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## China: Ballistic and Cruise Missiles

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(name redacted)

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# China: Ballistic and Cruise Missiles

## Summary

The People's Republic of China (PRC) is believed to have deployed a nuclear-armed missile force of over 100 nuclear warheads, with additional warheads in storage. Deployed in the People's Liberation Army (PLA)'s Second Artillery, the nuclear-armed ballistic missiles currently launch single warheads. China's nuclear-armed missile force is deployed with about 25 launchers for the limited-range DF-4 intercontinental ballistic missile (ICBM), about 25 launchers for the long-range DF-5A ICBM, about 40 launchers for the older DF-3A medium-range ballistic missile (MRBM), and about 50 launchers for the mobile, solid-fuel DF-21 MRBM. (There may be multiple missiles that could be re-loaded to some of the launchers.) Most of the PLA's ICBMs are believed to be targeted at U.S. cities as part of the PRC's second-strike, counter-value, minimum deterrence doctrine, officially declared as the "no first use" policy. In April 1999, President Clinton stated that the PRC has fewer than two dozen long-range nuclear weapons, compared to 6,000 in the U.S. arsenal.

China's program to deploy the JL-1 submarine-launched ballistic missile (SLBM) on a Xia-class nuclear ballistic missile submarine (SSBN) is not yet successful. In the future, the PLA plans to deploy after 2000 or 2005 the new, more survivable and reliable DF-31 ICBM with a lighter warhead and the JL-2 SLBM on the new Type 094 SSBN. The DF-31, China's first land-mobile, solid-fuel ICBM, was first tested in August 1999. In addition, China plans to deploy the land-mobile, longer-range DF-41 ICBM, perhaps after 2010.

There are also hundreds of increasingly accurate and mobile DF-21A MRBMs and M-9, M-11, and M-7 short-range ballistic missiles for theater operations, likely armed with conventional warheads. Since the mid-1990s, the PLA's dramatic build-up and launches (in 1995-96) of theater missiles have already spurred calls for meeting Taiwan's missile defense needs. In March 2000, Admiral Dennis Blair, Commander-in-Chief of the Pacific Command, publicly confirmed that the PLA has deployed about 200 ballistic missiles against Taiwan and is adding 50 more a year.

The PLA's cruise missiles have ranges up to 200 km. (125 mi.), and of these, the HY-3 and the SS-N-22 Sunburn (that Russia supplied in 2000) are supersonic anti-ship cruise missiles. However, China is reportedly developing longer-range, land attack cruise missiles (LACMs). In 1997, the Department of Defense reported that China has placed priority on developing LACMs "for theater warfighting and strategic attack." China's emphasis on its own LACM programs reportedly has been influenced by the U.S. military's success in using Tomahawk missiles for precision strikes during the 1991 Persian Gulf War and in conflicts since that war.

While clearly modernizing and expanding its ballistic and cruise missile forces, however, it is uncertain whether China will substantially build up its currently limited strategic ICBM forces. In 1999, the intelligence community predicted that, by 2015, the PLA is likely to have "a few tens" of missiles with smaller nuclear warheads (partly benefitting from stolen U.S. technology) that are capable of targeting the United States. The question remains whether the PRC would further expand its strategic force to dozens, hundreds, or even thousands of nuclear warheads.

## Contents

Introduction .....	1
PRC Ballistic Missiles .....	3
Growing Missile Threat .....	3
Phase 1: DF-3A, DF-4 .....	7
DF-3A MRBM .....	7
DF-4 ICBM .....	8
Phase 2: DF-5A, JL-1, DF-21/21A, M-9, M-11, M-7 .....	8
DF-5A ICBM .....	8
JL-1 SLBM .....	9
DF-21/21A MRBM .....	10
DF-15/M-9 SRBM .....	11
DF-11/M-11 SRBM .....	13
8610/M-7 SRBM .....	13
Phase 3: DF-31, JL-2 .....	14
DF-31 ICBM .....	14
JL-2 SLBM .....	15
Phase 4: DF-41 .....	15
PRC Cruise Missiles .....	18
Cruise Missiles in Service .....	18
HY-1 .....	18
HY-2/C-201 .....	18
YJ-6/C-601 .....	18
YJ-62/C-611 .....	19
HY-3/C-301 .....	19
HY-4/C-201 .....	19
YJ-2/C-802 .....	20
SS-N-22 Sunburn .....	20
Cruise Missiles under Development .....	21
YJ-21/YJ-22 .....	21
XY-41/YJ-63 .....	22
YJ-8 .....	22
YJ-9 .....	22
X-600 .....	22
Others .....	23
Conclusion and Policy Issues .....	23
Appendix: GPS and PRC Missiles .....	26

## List of Tables

Table 1. PLA Ballistic Missiles: Deployed and Under Development .....	2
Table 2. PLA Cruise Missiles with Ranges over 80 km. ....	17

# China: Ballistic and Cruise Missiles

## Introduction

This CRS report contains three parts. The first part discusses ballistic missiles of the People's Republic of China (PRC). The second discusses the PRC's cruise missiles. The last section offers concluding observations. Two tables summarize the discussion on current ballistic and cruise missiles in service or under development. The appendix, prepared by Robert Shuey, discusses China's reported application of global positioning system (GPS) technology to improve the accuracy of its missiles. This report focuses on the status and current developments of China's missile programs, rather than their history. The report is based on public sources of information which have been cited.

Ballistic missiles are self-propelled weapon delivery systems that are powered and guided during a part of their ascent and then follow a ballistic (unguided and unpowered) trajectory over the remainder of the flight. More advanced and accurate missiles also have terminal guidance to direct the weapon to the target. Cruise missiles are continually powered by an air-breathing or rocket engine and are generally guided for their entire flight.<sup>1</sup>

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### U.S. Classification of Ballistic Missiles

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Short-range ballistic missile (SRBM)	70-1000 km	(40-620 mi)
Medium-range ballistic missile (MRBM)	1001-3000 km	(620-1860 mi)
Intermediate-range ballistic missile (IRBM)	3001-5000 km	(1860-3100 mi)
Intercontinental ballistic missile (ICBM)	5001 km +	(3100 mi +)

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China is not party to international arms control agreements that limit the development or deployment of its missile forces, such as the Intermediate-Range Nuclear Forces (INF) Treaty signed between the United States and the Soviet Union in 1987. (The INF Treaty bans all intermediate-range and shorter-range ballistic missiles and ground-launched cruise missiles with ranges of 500-5,500 km.) China has promised to adhere to the Missile Technology Control Regime (MTCR), an informal set of guidelines limiting the transfer of ballistic and cruise missiles that have the inherent capability to deliver 500 kg. warheads to 300 km.

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<sup>1</sup> CRS Report RL30427, *Missile Survey: Ballistic and Cruise Missiles of Foreign Countries*, February 10, 2000, by Robert Shuey.

**Table 1. PLA Ballistic Missiles: Deployed and Under Development**

Type	PRC des.	US des.	Launchers Deployed	Range/Warhead (km/kg)	Warhead Type	Launch Platform	Fuel	Comments
MRBM	DF-3A	CSS-2	<40	2,800/2,150	nuclear (3 MT)	land-based	liquid	in service until 2002
ICBM	DF-4	CSS-3	<25	5,500+/2,200	nuclear (3 MT)	silos	liquid	in service
ICBM	DF-5A	CSS-4	<25	13,000/3,200	nuclear (4-5 MT)	silos	liquid	in service
SLBM	JL-1	CSS-NX-3		1,700/600	nuclear	Xia SSBN	solid	development; 12 missiles
MRBM	DF-21	CSS-5 Mod 1	<50	2,500/600	nuclear (250 kT)	mobile TEL	solid	in service; replacing CSS-2
MRBM	DF-21A	CSS-5 Mod 2	?	2,000/2,000	conventional	mobile TEL	solid	possible deployment
SRBM	DF-15/ M-9	CSS-6	<50	600/500	conventional	mobile TEL	solid	in service; test-fired in 7/95 & 3/96 toward Taiwan
SRBM	DF-11/ M-11	CSS-7	<32	300+/800	conventional	mobile TEL	solid	possible deployment; new launchers in Fujian in 1999
SRBM	8610/ M-7	CSS-8	?	180/190	conventional	mobile launcher	solid	in service; modified HQ-2 SAM
ICBM	DF-31	CSS-X-9		8,000/700	nuclear	land-mobile	solid	development; first test-fired in 8/99; after 2000
SLBM	JL-2	CSS-NX-4		8,000/700	nuclear	planned Type 094 SSBN	solid	development; 16 missiles; after 2005
ICBM	DF-41	CSS-X-10		12,000/800	nuclear	land-mobile	solid	development; after 2010

**Note:** Some of the launchers could be re-loaded with multiple missiles.

## PRC Ballistic Missiles<sup>2</sup>

### Growing Missile Threat

The PRC's first indigenous ballistic missile was designated DF-2 (DF stands for *Dong Feng*, or East Wind) and designated CSS-1 (CSS for Chinese surface-to-surface) by NATO or the United States.<sup>3</sup> The first DF-2 launch was believed to have taken place in June 1964, and the PRC tested its first atomic weapon in October 1964 at the Lop Nor nuclear test site in the northwestern Xinjiang region.<sup>4</sup> The PRC deployed about 90 DF-2s through the 1970s.

By the 1990s, the PRC made progress in the continued modernization of its ballistic missile force. In 1997, Undersecretary of Defense for Acquisition and Technology Paul Kaminski testified that China's strategic ballistic missile capability is "limited" today, but it is "emerging and growing."<sup>5</sup>

The People's Liberation Army (PLA)<sup>6</sup> is believed to have deployed a nuclear-armed missile force of over 100 nuclear warheads, with additional warheads in storage.<sup>7</sup> (Non-governmental experts estimate the PLA's total nuclear stockpile at roughly 400 nuclear warheads, including perhaps 150 aircraft-delivered bombs and 120 tactical nuclear weapons.<sup>8</sup>) In 1999, the PRC first publicly confirmed that it has the neutron bomb, claiming that it was indigenously developed and not based on

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<sup>2</sup> Public sources of general information on PRC ballistic missile forces include: National Air Intelligence Center (NAIC), *Ballistic and Cruise Missile Threat*, April 1999; Ballistic Missile Defense Organization (BMDO), *Theater Missile Defense (TMD) and East Asia: TMD Briefing for Congressional Research Service*, March 18, 1999; International Institute for Strategic Studies, *Military Balance 1999-2000*; *Jane's Strategic Weapon Systems 2000*, September 1998; William M. Arkin, Robert S. Norris, and Joshua Handler, *Taking Stock: Worldwide Nuclear Deployments 1998* (Natural Resources Defense Council, March 1998); Office of Secretary of Defense, *Proliferation: Threat and Response*, November 1997; John Wilson Lewis and Hua Di, "China's Ballistic Missile Programs: Technologies, Strategies, Goals" (*International Security*, Fall 1992); John Wilson Lewis and Xue Litai, *China's Strategic Seapower* (Stanford: Stanford University Press, 1994); Robert S. Norris, Andrew S. Burrows, and Richard W. Fieldhouse. *Nuclear Weapons Databook: British, French, and Chinese Nuclear Weapons*. Volume V. (Boulder: Westview Press, 1994).

<sup>3</sup> The first *Dong Fengs*, DF-1s, were Soviet SS-2 missiles produced in the PRC under license in the 1950s.

<sup>4</sup> For more information on the PRC's nuclear testing, see CRS Report 97-1022, *Chinese Nuclear Testing and Warhead Development*, November 14, 1997, by Jonathan Medalia.

<sup>5</sup> Testimony at a hearing on ballistic missile defense before the Subcommittee on Military Research and Development, House National Security Committee, March 6, 1997.

<sup>6</sup> PLA refers to the PRC's military, including all services.

<sup>7</sup> Office of the Secretary of Defense, *Proliferation: Threat and Response*, November 1997.

<sup>8</sup> Arkin, Norris, and Handler.

technology acquired from the United States.<sup>9</sup> (A neutron bomb is designed to kill large numbers of people with radiation rather than destroy buildings and equipment.)

The PLA's nuclear-armed ballistic missiles currently launch single warheads. China's nuclear-armed missile force is deployed with about 25 launchers for the limited-range DF-4 ICBM, about 25 launchers for the long-range DF-5A ICBM, about 40 launchers for the older DF-3A MRBM, and about 50 launchers for the mobile, solid-fuel DF-21 MRBM. (There may be multiple missiles that could be reloaded to some of the launchers.) Also, there are hundreds of increasingly accurate MRBMs and SRBMs for theater operations, likely armed with various types of conventional warheads, some to defeat missile defenses (including runway penetrators, submunition dispensing warheads, mine-laying warheads, electromagnetic pulse warheads, penetration warheads).<sup>10</sup>

China demonstrated its potential use of SRBMs by "test-firing" M-9s toward Taiwan in 1995 and 1996. Aside from diplomatic efforts to reduce tensions in the Taiwan Strait and urge for PRC restraint in its missile build-up, some have called for the development and deployment of theater missile defense (TMD) systems in the region and national missile defense (NMD).

Ballistic missiles are deployed in the PLA's Second Artillery, the strategic missile corps. Most of the PLA's ICBMs are believed to be targeted at U.S. cities as part of the PRC's second-strike, counter-value, minimum deterrence doctrine, officially declared as the "no first use" policy. Some have suggested that, since the late 1980s, the situation where the PRC had no choice but to use minimum deterrence has been changing and that some in the PLA may have been thinking of a "limited deterrence" concept. If applied in the future, "limited deterrence" would employ tactical, theater, and strategic nuclear forces in counter-force and counter-value strategies to deter or control the escalation of conventional or nuclear war. Such a strategy may incorporate elements of preemption.<sup>11</sup> Observers are monitoring whether actual deployments by the Second Artillery reflect such thinking.

The PLA's ballistic missile programs are summarized in Table 1, "PLA Ballistic Missiles." These programs can be divided into four phases of development and deployment. After developing a land-based, nuclear-armed MRBM and a limited-range ICBM in the first phase, China sought greater reach, diversity, and reliability. In the second phase, China added a long-range ICBM, a mobile and solid-fuel MRBM (with nuclear- and conventionally-armed versions), and SRBMs to its ballistic missile force. However, its program to deploy a submarine-launched ballistic missile (SLBM) on a nuclear ballistic missile submarine (SSBN) has not been successful. In the third phase, China plans to deploy after 2000 or 2005 a new land-mobile, solid-fuel ICBM

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<sup>9</sup> PRC, Information Office of the State Council, "Facts Speak Louder than Words and Lies Will Collapse by Themselves – Further Refutation of the Cox Report," July 15, 1999.

<sup>10</sup> Stokes, Mark A., *China's Strategic Modernization: Implications for the United States* (U.S. Army War College, Strategic Studies Institute, September 1999).

<sup>11</sup> Johnston, Alastair Iain, "China's New 'Old Thinking': the Concept of Limited Deterrence," *International Security*, Winter 1995/1996.

with a lighter warhead and a SLBM on a next-generation submarine. For the fourth phase, China plans to deploy a land-mobile, longer-range ICBM, perhaps after 2010.

At the June 1998 summit in Beijing, President Clinton and PRC President Jiang Zemin declared that the two countries “will not target the strategic nuclear weapons under their respective control at each other.” President Jiang also reiterated the PRC’s “no first use” policy, stating that “since the very first day when China came into possession of nuclear weapons, China has undertaken not to be the first to use nuclear weapons under any circumstances.”<sup>12</sup> It is not clear how this agreement has been implemented respectively by both sides, but a Pentagon spokesperson said that U.S. nuclear forces have been detargeted since 1994 and are not aimed at any country.<sup>13</sup> Some say that the PRC’s decision was a major concession, since China has long advocated “no first use” to counter the U.S. proposal for de-targeting. Others downplay the significance of a de-targeting agreement, due to the difficulty of verification.

Nonetheless, there are concerns in the United States about the continued modernization (quality) and build-up (quantity) of the PRC’s missile force. First, China may deploy ICBMs with multiple independently targetable reentry vehicles (MIRVs) in the future. China first decided to develop MIRVs for deployment in 1970. Development was in part stalled, however, by a lack of capability to miniaturize warheads.<sup>14</sup> The priority for the project on MIRVs was lowered in March 1980, but research and development on MIRVs resumed on November 10, 1983, as part of the DF-5 modification program. In April 1999, Director of Central Intelligence (DCI) George Tenet released an unclassified damage assessment completed by the intelligence community on China’s suspected acquisition of U.S. nuclear secrets. The study confirmed that the PRC already has the “technical capability” to develop a MIRV system for the currently deployed ICBM but has not done so. Nonetheless, the DCI reported that “U.S. information acquired by the Chinese could help them develop a MIRV for a future mobile missile.”<sup>15</sup>

In 1999, the bipartisan House Select Committee on U.S. National Security and Military/Commercial Concerns with the People’s Republic of China (popularly known as the Cox Committee) judged that, by 2015, the PLA could deploy up to 100 ICBMs with as many as 1,000 thermonuclear warheads. There had been concerns that Motorola’s use of a PRC-developed multi-satellite dispenser (called “Smart Dispenser”) to launch two Iridium satellites at a time on Long March rockets helped the PRC to develop MIRV capability. However, the Cox Committee concluded that “Motorola did not provide the PRC with information on how to design the Smart

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<sup>12</sup> News conference by Presidents Clinton and Jiang Zemin, June 27, 1998, Beijing.

<sup>13</sup> Department of Defense, news briefing by Kenneth Bacon, July 7, 1998.

<sup>14</sup> CRS Report 97-1022.

<sup>15</sup> CIA, “The Intelligence Community Damage Assessment on the Implications of China’s Acquisition of U.S. Nuclear Weapons Information On the Development of Future Chinese Weapons,” (unclassified release), April 21, 1999.



Dispenser; rather, the PRC built the Smart Dispenser indigenously to Motorola's specifications."<sup>16</sup>

Second, in 1998, Congress examined heightened concerns that China may have acquired U.S. missile technology from U.S. satellite manufacturers. At a hearing of the Senate Committee on Commerce, Science, and Transportation on September 17, 1998, Principal Deputy Assistant Secretary of Defense Franklin Miller testified that PRC commercial space launch activities have not improved the guidance systems of the "current generation of Chinese ICBMs." There are questions, nevertheless, about whether any U.S. missile technology transfers have applications for China's future missiles.<sup>17</sup>

Third, concerns have increased with suspicions since 1995 (publicly reported in 1999) that the PRC may have acquired U.S. nuclear weapon secrets, including that on the W88, the newest U.S. miniature nuclear warhead.<sup>18</sup> The DCI's April 1999 damage assessment, cited above, reported that "China obtained by espionage classified U.S. nuclear weapons information that probably accelerated its program to develop future nuclear weapons." According to the study, China obtained "basic design information on several modern U.S. nuclear reentry vehicles, including the Trident II" that delivers the W88 warhead as well as a "variety of U.S. weapon design concepts and weaponization features, including those of the neutron bomb." President Clinton has pointed out that U.S. nuclear forces still maintain decisive superiority over the PRC's relatively limited strategic nuclear forces, saying that "China has fewer than two dozen long-range nuclear weapons today; we have over 6,000."<sup>19</sup>

Fourth, the PLA is continuing to build up its missile force, especially theater ballistic missiles. In 1997, the Secretary of Defense reported to Congress that the PRC could produce, though not necessarily plan to produce, as many as 1,000 new, more accurate missiles within ten years. Most of those new missiles would be SRBMs and MRBMs that are road-mobile, use solid fuel, and armed with conventional warheads.<sup>20</sup> As for strategic missiles, the intelligence community predicted that, by 2015, "China is likely to have tens of missiles capable of targeting the United States, including a few tens of more survivable, land- and sea-based mobile

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<sup>16</sup> Cox Committee's declassified report, released on May 25, 1999; see CRS Report RL30220, *China's Technology Acquisitions: Cox Committee's Report – Findings, Issues, and Recommendations*, June 8, 1999, by (name redacted).

<sup>17</sup> See CRS Report 98-485, *China: Possible Missile Technology Transfers From U.S. Satellite Export Policy – Background and Chronology*, by (name redacted).

<sup>18</sup> See CRS Report RL30143, *China: Suspected Acquisition of U.S. Nuclear Weapon Data*, by (name redacted).

<sup>19</sup> President William Jefferson Clinton, speech sponsored by the U.S. Institute for Peace at the Mayflower Hotel, Washington, D.C., April 7, 1999.

<sup>20</sup> Secretary of Defense, "Report to Congress Pursuant to Section 1305 of the FY97 National Defense Authorization Act," April 1997.

missiles with smaller nuclear warheads – in part influenced by U.S. technology gained through espionage.”<sup>21</sup>

Fifth, there is concern that since Russia became the PLA’s primary foreign supplier in the early 1990s, Russia (and/or the Ukraine) may have provided some SS-18 missile technology to China in 1996.<sup>22</sup> Russia continues to sell broad military technologies to the PLA, which is increasingly choosing to modernize more rapidly through foreign acquisitions rather than relying solely on the deficient domestic defense industries.

Sixth, some observers are concerned about a possible PRC nuclear attack on the United States in a conflict over Taiwan. These concerns were heightened by a remark made by a PLA officer in 1995 during tensions in the Taiwan Strait. The officer reportedly told former Assistant Secretary of Defense, Chas. Freeman, Jr., that the PLA could use military force to prevent Taiwan’s gaining independence without fear of U.S. intervention, because American leaders “care more about Los Angeles than they do about Taiwan.”<sup>23</sup> While confirming this conversation in China, which he reported at a White House meeting on January 4, 1996, Freeman says that the PLA’s warning did not imply an offensive threat but was consistent with the PRC’s “no first use” policy, in the context of deterrence against any possible U.S. nuclear threats.<sup>24</sup>

### **Phase 1: DF-3A, DF-4**

The PRC’s current ballistic missile programs are evolving in four phases. The first phase features the PRC’s older MRBM and limited-range ICBM that can launch nuclear warheads around China’s periphery. The missiles use liquid fuel.

**DF-3A MRBM.** The PRC’s DF-3A MRBM has the U.S. designation of CSS-2. Deployed since 1988, the DF-3A is an improved version of the DF-3 that was first deployed in 1971 to target the Philippines, where the United States maintained bases until 1991. The DF-3A has a response time (preparation for launch after warning) of two to three hours. The DF-3A MRBM can deliver a 2,150 kg. (4,750 lb.) warhead to 2,800 km. (1,750 mi.). The missile has also been tested with a depressed trajectory for a shorter range of 1,550 km (960 mi.) at an altitude of only 100 km. Such a trajectory would help to attack closer targets while evading some missile defenses.<sup>25</sup> The single warhead is believed to have a yield of about 3 MT, with an accuracy of 1,000 m. (0.6 mi.) circular-error-probable (CEP). (In 1987, China secretly sold an

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<sup>21</sup> National Intelligence Council, “Foreign Missile Developments and the Ballistic Missile Threat to the United States Through 2015,” September 1999.

<sup>22</sup> Gertz, Bill, “China’s Arsenal Gets Russian Boost,” *Washington Times*, May 20, 1996; Steven Erlanger, “U.S. Warns 3 Nations Against Sale of Soviet Missile Technology,” *New York Times*, May 22, 1996.

<sup>23</sup> Tyler, Patrick E., “As China Threatens Taiwan, It Makes Sure U.S. Listens,” *New York Times*, January 24, 1996.

<sup>24</sup> Interview with Chas. Freeman, April 1998.

<sup>25</sup> Stokes, Mark A., *China’s Strategic Modernization: Implications for the United States* (Army War College, Strategic Studies Institute, September 1999).

estimated 36 CSS-2s to Saudi Arabia, but those are armed with conventional, high-explosive warheads, weighing 2,500 kg each.<sup>26</sup>) The missile is transportable and can be launched from pre-surveyed, above-ground launch bases. It is a single-stage missile using storable liquid propellant and strap-down inertial guidance. Based in northwestern, southern, and northeastern China, the DF-3As can target Russia, India, Japan, and South Korea. As of 1997, about 40 launchers were deployed (with multiple missiles for each launcher), but the DF-3As have been gradually replaced by the mobile, solid-fuel DF-21s (CSS-5s) and will likely be removed from service completely by 2002.<sup>27</sup>

**DF-4 ICBM.** Perhaps 25<sup>28</sup> DF-4 (CSS-3) ICBMs are deployed. The DF-4s can each deliver a 2,200 kg. (4,850 lb.) warhead to more than 5,500 km. (3,400 mi.).<sup>29</sup> The PLA has deployed DF-4s since 1980, in part to target Moscow and U.S. bases on Guam. A CEP of 1,500 m. (0.9 mi.) is reported. The missiles are based in silos, including those in northwestern China. The DF-4s have a response time of perhaps 2.5 hours. They have two stages and use storable liquid propellant and strap-down inertial guidance. The missiles launch single nuclear warheads with yields of about 3 MT. The missiles have also been produced as boosters for the Long March space vehicles that launch satellites.

## **Phase 2: DF-5A, JL-1, DF-21/21A, M-9, M-11, M-7**

In the second phase, China has a diversified ballistic missile force, with the addition of a longer-range ICBM, a mobile, solid-fuel MRBM (with nuclear and conventional versions), and SRBMs. The PLA has ballistic missiles for conventional use. The newer missile force features mobility and solid fuel, except for the ICBMs. However, the deployment of the PRC's first-generation SLBM is delayed.

**DF-5A ICBM.** Development of the DF-5A (CSS-4) ICBM involved overcoming challenges of new technical requirements before the first full-range test flight into the Pacific Ocean in May 1980. Deployed since 1986, the DF-5A is an improved version of the DF-5 first deployed in 1981. The DF-5A ICBM can carry a single 3,200 kg. (7,050 lb.) warhead to 13,000 km. (8,100 mi.), capable of reaching a number of U.S. cities. The yield of each nuclear warhead is 4-5 MT, sufficient to destroy a large city. The missile has a CEP of 500 m. (0.3 mi.) The DF-5A is a two-stage missile, and uses storable liquid fuel and gyroplatform inertial guidance with on-board computers. The missiles are based in hardened underground silos. The missiles are also produced as boosters for Long March vehicles to launch satellites.

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<sup>26</sup> See CRS Report 96-767, *Chinese Proliferation of Weapons of Mass Destruction: Background and Analysis*, September 13, 1996, by Shirley Kan.

<sup>27</sup> Gertz, Bill, "New Chinese Missiles Target All of East Asia," *Washington Times*, July 10, 1997, citing a secret report by the National Air Intelligence Center (NAIC).

<sup>28</sup> Gertz, Bill, "China Targets Nukes at U.S.," *Washington Times*, May 1, 1998; National Air Intelligence Center (NAIC), *Ballistic and Cruise Missile Threat*, April 1999.

<sup>29</sup> Office of the Secretary of Defense.

According to a news report (citing a classified CIA report), by 1998, the PRC deployed 18 CSS-4s with single nuclear warheads, of which 13 are targeted at U.S. cities, with the other five CSS-4s aimed at Russia and other countries closer to China.<sup>30</sup> When asked about this report, White House spokesman Mike McCurry confirmed that PRC strategic nuclear missiles are targeted at the United States by replying that “the President has spoken to the issue of ‘de-targeting’ on a number of occasions, making clear there are no *Russian* nuclear missiles targeted on the United States.”<sup>31</sup> Another report said that the PRC produced eight more CSS-4s in 1998, before the production plant at Wanyuan closed.<sup>32</sup> In September 1998, a CIA official publicly confirmed that China has deployed about 20 CSS-4 ICBMs, with most of them targeted at the United States. These missiles are kept in a status without fuel and without warheads mated to the missiles, so that an unauthorized or accidental launch is “highly unlikely.” On-going modernization “will likely increase the number of Chinese warheads aimed at the United States.”<sup>33</sup> According to a 1999 Air Force report, the PLA has deployed less than 25 CSS-4s in silos.<sup>34</sup> In April 1999, President Clinton stated that the PRC has fewer than two dozen long-range nuclear weapons, compared to 6,000 in the U.S. arsenal.<sup>35</sup> As discussed above, the DCI’s April 1999 unclassified damage assessment confirmed that the PRC already has the “technical capability” to develop a MIRV system for the currently deployed ICBM but has not deployed a MIRV system.

**JL-1 SLBM.** The JL-1 (JL stands for *Julang*, or Giant Wave) submarine launched ballistic missile (SLBM) is designated CSS-NX-3 in the United States. The JL-1 is intended to demonstrate a significant technological improvement. It is to be China’s first SLBM to provide the third leg of its nuclear triad and increased nuclear deterrence capability. In the 1960s, the JL-1 was developed as China’s first solid-fuel missile, providing greater survivability and more rapid response time. A total of 12 JL-1 SLBMs are designed to be deployed on China’s one Xia nuclear ballistic missile submarine (SSBN). The JL-1 would deliver a 600 kg. (1,300 lb.) warhead to about 1,700 km. (1,050 mi.).<sup>36</sup> The single nuclear warhead may have a yield of 250 kT. The missile has two stages and gyroplatform inertial guidance with an on-board computer. Accuracy is believed to be 700 m CEP. Contrary to some earlier reports that the JL-1 has been deployed since 1987, the Xia SSBN and its JL-1 SLBM are not

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<sup>30</sup> Gertz, Bill, “China Targets Nukes at U.S.,” *Washington Times*, May 1, 1998.

<sup>31</sup> White House, news briefing, May 1, 1998.

<sup>32</sup> Gertz, Bill, “China Adds 6 ICBMs to Arsenal,” *Washington Times*, July 21, 1998.

<sup>33</sup> Walpole, Robert D., National Intelligence Officer for Strategic and Nuclear Programs, speech at the Carnegie Endowment for International Peace, September 17, 1998.

<sup>34</sup> NAIC.

<sup>35</sup> President William Jefferson Clinton, speech sponsored by the U.S. Institute for Peace at the Mayflower Hotel, Washington, D.C., April 7, 1999.

<sup>36</sup> NAIC confirms the JL-1’s range to be about 1,000+ miles.

yet operational.<sup>37</sup> Meanwhile, the PRC is developing the Type 094 SSBN and JL-2 SLBM.

**DF-21/21A MRBM.** The new technology developed for the JL-1 was applied to other ballistic missiles, most notably its land-based variant, the DF-21 MRBM. It uses the same solid fuel and guidance as the JL-1 SLBM. The DF-21's automatic command-control-firing system is said to be the first in the Second Artillery. Launched from a mobile transporter-erector-launcher (TEL), the DF-21 is the PLA's first land-mobile, solid-fuel ballistic missile.

There are believed to be two versions of this MRBM: DF-21 (CSS-5 Mod 1) with a nuclear mission and the DF-21A (CSS-5 Mod 2) with a conventional role. (Still, the respective missiles may not necessarily be assigned an exclusively nuclear role or an exclusively conventional role.) The DF-21 MRBM can deliver a single 600 kg. (1,300 lb.) nuclear warhead with a yield of perhaps 250 kT to about 2,500 km. (1,600 mi.). The DF-21A can deliver a heavy, conventional high-explosive warhead up to about 2,000 km. (1,200 mi.).<sup>38</sup> If, as reported, the DF-21A replaced another conventional MRBM under development, it may have a 2,000 kg. (4,400 lb.) warhead.<sup>39</sup> According to one news report (citing a classified NAIC report), launchers for the DF-3A MRBM have been converted to launch the new MRBM to target Taiwan from Lianxiwang.<sup>40</sup> This site, in Anhui province, is just about 450 miles from Taiwan, which would indicate the possibility of a very high, lofted trajectory for the MRBM. In 1996, an engineer from the Beijing Research Institute for Telemetry reportedly said that China has been developing a terminal guidance system for the DF-

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<sup>37</sup> Office of Naval Intelligence, *Worldwide Submarine Challenges*, 1997; Secretary of Defense, "Report to Congress Pursuant to Section 1226 of the FY98 National Defense Authorization Act," July 1998; NAIC; Cox Committee's report.

<sup>38</sup> NAIC, BMDO (Ballistic Missile Defense Organization), Office of Secretary of Defense, and other open sources estimate the CSS-5's range at 1,800 km. *Jane's* reports ranges of 2,150 km for the DF-21 and 2,500 km for the DF-21A. Other sources give the range at 2,000 km. An approximate range of 2,500 km is used here for the DF-21 (sufficient to reach Japan and South Korea from bases in Qinghai province and India from bases in Yunnan province). The DF-21 is also reportedly replacing the 2,800-km DF-3A. An approximate range of 2,000 km is used for the DF-21A (sufficient to reach targets in Southeast Asia, such as Taiwan, from bases in Yunnan and Jilin provinces).

<sup>39</sup> Another program for a DF-25 was conceived (along with the DF-15 SRBM) as a mobile, solid-fueled MRBM with a conventional warhead. The DF-25 would deliver a 2,000 kg. (4,400 lb.) warhead to 1,700 km. (1,060 mi.). The missile would have two stages, inertial guidance, and solid propellant. The DF-25 would also be land-mobile, with trucks to transport it from semi-hardened storage sites to launch sites. The missile was said to be intended as a tactical weapon for use in the South China Sea in disputes over the Spratly Islands. However, the priority of this program may have declined. There have not been reports of test-firings of the DF-25. Indeed, China has abandoned development of the DF-25, according to *Jane's Defence Weekly* (December 4, 1996). Recent Pentagon reports do not mention this missile. It is presumed to be canceled, with the conventional DF-21A MRBM taking its role.

<sup>40</sup> Gertz, Bill, "New Chinese Missiles Target All of East Asia," *Washington Times*, July 10, 1997.

21. Other sources in Taiwan said that the new guidance system will be radar-based.<sup>41</sup> The DF-21 is believed to have an accuracy of 700 m CEP. As of 1999, the DF-21 had a nuclear mission only, but greater accuracy would permit a conventional role as well.<sup>42</sup> Since deployment in 1991,<sup>43</sup> the DF-21 has been replacing the older DF-3A, and complete replacement is expected by 2002.<sup>44</sup> There are up to 50 launchers, with several (perhaps 5-10) DF-21s that can be re-loaded onto each launcher.<sup>45</sup> The DF-21A may have been deployed after 1999.

**DF-15/M-9 SRBM.** The DF-15 SRBM, popularly known by the PRC's export designation of M-9, was given the U.S. designation of CSS-6. The M-9 is capable of delivering a conventional or nuclear warhead of at least 500 kg. (1,100 lb.) to at least 600 km. (370 mi.). The M-9 is believed to have a conventional, high-explosive warhead. It may also have a nuclear warhead of perhaps 90 kT. The M-9 is launched from a mobile TEL with a preparation time of 30 minutes.<sup>46</sup> The M-9 is a single-stage missile with solid fuel. The M-9 has a strap-down inertial guidance system with an on-board computer. In addition, a miniature propulsion system on the warhead can correct the missile's terminal velocity, reentry attitude, flight trajectory, and range. This control during the descent phase improves the M-9's accuracy and penetration. The missile has been promoted with a CEP of 300 m. (0.2 mi.). In 1996, an engineer from the Beijing Research Institute for Telemetry cited above said that PRC researchers are integrating GPS technology to improve the accuracy of the M-9 missiles. The PLA reportedly has plans to increase the accuracy to 30-45 m.<sup>47</sup>

The mobile M-9s have been operational in the Second Artillery since 1995. In part to show displeasure with then Taiwan President Lee Teng-hui's 1995 trip to the United States and to intimidate Taiwanese voters in advance of their first direct presidential election, the PLA held military exercises including missile tests in July 1995 and March 1996. In both periods, M-9s were "test-fired" to waters (closure areas) off Taiwan. In the first missile firing in 1995, six M-9s were launched.<sup>48</sup> Three landed in a target area about 90 miles north of Taiwan in the East China Sea, but one missed the target area, crashing prematurely. Two M-9s that landed within the closure area were said to have landed on the target's southern edge. The M-9s test-

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<sup>41</sup> Fisher, Richard D., Jr. "China's Missile Threat," *Wall Street Journal*, December 30, 1996.

<sup>42</sup> Presentation by Mark A. Stokes at a PLA conference in September 1999.

<sup>43</sup> Secretary of Defense, July 1998.

<sup>44</sup> Gertz, Bill, "New Chinese Missiles Target All of East Asia," *Washington Times*, July 10, 1997.

<sup>45</sup> NAIC.

<sup>46</sup> *Jane's Weapons Systems 1988-89*.

<sup>47</sup> Stokes, Mark A., *China's Strategic Modernization: Implications for the United States* (Army War College, Strategic Studies Institute, September 1999).

<sup>48</sup> Secretary of Defense, "Report to Congress Pursuant to Section 1305 of the FY97 National Defense Authorization Act," April 1997.

fired in 1995 displayed a CEP of 3,200 meters.<sup>49</sup> During March 8-15, 1996, the PLA fired four M-9 missiles into two closure areas about 20 miles off Taiwan's port city of Keelung and 30 miles off the port city of Kaohsiung — closer to Taiwan than the target used in July 1995.<sup>50</sup> According to one report, China was ready to launch 20 to 30 M-9 missiles, although only four were fired.<sup>51</sup>

During those missile firings, the PLA had 30-50 M-9s, but increased that number to 150-200 by 1998. Along with an unknown number of M-11 SRBMs, the PLA is expected to increase its number of SRBMs to 650 by 2005.<sup>52</sup> In February 1999, the Secretary of Defense's unclassified report to Congress on the situation in the Taiwan Strait did not provide numbers, but warned that "within the next several years, the size of China's SRBM force is expected to grow substantially." It also reported that the PLA is incorporating satellite navigation technology to improve the accuracy of its SRBMs and that these missiles would likely target Taiwan's air defense sites, airfields, naval bases, command and control infrastructure, and logistics facilities.<sup>53</sup> Admiral Dennis Blair, Commander-in-Chief of the Pacific Command (CINCPAC), has publicly confirmed that the PLA, by 2000, has deployed about 200 ballistic missiles<sup>54</sup> against Taiwan and is adding 50 more a year, aiming to deploy 500-600 SRBMs facing Taiwan.<sup>55</sup> One report estimates the PLA to have deployed about 400 M-9s by 1998.<sup>56</sup> The M-9s are launched from bases in Jiangxi (Leping) and Fujian provinces to reach Taiwan.<sup>57</sup>

There is reportedly a program to develop a version of the M-9 with a longer range of 1,200 km. (750 mi.). Such a range would allow the M-9 to have a faster re-entry speed to counter lower-tier missile defense systems and be able to reach Taiwan from the PLA's missile base at Huaihua in Hunan province.<sup>58</sup>

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<sup>49</sup> Chen, Kevin, "Chinese Missiles Hit Near Taiwan," *Washington Times*, July 24, 1995.

<sup>50</sup> Office of Naval Intelligence. *Chinese Exercise Strait 961: 8-25 March 1996*. May 1996; Mufson, Steven, "China Targets Missile Tests On Sites Near Taiwan's Ports," *Washington Post*, March 6, 1996.

<sup>51</sup> Fisher.

<sup>52</sup> Walker, Tony and Stephen Fidler, "China Builds Up Taiwan Missiles," *Financial Times*, February 10, 1999; citing a classified Pentagon report.

<sup>53</sup> Secretary of Defense, "Report to Congress Pursuant to the FY99 Appropriations Bill," February 1999.

<sup>54</sup> It is unclear if Admiral Blair included DF-21As, M-9s, M-11s, and/or M-7s.

<sup>55</sup> Gertz, Bill, "Admiral Calls for Pacific Missile Defense System," *Washington Times*, November 12, 1999; Admiral Dennis Blair, remarks presented at the Carnegie International Non-Proliferation Conference, Washington, D.C., March 16, 2000.

<sup>56</sup> *Jane's Strategic Weapon Systems*, September 1998.

<sup>57</sup> Stokes, Mark A. *China's Strategic Modernization: Implications for the United States* (Army War College, Strategic Studies Institute, September 1999).

<sup>58</sup> Stokes, Mark A., presentation at a PLA conference, September 1999.

**DF-11/M-11 SRBM.** The DF-11 SRBM, or M-11 (U.S. designation of CSS-7) is similar to the solid-fuel M-9 missile, but has two stages and a shorter range, originally 300 km. (185 mi.), for a payload of at least 500 kg. (1,100 lb.). It is also considered nuclear or conventional capable. In 1991 and 1993, the United States twice imposed sanctions on China and Pakistan for M-11 related missile technology transfers. Sanctions were not imposed for the transfer of complete M-11 SRBMs, first publicly confirmed by the CIA in September 1999. The CIA also warned that Pakistan's M-11s may have a nuclear role.<sup>59</sup>

As of 1999, the M-11 had not yet been deployed, while an improved version (reported as CSS-7 Mod 2) with a longer-range and a heavier, 800 kg. warhead was under development. Its accuracy is believed to be 150 m. CEP.<sup>60</sup> The M-11's range is sufficient to cross the Taiwan Strait (about 100 miles wide) in minutes. As noted above, the number of the PLA's SRBMs, including M-9s and M-11s, is expected to increase to perhaps 650 by 2005. In late 1999, it was reported that the PLA was expanding two new M-11 bases in Fujian province, across the strait from Taiwan. One base at Yongan, about 275 miles from Taiwan, would host a PLA missile brigade with perhaps 16 launchers for up to 96 M-11 SRBMs.<sup>61</sup> The location of this base indicates that the improved version of the M-11 would have a range of up to 450 km. (280 mi.). The M-11 may have a variety of conventional warheads, including high-explosive, cluster, deep-penetrating, and electromagnetic pulse (to disrupt electronic devices), and fuel-air explosives. Another new base at Xianyou would host a second PLA M-11 brigade.<sup>62</sup> Two bases would make a total of perhaps 32 launchers.

**8610/M-7 SRBM.** The 8610 or M-7 (CSS-8) SRBM is a modified HQ-2 surface-to-air missile (SAM). It is a two-stage missile that can deliver a conventional, high-explosive warhead of 190 kg. (420 lb.). The first stage has solid fuel, while the second stage has liquid fuel.<sup>63</sup> The 8610 was originally developed for export to Iran. First developed with a range of 150 km. (90 mi.), the M-7 is now believed to have a range of 180 km. (110 mi.) for possible deployment along the coast of Fujian province opposite the strait from Taiwan.<sup>64</sup>

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<sup>59</sup> National Intelligence Council, *Foreign Missile Developments and the Ballistic Missile Threat to the United States Through 2015*, September 1999; CRS Issue Brief IB92056, *Chinese Proliferation of Weapons of Mass Destruction: Current Policy Issues*, by (name redacted).

<sup>60</sup> Secretary of Defense, "Report to Congress Pursuant to the FY99 Appropriations Bill," February 1999; Mark A. Stokes, presentation at a PLA conference, September 1999.

<sup>61</sup> According to Stokes (*China's Strategic Modernization*), each PLA Second Artillery brigade is assigned one class of missile. Each brigade has 3-4 battalions, each with 3-4 launchers. Each launcher may be re-loaded with multiple missiles. According to the *Washington Times* article, there would be 6 M-11s available to be re-loaded onto each of 16 launchers for a total of 96 missiles in each brigade.

<sup>62</sup> Gertz, Bill, "China Points More Missiles at Taiwan" and "China Targets Taiwan with 2<sup>nd</sup> Missile Base," *Washington Times*, November 23, 1999 and December 8, 1999.

<sup>63</sup> NAIC.

<sup>64</sup> Stokes, Mark A., presentation at a meeting of the Project for the New American Century, (continued...)



### Phase 3: DF-31, JL-2

Phase three missile development includes the land-mobile, solid-fuel DF-31 ICBM and the next-generation JL-2 SLBM on a new ballistic missile submarine. These missiles may be deployed in 2000-2005 or later.

**DF-31 ICBM.** The DF-31 (CSS-X-9) would be China's next-generation ICBM, the PLA's first ICBM to be land-mobile and use solid fuel. The three-stage missile would be able to deliver a 700 kg. (1,550 lb.) warhead to 8,000 km. (5,000 mi.), sufficient to reach Russia, Hawaii, Alaska, and the U.S. west coast. The PRC may develop MIRVs for deployment on the DF-31 ICBM. Some intelligence reports say the DF-31's warhead would have a yield of 2.5 MT, but others estimate a miniature nuclear warhead at 100-200 kT.<sup>65</sup> China reportedly test-fired a new solid-fuel rocket motor for the DF-31 on July 1, 1998. Some questioned the timing of the test, since it took place during President Clinton's visit in China. The DF-31 development program is reportedly in the late stages.<sup>66</sup> The White House, on July 22, 1998, confirmed the test, saying the fact that China tested a rocket motor is "not surprising" and is "consistent" with PLA modernization.<sup>67</sup> On August 2, 1999, the PLA conducted the first flight-test of the DF-31, a test that the PRC said was successful, without naming the missile.<sup>68</sup> Reportedly, the DF-31 was tested with decoys, or penetration aids, designed to look like warheads and defeat missile defenses.<sup>69</sup> While confirming the DF-31's first flight-test, a Pentagon spokesperson said that the PLA is "not close to deploying a new mobile missile as far as we can tell" and that deployment would be "several years off."<sup>70</sup>

For the October 1, 1999 celebrations in Beijing marking the 50<sup>th</sup> anniversary of the founding of the PRC, the PLA showed the new DF-31 in its military parade.<sup>71</sup> The PLA may have tested the DF-31 a second time in December 1999.<sup>72</sup> The DF-31

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<sup>64</sup> (...continued)  
April 23, 1999.

<sup>65</sup> Gertz, Bill, "China Ready to Test New Missile," *Washington Times*, June 28, 1999.

<sup>66</sup> Gertz, Bill, "Rocket Test Sent Message to U.S." and "White House Plays Down Test of Rocket Motor by Chinese," *Washington Times*, July 22 and 23, 1998.

<sup>67</sup> White House, press briefing by Mike McCurry, July 22, 1998.

<sup>68</sup> *Xinhua* (New China News Agency), August 2, 1999; John Pomfret and Steven Mufson, "China, Taiwan Step Up Sorties Over Strait," *Washington Post*, August 3, 1999.

<sup>69</sup> Gertz, Bill, "China Develops Warhead Decoys to Defeat U.S. Defenses," *Washington Times*, September 16, 1999.

<sup>70</sup> Department of Defense, news briefing, August 3, 1999.

<sup>71</sup> August, Oliver and Michael Evans, "Beijing Parades Its Long-Range Missile Threat," *London Times*, October 2, 1999.

<sup>72</sup> Gertz, Bill, "China's Missile Test," *Inside the Ring*, *Washington Times*, December 3, 1999.

is not yet deployed<sup>73</sup> but expected to be in service sometime in 2000-2005, replacing the DF-4.

The Director of the Defense Intelligence Agency (DIA) presented his assessment of the PLA's strategic modernization to Congress in early 2000. He testified that:

China's strategic nuclear force is small and dated at present, but Beijing's top military priority is to strengthen and modernize its strategic nuclear deterrent. Several new strategic missile systems are under development, along with upgrade programs for existing missiles, and for associated command, control, communications and other related strategic force capabilities. In early August 1999, China conducted the first test flight of its DF-31 ICBM. It will be deployed on a road-mobile launcher and will have the range to target portions of North America. While the pace and extent of China's strategic modernization clearly indicates deterrent rather than "first strike" intentions, the number, reliability, survivability, and accuracy of Chinese strategic missiles capable of hitting the United States will increase significantly during the next two decades.<sup>74</sup>

**JL-2 SLBM.** The JL-2 SLBM (U.S. designation of CSS-NX-4) would be the submarine-launched version of the DF-31 ICBM. The JL-2 would have a much greater range than the JL-1 (8,000 km. (5,000 mi.) compared to 1,700 km. (1,050 mi.)) and be launched from the planned, next generation Type 094 SSBN. However, development of the land-based DF-31 was given priority over the JL-2 SLBM, perhaps because of the cost and difficulties of building the submarine. Each Type 094 SSBN is expected to carry 16 JL-2 SLBMs.<sup>75</sup> The JL-2 may carry a single nuclear warhead with a yield of 250 kT or smaller (50-90 kT). Speculatively, JL-2s may be deployed after 2005. If the JL-2 is deployed, it will provide the PLA with the capability, for the first time, to target parts of the United States from one or more SSBNs operating near the PRC's coastline.<sup>76</sup> The Type 094 SSBN is expected to benefit from Russian and Western submarine technology.<sup>77</sup>

#### **Phase 4: DF-41**

The fourth phase is represented by the longer-range DF-41 ICBM program. The DF-41 (CSS-X-10) ICBM would have three stages and use solid fuel. The new ICBM would be capable of delivering an 800 kg. (1,760 lb.) warhead to 12,000 km. (7,500 mi.). This ICBM would also be road-, rail-, and/or river-mobile. Deployment is planned to replace the old DF-5A ICBM which is expected to be withdrawn from service. China may develop MIRVs for the DF-41 and deploy it around 2010.<sup>78</sup> The

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<sup>73</sup> NAIC.

<sup>74</sup> Vice Admiral Thomas R. Wilson, Director of DIA, statement before the Senate Select Committee on Intelligence, February 2, 2000.

<sup>75</sup> Office of Naval Intelligence. *Worldwide Submarine Challenges*. 1997.

<sup>76</sup> NAIC.

<sup>77</sup> Office of Naval Intelligence, *Worldwide Submarine Challenges*, 1997.

<sup>78</sup> Montaperto, Ronald. "China," *Strategic Assessment 1997*. National Defense University.

## CRS-16

DF-41 may launch a single nuclear warhead, with a yield of 250 kT, or three warheads, each with a yield of 50-90 kT.

**Table 2. PLA Cruise Missiles with Ranges over 80 km.**

Type	PRC des.	US des.	Range/War-head (km/kg)	Speed (Mach)	Launch Platform	Comments
Anti-ship	HY-1	CSS-C-2 Silkworm	85/ 400	0.7	coastal defense	in service
Anti-ship	HY-2/ C-201	CSS-C-3 Seersucker	95/ 513	0.9	Luda destroyer; Jianghu frigate	in service
Air-launched, anti-ship	YJ-6/ C-601	CAS-1 Kraken	110/ 513	0.9	H-6D bomber	in service; version of HY-2
Air-launched, anti-ship	YJ-62/ C-611	CAS-1 Kraken	200/ 513	0.9	H-6D bomber	in service; improved YJ-6
Anti-ship	HY-3/ C-301	CSS-C-6 Sawhorse	180/ 513	2.0	coastal defense	in service
Anti-ship	HY-4/ C-201	CSS-C-7 Sadsack	135-200/ 500	0.8	coastal defense/ H-6D bomber	in service
Anti-ship	YJ-2/ C-802	CSS-C-8 Saccade	120/ 165	0.9	destroyers, frigates, aircraft, helicopters	in service
Anti-ship		SS-N-22 Sunburn	160/ 300	2.5	Sovremenny destroyer (2 purchased)	Russia first supplied in 2000
Land attack	YJ-21/-22		180-400/?			development
Land attack	XY-41/YJ-63		300-400/500			development
Land attack	YJ-8		300/165			development
Land attack	YJ-9		400/?			development
Land attack	X-600		600/?			development

## PRC Cruise Missiles<sup>79</sup>

Since the 1950s, China has developed and deployed a number of coastal defense, ship-launched, and air-launched anti-ship cruise missiles, based originally on the Soviet P-15 missiles (NATO designation of SS-N-2A Styx). The PRC has also exported cruise missiles, transferring them to the Persian Gulf in the 1980s. More recently, in 1995-1997, the PRC supplied C-802 anti-ship cruise missiles to Iran.<sup>80</sup> The PLA's cruise missiles (deployed and under development) with ranges of at least 80 km. (50 mi.) are discussed here and summarized in Table 2, "PLA Cruise Missiles." Of these, the HY-3 (C-301) and the Russian-supplied SS-N-22 Sunburn are supersonic anti-ship cruise missiles. The PLA's cruise missiles have ranges up to 200 km., but China is reportedly developing longer range, land attack cruise missiles (LACMs). Reflecting limits of its domestic defense industries, the PRC, since the early 1990s, has turned to foreign procurement, particularly from Russia.

### Cruise Missiles in Service

**HY-1.** China's HY-1 (HY stands for *Hai Ying*, or Sea Eagle) coastal-defense, anti-ship cruise missile has a U.S. or NATO designation of CSS-C-2 Silkworm. The missile can deliver a 400 kg. (880 lb.) warhead to 85 km. (50 mi.). The payload is a conventional high-explosive warhead. Its guidance uses an active radar seeker. The HY-1 travels at a speed of Mach 0.7. In the 1980s, China sold Silkworms to both Iran and Iraq. The HY-1 has been in service since 1974 with the PLA Navy's coastal defense forces.

**HY-2/C-201.** The HY-2 coastal-defense or ship-launched, anti-ship cruise missile has the export name of C-201 and a U.S. designation of CSS-C-3 Seersucker. The missile has a range of 95 km. (60 mi.) with a payload of 513 kg. (1,130 lb.). The missile launches a conventional high-explosive warhead. There are at least three terminal guidance systems used on various HY-2 versions. The missile cruises at Mach 0.9. It has been deployed on Luda-class destroyers and Jianghu-class frigates.<sup>81</sup> The HY-2 has been in service since 1978.

**YJ-6/C-601.** The YJ-6 (*Ying Ji*, or Eagle Strike) anti-ship cruise missile, with the export name of C-601, is the air-launched version of the HY-2. It has the U.S. designation of CAS-1 Kraken. It is launched from a PLA H-6D bomber. The YJ-6 can deliver a 513 kg. (1,130 lb.) warhead to 110 km. (70 mi.).<sup>82</sup> The missile uses

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<sup>79</sup> Open sources of general information on PLA cruise missiles include: *Jane's Strategic Weapons Systems 2000*, September 1998-September 1999.

<sup>80</sup> See CRS Issue Brief IB92056, *Chinese Proliferation of Weapons of Mass Destruction: Current Policy Issues*, updated regularly, by (name redacted).

<sup>81</sup> Information also provided in: Yang Xincheng and Luo Jiahong. "China's Hai Ying-2 Shore-to-Ship Missile Weapon System." *Missiles and Spacecraft*, January 1990, translated in *JPRS Report (JPRS-CST-91-016)*, August 1, 1991.

<sup>82</sup> A maximum range of 110 km. (70 mi.) is given in: Yang Jingqing and Xu Zimou. "China's C-601 Air-to-Ship Missile Weapon System." *Missiles and Spacecraft*, July 1990, translated (continued...)

inertial and active radar terminal guidance. It travels at Mach 0.9. The C-601 was first conceived in the 1960s and development began in 1975, completing nine years later.<sup>83</sup> The missile has been in service since 1985.

**YJ-62/C-611.** The YJ-62 air-launched, anti-ship cruise missile is an improved version of the YJ-6. It has the export name of C-611. It has an extended range of 200 km. (125 mi.), and improved propulsion, electronics, and terminal guidance. The YJ-62 uses new high-energy fuel.<sup>84</sup> It is also launched by the H-6D bomber.<sup>85</sup> The YJ-62 is believed to have been in service since 1989.

**HY-3/C-301.** The HY-3 coastal defense, anti-ship cruise missile has the export name of C-301 and the U.S. designation of CSS-C-6 Sawhorse. Cruising at Mach 2.0, the HY-3 is China's only reported indigenous supersonic cruise missile with a range of over 80 km. (50 mi.). (The C-101 also cruises at Mach 2.0, but has a range of only 50 km. (31 mi.), so it has not been included in this report.) The HY-3's original range is 130 km. (80 mi.), and it launches a 513 kg. (1,130 lb.) high-explosive fragmentation warhead. The HY-3 has been improved with an extended range of 180 km. (110 mi.).<sup>86</sup> According to an engineer of the China Aerospace Corporation, this goal of flying up to 180 km. at twice the speed of sound has been reached.<sup>87</sup> The HY-3 uses inertial and active radar terminal guidance. The missile may have entered service in 1995.

**HY-4/C-201.** Efforts to extend the range of HY-2 series missiles resulted in the HY-4 coastal defense or air-launched, anti-ship cruise missile. It has the export name of C-201 and the U.S. designation of CSS-C-7 Sadsack. With a turbojet engine, the HY-4 has a range of 135 km. (85 mi.) with a 500 kg. (1,100 lb.) high-explosive warhead. It uses active radar terminal guidance and cruises at Mach 0.8. The coastal defense HY-4 has been in service since 1985, and the air-launched HY-4, since 1991. There is at least one improved version, called HY-41/C-201W, with a range of 200 km. (125 mi.).

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<sup>82</sup> (...continued)

in *JPRS Report (JPRS-CST-91-016)*, August 1, 1991.

<sup>83</sup> Wang Jianmin, president of the Third Academy of the China Aerospace Corporation, "Speed Up the Progress of Basic Model, Then Serialization, and Work Hard to Develop China's Cruise Missile Industry," *Zhongguo Hangtian (China Aerospace)*, September 1, 1996; translated by FBIS.

<sup>84</sup> Wang.

<sup>85</sup> Yang and Xu.

<sup>86</sup> Jiang Junliang and Huang Taian, "China's C-301 Supersonic Anti-Ship Missile," *Missiles and Spacecraft*, February 1991, translated in *JPRS Report (JPRS-CST-91-016)*, August 1, 1991; Lennox, Duncan. "China's New Supersonic Anti-ship Missile," *Jane's Intelligence Review*, November 1992.

<sup>87</sup> Opall, Barbara. "Chinese Strive to Boost Range, Aim of Missiles," *Defense News*, December 9-15, 1996.

**YJ-2/C-802.** The YJ-2 air-, ground-, or ship-launched, anti-ship cruise missile is popularly known by its export name of C-802 and has a U.S. designation of CSS-C-8 Saccade.<sup>88</sup> Its air-launched version is marketed as the C-802K. It delivers a more compact, 165 kg. (365 lb.) high-explosive warhead. Its range is 120 km. (75 mi.).<sup>89</sup> (The YJ-1/C-801 variant has a range of only 40 km. (25 mi.), so it is not discussed here.) The C-802 missile uses inertial and active radar guidance and cruises at Mach 0.9 with a turbojet engine. The missile can be deployed on land, ships, aircraft, or helicopters. The missile has been in service since 1994. Starting in 1995, China transferred C-802 anti-ship cruise missiles to Iran for use on PRC- and French-supplied patrol boats.<sup>90</sup> China displayed C-802 missiles with improved guidance at "Airshow China 1996" in November 1996.<sup>91</sup> The Pentagon has reported continuing technological upgrades to the C-802, and that the air-launched version will likely be carried by the PLA Navy's new FB-7 bomber.<sup>92</sup>

**SS-N-22 Sunburn.** At the end of 1996, then PRC Premier Li Peng visited Russia. He reportedly concluded an agreement to purchase for the PLA two Sovremenny-class destroyers equipped with SS-N-22 Sunburn anti-ship cruise missiles.<sup>93</sup> Defense Department officials were quoted as saying that the Sunburn missiles were designed to counter U.S. naval warships equipped with the Aegis combat system. The sea-skimming Sunburn anti-ship cruise missiles are supersonic, traveling at Mach 2.5. The Sunburn can launch a high-explosive or nuclear (200 kT) warhead weighing 300 kg. (660 lb.) to an extended range of 160 km. (100 mi.). Each ship has eight Sunburn launchers (grouped in fours).<sup>94</sup> As confirmed by the Pentagon, in February 2000, the first Sovremenny-class destroyer for the PLA Navy arrived at a base belonging to the East Sea Fleet (in Zhejiang province) after sailing through the Taiwan Strait.<sup>95</sup> The destroyer was reportedly delivered without the missiles, but 24 Sunburns were transferred in the spring of 2000, with a second delivery later.<sup>96</sup>

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<sup>88</sup> China Precision Machinery Import Export Corporation (CPMIEC), "C802 Antiship missile," marketing brochure.

<sup>89</sup> Wang.

<sup>90</sup> See CRS Issue Brief IB92056, *Chinese Proliferation of Weapons of Mass Destruction: Current Policy Issues*, updated regularly, by (name redacted).

<sup>91</sup> Opall.

<sup>92</sup> Secretary of Defense, "Report to Congress Pursuant to the FY99 Appropriations Bill," February 1999.

<sup>93</sup> Gertz, Bill, "Pentagon Says Russians Sell Destroyers to China," *Washington Times*, January 10, 1997.

<sup>94</sup> *Jane's Fighting Ships 1997-98*.

<sup>95</sup> Karniol, Robert, "China's First Sovremenny Sets Sail for Home," *Jane's Defence Weekly*, January 19, 2000; Craig Smith, "New Chinese Guided-Missile Ship Heightens Tension," *New York Times*, February 9, 2000; *Zhongguo Tongxun She (China News Agency)*, Hong Kong, February 12, 2000; DoD News Briefing, February 10, 2000.

<sup>96</sup> Gertz, Bill, "Russia Sends Cruise Missiles to China for New Warships," *Washington Times*, May 19, 2000.

## Cruise Missiles under Development

In 1997, the Pentagon reported to Congress that China has placed priority on developing land attack cruise missiles (LACMs) “for theater warfighting and strategic attack.” The PLA’s future LACMs can be expected to be air-launched (from bombers) and then also sea-launched (from surface ships or submarines), and benefit from foreign technology (especially from Russia).<sup>97</sup> It is expected that the PLA’s first LACM to enter production will be operational in the early part of the 21<sup>st</sup> century.<sup>98</sup> China’s emphasis on its own LACM development programs reportedly has been influenced by the U.S. military’s success in using Tomahawk missiles for precision strikes during the 1991 Persian Gulf War and in conflicts since that war.

A LACM is an unmanned, armed aerial vehicle designed to attack a fixed or mobile ground-based target. A LACM mainly flies in level flight in a pre-programmed path to a pre-determined target. A small jet engine typically provides propulsion. A LACM may have a nuclear or conventional payload. Highly accurate guidance can make a conventionally armed LACM effective against even small targets. Guidance can be upgraded with a radar-based terrain contour matching (TERCOM) system, a radar or optical scene matching system, and/or a satellite navigation system (i.e., the U.S. Global Positioning System (GPS) or the Russian Global Navigation Satellite System (GLONASS)). A LACM flying at low altitudes and incorporating stealth features would pose a challenge to air or missile defense systems. On the eve of the 21<sup>st</sup> century, only the United States, Russia, France, and the United Kingdom have LACMs, but the PRC, Germany, Israel, and other countries are developing LACMs as well.<sup>99</sup>

There are various reports of possible reverse-engineering by the PRC of unexploded U.S. Tomahawks that were recovered from targeted countries, such as Afghanistan, Iraq, and Serbia. Tomahawks are launched from ships or submarines against land targets up to 1,600 km. (1,000 mi.) away. Some PRC and Hong Kong reports have claimed PLA development of a LACM similar to the Tomahawk that has a range up to 2,000 km., GPS and TERCOM guidance systems, and accuracy of 5 meters against fixed targets.<sup>100</sup>

**YJ-21/YJ-22.** At least since the 1995-1996 tensions in the Taiwan Strait, the PRC reportedly has accelerated its development of a version of the YJ-2/C-802 that would be a LACM with GPS and TERCOM systems to accurately hit targets in

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<sup>97</sup> Secretary of Defense, “Report to Congress Pursuant to Section 1305 of the FY97 National Defense Authorization Act,” April 1997.

<sup>98</sup> Secretary of Defense, “Report to Congress Pursuant to the FY99 Appropriations Bill,” February 1999.

<sup>99</sup> NAIC, April 1999. Besides the United States, Russia, and France named by NAIC, the Navy reports that the United Kingdom bought Tomahawks (operational since 1998).

<sup>100</sup> *Zhongguo Tongxun She (China News Agency)*, August 21, 1999; *Sing Tao Jih Pao (Hong Kong)*, August 14, 1999; translated by FBIS.



Taiwan.<sup>101</sup> According to *Jane's*, the C-802-based LACM programs include the YJ-21 with a range of 180 km. (110 mi.) and the YJ-22 with wings to extend the range to perhaps 400 km. (250 mi.).

**XY-41/YJ-63.** China is reportedly developing an improved version of the HY-4 as a LACM called XY-41.<sup>102</sup> This LACM may also be called the YJ-63.<sup>103</sup> This new XY-41 missile would be air- or ground-launched and deliver a 500 kg. (1,100 lb.) warhead to 300-400 km. (190-250 mi.).<sup>104</sup>

**YJ-8.** There is reportedly a LACM version of the YJ-8, with a smaller warhead (165 kg.; 365 lb.) than that of the XY-41. The YJ-8 LACM is being developed with a turbojet engine, with a range of at least 300 km. (190 mi.). It is to use GPS and TERCOM guidance, with accuracy of perhaps up to 10 m.<sup>105</sup>

**YJ-9.** The PRC reportedly is developing a new family of anti-radiation, LACMs called the YJ-9. (The PLA already has a new anti-radiation, surface-to-air missile called the FT-2000 that is designed to target aircraft with airborne early warning (AEW) systems.<sup>106</sup> The China Aerospace Corporation is also marketing the FT-2000 for export.<sup>107</sup>) The PRC is basing its development of the YJ-9 on Russia's Kh-31P and/or Israel's STAR-1 ARM systems, possibly with procurement or joint production. The supersonic Kh-31P is designed specifically to counter the U.S. AWACS, Patriot MPQ-53 radar, and the Aegis SPY-1D phased array radar. (It should also be noted that the United States has sold E-2T Hawkeye AEW aircraft and Patriot-derived Modified Air Defense Systems (MADS) to Taiwan.) The YJ-9 may have a range of up to 400 km. (250 mi.) and be launched from the air.<sup>108</sup>

**X-600.** Another reported LACM program is called the X-600. The program may have started in 1977. A range of 600 km. (375 mi.) is reportedly planned.<sup>109</sup>

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<sup>101</sup> Glashow, Jason and Theresa Hitchens, "China Speeds Development of Missile with Taiwan Range," *Defense News*, March 4-10, 1996.

<sup>102</sup> There has been some confusion about the designation of this missile. *Jane's* and others have called this missile a HY-41 or XW-41. Stokes notes that the "XY" name is probably a temporary name, since air-launched LACMs are expected to have a "YJ" designation.

<sup>103</sup> Interview with Taipei Economic & Cultural Representative Office (TECRO), April 2000.

<sup>104</sup> Stokes, Mark A., presentation at a PLA conference, September 1999.

<sup>105</sup> Stokes, Mark A., presentation at a PLA conference, September 1999.

<sup>106</sup> "China Shows New AWACS-killer Missile," *Jane's Defence Weekly*, September 16, 1998.

<sup>107</sup> Stokes, Mark A., *China's Strategic Modernization: Implications for the United States*.

<sup>108</sup> Stokes, Mark A., presentation at a PLA conference, September 1999.

<sup>109</sup> Lennox, Duncan, "China's New Cruise Missile Programme 'Racing Ahead'," *Jane's Defence Weekly*, January 12, 2000. The article attributed this missile to the Hong Niao (HN) family, but HN missiles have been reported as low-altitude air-defense missiles.

**Others.** Israel Military Industries (IMI) has reportedly developed a cruise missile with a hard-target penetrating warhead for China. The missile is said to have a range of 400 km. (250 mi.), with guidance that uses GPS and inertial navigation.<sup>110</sup>

## Conclusion and Policy Issues

Indigenously and through foreign acquisitions, China has worked to improve its ballistic and cruise missiles to provide a greater range of options for warfighting and increase combat effectiveness. Portending events to come, on June 12, 1995, the *Liberation Army Daily* discussed the utility of ballistic missiles in a conventional role. Then, in July 1995 and March 1996, Beijing's willingness to use its ballistic missile forces for political purposes, if not actual conflict, was forcefully demonstrated when M-9 SRBMs were "test-fired" to targets in waters near Taiwan. The missile test-firings were part of a psychological warfare campaign against Taipei. Other rationales driving China's missile modernization programs include technological advances, bureaucratic competition for resources, political objectives, international prestige, and development of related space and satellite programs.

After developing a land-based MRBM and a limited-range ICBM in the first phase, China pursued diversity and reliability. In the second phase, China added a longer-range ICBM, a mobile, solid-fuel MRBM (with nuclear and conventional roles), and mobile SRBMs to its ballistic missile force. In the third phase, China hopes to deploy after 2000 or 2005 a new land-mobile, solid-fuel ICBM with a more compact warhead, and a SLBM on a new submarine. For the fourth phase, China plans to deploy a land-mobile, longer-range ICBM later in the 21<sup>st</sup> century.

China has continued to increase the range, accuracy, survivability, reliability, safety, mobility, and response capability of its ballistic missile forces. China now has missiles for conventional and nuclear, strategic and theater operations, as well as for escalating military tensions short of war. Because the reliability of bombers in China's nuclear triad is questioned<sup>111</sup> and its SLBM is not operationally deployed, ground-based ballistic missiles are likely emphasized. Moreover, the Second Artillery is considered a "pocket of excellence" in the gradually modernizing PLA. China's missiles now have greater mobility, use solid instead of liquid propellant, on-board computers, and GPS technology for greater accuracy. Since 1990, the Second Artillery has deployed a diversified ballistic missile force consisting of short-range, medium-range, and intercontinental ballistic missiles.

China's cruise missiles include Russian supersonic SS-N-22 Sunburn cruise missiles. However, China does not have LACMs, but there are reportedly a number of development programs pursued with a high priority. The purchase of Russian Sunburn cruise missiles has indicated that the PLA is choosing to modernize more

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<sup>110</sup> "Israel to Equip Chinese Cruise Missile with Penetrator Warhead," *Flight International*, February 5-11, 1997.

<sup>111</sup> Lewis and Xue; Arnett.

rapidly through selective foreign acquisitions rather than relying solely on the deficient domestic defense industries.

In the future, the PLA's ballistic missiles can be expected to include land-mobile, solid-fuel ICBMs (perhaps with smaller nuclear warheads, improved accuracy, MIRV capability, and improved penetration capability) and SLBMs (perhaps deployed on an advanced SSBN). PRC cruise missiles can be expected to have extended ranges and greater accuracy, and include LACMs.

Since the mid-1990s, the PLA's dramatic build-up and launches of theater missiles have already spurred calls for meeting Taiwan's missile defense requirements and development of TMD.<sup>112</sup> While clearly modernizing and expanding its ballistic and cruise missile forces, however, it is uncertain whether China will substantially build up its currently limited strategic ICBM forces. The intelligence community predicted that, by 2015, the PLA is likely to have tens of missiles capable of targeting the United States. The question remains whether the PRC would further expand its strategic force to dozens, hundreds, or even thousands of nuclear warheads. If the PLA undertakes to expand its ICBM force, it could tap the civilian side of the PRC's aerospace industry. The DF-4 and DF-5A missiles have also been produced as boosters for the Long March space vehicles that launch satellites for the PRC and foreign companies.

A significant increase in China's strategic nuclear arsenal would send alarms through capitals in Asia, Russia, the United States, and Europe, at a time when the PRC is arguing that it is not a threat to any other country as it modernizes the PLA. Such a build-up would run counter to the PRC's stated priorities of economic development and promotion of international trade and investment to boost development. A significant increase in China's strategic missile forces would raise further questions about China's nuclear doctrine and military intentions, as well as the need to deploy NMD and expand arms control agreements to China.<sup>113</sup>

By 2000, U.S. policymakers and advocates have increasingly debated whether the PLA would significantly expand its strategic nuclear forces in response to U.S. deployment of NMD (because of PRC concerns about losing its nuclear deterrence) or build up and modernize its forces nonetheless.<sup>114</sup> In June 2000, the Pentagon's

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<sup>112</sup> See also: CRS Report RL30379, *Missile Defense Options for Japan, South Korea, and Taiwan: A Review of the Defense Department Report to Congress*, November 30, 1999, by (name redacted) and (name redacted); CRS Issue Brief IB98028, *Theater Missile Defense: Issues for Congress*, updated regularly, by (name redacted).

<sup>113</sup> See also: CRS Issue Brief IB10034, *National Missile Defense: Issues for Congress*, updated regularly, by (name redacted) and (name redacted); and CRS Report RS20031, *China and U.S. Missile Defense Proposals: Reactions and Implications*, updated March 17, 1999, by (name redacted).

<sup>114</sup> McDevitt, Michael, "China and National Missile Defense" series of workshops at the Center for Naval Analyses (CNA), 1999-2000; Bill Gertz, "U.S. Delegation Heads to China For Missile Talks," *Washington Times*, February 15, 2000; Bates Gill and James Mulvenon, "The China Puzzle," *Washington Post*, March 5, 2000; Robert A. Manning, Ronald  
(continued...)

spokesperson stated the latter view, saying that the PRC is “modernizing [its] strategic force and expanding it, and we anticipate that [the PRC] will do that whether or not we deploy a national missile defense system.” He added that “[China was] in the process of modernizing [its] strategic force long before the national missile defense became a hot political issue in the United States or a hot diplomatic issue on the world scene today. These are plans that weren’t started last week or last month. They’ve been ongoing for some time. So I don’t think that [China is] responding to particular concerns about the legitimate defensive plans we have underway to protect our nation from an attack against which we’re currently unprotected.”<sup>115</sup>

However, in August 2000, after debates among various intelligence agencies about how China and other countries might respond to U.S. deployment of NMD, a classified National Intelligence Estimate (NIE) apparently presented a different view. The NIE (the collective assessment of the intelligence community) reportedly concluded that China would significantly expand its strategic nuclear missile force beyond current plans. In response to U.S. pursuit of an NMD capability, the PRC would deploy mobile missiles with multiple warheads, expanding its force from perhaps 20 to as many as 200 warheads that could hit the United States by 2015. This larger force would be intended to overwhelm the limited NMD system under consideration. There would be further implications, with India and Pakistan responding with their own build-ups.<sup>116</sup>

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<sup>114</sup> (...continued)

Montaperto, and Brad Roberts, *China, Nuclear Weapons, and Arms Control* (Council on Foreign Relations, National Defense University, and the Institute for Defense Analyses, April 2000); Union of Concerned Scientists and the Massachusetts Institute of Technology, *Countermeasures: A Technical Evaluation of the Operational Effectiveness of the Planned U.S. National Missile Defense System*, April 2000; Erik Eckholm, “China Says U.S. Missile Shield Could Force An Arms Buildup,” *New York Times*, May 11, 2000; Jane Perlez, “China Likely to Modernize Nuclear Arms, U.S. Believes,” *New York Times*, May 12, 2000.

<sup>115</sup> Department of Defense, news briefing by Kenneth Bacon, June 29, 2000.

<sup>116</sup> Myers, Steven Lee, “U.S. Missile Plan Could Reportedly Provoke China,” *New York Times*, August 10, 2000; Roberto Suro, “Study Sees Possible China Nuclear Buildup,” *Washington Post*, August 10, 2000.

## Appendix: GPS and PRC Missiles<sup>117</sup>

China reportedly is trying to adapt satellite navigational technology to improve the accuracy of certain ballistic and cruise missiles. Satellites of the U.S. Global Positioning System (GPS) transmit signals that are accessible at no charge to anyone who has a commercially available receiver or a more capable military receiver. The receiver uses the signals to calculate its three-dimensional location on, above, or below the earth's surface. Russia has a similar system — the Global Navigation Satellite System (GLONASS).

The U.S. GPS consists of 24 satellites, ground control and monitoring stations, and receivers that take precise information from four or more satellites on the locations of the satellites and the time the signal was sent. A commercial receiver can determine the length of time it took the Standard Positioning Service signals to arrive from the satellites and calculate its position to within 100 meters. U.S. military receivers receive encrypted Precise Positioning Service signals that establish location within 21 meters. The system can be augmented to provide more accurate information. The most commonly used augmentation is Differential GPS (DGPS) which adds a signal from a base station whose location is precisely known, thereby enhancing the Standard Positioning Service to an accuracy of less than one meter.<sup>118</sup> In mid-1996, a U.S. company offered for sale a unit that receives and compares signals from U.S. and Russian satellites to provide more accurate position data. On May 1, 2000, President Clinton improved the civilian GPS, enabling receivers to be up to ten times more accurate. He also assured that national security would not be negatively impacted, since the United States has the capability to selectively deny GPS signals on a regional basis.<sup>119</sup>

If the guidance systems of China's missiles are supplemented by GPS, they can compare the actual position of the missile during flight, as determined by GPS, with the planned position along the flight trajectory and send correction signals to the missile control system. Cruise missiles generally travel in powered, aerodynamic flight all the way to the target, so they may use their control surfaces and propulsion adjustments to adjust course. During the boost phase, ballistic missiles can use control vanes or thrust deflectors to adjust course. Many missiles (but not SCUDs) jettison the rocket motor after the boost phase. In some sophisticated missiles, the reentry vehicle(s) can respond to signals from GPS-assisted guidance systems, using small thrusters to correct their course. Ballistic and cruise missiles can also use terminal guidance that will direct them to a recognized or designated point in the target area. Terminal guidance generally employs radar, imaging infrared, electro-

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<sup>117</sup> This appendix was prepared by Robert Shuey, Specialist in U.S. Foreign Policy and National Defense, Foreign Affairs, Defense, and Trade Division.

<sup>118</sup> Grier, Peter. "GPS in Peace and War," in *Air Force*, April 1996, pp. 76-78; "The Global Positioning System: Charting the Future," the National Academy of Public Administration and the National Research Council, May 1995, pp. 2-5.

<sup>119</sup> White House, "Statement by the President Regarding the United States' Decision to Stop Degrading Global Positioning System Accuracy," May 1, 2000.

optical, laser, millimeter wave, terrain contour mapping, or digital scene matching area correlation, rather than GPS.<sup>120</sup>

China has access to Standard Positioning Service GPS and commercial receivers. China has reportedly “refined the commercial GPS capability to provide accuracy of up to 10 meters,”<sup>121</sup> possibly using DGPS or an equivalent Russian augmented system.

China is reportedly trying to develop a land attack cruise missile based on its C-802 anti-ship missile. GPS-assisted guidance is said to be a key ingredient in the development of this cruise missile. Russia is said to be assisting China in the missile development and in the application of GLONASS to its guidance and control systems.<sup>122</sup>

GPS- and GLONASS-assisted missile guidance are advanced technologies, but probably within China’s capabilities. North Korea and Taiwan have much less experience in missile and space technology, but both have GPS-guided missiles.<sup>123</sup>

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<sup>120</sup> Ballistic Missile Proliferation. Training Course, TASC, Arlington, VA.

<sup>121</sup> Glashow and Hitchens.

<sup>122</sup> *Ibid.*, p. 1, 36; Lien-Ho Pao (Taipei), April 29, 1996, p. 1, cited in FBIS-CHI-96-086, April 29, 1996, abstracted in the Center for Nonproliferation Studies database, Monterey Institute for International Studies; Gertz, Bill. “China’s SS-18 plan underscores nuke-proliferation threat,” *Washington Times*, May 26, 1996, p. 4. The Taiwanese source that cited Russian technical assistance said China had probably bought from Russia and deployed cruise missiles capable of traveling 100 to 3,000 km with an accuracy of 10 meters. Russia may have such a system (perhaps the KH-65SE/KH-101), but K. Scott McMahan and Dennis M. Gormley report, “there have been no confirmed Russian transfers of advanced cruise missiles....” See their “Cruise Missile Proliferation: Threat and Response 1995-1996,” Pacific-Sierra Research Corporation, October 14, 1996, p. 5; Simon Saradzhyan, “Russia, China Discuss Manned Space Missions, Glonass Access,” *Space News*, March 20, 2000.

<sup>123</sup> National Ballistic Missile Briefings: North Korea, Center for Defense and International Studies, cited in Center for Nonproliferation Studies database; Lu Chao-Lung, “National Army to Test Surface-to-Surface Missiles this Year,” in *Chung-Kuo Shih-Pao* (Taipei), Sept. 11, 1996, FBIS-CHI-96-180, cited in Center for Nonproliferation Studies database.

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