China's Ballistic Missile Programs

Technologies, Strategies, Goals

John Wilson Lewis and Hua Di

Continued sales of ballistic missiles to countries in the Middle East and South Asia have intensified international interest in China's advanced weapons.[1] Proposals for halting these sales can succeed when the dynamics and motivations of China's defense system are taken fully into account. We have noted in an earlier article in this journal that the technologies, strategies, and goals relating to Beijing's missile programs must be better understood by the concerned international community in order to overcome its confrontational stance with China and to build a cooperative regime.[2]

This article focuses on those programs and their purposes. It describes the technological and strategic background of China's current programs for the modernization of its ballistic missile forces. We seek to lay the groundwork for a more factual discussion of those weapons and their potential missions, and to make the case for encouraging China to shift from military to peaceful rocket technologies.

One fundamental fact must be understood at the outset. There is no evidence that any overarching strategic doctrine informed Chairman Mao Zedong's decision to proceed with the strategic missile program in the mid-1950s. Westerners may find it hard to accept the fact that the program proceeded without such strategic guidance and without a reconsideration of Mao's doctrine of People's War. Nevertheless, until the early 1980s, there were no scenarios, no detailed linkage of the weapons to foreign policy

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John Wilson Lewis is a member of Stanford University's Center for International Security and Arms Control and co-author of China Builds the Bomb *(Stanford University Press, 1988). Hua Di, also a Center member, spent more than twenty years in the Chinese ballistic missile program after initial training in the Soviet Union at the Moscow Aviation Institute. In 1978 he won China's State Prize for Contributions to the Intercontinental Ballistic Missile and Satellite Programs.*

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1. This article is based on extensive interviews with Chinese specialists, 1981–91. The main outline of the missile program is discussed in Nie Li and Huai Guomo, chief ed., *Huigu yu Zhanwang* (Retrospection and Prospection: Forty Years of Defense Technology and Industry of New China) (Beijing: Zhongguo Shehui Kexue Chubanshe, 1989); Zhang Jun, chief ed., *Dangdai Zhongguo de Hangtian Shiye* (Contemporary China's Space Cause) (Beijing: Guofang Gongye Chubanshe, 1986); and unpublished materials of the First and Second Academies of China's Ministry of Space Industry.
2. John W. Lewis, Hua Di, and Xue Litai, "Beijing's Defense Establishment: Solving the Arms-Export Enigma," *International Security,* Vol. 15, No. 4 (Spring 1991), pp. 87–109.

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objectives, and no serious strategic research. Neither the Chinese leader nor his senior colleagues on the Central Military Commission considered, communicated, or authorized the investigation of the broader strategic purposes of the program.

Beijing's military industry spent the period from 1956 to 1981 developing and deploying its first-generation nuclear-armed missiles. At the end of the period, the Second Artillery of the People's Liberation Army (PLA) fielded two types of intermediate-range ballistic missiles (IRBM) and one intercontinental ballistic missile (ICBM).[3] The Second Artillery, the PLA's strategic rocket forces, had already decommissioned two types of shorter-range missiles. All of these liquid-fueled missiles were designed to carry heavy warheads against cities and other "soft" targets.

For their follow-on systems, the Chinese experimented with smaller, mobile missiles with the same liquid propellants, but then turned to solid-propellant rocketry after the successful flight of a submarine-launched ballistic missile (SLBM) in 1982. The replacement of the first-generation strategic forces with the more survivable solid-propellant missiles, both submarine-launched and ground-mobile, began in 1986 and is scheduled for completion before 2010. The goal is to create a less vulnerable, more flexible, and more reliable strategic retaliatory force.

Despite its early ability to build tactical ballistic missiles (TBMs), the People's Republic of China (PRC) did not seriously consider doing so until the mid-1980s, though it briefly flirted with the idea in the 1960s and 1970s. The major strategic objective was to deter the two nuclear superpowers, principally the United States before the early 1970s and the Soviet Union after the late 1960s. Conventional TBMs were not judged cost-effective for battlefield use. It was not until 1984, when the Chinese became aware of the potential market in the Third World, that they began developing TBMs for export. At the same time, the high command raised its assessment of battlefield TBMs as a supplement to the PLA's inadequate strike aircraft.

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3. In Chinese missile terminology, only missiles with ranges above 1,000 kilometers are considered strategic. The Chinese define missile ranges as follows: short-range (*jincheng*), less than 1,000 kilometers; medium-range (*zhongcheng*), 1,000–3,000 kilometers; long-range (*yuancheng*), 3,000–8,000 kilometers; intercontinental-range (*zhouji*), over 8,000 kilometers. In the long-range category there is a sub-category called intermediate-range (*zhongyuancheng*) denoting 3,000–4,800 kilometers. See, for example, *Zhongguo Dabaike Quanshu: Junshi* (Chinese Encyclopedia: Military Affairs) (Beijing and Shanghai: Zhongguo Dabaike Quanshu Chubanshe, 1989), pp. 504, 1219, and 1234.

The sections that follow expand on this brief account of China's strategic and tactical ballistic missile programs and offer some views on their underlying purposes or doctrines and future directions. We argue that in the early years these programs were essentially technology-driven and that only in the early 1980s did Beijing develop relevant strategic and tactical doctrines for its deployed and planned missile forces. One consequence of this doctrinal development was a willingness to borrow ideas from the West and to engage the West in a strategic dialogue. Although the crisis of 1989 interrupted that dialogue, the basic strategic link with the United States and other Western states has not been eliminated.

Strategic Ballistic Missiles

In January 1956, Soviet advisers in Beijing suggested that missile technology be included in the PRC's Twelve-Year Plan for the Development of Science and Technology (1956–67). A month later, on February 17, Qian Xuesen, a rocket specialist who had only recently returned from the United States, submitted a proposal on missile development to the Chinese leadership.[4] On May 26, 1956, the Party's Central Military Commission created a missile research and development (R&D) organization, the Defense Ministry's Fifth Academy. The Chinese leadership understood that only long-range ballistic missiles could strike the homeland of the United States, Beijing's enemy and a nation that had repeatedly threatened China with nuclear attack. The commission assigned the academy the task of building these missiles.

Having little knowledge about missile technology, the Chinese turned to the Soviet Union for help. On September 13, 1956, Moscow agreed to sell the PRC two R-1 missiles and relevant technical documents.[5] The missile (a copy of the German V-2) was, however, too primitive for the Chinese to learn much from it, and it was not until the following year, when Khrushchev

4. Qian Xuesen (H.S. Tsien) participated in an American military survey of the German missile industry after the Second World War. He was involved in early R&D on U.S. missiles before being allowed by the U.S. government to return to China. See Wang Shouyun, ed., *Qian Xuesen Wenji* (Collected Works of H.S. Tsien, 1938–1956) (Beijing: Kexue Chubanshe, 1991), esp. pp. 802–809.

5. The R-1, with a 270-kilometer range and code-named "Scunner" in the West, was first flight tested on October 10, 1948, and deployed in the late 1940s. See *Iz Istorii Sovietskoi Kosmonavtiki* (From the History of Soviet Cosmonautics) (Moscow: Nauka, 1983), pp. 226–227; and V.P. Glushko, chief ed., *Kosmonavtika: Entsiklopediia* (Cosmonautics: Encyclopedia) (Moscow: Sovetskaia Entsiklopediia, 1985), p. 477.

desperately needed Mao's support against opponents in the Kremlin and Eastern Europe, that Moscow agreed to provide a more sophisticated missile to Beijing. Under the Sino-Soviet New Defense Technical Accord signed on October 15, 1957, a Soviet Army missile battalion with two R-2 missiles and their associated launching equipment reached Beijing on December 24.[6]

The arrival of the R-2s, which the Fifth Academy named 1059, marked the real beginning of the Chinese ballistic missile program. The complicated generational development of that program from 1956 to the present is set forth in Tables 1 and 2.[7] On November 9 and 16, the academy created two research organs, the First Sub-Academy (general configuration and rocket engines) and the Second Sub-Academy (guidance systems). In the latter half of 1958, the blueprints and technical documents (totaling 10,151 volumes) for manufacturing, testing, and launching the R-2 were delivered to the PLA. During the same period, Soviet missile engineers arrived in Beijing, and the Fifth Academy purchased twelve more R-2s.

Although the Chinese intended to launch the 1059 on or before October 1, 1959, the PRC's tenth anniversary, the magnitude of the task delayed the launch of the Soviet-made R-2 until September 1960 and that of their own version of the R-2, the 1059, until November 5, the same year. A year later, a few conventionally-armed 1059s were assigned to the PLA for training purposes. Their production continued until February 1964.

Throughout these same years, 1958–64, Beijing was developing nuclear weapons, and as the nuclear program proceeded toward the first weapon test on October 16, 1964, the Chinese paid ever greater attention to a follow-

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6. The R-2, with a range of 590km, has had code name SS-2 or "Sibling" in the West; it was the first Soviet-developed ballistic missile, though still based on the V-2 technology. The R-2 was first flight tested on October 21, 1950, and deployed in early 1950s. See *Iz Istorii Sovietskoi Kosmonavtiki*, pp. 230–231.

7. The missile fuels named in Table 1 are described below, note 10. Any adequate description of the various missile guidance systems named in Table 1 would be long and technical, and there is no easily available reference on the strap-down system. We have discussed the technologies of all the relevant Chinese systems in John W. Lewis and Xue Litai, *China's Strategic Seapower: The Politics of Force Modernization in the Nuclear Age* (forthcoming), chap. 7. A useful reference on guidance systems is U.S. Department of the Air Force, *Guided Missiles Fundamentals*, AFM 52–31 (Washington, D.C.: U.S. Government Printing Office, 1972), chap. 6. For relevant Chinese works on missile guidance systems, see Zou Jiahua, *Zhongguo Dabaike Quanshu: Hangkong Hangtian* (Chinese Encyclopedia: Aeronautics and Astronautics) (Beijing: Zhongguo Dabaike Quanshu Chubanshe, 1985); Gao Keren and Yu Huijie, *Daodan Jishu Cidian* (Dictionary of Missile Technology) (Beijing: Yuhang Chubanshe, 1984), pp. 93–210; and Chang Gong, "Missile Flight Control Systems (Parts I, II)," *Hangkong Zhishi* (Aerospace Knowledge), No. 6, 1975, pp. 13–15, and No. 7, 1975, pp. 11–13.

Table 1. China's Ballistic Missiles.

Chinese Desig.	Western Desig.	Range[km]/ Payload[kg]	Technical Description	Comments
Ballistic Missiles Received from the Soviet Union				
None	V-2 (Scunner)	270/950	Single stage; non-storable liquid propellant: LOX/ ethanol; radio-inertial mixed strap-down guidance.	Designated R-1 by Soviets who sold China two in Dec. 1956 for educational purposes.
1059 (DF-1)	SS-2 (Sibling)	590/950	As above (V-2).	Designated R-2 by Soviets who sold China two in Dec. 1957 for production and troop training; first successful flight on Nov. 5, 1960; deployed in 1961; production stopped in 1964; renamed DF-1, after the original DF-1 (see below) became DF-3; retired soon after the DF-2 became operational.
1060	SS-1 (Scud-A)	162/950	Single stage; storable liquid: AK-20/kerosene; strap-down fully inertial guidance.	Soviet prototype of R-11FM transferred to China in Dec. 1959; reverse engineering began in June 1960 but abandoned in Aug. 1961.
China-Designed Strategic Ballistic Missiles				
DF-1	None	2000/1500	Single stage; storable liquid: AK-20/TG-02; fully inertial strap-down guidance.	Similar to Soviet R-12/SS-4 (Sandal); R&D started in Feb. 1960; renamed DF-3 in 1964 with major technical changes to extend range and increase throwweight.
DF-2 (DF-2A)	CSS-1	1050/1500 1250/1500	Single stage; 20.6m length, 1.652m diameter, 32-tonne lift-off weight; same propellant as the 1059's; fully inertial strap-down guidance.	Similar to Soviet R-5/SS-3 (Shyster); R&D started in June 1960; first successful flight on June 29, 1964; deployed since Sept. 15, 1966; production ceased in 1971; retired in 1979.
DF-3	None	10000/NA	Two-stage; non-storable liquid: LOX/kerosene.	R&D started in 1961 and abandoned in 1963.

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Table 1. China's Ballistic Missiles (continued).

Chinese Desig.	Western Desig.	Range[km]/ Payload[kg]	Technical Description	Comments
DF-3 (DF-3A)	CSS-2	2650/2150 2800/2150	Single stage; 24m length, 2.25m diameter, 64-tonne lift-off weight; storable liquid: AK-27/UDMH; fully inertial strap-down guidance.	Was DF-1 (see above); R&D started in Apr. 1964; first successful flight on Dec. 26, 1966; deployed since May 1971; used as the first stage for DF-4; sold to Saudi Arabia.
DF-4	CSS-3	4750/2200	Two-stage; 28m length, 2.25m diameter, 80-tonne lift-off weight; same propellant and guidance as DF-3's.	R&D started in Mar. 1965; first successful flight on Jan. 30, 1970; deployed since 1980; used as booster for satellite launcher CZ-1.
DF-5 (DF-5A)	CSS-4	12000/3200 13000/3200	Two-stage; 32.6m length, 3.35m diameter, 183-tonne lift-off weight; storable liquid: N_2O_4/UDMH; gyro-platform inertial guidance with on-board computer.	R&D started in Mar. 1965; first successful flight on Sept. 10, 1971; deployed since Aug. 1981; used as booster for satellite launchers CZ-2, CZ-3 and CZ-4.
DF-6	None	FOBS/3200	Three-stage; same propellant and guidance as DF-5's.	R&D started in July 1966; discontinued in Oct. 1973.
DF-14	None	8000/700	Two-stage; storable liquid: AK-40/ UDMH; computer-digitized strap-down inertial guidance.	Land-mobile IRBM; R&D began in Oct. 1973 and stopped in Sept. 1975; resumed in Aug. 1978 and renamed DF-22.
DF-22	None	8000/700	As above (DF-14).	Was DF-14; R&D discontinued in Jan. 1985.
JL-1/DF-21 (DF-21A)	CSS-N-3	1700/600 1800/600	Two-stage; solid propellant; 1.4m diameter, 10.7m length, 14.7-tonne lift-off weight; gyro-platform inertial guidance with on-board computer.	R&D started in Mar. 1967; DF-21 is land-mobile, JL-1 is submarine-launched; JL-1's first successful flight test was on Oct. 12, 1982; DF-21's first successful flight test was on May 20, 1985; both are operational.

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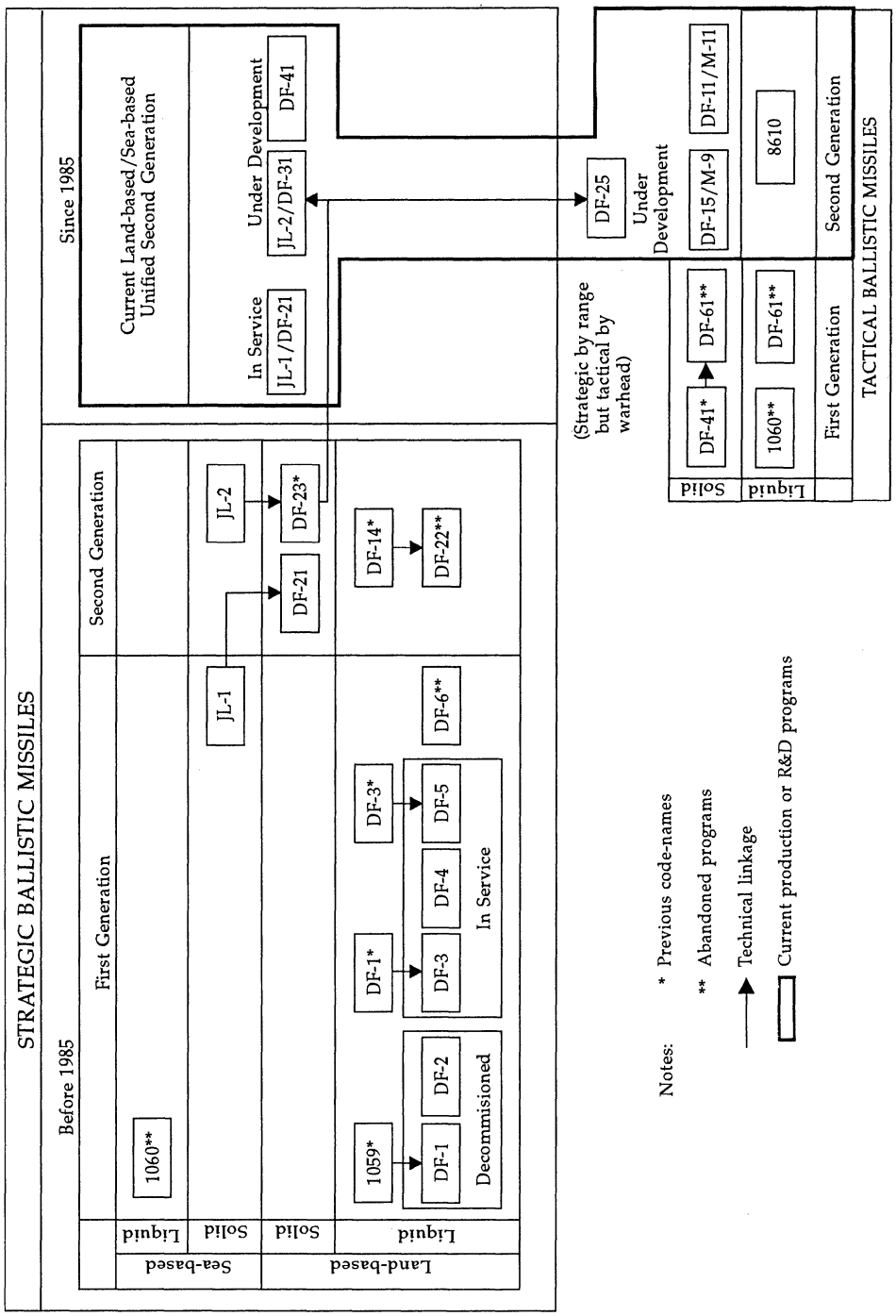
Table 1. China's Ballistic Missiles (continued).

Chinese Desig.	Western Desig.	Range[km]/ Payload[kg]	Technical Description	Comments
JL-2/DF-23	None	6000/800	Three-stage; solid propellant.	R&D started in Aug. 1970; became DF-31/JL-2 in Jan. 1985 with extended range.
DF-31/JL-2	None	8000/700	Three-stage; solid propellant.	DF-31 is land-mobile, JL-2 is SLBM; both are expected to be operational in mid-1990s.
DF-41	None	12000/800	Three-stage; solid propellant.	Preliminary research began in early 1986; expected to be operational in late 1990s.
DF-25	None	1700/2000	Two-stage; solid propellant.	Land-mobile conventional modification based on DF-31's first two stages; expected to be operational in mid-1990s.
China-Designed Tactical Ballistic Missiles				
DF-41/DF-61	None	N/A	Single-stage; solid propellant.	Land-based short-range missile; R&D started in June 1966 but soon abandoned.
DF-61	None	1000/500 600/1000	Single-stage; pre-packed storable.	R&D started in 1976 but discontinued in 1977.
M-9/DF-15	None	600/500	Single-stage; 1m diameter, 9.1m length, 6200kg lift-off weight; solid propellant; strap-down inertial computer-digitized guidance with terminal control.	R&D started in Apr. 1984; exhibited in Nov. 1986; successfully passed first flight test in June 1988; DF-15 is the code-name for domestic use, and M-9 is the code-name for export.
M-11/DF-11	None	300/500	Two-stage; solid propellant; same guidance system as M-9's.	R&D started in 1985; a photograph was displayed at an exhibition in 1988.
8610	None	300/500	Two-stage: solid propellant booster and storable liquid propellant main engine.	Modification from HQ-2 surface-to-air missile; R&D began in April 1986.

Table 2. Developmental Table of China's Ballistic Missiles.



on missile that could carry the bomb. The 590km R-2 could not even reach American military bases in Japan, and the atomic warhead under development exceeded the R-2's throwweight limit of 950kg. Thus, in addition to its work on the R-2, the Fifth Academy, on September 19, 1958, directed the development of a *dongfeng* (DF or East Wind) series of land-based ballistic missiles.[8]

The first in the DF series, the single-stage DF-1, was designed to have a range of 2,000km, enough to hit all of Japan from East China with a payload (or warhead weight) of 1,500kg. The academy scheduled R&D on the missile to be completed before 1962. The DF-1's idea originated from Soviet missile R-12.[9] Moscow had refused to sell the PLA this missile because it did not, as a rule, allow the transfer of state-of-the-art weapons to allies before it had deployed at least two types of more advanced systems. However, Chinese students majoring in rocketry at the Moscow Aviation Institute had gained a rudimentary knowledge of the R-12 even though they had not actually seen it. Similar to the R-12, the DF-1 used storable liquid propellants (TG-02/AK-20) for improved readiness and had a cluster of four engines with a total lift-off thrust of 64 tonnes.[10]

The Chinese students learned more about another Soviet missile, the R-5, a modified R-2, thanks to its display during a Red Square parade in October

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8. After a speech by Mao Zedong in 1957, the slogan "the East wind prevails over the West wind" became popular in all phases of Chinese life.

9. The R-12, code-named SS-4 or "Sandal" in the United States, had a 2,000km range and was first tested in 1955. Deployed in 1957, it appeared in public in 1961 and gained notoriety during the 1962 Cuban missile crisis. Duncan Lennox, ed., "USSR: Offensive Weapons," Jane's Information Group, JSWS–Issue 03, *Jane's Strategic Weapons Systems* (London: Jane's Publishing Company, 1990).

10. Table 1 describes the fuels and oxidizers for each of the missiles in greater detail. AK-20, AK-27, and AK-40 are liquid propellant oxidizers and are mixtures of nitric acid with 20 percent, 27 percent and 40 percent nitrogen tetroxide (N_2O_4), respectively. AK stands for the Russian *azotnaia kislota* (nitric acid); the higher the percentage of N_2O_4, the higher the energy. However, with an increase of N_2O_4, the liquid's boiling point is lowered while its freezing point is raised, making the propellant less storable. 100 percent N_2O_4, for example, has a boiling point of 21°C and freezes at –14°C. When used in combination with fuels such as TG-02 and UDMH (unsymmetric dimethyl hydrazine), all nitric acid–based oxidizers, from pure nitric acid to pure nitrogen tetroxide, are hypergolic (i.e., spontaneously igniting). When combined with kerosene (as in the case of 1060/R-11FM), however, they are not hypergolic. TG-02, a Russian designation, is a fuel developed by the Germans, and used in surface-to-air missiles (for example, the Soviet SAM-2 and the Chinese HQ-2) and anti-ship missiles (such as the Silkworm or HY-2). It consists of 50 percent triethylamine and 50 percent xylidine; called *hun an* (mixed amine) in Chinese, it is made of grain. The Chinese, to save grain, changed to UDMH for strategic missiles and a UDMH/kerosene mixture for tactical (surface-to-air and anti-ship) missiles. More expensive and toxic than TG-02 and kerosene, UDMH produces much higher energy.

1957 and its inclusion in courses at the Moscow Aviation Institute.[11] The students had copied restricted notes and had quizzed talkative Soviet experts about it. Although it had a shorter range and was less advanced than the R-12, the R-5 was not on the authorized list for sale to China because in 1958 the Soviet Rocket Forces had only one follow-on model, the R-7, which had launched the Sputnik on October 4, 1957.[12]

In February 1960, as Chinese relations with the Soviets were souring, the PLA's missile designers quickly understood that they were on their own. They recognized that the *dongfeng* program would have to begin by modifying the 1059, and in that month they named the new version DF-2. With a range (1,200km) comparable to the Soviet R-5, the DF-2 would have to be based near the Sino-North Korean border to strike all of Japan.

To counter the perceived U.S. nuclear threat to their homeland, the Chinese sought to build as soon as possible a missile that could reach the continental United States. Thus, on November 14, 1961, Qian Xuesen assigned a group of engineers to develop a 10,000km ICBM, which would use liquid oxygen and kerosene as propellants (similar to those used in the Soviet R-7 and the U.S. Atlas), and he nominated himself to be the chief designer. This projected ICBM was called DF-3. Soon thereafter, technical setbacks in the missile program and the national economic crisis produced by the politically-motivated Great Leap Forward introduced the cooling winds of reality. Developing a missile capable of reaching North America would have to be accomplished step by step, and in 1963 the Fifth Academy canceled the ICBM version of the DF-3.

Originally, the DF-1 was planned for completion before the DF-2. The numbering sequence did not reflect any greater sophistication of the DF-2; it was less advanced and had a shorter range than the DF-1. Not surprisingly, the development of the DF-1 proved more difficult than expected, and in August 1960, the Chinese reordered the priority and directed the flight testing of the DF-2 to begin before October 1, 1961. They believed that R&D on the DF-2 would proceed more rapidly than on the DF-1 (because the DF-2 was

11. The R-5 used the same liquid oxygen and ethanol propellants as the R-1 and R-2 and had a range of more than 1,200km. Code-named the SS-3 or "Shyster" in the West, it passed its first full-range flight test on April 28, 1953, and was deployed in 1956. See *Iz Istorii Sovietskoi Kosmonavtiki*, pp. 232 and 235.

12. With a diameter of 10.3 meters, the R-7 is a cluster rocket not designed for combat use, though it has an intercontinental range. It passed its first successful flight test on August 21, 1957, when Khrushchev cited this success in an effort to exaggerate the size and pace of the Soviet missile program.

based on an imported Soviet missile, the R-2, and on the information in hand on the R-5), but the first DF-2 test on March 21, 1962, failed. Only on June 29, 1964, after a major redesign, did a test succeed. The designers had reduced the engine's lift-off thrust from its original 45.5 tonnes to 40.5 tonnes with a consequent reduction of the DF-2's range to 1,050km, barely enough to reach western Japan.

Following this initial achievement, the Chinese continued to tinker with the DF-2, and on November 10, 1964, they agreed on additional modifications and dubbed the new missile the DF-2A. Its designed range would be extended to 1,250km with a 1,500kg payload. The first Chinese atomic device, which had been tested the month before on October 16, had a yield of 22 kilotons and weighed 1,550kg, far too heavy for the DF-2A (when the 200kg reentry-vehicle aeroshell had been added).[13] On December 13, the Defense Science and Technology Commission, which oversaw both the missile and nuclear bomb programs, demanded the reduction of the weight and size of the first operational atomic bomb in order to fit it on the DF-2A. The missile was first successfully flight-tested in November 1965, but the nuclear warhead had yet to be completed. When the missile entered the arsenal of the Second Artillery on September 16, 1966, it still lacked its nuclear warhead. On October 27, the missile crews at the Shuangchengzi test base in Gansu Province launched a DF-2A, whose nuclear device alone weighed 1,290kg and had a yield of 12 kilotons.[14] China's first strategic missile system had become operational.

Probably as early as April 1964, the Central Military Commission redefined the strategic requirements for the *dongfeng* program, leading to changes in the yet-to-be finalized DF-1. The range requirement for the launcher was raised to 2,500km, sufficient to hit U.S. bases at Clark Field and Subic Bay in the Philippines, and the payload requirement was raised to 2,000kg, the planned maximum weight of the hydrogen bomb then under development. On September 12, 1964, the commission gave this new DF-1 the designation DF-3 (the same designation as the canceled ICBM; hereafter all references to the DF-3 are to the IRBM version), while the original Soviet-designed and Chinese-manufactured 1059 took over the code name DF-1. To meet the added requirements, the DF-3 was redesigned to have four engines in a

13. *Zhongguo Junshi Baike Quanshu: Hewuqi* (Chinese Military Encyclopedia: Nuclear Weapons) (Beijing: Junshi Kexue Chubanshe, 1990), pp. 157–158.
14. Ibid., pp. 163–164.

cluster providing 96-tonne lift-off thrust and using unsymmetrical dimethyl hydrazine (UDMH) as the fuel and AK-27 as the oxidizer (in contrast to the original DF-1's 64-tonne propulsion system fueled by TG-02/AK-20).

In August 1964, the Fifth Academy scheduled the DF-3's flight tests to start in 1968, but a year later, Premier Zhou Enlai ordered the tests to commence during the first half of 1967. Zhou apparently was unsure of the DF-2A's success, which came three months later, in November 1965. He weighed the DF-3's strategic advantages over the DF-2A—longer range, storable propellant, greater readiness, and heavier payload—and assigned the DF-3 an urgent priority. The missile designers in turn exceeded their premier's expectations. They successfully launched the DF-3 on December 26, 1966, Mao Zedong's 73rd birthday, making this the only Chinese missile ever completed ahead of schedule.

The DF-3, capable of carrying a 2,150kg warhead over 2,650km, was deployed in May 1971, four months after production ceased on the DF-2A.[15] The DF-2A was fully retired in 1979. The Chinese continued to improve the DF-3, and in 1986 a missile with the range of 2,800km was commissioned the DF-3A. The outmoded DF-3 was sold to Saudi Arabia in 1988.[16]

The dream of a full-range ICBM had revived after the DF-2's successful flight in 1964. The next year, Zhou Enlai set in motion plans under which the missile units would finish R&D on the DF-2A MRBM and the DF-3 IRBM in 1968, complete R&D on a long-range missile between 1969 and 1972, and try to flight-test an ICBM before 1975. In a new spirit of realism, the high command ordered the missile agencies to discuss Zhou's initiative. In March 1965, after two months of debate, the First Academy (Carrier Rocket Research Academy) proposed a plan to build "four types of missiles in eight years" (*banian sidan*).[17] (The First Sub-Academy had been renamed the First Academy in January 1965, when the Fifth Academy became the Seventh Ministry of

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15. Chinese engineers always designed their missiles bigger than the original range and payload requirements dictated, because they would have been criticized if the missiles could not meet the requirements and would be praised if the missiles surpassed them.
16. For a discussion of the sale of the DF-3s to Saudi Arabia, see Lewis, Hua, and Xue, "Beijing's Defense Establishment," pp. 96, 104–105. One source states that the range of the DF-3A was 3,000km. See Li Ke and Hao Shengzhang, *"Wenhua Da Geming" zhong de Renmin Jiefangjun* (The People's Liberation Army in the "Great Cultural Revolution") (Beijing: Zhongkong Dangshi Ziliao Chubanshe, 1989), p. 310.
17. After a number of revisions, the plan was formally endorsed in 1965 as the Eight-Year Plan for the Development of Rocket Technology (1965–72). It summarized the many new requirements and the recommendations of thousands of workers and engineers.

Machine Building.) The DF-2A and DF-3, the first two of these four missiles, were already well advanced.

The *banian sidan* plan envisaged a staged effort toward an ICBM that would beat Zhou's 1975 deadline. The plan stipulated that a 4,000km long-range missile (the DF-4, intended to strike the B-52 base on the U.S. island of Guam) and a 12,000km ICBM (the DF-5, projected to cover the continental United States from northern China) could be built by 1970 and 1972, respectively. On December 31, 1965, an encouraged Zhou Enlai enlarged the scope of the *dongfeng* series when he ordered a feasibility study on a fractional orbital bombardment system (FOBS).[18] He had learned from foreign reports that the Soviet Union was close to having a FOBS, and the resulting study led to a proposal for developing a three-stage DF-6.

The DF-4 would use the DF-3 as the first stage and carry a 2,200kg payload; it would have the same warhead as the DF-3 but with more heat-insulation material for higher reentry speeds. Its second-stage engine duplicated one of the first stage's four engines but would be outfitted with a fiberglass-reinforced nozzle of large expansion ratio for better performance in space. R&D on the DF-4 started in March 1965, and proceeded rather slowly, partly because of the higher priority accorded the DF-5.

Moreover, the escalation of the Sino-Soviet military confrontation, following border clashes on the Ussuri River in September 1969, led the military commission to order the redesign of the DF-4 shortly after its first successful flight on January 30, 1970. The missile's range would be upped to 4,500km, bringing Moscow within range of bases in Da Qaidan, Qinghai Province. Zhou Enlai approved the new design on August 5, 1970. The DF-4's first-stage lift-off thrust had to be increased to 104 tonnes and its second stage lengthened by 0.42m in order to contain an additional two tonnes of propellant. The DF-4, eventually tested with a range of 4,750km, became operational in 1980, only a year before the DF-5's deployment.

As noted, R&D on the DF-5 proceeded in parallel with that of the DF-4, and both programs were heavily influenced by the actions of radical elements during the Cultural Revolution, which began in May 1966 and continued with varying degrees of intensity over the next decade. In October that year,

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18. This system launches a missile into very low orbit, approximately 95 miles above the earth. Before the completion of the first orbit, a retro-rocket retards the speed of the warhead, which hits the target with only a few minutes' warning. In 1965, China learned from an American report that the Soviet Union was developing a FOBS; this report was never publicly confirmed.

the First Academy determined that the DF-5 could pass its first flight test in October 1969, the twentieth anniversary of the People's Republic.

Despite many delays caused by the political turmoil, work on both the DF-4 and DF-5 went forward, although somewhat fitfully. For example, following the success of the PRC's thermonuclear test the month before, in July 1967 the academy argued that work on the DF-4 should give way to the DF-5, in case of a tug-of-war between the two programs over resources, because the thermonuclear warhead was too heavy for the DF-4.[19] The DF-5 was designed to carry a 3,000kg payload, while the DF-4, as noted, would carry only 2,200kg. In January 1968, the central leadership reiterated the importance of the DF-4 program and directed that its progress not be impeded, but the First Academy, while complying, also insisted on accelerating the DF-5's R&D.

However, the DF-5 required many new technologies: large rocket engines (four 70-tonne thrust engines clustered for the first stage) using a new oxidizer of 100-percent nitrogen tetroxide; swiveling engines on the first stage and vernier combustion chambers on the second stage for the missile's attitude control; a gyro-stabilized platform and on-board computer for flight control; and a large body of less easily welded aluminum-copper alloy.[20] Problems in developing these novel technologies introduced one delay after the other, and the DF-5 only passed its first successful flight on September 10, 1971, nearly 20 months later than the DF-4 (which could utilize the DF-3's technology).

Nevertheless, the pressure of the Sino-Soviet conflict forced the emergency deployment of the DF-5. Less than a month after the first two full-range test flights into the Pacific on May 18 and 21, 1980, the ICBM was delivered to the Second Artillery for "operational training," and in December, for "trial operational deployment" in an experimental silo.[21]

By contrast, the less powerful DF-4 was given to the rocket forces simultaneously for training troops and for operational deployment in November

19. The weapon tested on December 28, 1966, contained some thermonuclear material and had a yield equivalent to 122kt; the multi-stage thermonuclear device tested on June 17, 1967, had a yield equivalent to 3.3mt. *Zhongguo Junshi Baike Quanshu: Hewuqi*, pp. 160, 162.

20. The DF-5's 3.35m diameter is larger than that of the similar U.S. Titan II, which has a 3.05m diameter. In contrast to the DF-5, the DF-3 and DF-4 had a 2.25m diameter, graphite vanes in the efflux nozzles for attitude control, strap-down guidance systems using a simple calculating mechanism for range control, and aluminum-magnesium alloy skins.

21. The concept of "trial operational deployment" of DF-4 and DF-5 to meet the urgent demand for war-fighting readiness had been put forward by the Defense Science and Technology Commission on January 15, 1974.

that year. To Beijing, the situation in the late 1970s was alarming. The Soviet Union seemed to be on the offensive and prevailing, while the United States was retreating and losing. On October 30, 1979, Marshal Nie Rongzhen, once again in charge of defense science-and-technology development after his ouster in the Cultural Revolution, directed the urgent deployment of all available strategic weapon systems, saying that "though a bit backward in performance, [the DF-4 and DF-5 missiles] would still be better than 'millet plus rifles' in fighting a war." The crisis mood intensified following the Soviet invasion of Afghanistan that December.

Yet the DF-5 could become truly operational only in August 1981. Its silos could not be readied earlier. The construction effort, called Project 319, produced two silos by the end of 1980. These were then tested to verify their loading capability, their electro-mechanical interfacing, and their fueling and targeting systems. In mid-1981, the first DF-5 base containing the two silos passed all its comprehensive tests.

Furthermore, on November 10, 1983, the First Academy began to improve the DF-5's range, operability, and reliability. On December 19, 1986, the Ministry of Space Industry (the successor to the Seventh Ministry) concluded a contract with the Second Artillery on the development of the DF-5A. To date, only four of these missiles, upgraded to carry 3,200kg over 13,000km, have been deployed in silos.

As to the DF-6, the First Academy had suggested in July 1966 that it be developed by adding a third stage to the DF-5. The missile, it was hoped, could strike the Panama Canal. Used as a FOBS, moreover, the DF-6 could strike the U.S. homeland from the south, flying over the Antarctic and penetrating the weakest points in the American warning network. In August 1970, at the peak of the Cultural Revolution, the Defense Science and Technology Commission directed that the DF-6 become operational by 1974. However, by October 30, 1973, an endless chain of technical problems intervened and forced the cancellation of the DF-6. By this point, U.S.-China relations had begun to improve, while Beijing's confrontation with Moscow had reached a fever point.

THE TECHNOLOGICAL DETERMINANTS OF NUCLEAR STRATEGY

As we have remarked, before the 1980s, the development of the PRC's ballistic missiles was not matched by any serious formulation of nuclear strategy. Despite the recurring shifts in China's strategic position, the missile program did not respond to new enemies, and strategists did not explore

nuclear policies or doctrines in the earlier years. According to Mao, nuclear weapons and their delivery systems could not alter the basic nature of warfare or require the revision of his People's War doctrine. Technology, not strategy, determined the pace and main direction of the ballistic missile program at least until the late 1970s.

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, and after Mao's death in 1976, the more adventurous strategists began to make that doctrine explicit and to explore its ramifications for Chinese military and foreign policy.

When the Soviet Union was designated China's main adversary in the late 1960s, some technical adaptations were introduced into the ongoing programs. However, the basic features of the missiles, already under development for many years, were impossible to change and were left intact. General accuracy standards were set but not rigorously enforced, and the designers did not know whether the intended targets would be hardened silos or soft civilian areas.

The missiles' users in the Second Artillery also did not have access to studies on nuclear strategy. These did not exist. The missileers called periodically for achieving longer ranges, better accuracies, improved reliability and operability, and more rapid deployment capability, but these calls were never tied to any particular strategic requirements. The soldiers of the Second Artillery and their comrades in the First Academy merely imagined that nuclear strategy was a matter to be debated and decided upon by leaders in the Central Military Commission. With other pressing demands at hand and with no research institutes to help them, however, these leaders never considered, let alone issued a document on, nuclear strategy until the mid-1980s.

Nevertheless, by the 1970s there were fragmentary, sometimes improvised, strategic instructions, and the imaginary targets associated with each missile provided some clues to the potential use of the strategic forces. For example, the principle of no-first-use was repeatedly proclaimed after the first nuclear test. It implied that Chinese strategic forces would have to survive an enemy's preemptive attack. Another example occurred in the DF-5 program when its guidance system could not meet the original accuracy requirements, and the entire effort was put on hold. During a 1973 debate on accelerating the DF-

5 program, one engine designer argued that if a missile landed on the Bolshoi Theater instead of the Kremlin it would be equally effective and that, even if every missile had pinpoint accuracy, the tiny number in the PRC's small arsenal could destroy only a small fraction of the enemy's silos, after which China would lie unarmed. Zhang Aiping, then chairman of the Defense Science and Technology Commission, supported the arguments and thereby confirmed a countervalue targeting doctrine, in the Western terminology. A core idea in the doctrine of minimum deterrence strategy had been accepted without comment or further explication.

While technologically the Chinese designers had to follow the Soviet path of building ballistic missiles with liquid propellants and large throwweight, they learned of the main strategic trends almost exclusively from the West because Soviet writings rarely revealed valid details on Soviet nuclear strategy. When, for example, the western media reported that the United States had been developing an antiballistic missile system mainly for protection "against the small ICBM force the Chinese might develop in the future," Beijing's designers urgently concentrated on the penetration capability ("penetrability") of their ICBM in addition to its range and accuracy.[22]

On January 4, 1966, Qian Xuesen advocated the development of an advanced DF-5 warhead with penetration aids. In December, the First Academy completed the preliminary design of the missile's reentry vehicle. It would be equipped with electronic countermeasures and light exo-atmospheric decoys even though the latter would be ineffective after reentry. Endo-atmospheric decoys with the same aerodynamic characteristics as real nuclear warheads were deemed too heavy for the DF-5. Via technological channels, the concept of penetrability was becoming a part of the Chinese strategic vocabulary.

On July 30, 1970, when the United States was deploying multiple reentry vehicles (MRVs) and developing multiple independently targetable reentry vehicles (MIRVs), the First Academy proposed the deployment of multiple warheads on the DF-6 that was still on the drawing boards. However, without the miniaturization of the warhead, the missile designers could not proceed. A decade later, in March 1980, the Chinese, becoming more realistic, lowered the priority for the MIRV project and did not resume work on MIRVs until

22. The quotation, from Robert McNamara, is found in Coit D. Blacker and Gloria Duffy, eds., *International Arms Control: Issues and Agreements*, 2d ed. (Stanford, Calif.: Stanford University Press, 1984), p. 206.

November 10, 1983, when the First Academy included them in the DF-5 modification program. However, the four DF-5As currently in silos are not MIRVed.

On September 20, 1981, the Chinese orbited three satellites from one carrier rocket, and many in the West mistakenly regarded this success as evidence that the PRC possessed or was actively pursuing MIRV technology. In fact, that launch tested neither a MRV nor a MIRV. The lift capacity of the launcher, a modified DF-5, simply was too large to carry just one or two small scientific satellites.[23] However, the carrier's nose-cone was too small to contain three of them, and the launch crews had to put one of the three in the tail-deck of the second stage.[24]

While they could not do much to augment missile penetration, survivability had to be improved. The vulnerability of the PLA's retaliatory forces had become an ever more serious problem as foreign satellite reconnaissance technology and missile accuracy advanced after the late 1960s and especially after the SALT I accords of 1972, when the superpowers shifted the emphasis to a more qualitative arms race. From this point on, the Chinese paid continuous attention to survivability. They emphasized two aspects, basing survivability and pre-launch survivability, and tried especially hard both to reduce the time needed for pre-launch preparations and to find less vulnerable basing modes.

Large liquid-propellant missiles are long and have thin skins. They cannot be filled with propellants in a horizontal position without causing serious body damage. In the original plans for the DF-3, for example, an unfueled missile would first be erected on the launching pad and receive preliminary targeting alignment and on-board equipment checks. It would then be filled with oxidizer and fuel, which would be done separately because they are hypergolic (spontaneously igniting). The missile, somewhat deformed by the loaded propellants, would then undergo final alignment and checks, and data corresponding to the assigned range would be fed into the missile's instruments. All these preparations would consume on average no less than four hours, in addition to the time of transport from storage to the launch site.

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23. One of the three was, for example, a radar-beacon satellite for testing, calibrating and coordinating radars of a ground radar-network.
24. Shi Jinmiao, "The Path of Flying Toward the Cosmos: A Brief Story on Shanghai's Space Technology," *Hangtian* (Space), June 1990, p. 6.

The Chinese understood that reconnaissance satellites, revolving around the earth every 90 minutes, could readily detect an erected DF-3, and an enemy, thus warned, could launch a preemptive strike in hours if not minutes. Without advanced computerized guidance systems, the Chinese could not lessen the DF-3's pre-launch exposure time expended for alignment, test checks, and range setting.[25] Consequently, they had to focus on ways to reduce the propellant loading time. Experiments with the simultaneous filling of the DF-3's hypergolic propellants were conducted between April 14 and May 14, 1977, and these led to shortening the pre-launch preparation time by 40 minutes to one hour. During exercises conducted between November 10 and 29, 1977, the Second Artillery's DF-3 troops stationed in Liaoning Province proved that the pre-launch time could be shortened to 2–3 hours, which became the target norm. Finally, on October 23, 1978, they fired a DF-3 after 2 hours and 32 minutes of pre-launch exposure.

The survivability of the two-stage DF-4 was more troublesome. Fully assembled, it was too long to be road-mobile. If the two stages were transported separately and then mounted at the launch site, the pre-launch exposure would far exceed the stipulated 2–3 hour limit. The Chinese thus decided to improve the DF-4's survivability by basing it in silos, the preferred land basing mode in the Soviet Union and the United States in the 1960s. They had begun studying the silo-basing concept as early as December 1964. In June 1965, before they grasped the DF-4's pre-launch exposure predicament, the Chinese planned to base the bigger DF-5 in silos because its size precluded making it road-mobile or erecting it after the two stages had been connected.

The designers began analyzing the DF-4's optimal basing mode after February 9, 1966, and in July concluded that the DF-4 also would have to be stored in silos but only ignited after being raised by an elevator system. This system would make the silo construction less complicated. However, the missileers could not decide whether to load the propellant and conduct the pre-launch preparation procedures before or after missile elevation. If done in the silo, the missile would experience less exposure time but building the silo and the elevator would be far more difficult and expensive. On November

25. Four soldiers, each sitting near one of the legs on the launching pad, made coordinated adjustments of the missile's position to get it strictly vertical and to have its "shooting plane" accurately oriented. They used hand cranks and were aided by a gravitational levelling instrument and a theodolite collimator.

28, 1966, Zhang Aiping decided that the two ways should be developed concurrently, and the Chinese successfully conducted full-range flight tests on the in-silo method from the base in Jilin Province on November 15, 1971.

By this time, the strategic literature in the West was replete with stories about the vulnerability of hardened silos, and the Chinese weaponeers sarcastically began calling their newly built silos "missile tombs." On May 25, 1975, Mao Zedong approved a report recommending that the DF-4 basing mode be changed from silos to caves under high mountains, that it be launched immediately outside the mouth of the caves, and that feasibility studies be made on rail-mobile and other basing modes.

From September 18 to October 2, 1975, the Chinese conducted DF-4 rail-mobile tests over 8,000km in ten provinces. On December 19, 1975, the Defense Science and Technology Commission (DSTC) approved the cave-basing mode but did not rule out other modes and ordered the experiments to continue. Finally, on May 20, 1977, the Central Military Commission and the State Council adopted the concept "in-cave storage/preparation and out-cave erection/filling/firing." Zhang Aiping dubbed the concept *chu men fang pao* (shooting a firecracker outside the front door). On November 18, 1978, the DSTC halted further rail-mobile trials, and on August 2, 1980, the cave-basing mode was operationally confirmed by a full-range test flight. The DF-4 was soon deployed in this mode.

Next came the problem of survivable basing for the DF-5. The Chinese chose silos in the first instance, as we noted, because of the missile's size and because the DF-5's U.S. "twin," the Titan-II, had been silo-based. On May 24, 1967, the DSTC ordered an experimental silo for the DF-5 to be built in Shanxi Province of northern China. A static test-firing was conducted in the silo in mid-1976, and on January 7, 1979, a successful silo launch confirmed the basing mode for the DF-5.

The Chinese had investigated other possible basing modes for the DF-5. The report approved by Mao on May 25, 1975, had offered these possibilities: Changjiang (Yangtze) River ship-mobile, rail-mobile, and various camouflaged fixed basing modes.[26] All were seriously examined and then abandoned as being impractical or no less vulnerable than silos. Launch-on-warning was also dismissed because of the PRC's inability to build a reliable early warning system.

26. One proposed mode was to use narrow mountainous gorges camouflaged on the top, another was to install the missile in fake bridge towers, and a third was to store the missile horizontally in civilian houses with removable roofs.

That still left the DF-5s in their "tombs," and to make them more survivable, the Chinese, who had studied the then-current American schemes for deceptive basing (multiple protective shelters), decided to build a large number of bogus silos. All the fake silos were shallow holes disguised to look like the real thing. The Chinese were playing a traditional shell-game without a U.S.-type "racetrack" system to shuttle the missiles from shelters to silos and from silo to silo.

The first successful DF-5 flight test was conducted in 1971, and the *banian sidan* goals for the first-generation missiles had been met. The time had come to plan for the new generation, and survivability remained the central concern. As one consequence, the designers immediately decided to shift from fixed-based to mobile systems. Two technological achievements justified their decision: the miniaturization of nuclear warheads as part of the SLBM system and the computerization of the DF-5's missile control system. However, the requisite solid-rocket technology had not yet been developed, and for the moment the Chinese remained committed to liquid propellants for the future mobile missiles.

In October 1973, at the same time they were shelving the DF-6 effort, the Chinese started a program code-named DF-14. This two-stage missile would have a liquid propellant (AK-40/UDMH) and be capable of delivering a 700kg payload over 8,000km. The relatively small payload would allow the DF-14 to be road-mobile, and its computerized control system would permit rapid targeting and the automatic checking of the on-board equipment. The new system would eliminate the need for pre-launch targeting alignment, drastically reducing the pre-launch exposure time. Once the missile was erected, on-board gyros would automatically measure the deviations of the missile's verticality and targeting orientation, and input the data into the on-board computer's memory. In the first few seconds after lift-off, the missile would automatically align itself toward its target. Range setting would also be done via computer, and the fuel and oxidizer would be simultaneously loaded as in the DF-3. With these innovations, the designers suggested that the PLA could wage a modern guerilla warfare with the DF-14 according to Mao Zedong's tenet, "You won't catch me when you want to hit me; I'll hurt you painfully if I want to hit you."

The DF-14 program was interrupted in September 1975 by resource constraints caused by the higher priority DF-4 and DF-5 programs, which were in their final developmental phases. However, Deng Xiaoping strongly favored applying the modern guerilla warfare concept to the nuclear confron-

tation. On August 2, 1978, he said, "I have the greatest interest in mobility on land; that is, in the use of modern weapons for fighting guerilla war." On August 31, 1978, the DSTC decided to resume the DF-14 project, but renamed it DF-22. The decision read, "To fight modern guerilla war, the second-generation strategic ballistic missiles must be mobile, rapid [in pre-launch preparation], and concealable, with mobility as the focus." On November 24, 1978, the central leadership approved the DF-22 program, and on April 15, 1980, one month before the DF-5's test-flight to the Pacific, it made the DF-22 program a national priority. The program was named Project 202.

Shortly after the 202 decision, the international situation and Beijing's perception of it radically changed. In 1984, during their annual summer meeting at the resort town of Beidaihe, the central authorities issued an instruction indicating that no major world war would occur in the coming 10–15 years and that the PLA would have ten or more years for improving its first-generation strategic weapons and developing the second generation. Accordingly, the Central Military Commission ordered a shift from liquid to solid rocketry and a slowdown of Project 202. One factor underlying its decision was a breakthrough in making a 2m-diameter solid rocket motor the previous December. On October 28, 1984, Zhang Aiping explained that the future task would be to improve weapons' sophistication, in contrast to the previous priority, when the problem of "to have or not to have" made Beijing eager to attain quick results. Three months later, Project 202 died, putting an end to the PRC's liquid-propellant ballistic missile programs.

SOLID ROCKETRY AND THE CURRENT MODERNIZATION PROGRAM

The PLA's successful launch on October 12, 1982, of a 1,700km SLBM, the JL-1, carrying a 600kg payload signified a fundamental achievement in developing solid-propellant ballistic missiles.[27] R&D on the two-stage rocket had started in March 1967, but had progressed somewhat haphazardly for many reasons. First, China received no Soviet assistance on solid rocketry. Second, two essential components of the SLBM system, the small nuclear warhead and the nuclear-powered submarine, proceeded so slowly that the

27. JL originally came from *julong* (giant dragon). It was changed to *julang* (giant wave) on April 29, 1972, because Mao Zedong said that he did not like the dragon, the traditional symbol of China. For a complete history of the Chinese SLBM program, see Lewis and Xue, *China's Strategic Seapower*, part 2.

JL-1 designers did not feel an immediate or compelling urgency in comparison to the DF crash effort. Third, there was opposition to the program. While one submarine carries a dozen or more SLBMs to justify its cost and can move closer to some targets, many officials and designers considered it irrational "to put so many eggs in one basket" when the PRC had so few "eggs" to deploy. The JL-1 also suffered from the vagaries of the political opposition in the Cultural Revolution. Finally, China's geographic location, in the minds of many military officials, reduced the need for SLBMs. Its seacoast is far removed from the Soviet heartland, and the island chain opposite the Chinese coast hinders easy access to potential American targets. Worse still, the seas surrounding China, especially the Yellow Sea, are too shallow to hide submarines with confidence.

At a meeting of the First Academy in April 1975, Zhang Aiping belittled the idea that the PLA might send a submarine as far as the Arabian Sea to launch a missile. Even from there, the closest Asian location for a sub firing on Moscow, the distance to the Soviet capital would be too far for the JL-1. Zhang concluded with the judgment *"julang shangan"* (the JL [must] go ashore), and all participants accepted his ruling.

In early 1978, the missile ministry's Solid Rocket Motor Academy (Fourth Academy) achieved a breakthrough in a test of a 1.4m-diameter solid-rocket engine for the JL-1.[28] That August, certain of the design of the JL-1, the Chinese started work on its land-version modification, the DF-21, immediately after Deng Xiaoping had proclaimed his interest in land-mobile missiles. At the same time, they planned to develop another road-mobile solid rocket. The planned IRBM, the DF-23, would later be retrofitted for submarine deployment as the second-generation JL-2. This SLBM, a 6,000km missile, was placed on the Chinese wish-list in August 1970, at a particularly tense moment in the Sino-Soviet military confrontation. Its preliminary R&D, however, did not start until September 1974.

The JL-1 was first launched from a submerged Golf-class submarine, a Soviet-designed boat rebuilt by the Chinese for testing the JL-1. In this and subsequent successful tests, the missile's engines ignited after rising above the ocean surface. Later, the Chinese tried to develop underwater ignition, but gave up after three failures in 1985. Originally, the JL-1 was considered China's first-generation SLBM, but with the shift in emphasis to mobility it

28. Originally located in Hohhot, Inner Mongolia, and now in Lantian County, Shaanxi Province, the academy has pioneered all solid rocketry in China.

was designated the pioneer second-generation strategic missile. It became operational in August 1983, and is currently deployed on two nuclear submarines (one 09-2 class and one 09-3) with 12 JL-1s on each.

The road-mobile DF-21 was first successfully launched from a transporter-erector-launcher triple-purpose truck on May 20, 1985, and the Second Artillery's first DF-21 regiment was established the same year. For combat operations, a DF-21 missile is served by six vehicles. The missile is ejected from its container and ignited when air-borne. The missile's automatic command-control-firing system is the first of its kind in the PLA's strategic missile forces.

Meanwhile, the Chinese undertook to extend the DF-21's range. In February 1981, Zhang Aiping called for the increase even though neither the DF-21 nor JL-1 had yet been perfected.[29] Zhang personally favored the land-mobile DF-21 over its sea-based sister, and the modification program, called DF-21A, began in July 1986. The engineers were able to reduce the DF-21's structural weight, add propellant, and boost the thrust of the second stage in comparison to the JL-1, because of the lesser requirements for the land-based ejection system.

The JL-2 as well as its land version, the DF-23, did not receive much attention until the 2m-diameter solid rocket engine passed its first test-firing at the end of 1983. Within a few months, this success in solid rocketry and the ever greater relaxation of the PRC's security relations encouraged Beijing to shift totally to solid-propellant missiles and to cancel the liquid-propellant DF-22. On December 26, 1984, the Ministry of Space Industry issued a directive stressing four fundamental changes in future missile development: from liquid to solid propellants; from strategic to tactical missiles; from first- to second-generation strategic launchers; and from experimental to utilitarian satellite missions.[30]

On January 19, 1985, the State Council and the Central Military Commission delineated the specifications of a unified second generation of strategic weapons. In compliance, the DF-23 was renamed the DF-31, to follow the solid-fueled DF-21, rather than the abandoned liquid-fueled DF-22. Similar to the JL-1/DF-21 combination, the DF-31 and JL-2 are variants, land-based

29. On January 2, 1981, the first JL-1 test launch, from an open launching-pad on land, failed, but a second land test on June 17, 1981, succeeded. The following January, the JL-1 passed its first test launch from a land-based container.
30. The Seventh Ministry of Machine Building was renamed the Ministry of Space Industry on May 4, 1982.

and sea-based, of a largely identical missile. The Chinese call the concept *yidan liangyong, luhai jiangu, jishu gongyong* (one missile for two uses, considering both land and sea, and sharing a common technology). However, unlike the JL-1 that "goes ashore," the DF-31 was given the priority over the JL-2. The new principle is *dongfeng xiahai* (the DF goes to sea). R&D, which began in early 1986, would now focus first on the DF-31 and then shift to a sea-based twin, the JL-2; both would have three stages capable of carrying a payload of 700kg over a range of 8,000km.

Deployment of both the land- and sea-based versions is scheduled for the mid- to late 1990s. The Second Artillery will store the mobile DF-31 in caves in peacetime and move it on a triple-purpose truck to a pre-selected launching site for rapid response in crises. The navy will install the JL-2 on its second-generation 09-4 class nuclear-powered submarine.

The guidance and flight control systems for the new missile remain the bottlenecks. The First Academy's Institute Thirteen (Inertial Component Institute) has not yet developed the required inertial guidance system. The Chinese began to study sophisticated guidance systems, such as stellar-aided guidance and terrain-matching terminal guidance, in 1975 and 1977, respectively, and originally intended to use stellar-aided guidance on the DF-23. Since 1982, the stellar-aided guidance has been on the ministry-sponsored priority list. In experiments so far, Chinese specialists have not yet achieved the required accuracies and are attempting to use man-made satellites, instead of distant stars, for the guidance system. Although they did not intend to reach a hasty decision on this system, the specialists were greatly impressed by the U.S. positioning systems that were linked to satellites and used during the Gulf War.

Meanwhile, since July 1986, plans have proceeded for the development of an even more advanced system, the DF-41. This three-stage solid-propellant ICBM will have a range of 12,000km and will be mobile. Deployment is planned for the first decade of the 21st century. When deployed, the DF-41 will replace the DF-5 which, according to a recently issued Central Military Commission document, will remain in service until the year 2010.

The DF-41's final basing mode has yet to be decided, though it will be stored in caves. What remains unclear is whether it will be road-, rail- and/or river-mobile. In highly centralized China, no community opposition to basing or launching nuclear missiles (such as occurred in the United States against the various MX basing schemes) stands in the way of any of these alternatives. A road-mobile version is the most likely, the river-mobile the

least. In the past, most highway bridges in the country could not carry the weight of the missiles and their carriers, but extensive highway construction programs are designed to remove this obstacle.[31]

According to the general design plans, the nuclear devices of the JL-1/DF-21, DF-31/JL-2, and DF-41 missiles are virtually identical. Each weighs 500kg and was originally designed to deliver a 200–300kt yield. (The underground test of a 1mt nuclear device on May 21, 1992, however, may indicate that the Chinese are attempting to increase the yield-to-weight ratio to a level comparable to the U.S. Minuteman II.) The warheads differ only in their thermal insulation and their technologies for penetration. At first, the Chinese were unable to miniaturize their thermonuclear warheads for various technical reasons, but they eventually learned how to reconfigure the warhead and thereby to reduce its size but maintain its yield.

Recent information from the PRC confirms that the Chinese plan to develop MIRVs, though the task is complicated because the throwweight of the projected solid-propellant missiles is smaller than that of the first-generation, liquid-propellant missiles. With the MIRVs mounted on more survivable mobile ICBMs, they may simply decide to build a larger force with less expensive missiles. Assuming the continued limits on the PLA's ICBM arsenal, however, the Chinese will never be able to have sufficient missiles, even if MIRVed, to overwhelm any effective ballistic missile defense system. In the unlikely event that a true SDI system became operational, the Chinese would have no means under development to defeat it. Deng Xiaoping's statement, "Star Wars must not become reality," reflects the PLA's concern that its own arsenal might become "impotent and obsolete." In 1992, Beijing repeated its stance against "the arms race in outer space" and all proposals for pursuing any SDI programs.[32]

In 1984, the Chinese began to consider using mobile solid-fueled missiles to carry conventional warheads. On April 28 and May 17, the First Academy submitted proposals to the military leadership for developing such ballistic missiles with short and long ranges, later named DF-15 and DF-25, respectively. Equipped with a 2,000kg conventional warhead, the two-stage DF-25 has a maximum range of 1,700km and is considered strategic. Its conventional

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31. Unlike liquid missiles which are transported unfueled, solid rockets are always fully loaded. Solid propellants are sensitive to environmental conditions (especially to temperature and moisture) and shocks which may cause cracks in the propellant grain. Therefore, the transporter-vehicle must be equipped with air-conditioning and anti-vibration mechanisms.
32. Zhang Ping, "State Lauds Disarming Proposals," *China Daily*, January 31, 1992, p. 1.

warhead, however, makes it a tactical weapon. That is probably why the designator DF-25 does not fit within the series of nuclear-tipped DF-21, DF-31, and DF-41. The name DF-25 relates to the conventional-tipped short-range tactical DF-15, which we discuss in the next section.

The maximum ranges of the DF-25 and the DF-21 are almost the same. However, the DF-21's payload is only 600kg, compared to the DF-25's 2,000kg. The DF-21 thus would cause too little damage for its cost to constitute a viable battlefield weapon. The cost of the DF-25's development, by contrast, would be relatively low. It could be derived from the three-stage DF-31 by removing the third stage and substituting a modified second stage and a 2,000kg payload.

Although it may seem odd to some Western strategists, the purpose of the DF-25 would be to defend the Nansha Islands in the South China Sea. The Chinese have neither aircraft carriers nor inflight refueling capability. Conventional-tipped ballistic missiles, if accurate enough, might provide quick fire support over long distances. Their use supplements and does not rule out two more costly options, aircraft carriers and air-refuelling aircraft. Both of these options are still under consideration.

Tactical Ballistic Missiles

After delivering the R-1 and R-2 missiles to the PLA, Moscow shipped it the 162km R-11FM, an SLBM capable of carrying a 950kg payload.[33] The Soviets had flight-tested the first R-11FMs in October 1955, and the weapon system had become operational by the end of 1956.[34] Deployed on the diesel-powered Golf-class submarine, the R-11FM was the only Soviet missile then capable of reaching the United States.

Despite his worsening relations with Mao, Khrushchev authorized the sale of both the missile and the Golf submarine to China in December 1959. The Soviet leader apparently hoped the sale would help mitigate the damage to their relations and perhaps facilitate other deals. It did not, and this was the last major weapon system Beijing received from Moscow.

The road-mobile version of the R-11FM, called SS-1 or Scud-A in the West, had a storable liquid propellant (AK-20 and kerosene). The technical docu-

33. FM stands for *flotskaia modifikatsiia* (fleet model).
34. *Iz Istorii Sovietskoi Kosmonavtiki*, pp. 235–236.

ments accompanying the missile stipulated that when fully loaded it should not travel more than 200km on paved roads or 100km on dirt roads.

The Chinese gave the R-11FM the name 1060, and began reverse engineering on it in June 1960. The military halted the effort in August 1961, when it lost interest in a short-range mobile tactical ballistic missile and raised the priority on long-range strategic weapons. Nevertheless, the Chinese had learned a great deal from the R-11FM's fully inertial guidance system, which was more advanced than the radio-inertial mixed guidance systems on the R-1 and R-2. The Chinese also copied the R-11FM's gyroscopic integrator for use on the DF-3 and DF-4, instead of the R-2's primitive electrolytic integrator.

Another attempt to develop tactical ballistic missiles occurred in June 1966, at the onset of the Cultural Revolution. With the spotlight on Mao, all institutes competed for his approval, and the Fourth Academy, envious of the First Academy's celebrated contributions to the DF program, proposed the development of a single-stage solid-propellant tactical missile. The Fourth had achieved success in casting grains of polysulfide-rubber-based composite solid propellants up to one meter in diameter. The size was too small for long-range missiles but adequate for small tactical weapons.

The proposed missile, first dubbed DF-41 and later DF-61, did not receive high-level approval but, like many other projects at the time, work on it proceeded at the local level despite Beijing's lack of interest in tactical missiles. The program's fate thus depended principally on the mood of the society, and it quietly died when the fervor of the moment passed on to other targets. Almost as a consolation prize, the central leadership assigned the Fourth Academy the task of starting the JL-1 SLBM program in March 1967.

Interest in a tactical missile did not reappear until 1975. In April that year, during Kim Il Sung's visit to Beijing, North Korean Defense Minister O Jin U inquired whether China could equip his forces with 600km missiles. The Chinese said no, but the timing of O's question coincided with the PLA's interest in developing weapons that could counter the Soviet threat along the Chinese border. At a meeting in 1975, the head of the Operations Department of the PLA General Staff argued that a few such missiles, either conventional or nuclear, could block remote mountainous passes along the border and thereby halt or impede a Soviet invasion. The Central Military Commission agreed.

It authorized an immediate R&D program and gave the project the same DF-61 name as the aborted 1966 project. The task was to build a missile for both foreign military assistance and domestic use. At that time, the Chinese

supported the transfer to North Korea as a political rather than a financial arrangement. It would help draw Pyongyang away from Moscow. The program was approved in 1976.

This single-stage mobile missile, unlike the 1966 DF-61, would have a prepacked liquid propellant and come in a 600km version with a 1,000kg conventional warhead and a 1,000km, 500kg nuclear version for Chinese use only. Its designers studied the use of cluster bomblets and fuel-air explosives for the conventional warheads. In 1976 the army tested the effectiveness of these warheads by detonating American weapons which had been captured by the Vietnamese and transferred to China.

The builders of the one-by-nine-meter DF-61 sought to adapt many of the DF technologies to the DF-61. Its fully inertial computerized strap-down guidance system and propellant (AK-40 and UDMH) mirrored those of the DF-14 mobile IRBM then under development. The DF-61 would use four vernier combustion chambers (and their associated servomechanisms for attitude control) and a turbo-pump system; these technologies were to be derived from the DF-5's second stage. The Chinese hoped that the DF-61 would exceed the performance of the somewhat comparable American Lance and Soviet Scud-C. However, the DF-61 program, which had been backed by Chen Xilian (who was then running the daily affairs of the Central Military Commission), collapsed when Chen was ousted in 1978.

CURRENT PROGRAMS

In 1979, the Party's Central Committee issued a directive to the nation's defense industries as part of the new policy of economic reform. It stipulated that the guideline for managing the defense industries should be *junmin jiehe, pingzhan jiehe, junpin youxian, yimin yangjun* (combine military with civilian [products], combine peacetime with wartime [production], give priority to military products, and use civilian [sales] to foster military [R&D]).

The military quickly realized, however, that the sale of civilian goods was insufficient to pay for military R&D, and the leaders of the defense industries added the phrase *yijun yangjun* (utilize the military [sales] to foster the military [R&D]) to the Party's guideline. Although they converted part of their capacity to civilian production, the defense industries looked to the international arms market for their true salvation. Within a few months, arms-export corporations sprouted throughout the country, with the main organizations located in Beijing.[35]

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35. For a discussion of the development of the arms-export corporations, see Lewis, Hua, and

The Chinese were not newcomers to arms exporting, but in the past, politics or ideology, not money, had governed the transfers. However, in 1979 the Chinese began selling conventional weapons and munitions to acquire hard currency, and in that year the ordnance ministry established the country's first arms trade organization and named it China North Industries Corporation (NORINCO). In 1980, the Central Military Commission and the State Council authorized the entire defense establishment to engage in arms exports.

The space ministry followed other defense ministries in pursuing arms deals. Among other items on its list for export were satellite-launching services from the First Academy, anti-aircraft missiles from the Second Academy, and anti-ship missiles from the Third Academy. By mid-1984, however, the First Academy had received no contract for its services and was increasingly feeling the financial pinch as its domestic orders declined.[36] Facing a two-thirds cut in its R&D appropriation for 1985 and watching the Second and Third academies prosper from their sale of tactical missiles, the First Academy decided to build its own tactical surface-to-surface ballistic missiles for export. The Soviet sale of Scud missiles to the Middle East contributed to this decision, as did the later "War of the Cities" between Iran and Iraq.[37]

Engineers in the First Academy concluded that they could easily and cheaply adapt the technologies from China's second-generation strategic missiles to a new class of short-range tactical ballistic missiles. These missiles would far exceed the capabilities of the Soviet-supplied Scuds. On April 28, 1984, the First Academy initiated work on the missile, the M-9. The "M" is derived from the English word missile, implying that the weapons of this class were being developed for export; as noted, the PLA uses the Chinese acronym DF for its own land-based ballistic missiles. On May 14, the space ministry approved the First Academy to be the prime contractor for all tactical surface-to-surface ballistic missiles and received a go-ahead from the

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Xue, "Beijing's Defense Establishment: Solving the Arms-Export Enigma." We should note one error in that article: the China State Shipbuilding Corporation (CSSC) should be labelled the China Shipbuilding Trading Corporation (CSTC) on pp. 89, 92–93.

36. The Chinese had decided to sell satellite-launching services on June 15, 1983.

37. In early 1988, Iran launched a desperate search on the international market for ballistic missiles to counter Iraq's Scud attacks on Tehran, and negotiated a contract with the Great Wall Industry Corporation of the space ministry to equip China's unguided sounding rockets with warheads. The contract could not be concluded because the Chinese would not accept payment in crude oil as the Iranians demanded. The ending of the war soon thereafter halted the negotiations.

Commission of Science, Technology, and Industry for National Defense (COSTIND) on December 5.[38] A feasibility study for the M-9 program was completed within a few months, and in October 1985, the general design of the M-9 began.

The M-9 is a 600km-range single-stage solid-propellant road-mobile ballistic missile one meter in diameter and 9.1m in length. The missile is vertically launched from a transporter-erector-launcher vehicle. It has a strap-down inertial guidance system with an on-board computer to exercise fully-digitized control. The control system allows rapid retargeting at the launch site and eliminates the need for weather corrections. To enhance the weapon's accuracy and penetrability, a miniature propulsion system is applied on the warhead to correct its terminal velocity and reentry attitude and to change its flight trajectory and range.

The Chinese, in their quest to sell the M-9, displayed it at the First Asian Defense Exhibition (ASIANDEX) in Beijing on November 4–11, 1986, two months before the missile's design was completed. The academy's engineers applauded the attention given to the missile at the exhibition and welcomed the interest it aroused throughout the international community. No one in the academy was aware of the Missile Technology Control Regime (MTCR) or how opposition to missile proliferation would also capture the West's attention.[39]

In the meantime, the M-9 had caught the eye of the PLA's rocket forces. On November 8, 1986, before the end of the ASIANDEX and two years after the M-9 program had started, the ministry added the M-9 to the DF-series of ballistic missiles for the PLA and named it DF-15. The emphasis would remain on the export version, however, and the ministry listed the R&D on the M-9 as one of its three top priorities in its 1987 plan; the other two were the DF-31 mobile IRBM and the CZ-3A satellite launcher. The director of the First Academy told his colleagues: "For money, develop the DF-15; for fame, develop the CZ-3."

On March 2, 1987, the ministry approved the production schedule for the M-9. So confident were they of their competence to build the missiles that

38. COSTIND was established in 1982 through a merger of the National Defense Industry Office and the Defense Science and Technology Commission.

39. In 1983 seven countries—Canada, France, the Federal Republic of Germany, Italy, Japan, the United Kingdom, and the United States—began secret talks to limit the proliferation of selected missile technologies. In April 1987, these talks led to the completion of the Missile Technology Control Regime (MTCR) through an exchange of letters. The regime restricts sales of ballistic missiles with ranges above 300km and payloads over 500kg.

their representatives signed a preliminary agreement with Syria on the sale of the M-9 even before it was flight-tested in June 1988. This confidence was well-placed: no M-9 ever failed its test. The Syrians paid a deposit on the future delivery of the missile, and the First Academy used the money to build a library and guest houses.

At the ASIANDEX in 1986, the Chinese disclosed the existence of an entire class of M-family tactical ballistic missiles.[40] In fact, at about the same time as the M-9 was under development, two other units within the ministry began development of tactical ballistic missiles for export. One unit was Base 066. Located in Dangyang County, Hubei Province, the base was at one time affiliated with the Third Academy (Anti-Ship Missile Academy).[41] The base had concentrated on solid-propellant boosters for non-ballistic tactical missiles, but in 1985, given the funding pressures, it started work on a ballistic missile called M-11 for export and DF-11 for the PLA. The solid-propellant missile reportedly had a maximum range of 300km.[42]

Base 066 invited experienced engineers from Institute Twelve (Control System Institute) and Institute Thirteen (Inertial Component Institute) of the First Academy to help solve the technical problems relevant to the M-11/DF-11. The M-11 program lagged some two years behind the M-9 and was not successfully flight-tested until mid-1990. China reportedly exported the M-11 to Pakistan in early 1991.[43]

The Second Academy developed yet another tactical ballistic missile for sale, this one a variant of a surface-to-air missile (SAM). The academy had conducted R&D on most of China's SAMs, and in 1978 it took over the development programs on the JL-1 SLBM and the DF-21 MRBM. Its strengths lay in its long experience with solid propulsion and mobile systems. In 1986 the ministry told the academy to concentrate on SAMs and relieved it of further work on strategic ballistic missiles.

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40. "China Exhibits New Weapons," *Xiandai Junshi* (Conmilit), No. 123 (1987), p. 2.
41. In the latter half of the 1980s, Base 066 split off from the Third Academy as an independent missile research and industrial complex.
42. Duncan Lennox, ed., "China: Offensive Weapons," Jane's Information Group, JSWS–Issue 04, *Jane's Strategic Weapons Systems*, section on M Family, says that the M-11 is a two-stage missile and was exhibited. An article entitled, "China's Record of Proliferation" in U.S. Senate, Committee on Governmental Affairs, *Proliferation Watch*, Vol. 2, No. 2 (March–April 1991), p. 3, says that the M-11 was displayed at the 1988 Chilean FIDA 88 Arms Show.
43. R. Jeffrey Smith, "U.S. Reports Chinese Missile Launchers Sighted in Pakistan," *Washington Post*, April 6, 1991, p. A17. "Road to Damascus," *Far Eastern Economic Review*, August 22, 1991, p. 6, reported that 24 M-9s were seen in Syria; see also Nicholas D. Kristof, "Potent Office Weaves Web in China Arms," *New York Times*, August 21, 1991, p. A16.

However, when the academy lost a large part of its R&D budget, it decided to enter the arms market along with its sister organizations and determined that, to add to the sale of SAMs, its HQ-2 SAM could be converted into a short-range, surface-to-surface ballistic missile at low cost. A technical meeting, held April 11–12, 1986, confirmed the feasibility of the conversion program. The following week, Minister Li Xue ordered the Great Wall Industry Corporation to provide a loan for support of the program, code-named 8610, and made the Second Academy the 8610's prime technical contractor.

The 8610 is a two-stage missile with a range below 200km. Based on the HQ-2 system, the first stage is a solid propellant booster, while the engine on the second stage uses storable liquid propellants. The control system, however, differs completely from the SAM and will have to be developed from scratch. The missile lifts off at an angle (similar to the U.S. Lance) and thereby is unlike any other Chinese ballistic missile. The novelty of this launch mode caused most of the difficulties in the development of the control systems, the main bottleneck in the 8610 program.

The 8610 is not included in the DF-series for domestic use and is designed exclusively for export. We are uncertain whether it will be given an M-family code name, though it may be one of two M-class missiles on which we have little information, the M-7 and the M-18.[44] These unknowns add some uncertainty to what was sold to Pakistan. The Chinese ambassador to the United States, Zhu Qizhen, told the National Press Club in Washington, "We have sold some conventional weapons to Pakistan, including a tiny amount of short-range tactical missiles. I think here you call it M-11. We don't call it M-11, but since you say M-11, let's say M-11."[45] He added, "We don't use the name M-11. It is a United States code name, M-11. Let's say if it is M-11 this is within the range of the MTCR; that is, the range is only a little more than 200 kilometers." In fact, of course, M-11 is the Chinese, not the American, code name, but it could be that Pakistan bought a missile other than the M-11. The key point in Zhu's speech was that China had not violated the MTCR guidelines.

It should be noted that China's export of weapons has enjoyed popular support in the country. Those working in defense industries judge every

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44. Lennox, "China: Offensive Weapons," reported that an M-18 (which has two stages and is larger than the M-11) and an M-7 also exist. We have no other confirming information on these missiles.

45. See the Reuter Transcript Report (ao898 reutt.rw. BC-Text-China-3rdadd 06-27-0542), June 27, 1991.

foreign sale of their weapons to be a contribution to the nation. Many had felt guilty about the expenditure of so much money and man-hours to develop these weapons, and now can see a tangible payoff. Their repeated comment is, "Others are selling weapons, why not we Chinese?" When talking about the sale of DF-3 IRBMs to Saudi Arabia, they hailed the deal as *gande piaoliang* (beautifully done).

The Chinese believe that so long as missiles are not equipped with nuclear warheads, they are less effective than strike aircraft. To use chemical warheads, the wind direction in the area of a potential target must be considered. Missiles cannot adjust themselves to the wind direction, but aircraft pilots can do so while on site. Therefore, the Chinese position is that nuclear and chemical weapons technology should not be proliferated, but that missiles can be sold so long as other countries are selling strike aircraft.

Yang Shangkun, China's president, said, "American opinion censures us for selling weapons. Yet the United States also sells weapons. Why does it not censure itself? . . . So there is a question of fairness here. . . . China has a saying, 'Only magistrates are allowed to set fires. Ordinary people are not allowed to light lamps.' You are strong, so you can sell without constraint. We are not so strong, and we sell very much less. Yet you denounce us every day. We feel uncomfortable."[46] Nevertheless, Beijing reluctantly did respond to U.S. pressure even though, in our judgment, the price was a further deterioration in Sino-American relations. In February 1992, under duress but following Washington's promise to lift sanctions on the sales of satellite parts and high-speed computers to the PRC, Beijing announced that it would abide by the MTCR's restrictions.[47]

Meanwhile, China has further reduced the dependency of its defense industry on military-related sales. Its aerospace industry continues to shift to civilian production. In 1991 civilian goods accounted for 65 percent of the industry's total output, compared to only 10 percent in 1980.[48] China's foreign exchange reserve at the end of 1991 had reached more than $40 billion, another indication of its lessening dependence on foreign arms sales.[49] The

46. "The United States Also Sells Weapons," *U.S. News & World Report*, May 27, 1991, p. 43.
47. Elaine Sciolino, "U.S. Lifts Its Sanctions on China Over High-Technology Transfers," *New York Times*, February 22, 1992, pp. 1, 5; "Foreign Ministry Spokesman's Statement," *Renmin Ribao*, overseas ed., February 24, 1992, p. 1.
48. Li Hong, "Aerospace Trade Goes to Public Products," *China Daily*, February 1, 1992, p. 1.
49. Chang Hong, "Big Foreign Cash Store Improves Credibility," *China Daily*, December 31, 1991, p. 1.

nation had created the economic conditions for greater cooperation—and greater independence.

Conclusion

When Beijing set its sights on intercontinental missiles and then on space in the 1950s, no one could have imagined that within some three decades it would be able to compete with the industrialized West on an equal footing. Now it can.

Just as the Chinese leadership no longer considers complete self-reliance a necessary or wise policy for its modernization efforts, including those related to strategic and tactical missiles, so, too, does it no longer place itself outside the global norms of peace and cooperation. It thus would be a mistake to regard China's aspirations toward defense development as being any more sinister than those of other great powers. China has paid a high price to reach the point where other nations take it seriously and pose fewer threats. Thirty years ago, the country's fate was largely determined by what others did; even its friends had a patronizing attitude toward it. China's strategic weapons programs changed all that.

The nation now seeks to operate in an increasingly interdependent world, a goal that it highlighted by its actions at the United Nations both during the Gulf War and in response to President Bush's call for a collective approach to arms proliferation in the Middle East. Although buffeted by accusations of human rights violations and of gunrunning to radical regimes, the Chinese government still took its place on the side of international order. It aligned itself with the Security Council majority against Iraq, expressed its willingness to join in negotiations for an equitable arms control regime for the Middle East, and formally adhered to the nuclear nonproliferation treaty.

China's position on its own strategic arms reductions has been far more cautious and has reflected China's ambition to become a major power equal now at least to Russian power. Responding to the reciprocal unilateral strategic arms cuts announced by Moscow and Washington in 1991 and 1992, China reiterated its approval of the goal of a "complete prohibition and thorough destruction" of such arms, but has now declared that only when Russia and the United States "cut their nuclear arsenal to China's level" would China join the process of nuclear disarmament.[50]

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50. Zhang Ping, "State Lauds Disarming Proposals."

Following the Gulf War, China's leaders decided that the time had come to offset American hegemony and unpredictability and to accelerate the coalescence of Asian interests. A more united Asia would be able to balance America's global dominance as envisaged by the U.S. Defense Department's draft document calling for the prevention of the reemergence of a new global rival and "deterring potential competitors from even aspiring to a larger regional . . . role."[51] The Chinese leadership made two impressive moves to improve relations with Japan: an historic invitation for the emperor of Japan to visit China, and an offer of an exclusive deal for Japan to develop Xinjiang's huge oil reserves. Deng Xiaoping also speeded up accommodation with the Russians, a process that seemed to move swiftly until the dramatic failure of the August 1991 coup in Moscow accelerated the collapse of communism and central rule in the Soviet Union. By that time, however, Party leader Jiang Zemin and Soviet President Mikhail Gorbachev had formally agreed to a border settlement for virtually all of the disputed eastern region.

Meanwhile, after Tiananmen, the economies of the PRC, Taiwan, and Hong Kong drew closer. While U.S. Congress members spoke of punitive sanctions, China's economy recovered and grew. The Chinese thereby gained the capacity to compete more as an equal, to disengage, or to join in a common quest for a new regional order. Although many of the PLA's most sophisticated leaders, especially those in the missile and space programs, were opposed to the violent crackdown in Beijing before it happened, they are equally against the West's response, which resurrected many of the hated images of Western arrogance and the assumption that foreigners have the right to dictate to China.

China's strategic military prowess places it in a position either to defy presumptuous Western demands and interference or to work with the West to build the new world order. The history of China's ballistic missile programs demonstrates its potential and its determination. In the Chinese mind, these programs are linked both to independence and defense and to the ability to enter the international system as an equal. In such matters, Mao Zedong always spoke about their inherent contradictions, their "potential for destruction and for construction," as he put it. The Chinese have spoken out for construction on terms to be negotiated, not imposed. That, in the final analysis, is the message of their profound commitment to high technology for both defense and civilian modernization.

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51. See Patrick E. Tyler, "U.S. Strategy Plan Calls for Insuring No Rivals Develop," *New York Times*, March 8, 1992, pp. 1, 4. The quotation is from "Excerpts from Pentagon's Plan: 'Prevent the Re-Emergence of a New Rival'," ibid., p. 4.