Ballistic Missile Defense Organization

Country Profiles

CHINA

BMDO Countermeasure Integration Program

April 1995

Countermeasure Integration Program: Country Profiles

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EXECUTIVE SUMMARY

- The Chinese ballistic missile program has existed for nearly 40 years. A modernization effort is under way with an emphasis on solid-fueled, mobile, MIRVed systems equipped with miniaturized nuclear warheads.
- Because the development of BMD systems by both Russia and the United States threatens China's ballistic missile strategy of retaliatory deterrence based on small-scale missile deployment, China has a clear requirement for countermeasures to missile defenses.
- China's interest in countermeasures dates back to the mid-1960s, when the Chinese became concerned about the proposed U.S. Sentinel ABM system.
- Some Chinese ballistic missiles may be equipped with electronic countermeasures, light exoatmospheric decoys, an attitude control system, or some combination of these capabilities.
- China can use resources and expertise from a number of industries (e.g., missiles, aircraft, electronics, artillery, munitions, satellites, space launch vehicles) for development of a variety of countermeasures.
- Penetration aids, defense suppression, and circumvention of ballistic missile defenses by cruise missiles are categories of countermeasures that China is likely to consider. Saturation through large numbers of missiles or RVs appears to be a less feasible option, given the relatively small inventories and economic constraints on mass production of ballistic missiles for national deployment.
- China might pursue technology assistance from Russia, Ukraine, or Israel to shorten lead times for countermeasures development.
- Chinese defense modernization traditionally has stressed R&D with production and deployment based on apparent need. In this case, countermeasures deployment would be highly dependent on China's perception of the severity of BMD system deployment threats to itself or its client states.
- Development and production of countermeasures also could be influenced increasingly by China's interests in the ballistic missile export market. Demand for tactical ballistic missile systems with demonstrated effectiveness against ballistic missile defenses will grow.

I. INTRODUCTION

China has the world's largest population—nearly 1.25 billion people. Rapid economic growth and modernization of the industrial base are the hallmark of the government's domestic policy. By some measures, China may have the fourth largest economy in the world. The combination of a large population base and a robust economy allows Beijing to maintain the world's largest standing army and undertake the large-scale investments needed to build a modern navy and air force. China is also the world's fifth largest arms exporter and a leading arms supplier to the Third World with agreements worth more than $16 billion.

Historically, China has been the dominant power in East Asia. Notwithstanding cordial political and economically profitable relations with its neighbors, China continues to have some territorial disputes. India still disputes the border demarcations stemming from its 1962 war with China. There are indications that disagreements with Malaysia, Vietnam, and the Philippines over ownership of the oil-rich Spratly Islands could intensify as each country moves to establish a permanent presence on the contested islands. China has never given up its claim to Taiwan, and despite growing economic exchanges between the two, Beijing has hinted that it retains the option of using force to take control of the island, especially if Taipei declares its independence. Finally, in contrast to the final stages of the cold war, when China quietly sought a U.S. naval presence in the region to counterbalance that of the Soviet Union, Beijing's current attitude toward Washington's military engagement in the area is unclear. However, it does appear that China continues to view Japan, Russia, and the United States as long-term strategic rivals for regional influence and as potential military adversaries. Accordingly, China can be expected to maintain a strategic nuclear retaliatory force based on intermediate-range ballistic missiles (IRBMs), intercontinental ballistic missiles (ICBMs), and submarine-launched ballistic missiles (SLBMs). China's perceived adversaries are shown in Figure 1.

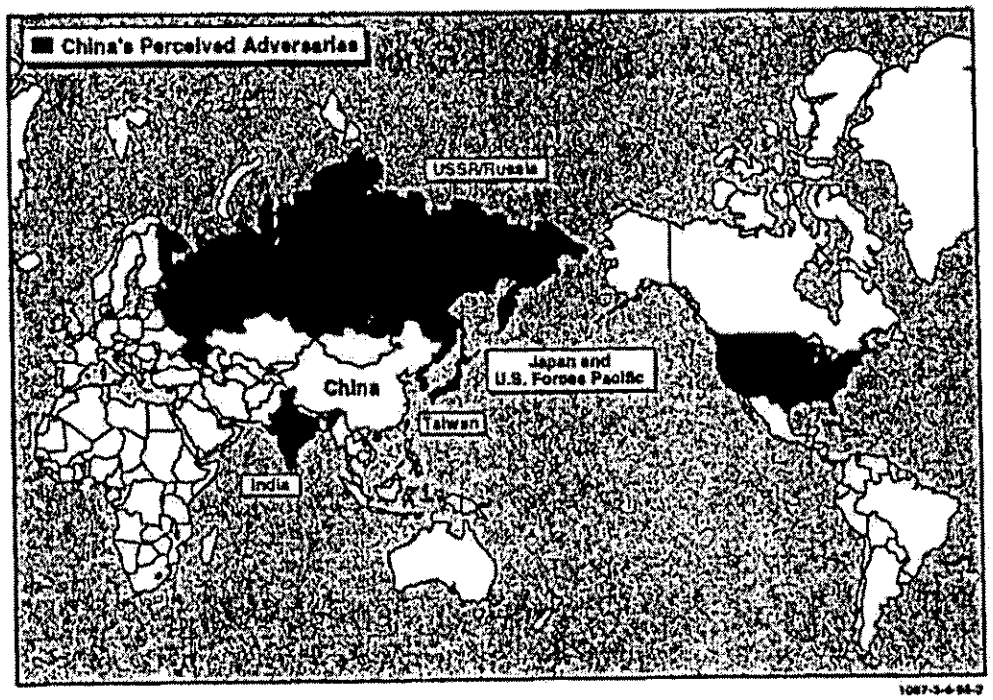

Figure 1. China's Strategic Threat Perception

China's development of nuclear weapons and ballistic missile delivery systems has its origins in technical assistance rendered by the former Soviet Union in the 1950s, although relations had cooled by the end of the decade. China's first generation of nuclear weapons and liquid-fueled ballistic missile forces emerged during the 1960s, 1970s, and early 1980s. Short-range systems (such as the DF-2 and DF-3) were developed first, providing capabilities to attack Taiwan and hold at risk U.S. forces deployed in the Western Pacific. As longer range systems (such as the DF-4) were developed, China could extend its target list to much of the Soviet Union. China's relations with India deteriorated rapidly after the brief war in 1962, perhaps leading to some missile targeting of that country as well. With the development of true ICBM systems (e.g., the DF-5) in the 1980s, China finally could reach the continental United States.

At a time when many major powers are decreasing their defense spending, China has increased its overall level of defense outlays in recent years by an average of more than 10 percent. The increases have been used in part to fund a significant modernization of its strategic nuclear forces. Although missile inventories may not have been expanded appreciably, this modernization includes the development and deployment of a new generation of IRBMs and ICBMs, and the transition from surface-to-surface missiles (SSMs) mounted with single or multiple reentry vehicle (MRV) nuclear warheads to multiple independently targetable reentry vehicle (MIRV) warheads.

China's fragile economy has not been able to sustain large missile force deployments such as those undertaken by the United States and the Soviet Union under the strategies of massive retaliation or mutual assured destruction (MAD). Instead, China has chosen a strategy that is within its economic resources and suited to its geopolitical situation. It deployed relatively few missiles against each adversary or perceived threat. While the systems were not accurate, they were armed with large-yield nuclear warheads, aimed at major population and industrial centers, with the objective of retaliatory deterrence.

Such a strategy is vulnerable to precise preemptory attacks or ballistic missile defenses. The Chinese approach to missile deployment made detection of their camouflaged and often hardened support bases extremely difficult, so perhaps they could have some confidence that preemptory attacks might not be 100 percent effective. The deployment of a limited antiballistic missile (ABM) system around Moscow since the 1970s, and the anticipated development of capable theater missile defense (TMD) and possibly national missile defense (NMD) systems by the United States and its friends and allies, pose an increased threat to the Chinese strategic deterrent. For this reason alone, China would have a major incentive to intensify countermeasures research. Moreover, China may see countermeasures technology as a niche in the international arms market that it might fill, in part, to assure potential customers of Chinese missile technology that the missiles they acquire can effectively penetrate future missile defenses.

II. HISTORY OF CHINESE MISSILE ACTIVITY

Ballistic Missiles

The Chinese ballistic missile program has its origins in a treaty of mutual assistance signed in 1950 with the Soviet Union, in which the Soviets agreed to supply large quantities of arms, technology, and training. Through the 1950s, China was almost completely dependent on the Soviets for the development of its ballistic missile program. During that time, three types of missiles were supplied to the Chinese either for educational or production purposes: the R-1 missile (a copy of the German V-2 or the Soviet Scunner), the 1059 (SS-2 or Sibling), and the 1060 (SS-1 or Scud A). Missile production facilities were established and work was begun to build a missile flight test center—all with active Soviet participation. Direct assistance ended in 1960 when the Soviets withdrew thousands of their technical advisors to the Chinese missile, aircraft, and nuclear weapons industries.

A chronology of significant milestones in China's quest for ballistic missile and nuclear weapons capabilities is included in the Appendix.

First Generation Systems. Through a combination of reverse engineering on missiles supplied by the Soviet Union and application of technology and training received from Moscow, China produced its first ballistic missiles, the DF-1 and DF-2. First deployed in the 1960s, these missiles were single-stage systems using liquid-propulsion rocket motors that carried a single warhead. As relations with the Soviets deteriorated in the 1960s, the Chinese increased their efforts to develop an independent missile program, as shown in Figure 2. The first missile to emerge from this indigenous effort was the DF-3.

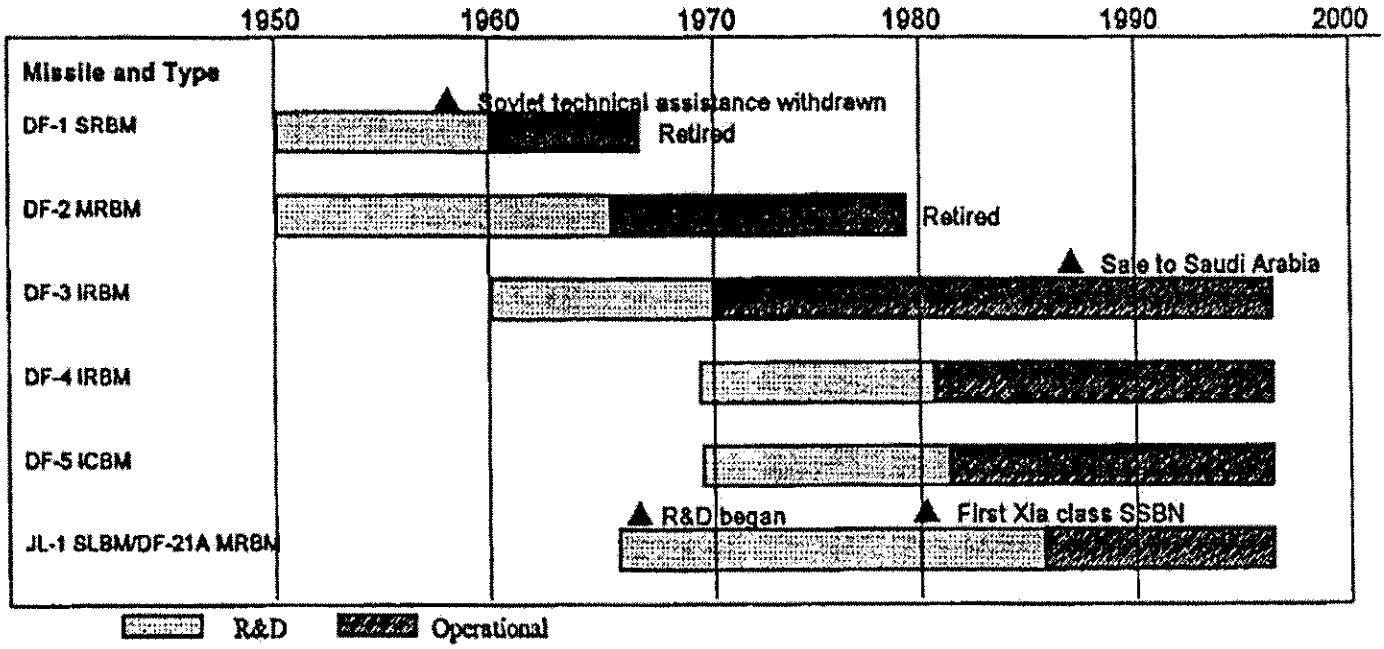

Figure 2. First-Generation Chinese Ballistic Missile Development Timelines and Milestones

The initial targets of China's SSMs have been understood to include U.S. military bases in Japan (DF-2), the Philippines (DF-3), and Guam (two-stage DF-4). Following border clashes with the Soviet in 1970, the Chinese modified the DF-4 to increase its range to 4,500 kilometers, thus enabling it to reach Moscow. In the 1970s, to enhance China's nuclear deterrent vis-à-vis the United States, Beijing also began development of its first ICBM, the DF-5, initially deployed in 1981.

Twenty years following the development of China's first SSM, China had developed only two types of IRBMs (DF-3 and DF-4) and one ICBM (DF-5). All three were liquid-fueled missiles serving as a second-strike minimal retaliatory force; they were intended to carry a single nuclear warhead for use against cities and similar large, soft targets. A summary of the technical capabilities of these missiles is presented in Table 1.

Table 1. First-Generation Chinese Ballistic Missile Characteristics

Missile	Range (km)	Payload (kg)	Technical Characteristics	Status
DF-1	590	950	One stage, liquid fuel	Deployed 1961-66 (retired)
DF-2	1,050	1,500	One stage, liquid fuel	Deployed 1966-79 (retired)
DF-3	2,650–2,800	2,150	One stage, liquid fuel, MRV	Deployed 1971; modernized 1986; basis for DF-4 and CZ-1 (SLV)
DF-4	4,750	2,200	Two stages, storable liquid fuel	Deployed 1980
DF-5	12,000	3,200	Two stages, storable liquid fuel	Deployed 1981
JL-1/ DF-21A	1,700-1,800	600	Two stages, solid fuel	Deployed 1988; JL-1 is an SLBM, DF-21 is a land-mobile IRBM

China has a long history of unsuccessful attempts to develop an SLBM. Under Soviet guidance in the 1950s, work was initiated to convert a Golf class submarine to a ballistic missile platform. The withdrawal of Soviet technicians halted these efforts.[1] During the 1960s, China indigenously developed a naval nuclear reactor and launched its first SSN in the early 1970s. The Xia class SSBN did not appear until the early 1980s. The Chinese began flight testing the JL-1 SLBM from the Golf test boat in 1982 and from the Xia boat in 1985. If the Xia/JL-1 system can be considered operational, it probably did not achieve that status until the late 1980s.

Intelligence reports indicate that China currently has over 100 land-based nuclear ballistic missiles operationally deployed—an estimated 14 ICBMs and 90 IRBMs. It is not known whether there will be a net increase in the number of strategic ballistic missiles deployed once modernization begins. However, there is expected to be an increase in the number of nuclear warheads that the Chinese ballistic missile forces are

[1] The boat apparently became the test launch platform for SLBM development.

capable of delivering as China moves toward MIRV technology.[2] At the same time, the DF-21 IRBM—a nuclear-armed, land-based variant of the JL-1 SLBM—reportedly is being reconfigured for conventional warfare operations in limited regional conflict scenarios.

Second-Generation Systems. China is expected to complete replacement of its first-generation strategic missile force with more survivable solid-fueled missiles, including both submarine-launched and ground-mobile versions, around the year 2010. The apparent goal is to field a less vulnerable and more flexible, accurate, and reliable strategic retaliatory force.

The characteristics of China's new generation of ballistic missile systems are summarized in Table 2. Three strategic missiles are under development: the 12,000-km DF-41 ICBM and a dual-purpose 8,000-km missile for both submarine (JL-2) and ground (DF-31) launch. All three missiles will be solid-fueled, and the land-based systems are being designed for firing from mobile launchers. These missiles can be expected to replace aging liquid-fueled systems, some of which are more than 25 years old. Although the new missiles will not provide increased range or payload, they will have greater prelaunch survivability and thus enhanced deterrent value. In all likelihood, these missiles will be MIRVed, requiring China to develop smaller nuclear weapons.

Table 2. Second-Generation Chinese Ballistic Missile Characteristics

Missile	Range (km)	Payload (kg)	Technical Characteristics	Status
JL-2/ DF-31	8,000	700	Three stages, solid fuel	JL-2 is an SLBM; DF-31 is land-mobile; both to be operational in the mid-1990s
DF-41	12,000	800	Three stages, solid fuel, MIRV	Expected to be operational in the late 1990s
DF-25	1,700	2,000	Two stages, solid fuel	Land mobile modification from DF-31; expected to be operational in the mid-1990s.
DF-15 (M-9)	600	500	One stage, solid fuel	Code DF-15 for domestic use; code M-9 for export
DF-11 (M-11)	300	500	Two-stages, solid fuel	Designation scheme similar to DF-15's
M-18	1000	400	Two stages, solid fuel	Displayed at an exhibition in 1988; no further details available
8610 (M-7)	300	500	Two stages, solid fuel	Modification from HQ-2 surface-to-air missile

The future scope and direction of China's SSBN/SLBM program is unclear. Although only one Xia class SSBN is known to exist, it is believed that the Chinese have built two additional boats and are constructing two more. Ongoing development of a new solid-fueled, enhanced-range SLBM, the JL-2, suggests continuing Chinese resolve to put some of their strategic deterrent forces to sea. Accordingly, the production of a larger fleet of SSBNs as launch platforms for this more powerful SLBM, with a range of 4,800 miles, is a possible future scenario. There have been no confirmed reports of the development of a new class of SSBN for the JL-2.

[2] China's continued pursuit of nuclear weapons probably indicates an interest in development of smaller nuclear warheads for a MIRV program.

China has been developing tactical ballistic missiles in the 300- to 600-km range since the mid-1980s, including the 8610 (export designation M-7), DF-15 (M-9), and DF-11 (M-11). China's motivation for developing these systems may have been initially to satisfy certain requirements for longer range artillery systems for the People's Liberation Army (PLA). In addition, China may have developed these systems in recognition of the lucrative missile export market as a significant potential source of hard currency.

The M-7 is an SSM variant of the HQ-2, China's domestic version of the Guideline (SA-2) surface-to-air missile (SAM), and does not represent a significant capability. Both the DF-15 (M-9) and DF-11 (M-11) are mobile, solid-propellant SSM systems that represent significant improvements over the Scud SSM and its derivatives—the only real competition in the export SSM field. Both systems are nearing operational status. Whether China will continue the drive for export sales, in the face of serious opposition from the United States, remains uncertain.

Space Launch Vehicles

China has a growing indigenous space launch vehicle (SLV) capability. Over the past few years, the average annual budget of the Chinese civilian space program has been 1.5 billion yuan ($168-$180 million), which covers research and development, rocket and satellite production, and launch site tests. China is increasingly active in the international satellite launch market, often undercutting the competition's prices.

Seven types of Long March (LM) civilian rockets, capable of launching satellites into low-earth polar and geostationary orbit, have been developed, as shown in Table 3. China has had technical difficulties in the development and operation of its largest LM rockets. For example, in March 1992, a launch of an LM-2E, China's newest and most powerful rocket, was aborted when a short circuit disrupted the flow of fuel to the auxiliary engines. The following year, an LM-3 SLV failed to put a satellite in orbit due to a malfunction of the third stage, and the missile failed its second launch as well. In yet another attempt in January 1995, an LM-2 rocket exploded after being launched from the Xichang Space Launch Center, destroying a U.S.-manufactured communications satellite.

Table 3. Chinese Long March Family of SLVs

Name	Payload Mass (kg)	Technical Characteristics	Availability
LM-1D	750	Three stages; converted from DF-4, a two stage missile	1970
LM-2C	2,800	Two stages; converted from DF-5	1975
LM-2E	9,000	Two stages	1991
LM-3	1,450	Three stages	1984
LM-3A	2,300	Three stages	1993
LM-4	2,500/1,000	Three stages	1988
LM-2E/HO	4,800	Three stages	1994

China's first two SLVs were derived from its DF-4 and DF-5 missiles, revealing a technological link between its SSM and SLV programs. In this regard, China's SLV program could provide useful technological input to the development of its MIRV program as well as the development of countermeasures.

As a result of recent launch failures, the future of China's SLV marketing effort is now far less secure. China will need a series of successful launches to convince potential customers that it can provide reliable satellite launch services in this increasingly competitive market.

Research, Development, Testing, and Production

Since 1960, China has developed a large, integrated infrastructure of research, development, and test facilities to support both their military ballistic missile and civilian space launch programs. As a result of a 1988 reorganization, the Department of Aerospace System Engineering—one of 17 departmental units under the Ministry of Aerospace Industry—is now composed of divisions of liquid-fuel missile and carrier rockets, SAMs, coastal defense missiles, SSMs, and satellites. Each division is responsible for one of five corresponding design academies, established previously in the 1964 reorganization. There are five principal missile/rocket launch areas, three of which are associated with both military and civilian programs, as indicated in Figure 3.[3] Data on instrumentation at these launch areas are unavailable from open sources.

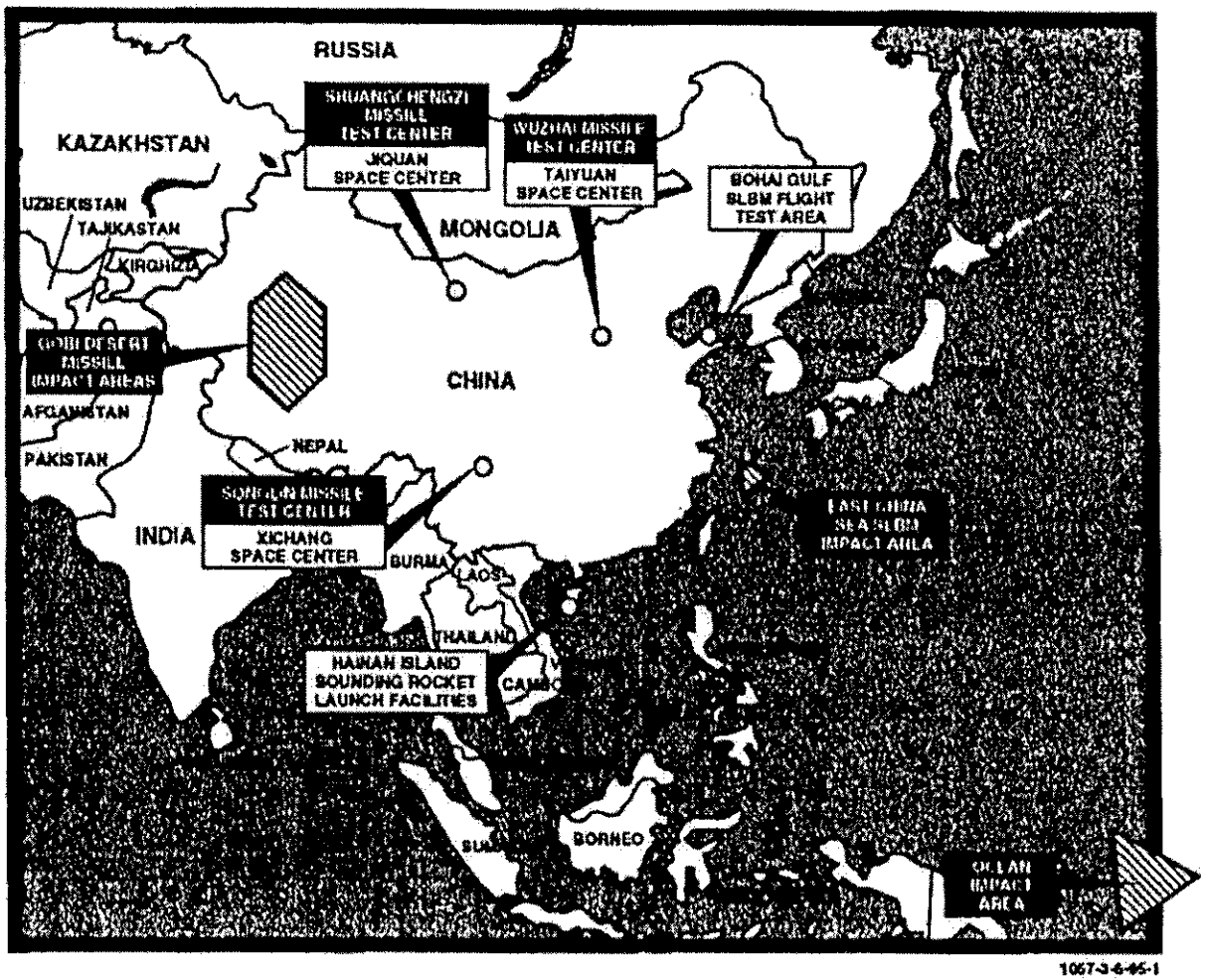

Figure 3. Chinese Missile and SLV Test Launch Sites

[3] Note: The names of civilian facilities are indicated by black lettering on a white background, whereas the names of military facilities are indicated in reverse lettering.

- Shuangchengzi Missile Test Center (formerly known in the U.S. as Shuang Cheng Tzu) is the oldest in China; its construction was begun in the late 1950s with direct Soviet assistance. Hundreds of ballistic missiles and SLVs have been launched from this complex. The base area is known as Dong Feng or "East Wind", which is the source of Chinese system designators—DF-1, DF-2, etc. In one historic test on October 27, 1966, a DF-2 missile armed with a 30-kt nuclear warhead was launched from this base to the Lop Nur nuclear test site, where the warhead detonated. When this base is used for civilian SLV operations, it is called the Jiquan Space Center. To avoid overflying Russia and Mongolia, China uses this facility to launch satellites only into 57- to 70-degree low-earth orbits. If plans are followed through, China's manned space operations will be supported in this complex. Facilities at this large complex are spread over an area more than 30-km long.
- Wuzhai Missile Test Center is the newest in China; operations at this complex began in September 1988. This complex has been associated with DF-5 ICBM flight testing. It is also the site used for initial land-based flight testing of SLBM systems. The civilian section of this complex is known as the Taiyuan Space Center. It supports all of China's LEO polar operations—primarily using the LM-4 launch vehicle.
- Songlin Missile Test Center was developed during the late 1970s with the first launch operations reported in 1984. Extensive civilian SLV operations in particular are conducted from this complex—reported under the name Xichang Space Center. LM-2 and LM-3 operations are conducted from this complex, which enjoys a dry season from October to May and averages 320 days of sunshine annually. It is China's premier site to support geostationary missions and has extensive ground-station facilities supporting China's diverse constellation of earth orbiting satellites.
- SLBM flight tests are usually conducted from a launch area in the Bohai Gulf. Some shore-based facilities are probably associated with these operations.
- Sounding rocket operations have been conducted from a complex on the west coast of Hainan Island since 1988. To date launches into the 120-km-altitude regime have been reported (with the Zhinui 1 rocket). Reportedly, facilities are being upgraded to accommodate the Zhinui 3 sounding rocket, which will achieve a 300-km altitude.

Most ballistic missile test flights are launched into impact areas in the Gobi Desert in western China. For IRBMs and ICBMs, these tests are at less than full range. Three ocean impact areas also have been associated with China's ballistic missile programs. They are used much less frequently than the Gobi Desert areas.

- An open-ocean impact area north of the Soloman Islands was used for two DF-5 ICBM extended-range flight tests in May 1980.
- A 65-km-radius impact area in the East China Sea is used for SLBMs launched from the Bohai Gulf.
- Sounding rockets launched from Hainan Island impact in Beibvwan Bay (not annotated on Figure 3).

China has three principal facilities for missile production:

- The Huludao shipyard has been the construction site of the Han class SSNs and the Xia class SSBNs since 1978. It is also the location of the North Sea Fleet naval base and SLBM test launch center.

- The Shanghai Bureau of Astronautics is the production site of the first and second stages of the LM-3 SLV, DF-5 ICBM parts, the LM-3 cryogenic third-stage altitude control system, and guidance systems of all launchers. The Xinxin Factory, outside of Shaghai, produces liquid-fuel engines for the FB-1 SLV booster and is reportedly the manufacturing plant for the LM-2, LM-3, and DF-5 boosters.
- The Wan Yuan Industry Corporation, located 30 miles south of Beijing, is a major industrial complex responsible for the development and assembly of almost all space booster and heavy ICBM hardware. The plant produces the LM-2 SLV, the DF-5 ICBM, and other medium-range ballistic missiles. It reportedly can build five to six missile/rocket airframes per year, with up to four vehicles in the checkout facility simultaneously.

Arms Exports/Imports

China is the world's fifth largest arms exporter and a leading arms supplier to the Third World with agreements worth more than $16 billion. In recent years, the Chinese have turned increasingly to the international arms market to generate revenues that help to defray the costs of military research and development.

Partly to facilitate arms sales, the Chinese defense sector has been reorganized. Currently, there are 23 identified Chinese government-owned or-controlled companies through which most arms sales are arranged. They are profit-oriented firms and main conduits for acquisition of new and advanced technologies. All are essential components of China's aggressive and lucrative defense industry.

Beijing did not seriously consider building tactical ballistic missiles (TBMs) until the mid-1980s, in spite of its early ability to do so. Primarily as a result of the widespread use of ballistic missiles in the Iran-Iraq War, China became aware of the potential Third World market and began developing the M-series of TBMs for export. Arms sales, particularly ballistic missile sales, to countries in the Middle East and South Asia have raised international concern and led to U.S. opposition to China's export activities. Among the reasons for U.S. concerns are the following:

- China reportedly provides technological and production assistance to inchoate missile-producing nations that threaten the regional interests of the United States and its allies.
- The primary markets for Chinese missile-related exports have been in unstable regions such as the Mideast, South Asia, and the Korean Peninsula, which have a history of resolving political conflict through violence and are involved in regional arms races. Many suspected Chinese missile importers such as Syria, Pakistan, and Iran are reportedly interested in acquiring weapons of mass destruction, assured delivery of which is provided by ballistic missiles.
- Another issue of serious concern to the United States and its allies is China's apparent covert attempts to circumvent guidelines of the Missile Technology Control Regime (MTCR). In spite of China's recently stated intention to abide by restrictions on missile sales incorporated in the MTCR, Beijing's interpretation of the regulations and the potential effects on future sales to Syria, Iran, or Pakistan remain unclear.

China is believed to have transferred missile-related hardware and technology to several countries, including Pakistan, Saudi Arabia, Iran, and Syria. The Chinese have made significant coutributions to the

indigenous missile development objectives of these nations. China's technical expertise contributes to the development of more advanced systems, including the indigenous production of modified tactical ballistic missiles.

China has basically three motivations for its missile-related sales: economic, political, and strategic. Missile sales have the potential to be a primary source of hard currency for the PLA, Chinese defense industries, and the Chinese leadership. Moreover, the Chinese view arms sales as a way to solidify important political ties; the DF-3 sale to Saudi Arabia helped establish diplomatic relations between the two countries. Finally, missile sales are a means whereby China can aid its own strategic needs. Contrary to the U.S. view, China contends that its missile sales may create a military balance between adversaries (e.g., Syria and Israel).

Recent Assistance to the Chinese

Political and economic relations between Beijing and Moscow have improved since the collapse of the Soviet Union. For instance, in December 1992, Russia and China signed agreements that presage the most extensive cooperation between Moscow and Beijing since the early 1950s. The two nations signed 24 joint statements, documents, and memorandums of understanding in areas such as military and technological cooperation, space exploration, and nuclear energy development. Under these agreements, cash-strapped Russia will sell Beijing advanced weapons such as the Su-27 FLANKER and the SA-10 air defense missile system with anti-tactical ballistic missile capabilities.

More recently, in November 1993, Russia and China signed a 5-year military cooperation agreement that is expected to broaden the transfer of military technology to China. Western officials say China is now focused less on buying large and expensive weapons from Russia and more on modernizing Chinese military industry by purchasing Russian expertise, particularly in rocketry and air defense. Recently, China has been attempting to acquire Russian defense and space technologies through the exchange of specialists in the areas of aircraft and rocket building. Chinese delegations have sought technical information about production processes, materials, and organizational matters.

In addition to assistance from Russia, Israel has reportedly had secret military ties with China since 1980. Israel may have exported from $1 to $3 billion worth of arms and technology to China, including laser-guided, armor-piercing warheads. Israel is now China's leading supplier of advanced technology with assistance in the development of the HQ-61 surface-to-air missile, an improved DF-3 guidance system, and production of the Gabriel antiship missile. Israel is providing LAVI fighter technology for new Chinese fighters, much of which is of U.S. origin. Indeed, Israel has been termed China's "back door" to U.S. technology.

III. COUNTERMEASURES POTENTIAL

China has demonstrated a longstanding interest in developing countermeasures to ballistic missile defenses. The Chinese could pursue a number of technology options to preserve the effectiveness of their ballistic missile forces for both theater and strategic missions.

Background

Chinese interest in developing countermeasures dates back to the 1960s, as China's missile program began to produce longer range missiles and as U.S. deployment of some form of ABM system seemed likely.[4] As relations with the USSR worsened, Beijing began to consider the problem of ensuring penetration of its long-range nuclear-armed missiles through the Moscow ABM system. In January 1966, a concept for the development of an advanced Chinese ICBM warhead with penetration aids reportedly was proposed, and preliminary design of the reentry vehicle was completed in December of that year. The RV would be equipped with electronic countermeasures (ECM) and light exoatmospheric decoys, despite the admission by the Chinese that the decoys would be ineffective after reentry. The warhead for the recently developed 600-km M-9 ballistic missile is believed to incorporate a miniature propulsion system to correct terminal velocity and reentry attitude and to change flight trajectory and range; although designed to enhance accuracy, it also could have the collateral benefit of improving penetrability.

In recent years, China has expressed concern about U.S. advances in ballistic missile defense research and development. The Chinese charge that attempts by the United States to develop antimissile defense systems are part of an effort to create the military superiority required to dominate a "new world order." Recent Chinese statements reflect the military leadership's opposition to the possible deployment of advanced U.S. BMD systems around U.S. forces in East Asia. China can be expected to maintain its stance against "the arms race in outer space" and all proposals for pursuing strategic defense programs. However intensely China uses diplomatic means to curtail development of missile defense systems, its pursuit of technical countermeasures to such systems is both likely and well within its technological capabilities.

Propensity

China has a growing requirement for countermeasures and the demonstrated willingness to develop them. This stems primarily from the relatively small size of its ballistic missile force (Table 4) and the anticipated threat to its effectiveness posed by BMD systems (Table 5).

Table 4. Estimated Numbers of Operational Chinese IRBMs, SLBMs, and ICBMs

Missile	Number
DF-3 (DF-3)	40-80
DF-4 (CSS-3)	8
DF-5 (CSS-4)	10-20
JL-1 (CSS-N-3)	12-24
DF-21	25-50

Sources: *IISS Military Balance 1994-1995; Jane's Offensive Weapon Systems; Arms Control Today*

[4] Indeed, the given rationale for the 1960s-era thin U.S. ABM defense concept known as Sentinel was a projected modest Chinese ICBM threat.

The Chinese ballistic missile force will remain the country's principal means for deterrence. The Chinese air force has long had questionable deep-strike capabilities, and China has never had a strong deep-water navy. The army is the dominant service among China's armed forces; it controls all Chinese ballistic missile systems, except for the small number of SLBMs controlled by the Navy. Despite having deployed ballistic missiles for nearly 30 years, China has not produced them in large numbers for national deployment, particularly the longer range ICBMs such as the DF-4 and DF-5. The introduction of capable missile defenses, and particularly an NMD system, would pose a clear threat to the viability of China's ballistic missile deterrent.

Table 5. Potential BMD Threats Faced by China

Country	System	Status
Russia	ABM-1/GALOSH	Operational
Russia	S-300P (SA-10)	Operational
Russia	S-300V (SA-12)	Operational
United States	PAC-2	Operational
United States	PAC-3	System Development
United States	THAAD	System Development
United States	Aegis/SM2 Block IV	System Development
United States	NMD	Technology Development
Russia	S-500	System Development
Taiwan	Sky Bow SAM upgrade	System Development
India	Akash SAM upgrade	Technology Development

At present, the principal threat to Chinese missile effectiveness is posed by Russia's ABM defense around Moscow. The Russians recently upgraded this system and it is not known what measures China might have taken in response. In recent years, Russia has deployed the mobile SA-10 and SA-12 SAM systems, which might have some effectiveness against Chinese ballistic missiles.

China also is likely to consider scenarios involving several types of missile defense systems in a future conflict. The Chinese recognize that the United States is likely to deploy TMD systems more capable than the PAC-2 (Patriot) system used in the Gulf War in any major regional conflict involving U.S. forces. Two such scenarios on the periphery of Chinese territory are a conflict with Taiwan in which the United States helps the Taiwanese fend off a Chinese attack, and a conflict in Northeast Asia with U.S. forces assisting South Korea and perhaps Japan in defending against a North Korean attack into which China could be drawn. In addition, Taiwan and India could upgrade their air defense systems to acquire some anti-tactical ballistic missile (ATBM) capability. If Taiwan acquires the PAC-2 (Patriot) system, China may perceive a requirement to develop countermeasures even for its short-range missile systems. Israeli development of the Arrow ATBM could significantly reduce the penetrability of missiles supplied by Beijing to its Middle Eastern client-states. Finally, China cannot ignore the possible deployment of a thin U.S. NMD system, ostensibly to protect against a limited accidental or terrorist launch of ballistic missiles against CONUS, but which would have significant effectiveness against a Chinese missile strike, given the small quantity of SLBMs and ICBMs that China has deployed.

Senior figures in the Chinese military apparently recognize the need to address these threats. In 1989 the deputy commander of China's strategic missile organization, Major General Yang Heng, identified "enhancement of the penetration capacity... in an era when space technology is developing rapidly and when various types of defensive systems are emerging one after another" as one of three objectives for R&D of China's nuclear weapons. The Institute of Scientific and Technical Information, located in Beijing, has sponsored numerous technical reports on BMD countermeasures R&D, dating back to at least 1988.

Given the variety of missile defense system deployment threats (see Table 5) and the important deterrent role assigned to its relatively small ballistic missile arsenal, the Chinese are likely to undertake serious research to develop several countermeasure concepts. However, they may not deploy such countermeasures until the threat BMD systems can be clearly defined.

Technical Capabilities

China could pursue a variety of concepts across the four major categories of BMD countermeasures. The Chinese can draw on resources and expertise from several sectors of these defense industry, such as combat aircraft, munitions, and military electronics, as well as their relatively mature SLV program. Some of the principal manufacturers and selected products from these industries are shown in Table 6.

Table 6. Non-Missile Industries Relevant to Possible Chinese Countermeasure Development

Manufacturer	Selected Products
Space Launch Vehicles and Satellites	
Beijing Wan Yuan Industry Corporation	LM-2C SLV, cryogenic rocket upper stages, other SLV hardware
Shanghai Bureau of Astronautics	LM-3 and LM-4 SLVs
Chinese Academy of Space Technology	Recoverable spacecraft
Electronics	
China National Electronics Import and Export Corporation	GT-1 chaff and IR flare dispensing set, Model 265 radar altimeter, Model 970 mobile radar frequency jamming system
Southwest China Research Institute of Electronic Equipment	Airborne self-protection noise and repeater jammers, BM/KZ 8608 airborne ELINT system, BM/DJG 8715 mobile radar jamming system, numerous surveillance and warning radar systems
China Precision Machinery Import and Export Corporation	Gin Sling target acquisition and tracking SAM guidance radar, SJ-202 phased-array radar, satellites
Aircraft	
Chengdu Aircraft Industrial Corporation	Over 2,000 fighters of 10 models or variants built, including the J-7/F-7 (MiG-21 copy)
Harbin Aircraft Manufacturing Corporation	H-5 light bomber (Il-28 copy)
Nanchang Aircraft Manufacturing Company	J-6 fighter (MiG-19 copy), Q-5 attack aircraft (J-6 derivative)
Shenyang Aircraft Corporation	J-5 fighter (MiG-17 copy), J-8/F-8 fighter
Munitions and Artillery	
China North Industries Corporation	Rocket launchers, howitzers, ATGMs, submunition warheads, laser-guided bombs, fuel-air explosives

China's large technical labor force is recognized for its scientific and military expertise. Many of the top Chinese scientists and engineers who led the effort to develop nuclear weapons were educated and trained in the

West, including Qian Wuesen, the U.S.-trained "father" of Chinese ballistic missile development. Hundreds more received training in the former Soviet Union. Despite these early outside influences on its missile development program, however, China has not relied to a significant extent on foreign expertise in developing its robust defense base. Military industries exist in virtually every class of weapon system. Although their products are typically not regarded as highly as those of advanced Western countries, they are undoubtedly superior to those of most other rest-of-world (ROW) countries.

Potential BMD Countermeasures

Penaids. China might pursue a variety of penetration aid (penaid) concepts. As mentioned earlier, China has already considered designing an advanced ICBM warhead with electronic countermeasures and light exoatmospheric decoys, with the latter recognized as a suboptimal solution. A recent report indicates that the developmental 12,000-km DF-41 ICBM will have a "far higher... penetration capacity" than previous Chinese ICBMs, implying that it will be deployed with some form of penaid. The warhead for the M-9 ballistic missile is fitted with an attitude control propulsion system that enhances its penetrability as well as its accuracy.

In the wake of the Persian Gulf War, a central technology focus of the Chinese military is in electronics, with particular attention devoted to electronic warfare and electronic countermeasures. Employment of ECM is described in a recent Chinese monograph, *Can the Chinese Army Win the Next War?*, in a discussion of a conflict scenario involving operations in the disputed Spratly Islands. It is suggested that ECM units conduct continuous jamming to confuse the enemy, enabling the task force to advance undetected. Laser weapons reportedly have been developed and tested. A report on an experimental study of electromagnetic pulse effects on missiles appeared in a recent Chinese electronics journal.

Another penaid option involves radar cross section (RCS) reduction. A number of articles in Chinese astronautics and electronics journals have described ongoing research on RCS reduction, covering subjects such as experimental types of composite radar absorbing coating, methods of calculating the RCS for wing-body blended targets, methods for extending the low-reflection (high-absorption) frequency band according to the coating's dispersive characteristics, and preparation of hexagonal-ferrite-based Ku-band radar absorbent materials.

Circumvention. China has not deployed an indigenously developed cruise missile. However, it reportedly is developing one with a range of 600-km. China has as many as six antishipping missile systems—the XW-41, YJ-2, CK-1, HY-3, HY-4, and C-101—that it could develop into land-attack cruise missiles. It has been estimated that by the 2000-2010 timeframe, China will have developed cruise missiles with some low-observable capabilities (likely including heat signature reduction and radar absorbing materials), probably with nuclear, biological, and chemical warheads available. The accuracy of these missiles could be improved by use of satellite navigation technology. China plans to develop a space-based Asian-navigation system called Twin Star by the late 1990s, and it reportedly is working to exploit GPS navigation technology for use in its next-generation missiles.

Another possible means of circumvention is a depressed-trajectory SLBM. China has had an SLBM capability since the successful test flight of the two-stage 1,700-km JL-1 in 1982. The Chinese are developing the three-stage JL-2 SLBM, to be deployed on a second-generation SSBN. A constraint on this option would be the demonstrated difficulty of China in operating naval forces beyond the traditional coastal defense role. Moreover, the Xia class SSBN would be unlikely to penetrate U.S. antisubmarine warfare (ASW) systems, and it is unclear whether China has the resources and technology necessary to develop a sufficiently "quiet" SSBN.

A more exotic circumvention option is a fractional orbital bombardment system (FOBS), in which the missile would follow a trajectory over the South Pole to outflank U.S. ground-based early warning radars. This would entail the resurrection of a FOBS concept for a DF-6 ICBM first proposed in 1966 as a means by which to strike the Panama Canal. The project was canceled in 1973 due to a host of technical problems and to the marked improvement in Sino-American relations. However, it could reemerge as a countermeasures option in response to the potential deployment of an NMD system in CONUS.

Suppression. Much of the above discussion of "circumvention" also is pertinent to "suppression." In addition, China has a limited aircraft ECM jamming capability. Chinese firms have produced self-protection noise and repeater jammers, operating in conjunction with a chaff and infrared flare dispenser system. Its 8601 repeater jammer operates in the E/F and I-J bands to counter airborne tracking, antiaircraft fire control, and SAM guidance radars.

Among the efforts of the munitions industry, centered in the China North Industries Corporation (NORINCO), China has developed a variety of advanced munitions, including a submunition warhead for its 273-mm multiple rocket system and the fuel-air aero cargo bomb, a fuel-air explosive that has been offered for export. These could be adapted to a TMD suppression role. China also has had a nuclear weapons capability since 1964 and could use a portion of its arsenal to attack defense systems in advance of a follow-on missile strike. Recent nuclear tests appear to be related to the development of missiles with smaller, multiple warheads. An enhanced radiation device ("neutron bomb") reportedly was tested in 1988 and might be in development.

Building on its 25 years of space launch efforts, China could attempt to develop an antisatellite (ASAT) capability against U.S. early-warning satellites associated with a BMD system. China's experience in designing and launching over 30 earth resources/reconnaissance and communications satellites (including a geosynchronous capability) since 1970 would be useful in an ASAT development effort. No such system is known to exist in China, although several approaches were described in the aforementioned monograph including:

- The scattering of steel balls along the orbit of U.S. military satellites (described as the *shotgun approach*)
- Spraying dust at the reflective mirror of a satellite (the *smearing approach*), requiring a survivable dust-dispensing mechanism
- Using 1.5- to 2.5-kg smart bombs (the *small bomblet approach*)
- Deploying as many as 12,000 light intercept satellites into orbit (the *small honeybee method*).

These approaches demonstrate an awareness of the importance of suppressing a space-based early warning system, but they are too complex, are too costly, or pose too many unacceptable tradeoffs to warrant serious consideration by China.

Saturation. China is producing several ballistic missile systems, including the M-9, M-11, M-7, and DF-21A. However, published estimates indicate that relatively small quantities of these missiles and their launchers have been produced. A significant portion is produced for export instead of national deployment. The LM-2 series of SLVs—used to launch indigenous and foreign commercial satellites—is produced exclusively at the same facility that builds the DF-5 ICBM and other IRBM systems. If airframe production was diverted from SLVs to ballistic missiles, China could lose most of its space launch business. Thus, mass production of ballistic missiles, especially strategic systems, for saturation of missile defenses does not appear to be an attractive option for China.

A more palatable alternative would be to produce multiple reentry vehicles (MRVs) to perform limited saturation attacks, although their effectiveness would continue to be constrained by the relatively small numbers of delivery systems. China reportedly modernized its older DF-3 IRBMs in the 1980s by replacing its single 1- to 3-Mt warhead with three 50- to 100-kt warheads. An article has been published by a Chinese missile specialist on the mathematical theory to describe the operation of a hybrid guidance system for a maneuvering reentry vehicle (MaRV), but it is uncertain whether systems are being designed specifically as MaRVs optimized for a countermeasures role. There is evidence, however, that China is interested in developing multiple independently targetable reentry vehicles (MIRVs) for its longer range systems. An SLV launched on 20 September 1981 orbited three satellites, but it also demonstrated China's limitations in potential MIRV development. The lift capacity of the launcher, a modified DF-5 ICBM, was large enough to carry at least several small scientific satellites. However, the small nose cone of the rocket could contain only two of them, reportedly forcing the placement of one of the three satellites into the tail-deck of the second stage. Nevertheless, the practice of using a space shot to test MIRV technology was employed by the USSR in the late 1960s, and plans reportedly are under way to develop MIRVs for the next generation of Chinese ICBMs. MIRV development could be complicated by the reduced payload capacity anticipated for future Chinese ICBMs.

Testing Resources

China has considerable resources available for testing countermeasure concepts that advance beyond the design and development stages, in addition to the missile flight test ranges described in Chapter II.

Use of TMD Systems. China has acquired from Russia the S-300 (SA-10) air defense missile system, designed primarily to defend against aircraft and cruise missiles. This acquisition occurred after the alleged transfer of U.S. Patriot missile defense system guidance and propulsion technology by Israel to China. Reports indicate that China is trying to use the Patriot technology to develop an improved version of the S-300 that could give it some ATBM capability. If this effort succeeds, it would enable China to test some countermeasure designs in the field against the S-300 that might be effective against U.S. Patriot PAC-2 or follow-on systems, in an attempt to gain insight into the characteristics, performance, and vulnerabilities of TMD systems.

Instrumentation and ranging radars. China has two radar systems that might have some utility in development of countermeasures using RCS reduction. The Type 791-A Precision Approach Radar (PAR) closely resembles the former Soviet RSP-7 (Two Spot) PAR. It operates in the I/J band from either mobile or fixed installations. China also manufactures the HN-C03-M mobile precision instrumentation radar, with high-accuracy measuring equipment operating in the G band to a range of up to 300-km for a reflecting target.

Modeling and Simulation. Although no models or simulation techniques have been identified for Chinese testing of specific BMD countermeasures, there is considerable evidence of Chinese capability in this area.. The Northwest Institute of Nuclear Technology developed the FLASH II pulsed intense relativistic electron beam (IREB) accelerator in 1993, with applications in simulation of electromagnetic phenomena, in high-power microwave defense research, and in aerospace, laser, and materials technologies. In 1989, a Chinese newspaper reported the development of a "large, integrated guided missile training simulator" for training in missile launch techniques. More recently, a general-purpose, state-of-the-art computer simulation/modeling system software was developed for direct application to Chinese defense modernization; it has been used to simulate systems and components for the LM-2E strap-on SLV. A satellite simulation center performs semi-physical simulation tests of satellite control systems. An experimental trans-supersonic two-dimensional wind tunnel should be operational by 1996; it will be the largest such facility in the country. A strong parallel-processing supercomputing capability exists: the YH-2 Supercomputer is the country's first one-billion-

operations-per-second parallel supercomputer; a Cray Computer has been acquired from the United States; and China's first advanced supercomputer real-time 3-D image generation system, the 2100CIG, reportedly has system applications that include flight training under complex meteorological conditions and missile development.

External Sources of Assistance

With a large defense infrastructure in place for several decades, China would require little if any external assistance to develop various countermeasure concepts. Nevertheless, the Chinese may seek such assistance, given their proclivity for copying foreign designs in their weapons systems as well as their interest in shortening the lead time of system development. If China pursues parts, components, or technology acquisition, it most likely will turn to Israel or the former Soviet Union (FSU). China and Israel reportedly have engaged in a clandestine defense technology relationship for at least a decade. An example of this relationship is the alleged illicit transfer of U.S. Patriot missile defense system technology by Israel to China soon after the 1991 Persian Gulf War. Another example is the reported Israeli technological assistance used by China to improve the guidance system of the DF-3 IRBM that was exported to Saudi Arabia. Israel could provide China with assistance that would be applicable to development of some sophisticated countermeasure concepts, especially those that would rely on electronic warfare and unmanned aerial vehicle (UAV) technology—areas in which Israel is a world leader.

The other likely source of external assistance is the FSU, particularly Russia. For years many of China's weapons systems were based on Soviet designs. Since the dissolution of the Soviet Union, China has gone on a buying spree, acquiring sophisticated aircraft, air defense, and other weapons systems from a cash-hungry Russia. More ominously, China allegedly has recruited a number of former Soviet missile and nuclear weapons experts, possibly to assist Chinese efforts to develop solid-fueled, single-warhead, mobile, SS-25-like ICBMs with miniaturized nuclear warheads. The pursuit of Russian assistance has focused on transfer of technology rather than hardware.

Range of Options

Based primarily on its ability to produce entire ballistic missile systems, the Chinese defense establishment could develop a wide range of countermeasures in response to various operational missile defense threats, as illustrated in Table 7. The countermeasures could vary by range class and by threat system. For example, substrategic missile systems could be equipped with a suite of countermeasures entirely different from those deployed on ICBMs targeted against Russia and from those deployed on ICBMs or SLBMs targeted against CONUS.

Deployment

The countermeasures that China selects for deployment would depend on factors such as the urgency of the BMD system deployment threat, the funding available for competing defense programs, and the progress made in advancing a concept through the development and testing stages into production. A Chinese countermeasures acquisition effort could follow the trend of other systems in the country's long-term modernization program, which stresses R&D with quantities acquired being predicated on demand. R&D, testing, and production in the massive Chinese defense industry have been hampered by a lack of centralized

Appendix

Chronology of Chinese Ballistic Missile-Related Events: 1945-94

1950	February 14: USSR and China sign a 30-year Treaty of Friendship, Alliance and Mutual Assistance. Soviet advisers begin arriving in China.
1956	April: China publishes *12 Year (1956-1967) Long-term Plan for the Development of Science and Technology in China.* Rocketry is a key area. April: Qian Zuesen begins technical supervision of missile, rocket, and spacecraft R&D. Mid-1956: The Chinese begin construction of a railroad on the missile test center at Shuangchengzi. October: The Chinese establish the Fifth Research Institute (under the Defense Ministry), which begins construction of a rocket manufacturing base and launching site.
1957	October 15: Under the New Defense Technical Accord between the USSR and China, the Soviets agree to supply China with a prototype atom bomb, ballistic missiles, and associated technologies.
1958	January: USSR transfers two R-2 (SS-2) missiles and their blueprints to China. June 21: Mao Zedong boasts that China could develop atomic bombs, hydrogen bombs, and intercontinental missiles within 10 years.
1959	June 20: The USSR notifies China that it will not provide technical details (or a working model) of atomic bombs. China sets up trial production lines for tactical missiles in Shenyang and Nancheng.
1960	February 19: China launches its first indigenously developed sounding rocket. July 16: The Soviets nullify all agreements and contracts between the USSR and China. August 23: All Soviet advisers and technicians working in China in the Second Ministry (on nuclear weapons and energy) are withdrawn. This forces China into indigenous development. November 5: China launches its first short-range ballistic missile, copied from a Soviet SS-2 design. This launch signified China's first step toward mastering ballistic missile technology.
1963	August: China begins theoretical research on design of a ballistic missile nuclear warhead.
1964	April: China begins design work on a nuclear warhead for missile delivery. June 29: China launches its first indigenous MRBM, almost certainly a Dong Feng 2 (DF-2). October 16: China detonates its first nuclear device, which has a yield of 20 kt.
1965	May 14: China conducts its second nuclear test.
1966	May 9: China conducts its third nuclear weapon test—an airburst with a yield of more than 200 kt. October 27: China conducts its fourth nuclear test, in which a DF-2 missile armed with a 20- to 30-kt warhead is flown more than 800 km to the Lop Nur nuclear test site and the warhead detonated.
1967	June 17: China detonates its first thermonuclear device.

1969	November 1: China attempts to launch a satellite using the DF-3 launcher.
1970	January 30: China launches a "China-made long-distance missile," presumably a DF-4.
	April 24: China launches its first satellite using the DF-3 launcher.
	October: China conducts a test in which a ballistic missile reportedly travels 2,000 miles within its borders.
1979	January 7: China conducts a partial-range test of a DF-5 ICBM from Wuzhai Missile Test Center.
	October: China apparently conducts a partial-range test of a DF-5.
1980	February: China conducts a partial-range test of a DF-5.
	March: China begins preparations for full-range flight tests of the DF-5, including base exercises at Shuangchengzi Missile Test Center and ship exercises in the Yellow Sea.
	May 18: China conducts its first full-range test of a DF-5 from Shuangchengzi to a Pacific Ocean impact area approximately 6,400 statute miles away. The reentry vehicle is monitored and retrieved by a fleet of 18 Chinese naval vessels.
	May 21: China conducts its second long-range test of a DF-5. The missile reportedly fell about 800 miles short of the observation fleet.
	August: China conducts a DF-4 missile test launch.
	October: China conducts a DF-4 missile test launch.
1981	April 30: China launches its Xia class nuclear-powered ballistic missile submarine.
	December 7: China conducts a test launch of a DF-5 from the Wuzhai Missile Test Center.
	December: The U.S. Joint Chiefs of Staff report that China has more than 100 DF-2 and DF-3 launchers with a possible missile refire capability.
1982	October 12: China conducts its first underwater launch of an SLBM, the Julang 1 (JL-1), from its modified Golf class test submarine in Bohai Bay.
1985	October 15: China launches a JL-1 SLBM from a Xia class SSBN for the first time, a partial failure.
1986	June: China begins flight tests on a modernized DF-3 missile with multiple reentry vehicles.
	November: China displays the DF-15 (M-9) TBM for the first time at the Asian Defense Exhibition in Beijing, marking its entry into the ballistic missile export market.
1988	January: The United States has the first indications that Saudi Arabia has acquired a few dozen DF-3 IRBMs from China.
	September 27: China conducts its first successful test launch of a JL-1 SLBM from a Xia class SSBN to an impact area with a radius of 65 km.
1992	May 21: China conducts an underground test of a nuclear warhead believed to be designed for a new developmental ICBM.
	September 25. China conducts a second underground test of its new ICBM warhead.
1994	June 10: China conducts its most recent nuclear weapon test.

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