helped establish a Hwasong 5 assembly facility in Iran and provided all the required technical documentation for future production. On a regular basis, key engineers and military personnel have been exchanged between these two countries and the DPRK.

The PRC provided assistance to the DPRK from the beginning of the Hwasong 5 program, in the areas of engine design and production, metallurgy, and airframe design. It appears, however, that a majority of the missile-related support was academic or generic in nature, rather than aid specifically targeted to the Hwasong 5 program. For example, the PRC provided technical training to DPRK engineers and specialists, transferred high-quality machine tools, etc.

The numerous allegations of Soviet involvement in the DPRK's early ballistic missile program are erroneous.[63] There is no evidence that the Soviet Union worked with the DPRK on the Hwasong 5 program or in the development of new warheads. Additionally, the Soviets provided no missile components during the early- to mid-1980s. DPRK–Soviet relations were strained during the late 1970s and only began to improve following Kim Il-song's May 1984 visit to Moscow. Following that visit, relations improved dramatically and the Soviet Union did agree to provide the DPRK with several new SAM systems, maintenance, training, and equipment.[64] It is possible that the DPRK requested Soviet Scud Bs during this period of rapprochement, but the Soviets apparently declined because of fears that missile transfers would exacerbate regional tensions. With the dramatically changing domestic situation within the Soviet Union and Eastern Europe during the late 1980s, the DPRK appears to have achieved some success in acquiring—either through official or unofficial channels—technologies and components for its ballistic missile programs.

Other Missile-Related Developments

During this period, DPRK proficiency in HQ-2 production continued to increase. In 1984, the DPRK signed a contract to provide Egypt with technical assistance in Cairo's effort to develop a variant of the SA–2b Mod. 1, known as the Tair al–Sabah ("Morning Bird"). Like most of Egypt's indigenous advanced weapons projects during the 1980s, this SAM program was soon cancelled.[65]

As noted, Kim Il-song's May 1984 visit to Moscow began a new era in DPRK–Soviet relations. One important result of improved relations was a 1985 agreement for the Soviets to provide modernization assistance to the DPRK's armed forces. The agreement ultimately led to the introduction of the Soviet S-125 Pechora (SA-3b GOA) and S-200 Angara (SA-5 GAMMON) missiles into MPAF service.

During the mid-1980s, the DPRK acquired the HJ-73 and HN-5A SAMs from the PRC.[66] It also undertook production of the HN-5A, and assembly

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[62] Egypt was at the time involved in the Condor II/Vector missile project, which included cooperation with Iraq during certain stages of development.

[63] Author interview data; Chang-uk Chin, "North Korea's War Preparedness," *Chungang Ilbo*, August 20, 1985, p. 3, in JPRS-KAR-86-008 (February 21, 1986), p. 9; "Soviet Base in North Korea," *Jane's Defence Weekly*, September 21, 1985, p. 612.

[64] US Navy, *Current Naval Intelligence Issues* (Washington, DC: Office of Naval Intelligence, March 1987); US House Armed Services Committee, *Statement of Rear Admiral William O. Studeman, US Navy, Director of Naval Intelligence, Before the Seapower and Strategic and Critical Materials Subcommittee of the House Armed Services Committee in Intelligence Issues*, March 1, 1988; Committee on Appropriations, *Statement by General Louis C. Menetrey, US Army, Commander-in-Chief, United Nations Command/US Forces Korea, Before the Subcommittee on Defense, Committee on Appropriations*, May 26, 1988; and Department of Defense, *Soviet Military Power* (Washington, DC: Government Printing Office, 1985, 1986, 1987, and 1988). Rear Admiral Thomas Brooks, Director of Naval Intelligence, testified in 1991 that the DPRK produces the Scud B. See US House Armed Services Committee, *Statement of Rear Admiral Thomas A. Brooks before the Seapower, Strategic and Critical Materials Subcommittee of the House Armed Services Committee*, March 7, 1991, p. 47.

[65] "Egypt," *Military Powers* 1 (February 1987), p. 73.

[66] HJ stands for Hong Jian ("Red Arrow") and HN stands for Hong Nu ("Red Cherry").

or production of the Soviet AA-2 and Chinese PL-2 and PL-5 air-to-air missiles.

LONGER RANGE DESIGNS, 1989-PRESENT

Reorganization of the Missile Program

The Hwasong 5 provided the DPRK with its first ballistic missile capability, but its modest range did not provide the capability to strike at the entire ROK—a MPAF requirement. To address this limitation, the DPRK initiated development of an extended-range variant of the Hwasong 5 to be known as the Hwasong 6.

By 1989, a number of factors converged and prompted the DPRK leadership to establish comprehensive, long-term requirements for the ballistic missile program. These factors included:

- the end of the 1980-1988 Iran-Iraq war, which allowed resources previously engaged in Hwasong 5 production to be refocused on other projects;
- the DPRK's desire to strike at targets in the southernmost sections of the ROK and at US bases in Japan;
- the DPRK's desire to eventually develop a true strategic missile force capable of striking US targets throughout East Asia and the continental United States;
- the increase in international prestige associated with the acquisition and production of ballistic missiles, which held a strong allure for the DPRK leadership;
- the legacy of the "War of the Cities" combined with ongoing Iraqi missile developments (e.g., al-Abbas, al-Abid, etc.), which led to Iranian interest in missiles with greater range than the Hwasong 5; and
- The DPRK's long-standing involvement with Egypt in an effort to produce an improved R-17E.

As a result of these factors, the DPRK established long-term requirements that called for more ambitious missile systems based, not upon the technical capabilities of the missile infrastructure, but upon targets which the leadership desired to be able to strike (see Table 2).[67]

In this regard, the DPRK followed the PRC's example of basing missile-development goals on target ranges.[68] Whether the DPRK defined its requirements at once or over a period of several years is unclear, but they were in place by 1990. These range requirements led to the reorganization of the missile program into four distinct, but interrelated, projects.

The easiest project technically, and thus the one that could be brought to completion in the shortest amount of time, was already underway in the form of the Hwasong 6. This effort would entail only minor modifications to the basic Hwasong 5 system. The more complicated and thus longer term projects involved design of completely new missiles based upon experience gained in refining Scud technologies for the Hwasong 5/6 programs. The first "new" missile would become known as the No-dong in the West. The No-dong itself became the basis for the development of two more advanced and more capable systems—the Taep'o-dong 1 and Taep'o-dong 2. A space launch vehicle (SLV) would also be developed from the Taep'o-dong 1. Iran was the primary financial backer for all these projects.

By the early 1990s, the FROG battalions were reorganized into a brigade subordinate to the Artillery Command. Whether this change was related to the reorganization of the ballistic missile program is unclear.

Hwasong 6 (a.k.a., Scud Mod. C, Scud C, Scud PIP)

It is uncertain whether an extended-range variant of the R-17E was an initial goal of the DPRK from the inception of the ballistic missile program.

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[67] Author interview data; Bill Gertz, "N. Korea Building Missiles That Could hit American Forces in Alaska," *Washington Times*, October 22, 1997, p. A1; C. W. Lim, "Korea," AP, August 24, 1993; and "Korea-Defector," UPI, August 24, 1993.

[68] John Lewis and Hua Di note that, "In practice, the designers were neither told nor supposed to worry about the possible strategic purposes of their missiles. They were simply given the range and payload requirements for striking, sequentially, Japan (DF-2), the Philippines (DF-3), Guam (DF-4), and the continental United States (DF-5). Although their world was essentially technology driven, a strategic retaliatory doctrine was implicit in the target selection…." Lewis and Di, "China's Ballistic Missile Programs: Technologies, Strategies, Goals," p. 20.

By 1987-1988, however, work on such a system—to be known as the Hwasong 6—had begun. The Hwasong 6 became the first design and production milestone of the DPRK's reorganized ballistic missile program.[69]

[69] Author interview data; Joseph S. Bermudez Jr., "Ballistic Ambitions Ascendant," *Jane's Defence Weekly*, April 10, 1993, pp. 20-22; Barry Schweid, "Washington News: US-Missile Projects," AP, September 19, 1988; and "US/Allies Seek to Curb Argentine/Brazil/North Korean Missiles," *Defense Daily*, September 21, 1988, p. 109.

Table 2. Ballistic Missile Range Objectives

Target	*Range Required*
The entire ROK	500 km
US bases in Japan and major Japanese cities	1,000-1,500 km
US bases in East Asia	1,500-2,500 km
US bases in Alaska and Pacific Ocean	4,000-6,000 km
Continental US	6,000+ km

DPRK engineers quickly achieved their goals by making only minor modifications to the basic Hwasong 5. Chief among these changes were reduction of the warhead weight from 1,000 kg to 770 kg, and lightening of the airframe through use of a special stainless steel imported from the Soviet Union (and later from Russia).[70] A modified inertial guidance system was also used. The resulting missile is almost identical in size to the Hwasong 5, being 11.3-m long, with a .884-m diameter, and a weight of just under 6 tonnes. Yet the Hwasong 6 has a range of 500 km—sufficient to strike any target within the ROK, including the southern island of Cheju-do. The Hwasong 6 benefited from warhead research conducted under the Hwasong 5 program and thus could be armed with HE, chemical, and cluster warheads.[71] Early concerns that the Hwasong 6 would be armed with a nuclear warhead appear to have been premature. Although the DPRK could theoretically have designed and mounted a nuclear warhead on the Hwasong 6 for a contingency capability, it appears that the No-dong discussed below was the first missile intended to carry a nuclear warhead.[72]

Low-rate series production of the Hwasong 6 is believed to have begun in 1989, and the first systems became operational the same year. Full-scale production followed in 1990 or 1991. Production rates for the Hwasong 6 are believed to have averaged four to five missiles per month, with production continuing through the late 1990s. The Hwasong 6 likely superceded the Hwasong 5 on the production lines; in turn, Hwasong 6 production was either reduced or superceded by No-dong production. There appear to be several sub-models of the Hwasong 6, although details of these are unknown. The guidance system is believed to have given the DPRK considerable (though unspecified) difficulties and has undergone several updates. Some Hwasong 5s may have subsequently been remanufactured to Hwasong 6 standards.

It is estimated that by the end of 1999, the DPRK will have produced a total of 600 to 1,000 Hwasong 5/6 missiles. Of these, approximately 300 to 500 were sold to foreign countries; 25 were used for initial operations, tests, and evaluation/training; and approximately 300 to 600 are in current inventory.

Complementing Hwasong 6 missile development were efforts to produce TELs, and to expand the Musudan-ri Launch Facility and missile support infrastructure. DPRK engineers slightly modified the support arms of existing TELs to accommodate the Hwasong 6 (possibly due to a different center of gravity).[73] Many of the original Soviet-produced components in the TELs were replaced by commercially available equivalents (e.g., the auxiliary power units were replaced by commercial Mitsubishi units).

[70] Author interview data; Bill Gertz, "Pakistan Gets Help with Missile," *Washington Times*, September 14, 1998, p. A1; Bill Gertz, "CIA Seeks Missile Data from Defector," *Washington Times*, August 27, 1997, p. A1; and Bill Gertz, "Russia Sells Iran Missile Metals Contract Contrary to Official Denials," *Washington Times*, October 20, 1997, p. A1.

[71] As with the Hwasong 5, there is some speculation that the Hwasong 6 could also be armed with a biological warhead. This remains unconfirmed.

[72] Author interview data; "DPRK Developing Improved Scud Missile;" Brendon McNally, "Pentagon Seriously Reviews Ability of Patriot to Defeat New N. Korean Scuds," *Inside the Army*, August 5, 1991, p. 12; and Steven Emerson, "The Postwar Scud Boom," *Wall Street Journal*, July 10, 1991, p. A12.

[73] Author interview data; Peter Seidlitz, "Nuclear Threat Increases," *South China Morning News*, December 19, 1993, pp. 1, 9, in FBIS-EAS-93-242 (December 20, 1993), p. 42; "P'yongyang Seeks Self-Sufficient Auto Industry," *Naewoe Tongsin*, June 10, 1993, pp. D1-D4, in FBIS-EAS-93-145 (June 12, 1993), p. 14; and "North Developing Scud Mobile Launcher," *Yonhap*, October 4, 1991, in FBIS-EAS-91-193 (October 4, 1991), p. 19.

Meanwhile, the DPRK tried to obtain additional MAZ-543 chassis, TELs, and spare parts from the Soviet Union (later Russia), Ukraine, Kazakhstan, and other countries. Apparently, due to the difficulty in obtaining additional complete MAZ-543 TELs, the DPRK decided to produce its own copy of the vehicle. All TEL developments, along with other launch vehicle-related work, were apparently undertaken with the support of the Sungni General Automotive Factory and Second Machine Industry Bureau. The DPRK also produced a small range of missile support vehicles. The Musudan-ri Launch Facility continued to expand with the construction of new launch towers and the development of ground-support equipment.[74] The similarity of some of these developments to PRC designs has sometimes led to erroneous speculation that the equipment and the No-dong missile were based on PRC designs, or were built with PRC assistance. Finally, during the mid-1980s construction of hardened (i.e., underground) missile facilities throughout the country was initiated.

The timing of the Hwasong 6 development is interesting in that it occurred almost simultaneously with Iraq's development of its extended-range variant of the Scud B—the al-Husayn. It is probable that the Iranians provided the DPRK with technical intelligence concerning the Iraqi systems, including access to wreckage recovered from al-Husayn attacks on Tehran during the 1988 "War of the Cities." The Hwasong 6 program, however, did not directly benefit from the al-Husayn, and reports suggesting that it was a copy of the al-Husayn are incorrect.[75]

To date there have been five Hwasong 6 test launches, all of them apparently successful. The first test occurred in June 1990 from the Musudan-ri Launch Facility.[76] Given the difficulties encountered in developing new guidance systems, there is a strong possibility that this first test either included a slightly modified Hwasong 5 guidance system (i.e., changes to the Pendulous Integrating Gyro Accelerometer, or PIGA) or engineers simply used a timer to control engine shutoff. In July 1991, a second Hwasong 6 was test launched. This time, however, the missile was fired from an indigenously produced TEL at a forward KPA base in Kangwon-do Province (which encompasses the I and V Corps deployed along the DMZ). The missile flew northeast and impacted in the East Sea.[77] In late May 1993, the DPRK launched three Hwasong 6 missiles and one No-dong missile, its most important missile test event to that date. In addition to Hwasong 6 tests in the DPRK, Syria and Iran have carried out an ongoing series of Hwasong tests focused primarily on operational readiness and troop training. To date, four of these tests have been publicly revealed: three Syrian (July 1992 and mid-1994) and one Iranian (May 1991).[78]

By 1991 the Hwasong missile regiment had been expanded to an estimated 27 to 30 TELs and was equipped with a mixture of Hwasong 5 and 6 missiles. This regiment was under the direct control of the General Staff Department.[79] The regiment is believed to be headquartered in the Chiha-ri area (approximately 85 km southeast of P'yongyang and 50 km north of the DMZ). Individual missile battalions are deployed nearby in separate bases. The regiment's technical support battalion is also reported to be at Chiha-ri.[80] By the early 1990s, the infrastructure built to support the regiment had two to three times the number of hardened bunkers required to house all the unit's TELs and support vehicles.[81]

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[74] Author interview data.

[75] "2nd Sermon on Missile Attacks," *Tehran Domestic News Service*, March 11, 1988, in FBIS-NES-88-049 (March 11, 1988), p. 8.

[76] Bermudez, "Ballistic Ambitions Ascendant," pp. 20-22; "DPRK Developing Improved Scud Missile."

[77] Bermudez, "Ballistic Ambitions Ascendant," pp. 20-22; "North Developing Scud Mobile Launcher."

[78] Author interview data; and Joseph S. Bermudez Jr. and Greg Gerardi, "An Analysis of North Korean Ballistic Missile Testing," *Jane's Intelligence Review* 7 (April 1995), pp. 184-191.

[79] Author interview data; David A. Fulghum, "North Korean Forces Suffer Mobility Loss," *Aviation Week & Space Technology*, November 24, 1997, p. 62; "North Developing Scud Mobile Launcher;" and "North Reportedly Expands Scud Unit," *Tong-A Ilbo*, August 25, 1991, p. 2, in FBIS-EAS-91-165 (August 26, 1991), pp. 32-33.

[80] "NK Builds Two New Missile Sites," *Digital Chosunilbo*, November 21, 1998, <http:// www.chosun.com>; and Dana Priest and Thomas W. Lippman, "N. Korea Expanding Missile Programs," *Washington Post*, November 20, 1998, p. A1.

[81] Author interview data; and Fulghum, "North Korean Forces Suffer Mobility Loss," p. 62.

The Hwasong 6 regiment probably consists of a headquarters (staff, rear services company, communications company), missile technical battalion, air defense company, and four to five launch battalions. Each launch battalion has six TELs or mobile-erector-launchers (MELs) and approximately 175 personnel organized into a headquarters and three firing batteries. The headquarters consists of a small staff, technical, communications, and rear services platoons, a meteorological section with a RVS-1 Malakhit (BREAD BIN) meteorological data receiver, and a survey section. Each firing battery consists of two launcher sections, each with one TEL, and an air defense section with SA-7/14 SAMs. Any independent launch battalions are probably configured in a similar manner, but may have larger support units.[82]

Foreign Developments

In late 1990, Iran and the DPRK concluded several new agreements. These provided for an Iranian purchase of the Hwasong 6 and associated TELs, and DPRK assistance with the conversion of a missile-maintenance facility to give Iran the ability to assemble and later to manufacture the Hwasong 6. Beginning in January 1991, US intelligence tracked shipments of Hwasong 6 missiles, TELs, and related equipment on their way to Iran. The exact number of missiles acquired by the Iranians is not known, but a total of 60 has been suggested.[83] Within Iran, the Hwasong 6 is known as the Shehab 2. In May 1991, US satellites observed the test launch of a Shehab 2/Hwasong 6 missile from a DPRK-produced TEL near the city of Qom.[84] It is probable that the test was conducted in conjunction with DPRK advisors or observers. The missile flew 500 km before impacting south of Shahroud in the Dasht-e Kavir (Salt Desert) where Iran has a major missile test facility. Iran likely monitored the test from a tracking station located near the town of Tabas. Both the missile test facility at Shahroud and the tracking station at Tabas were constructed, in part, with DPRK assistance.[85] Deliveries of Hwasong 6 missiles and support equipment are known to have continued through 1995. In late 1994 or early 1995, Iran "received at least four" Hwasong 6 TELs from the DPRK that may have been delivered by air.[86]

The 1990 DPRK-Iran agreements were soon followed by a DPRK-Syria agreement. For several years, Damascus sought to acquire the R-400 Oka (SS-23 SPIDER) from the Soviet Union. These efforts failed, and Syria then turned to the DPRK for Hwasong 6 missiles, TELs, and production technology. The agreement signed between the DPRK and Syria was financially and materially supported by Iran and the PRC. Deliveries of an estimated 60 missiles and 12 TELs began in April 1991 and continued through at least 1995. A number of these deliveries were by air, using private contractors flying An-124 Ruslan heavy transports. The Syrians experienced significant problems with the Hwasong 6 guidance system that were apparently never resolved with the DPRK. Syria therefore turned to the PRC, which provided replacements or upgrades. The DPRK, with assistance from Iran and the PRC, also assisted Syria in the construction of Hwasong 6 production facilities near Aleppo and Hamah.[87]

Syria has conducted a small number of Hwasong 6 launches. The first, at the end of July 1991, consisted of two Hwasong 6s just before the missiles became operational.[88] Syria conducted

[82] Author interview data; US Marine Corps, *North Korea Country Handbook* (Washington, DC: Marine Corps Intelligence Activity, May 1997), p. 134; and Defense Intelligence Agency, *North Korea Handbook* (Washington, DC: Defense Intelligence Agency, 1994), pp. 5-22.

[83] Bill Gertz, "Iran Fired Ballistic Missile," *Washington Times*, May 24, 1991, p. A5. For a report suggesting that the contract was for 200 Scud B and Scud C missiles, see Knut Royce, "The Gulf War Briefing: Iran's Arsenal Worries Analyst," *Newsday*, January 30, 1991, p. 16. In October 1991, reports surfaced indicating that the DPRK had exported 20 Scud missiles to Iran and that some of them already had arrived and were fully assembled. See Yong-Sok Chong, "DPRK Scuds Arrive in Iran," *KBS–1*, October 13, 1991, in FBIS–EAS–91–199 (October 15, 1991), p. 26.

[84] Gertz, "Iran Fired Ballistic Missile"; and Emerson, "Postwar Scud Boom."

[85] Bill Gertz, "Stop Arming Mideast, Bush Urges Iran Now Top Threat in Region," *Washington Times*, May 30, 1991, p. A1; and Gertz, "Iran Fired Ballistic Missile."

[86] Author interview data; Barbara Starr, "Iran Gets 'Scud' TELs From North Korea," *Jane's Defense Weekly*, May 13, 1995, p. 5; Ron Ben-Yishay, "Al-Asad is Also Preparing for War," *Yedi'ot Aharonot*, October 29, 1991, in FBIS-TND-91-018 (November 18, 1991), pp. 16-17.

[87] Bill Gertz, "Iran-Syria Deal Revealed as Scuds Near Gulf Ports," *Washington Times*, March 10, 1992, p. A3.

[88] Bill Gertz, "Iran-Bound Mystery Freighter Carried Parts for Missiles," *Washington Times*, July 16, 1992, p. A3; and David Hoffman, *Washington Post*, "Israelis Say Syrians Test-

a second Hwasong 6 test in mid-1994.[89] In November 1994, the DPRK delivered Hwasong 6 cluster warheads to Syria. That same month, Damascus test fired the Hwasong 6, although with a conventional warhead. Three years later, in early 1997, Syria conducted several missile tests. Although most are believed to have been R-17s, it is possible that several were Hwasong 6 launches.[90] It is believed that all these tests were intended to verify missile reliability and to train Syrian missile troops. Missile cooperation between Damascus and P'yongyang has continued throughout the 1990s. For example, in 1996, a group of Syrian missile technicians reportedly traveled to the DPRK for two weeks.[91] In 1999, the DPRK provided Syria with 10 tonnes of powdered aluminum originally purchased from the PRC. This powdered aluminum was reportedly delivered to the Centre des Etudes et de Recherche Scientifique (CERS, Scientific Studies and Research Center)—the agency which oversees Syria's missile and chemical weapons programs.[92]

Egypt's participation in the Hwasong 6 effort appears to have been as a purchaser of technology rather than as a co-developer. With the failure of the "Condor II" project (known as Vector in Egypt) in late 1989, the Hwasong 6 assumed a higher level of importance for Cairo. In May 1990, shortly before the first test launch of the Hwasong 6, President Hosni Mubarak visited P'yongyang. While in the DPRK capital, he is believed to have visited the 125 Factory where the Hwasong 6 is assembled. Although Egypt is not known to have received entire Hwasong 6 missiles from the DPRK, it has received Hwasong 6 components and related technologies.[93]

In 1998 or 1999, Vietnam is reported to have obtained a small number of Hwasong 6 missiles as part of an arms agreement with the DPRK that included two SANG-O class coastal submarines and DPRK produced 9K310 Igla 1 (SA-16 GIMLET) SAMs. The exact number of Hwasong 6s obtained and whether the arms agreement included TELs are presently unknown.[94]

Throughout the 1980s and 1990s, Libya has both pursued its indigenous al-Fatah missile program and provided varying levels of financing to the DPRK missile program. Although this financing has been primarily in support of the Syrian and Iranian missile programs, Libya has also purchased DPRK missile components and technology. DPRK components and technology have been used to maintain Libya's existing R-17s and incorporated into the al-Fatah and possibly other missile programs. While there have been numerous reports indicating Libyan interest in purchasing the Hwasong 6, none are known to have been delivered.[95]

During the 1990s, the DPRK's relations with Sudan have grown steadily closer (probably as a result of growing Iranian-Sudanese relations). During 1998-1999, the DPRK is reported to have offered to sell Sudan a complete production facility for the manufacture of the Hwasong 5/6. The status of this offer is presently unknown.[96]

It is estimated that between 1987 and 1992, the DPRK exported 250 missiles and related technology worth $580 million to Egypt, Iran, Libya, and Syria. Hwasong 5 and Hwasong 6 missiles are estimated to cost $1.5 to $2 million apiece.[97]

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fired New Scud," August 13, 1992, p. A25.

[89] Michael R. Gordon, "US Says Russians Helped Damascus in a Missile Plan," *New York Times*, December 12, 1993, p. A1; and David E. Sanger, "North Korea Buying Old Russian Subs," *New York Times*, January 20, 1994, p. A6.

[90] Author interview data; and Barbara Starr, "US Aegis Cruisers Spy on Syrian Missile Launches," *Jane's Defence Weekly*, January 15, 1997, p. 3.

[91] "Better firepower for Syria's Assad," *US News & World Report*, August 5, 1996, p. 20.

[92] Bill Gertz, "North Korea Continues to Develop Missiles," *Washington Times*, October 28, 1999, <www.washtimes.com>.

[93] Author interview data; Sid Balman Jr., "US Probes Scud Shipments to Egypt," UPI, June 21, 1996; "US-Egypt-N Korea," AP, June 21, 1996; "US Probing Reports of Egypt-N. Korea Deal," Reuters, June 21, 1996; and Ottaway, "Egypt Drops Out of Missile Project."

[94] Robert Karniol, "Vietnam Stocking Up 'SCUDs'," *Jane's Defence Weekly*, April 14, 1999, p. 63.

[95] Author interview data; Gertz, "North Korea Continues to Develop Missiles;" Pyong-Tae Hwang, "North to Develop Missiles With Libya," *Hanguk Ilbo*, February 17, 1992, p. 1, in FBIS-EAS-92-032 (February 18, 1992), p. 37; "DPRK Developing Improved Scud Missile;" Bill Gertz, "Libya May Buy N. Korea Missiles," *Washington Times*, June 4, 1991, p. A4; and "Qadhafi Financing Syrian Purchase of Scud-C Missile," *Defense & Foreign Affairs Weekly*, January 28–February 3, 1991, p. 2.

[96] Gertz, "North Korea Continues to Develop Missiles."

[97] Author interview data; "North Korea's Taepodong I Missile Priced at $6 Million," *Korea Times*, October 29, 1999

No-dong (a.k.a., No-dong 1, Rodong 1, Scud Mod. D, Scud D)[98]

Work on what would eventually become known in the West as the No-dong (the DPRK name is unknown) is believed to have begun in 1988, shortly after the DPRK began its Hwasong 6 efforts. There appear to have been three primary design objectives for the No-dong. The first was to design a ballistic missile that could deliver a 1,000- to 1,500-kg warhead to a range of 1,000 to 1,500 km, enough to strike targets throughout Japan, including US bases on Okinawa. The second goal was to develop a "base" missile system (and related technologies) that could be used as a core, or first stage for even longer range ballistic missiles. The final objective was to design a ballistic missile with the capability to deliver a first-generation nuclear weapon.[99]

To achieve the ambitious range and payload objectives with the technology base available to the DPRK, the decision was made to scale-up the existing Hwasong 6 design by 150 percent. The resulting missile is 16-m long, has a diameter of 1.32 m, and weighs approximately 16 tonnes. It can carry either a 1,200-kg warhead to a range of 1,350 km or a 1,000-kg warhead to a range of 1,500 km.[100] While this scale-up expedient would be sufficient for the airframe and warhead, designing and building a new engine and guidance system provided a greater challenge. To address these difficult issues, the DPRK secured the services of foreign engineers, most notably from Russia, Ukraine, and the PRC. Because No-dong presented new complexities in missile design and manufacture for the DPRK, progress came at a considerably slower rate than was the case for the Hwasong 5/6 programs.

The new No-dong required a more powerful engine than the DPRK-produced version of the Isayev 9D21 found in the Hwasong 5/6. Following the pattern established with the airframe, DPRK engineers scaled up their existing Isayev 9D21 copy. This work was accomplished with the assistance of Russian engineers formerly with the Makeyev design bureau in Miass. Although design of the new engine proceeded relatively quickly, there appear to have been problems with its manufacture, notably in the areas of quality control and the acquisition of special materials. No-dong engines undoubtedly incorporate a number of foreign-produced components. Reports stating that the No-dong engine consists of four clustered Scud B engines are incorrect.[101]

The No-dong's guidance system is apparently a version of the guidance set used in the Hwasong 5/6. It is believed, however, that the DPRK received foreign assistance in adapting it for use in the No-dong. This guidance system has apparently undergone several development cycles aimed at improving both reliability and accuracy, and later models are probably significantly different, and more accurate, than those produced early in the program. There are concerns that this system may be modified to incorporate Global Positioning Satellites (GPS) to further improve accuracy.[102] At present, there are no reliable CEP estimates for the No-dong.

Estimates concerning the size and nature of the No-dong warhead have varied considerably. Information that became available in 1998

<http://www.korealink.co.kr/times>; and "DPRK Reportedly Asking $6 Million Per Taepo Dong Missile," *Yonhap*, October 29, 1999 <http:// www.ytn.co.kr>.

[98] Author interview data; Bermudez, "North Korea's Ballistic Missile Programme"; Central Intelligence Agency, *Gordan C. Oehler, National Intelligence Officer for Science, Technology, and Proliferation and Director, Nonproliferation Center, Address to the Annual Soref Symposium of the Washington Institute for Near East Policy*, April 27, 1992; Chun-pom Kim, "State of North Korea's Nuclear and Missile Technology," *Chungang Ilbo*, March 19,1992, p. 6, in FBIS-EAS-92-055 (March 20, 1992), p. 8; and "North Developing Scud Mobile Launcher."

[99] Author interview data; and Barbara Starr, "No Dongs May Soon be Nuclear, Warns USN," *Jane's Defence Weekly*, June 18, 1994, p. 1.

[100] There is continuing debate about the dimensions for this system, with some reliable sources indicating a diameter of 1.25 m, a length of 15.3 m, and a weight of 15 tonnes. Author interview data; and "IRGC Commander Reveals Shahab-3 Missile's Size, Capability," *IRNA*, August 4, 1998, World News Connection (FBIS) <http://wnc.fedworld.gov>.

[101] The author thanks Steven J. Zaloga for providing details concerning the development of the R-17E and R-21 and their engines. Author interview data; Vladimir Gubarav, "Miass Missile Center Designer on Industry Development," *Segodnya*, January 25, 1995, p. 9, in JPRS-TAC-95-004-L; Bermudez, "North Korea's Ballistic Missile Programme;" Andrei Kolesnikov, "Russian Scientists Accused of Wanting to Help North Korea Become a Nuclear Power," *Moscow News*, April 2, 1993, p. 9, in JPRS-TND-93-O13 (May 10, 1993), pp. 5-7.

[102] Author interview data.

indicates the No-dong is capable of carrying a 1,200-kg warhead. Following the lead of the Hwasong 5/6 program, it is probable that the No-dong can be armed with HE, cluster, chemical, or possibly biological warheads.[103] More significantly, and given what is known about the DPRK's nuclear and ballistic missile programs, it appears that the No-dong was intended to carry a first-generation nuclear warhead.[104]

In May 1990, US intelligence observed what appears to have been the first prototype No-dong on a launch pad at the Musudan-ri Launch Facility, although no missile launch was detected.[105] Subsequent photographs revealed burn marks at the launch site leading to the assumption that there may have been a catastrophic failure of the missile during a test. In November of the same year, the DPRK initiated preparations for a second missile test. These preparations were accompanied by increased Korean People's Navy (KPN) activity along the east coast and vessels were positioned to track the missile's flight over the East Sea. US Navy radar tracking ships positioned in the East Sea, however, detected no launch.[106] It was not until June 1992 that any further test activity associated with the No-dong program was detected, when Japanese military sources indicated that a second launch cancellation or failure occurred.

In May 1993, the DPRK launched four missiles—three Hwasong 5/6 and one No-dong—its largest ballistic missile test event to date. US intelligence first detected preparations for a test launch in late April. Activity at the Musudan-ri Launch Facility was far more significant than had been previously observed and included the assembly of loading cranes and TELs (and possibly MELs), and modification of launch towers to accommodate a larger missile. These activities were accompanied by an increased level of KPN activities at Ch'ongjin and other ports along the east coast. On May 29, the test launches began and continued the following day. All four missiles were apparently aimed at target buoys in the East Sea and along an azimuth facing Japan's Noto Peninsula.

In these tests, the No-dong traveled the farthest—500 km—over-flying the KPN tracking ships. One Hwasong 5/6 traveled 100 km, while the remaining two fell short of the 100-km mark. No telemetry data were detected from any of the missiles.[107] While some analysts have speculated that the missiles' ranges were intentionally reduced to secrete the No-dong among the Hwasong 5/6s being tested, this does not explain why all the missiles were not launched to a range of 500 km. Although reduced ranges suggest a failure, it is also possible that range was intentionally restricted to test the accuracy of the missiles at shorter ranges, or to test other performance characteristics. Absence of telemetry data is intriguing given the limited number of missile tests conducted throughout the DPRK program.

One final aspect of the May 1993 launches is of interest—the presence of Iranian and Pakistani observers at the tests.[108] In March 1993, an Iranian delegation traveled to P'yongyang to discuss ballistic missile-related cooperation and the No-dong, while Pakistani interest in the No-dong dates to the early 1990s (see below). In August 1992, DPRK Deputy Premier-Foreign Minister Kim Yong-nam had traveled to Pakistan to discuss, among other matters, missile cooperation and the No-dong.[109] These visits had set the stage for observer teams from Iran and

[103] Author interview data; and Bill Gertz, "Pentagon: N. Korea's Missiles Operational US Forces in Japan Now Within Range," *Washington Times*, June 10, 1998, p. A9.

[104] Nick Ludington, "Iran-Korea Missiles," AP, April 8, 1993; and Ed Blanche, "Iran-Missiles," AP, February 16, 1993.

[105] Gertz, "Libya May Buy N. Korea Missiles," p. A4; and "Defense Ministry: May Nodong-1 Test Successful," *Yonhap*, June 24, 1993, in FBIS-EAS-93-120 (June 24, 1993), p. 19.

[106] Gertz, "Libya May Buy N. Korea Missiles," p. A4.

[107] Bill Gertz, "General Spotlights N. Korean Threat," *Washington Times*, September 15, 1993, p. A6.

[108] Iranians and "other potential buyers" were present at the June 1994 and May 1997 tests of the DPRK AG-1 anti-ship cruise missile. The AG-1 is believed to be based upon the CSS-C-3 SEERSUCKER. Author interview data; and Bill Gertz, "N. Korea as Nuclear Exporter?," *Washington Times*, June 8, 1994, p. A1.

[109] Author interview data; "North Korea Strengthens Ties With Syria, Iran and Pakistan - Foreign Minister Makes Official Tours," *North Korea News*, August 24, 1992, pp. 5-6; "Foreign Minister Kim Yong-nam Visits Syria, Iran and Pakistan," *North Korea News*, August 10, 1992, p. 5; "Kim Yong-nam Leaves For Syria, Iran, Pakistan," *P'yongyang* KCNA, July 27, 1992, in FBIS-EAS-92-145 (July 28, 1992), p. 15; and Lally Weymouth, "In Israel, a New View of Syria," *Washington Post*, July 6, 1992, p. A1.

Pakistan to be present at the Musudan-ri Launch Facility for the May 1993 test event.[110]

During late April 1994, US intelligence again detected preparations at the Musudan-ri Launch Facility and increased KPN activities for what was believed to be a production series No-dong test. However, all activity ceased without explanation. The cancellation of this test was apparently in response to the very sensitive and intense US-DPRK nuclear negotiations then underway in Geneva. The DPRK has not conducted any further flight testing of the No-dong although another flight test had been planned for October 1996, but was cancelled.[111]

Concurrent with missile system development, the DPRK undertook a number of programs to design and develop support vehicles, and to expand the basing and deployment infrastructure. Due to the No-dong's large size and greater weight, it could not use Hwasong 5/6 TELs and transport vehicles. This led to the development of a number of system-specific vehicles, including a new MEL and a missile transport vehicle.[112] A decoy launch vehicle was also produced.[113] Vehicle-related work probably has been performed in cooperation with the Sungni General Automotive Factory. Reports suggest that the DPRK currently uses IVECO heavy-duty trucks manufactured by Fiat in Italy for the MEL chassis, and cranes manufactured by the Austrian company Palfinger AG.[114] The increased size of the No-dong required changes to the DPRK's deployment and support infrastructure: storage tunnels and fuel depots needed to be enlarged, and access roads widened. More significantly, the ambitious construction program for specialized and hardened missile tunnels and launch facilities continued.[115]

Estimates vary considerably both for the No-dong's operational dates and production numbers. Small numbers of prototypes were apparently built in 1989 and 1990. Low-rate production had begun by January 1991, and a small number of missiles were available for contingency use shortly afterwards (the DPRK apparently accepted a low level of reliability and readiness in order to field the systems more quickly). It probably was not until 1993 or 1994, however, that the system was produced and fielded in sufficient numbers to be considered truly operational.[116] Production rates for the No-dong appear to have averaged two to four per month, and production has occurred concurrently with that of the Hwasong 6. It is likely that Hwasong 6 manufacture will be phased out completely when the Taep'o-dong 1 comes into production. By the end of 1999, the DPRK will have produced an estimated 75 to 150 No-dong missiles. Of these, 24 to 50 were sold to

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[110] Author interview data; Bermudez and Gerardi, "An Analysis of North Korean Ballistic Missile Testing"; and Gertz, "Iran-Bound Mystery Freighter Carried Parts for Missiles."

[111] Agency for National Security Planning, Republic of Korea, *NSP Issues Press Release on Hwang's Comments*, Press Release, Seoul, May 9, 1997, in FBIS-EAS-97-091.

[112] Author interview data; Seidlitz, "DPRK May Have Several Nuclear Bombs," pp. 1, 9; "P'yongyang Seeks Self-Sufficient Auto Industry," pp. D1-D4; and "North Developing Scud Mobile Launcher."

[113] There may actually be several different versions of decoy vehicles and decoys.

[114] It is interesting to note that from 1978 to 1987, the DPRK imported 156 heavy-duty log-carrier trucks from Nissan Diesel Industries, a subsidiary of Nissan Motors Corp. US intelligence sources stated that a number of these vehicles were subsequently converted into MRLs by the DPRK and deployed along the DMZ. Although there was nothing illegal concerning these Nissan sales, the company announced that henceforth "...we have decided to voluntarily control our sales to the country [the DPRK] and refrain from exporting large-size trucks which can be converted for military use." Author interview data; John E. Peterson, "Nissan Truck Sales Probed," *Detroit News*, June 12, 1987, p. A3; and Daniel Sneider, "Japanese Investigate Use of Trucks Sold to North Korea," *Defense News*, June 15, 1988, p. 14.

[115] Author interview data; "P'yongyang Found Constructing 5 Underground Facilities," *Yomiuri Shimbun*, January 8, 1999, <http://www. yomiuri.co.jp>; "US Military Detects Underground Bases in DPRK," *NHK*, December 8, 1998, in FBIS-EAS-98-342; and "Says Long-range Missile Bases Built," *KBS-1*, August 24, 1993, in FBIS-EAS-93-162 (August 24, 1993), p. 23.

[116] In January 1991,General John Tilelli, Commander of US Forces Korea, stated that, "We know that the Nodong missile has come out of [research and development] and is being produced….Whether or not we would categorize it as deployed or not, at this point is difficult to say....We believe they are building them." See "US Commander Says DPRK's Military Posture Changed Little," *Korea Times*, January 29, 1999, <http://www.korealink.co. kr/times>; Bill Gertz, "US Commander Voices 'Concern' Over N. Korea, Fears its Quest for Long-range Nuclear Missiles," *Washington Times*, January 27, 1999, <http://www.washtimes.com>; Gertz, "Pentagon: N. Korea's Missiles Operational US Forces in Japan Now Within Range"; Central Intelligence Agency (Oehler), *Address to the Annual Soref Symposium of the Washington Institute for Near East Policy*; and "DPRK Developing Improved Scud Missile."

foreign countries; up to five were used for initial operations, test, and evaluation/training; and 50 to 100 are in current inventory.

To facilitate the operational deployment of the No-dong, the DPRK transferred experienced personnel from the Hwasong 5/6 regiment to a newly formed, independent No-dong battalion. The organization of this battalion is probably similar to that of Hwasong 5/6 battalions, although some reports suggest that it is equipped with six to nine TELs. Published reports suggest that a base for an independent No-dong battalion, with six TELs, is now being constructed near Yongo-dong, Yanggang-do.

During the late 1990s, the DPRK undertook a major reorganization of its FROG and ballistic missile forces and established a ballistic missile division directly subordinate to the General Staff Department. The organization of this division is unclear, but it is known to consist of the FROG brigade (previously subordinate to the Artillery Command), Hwasong 5/6 regiment, and the No-dong battalion. Administration and support units probably consist of a headquarters (staff and rear services), communications battalion, missile technical battalion, air defense battalion, engineer battalion, and a nuclear-chemical defense company.[117]

Pakistan's Ghauri (Hatf V) and Ghauri 2

The Pakistan-DPRK missile relationship dates to the late 1980s. In December 1988, Benazir Bhutto became prime minister of Pakistan and threw her full support behind the acquisition of PRC ballistic missiles and expanded Pakistan-DPRK missile and nuclear cooperation. One example of this was the Pakistani visit to the 125 Factory in P'yongyang (and possibly the Sanum-dong military research-and-development facility) to examine the No-dong. This visit may have been related to the June 1992 failed, or cancelled, No-dong test.[118] The following month, DPRK Deputy Premier-Foreign Minister Kim Yong-nam traveled to Syria (July 27-30), Iran (July 30-August 3), and Pakistan (August 4-7) to discuss a number of issues, including missile cooperation and DPRK sales of Hwasong 6 and possibly No-dong missiles.[119] Pakistani and Iranian specialists are believed to have been present for the DPRK's May 29-30, 1993 tests.[120]

In December 1993, two months after she was re-elected as prime minister, Benazir Bhutto traveled to the PRC and DPRK. Although she publicly denied it, subsequent events indicate that she was seeking, among other items, increased cooperation in ballistic missile development and, in particular, a system capable of striking strategic Indian targets.[121] Shortly afterwards, Pakistan established a ballistic missile project to purchase and manufacture the No-dong missile—known in Pakistan as the Ghauri (Hatf V).[122]

With the agreement on a missile project came accelerated Pakistan-DPRK political, scientific, and missile cooperation. In April 1994, a DPRK Foreign Ministry delegation headed by Pak Chung-kuk traveled to Iran and Pakistan.[123] In September of the same year, another delegation led by Choe Hui-chong, chairman of the State Commission of Science and Technology, traveled to Pakistan.[124] In late November 1995, a DPRK

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[117] Author interview data; "N.K. Building Bases for Scud-C Missiles," *Korea Herald*, October 28, 1999; "S. Korea Denies Report North Deploys Missile Units," Reuters, October 25, 1999; Kwon-hyun Jung "NK Deploys Rodong-1 Missiles," *Choson Ilbo*, 24 October 1999; and "N. Korea Deploys 10 More Subs," *Korea Times*, October 12, 1999.

[118] Author interview data; Bermudez and Gerardi, "An Analysis of North Korean Ballistic Missile Testing;" and Gertz, "Iran-Bound Mystery Freighter Carried Parts for Missiles."

[119] Author interview data; "North Korea Strengthens Ties With Syria, Iran and Pakistan - Foreign Minister Makes Official Tours," pp. 5-6; "Foreign Minister Kim Yong-nam Visits Syria, Iran and Pakistan," p. 5; "Kim Yong-nam Leaves For Syria, Iran, Pakistan;" and Weymouth, "In Israel, a New View Of Syria."

[120] Author interview data; Bermudez and Gerardi, "An Analysis of North Korean Ballistic Missile Testing;" and Gertz, "Iran-Bound Mystery Freighter Carried Parts for Missiles."

[121] "Bhutto Holds News Conference, Departs for DPRK," *Radio Pakistan Network*, December 29, 1993, in FBIS-CHI-93-248 (December 29, 1993), p. 19; "Bhutto Holds News Conference, Departs for DPRK," Xinhua, December 29, 1993, in FBIS-CHI-93-248 (December 29,1993), p. 20; "Denies Possible Talks on Missiles," *Radio Pakistan Network*, December 26, 1993, in FBIS-NES-93-246 (December 27, 1993), p. 24.

[122] An alternate spelling for Ghauri is Ghuri.

[123] "Foreign Ministry Group Leaves for Iran, Pakistan," KCNA, March 31, 1994, in FBIS-EAS-94-063 (April 1, 1994), p. 13.

[124] "Science Delegation Leaves for Pakistan 26 Sept," KCNA, September 26, 1994, in FBIS-EAS-94-187

military delegation led by Marshal Choe Kwang (vice-chairman of the National Defense Commission and minister of the People's Armed Forces) traveled to Pakistan. There he met with Pakistani President Sardar Leghari, Defense Minister Aftab Shaban Mirani, the Chairman of the Joint Chiefs of Staff, Chief of Naval Operations, Commander of the Air Force, and various other military officials. Choe is also believed to have visited the missile-related production facilities in the Faisalabad–Lahore area and possibly even Jhelum (the area from which Ghauri was subsequently launched).[125] Choe is believed to have finalized an agreement to provide Pakistan with key components from either the No-dong or Taep'o-dong programs, about 12 to 25 No-dong missiles, and at least one TEL or MEL.[126]

The agreed items were produced by the Fourth Machine Industry Bureau of the Second Economic Committee and a majority are believed to have been delivered to the Khan Research Laboratories at Kahuta in the spring of 1996 by the Changgwang Sinyong Corporation (a.k.a., North Korea Mining Development Trading Corporation/Bureau).[127] On April 24, 1998, the US State Department imposed sanctions against both the Khan Research Laboratories and Changgwang Sinyong Corporation.[128] This was the second time that the State Department imposed sanctions against the Khan Research Laboratories.[129] The Changgwang Sinyong Corporation was the same organization responsible for supplying Iran with DPRK missile technologies, components, and missiles during the mid-1990s. Changgwang and the Iranian Ministry of Defense Armed Forces Logistics and State Purchasing Office were subsequently placed under US State Department sanctions in June 1996.[130]

On April 6, 1998, Pakistan conducted its first test of the Ghauri, which it claimed had a range of 1,500 km. While Pakistan has stated publicly that the missile was designed and produced indigenously it was, in fact, a DPRK-produced No-dong launched from a MEL. This was the second test of a No-dong, and it is believed that DPRK observers were present. On April 14, 1999, Pakistan tested what it called the Ghauri 2, which it claimed had a range of 2,000 km; again this was a DPRK-produced No-dong, making this Pakistani launch the fourth test of this DPRK missile system.

Since the flight tests of the Ghauri and Ghauri 2, there have been numerous Pakistani statements indicating that it is developing three more-capable ballistic missiles—the Ghaznavi, Abdali, and Shaheen. The status of these programs and the extent of DPRK involvement are unclear.

Iran's Shehab 3

Iran has participated in the No-dong program since its inception. This participation led directly to Iran's establishment of the Shehab 3 program, which apparently began in 1988, roughly the same date as the start of the No-dong project.

In March 1993, a 21-member Iranian delegation traveled to P'yongyang.[131] This delegation was led by Brigadier General Hossein Mantequei, then director of the Defense Industries Organization (a body responsible for Iran's ballistic missile development and production program under a project known as

(September 26, 1994), p. 18.

[125] Author interview data; "Delegation Visiting Pakistan Attends Banquet," *Korean Central Broadcasting Network*, November 24, 1995, in FBIS-EAS-95-227 (November 25, 1995); "Choe Kwang Delegation Meets Pakistani President," *Korean Central Broadcasting Network*, November 22, 1995, in FBIS-EAS-95-226 (November 23, 1995); "Choe Kwang-Led Delegation Arrives in Pakistan," *Korean Central Broadcasting Network*, November 20, 1995, in FBIS-EAS-95-224 (November 21, 1995); and "Military Delegation Leaves for Pakistan," *Korean Central Broadcasting Network*, November 19, 1995, in FBIS-EAS-95-223 (November 20, 1995).

[126] Author interview data. A photograph illustrating the erecting arm of the TEL with the Ghauri upright prior to launch may be found at <http://www.pak.gov.pk/govt/Ghauri.htm>.

[127] Author interview data; and US Department of State, "Imposition of Missile Proliferation Sanctions Against Entities in North Korea and Pakistan," *Federal Register*, May 4, 1998.

[128] Ibid.

[129] It first imposed sanctions in August 1993 in response to Pakistan's acquisition of PRC M-11 ballistic missiles.

[130] US Department of State, "Imposition of Missile Proliferation Sanctions Against Entities in Iran and North Korea," *Federal Register*, June 12, 1996.

[131] "P'yongyang Strongly Denies Reports of 'An Agreement With Iran for Missile Exports'," *North Korea News*, April 26, 1993, p. 5; and Douglas Jehl, "North Koreans Reported Selling Missiles to Iran," *New York Times*, April 8, 1993, p. A9.

"Department 140").[132] The purpose of the visit was reportedly to discuss missile-related cooperation, arrangements for Iranian participation in the forthcoming No-dong test, and the purchase of No-dong missiles. In February 1994, KPAF commander General Cho Myong-rok visited Iran with a 29-member delegation of military and nuclear experts and toured the missile test site at Shahroud.[133]

Delivery of either No-dong components or a small number of completed missiles is believed to have occurred in mid- to late-1994. Sometime during late 1994 or early 1995, the DPRK also provided four TELs. While these are believed to have been for the Hwasong 6, it is possible that a No-dong MEL was included with the shipment. Further deliveries continued at a very slow rate for approximately one year, until funding and other problems resulted in their halt. By 1997 low-level deliveries appear to have resumed.[134]

There were a number of quality, technical, and production issues to be resolved with the new missiles and components. These problems slowed shipments of missiles from the DPRK, introduction of the missiles into Iranian service, and the startup of Iranian production. It has been suggested that the Iranians were not pleased with the overall progress of the No-dong program and that the problems they encountered with the newly delivered missiles exacerbated this sentiment. This may have led to a decision to replace a number of the missile's subsystems with technology acquired from Russian sources and to focus longer range missile projects (e.g., Shehab 4) on Russian technology rather than on the DPRK's developmental Taep'o-dong.[135] At present, there is no reliable information detailing the type of components and number of No-dong missiles that the DPRK provided to Iran. Some sources suggest that there was an agreement for 150 missiles, but this number seems to be excessive.[136]

On July 22, 1998, Iran conducted its first test of the Shehab 3 (the third test of a No-dong). This missile is believed to have been an Iranian-assembled No-dong with few, if any, local internal modifications. The missile flew for approximately 100 seconds before exploding. If this were an accidental explosion, it would suggest that the problems the Iranians had noted earlier may not have been resolved. Regardless, the Iranians may follow the DPRK lead and deploy the system in spite of problems. Like the earlier test of the Ghauri, DPRK observers are believed to have been present for the Shehab 3 test.[137]

Further development of the No-dong/Shehab 3 system is being undertaken cooperatively by the Iranians and the DPRK. It is believed, however, that production versions of the missile will incorporate increasing levels of Russian, and possibly PRC, technologies or components.[138] If this trend continues, it could result in a missile that is significantly different from the DPRK-produced No-dong.

Iranian-DPRK Shehab 3 cooperation may have also extended into space launch vehicles. In August 1998, Iranian television showed what appeared to be a mock-up of a clam-shell nosecone with a small satellite inside and a model of a space launch vehicle with a bulbous payload section, apparently based upon the Shehab 3.[139]

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[132] Stephen J. Hedges and Peter Cary, "The Other Problem in the Persian Gulf," *US News & World Report*, November 14, 1994, pp. 87-88.

[133] "Iran's Top Diplomat Visits P'yongyang," *North Korea News*, February 7, 1994, p. 4; "North Korean Air Forces Chief Visits Iran," *North Korea News*, January 24, 1994, p. 5; and Ed Blanche, "Iran-North Korea," AP, February 24, 1994.

[134] Author interview data; and Starr, "Iran Gets 'Scud' TELs," p. 5.

[135] Author interview data; Steve Rodan, "Iran Has Problems With Shihab-3," *Middle East News Line*, March 1, 1999 <http://www.hania.com/menl.htm>; and Bill Gertz, "Longer Range on Iranian Missile Shehab-4 Could Hit Central Europe," *Washington Times*, July 29, 1998, p. A12.

[136] Author interview data; Song-chae Ku, "North Korea's Exports of Nodong-1 to the Middle East," *Choson Ilbo*, July 10, 1993, p. 6, in FBIS-EAS-93-132 (July 13, 1993), p. 22.

[137] Author interview data; Michael Eisenstadt and Azriel Lorber, "Iran's Recent Missile Test: Assessment and Implications," *Policywatch*, Number 303, Washington Institute for Near East Policy, August 5, 1998; Bill Gertz and Martin Sieff, "Iran's Missile Test Alarms Clinton," *Washington Times*, July 24, 1998, p. A1; Tim Weiner, "Iran Said to Test Missile Able to Hit Israel and Saudis," *New York Times*, July 23, 1998; and Bill Gertz, "Iran Tests Medium-Range Missile Weapon, Could Strike Israel, US Troops," *Washington Times*, July 23, 1998, p. A1.

[138] Author interview data; Rodan, "Iran Has Problems With Shihab-3;" and James Risen, "C.I.A. Sees a North Korean Missile Threat," *New York Times*, February 3, 1999, <http://www.nytimes.com>.

[139] Author interview data; "Iranian Defense Minister on Shehab-3 Missile," *IRIB Television*, August 5, 1998, in FBIS-NES-98-217 (August 5, 1998); "Further on Khatami's Visit to Defense Ministry," *IRIB Television*, August 1, 1998, in

Egypt, Libya, and Syria

Throughout the 1990s, there have been reports that Egypt, Libya, and Syria have been interested in obtaining or producing the No-dong. To date, there are no known sales of complete missile systems to any of the three countries.

Egypt's involvement in the No-dong program is believed to be limited to the acquisition of No-dong-related technology or components. It continues to cooperate with the DPRK in a broad range of ballistic missile development activities. For example, in July 1999, the DPRK shipped Egypt specialty steel—with missile applications—through a PRC company in Hong Kong. Meanwhile, missile technicians continue to travel between the two countries.[140]

Although Syria appears to be satisfied with its current Hwasong 6 capabilities, it is believed that Damascus would also like to obtain a small number of No-dong missiles. The 1996 visit to the DPRK by a delegation of Syrian missile technicians, while primarily concerned with the Hwasong 6 program, may also have been related to Syrian interest in the No-dong.[141]

Libya has probably received No-dong components and technology. There have also been reports indicating the development of a joint DPRK-Libyan missile test facility in Libya. This, however, remains to be verified.[142]

Taep'o-dong 1 (a.k.a., No-dong 2, Rodong 2, Scud Mod. E, Scud X), Taep'o-dong 1 SLV, Taep'o-dong 2 (a.k.a., No-dong 3)

During the early 1990s, the DPRK initiated development of two ballistic missile systems that would become known in the West as the Taep'o-dong 1 and Taep'o-dong 2 (the DPRK designators are unknown).[143] Taep'o-dong 1 design objectives were apparently for a system that could deliver a 1,000 to 1,500-kg warhead to a range of 1,500 to 2,500 km; Taep'o-dong 2 is intended to carry the same warhead to 4,000 to 8,000 km.[144]

FBIS-NES-98-217 (August 5, 1998); and "Iran's Khatami on Military Issues, Missiles," *IRIB Television*, August 1, 1998, in FBIS-NES-98-217 (August 5, 1998).

140 Author interview data; and Gertz, "North Korea Continues to Develop Missiles."

141 "Better firepower for Syria's Assad," p. 20.

142 Author interview data; Bill Gertz, "China Assists Iran, Libya on Missiles," *Washington Times*, June 16, 1998, p. A1; Gertz, "N. Korea as Nuclear Exporter?" p. A1; Gertz, "Libya May Buy N. Korean Missiles," p. A4; Elmar Guseynov, "Scuds Known and Loved in the Gulf," *Izvestiya*, November 13, 1993, p. 3, in FBIS-SOV-93-218 (November 15, 1993), p. 27; and Murat Yetkin, "Possible Missile Threat From Middle East Neighbors Detailed," *Turkish Daily News*, July 30,1993, pp. 1, 11, in JPRS-TND-93-026 (August 10, 1993).

143 Starr, "Iran Gets 'Scud' TELs," p. 5; Barbara Starr, "Economics Could Undermine North Korean Capability," *Jane's Defence Weekly*, June 25, 1994, p. 15; Starr, "No Dongs May Soon be Nuclear, Warns USN," p. 1; Barbara Starr, "North Korean Missile R&D Gains New Pace," *Jane's Defence Weekly*, June 25, 1994, p. 10; Barbara Starr, Paul Beaver, and Joseph S. Bermudez Jr., "North Korea Grasps at the Stage Beyond Nodong 1," *Jane's Defense Weekly*, March 19, 1994, p. 18; and Barbara Starr, "N Korea Casts a Longer Shadow With TD-2," *Jane's Defense Weekly*, March 12, 1994, p. 1.

144 Ranges for both could be significantly increased with smaller warheads.

Table 3. DPRK Ballistic Missile Characteristics [a]

Class	Name (Alternate names)	Max. Range (km)	Warhead (kg)	Stages	Length (m) [b]	Diameter (m)	Weight (tonnes)	DPRK IOC [c]
SRBM	SA-2/HQ-2 SSM	60-160	190	2	10.7	.65/.5	2.287	1976
	DF-61	600	1,000 [d]	1	9.0	1.0	6.0	n.a.
	Scud B (R-17E)	300	1,000	1	11.2	.884	5.86	1981
	Hwasong 5 Prototype (Scud Mod. A)	300	1,000	1	11.2	.884	5.86	1984
	Hwasong 5 (Scud Mod. B, Scud B)	320-340	1,000	1	11.2	.884	5.86	1985
	Hwasong 6 (Scud Mod. C, Scud C, Scud PIP)	500	770 [e]	1	11.3	.884	5.93	1989
MRBM	No-dong (No-dong 1, Rodong 1, Scud Mod. D, Scud D,)	1,350 [f] 1,500 [f]	1,200 700	1	16.0	1.32	16.25	1993
	Taep'o-dong 1 (Daep'o-dong 1, No-dong 2, Scud X, Scud Mod. E, Rodong 2)	2,500 [g]	700-1,000	2	25.5 (13.7/11.8)	1.32/.884	20.7	1998
IRBM	Taep'o-dong 1 SLV	4,000 [h]	50-100	3	26.0 (13.7/9.1/3.2)	1.32/.884/.884	18.7	1998
ICBM	Taep'o-dong 2 (Daep'o-dong 2, No-dong 3)	6,700 [i] 6,000+	700-1,000 100-500	2	32 (18/14)	2.4/1.32	64.3	2000
	(Three Stage Taep'o-dong 2) (Taep'o-dong 3)	10,000-12,000	500-1,000	3	?	?	?	?

Notes

a. Figures for all DPRK-produced systems are based upon the best "open source" information currently available and should be regarded as provisional.
b. Figures are for 1st, 2nd, and 3rd stages, respectively. The 2nd stage figures include the interstage assembly.
c. DPRK IOC: Initial operational capability. The DPRK places missile systems into service decidedly earlier in their development phase than do most other nations.
d The PRC planned a domestic version with a 1,000-km range and a 500-kg nuclear warhead.
e. Several sources suggest that the Hwasong 6 warhead weighs 700 kg.
f. The 1,350-km figure is derived from Iranian information for the Shehab 3 which "…can carry at least 1,200 kilos of explosives…;" the 1,500-km figure is based upon Pakistani information which gives the Ghauri this range with a 700-kg warhead.
g. This is the latest ROK Ministry of Defense estimate. Earlier public estimates were 1,500 to 2,000 km.

h. The best information currently available suggests that during the 1998 Taep'o-dong 1 SLV launch the payload, or debris from the payload, traveled approximately 4,000 km. When employed as a ballistic missile, a space launch vehicle capable of placing a 100-kg payload into low earth orbit is theoretically capable of delivering a 200-kg warhead to a range of approximately 10,000 km. This is assuming a launch trajectory due east.
i. This is the latest ROK Ministry of Defense estimate. Earlier public estimates were 4,000 to 6,000 km.

Both systems build upon the experience gained, and technology employed, in the development and production of the Hwasong 5/6 and No-dong. No-dong and Hwasong 6 serve as the basic "building blocks" for the new systems. The two-stage Taep'o-dong 1 appears to utilize a No-dong derivative as the first stage and a Hwasong 6 as the second stage. It is approximately 25.5-m long and weighs 20.7 tonnes and can carry a 700- to 1,000-kg warhead to a distance of 1,500 to 2,500 km.[145] The Taep'o-dong 2 is also a two-stage system, apparently with a newly designed first stage and a No-dong variant as the second stage. Weighing 64.3 tonnes and with an overall length of 32 m, it can carry an estimated 700- to 1,000-kg warhead to a distance of 6,700 km. The first stage appears to be based on either the clustering of three No-dong engines or a new single engine (possibly of Russian or PRC origin) and is approximately 18-m long and 2.4 m in diameter.[146] There have been frequent reports suggesting a linkage between both systems—especially the Taep'o-dong 2—and PRC missiles (i.e., DF-3). These claims, however, remain to be confirmed.[147]

The relatively long developmental period for these systems is a result of delays in the No-dong program; technical difficulties concerning multi-staging, engine clustering, guidance, and airframe design and development; and the economic turmoil that the DPRK has faced in the 1990s. As noted above with the No-dong program, many of these technical issues were, and are being, addressed by the DPRK's employment of missile designers and engineers from Russia, Ukraine, and other countries. DPRK missile designers and engineers have continued to travel to the PRC for professional training and possible technology exchanges throughout the 1990s.

Estimates concerning the size and type of warheads the Taep'o-dong 1/2 can carry have varied considerably. Following the lead of the No-dong program it is probable that the DPRK has designed HE, cluster, chemical, and nuclear warheads for the Taep'o-dong 1/2.

In February 1994, US intelligence identified mock-ups of the two new systems at the Sanum-dong military research-and-development facility.[148] Since this revelation, the DPRK has expanded camouflage and deception operations to mask its missile development activities, including construction of fake facilities, and manufacture and deployment of numerous decoy vehicles and missiles.[149] These deception activities make it increasingly difficult to determine the progress in Taep'o-dong 1 and 2 development. There are reports that a February 1994 static engine test at the "Taep'o-dong rocket test stand" was directly related to the Taep'o-dong program.[150] The May 1994 modification of the launch towers at the Musudan-ri Launch Facility and the erection of a "giant shelter pad against propellant jets" provided some additional indications of Taep'o-dong progress.[151]

At a late-1993 or early-1994 meeting of the Korean Workers' Party (KWP) Central

[145] Other sources suggest a T'aepo-dong 1 length of 27 m, weight of 22 tonnes carrying a 0.8 tonnes warhead to a range of 2,200 km. Author interview data.

[146] The diameter may be closer to 2.8 m.

[147] Author interview data; Bill Gertz, "China Assists North Korea in Space Launches," *Washington Times*, February 23, 1999, p. A1; "Taepodong Missile 'Does Not Make Technical Sense'," *Jane's Missiles & Rockets*, May 19, 1998 <http://www.jmr.janes.com>; and "North Reportedly Deploying Nodong-1 Missiles," *Kyodo*, September 12, 1995, in FBIS-EAS-95-177 (September 13, 1995).

[148] Although most sources attribute the first sighting of these missiles at Sanum-dong, this would appear to be incorrect. Until a national identifier becomes known, US intelligence usually names a new weapon system after the nearest geographic feature in which it is first sighted. Therefore, if the missiles were first sighted at Sanum-dong, they would have been labeled the "Sanum-dong 1/2." But since they are, in fact, labeled "Taep'o-dong 1/2" it would appear that they were first identified at Taep'o-dong near the Musudan-ri launch facility.

[149] Author interview data; and Starr, "North Korean Missile R&D Gains New Pace," p. 10.

[150] Starr, "North Korean Missile R&D Gains New Pace," p. 10.

[151] Shunji Taoka, "Demonstration of Military Power Will Adversely Affect Negotiations with the United States," *Aera*, June 13, 1994, p. 17.

Committee, Kim Il-song expressed his desire to place a satellite into orbit.[152] This decision was apparently precipitated by the international recognition Seoul received after the successful launch of its second research satellite, Uribyol II, in September 1993. Kim's appeal to the Central Committee led to the expansion of the DPRK's nascent space program and the requirement for a space launch vehicle. The most likely candidate for use as a SLV was the Taep'o-dong 1. Because the timing of this decision and the start of the Taep'o-dong program were so close, it is possible that there were plans for a SLV version from the project's inception.[153]

The Taep'o-dong 1 SLV is a three-stage rocket that appears to utilize a No-dong derivative as the first stage, Hwasong 6 as the second stage, and a solid-fuel third stage (possibly derived from the HQ-2 booster). It is approximately 26-m long and weighs 18.7 tonnes. Work began on a small satellite named the Kwangmyongsong 1 ("Bright Lodestar") concurrent with launch vehicle development.[154] In designing the Kwangmyongsong 1, the DPRK is believed to have received considerable assistance from the PRC's Academy of Launch Technology. This assistance, albeit at varying levels of intensity, has continued with development of the forthcoming Kwangmyongsong 2 satellite project. It may also extend to additional, unnamed satellites—possibly including a crude reconnaissance satellite.[155]

To support the No-dong and Taep'o-dong programs, expansion of the DPRK's ballistic missile infrastructure has continued. Construction of specialized "underground missile bases" or "missile silos" that began during the mid-1980s has continued through the 1990s. A small number of these facilities are located throughout the country and are now believed capable of handling both the No-dong and Taep'o-dong 1—and possibly the Taep'o-dong 2. In addition, a small number of specialized transport and support vehicles have been manufactured for the Taep'o-dong 1/2 programs, including a MEL for the Taep'o-dong 1 and missile transport vehicles.[156]

Initial prototypes for these systems were probably manufactured in 1995 or 1996. An initial production run for the Taep'o-dong 1 may have begun during 1997 or 1998, and it is estimated that a rate of one per month could possibly be achieved if Hwasong 6 and No-dong production were curtailed. It is estimated that by the end of 1999, the DPRK will have produced a total of one to ten Taep'o-dong 1/SLVs and one to two Taep'o-dong 2 prototypes.

On August 31, 1998, the DPRK conducted its first flight of a Taep'o-dong system—the three-stage Taep'o-dong 1 SLV. The objective of the mission was to place the DPRK's first satellite—the Kwangmyongsong 1—into orbit. Launch preparations began at the Musudan-ri Launch Facility on August 7. Two weeks later, these preparations were accompanied by the movement of KPN vessels into the East Sea. By August 27, final preparations for a test were detected by US intelligence, and thus surveillance assets were moved into position. Liftoff occurred at 12:07 hours (local time) on August 31 from the Musudan-ri Launch Facility. The three-stage Taep'o-dong 1 SLV flew due east across the East Sea. The first stage separated at T+95 seconds and impacted in the East Sea approximately 253 km east of the Musudan-ri Launch Facility. At T+144 seconds, the payload shroud separated and impacted in the Pacific Ocean approximately 1,090 km from the launch site (east of the main Japanese island of Honshu). The second stage separated at T+266 seconds and impacted in the Pacific Ocean approximately 1,646 km east of the Musudan-ri Launch Facility. The third stage apparently suffered a technical failure and failed to insert the Kwangmyongsong 1 into orbit. Instead it continued east, burning up, with a debris trail that apparently extended to

[152] Author interview data. DPRK sources suggest that their space interests date to much earlier. See "DPRK's Power in Launching Satellite Lauded," *Korean Central Broadcasting Network*, October 6, 1998, in FBIS-EAS-98-28 (October 8, 1998).

[153] Given the timing of the various Taep'o-dong sub-programs it is possible that the Taep'o-dong 1 was always intended as an SLV and that the Taep'o-dong 2 is the ICBM component.

[154] Kwangmyongsong is the name Kim Il-song gave Kim Chong-il on his 50th birthday. It is also meant as a slight to the ROK Uribyol satellites. Uribyol means "Our Star."

[155] Author interview data; and Gertz,"China Assists North Korea in Space Launches," p. A1.

[156] Author interview data; "P'yongyang Found Constructing 5 Underground Facilities;" "US Military Detects Underground Bases in DPRK;" and "Says Long-range Missile Bases Built."

approximately 4,000 km. US aircraft and ships tracked the test. Following the test, Japan's Self Defense Forces sent three destroyers and patrol aircraft to search the impact areas in the Pacific for wreckage of the missile and its warhead. These efforts may have been in vain since the second stage impacted on the edge of the Japan Trench in waters with a depth of some 5,000 m.[157]

The DPRK has never acknowledged this failure. Instead, on September 4, the Korean Central Broadcasting Network read an announcement signed by Kim Chong-il that, "…our scientists and technicians succeeded in launching its first satellite into orbit with multi-staged delivery rockets."[158] The DPRK further claimed that the satellite was circling the Earth and transmitting the revolutionary anthems "the Song of the Sun, the Song of General Kim Il-song and General Kim Chong-il."[159] For "successfully launching Kwangmyongsong 1," numerous scientists, technicians, workers, and officials were awarded state commendations, titles, and gifts.[160] In December 1998, the DPRK announced that it would launch the Kwangmyongsong 2, but did not set a launch date.[161]

While the timing of the Taep'o-dong 1 SLV launch was correctly predicted by US intelligence, it also demonstrated a number of unanticipated developments. Until August 1998, the DPRK was known to have developed only a two-stage Taep'o-dong 1 ballistic missile. The third stage and satellite capabilities came as a surprise, indicating that the program was further along in developing ICBMs than had previously been estimated. The launch tested a number of important aspects of ICBM development, such as multi-stage separation, guidance, multi-fuel systems, etc. It also validated the two-stage Taep'o-dong 1 and its ability to deliver a 700- to 1,000-kg warhead to about 2,500 km. If the three-stage Taep'o-dong 1 SLV were to be configured as a missile, it could deliver a 200-kg warhead into the central section of the United States, although with poor accuracy. With a 100-kg warhead, it could reach Washington, DC. The larger and more powerful Taep'o-dong 2, which has yet to be tested, is now assessed as being able to deliver a 700- to 1,000-kg warhead to 6,700 km, although the accuracy would also be poor. If the DPRK were willing to settle for a smaller warhead, this system has the potential to strike any large, city-sized target within the continental United States.[162]

Although current estimates suggest that the Taep'o-dong 1 could become operational during 1999 to 2000, two other scenarios are possible. First, the Taep'o-dong 1 may already be deployed or considered "operational" by the KPA, given that the DPRK has apparently established significantly lower levels of reliability and readiness than have most Western nations. Second, only a few (and possibly no) Taep'o-dong 1 systems will become operational with the KPA. Instead, the DPRK will concentrate the majority of its limited resources into developing and fielding the Taep'o-dong 2. When the Taep'o-dong systems do become operational, they will probably not replace the No-dong; rather, the

[157] Author interview data; Phillip Clark, "Fact and Fiction: North Korea's Satellite Launch," *Spacelaunch* 4, January/February 1999, pp. 39-41; "DPRK's Power in Launching Satellite Lauded;" and Hae-ch'ol Han, "Common Knowledge About Artificial Satellite," *Nodong Sinmun*, September 16, 1998, p. 4, in FBIS-EAS-98-281 (October 8, 1998).

[158] "N. Korea Says It Launched 'Satellite'," UPI, September 4, 1998.

[159] "DPRK's Power in Launching Satellite Lauded;" and Han, "Common Knowledge About Artificial Satellite," p. 4.

[160] "Kwangmyongsong 1 Moves Round Earth 770 Times," KCNA, December 8, 1998, in FBIS-EAS-98-342 (December 9, 1998); "KCNA Reports on Awards Given to Satellite Scientists," KCNA, December 1, 1998, in FBIS-EAS-98-335 (December 2, 1998); and "Satellite Scientists Receive State Citation, Gifts," *Korean Central Broadcasting Network*, November 30, 1998, in FBIS-EAS-98-335 (December 1, 1998).

[161] "No Advance Announcement for 2nd Launch," *Asahi Shimbun* (on-line version), December 11, 1998, in FBIS-EAS-98-345 (December 11, 1998).

[162] Author interview data; Gertz, "North Korea Continues to Develop Missiles;" David E. Sanger, "North Korea Warns US It Can Launch Another Missile," *New York Times*, December 26, 1998, p. A1; "Ground Zero," *Inside Missile Defense*, February 10, 1999, p. 1; "Intell Says Taepodong 2 Could Strike Entire US," *Defense Week*, January 25, 1999; Central Intelligence Agency, *North Korea's Taepo Dong Launch and Some Implications on the Ballistic Missile Threat to the United States*, speech by Robert D. Walpole, National Intelligence Officer for Strategic and Nuclear Programs, at the Center for Strategic and International Studies, December 8, 1998; Gertz, "Pentagon: N. Korea's Missiles Operational US Forces in Japan Now Within Range," p. A9; and Central Intelligence Agency, *Speech by Robert D. Walpole, National Intelligence Officer for Strategic and Nuclear Programs, at the Carnegie Endowment for International Peace*, September 17, 1998.

KPA will opt for a mix of ballistic missile systems.

Taep'o-dong development is being aggressively pursued, and improvements are being incorporated into the systems.[163] As of December 1999, the Taep'o-dong program is assessed as being able to:[164]

- conduct a second Taep'o-dong 1 SLV launch, possibly with the Kwangmyong-song 2 satellite;
- conduct the first launch of a Taep'o-dong 1 MRBM/IRBM;
- conduct the first launch of a Taep'o-dong 2 ICBM;
- conduct the first launch of a Taep'o-dong 2 SLV, possibly with the Kwangmyongsong 2 satellite; and
- place the Taep'o-dong 2 ICBM in service with the KPA without a flight test.

Excluding either political developments or the collapse of the DPRK, development of the Taep'o-dong family will undoubtedly continue for the foreseeable future. If the program were allowed to proceed unfettered, likely developments within the next 10 years will include:

- a three stage version of the Taep'o-dong 2 ICBM (sometimes identified as the Taep'o-dong 3 in press reports); such a system could deliver a 500- to 1,000-kg warhead to a distance of 10,000 to 12,000 km (e.g., anywhere within the United States);
- more sophisticated reentry vehicles, warheads, and penetration aids; and
- a new and more sophisticated two- or three-stage system incorporating improved guidance (possibly utilizing GPS and/or stellar navigation), engines with gimbaled nozzles, greater throw weight, etc.

The KPA will either integrate the Taep'o-dong within the new ballistic missile division or will deploy the missile as an independent battalion. An independent launch battalion might consist of a headquarters (staff, technical section, rear services section, and communications section), one to two firing batteries (each with one launcher), and an air defense company. The independent launch battalions will likely deploy in the specialized "underground missile bases" or "missile silos" built during the 1980s and 1990s.

Like the No-dong program, it is probable that the Taep'o-dong has benefited from technology exchanges and test flights related to the Pakistani Ghauri and Iranian Shehab 3 programs. It is also believed that both Iranian and Pakistani observers were present for the Taep'o-dong 1 SLV launch.[165] Iran has been involved in the development of the Taep'o-dong family from its inception, including financing and the exchange of information, technology, and personnel. Although Iran was at first deeply interested in the acquisition of Taep'o-dong 1/2 missiles and technology, it appears that Tehran has now committed itself to utilizing Russian technology for its Shehab 4. Iran-DPRK cooperation in the program may extend to the Taep'o-dong 1 SLV and Kwangmyongsong satellites. The export of Taep'o-dong 1/2 missiles or technology to Pakistan is also of great concern. Pakistan announced a 2,000-km range Ghaznavi; this missile may actually be a Taep'o-dong 1.[166] The extent of Egyptian, Libyan, or Syrian interest or involvement in the Taep'o-dong program is currently unknown. The DPRK is reportedly offering the Taep'o-dong 1 to these countries at a cost of $6 million apiece.[167]

Other Missile Systems

During the 1990s a number of events influenced missile-related developments within the DPRK, especially the 1991 Gulf War. Extensive use of BGM-109 Tomahawk cruise missiles, al-Husayn ballistic missiles, and unmanned aerial vehicles (UAV) had a profound

[163] Ibid.
[164] Ibid.
[165] Author interview data; "Iran Attends DPRK Test," *Iran Brief*, September 8, 1998; and "Second Shehab Test Planned," *Iran Brief*, February 8, 1998.
[166] Dina Nath Mishra, "The Essence of Intolerance," *Observer*, March 30, 1998, p. 1.
[167] Author interview data; "North Korea's Taepodong I Missile Priced at $6 Million;" and "DPRK Reportedly Asking $6 Million Per Taepo Dong Missile."

effect on the thinking of military planners and missile designers in the DPRK. This led the DPRK to establish cruise missile and UAV programs and spurred the development of the No-dong and Taep'o-dong systems.

In the years following that war, Iran is believed to have provided the DPRK with access to BGM-109 Tomahawk wreckage from missiles that impacted on its territory, or that it acquired from Bosnia.[168] Given the complexity of the system, it is unlikely that the DPRK gained significant design, production, or operational knowledge from the wreckage, although access may have provided some insight into possible counter-measures or served as a design catalyst.

During 1994, and as a result of the expanding Syria–DPRK missile relationship, the DPRK was allowed extensive access to Syria's missile systems, missile technology, and UAVs. Syria gave the DPRK access to the 9K79 Tochka (SS-21 SCARAB), P-35 Redut (SSC-1b SEPAL), and P-20 Rubezh-A (SS-C-3 STYX) missiles; solid-fuel motor technology; and the DR-3 Reys UAV. More significantly, it is believed that Syria provided examples of some of these systems to the DPRK. Of these, the possible acquisition of the 9K79 Tochka is the most interesting. A number of unconfirmed reports from a variety of sources suggest that during the 1990s the DPRK was interested in replacing its aging inventory of Luna-2 (FROG-5) and Luna-M (FROG-7B) artillery rockets and in developing a solid-fuel tactical ballistic missile. During mid-1996, an unknown number of Syrian technicians spent two weeks in the DPRK. This group both studied the production of the Hwasong 6 and reportedly shared information concerning the 9K79 Tochka.[169] Despite this access, it is unlikely that the DPRK has made significant progress in developing a solid-fuel ballistic missile given financial, manpower, technology, and other limitations.

During the late 1980s and through the 1990s, the DPRK acquired the 9M111 Fagot (AT-4 SPIGOT) and 9M113 Udar (AT-5 SPANDRAL) ATGMs, and the 9K34 Strela 3 (SA-14 GREMLIN), and 9K310 Igla-1 (SA-16 GIMLET) SAMs from Russia. P'yongyang is believed to have undertaken production of at least the 9M111 Fagot and 9K34 Strela. In addition to these systems, the DPRK has continued development of existing SAMs and air-to-air missiles, although details are lacking.

On March 19, 1991, the DPRK reportedly signed an arms agreement with Cuba. This agreement called for the sale of SAMs (presumably SA-14/16s) and other anti-aircraft weapons to Havana. This agreement came at the end of an official visit to Cuba by a delegation led by MPAF Chief of Staff Choe Kwang.[170]

In the mid-1990s, defectors revealed that the DPRK had earlier obtained examples of both the French Exocet anti-ship cruise missile and US FIM-92 Stinger SAM.[171] These were acquired with the intention of reverse-engineering the systems and deploying them with the KPA. It is unclear how successful the DPRK has been in this effort, although US intelligence believes that the Stinger may be available in limited numbers.[172] It is unclear if these are US-origin missiles or copies.

CONCLUSION

During the past 30 years, the DPRK has pursued a steadily expanding ballistic missile development program. This program has been pursued fully in line with its national philosophy of *Chu'che* and with single-mindedness and determination second only to that devoted to its nuclear program. This is being accomplished, however, at a high cost to both its economy and society as scarce human and natural resources are funneled into the program. These costs are,

[168] Iran is also reported to have acquired BGM-109 TOMAHAWK wreckage from Bosnia. Zvi Barel, "A (Missile) Shot in the Dark," *Ha'aretz*, July 31, 1998 <http://www.haaretzdaily.com>.

[169] "Better firepower for Syria's Assad," p. 20.

[170] Bill Gertz, "Cuba, North Korea Getting Cozy, US Fears," *Washington Times*, November 29, 1991, p. A1; and "DPRK-Cuba Contract for Missiles Export Alleged," *Choson Ilbo*, March 20, 1991, p. 2, in FBIS-EAS-91-054 (March 20, 1991), p. 23.

[171] *Statements of Colonel Joo-hwal Choi and Young-hwan Ko, Before the Senate Committee on Governmental Affairs Subcommittee on International Security, Proliferation and Federal Services*; Gertz, "N. Korea Building Missiles that Could Hit American Forces Alaska," p. A1; and "NK Said to Target 200,000 US Casualties: Defector," *Korea Herald*, October 22, 1997 <http://www.koreaherald. co.kr>.

[172] DIA, *North Korea Handbook*, p. 6-80; and US Marine Corps, *North Korea Country Handbook*, p. A-70.

however, offset to a small degree by the monetary rewards of selling ballistic missiles systems, technologies, and components to other Third World nations. Moreover, the DPRK leadership believes that the possession of ballistic missiles is an essential component in preventing foreign aggression against it and that the international prestige and recognition that its ballistic missile program afford it more than justify the monetary and human costs.

Today, the DPRK fields the largest ballistic missile force in the Third World and possesses nascent SLV and ICBM capabilities. It is arguably also the world's greatest proliferator of ballistic missile systems, technologies, and components. These proliferation activities provide the DPRK with a large proportion of its foreign trade and are the sole positive component of its ailing economy. Barring momentous domestic or international political developments, the DPRK will continue to pursue its ballistic missile program and sales for the foreseeable future.