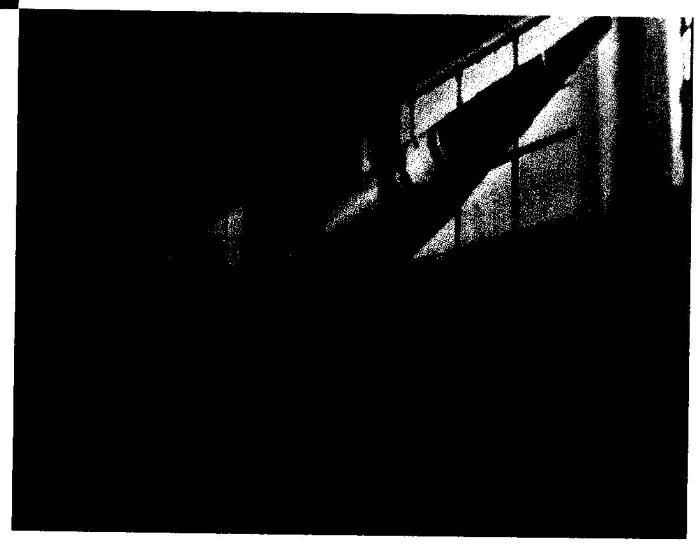
A study on:

Exploring U.S. Missile Defense Requirements in 2010:

What Are the Policy and Technology Challenges?

April 1997



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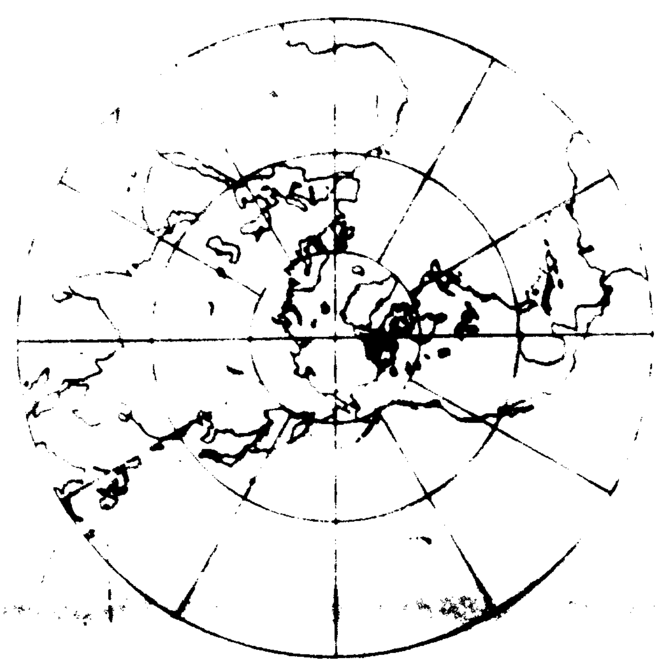

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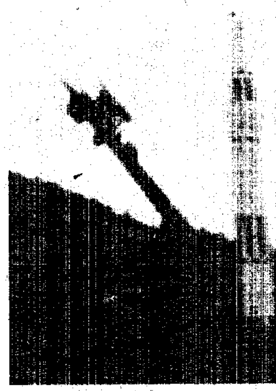
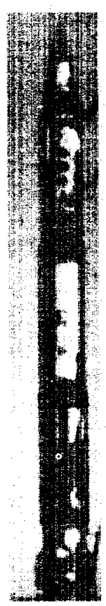
What Are the Policy and Technology Challenges?





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Abstract: This report is based on extensive research conducted under the auspices of the Institute for foreign Policy Analysis with a focus on the policy and technical challenges likely to shape the missile environment in the first decade of the next century.

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FOREWORD

As we move toward the end of this decade and into the next century, it is increasingly apparent that technology proliferation is conferring unprecedented destructive capabilities on a larger number of actors — including states but also other entities as well. Aspiring regional powers and rogue states continue to invest often scarce resources in the development and/or acquisition of ballistic and cruise missiles with the expectation that they will confer both power and status. For smaller states, missiles, together with weapons of mass destruction (WMD) warheads, are sometimes seen as a "great equalizer" that furnishes a basis for asymmetrical warfare or for deterrence by a smaller state against a larger state. In many cases, such states are situated in regions such as Southwest Asia and Northeast Asia that are of major importance to the United States and its allies.

The increasing availability of WMD coincides with the emergence of a conflict map that encompasses disputes, wars, and other armed confrontations across a spectrum from major regional wars to substate ethnic conflict and terrorism. We confront a dynamic and changing security setting in which states hostile to our interests may acquire the means to threaten WMD use against our forward deployed forces, the territory of our allies and even possibly the United States itself. The simple threat of retaliation that worked in the Cold War to deter the use of nuclear weapons by the Soviet Union may not work in the post-Cold War era.

Because emerging and future possessors of such weapons may be tempted actually to use them, we must rethink deterrence strategy, including the relationship between, and the relative importance of, offensive and defensively based deterrence. Added to this dramatically changed strategic setting is the fact that we cannot be certain that the possessors of such capabilities will have acquired them by indigenous development or, more quickly, by theft, purchase, or barter. Therefore, we will need to think about proliferation timelines in a way that takes these alternative approaches into account. If there is emerging uncertainty about when and how such capabilities will be acquired, it follows that we face technological challenges to an effective defense that must be addressed as we plan for the next century. As we begin to deploy missile defenses, we will face continuing challenges as offensive and defensive technologies become more widely available.

This Report is based on extensive research conducted under the auspices of the Institute for Foreign Policy Analysis with a focus on the policy and technical challenges likely to shape the missile environment in the first decade of the next century. In addition to Russia and China, the study includes a detailed consideration of other likely or potential missile possessors: Korea, India, Pakistan, Iran, Iraq, Syria, and others. Emphasis is placed on the high level of uncertainty that exists about the pace of missile technology proliferation, as well as the difficulties facing the United States and other technologically advanced states in maintaining effective export control regimes as part of a counterproliferation strategy. Because it is likely to become increasingly difficult to predict the rate at which ballistic and cruise missile proliferation will take place, the lead times for the United States to deploy effective missile defenses will be shortened. At the same time the development of penetration aids, maneuvering warheads, and related technologies will make countermeasures to missile defense more widely available.

Although this study is based on a vast array of open source data and information that includes trends into the future, it is necessarily the case that there are no facts about the future. Therefore, the present study is based on an analysis of potential implications of existing trends. It is designed to assist members of the policy community, within government and outside, in thinking about the implications of rapidly advancing and proliferating technology in a world of dramatic political, economic, and military change. This Report is principally the work of David R. Tanks, Senior Staff Member of the Institute for Foreign Policy Analysis. As part of the study effort leading to this Report, the Institute has convened a series of major meetings designed to bring together appropriate expertise from diverse political, military, scientific, and technological backgrounds. In addition to preparing this Report, Mr. Tanks has presented a series of briefings on various aspects of the study during the preparatory phases. Inputs from such presentations have contributed to this Report, which will form the basis for other ongoing IFPA studies and analyses on missile defenses and the transformed post-Cold War security setting.

Robert L. Pfaltzgraff, Jr.
President
Institute for Foreign Policy Analysis, Inc.

Executive Summary

Introduction

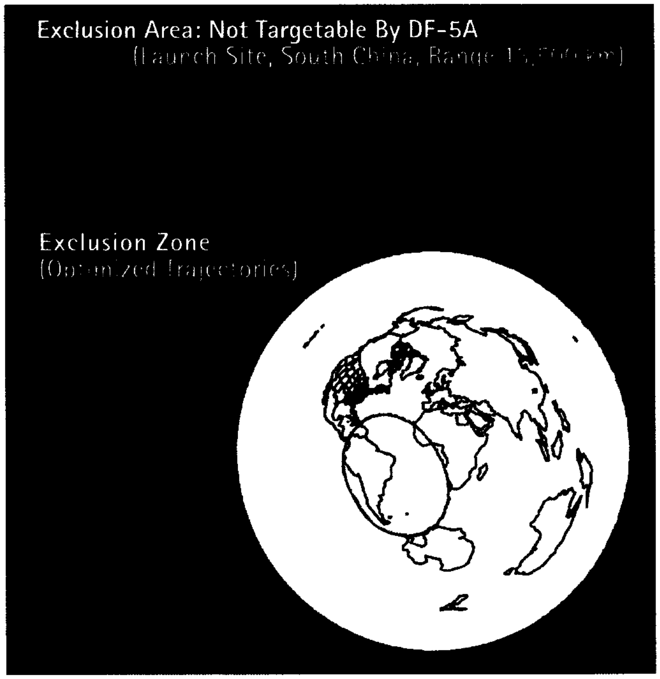
In determining the policy and technical challenges that will govern missile development 7-15 years in the future, this study effort goes well beyond the missile issue to examine the underlying goals and objectives that are likely to motivate the behavior of the major states during the next decade (Chapters 1-4). Included in the first chapter of this assessment is an explanation of how the migration of knowledge is tending to move technological and manufacturing capabilities towards a position of greater international equilibrium. This equilibrating effect will allow more of the world's states to develop the precision-guided munitions, cruise missiles, and ballistic missiles that they saw demonstrated with such good effect during the Gulf War. Chapters 2-4 then examine the national dynamics that are at work in a number of states of concern. This portion of the assessment looks at internal technology transfer environments, non-official actors within the states that influence the flow of sensitive weapons and technology (to include organized crime groups and China's Red Princes), and tries to develop a sense of what types of missile threats are likely to emerge from these actors and how those missile capabilities might affect the United States' ability to defend important national interests in the future.

The assessment then turns to the issue of the technical challenges inherent in mounting a missile defense. Chapter 5 describes the missile defense countermeasures that missile designers are incorporating into their missile systems, the practical difficulties that these countermeasures pose for U.S. missile defenses, and what is or is not being done to solve those challenges. Chapter 6 describes the findings and recommendations, to include the rationale for them. Chapter 6 is wholly devoted to just those aspects of the problem that directly influence the missile defense environment.

Uncertainties in the New Era

In examining the international situation likely to govern future relations, it is clear that most countries want long-range strategic missile systems for their deterrent value. Unfortunately, what is not so clear is whether or not all other countries would be mutually deterred by U.S. nuclear forces if issues involving perceived national sovereignty were involved in some future confrontation.

At the tactical level, cruise and ballistic missiles with battlefield- through theater-level applications



are proliferating widely. There is a general consensus in the United States that accepts the requirement for the development of tactical missile defenses against cruise and ballistic systems. However, much of the current thinking is still oriented toward defeating *Scud* missiles. During the next decade, it appears that a number of missile systems with detachable warheads and greater penetration sophistication will become common. Thus, future tactical missile defenses must be able to defend against targets that will be much more capable than *Scuds*.

Although it is clearly recognized that a significant number of countries will possess tactical missile systems by 2010, the possible threats to the United States are less clear. While the study discusses the expected environment of 2010 in some detail, it is noteworthy to review the potential missile threat to the United States itself in that time frame.

Russia, of course, still poses a threat to the United States, both in terms of its missile forces and as a source of proliferation. As is generally known (and discussed in detail in Chapter 2), Russia's military is in disarray; the control that it exercises over its strategic missile forces is weakening. Thus, the possibility of an unauthorized launch is increasing and must be considered to be a distinct possibility.

Perhaps of equal or greater significance is the problem of proliferation from Russia. Nuclear materials are leaking across Russia's borders, and the transfer of missile technology and components is occurring. Much of this trade is taking place outside of official channels. Unfortunately, what now constitutes official channels is not very clear. The explosion of crime and corruption in Russia is leading to a fusion of government, industrial, and criminal groups into an integrated whole so that it is difficult to distinguish their separate roles.

Consequently, it should be expected that Russia will be a source of proliferation for the foreseeable future. It must also be considered that Russia may help arm potential allies as a means of building a better balance against U.S. power. Iran, India, and China have been specifically cited by Russian strategists as being potential candidates for membership in an alliance with Russia designed to counter the power of the United States, Europe, and Japan. The missile proliferation role which Russia could play will be further examined shortly.

At the same time, China is emerging as a power in its own right. China now has the capability of striking the United States with an acknowledged 17-20 ICBMs, most of which are the DF-5A with a range of *over* 13,000 kms. As shown in the figure, from an assumed firing location in Southern China, the DF-5A can strike anywhere in the world with the exception of Latin America and the edge of West Africa. China is in the process of developing Multiple Independent Re-entry Vehicle (MIRV) warheads for this missile (which is also expected to incorporate penetration aids). Open source accounts indicate that by the year 2000, the DF-5As are likely to be equipped with 6-9 RVs per missile.

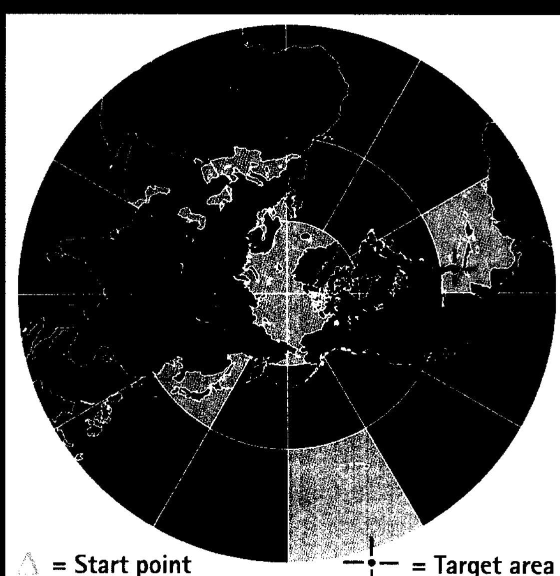
China also has several missile modernization programs. The DF-31 mobile missile will have 8000 kms range and will be able to strike several states (see figure). This same missile will have a naval version, the JL-2. It will be deployed on China's new Type 094 nuclear submarine by about 2005. A 12,000 km range version of this mobile missile, the DF-41, is expected to be deployed by 2010. In addition, China has a family of tactical missile systems that it values for their ability to strike high-value targets on China's periphery. Chinese strategists are in the process of discussing warfighting strategies for the missile and nuclear forces.

DF 31, Range 8,000 km
(Launched from Manchurian Sites)

China has a real concern regarding the survivability of a second-strike missile force. Lacking a comprehensive early warning system, China has long worried about the possibility of a preemptive strike. In an effort to ensure the security of its deterrent force, there are some suspicions that China may have created extensive tunnel complexes (perhaps as much as 5000 kms) in which to hide its missile forces. The massive 12 year effort was called the Great Wall project. If these suspicions prove correct, China has a strategic strike force that might be protected by more than one-km of overhead earth. Considering China's evolving thinking on nuclear warfighting doctrine, coupled with its general sensitivity to sovereignty issues, the possibility should be considered that in the event the United States finds itself in a major confrontation with China (similar to the Cuban Missile Crisis), China might not back down if it, in fact, has an assured retaliatory missile force deep underground. (Note: the Soviet missile forces were vulnerable to preemption during the Cuban Missile Crisis.)

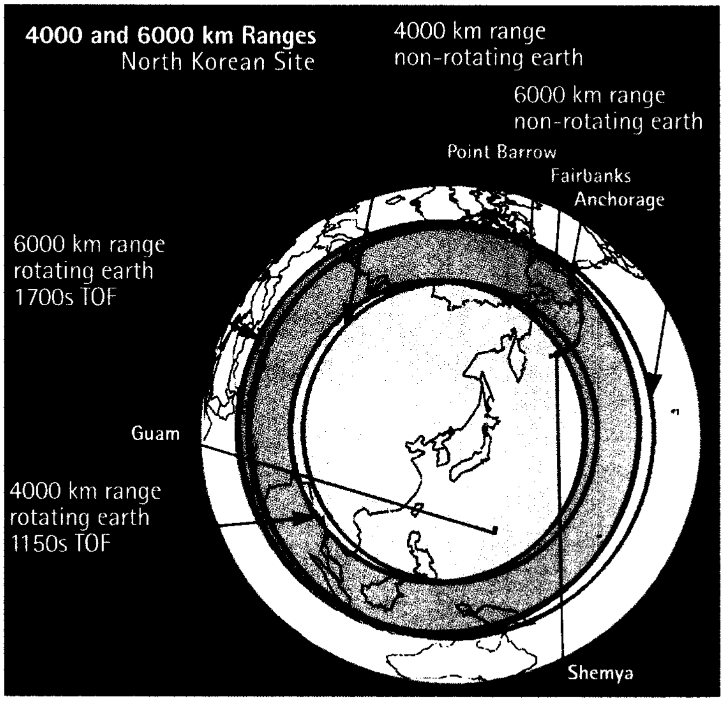
India also has nuclear devices and a growing missile capability. Its polar space launch vehicle (PSLV) uses a solid booster with a reported one million pounds of thrust. The PSLV could now be adopted as an 8000-km range ICBM if India decided to do so. It is expected that parts of the PSLV are being incorporated into the rumored *Surya* ICBM. The *Surya* is believed to have begun development in 1994 and could be ready for test-

Trajectory Ground Range
New Delhi to U.S. Cities



Start Point	Latitude	Longitude	End Point	Latitude	Longitude	Ground Range (km): Non-Rotating Earth	Rotating Earth*: 2500s TOF		Rotating Earth*: 2000s TOF	
New Delhi	28.62	77.22	Bangor ME	44.79	-68.77	11107	10648	Δ=4.1%	10748	Δ=3.2%
			Miami FL	25.78	-80.20	13539	13047	Δ=3.6%	13158	Δ=2.8%
			Omaha NE	41.27	-95.97	12198	11997	Δ=1.6%	12043	Δ=1.3%
			Seattle WA	47.60	-122.33	11299	11465	Δ=1.5%	11441	Δ=1.3%
			Los Angeles CA	34.05	-118.23	12823	12989	Δ=1.3%	12969	Δ=1.1%

* Range [illegible] between Rotating and Non-Rotating [illegible] time-of-flight. Other factors such as [illegible]



ing within the next year or two. As can be seen in the figure, if the *Surya* does achieve its expected range of 12,000 kms, from New Delhi it would be able to strike targets in the United States north of a line extending from Raleigh, NC, to Eugene, OR.

North Korea is, of course, working on the development of *Taepodong* 2 (TD-2) missile that is expected to have a range of 4000-6000 kms (see figure). North Korea wants to develop an ICBM as a means of deterring the United States. Its TD-2 missile is believed to be a part of that program. However, the missile is reportedly experiencing problems. The amount of delay these problems will cause in fielding the system is unknown. Current estimates look for the TD-2 to be fielded between 2000-2005.

Unfortunately, indigenously produced missiles may not be the only threat to the United States. One of the more serious possibilities raised by the study is that the long-held idea that nations will not transfer ICBMs to other states may no longer prove true as the next decade unfolds.

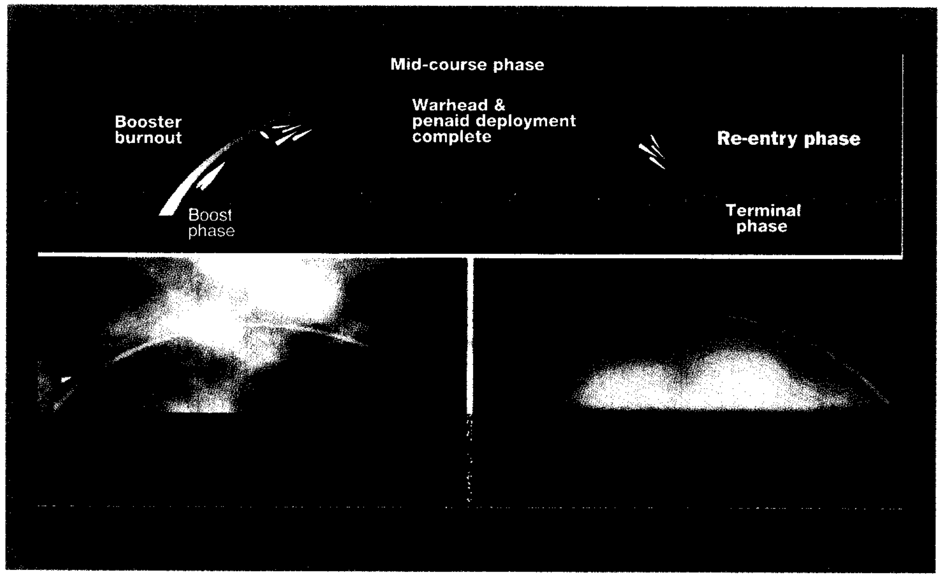
As noted earlier, with respect to control in Russia and, to a certain extent, Ukraine, sensitive technologies are flowing out of these countries at an increasing rate. Central control over Russia's mobile ICBM systems, such as the SS-25, is becoming tenuous as living conditions and discipline in those units decline. There is also no guarantee that this system or some other model of ICBM could not be transferred to another country directly from factory representatives as knock-down kits for assembly. As discussed in the report, it is relatively easy to bribe materials out of Russia.

Many officials, factory managers, military officers, law enforcement personnel, and organized crime groups are willing to engage in illegal activities for a price. This willingness apparently includes the transfer of MTCR restricted long-range missiles and missile technology. For example, one SS-25 may have already been sold to China, and there are unconfirmed reports that 45 of the SS-25's replacement, the *Topol* M, may have been offered for sale to India by Russian military officials. If so, the taboo on transfer of long-range ballistic missiles may already be weakening. The recent reports of a suspected transfer of Russian SS-4 missile technology and components to Iran further underlines this concern.

It should be kept in mind that the view of the ICBM as a strategic system is a perspective held most strongly by the United States. That thinking is heavily influenced by the existence of the Atlantic and Pacific Oceans and friendly neighbors. To Russia and China, shorter-range missile systems on their borders are strategic systems. As medium-range missiles proliferate on the peripheries of these two countries, it could well be that the decision makers involved will no longer see a reason for withholding ICBM technology to the states along the Eurasian rimland. From their perspective, since they will already be threatened, there will be no reason to protect the United States from being subjected to the same type of situation rather than lose potential missile sales that could benefit their own economic well-being.

One of the more serious scenarios might involve the transfer of ICBMs to North Korea. If North Korea made a decision to reunify the Korean peninsula by military conquest, it might first make a major effort to acquire some number of ICBMs as a deterrent against U.S. intervention in defense of South Korea. Although the missiles could be mobile SS-25s moved across the border from Russia, they could just as well be missile component assemblies acquired from Russian factories for final assembly in North Korean facilities. Since North Korea has hundreds of underground fortified sites, it could easily hide this missile force undetected until needed to force the United States to leave South Korea to its fate.

As reflected by the findings and recommendations, there is insufficient effort being devoted to developing the technology that will be required for future insertion. The U.S. Congress is oriented on funding hardware, not technology. The Administration claims it wants to wait until the technology matures, yet funds technology as a last priority.



Such a development would pose a major quandary for U.S. decision makers. If they decide the U.S. will fight in the defense of South Korea, several U.S. cities might well be destroyed. If they decided the risks are too great, and the U.S. sat on the sidelines of the subsequent fight, U.S. credibility as a reliable strategic partner would be destroyed, current allies would move to make alternative security arrangements, and many existing trading patterns would change (to the detriment of the United States) as countries sought to develop and strengthen new security relationships. The United States' global position of leadership would be weakened.

Unfortunately, if North Korea should obtain either the SS-25 or its replacement, the *Topol M,* the envisioned first generation U.S. national missile defense capability that could be established by 2003 may have some difficulty making an intercept against the SS-25. However, the new *Topol M,* with its advanced penaid capabilities could prove to be extremely challenging. Although the United States' efforts to build a limited national missile defense system prior to 2010 is clearly warranted and should proceed, it should do so with the understanding that the initial systems deployed are not end products. They will require frequent upgrades as technology matures.

Major Findings

- Export control regimes are expected to become increasingly ineffective as nonproliferation tools. The evolving international political and technological environment will continue to erode the utility of this approach to security.
- Missiles, both ballistic and cruise, will likely proliferate at an accelerating rate, along with warhead technology. Within the overall proliferation trend, it is becoming more difficult to predict the rate at which a specified country will emerge as a holder of ballistic missile and weapons of mass destruction (WMD) capabilities since the foreign assistance aspect is an incalculable variable.
- The probability is increasing that ICBM missiles (either assembled as systems or as part of "knock-down kits" for assembly) could be transferred to other states prior to 2010.

- Currently, four states can target the United States with either ICBMs or SLBMs: Russia, China, France, and the United Kingdom. Prior to 2010, India and North Korea will likely join this group. Ukraine, Japan, Israel, Germany, Sweden, Italy, Brazil, Argentina, and South Korea (or a unified Korea) could join this group if they decided to do so. More problematic are the states of the Middle East. Iran and Iraq will likely be able to target London and Moscow by 2010. *The unknown variable is the foreign assistance factor.*
- By 2010, penetration aids, maneuvering warheads, low radar cross sections, and similar technologies will become increasingly common in ballistic missiles. Most newer versions of cruise missiles will also incorporate some level of stealth technology.
- Tactical missile defenses must be able to defeat an array of warhead types: unitary, submunition, and bomblet. National missile defenses should be able to defend against MIRVed nuclear warheads. There is a limited possibility that BW agents might be packaged in submunitions for ICBM delivery.
- The initial missile defense systems deployed by the United States will have some difficulties defending against the more advanced classes of missiles discussed in the foregoing findings.
- The developmental process and related funding allocations are not well balanced for long-term technological growth and system sustainment.
- The technology community and the program management organizations are not well integrated; their respective operations are too independent from each other so that the flow of technology from conception through procurement is not a smooth process. Since offensive missile developments will control the speed with which U.S. missile defenses will have to be upgraded, the efforts of the technologists and PM organizations need more unity of effort if the United States is to maintain an effective missile defense capable of maintaining its effectiveness in the face of rapid change.

Recommendations

- Develop and deploy a robust system of tactical defenses against ballistic and cruise missile systems; field a first-generation national missile defense in the near-term, one capable of incorporating frequent upgrades without major system rework. Begin now to develop the upgrades needed to increase the capability of these initial systems.
- Balance the missile defense programs for indefinite sustainment. The program focus should be on the delivery of capabilities that can grow and develop over the decades ahead. Let the funding levels appropriated determine system deployment dates.
- The technology community and the program management organizations should be better integrated to facilitate an improved flow of technology from conception through procurement. Require PMs to first conduct a review of already developed or ongoing technology programs before contracting for new technology development. Likewise, hold technologists responsible for the delivery to the PMs of insertion-ready products.

- Require all future missile defense systems to be designed for easy upgrade and technology insertion. To the extent possible, avoid proprietary architectures that would be expensive to replace as new technologies are developed.

Conclusion

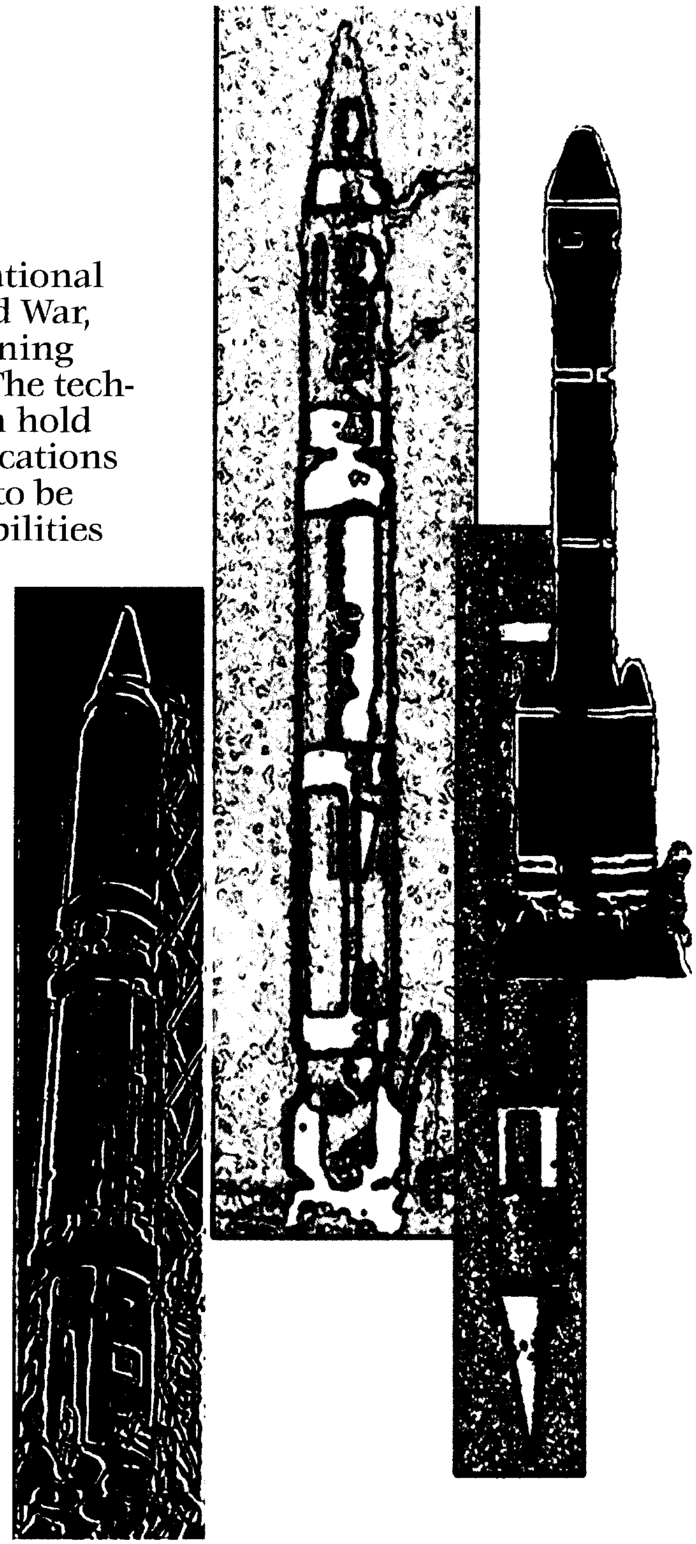
The security structure and political alignment in the international community may well change in significant ways prior to 2010. The common perceptions that developed during the Cold War, under conditions of bipolarity, may no longer prove valid under conditions of multipolarity. One perception that may prove false is the idea that it is in no country's national interest to transfer ICBM systems. The second is that nuclear weapons are unusable. As was discussed in Chapter 3, there are at least some in the Chinese military establishment who think otherwise.

The United States' missile defense program is going in the right direction in that it is working toward the deployment of hardware. Unfortunately, the systems being developed are first generation developments with some limitations against newer-generation missile systems. Unless the United States develops a balanced program that sustains the missile defense effort indefinitely, the missile defense systems deployed could always be one generation behind the offensive systems they were intended to defend against.

UNDERSTANDING THE PROBLEM

Introduction

Concurrent with the upheaval in the international security system triggered by the end of the Cold War, much of the world is in the process of transitioning from an industrial era to an information age. The technologies and capabilities fueling this transition hold significant implications for future wars—implications that must be understood if the United States is to be prepared to cope with the global military capabilities that will be prevalent in this new era: greater transparency on the battlefield, the proliferation of precision-guided munitions, the increasing number of missiles, the spread of weapons of mass destruction, and the related advanced military capabilities that the maturation of the ongoing revolution in military affairs (RMA) will yield.



Although each aspect of the RMA is important, for purposes of this unclassified study the development of missile delivery systems and related capabilities will be the focal point. In short, **this study will review the probable conditions that are expected to govern missile developments 7-15 years into the future, determine the implications for U.S. missile defense requirements, examine the capability of U.S. programs to meet those anticipated requirements, and identify possible courses of action for overcoming apparent shortfalls.**

When projecting the missile-based technology that the United States and its forces are likely to face by 2010, some basic points need to be made regarding the framework that was used in developing this open-source study. In preparing this report, well over one thousand relevant primary and secondary sources were consulted, which include dozens of studies and books covering various facets of the issue, along with many interviews with subject-matter experts to clarify technical points. Thus, this study is based on a detailed assessment of current facts, observed trends, and the stated/implied objectives of the states that are most likely to exert a major influence on the global security situation 7-15 years in the future.

While the findings detailed in this report reflect a steadily growing level of potential challenges to the United States as advanced technologies and information access continue to expand, thus moving the world toward a state of greater technological equilibrium, it should be kept in mind that "there are no facts concerning the future." A major war, an unanticipated economic catastrophe, or some other unexpected trend-changing event could quickly alter the timetables or outcomes projected by this (or any other) predictive report. As such, it is essential that the U.S. formulate its security policy based on assessed *capabilities*, not intentions.

As the future spread of advanced-missile systems and weapons of mass destruction depends on a variety of inter-related factors, this study, by necessity, includes some assumptions regarding the anticipated geopolitical and economic dynamics that will bear on the issue.

Assumptions

The projections made in this study are based on a view of the future world in which:

- **It continues to be in the United States' national interest to maintain the status quo in international affairs** (i.e., a global economic system that is open to U.S. trade under equitable and stable conditions, conditions in which U.S. national security is not unduly threatened).

- **Russia and China continue to be difficult problems for U.S. policy makers.** Russia may or may not become more authoritarian but, in either case, will remain slow to establish tighter control over its arms and technology transfers. Any action by a more authoritarian government to slow illegal exports is likely to be offset by a more robust arms sales program. In the case of China, it will remain a growing power and a difficult state with which to deal politically for the foreseeable future. China will continue to be a source of arms proliferation. In the case of both Russia and China, some allowance must be made for periods of instability. Both countries could still experience severe internal disorder. Both are also likely to improve the quality of their weapon systems as Western technology becomes embedded in their economies.

- **Western Europe continues to be allied with the United States, but does not necessarily follow the United States' lead in all matters** of foreign policy and arms control. European states will export arms and technologies based on their own assessment of domestic and international considerations.

- **Korea begins the process of merging by 2010.** The key question is whether or not this reunification will be accomplished peacefully. If the Korean peninsula explodes in conflict, it is impossible to foresee the outcome. The major unknowns include how many countries might be dragged into such a fight and whether or not weapons of mass destruction (WMD) are employed during the conflict (especially if they are employed against states outside the Korean landmass—such as Japan). The use of WMD systems in a future conflict could well change global perceptions regarding issues of deterrence and the warfighting utility of WMD systems. (In addition, the capabilities and performance of U.S. forces in such a conflict would be watched closely by other states. Their observations would play a major factor in the formulation of their future security policy.)

- **There will remain a group of states that are hostile to the West (and the United States in particular). The countries comprising this group are not immutable.** While the U.S. currently lists Iran, Iraq, Libya, and North Korea as "rogue" states, there is no guarantee that this list may not change in composition or grow in size during the next 15 years. Although not an outcome to be desired, a number of states, such as Saudi Arabia, Turkey, Egypt, and Algeria, have significant internal problems that indicate that future governments could emerge which are hostile to the West. Conversely, the current "rogue" states of Iran, Iraq, and Libya have governments that are facing serious internal problems that could result in major political changes which may or may not be favorable to the United States. (As stated previously, it is assumed that North Korea will not survive as a separate state.)

- **The trend toward the evolution of an information age will continue, along with the globalization of the manufacturing base, the technology base, and the general migration of knowledge.** This trend will likely result in expanded indigenous production capabilities that could be used for the production of advanced military systems.

- **Nations continue to seek advanced technology weapon systems** (i.e., the lessons of *Desert Storm* and the ongoing revolution in military affairs will continue to influence national military procurement programs).

- **The spread of advanced weapon-related technologies will allow lesser powers and non-governmental groups to develop greater capabilities to disrupt regional affairs** and inject instability into both intrastate affairs and the international system. In essence, the ability of more players to field advanced weapon systems will add more complexity to future security calculations.

As these general assumptions regarding the global geopolitical and economic environment portend some specific issues for future U.S. security requirements, a few points require amplification.

The Migration of Knowledge and the Spread of Manufacturing Infrastructure

Processes are currently in motion whereby the next century is likely to see a great leveling effect so that the technological advantages currently concentrated in just a few of the world's states become more widely distributed throughout the international system. This leveling effect is being generated by a number of factors:

- **Many of the world's leading technological and scientific talent do graduate training at commonly selected universities** (e.g., MIT and the University of California, Berkeley). This means that the human resources that each state draws upon are being equalized in terms of education and common training. For example, over half of the science- and technology-based doctoral degrees awarded in the United States are earned by foreign nationals. As a result of this global leveling of educational access, the United States is gradually losing some of the enormous human-resources advantage that it has enjoyed in the past. As industrial leaders point out, the best of the foreign scientists are on par with the best of America's scientists.[1]

- **The demise of Cold War era restrictions on personal travel now facilitates the movement of scientific talent and technological innovations.** For example, Russia and Israel recently signed a deal to jointly develop a helicopter. Few coordination problems are expected since 6-7 of the technologists on Israel's team are Russian emigrants who had been part of the 20 or so key people in Russia working the helicopter's design.[2] In private conversations with Russian officials, it is not unusual for them to admit that some of their best and brightest scientists are now in Israel.[3]

- **The internationalization of technology as international corporations increasingly**

[1] This claim has been made by many. For an example, see Robert M. White, "The Migration of Know-How," *Technology Review*, August/September 1995, p. 81.

[2] Private conversation between the author and an aerospace expert on a nonattribution basis, June 12, 1996. For additional insights into the migration of Russian scientific talent see R. Adam Moody, "Armageddon For Hire," *Janes International Defense Review*, February 1997, pp. 21-23.

[3] Ibid.

treat technology as a commodity that can be purchased on the world market. For example, General Electric now conducts a global search for technology before it commits funds for in-house research and development. This type of policy requires the development of a global network of "scouts" who ferret out leads for promising innovations, a network which, in its own right, helps develop a scientific community without borders.[4]

- **The exodus of scientific talent returning to their countries of origin.** A significant number of foreign graduates from U.S. universities who subsequently accepted employment in U.S. laboratories and high-technology industries are being enticed to return to their native lands to lead indigenous technology and/or manufacturing projects.[5] Many countries realize that advances in technology are a major engine for economic growth. Economists have fundamentally come to realize that technology advances are responsible for at least 50 percent of the economic growth of the United States.[6] Other states also want that advantage. Fortunately for them, the United States contains the skilled manpower they need. Layoffs resulting from U.S. corporate downsizing, foreign experts stuck in upper-middle-management/research positions, and other resident aliens who have become alarmed at U.S. crime rates or are unhappy with the U.S. public school system are among those who are returning to their countries of origin.

- **Manufacturing facilities are being established around the globe as corporations seek to move production to locations offering maximum competitive advantage.** Although the dispersion of the global technology base is credited with spawning widespread economic growth, it also establishes the means for developing weapon systems that have been heretofore beyond many states' capability to produce. As a result of this drive, increasingly, multinational corporations truly have a global presence. For example, in 1982, U.S. multinational corporations earned about 20 percent of their net income from overseas operations; 10 years later, this figure was close to 60 percent.[7]

- **Corporations are treating engineering skills as a commodity to be purchased based on price and quality considerations.** Thus, engineering services for U.S. firms may be obtained from foreign sources, while at the same time foreign corporations fund and receive about 15 percent of the engineering effort that occurs in the United States.[8] Moreover, engineering efforts are increasingly linked via internet or wide area networks to allow engineers from sites scattered around the globe to cooperate on product development. This offshore engineering trend is facilitated by a growing communications infrastructure that permits rapid transmission of computer-aided design (CAD) data and computer-aided manufacturing (CAM) information (coupled with emerging system integration software). The result is that missile engineering

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4 In tracing current corporate R&D practices, the author talked to representatives from Ford, General Electric, Hewlett-Packard (HP), and other similar corporations to determine how they approach their R&D requirements. Ford conducts advanced R&D, puts it "on the shelf," and limits its product engineers from going elsewhere for technology without strong justification. GE has adopted a policy of first trying to find the technology elsewhere prior to funding R&D efforts. This approach does increase the travel budget, but can produce enormous cost savings. The GE representative was very excited about a catalyst found in India that will allow some new coatings to be bonded to metal (especially for auto finishes). HP does almost no advanced technology research. It specializes in finding innovative ways to apply new developments as it improves its product line. In all cases, the commercial firms stressed engineering-to-cost constraints and the innovations that can come out of those restrictions and the need for concurrent engineering approaches to product design.

5 Ashley Dunn, "Skilled Asians Leaving U.S. for High-tech Jobs at Home," *The New York Times,* February 21,1995, pp. A1 & B5. The article claims that 195,000 foreign-born Americans are leaving the U.S. each year.

6 Graham R. Mitchell, Presentation at Symposium on *Exploring U.S. Missile Defense Requirements in 2010,* hosted by the Institute for Foreign Policy Analysis, Inc., Washington, DC, June 7, 1996.

7 Ibid. Dr. Mitchell also noted that 1992 was a very poor year for U.S. industry [1982 was also a weak year], thus the figure slightly exaggerates the situation, but still reflects the trend.

8 Ibid.

and/or manufacturing specifications can be moved around the world in a matter of hours.

- **CAD and CAM specifications and data are being applied directly to the production process.** For example, using current computer-aided design (CAD) technology, engineers can use a computer to develop 3-D drawings of a part or component, then turn that drawing into a plastic prototype by linking the CAD graphics file to a laser which is focused in a pool of liquid plastic or powdered particles. The plastic or particle medium will bind together when exposed to the laser's heat. The CAD software controls a laser-traced pattern of light in the pool of plastic or powder which solidifies the material and produces an exact plastic prototype of the part designed on the computer. Engineers can then check the fit of the plastic part within its component assembly and use the prototype as a template for forming the tool and die required for production.[9] CAD also makes it possible to transmit designs directly to cutting and forming machines which can follow digital directions precisely.[10]

- **CAD and CAM codes and specifications are very portable.**[11] While these technologies are still maturing, it is clear that they are well on their way to becoming the standard international engineering tools. Thus, national technological advantages will become increasingly a fleeting edge as communication and digitalization capabilities facilitate both sanctioned and unauthorized transfers of technological data.

When this advanced engineering system is fused with the manufacturing centers that are being developed in many heretofore underdeveloped regions, it becomes clear that the indigenous capacity to produce precision weapons and missile systems will likely spread rapidly early in the next century. This spread of knowledge and technological capabilities means that traditional export control mechanisms will likely become less effective in limiting the spread of advanced weapon systems.

The Leakage of Armaments and Advanced Technologies

Future control of advanced armaments, missiles, and their related technologies will be difficult due both to the pressures most arms-producing countries are under to export armaments to preserve their domestic arms industries and to the unofficial exports that are brokered by unscrupulous or desperate industrial leaders, organized crime rings, or state officials acting contrary to national policy. While a majority of the smuggled transfers are believed to originate in Russia and China and will be covered more extensively in sections dealing with those countries, all arms-producing states are under pressure to export or perish with respect to their arms industries.

Even in cases where national governments are committed to controlling the export of sensitive technologies, these efforts can be thwarted by the international nature of modern business corporations. Thus, it is not uncommon for corporations that are prohibited from exporting a technology from a factory located in one country to simply suggest to the client that they place the order with a subsidiary company located in a country likely to approve the transfer.[12] Thus, unilateral national export control regimes become increasingly ineffective as an arms control tool.

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9 Gadi Kaplan, "Manufacturing A' La Carte," *IEEE Spectrum (Special Edition)*, September 1993, p. 12.

10 "The Mind's Eye," *The Economist: A Survey of Manufacturing Technology*, March 5, 1994, p. 7.

11 For insight into the world of industrial espionage see, Calvin Sims, "The Strange Case of a Computer Spy," *International Herald Tribune*, July 11, 1996, p. 2.

12 For example, Iraq gained access to precision milling machines when a U.S. company suggested that Iraq purchase the machines from the company's German subsidiary. David Kay, Presentation to the George C. Marshall Institute's Technical Panel On Missile Defense, July 29, 1996. Likewise, Raytheon Corporation was approached by Iran for a purchase of air-traffic control radar and equipment. The U.S. refused an export license. Iran subsequently purchased the equipment from Raytheon Canada. Edward Woolen, *Conference on Arms and Technology Transfers: Security and Economic Considerations*, organized by the Institute for Foreign Policy Analysis, February 14-15, 1994.

As a complicating factor, the nature of the international arms market is changing in several ways. First, the measured dollar volume of arms exports is declining. Between 1985 and 1994, the annual value of international arms exports declined from $70 billion to about $22-$24 billion.[13] However, these numbers are "soft" numbers in that they may not reflect much of the black-market trade, nor do they reflect most component transfers that are used for domestic assembly of weapons or used in co-production arrangements. This means, for example, that the development of the South Korean K-1 tank, which is system-integrated in Korea using major components from several different countries, is not reflected in the published export figures. Thus, as states increasingly turn to co-production, licensed production, and indigenous production for their military procurement needs, the arms export figures are not likely to provide an accurate perspective of the changing international military situation. In short, the international arms market is changing in ways neither fully recognized nor well measured.

Second, as a consequence of *Desert Storm,* states suddenly realized that conventional weaponry of the type held by Iraq only served to provide expensive targets for advanced weapon systems. At the same time, it has become clear that the international arms market has shifted to become a "buyers' market." Purchasing countries could make demands for special deals or weapon systems and selling states would compete to fulfill those demands without regard to any factors other than those that were economically related.

As a result of these new realities, current arms purchases are focusing on offset agreements, which are a type of economic barter arrangement and often include requirements for substantial amounts of technology transfer and co-production arrangements as a condition of sale. Thus, for example, in 1994, the amount of technology transfers required by contract rose to $463 million, a 150 percent increase over 1993.[14] In addition, the weapons being purchased are often state-of-the-art systems that provide significant advantages in capabilities over past systems. In some cases, purchasing nations are receiving selected weapon systems before the producing state equips its own forces with that system.

Lastly, a number of nations have shifted their focus to using their limited defense dollars to upgrading existing platforms at reasonable costs (rather than purchase new delivery platforms) and then equipping the upgraded delivery platforms with highly effective advanced weapon systems that can be stand-off delivered by missile for maximum effectiveness at minimum risk. This approach allows weaker states to leverage their defense dollars. Thus, the selected use of microsystems of advanced technologies may create pockets of capabilities that will allow smaller states to hold off the megasystems of the larger states.[15] In many cases, this improved capability is being protected through the construction of underground shelters and military facilities, a trend that has boomed in the aftermath of Operation *Desert Storm.* In any event, the current pattern of international arms transfers contributes to the proliferation of advanced weapon systems and production capabilities, while minimizing the costs associated with devel-

[13] U.S. Arms Control and Disarmament Agency, *World Wide Military Expenditure and Arms Transfers, 1995,* March 1996, p. 9. cites $22 billion; other sources use slightly higher figures.

[14] "Technology Seepage is Offset Concern," *Arms Trade News,* June 1996, p. 1. Also cited is a report that McDonnell Douglas offered to sell Poland F-18 attack aircraft and the opportunity to produce 60 percent of the parts in Poland. This type of deal helps support indigenous arms production capabilities.

[15] Eliot A. Cohen, "A Revolution in Warfare," *Foreign Affairs,* March/April 1996, p. 53.

oping advanced military capabilities in specific areas of interest.[16]

The Future Strategic Environment

In the absence of an effective deterrent to such actions, some states develop nationalistic aspirations of dominating their respective regions or otherwise flexing national might to intimidate surrounding states into acceding to economic or political demands, demands that may be counter to U.S. interests. Thus, to maintain international leverage, the United States must be perceived by the world community as being able and willing to defend its national interests and shield allied and friendly states from military pressure. (As about two-thirds of U.S. exports consist of common goods and services that can be supplied by a number of states, it is clear that it is not in the United States' interest to allow regional trade patterns to be artificially skewed by would-be regional hegemonic powers.)

Obviously, many states would like to find ways of checkmating U.S. military capabilities. Logically, attempts to prevent U.S. use of military force could involve the capability of inflicting unacceptable levels of casualties on deployed forces or of being able to threaten retaliation against U.S. territory or the territory of its key allies.

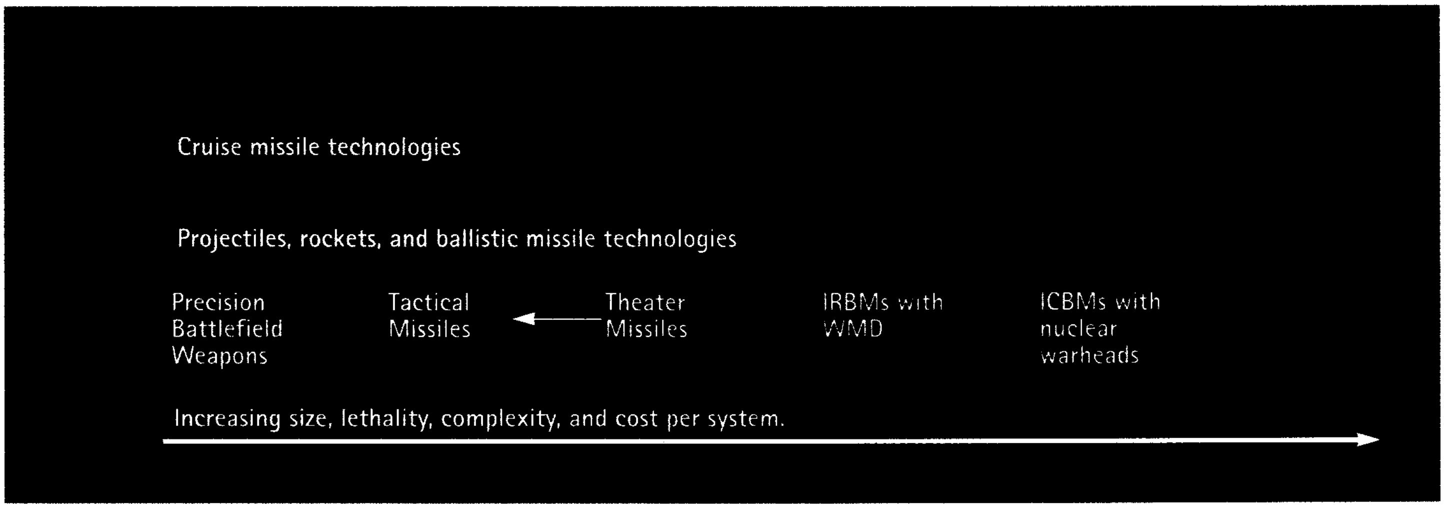
Looking toward 2010, the spectrum of threat is likely to include a wide array of precision weapons, cruise missiles, and ballistic missile systems that can be employed against battlefield-deployed forces and regionally-located target arrays, plus some intercontinental ballistic missile systems (ICBMs) and cruise missile systems capable of hitting the United States' homeland (the cruise systems could be air- or sea-launched). Figure 1-1 (see next page) reflects a hypothetical scale in which the number of systems that will be available on the left side of the wedge will vastly exceed the number of ICBMs that are likely to be fielded (right side of the scale).

Both ends of the scale represent the potential for inflicting major casualties on U.S. citizens. While the weapon systems on the left side largely would be conventional systems, the thousands of these weapons available collectively represent a major casualty-infliction capability. Considering that most countries also learned the value of U.S. AirLand Battle tactics from observing *Desert Storm*, it is likely that foreign forces would attempt to emulate the United States and target their smart weapons against vulnerable points, such as ports, communications infrastructure, airfields, command centers, logistical support bases, etc. As for ICBMs and long-range cruise missile systems, most countries that develop these types of systems are also likely to develop WMD warheads. The developmental cost of ICBMs is sufficiently great so that only WMD capabilities can justify the expense. Thus, while there are fewer long-range systems, the casualties produced by each warhead are likely to measure in the tens or hundreds of thousands.

Most countries enter the spectrum with the development of short-range rocket and missile systems (left-center area of figure 1-1). Currently, there are some 2,000 theater ballistic missiles deployed in the non-NATO/non-Russian militaries of the world, with some analysts predicting a doubling of today's inventory by 2001.[17] Once these systems are mastered, the states then have the option of expanding their indigenous production capabilities toward the left or right side of the scale. They also have the option of purchasing some of these capabilities.

[16] For an insightful examination of the changing conditions of the international arms market, see Andrew W. Hull and David R. Markov, *The Changing Nature of the International Arms Market*, Institute for Defense Analysis paper P-3122, March 1996. According to a nonattributable report based on a contact with a Western European construction firm at the Abu Dhabi international arms show in March 1997, there is "cut throat" competition ongoing for the construction of underground military facilities throughout the Middle East. Advances in controlled explosion techniques and tunneling machinery technology allows 30-100 workers to construct a 1-half km square facility in about three months.

[17] Dennis M. Gormley and K. Scott McMahon, "Who's Guarding the Back Door?" *Jane's International Defense Review*, May 1996, p. 21.



Moreover, countries currently have easy access to precision-guided munitions, and when these advanced munitions are procured, they are generally purchased in fairly large quantities. Considering the competition that currently exists for foreign military sales among most of the developed countries, including the United States, France, the United Kingdom, Germany, Israel, South Africa, and Russia, the export of these systems is likely to increase in volume in future years.[18]

For example, in 1995, Russia granted a number of defense manufacturers the right to market their products internationally without going through the central state arms export agency. Included in the group of industries granted this authority was the Instrument-Making Design Bureau in Tulsa which makes guided artillery rounds, anti-tank missile systems, air-defense systems, etc. In addition, the Antei concern which makes the S-300V (SA-10 missile defense system) was also granted this status.[19] Furthermore, if a July 1996 report is true, the Russian government has now granted its arms export corporation permission to sell armaments to any country in the world.[20] As a result, Russian arms exports are likely to increase in sophistication and include countries that the United States considers to be rogue states.

As for the development of indigenous production capabilities, countries that can master the production of short-range missile systems could also apply their skills to learn to build the required miniature circuitry that is capable of withstanding the high G-forces inherent in gun-delivery or high-velocity precision-guided weapon systems (i.e., the systems shown on the left side of Figure 1-1). Many of the skills learned at major engineering universities (e.g., MIT) that are useful for developing missile systems are also applicable to the pursuit of precision weapon technologies.

One of the major challenges associated with the proliferation of advanced precision-guided weapon systems is how to protect U.S. deployed forces. In the past, dumb munitions had to be delivered in great volume to inflict significant levels of casualties against dug-in static troop positions or moving armored forces. For example, the left side of Figure 1-2 shows the typical effects of a strike against a

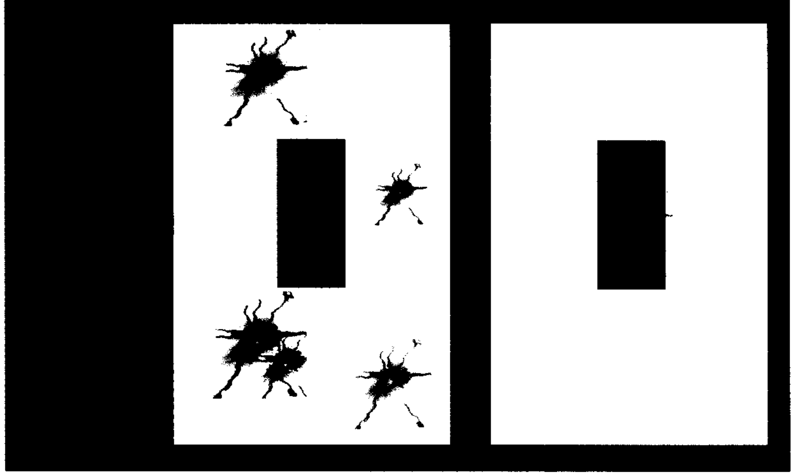
[18] For a good overview of smart munitions development efforts, see Mark Hewish, "Smart Munitions: Brains Plus Brawn," *Jane's International Defense Review*, February 1996, pp. 34-40. By the year 2010, many of the systems described in this article will likely be widely distributed throughout the world.

[19] Interview with Gennady G. Yanpolsky, "A New Era for Russian Defense Export," *Military Technology*, December 1995, p. 33.

[20] Vago Muradian, "Russia Wants Cooperation to Secure Overseas Sales," *Defense Daily*, July 10, 1996, p. 46. In this report, Victor Kuzine, the chief of international marketing for *Rosvoorouzhenie*, Russia's state-owned arms corporation, claimed that his firm had received permission from the Russian government to conduct business with any nation in the world.

protected target using dumb munitions. As long as the target is sufficiently protected, it is almost a case of "dumb luck" if the target is actually hit and destroyed using this type of technology. Thus, a passive defense is acceptable against this type of threat. However, the right side of Figure 1-2 shows the effects that smart munitions typically yield. The bomb damage assessments for Bosnia reflected this type of pattern: a destroyed fortifica-

Dumb Ordinance and Precision Weapon Effects



tion with one crater directly in the center. In short, future precision-guided munitions employed against targets located within the weapon's search footprint are likely to produce casualties in at least 60 percent of the engagements. Dug-in positions and force movement are unlikely to be very effective in protecting U.S. forces. Thus, without active defenses, U.S. intervention forces are likely to suffer high casualty rates if employed against a force equipped with precision weapon systems.

ICBM Developmental Challenges

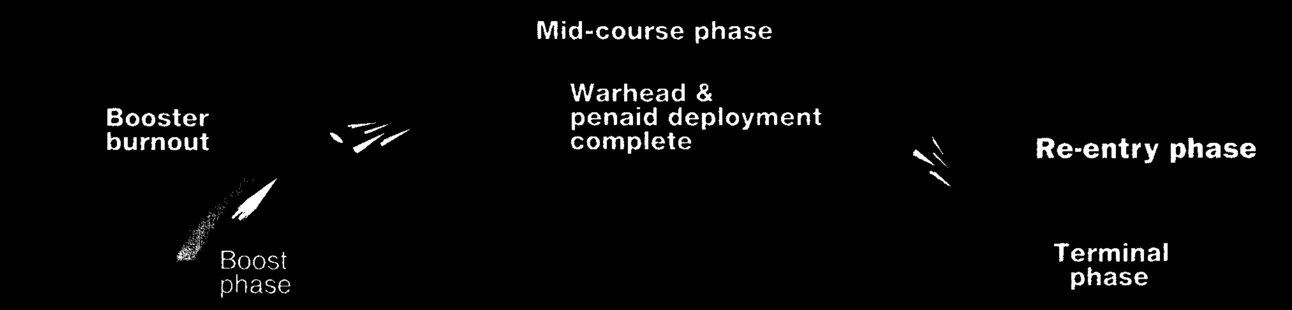
Turning toward the right end of the scale in Figure 1-1, there are several developmental "walls" that must be overcome before a state can develop an indigenous ICBM capability (see exoatmospheric trajectory shown in Figure 1-3, pg. 1.10)

- **Countries must overcome the problems of re-entry.** When a missile travels a course that is longer than 300 to 350 km, the warhead leaves the earth's atmosphere, travels through the vacuum of space (exoatmospheric) and experiences heating and shock as the re-entry vehicle (RV) penetrates the atmosphere. (Some sensible atmospheric heating begins to occur at about 105 kms altitude, but the real heating occurs as the atmosphere thickens in the 90-75 km band.) At 21 kms altitude (70,000 feet), the atmospheric density increases greatly and exerts stress on the re-entry vehicles, similar to "hitting a wall". It is not unusual for the initial payloads flown by a country to shake apart when this first dense "wall" of air is encountered.[21] The second point where RVs experience difficulty with shock action is at cloud level. Essentially, the heat and shock of re-entry requires more effort to overcome than is generally recognized when countries first embark on the development of longer-range ballistic missiles (the longer the range the higher the velocity, which increases the degree of heat and shock that will be experienced during re-entry). To scale this wall, some countries have used recoverable satellites as part of their space-launch programs to learn how to overcome the shock and the heating problems associated with re-entry.

- **A limited precision manufacturing capability is a prerequisite for long-range exoatmospheric missile systems.** Although it

[21] Information on re-entry problems based on a conversation with Pat Duggan, Office of the Project Manager, National Missile Defense, Huntsville, AL, February 12, 1996.

Figure 1-3



- ICBMs travel at 6-7.5 km per second. Multiple warheads and penaids (if so equipped) are deployed immediately following boost phase burnout.
- Large deceleration occurs from atmospheric drag upon re-entry.
- Packaging payloads for re-entry is difficult--early efforts tend to fall apart after hitting air mass "walls" at 21kms (70,000 feet) and cloud level.
- Future defense penetration efforts will become more sophisticated (shrouds, decoys, and maneuverability).

is now easier than it was 10-20 years ago to produce liquid-propelled rocket motors (due to the greater availability of information), it still requires fairly sophisticated manufacturing skills and careful attention to detail, especially for the production of the rocket nozzles and guidance systems. The temperatures inside an ignited missile may exceed 5,000 degrees Fahrenheit, and the components must function under conditions of severe temperature, vibration, and stress.[22] A slight manufacturing flaw can result in the loss of the missile. In the case of solid propellants, the requirement for manufacturing precision increases, and the casting requirements are demanding. However, once the practical aspects of solid propellant manufacturing are mastered, far fewer components are required for production than is the case for liquid-fueled systems.[23]

- **"A traditional ballistic missile must be placed very precisely at a given point in space, angled exactly so as to enter a specific orbit, and travel at a precise velocity."**[24] For example, in the case of the U.S. MX missile, it has a velocity of nearly 23,000 feet per second at burnout. A velocity error of just one foot per second would result in a miss of one statute mile.[25] However, *new guidance-system technologies allow terminal-phase maneuvering of the re-entry vehicle to correct the inaccuracies of the delivery trajectory. Thus, single warhead missiles can now be maneuvered to target.*

- **The final wall is being able to properly stage a multistage missile system.** Given the degree of accuracy that must go into a missile's flight, the ability to ensure that the various stages ignite and burn precisely is another difficulty that must be mastered. Moreover, "once the missile leaves the atmosphere, the missile can easily begin to tumble at the stage transition, because aerodynamic forces cannot be utilized to stabilize it."[26]

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22 Kathleen C. Bailey, *Doomsday Weapons in the Hands of Many,* (Chicago: University of Illinois Press, 1991), pp. 100-101.

23 For a detailed discussion of missile technology issues, see U.S. Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction,* OTA-BP-ISC-115 (Washington, DC: U.S. Government Printing Office, December 1993), pp. 197-255.

24 Ibid., p. 101.

25 Ibid., pp. 101-102.

26 U.S. Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction, op. cit.,* p. 226.

As a general rule, IRBMs and ICBMs are staged missile systems.[27]

The degree of precision required for guidance systems and for precision in manufacturing makes the development of ICBMs difficult. While the development of a commercial space industry can be used to camouflage the development of an ICBM force, a commercial space-launch vehicle (SLV) does not necessarily mean that a country has an effective ICBM capability. When lofting a commercial satellite, the satellite's position in space can be corrected by firing on-board thrusters that gradually change the orbit. In the past, the ability to correct an ICBM's trajectory has been minimal. Thus, an ICBM had to be more accurate than an SLV. However, other than the issue of accuracy, ICBMs and SLVs share identical technologies.

It should also be noted that an *increased availability of information is helping countries overcome some of the "walls" that have hindered ballistic missile development in the past.* For example, rocket-society papers on staging problems, discussions on guidance systems, and detailed instructions on how to feed Global Positioning System (GPS) data into a rocket's guidance system can now all be downloaded from the Internet or located in open-source literature. Moreover, much U.S. declassified information is available to states seeking indigenous production capabilities. For instance, a lot of information on managing staging problems has been declassified. Radio guidance system navigation (now obsolete by U.S. standards) also has been declassified. Similarly, data on the entire Lance missile system are now available in unclassified format. As an enabler, today's precision-milling machines facilitate the automated manufacturing of components that are so well machined that it makes past nuclear and missile production efforts seem crude by comparison.[28] As a result, the "walls" to future long-range missile production are rapidly diminishing in size.

The Cruise Issue

As for cruise missile threats, while cruise systems may be employed against similar targets as ballistic missiles, essentially the cruise missile is more closely related to airplane technology than it is to ballistic missile technology. Furthermore, the cruise missile is easy to design and manufacture. It has a low radar cross section and a low infrared (IR) signature. It is also maneuverable, hard to intercept, and can carry a wide variety of warheads, to include conventional, nuclear, chemical, and biological. *As of 1995, some 130 models of cruise missiles, manufactured by 19 countries, are held in the inventories of 75 countries.*[29] *About 70 percent of the current inventory of approximately 75,000 cruise missiles are anti-ship systems.*[30] As for the future, there are some 72 new models of cruise missiles under development. About 53 percent of the new systems are designed for land-attack missions; the remainder will be anti-ship systems.[31]

Summary of Potential Challenges

In essence, the United States, its forces, and its allies will be faced with a combination of threat systems (precision weapons, cruise missiles, and ballistic missiles) against which they will have to

[27] While staging is the key for efficient missile development, it should be remembered that both the U.S. Atlas and the Soviet SS-6 missile systems were single-stage missiles that used brute force to reach target. For example, the SS-6 had a range of 10,000 kms and was boosted into orbit using 32 rocket engines, all firing together.

[28] David A. Kay, Presentation to the George C. Marshall Institute's Technical Panel On Missile Defense, July 29, 1996. Dr. Kay related the results of his efforts to find open source data on the internet and in declassified files on missile and nuclear-related technology challenges.

[29] Lieutenant General James Clapper, USAF, testifying before the Senate Armed Services Committee, January 17, 1995.

[30] Ibid., and Gormley and McMahon, *op. cit.*

[31] Ibid. For some insights into Russian development efforts of anti-ship cruise missile systems, see "Russia Presses Ahead With Supersonic Designs," *International Defense Review,* May 1. 1994, p. 58.

defend in the future. Obviously, any country contemplating the acquisition or development of any of these systems will tend to put its limited resources into those systems which appear to hold the greatest potential for successful deterrence or employment. At the same time, countries also seek to maximize their national prestige in the international community. Consequently, countries capable of so doing will attempt to develop capabilities in all areas. Thus, if the United States focuses its active defense efforts in only one area of the threat spectrum depicted in Figure 1-1, it will tend to encourage proliferating states to expend their resources developing systems designed to exploit those areas in which there is no effective counter, while, at the same time, remaining vulnerable to those states that have developed offensive capabilities across the entire threat spectrum. As a result, the United States will be forced to focus any defensive efforts on developing an integrated system of active defenses against the entire threat spectrum—battlefield-precision-guided weapons through ICBMs.

Countermeasures to Anticipated U.S. Missile Defenses

Just fielding a missile defense system will not be enough. As has occurred throughout the course of human history, every defensive measure generates a countermeasure. *For the foreseeable future, it is clear that a struggle is emerging that will pit the ingenuity of those building or developing offensive missile systems against those who must develop the defenses against those capabilities.* [32]

In the near term, as this study will show, countries such as Russia, China, India, and others are anticipating that the United States, Israel, and eventually other states will develop missile defenses. To protect their attack options, they are acting to ensure that their future missile systems will be able to penetrate the anticipated defenses. Moreover, as it is the offensive weapon systems that determine the nature of the threat and control the initiative in determining the characteristics and the pace of threat development, the defensive systems always run the risk of being continually one step behind the offensive systems, and thus incapable of stopping the threat. The bottom line is that any missile defense system that is fielded must be able to be upgraded very quickly as offensive systems are modified to improve their penetration capabilities.

The United States is currently developing a first-generation missile-defense system that uses a ground-based radar for tracking the target (painting a 3-D picture), then passing that targeting information to the intercepting missile that mounts an infrared (IR) seeker that "sees" a 2-D picture (a picture created by detecting a heat source and determining the angle to that source). The interceptor then vectors toward the target (but without any on-board ability to determine range to target. It is dependent upon receipt of range data from ground control).

This type of missile-defense system can be degraded or countered by the following actions:

- **Stealth.** All countries are working on reducing the radar cross section of their missiles and warheads. This is being done by use of radar absorbing paints/materials and use of radar non-reflecting designs. In addition, there is some possibility that future efforts could include such actions as putting re-entry vehicles (RVs) inside of plastic balloons filled with radar absorbing foam (available on the commercial market) to camouflage the RVs from the ground-based radar systems.

[32] Andrew Hull, David Markov, Reuben Johnson, "Implications of Third World Acquisition and Employment of Ballistic Missiles and Space Launch Vehicles for SDIO/POET, "*Institute for Defense Analyses*", IDA D-1274, October 1992, pp.VI-1 to VI-8.

- **Decoys.** Decoys are already deployed by some other countries, such as Russia and the U.K. These are designed to look like RVs and provide defenses with a higher number of targets to interdict. Decoys also provide potential platforms for radar jammers.

- **Maneuver.** Almost all countries are working on maneuvering their missiles and warheads to make them more difficult to intercept. At this time, only Russia is believed to be working on an exoatmospheric maneuvering missile system (maneuvering outside the atmosphere consumes large quantities of fuel and is limited to gentle turns measuring 2-3 Gs). Most other countries with ballistic missile capabilities are currently limiting their efforts to maneuver their missiles to the endoatmospheric segment of the trajectory (once the missile leaves the vacuum of space and regains aerodynamic maneuverability from the earth's atmosphere). Maneuvering can cause the intercepting missile to deplete its fuel as it constantly readjusts its intercept vector (burning fuel) or to be unable to make the vector correction fast enough to make a successful intercept.

- **Coning** (also called corkscrewing). Coning is an example of a maneuvering warhead. If a RV or warhead wobbles as it reenters the atmosphere (accidentally or deliberately caused) a spiraling maneuver can be introduced consisting of 10-15 G turns which corkscrews the RV in a 30-40 meter diameter circuit. An interceptor would need a vector and range to target (and on-board computational capability) to plot a successful intercept against a warhead engaged in this type of maneuver.

- **MIRVs and Submunitions.** By placing multiple warheads or submunitions on each offensive missile, the offense can overwhelm the defense unless the defense develops a cost-effective way of dealing with multiple munitions from a single missile. Complicating the problem for national missile defense is the limitation in the ABM Treaty against putting multiple intercept capabilities on defensive missiles. (That limitation would not apply to theater missile defenses.) It should also be noted that the Chinese, for example, reportedly plan to salvo fire their offensive missile attacks in order to saturate missile defenses.

- **Reducing Infrared Signature.** Infrared warhead signatures might be nearly eliminated by the addition of a double shroud (inter-shroud insulated), since much of the heat signature will be eliminated by simply jettisoning the hot shroud(s) since the frigid temperature of space would soon cool the outer skin of the warhead or RVs to near ambient temperature. (The discarded shroud would also act as a decoy.) In addition, IR altering paints can be applied to the exterior of the warhead to change the nature of the IR signature. These counter measures could make it very difficult for the IR seeker on the intercepting missile to find the target against the background coldness of space.

- **Radar Jammers.** Small microwave antennas can be mounted on the RVs and decoys and equipped to receive frequency-hopping radar signals, amplify them, and rebroadcast them, and, in the process, elongate the radar signal in a way that creates a dead space in the coverage (i.e., a volume masker). In addition, simple chaff clouds and metallic balloons can also be released with the RVs and used to scatter the radar signal or to hide the RVs. In the vacuum of space, these simple devices would continue to travel with the warheads until stripped off by the atmosphere during re-entry.

- **Simple Masking.** Warheads can be difficult for an infrared seeker to identify due to simple masking. For example, when China's *Dong Feng* 15 is launched (the type fired near Taiwan in March 1996), the warhead trajectory is trailed by the missile body. The missile body is a hot object and creates a large infrared signature that helps mask the signature of the much smaller warhead. In addition, in the case where a missile breaks up as Iraq's Scuds were prone to do, the resulting hot metal may give off an IR signal larger than that of the warhead, making it difficult to pick out the target. Similarly, in the case where a missile tumbles (easily triggered when staging occurs exoatmospheric where there are no aerodynamic forces to help stabilize the missile's flight), there is no way that the current sensor technology can determine which end of the missile should be targeted to hit the warhead.

Conclusions

Due to technology leveling and the spread of manufacturing facilities, the trend line that measures the speed with which countries develop advanced weapon capabilities is expected to make a rapid climb early in the twenty-first century. As a result, any projection of future capabilities that is made by a continuation of past trends could fall well short of tomorrow's reality.

In the area of offensive military weapon systems, it is clear that the world is moving toward precision-guided weapons, cruise missiles, and ballistic missiles. The walls that have in the past made it difficult for countries to develop these systems are diminishing as information becomes more accessible, new materials allow technical hurtles to be jumped, and computer-controlled precision machine tools make the manufacturing processes easier.

As a result of the changing technological environment, the United States will be forced to develop defenses against the weapon systems it pioneered. These defenses should cover the full spectrum of the threat.

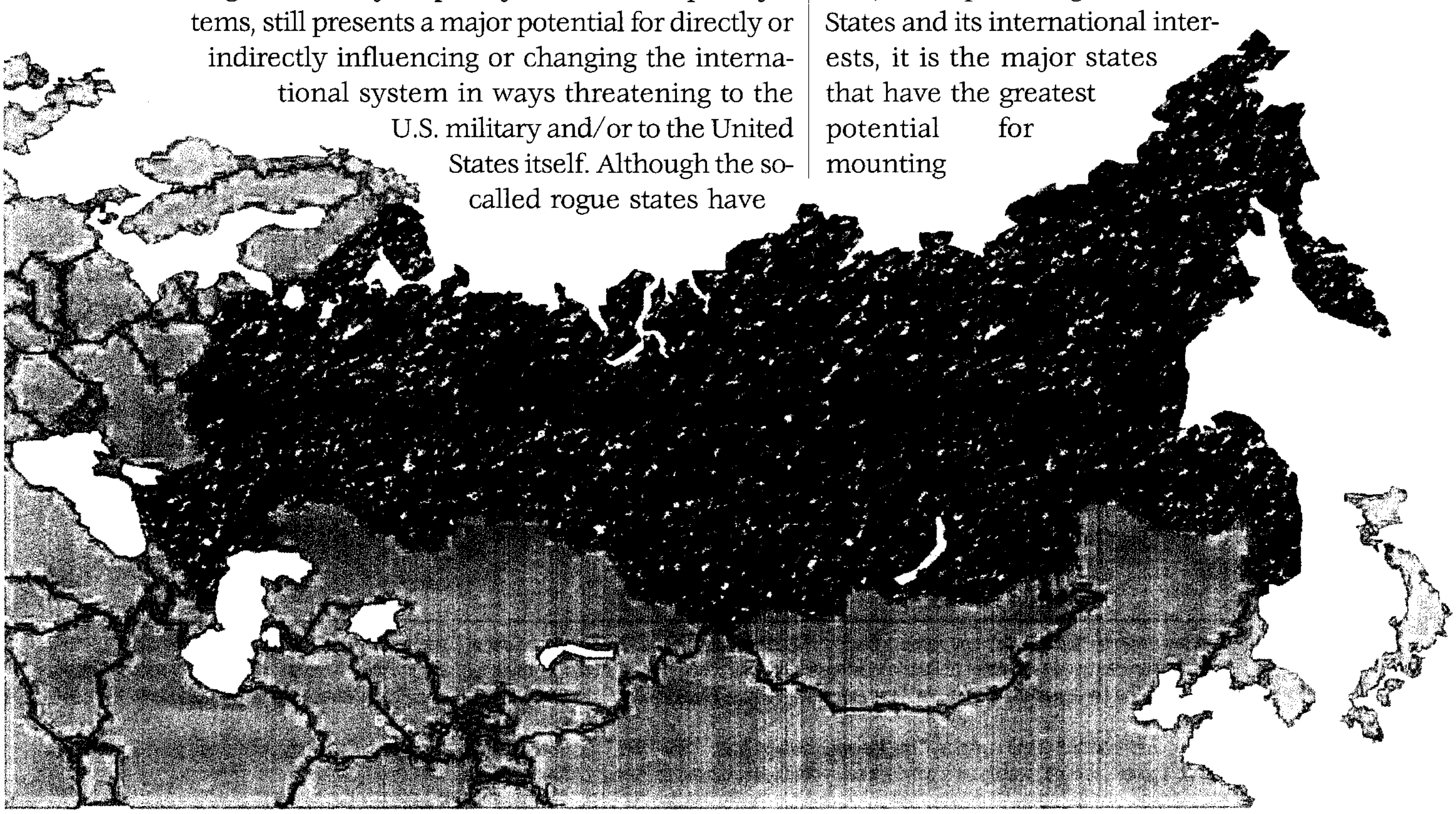
Currently, the United States is developing first-generation missile defense systems. Although these systems will incorporate some impressive capabilities, they will have some difficulty dealing with the more advanced penetration aids. Thus, any missile defense system developed must lend itself to being upgraded quickly and at a reasonable cost. In short, U.S. missile defense initiatives must be planned and programmatically balanced so as to be sustainable over time.

RUSSIA: FRIEND, FOE, OR ACCIDENTAL THREAT?

Strategic Setting

Within the context established in Chapter 1, the major missile defense related challenges likely to face the United States in 2010 need to be assessed in some detail. As it is the major state actors, such as Russia, India, and China, that have the greatest potential for disrupting the international status quo in ways in which only the United States is likely to be able to counter, these are the states which will undoubtedly become the "pacing states" upon which future U.S. defense planning must be most focused.

Despite the relative loss of power that has beset Russia in recent years, Russia, with its large nuclear force structure, extensive military technology capabilities, and large inventory of poorly secured weapon systems, still presents a major potential for directly or indirectly influencing or changing the international system in ways threatening to the U.S. military and/or to the United States itself. Although the so-called rogue states have the potential to trigger wars within their respective regions and, if they should prove successful in their quest for effective inventories of weapons of mass destruction, could pose a significant threat to the United States and its international interests, it is the major states that have the greatest potential for mounting



military challenges sufficiently large so that only the United States would have the capabilities to counter them within their respective regions of influence. As Russia is still foremost among these powers, it will be assessed first.

Russia's Apparent National Objectives

As Russia is currently preoccupied with its internal affairs, it is difficult to enumerate with any degree of authority a listing of Russia's official national objectives. As Aleksey Arbatov carefully points out in a detailed paper published in May 1994, Russia has not yet developed a coherent foreign policy.[1] Nevertheless, a careful review of the comments and writings of Russia's political elite provides some recurring patterns of thought from which insights can be derived.

1. **Russia seeks its former level of international status** (the status accorded to the former Soviet Union)—to include a larger share of global markets (arms) and greater influence in the international decision-making process.

One of the main irritations expressed by Russia's political community is frustration over its diminished international stature in the post-Cold War order. Moreover, there is a high degree of anger over the decline in Russia's share of the international arms market.[2] Many Russian leaders claim that much of the United States' criticism and pressure to halt potential Russian arms sales to so-called rogue nations, in actuality, is part of a U.S. ploy to dominate the global arms market. Russians look at the increase in U.S. arms market share and complain that the United States is trying to destroy Russia's defense industries and gain a monopoly for its own industries. As a result, Russia's political community is becoming much more adamant regarding Russia' right to sell arms to whomever it wishes.

2. **Russia wants to encourage a military balance in East Asia;** it perceives itself as vulnerable in that region. (Its historic fear of Japan is again becoming evident.)

Russia's policy community believes that a withdrawal of U.S. forces from East Asia would undoubtedly result in a rearming of Japan—a possibility most Russians fear. Thus, an apparent majority seem to believe that a limited U.S. presence in East Asia (one sufficient to reassure Japan but limited enough to be kept in check by the other states) would be beneficial to Russia's national interests and contribute to a stable East Asian balance of power. Within a new power alignment, many Russians seem to believe that a reunified Korea would prove to be the natural ally of Russia—thus Russia is actively courting both North and South Korea.[3] With regard to China, there seems to be divided opinion. There are those in the Russian policy community who believe that a more capable China would tend to expand its interests toward the South, which would pose problems for the United States and divert U.S. attention away from Russian affairs. Concurrently, a few political thinkers also fear that Russia's technical and military assistance to China is an act of "selling China the rope to hang themselves" since China has a long-standing claim to much of the Russian Far East which was wrested from China by the Czars during the previous century.[4]

Regardless of these cited reservations, the fact remains that Russia and China are growing closer together in the face of U.S. policies that are displeas-

[1] Aleksey Arbatov, "Aleksey Arbatov Ponders Security Needs in Late 1990's," *FBIS Report: Central Eurasia*, FBIS-USR-94-129, JPRS, November 29, 1994.

[2] For a comprehensive assessment of Russia's defense industrial problems see study: Institute for Foreign Policy Analysis, *Defense Conversion and Arms Transfers: The Legacy of the Soviet-Era Arms Industry—Russia, Ukraine, The Czech Republic, Slovakia, Poland* (Washington, DC, and Cambridge, MA, July 1993).

[3] Herbert J. Ellison and Bruce A. Acker, "The New Russia and Asia: 1991-1995," *The National Bureau of Asian Research*, June 1996, pp. 8-9. Note, this report is recommended reading as it provides an in-depth assessment of Russia's Asian interests.

[4] For example, see S. Enders Wimbush, "When China Absorbs the Russian Far East," *The Wall Street Journal*, April 25, 1996, p. A20.

ing to both countries. Depending on the source of the report, the conservative estimate is that at least 1000 Russian technicians are working in China's nuclear and rocket programs.[5] Between 1991 and 1994, China is estimated to have purchased between $4.5 and $6 billion worth of weapons and military equipment from Russia.[6] Included in this trade are advanced military aircraft, *Kilo* submarines, defense manufacturing facilities, defensive missile systems, and reportedly, key ICBM missile components (and possibly manufacturing information).[7] For Russia, China is a source of inexpensive consumer goods and provides an easily accessible market for its defense production. In addition, the possible option of using China as Russia's "China card" to help maintain a check on U.S. behavior may well become part of Russia's national security game plan. Thus, the future Russian-Chinese relationship will be a key factor in the United States' future security equation.

3. **Russia plans to exercise hegemony over Central Asia** and ensure that the region does not threaten Russian security.

There is a significant level of unhappiness about the loss of Russian control over greater Central Asia. This region contains the world's second largest reserves of petroleum, is rich in natural resources and raw materials, contains a majority of the 20 million ethnic Russians who live outside of Russia's borders, and is judged to be the direction of greatest security vulnerability (Russia's soft underbelly). As a result, many in Russia's policy-making community deeply regret Russia's loss of direct control over the region and are actively working to maintain indirect control.[8] As an exacerbating factor, the area's dominant Islamic and Turkic religious and ethnic roots are viewed as potential avenues for exploitation by Turkey and Iran.[9] Russia wants to prevent Turkey from expanding its influence in Central Asia, while concurrently ensuring that Iran does not use its religious influence to fan the flames of Islamic fundamentalism.

Toward this end, most Russians seem to view the development of close ties with Iran as a vehicle for furthering Russia's national interests. Russians seem to believe that if Iran views Russia as a strategic partner, then it will be less likely to inflame the Islamic populations of Central Asia in ways that could be detrimental to Russia's national interests. Moreover, most Russians also seem to think that the development of Iran's military capability will act as a check on Turkey's influence in the region, while, at the same time, helping to provide a bulwark against unfettered U.S. domination of the Persian Gulf region.

In a similar vein, *there seems to be significant Russian interest in the idea of developing a close relationship with Iran, India, perhaps China, and a unified Korea to balance the power of the United States, Japan, Turkey, and related allies that could threaten Russian interests—particularly in Central and Eastern Asia.*[10] The concept would use India and Iran to check U.S. influence in South Asia and the Persian Gulf, while China and perhaps a unified Korea would keep Japan and U.S. Pacific-deployed forces balanced.

4. **Russia hopes to develop the capability of participating effectively in the international economy.**

[5] The number 1000 was reported by Mikhail Urusov, *Moscow News*, October 7-13, 1994, p.8; during a 1996 background conversation between a U.S. visitor and a Russian official, the Russian noted that he could not keep track of what technology information was being passed to the Chinese—on any given day 5000 Russian technicians are in China, it is impossible to know what they are all doing.

[6] Theresa Hitchens, "Industry, Defense Needs Forge Russia-China Arms Link," *Defense News*, February 5-11, 1996, p. 24.

[7] Ibid., and Bill Gertz, "China's Arsenal Gets A Russian Boost," *Washington Times*, May 20, 1996, p. A1.

[8] Ellison and Acker, *op. cit.*, pp. 8-9, 22-25.

[9] Arbatov, *op. cit.* Although this issue has been widely discussed in press reports, the Arbatov paper provides a fairly detailed discussion of the issue.

[10] While there are innumerable reports on the issue, for some sample reading of ongoing comments and discussions see Arbatov, *op. cit.;* Marshall Ingwerson, "The Bear's Hunt for Arms Sales," *The Christian Science Monitor*, April 8, 1996; Sergey Tretyakov, "Russian Ambassador Discusses Nuclear Cooperation," *FBIS-NES-95-221*, November 16, 1995, pp. 41-42; Stephen Blank, "Russian Nuclear Exports to Tehran," *Jane's Intelligence Review*, October 1995, p. 452; comments ascribed to Victor Titov (a senior advisor to General Aleksandr Lebed), "Transformation Watch: Lebed is not 'A Man to do Business With'," *Decision Brief: The Center for Security Policy*, June 18, 1996; Aleksandr Lyasko, "Theses Reportedly Underlie New Military Doctrine," *FBIS-TAC-95-006, FBIS Report: Arms Control & Proliferation Issues*, December 8, 1995; and "Russia Denies Supplying Missiles to India," *FBIS-NES-95-242*, December 18, 1995.

Russians well understand that membership in the international economic system is key to their future. Indeed, some well-placed Russians claim that the moderation of Soviet behavior during the late 1980s was in part triggered by a fear that Europe was about to integrate politically and leave the Soviet Union permanently isolated outside of the European economic system. Meanwhile, Russia has since become disenchanted with the West, the movement toward true European integration has slowed, and it is unlikely that Russia ever will be invited to become a member of the European Union. In addition, the West seems bent on limiting Russia's influence in international affairs. Consequently, political support for the pro-Western policy adopted at the conclusion of the Cold War has largely evaporated.[11]

As a result, Russia can be expected to steer a more independent political course in the future as it pursues its national interests. Nevertheless, Russia also understands that it must exercise caution and discretion when acting contrary to U.S. wishes as the potential economic consequences must be balanced against the security issues involved. Considering the unpredictability of Russia's political future, it is uncertain how Russia will balance internally its economic needs and desires to integrate into the international economic system against its national security interests. Moreover, it is not yet clear if Russia's experiment with democracy and capitalism will survive the problems plaguing that system. A return to an authoritarian government or a further breakdown of central authority in Russia could significantly alter the situation outlined in the foregoing.

Russia's Ballistic Missile Development Activities

As is commonly known, Russia's conventional military capabilities are in disarray.[12] Units are undermanned; most military equipment stocks are in poor condition; acquisition of new equipment has been drastically reduced from past levels; and troop morale (due to lack of pay, shortage of food, shortage of housing, loss of public esteem, and poor discipline) is very low. The weakening of conventional defensive capabilities has caused Russia to become more reliant on its strategic nuclear forces as its primary means of defense. As a result, the nuclear threshold has been lowered as Russia has adopted a launch-on-warning posture and, in November 1993, dropped the pledge of no-first-use of nuclear weapons from its military doctrine.

Although overall Russian defense research, development, and acquisition funding has been severely slashed, a few high priority programs are still being resourced, including precision weapons, submarines, advanced aircraft, and various cruise and ballistic missiles. Of interest (for purpose of this study) is Russia's ongoing military development of ballistic missiles. It is clear from Russian public statements regarding missile R&D efforts that Russia's defense policymakers have assumed that the United States will deploy missile defenses in the future. Consequently, they are taking action to ensure that Russia's future missile systems will be able to penetrate the U.S. defense systems.

Current U.S. missile defense programs are designed to field first-generation defensives capable of hitting "well-behaved" offensive missiles (i.e., standard, non-maneuvering ballistic trajectories with limited or no penetration aids). While most of the world's non-Western inventory of current mis-

11 Based on personal conversations with several Russian officials and Ellison and Acker, *op. cit.*, pp. 15-16, 21. Of similar note, Israeli officials who accompanied Prime Minister Rabin to Russia claimed that they were shocked by the "intense anti-American sentiment" they witnessed in Moscow, *Intelligence Digest*, September 22, 1995, p. 1.

12 For a concise summary of Russia's military readiness posture and problems, see "The Russian Armed Forces: Super Power to Limited Power," *Jane's Defense Weekly*, February 14, 1996, p. 17.

sile systems fit this category,[13] *Russia has some missiles that are believed to have added capabilities for penetrating missile defenses.* For example, the SS-18 (one of Russia's most capable MIRVed systems) was observed during test firings deploying some objects in addition to its re-entry vehicles. As Russian missile tests are conducted under conditions as realistic as possible (testing almost all functions to include detonation of the fuses in the dummy warheads), it is believed that the non-RV objects sighted were designed to test a decoy deployment function. Russian sources claim that 1000 non-RV objects are deployed along with the SS-18s RVs.[14]

For the next generation of Russian missile systems, additional steps are being taken to enhance the penetration potential of Russia's offensive missile systems. Toward this end, there are at least three systems reportedly under development that should prove challenging to U.S. missile defense efforts.

SS-X-26. This five-ton mobile tactical missile system is undergoing operational testing and could begin deployment as early as 1997. It has a range of 400 km, will be fired from a quad-axle amphibious combat vehicle/launcher, a crew of four or five, and is being touted as having a CEP of less than eight meters. The warhead will have a low radar cross section (stealthy) and is reputed to be able to maneuver in flight. It has an autonomous inertial flight control system that incorporates an onboard computer. The firing data will be inserted into the guidance system while the missile is in the horizontal position, allowing the missile to be erected and fired rapidly so as to prevent enemy detection and counteraction prior to launch. It is also equipped with other countermeasures to evade enemy defenses.[15] It is claimed that the system will be equipped with a conventional warhead. Essentially, this missile is designed to replace the SS-23 *Spider* which was destroyed in 1989 in compliance with the INF Treaty. The new missile was built to fit under the INF Treaty limits. It may be that the Russians will produce this missile in an export version with a range of 300 kms.[16]

SS-X-27 or *Topol* M. This 45-ton, three-stage missile is also known as the new SS-25, the SS-25B *Sickle*, and the RS-12M2. Production of this mobile missile will for the first time, be conducted exclusively by Russian companies (the Votkinsk Machine-Building Plant at Udmurt, the Moscow Institute of Thermal Engineering, and the VNIIEF Design Bureau at Arzamas-16—which is being renamed Kremlev). Production is expected to begin in 1997 (funding shortages slowed testing and caused the fielding schedule to slip from the previously announced 1996 date).[17] This 10,500 km missile is being developed with a single one-ton warhead as required under Article V, START I, which prohibits MIRVed warheads on mobile ICBMs. The Russians are calling the *Topol* M an upgrade to the SS-25 mobile missile system. However, the missile may in fact be composed of new components which will "make it faster, more accurate and harder to detect."[18] The missile has a larger first stage than the current SS-25 and may be

13 The United Kingdom, with U.S. technical assistance, has developed a fairly sophisticated capability to penetrate missile defenses. See the discussion of the Chevaline program in Robert S. Norris, Andrew S. Burrows, and Richard W. Fieldhouse, *Nuclear Weapons Databook, Volume V: British, French, and Chinese Nuclear Weapons* (Boulder, CO: Westview Press, 1994) pp. 105-113.

14 Phone conversation with Professor Ted Postol, Defense and Arms Control Program, MIT, June 20, 1996; and *Russian OI Television*, "Test Range, Missile Deactivation Program," January 30, 1994, 0700 GMT. In addition, the Russian SS-25 post-boost bus has 4 large protrusions that may house decoys or other penaids. See Andrew Hull, David Markov, and Steven Zaloga, "The Topol (SS-25 Sickle) Intercontinental Ballistic Missile," *The Institute for Defense Analyses*, IDA D-1772, May 1995, p. 5.

15 "Russia, 12/21/95," *The Nonproliferation Review*, Spring-Summer 1996, p. 155; and Steven Zaloga "Russia's SS-X-26: The Son of *Scud*," *Jane's Intelligence Review*, Vol. 8, No. 3, pp. 102-103.

16 Sergey Novikov, "New Russian Operational-Tactical Missile in Testing at Kapustin Yar," *FBIS-UMR-96-021-S*, December 21, 1995; and Steven J. Zaloga, "Son of Scud: The *Iskander* (SS-X-26) Tactical Ballistic Missile," unpublished paper, March 1997.

17 "Russia, 11/29/95," *The Nonproliferation Review*, Spring-Summer 1996, p. 154; "We Still Do Make Rockets," *Official Kremlin International News Broadcast*, January 20, 1996; and Pyotr Yudin, "Moscow's Budget Squeeze May Stall New Nuke Missile," *Defense News*, August 19-25, 1996, p. 1.

18 "Russian ICBM," *Forecast International/DMS Intelligence Report*, February 1996, pp. 3-4.

able to maneuver while in flight.[19] It also seems clear that the warhead incorporates sophisticated penetration technologies. One unidentified Strategic Missile Force officer reportedly stated that the *Topol* M can "sneak through any anti-missile defense, maintaining the projected trajectory and reaching the target in any circumstances."[20] The *Topol* M and the SS-19 are expected to be Russia's only ICBM systems during the first decade of the next century. The *Topol* M production will be split with about half of the missiles deployed in silos and the other half in a mobile configuration.[21]

Project X. Russia's NIIGrafit research institute (according to a report in the April 1995 issue of *OGONEK* magazine) is working on a top-secret, nuclear-armed missile that performs like a cross between a satellite system and an airplane. It is a six-meter long wedge with wings that are .5 meters long. It will travel at ballistic missile speeds (greater than 3,000 km/h) while maneuvering like a cruise missile. It can be placed into orbit from either a strategic bomber or by a ballistic missile launch carrier. It is claimed that the system will be able to evade planned U.S. missile defenses because it will be virtually undetectable in orbit, and once activated by a command from a control console, will begin a rapid descent to strike its designated target. It is claimed that it will be able to defeat U.S. missile defenses as the defending forces will not be able to calculate its trajectory fast enough to respond. In the first two tests, the Bora-1 and Bora-2 test vehicles melted. In the last two, the Bora-4 and Bora-5, according to the Russian comments, came through re-entry "as cool as cucumbers" after some new technology was added.[22]

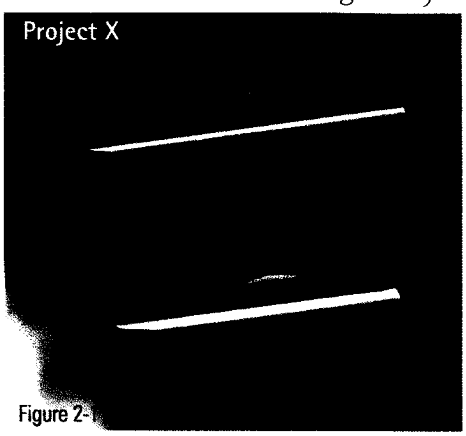


Figure 2-

The Russia press report on Project X raises the question of what is really going on with this project. During the September 1993 Moscow Air Show, Russian specialists were trying to interest potential investors in a rocket/space ambulance system named *Pryzyv*. The "sales pitch" included a four page handout that showed conceptualized pictures for the space vehicles involved. See Figure 2-1. It is clear that Project X and the space ambulance system are the same project.

Typically, during the immediate post-Cold War era, many Russia projects were in danger of being canceled as funding was reduced. Many project managers of that era tried to find commercial uses for their projects, then packaged the effort under the "defense conversion" rubric. Thus, the real questions become: has Project X been resuscitated as a current developmental effort, and if so, is it receiving serious funding? If Project X is still a real program, it will provide the United States with a serious missile defense challenge in the future. On the other hand, it may represent a terminally ill program that has not yet responded to its Cold War death knell.

19 Ibid.

20 "Russia, 12/20/94," *The Nonproliferation Review,* Spring-Summer 1995, p. 188

21 "We Still Do Make Rockets," *op. cit.* Originally, the Topol M was to be the only ICBM in Russia's arsenal by 2005; see "Russia, 12/8/93," *The Nonproliferation Review,* Fall 1994, p. 193. However, recent statements indicate that Russia plans to extend the service life of the SS-19 from 10 to 25 years and keep it on active status; see "Russia, 11/29/95," *The Nonproliferation Review,* Spring-Summer 1996, p. 154; also see forthcoming article by David R. Markov, "The Russians and Their Nukes," *Air Force Magazine,* February 1997, pp. 40-43.

22 "Russia, 6/30/95," *The Nonproliferation Review,* Spring-Summer 1996, p. 154; and "Russia: Developing Advanced Weapons, *FBIS: S & T Perspectives,* Vol. 10, No. 5, June 30, 1995, p. 7. The description of this missile makes it appear that it might be left in orbit until activated (a weapons-in-space issue). The technology used to cool the missile and make it invisible in space may include stealth and actions to limit its IR signature. It is also likely that the missile would be able to execute sharp turns and maneuvers on its way to target. The velocity of "greater than 3,000 kms/h" seems greatly understated as an orbiting space vehicle would travel much faster.

Russia's Technology Transfer Potential

The lessons learned from *Desert Storm* regarding the value of high-technology weapon systems have helped soften the global market for weapon systems that are based on medium-levels of technology (e.g., tanks, artillery, various gun systems, dumb munitions, etc.).[23] As a result, defense sales increasingly are awarded to those sources who are willing to sell advanced technology-based weapon systems and components. For Russia (and China), this has reduced sales volume in mainstay product lines and produced economic pressures to sell advanced armaments and manufacturing technology to offset the decline in sales volume of products based on mature technologies. As such, Russia represents a key potential source of missile and WMD weapons and technologies.

Russia's potential transfer of defense technologies comes from at least four sources, three of which will be considered here: 1) state-sanctioned export of military technology and equipment, 2) questionable or unofficial defense exports arranged through factory managers, government officials, or military officers acting on a personal basis, and 3) smuggled exports (often involving organized crime groups). In addition, the migration of Russian scientists and engineers (as summarized in Chapter 1) also provides an avenue for military technology transfers.

Official Exports. Russian defense exports plummeted at the end of the Cold War to a level of $2-3 billion a year, a figure that is only about 10-15 percent of the dollar volume generated during the peak-sale-levels experienced in the mid-1980s. At the same time, Russian military procurement also fell precipitously, which left many Russian defense firms totally dependent on export earnings to stay in business. For example, it is claimed that 100 percent of all work done at the MiG design bureau and its production factory since 1993 has been in support of foreign sales.[24] Indicatively, in 1995, only 35 MiG-29 aircraft were built, all for foreign customers.[25] In a country where 74 major cities have 80 percent of the workforce dependent on the defense sector (with little alternative work available),[26] the problem is a serious economic and political issue.

The grim reality of Russia's economy is reflected in its policy toward arms sales. As Russia's Deputy Prime Minister remarked in 1993, Russia is "willing to sell anything that our customers want, except nuclear weapons."[27] This offer includes complete systems or individual components—whatever the customer desires.[28] In many cases, this means Russia is willing to sell military systems that are currently in use by, or have not yet been issued to, its own forces.[29] For example, the *Zhuk* (*Beetle*) radar which is designed for deployment on the MiG-29 is being offered for sale even though it is not yet in service with the Russian Air Force.[30] Similarly, Russia is offering to sell the UAE the advanced Su-35 with the state-of-the-art AA-12 missile (Russian designation R-77).[31] In addition, *Russian firms are known to have offered to provide technicians and technologies to clients wishing to develop countermeasures to missile defenses as well as to acquire technologies such as a long-wave, counter-stealth radar system and cryptological equipment.*[32] This policy seems to be yielding some results. In

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23 For a detailed discussion of the issue see Institute for Foreign Policy Analysis, *Defense Conversion and Arms Transfers, op. cit.*, pp. 79-88.

24 David Markov, Presentation at Symposium on *Exploring U.S. Missile Defense Requirements in 2010*, hosted by the Institute for Foreign Policy Analysis, Inc., Washington, DC, June 7, 1996.

25 Nikolay Novichov and Craig Covualt, "New Russian MiGs Set for Flight Test," *Aviation Week and Space Technology*, January 1, 1996, p. 21.

26 Hull and Markov, *op. cit.*, p. 2.

27 Richard Beeston, "Kremlin's Arms Salesman Return to the Offensive," *The [London] Times*, June 16, 1994, p. 11.

28 Muradian, *op. cit.*

29 "Russia: State Plan for Exports on Target," *Jane's Defense Weekly*, August 21, 1996, p. 25.

30 Hull and Markov, *op. cit.*, p. 9.

31 Ibid., p. 10.

32 Ibid., p. 11.

1995, Russia signed arms export agreements worth $9.1 billion.[33] In short, Russia's defense export policy is aimed at the survival of its defense industries. As such, there seems to be very little that Russia is not willing to export on an official basis except weapons of mass destruction.

Questionable Exports Involving State/Industrial Personnel. One legacy of communism is a prevailing contempt toward private property rights. Under the communist system, people often claimed, "All property belongs to the state, but as we [the people] are the state, I'll take my share now!" This general attitude was well expressed in a Soviet-era cartoon that showed workers streaming out of a food depot at the end of the work day, all but one with arms full of plundered supplies. The one man with empty arms was being eyed with suspicion by two militia guards. The honest man's companion leaned over and whispered: "Quick! Take something for appearance sake, they have their eyes on you already!"

Even with the coming of capitalism, this same basic attitude is still in evidence. Theft, graft, and corruption are deeply embedded in the Russian outlook toward property rights and economic activity. Moreover, corruption among officials and personnel with access to military equipment and technology is also influencing Russia's arms transfer profile.

There have been a significant number of reports of unauthorized armament transfers by officials charged with safeguarding Russia's military arsenal. For example, in October 1995, former General of Chemical Troops Kuntsevich was charged by the Russian Federal Security Service with delivering 800 kilograms of chemicals to Middle Eastern buyers in 1993 and attempting to smuggle an additional 4.5 tons in 1994.[34] Yet, members of the Russian Security Service itself are apparently involved in similar types of activity. A news article (claiming to be based on a secret German government document) identified two nuclear dealers who were arrested in Moscow in August 1994 as being members of Russia's Federal Security Service.[35]

More explicitly, a former State Duma committee Vice-Chairman, Vitaly Savitskiy, testified that the Russian Federal Security Service facilitated Aum Shinrikyo's (the Japanese cult that conducted the March 1995 chemical attack on the Tokyo subway) access to Russian facilities where nuclear and toxic substances were stored. ***He claims that they were allowed to take nuclear materials.***[36] As has been the case with a significant number of people in Russia who have publicly identified illegal activities, Vitaly Savitskiy subsequently died under mysterious circumstances.[37]

In an attempt to control corruption in arms transfers, in 1993 Russia created a centralized organization, *Rosvoonruzhenive,* to manage its foreign military sales efforts. Apparently, this move has been less than successful. One of the prominent questions about Russia's arms sales under *Rosvoonruzhenive's* direction has been "where is all of the money going?"[38] It is clear from other research done on this issue that much of *Rosvoonruzhenive's* profits from international arms sales are ending up in the pockets and foreign bank accounts of ranking Russian officials and high-level

[33] Barbara Starr, "Russia Leads World In Arms Transfers Says U.S.A., *Jane's Defense Weekly,* August 28, 1996, p. 27. The article cited a report entitled, U.S. Congressional Research Service, *Conventional Arms Transfers to Developing Nations, 1988-1995.*

[34] Graham H. Turbiville, Jr., *Weapons Proliferation and Organized Crime: The Russian Military and Security Service Dimension* (Colorado Springs: USAF Academy, Institute for National Security Studies, 1996), p. 42.

[35] "BND Identifies Terrorist Mastermind Targeting Jews," *FBIS-WEU-94-202,* October 19, 1994, pp. 16-17.

[36] "Japan, 10/31/95," *The Nonproliferation Review,* Spring-Summer 1996, p. 117.

[37] Ibid. For additional insight into some of the mysterious accidents that have been occurring in Russia, see "Political Assassinations in the East," *The Fight,* Number 255, July 11, 1995.

[38] Turbiville, *op. cit.,* p. 16.

military officers.[39] In an attempt to improve the situation, Russia has again taken steps to decentralize some of its arms sales—the first step occurring in 1994, then expanded in late 1995, to allow specified industrial concerns to market their products (under nominal state control) directly to potential customers.[40]

In a similar set of circumstances, "the *Voyentekh* State Armament and Military Equipment Sales Company was established in the summer of 1992 at the behest of Defense Minister Grachev. The idea was for *Voyentekh* to export excess equipment and armaments from the inventory of the Ministry of Defense and use the money to build housing for servicemen."[41] Essentially, this was to be a surplus sales organization, and the military was free to determine which items were to be declared surplus. However, some of the items sold apparently were not truly excess equipment, and the funds received were manipulated so that a significant amount of the proceeds did more to enrich members of the military's leadership than it helped to solve Russia's military housing shortage.[42] This activity reportedly was not limited to foreign sales. There are allegations that Russian military stocks were also used to arm Chechen rebel forces—with the cooperation of ranking Russian military officers.[43] (It has been reported that some of the actions taken by military representatives to transfer arms to Chechen forces may have been aimed at protecting Russian aircraft access to Groznyy airport, a suspected international drug-traffic transit point.)[44]

Unfortunately, the examples cited are representative of the arms and technology transfer climate in Russia. *Numerous factory managers, high-level officials, military officers, and security personnel are involved in unauthorized or questionable sale and transfer of key technologies and military armaments.* It seems doubtful that the recent actions taken to again decentralize arms sale activities will make the situation better. It may, in fact, further exacerbate the flow of sensitive technologies out of Russia by increasing the number of people involved in such arms sales.

Smuggled Exports. It is impossible to separate official corruption and organized crime activities in Russia—they are intertwined. Some of this intermingling is attributable to the way that organized criminal activity developed under the Soviet system. Although organized crime groups have existed for all 74 years of Soviet history,[45] the current problem seems to be attributable to several factors, including: 1) the networks and organizations that certain criminal elements developed while locked away in Stalin's labor camps were transplanted into the civil society when the members were released upon Stalin's death (the activities of these organized gangsters have become increasingly vicious as civil authority has weakened);[46] 2) the entrepreneurial "specialty" supply networks, that first began to emerge during the 1940s and 50s, evolved during the 1960s and 70s into organized crime families that included government officials; and 3) the termination of communist authority prior to the establishment of an effective rule-of-law system of government left a power vacuum in the hinterlands of Russia. In particular, these last two points warrant some amplification.

Historically, as the Soviet economy grew in size, it became impossible to centrally plan the produc-

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39 For an enlightening account of Russia's arms sales under *Rosvoonruzhenive's* supervision, see Turbiville, *op. cit.*, pp. 16-21.
40 Yanpolsky, *op. cit.*
41 Turbiville, *op. cit.*, pp. 21-22.
42 Ibid., pp. 22-24.
43 Ibid., pp. 25-26.
44 Ibid., p. 25 and footnote 56 on p. 50.
45 Center for Strategic and International Studies, *Global Organized Crime: The New Evil Empire* (Washington: CSIS Report, 1994), p. 140.
46 "Organized Crime in Russia," *Jane's Special Report No. 10*, ed. Robert Hall and Peter Felstead, June 1996, p. 5 & 7.

tion requirements for the entire nation (i.e., to make provisions for every screw, nut, bolt, and washer required to meet the central plan). To correct the deficiencies of the plan, specialty entrepreneurs, known as jobbers, emerged. They would locate and supply the items not issued by the central planners but needed to meet production goals. Essentially, the jobbers would procure the items not provided in exchange for products or raw materials controlled by the enterprise needing production feed stock or equipment. While a few small-time jobbers emerged during Stalin's reign, it was during the Khrushchev era that the use of jobbers became common.[47]

Obviously, if one is a jobber facing the task of procuring parts and components from across the breadth of the Soviet Union, networking with other jobbers would become a necessity. Hence, networks of jobbers soon developed that were specialized by industry/commodity. The state initially turned a blind eye toward the activities of these small capitalists as long as they did not become too greedy or try to trade in items such as nuclear materials. Those who failed to keep within acceptable boundaries were sent to the Gulag.[48] Of course, at about the same time, corrupt local and regional party officials realized that they could also use the Gulag to discipline capitalistic entrepreneurs who failed to share their profits with the appropriate officials.

During the years of stagnation under Brezhnev's listless leadership, the forging of the modern crime families gathered momentum. Communist party bosses, KGB officials, and police/militia leaders who had allied with the jobber networks in the 1950s,[49] in many cases became the "godfathers" of their respective "mafia" groups during the 1960s and 70s. In some cases, enterprising government officials and factory managers created their own networks to supply items not provided by the system. Gradually, the criminal activity became more ruthless as the participation of government officials, factory managers, and law enforcement organs in many of the criminal groups made it difficult to bring gang members to justice.[50] The communist party was the only organ capable of ensuring that the criminal activity did not get too far out of hand. Nevertheless, the end result was that organized crime became deeply embedded into the very fabric of Soviet society and government organs.

To better understand how criminal gangs operated in the Former Soviet Union (FSU), two reports provide some insights. In the first account, the government investigated the gold mining artels in 1987-88. The supply records showed that the artels had only received from the state 14 percent of the equipment authorized by the central planning agencies. Yet, over 1,000 bulldozers and roughly half of the machinery and equipment acquired by the artels over the past five years had not been issued by state agencies. The Soviet report noted that the artels had solved their equipment shortage problem "by a well-tried method, by organizing a clandestine network of suppliers." At the same time hundreds of kilograms of gold and precious metals had disappeared; about 300 kilograms of gold were recovered from officials and suppliers

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47 The material on the development of organized crime in Russia is based primarily on a series of lectures given by Dr. Craig Nation during a graduate course on Communism, University of Southern California, 1984. The insights he gained while living in Russia were corroborated by subsequent Soviet articles that began to be published in the late 1980s.

48 Center for Strategic and International Studies, *Global Organized Crime, op. cit.*, p. 140.

49 Brian Sullivan, "International Organized Crime: A Growing National Security Threat," *Institute for National Strategic Studies Strategic Forum*, Number 74, May 1996, p. 2.

50 "Battle Against Scum of Organized Crime Cited," *FBIS-SOV-88-208*, October 27, 1988, pp. 83-86. The article translated from *TRUD* provides insights into the evolution of crime groups and their relationships with government officials. It was believed by Soviet officials in 1989 that one-fifth of the crime groups had connections with officials, and all of the groups involved in economic criminal activity had the support of government/Party organs, "Operations of Moscow Organized Crime Reported," *FBIS-SOV-89-005*, January 9, 1989, p. 81. See also, "Fight Against Mafia Corruption Reviewed," *FBIS-SOV-88-194*, October 6, 1988, pp. 51-52.

who were arrested for bribery, theft, and abuse of their official positions.[51]

In the second account, a prominent Russian economist told a Western visitor that "organized crime groups starve entire urban settlements by stealing supplies from distribution centers—retributions for unsuccessful efforts to extort money."[52] Obviously, for the settlement to starve, resupply operations would have to be executed slowly which begs the question of official collusion.

As the Soviet Union began to break up, criminal activity exploded. In 1991, Russian law enforcement agencies identified 780 organized gangs;[53] but according to a 1993 report attributed to the Russian Ministry of Internal Affairs, the estimate had risen to 5,700 organized crime groups in Russia, of which 200 were classified as large sophisticated organizations. Over 100 of those groups operated on both a national and an international scale.[54] The international operations included connections with the Italian Mafia and the Chinese Triads,[55] as well as the establishment of overseas divisions of Russian criminal gangs that are now operating in at least 50 countries.[56] Jim Woolsey, then Director of Central Intelligence, noted that Russian organized crime groups are "involved in drug trafficking, sale of weapons, antiques, icons, raw materials, stolen vehicles, *and even some radioactive materials*, and they [were making] concerted efforts to gain influence—and as much control as they [could]—over Russia's growing banking and private sectors."[57] Russia's organized crime factions are now in the process of consolidating their operations (with about 5000 organized crime groups operating in 1996).[58] They are also developing a global distribution network which will allow them to more easily smuggle materials, launder money, and gain access to potential customers and clients outside of Russia's borders.

The sharp increase in the number of Russian crime groups between 1991 and 1996 stems from at least two factors. First, the collapse of the communist system meant that those who manned the party's regional and local hierarchy and were responsible for enforcing the party's edicts had their jobs abolished rather suddenly. Many transitioned into the new power structures; about 61 percent of the new business leaders and 75 percent of the new political elite came out of the hierarchy of the old communist party structure.[59] However, other former communist party employees/leaders gravitated toward criminal groups or formed their own gangs.[60] Extortion, prostitution rings, protection rackets, murder for hire, money laundering, smuggling, and the infiltration of legitimate business activities all characterize the orientation of the organized criminal groups in Russia today.[61]

Second, the demise of the communist party also meant that the ability of the central government to enforce its will was greatly weakened. President Yeltsin has issued thousands of edicts, but who now enforces them? Under the communist system, when the Politburo issued an edict, the regional and local party organs took action to ensure that the edict was implemented and obeyed. Under the current government structure, there is still no effective independent court system or organization that enforces federal law throughout the land.

51 "Daily Condemns Artels' Theft of Gold, Goods," *FBIS-SOV-88-171*, September 2, 1988, pp. 48-50.
52 Panel intervention by Jan Vanous, "The 19th Conference of the CPSU: A Soviet Economy Roundtable," *Soviet Economy*, vol. 4, April-June 1988, p. 116.
53 Center for Strategic and International Studies, *Global Organized Crime, op. cit.*, p. 106.
54 Jim Woolsey's remarks were transcribed in Ibid., p.141.
55 Center for Strategic and International Studies, *Global Organized Crime, op. cit.*, p. 136.
56 John Deutch, Statement to the U.S. House of Representatives Committee on International Relations, April 30, 1996.
57 Ibid., p. 140.
58 "Organized Crime in Russia," *op. cit.*, p. 10. Note: Some Western estimates place the number of crime groups at a lower figure (in the 3000 range), but all agree on the seriousness on the resulting situation.
59 Ibid., p. 4.
60 *Institute for National Strategic Studies Strategic Forum, op. cit.*, p. 3.
61 Lewis J. Freeh, Statement to the U.S. House of Representatives Committee on International Relations, April 30, 1996.

Outside of Moscow, local political and military leaders generally do as they please.[62] Thus, even if the federal government wished to control arms exports, it is questionable that it could enforce its will effectively in the provinces and factories that are scattered across the 11 time zones of Russia.

Consequently, the power of criminal gang activity in Russia has become enormous. As of 1993, it was reported that organized crime controlled over 2,000 banks, some 40,000 state and private enterprises, and about one-third of the turnover in goods and services. Many of the firms that have been privatized were taken over by criminal groups.[63] By 1995, the Ministry of Internal Affairs reported that "criminal structures in the state now control over 50 percent of economic entities."[64] It is estimated that 80 percent of Russia's businesses pay 20 to 30 percent of their profits as protection money to organized crime groups.[65] In addition, ruthlessness in the pursuit of financial gain is not limited to the recognized criminal elements. Press reports of officials using the police and the judiciary to punish opponents and intimidate would be "whistle blowers" are still found. As for the Kremlin's leadership, noted journalist Alexander Minkin, "Everyone understands that these people are deathly dangerous."[66] These people are engaged in criminal activity and apparently are not adverse to having their opposition assassinated.[67]

Official collusion in criminal activity occurs routinely. For example, in the fall of 1995, the Interior Minister announced that some 85 of the candidates running for election to the Duma were criminals, that 1600 linkages between criminals and high government officials were under investigation, and that an estimated 30-50 percent of criminal profits were used to bribe state officials.[68] Therefore, it is not surprising that a recent estimate claimed that at least 30 percent of Russia's exports bypass the customs system.[69] Other knowledgeable experts believe that figure is far too low—that the level of criminal activity in Russia, coupled with the weakness of border controls in the FSU, make it easy to smuggle equipment out of Russia. As there are few border controls between Russia and the other FSU states, the actual controls on the flow of illegal materials are still located at the exterior borders of the former Soviet Union. Unfortunately, these borders are very porous (especially along the southern borders of Central Asia); customs agents and border guards are poorly trained and bribable. They also may be unable to identify restricted technologies and materials if they are found.[70]

In short, Russia has many advanced technologies, an economy that is in a state of severe economic depression, a population that has seen its savings and retirement funds evaporate due to high inflation rates, a feeble and corrupt central government, and a society in which the social mores that would normally help limit criminal activity have become weak and distorted. *Organized criminal activity is now embedded in all aspects of Russian life.* As a result of this overall situation, it should be assumed that if a technology, weapon system, or product is located inside of Russia, it can be obtained if the client makes the right connections and is willing to pay the asking price.

62 For example, the military leadership in charge of operations in chechnya stopped responding to Moscow's directions. Michael Specter, "Kremlin Jousts With the Army Over Chechnya," *The New York Times,* August 22, 1996, p. A1, A9.

63 Ibid., p. 141. See also Richard Starr, "How the Mob Moves in on Moscow," *The Washington Times,* November 27, 1996, p. A15; and Mitchell Landsberg, "Russians Learn How to Live on Nothing," *The Washington Times,* March 20, 1997, p. A9.

64 Quoted in Turbiville, *op. cit.* p. 6.

65 "Organized Crime in Russia," *op. cit.*, p. 9.

66 For insight into high-level criminal activity involving Yeltsin's government, see Lee Hockstader, "Scandal Shrouds Kremlin Figures," *The Washington Post,* August 5, 1996, p. A13.

67 Ibid., and "Political Assassinations in the East," *The Fight, op. cit.*, pp. 1-3.

68 Turbiville, *op. cit.*, pp. 6-7.

69 Theresa Hitchens, "Experts: U.S. Nonproliferation Aid to CIS is Not Enough," *Defense News,* February 19-25, 1996, p. 12.

70 Ibid.; Tulegen Askarov, "New Strategic Nuclear Weapons Path Viewed," *FBIS-SOV-95-224-S,* October 27, 1995; and John Deutch, Statement for the Record to the Permanent Subcommittee on Investigations of the Senate Committee on Government Affairs, March 20, 1996, pp. 3-4.

Russia's nuclear facilities

Figure 2-2

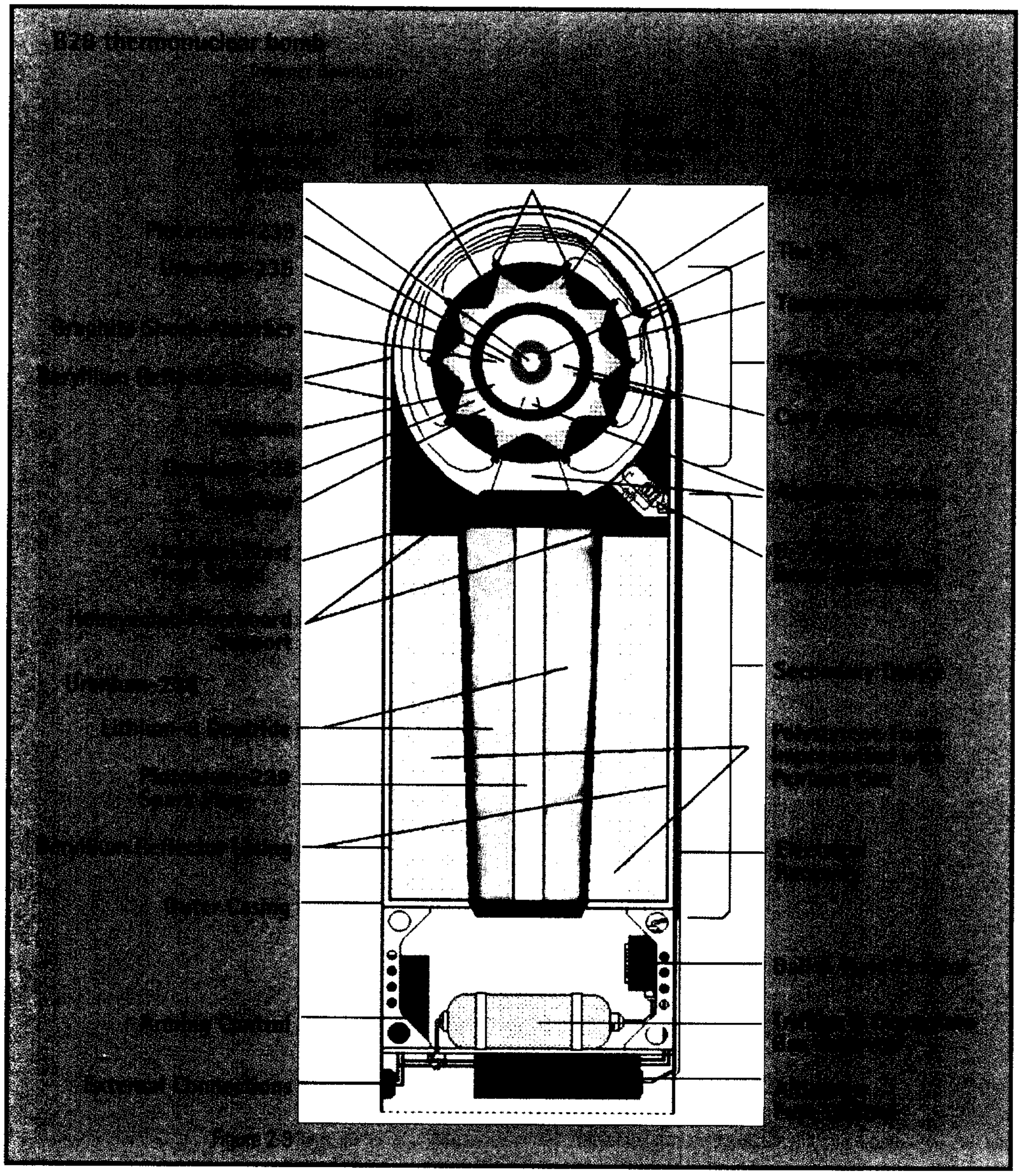
Angarsk	[illegible]
Arkhangel'sk, Murmansk, Petropavlovsk, Vladivostok	[illegible] storage
Arzamas	Weapons lab/assembly
Chelyabinsk	[illegible] production, weapons [illegible]
Dimitrovgrad	[illegible] research, MOX [illegible]
Krasnoyarsk, Tomsk	[illegible] production, uranium enrichment
Moscow	[illegible] reactor facilities, fuel fabrication
Novosibirsk	[illegible] fabrication
Obninsk	[illegible] reactors
Podolsk	[illegible]
St. Petersburg	[illegible]
Sverdlovsk	Uranium enrichment, Weapons assembly

Weapons of Mass Destruction (WMD) and Missile Systems

Within this unstable political and economic environment, there is reason to be concerned about the security of the FSU's weapons and technologies with regard to WMD and missile systems. Under the Soviet Union, these systems were secured by physical guards under the watchfulness and authority of the communist party apparatus. Essentially, the nuclear security system relied on the control that the communist party exercised over the population as opposed to an effort to develop extensive physical security measures over the nuclear systems themselves. As a result, it has been estimated by some that as much as 50 to 60 percent of the Soviet Union's nuclear surveillance system was provided through the activities of the party.[71]

Notwithstanding the party's oversight, there was no central inventory accounting system for WMD materials in the FSU. *Even today, the Russians are not certain how much fissile material (and may not*

[71] Presentation by U.S. Deputy Secretary of Energy, Charles B. Curtis, "Securing Fissile Material in the Former Soviet Union," *Stimson Center Nuclear Roundtable*, February 28, 1996.



know how many nuclear weapon systems) were produced in the Soviet Union and where they are located.[72] Thus, when Russian spokesmen state that "there are no missing nuclear weapons or fissile materials," the question needs to be asked, "Missing from what number or amount?"

As is commonly known, the nature of the communist system encouraged the submission of falsified reports. Enterprise managers were expected to meet the production goals set by *GOSPLAN*, even if the distribution system failed to provide the necessary raw materials. As a result, it became routine for factory managers to horde raw materials or to stash unrepórted production as a hedge against the possibility of being unable to meet production-target quotas due to some future unforeseen event. As a result of this national practice, there remains the probability that clandestine stocks of WMD weapon materials or components may still be hidden away near the various weapon fabrication facilities.[73] The same situation apparently exists for missile materials.[74] Although the Soviet Union is gone, some of the same practices may be continuing in many production facilities as factory managers try to shield themselves from Russia's confiscatory tax code.[75] Consequently, the official number of systems pro-

[72] John Deutch, Statement for the Record to the Permanent Subcommittee on Investigations of the Senate Committee on Government Affairs, March 20, 1996, p. 9. In October 1996, the Russian Government finally approved a set of proposals to set up a government register and introduce monitoring of nuclear materials. Even so, it will take time to actually establish a national inventory control system. See "Russia: Government Approves Proposals on Nuclear Material Security," *Interfax*, transcribed in *FBIS-SOV-95-207*, October 23, 1996.

[73] For example, see U.S. General Accounting Office, *Nuclear Nonproliferation: Status of U.S. Efforts to Improve Nuclear Material Controls in Newly Independent States*, GAO/NSIAD/RCED096-89 (Washington: Government Printing Office, March 1996), p. 21.

[74] Carla A. Robbins, "Russia's Nuclear Stockpile Still Raises Concerns Despite Major Cutbacks and Improved Security," *The Wall Street Journal*, April 18, 1996, p. A20.

[75] In conversations with numerous Western businessmen who have dealt with Russian enterprises, they are always surprised by the accounting systems and the ploys used by Russians to avoid showing their real production levels and subsequent profits.

duced, as recorded on local inventory sheets, may not represent the actual production figures.

Nuclear Proliferation Potential. The existence of Russia's massive nuclear arsenal is a well-established fact. The inherent nuclear infrastructure that evolved with Russia's nuclear program now poses a threat to the international nonproliferation effort. The FSU currently has weapons-usable fissile materials stored in 80-100 buildings located at 40 sites—most of which are located in Russia. Although efforts are ongoing to improve the physical security of these facilities, Russia's nuclear weapons materials are still very vulnerable to pilferage.

The security of Russia's nuclear materials is of key concern. Today, there are few remaining secrets regarding basic nuclear weapon design and functioning. Declassified U.S. nuclear information, the knowledge that has been accumulated by the nuclear physics departments in the academic community, and the accumulation of information that has been made public over the course of the 51-year history of nuclear weapons has largely dispelled the mystery of the bomb. For example, the U.S. B-28 thermonuclear bomb drawing (Figure 2-3) was downloaded from the Internet (which also contains similar drawings of other nuclear weapons). The original Internet download also contained a scale for determining the relative size of the B-28's components. Clearly, if nuclear weapon design information is available, the only real obstacle remaining to nuclear weapon proliferation is the difficulty inherent in obtaining weapons-grade nuclear materials. For a country or faction desiring a nuclear capability, Russia is a real nuclear treasure-trove.

It is estimated that $12-20 billion worth of materials are being smuggled out of Russia each year.[76] What amount of this trade consists of nuclear materials is uncertain. To date, most reported interceptions of smuggled fissile materials have come from Europe, with the highest number of apprehensions occurring in Germany. Most of these interceptions have involved amateurs trying to sell small amounts of nuclear materials. Apparently, some of the radioactive materials that have been offered were originally obtained by stripping the minute amounts of fissile material from Eastern bloc smoke detectors. Some individuals accumulated enough of this material to be able to attempt to run a swindle by claiming the material was a sample from a larger shipment.[77]

There are, however, certain aspects of this pattern that are worrisome. First, Germany has one of the most efficient law enforcement establishments in the world; thus, it is likely that the Germans would be more successful in apprehending nuclear smugglers than would be countries with less efficient law enforcement agencies and population control systems.[78] Second, the historic smuggling and trade routes tend to run North-South. (It was difficult to traffic East-West during the Cold War.) As a result, professional smuggling operations are more likely to use the established conduits which moves materials through the Balkans, Turkey, Iran, Afghanistan, Mongolia, and China, with some East-West movement through the Baltics.[79] Considering the relative quality of the various police forces in

[76] "Organized Crime in Russia," *op. cit.*, p. 9.

[77] Ronald F. Lehman II, Assistant to the Director, Lawrence Livermore National Laboratory, communication with the author, July 17, 1996.

[78] For example, in Germany, citizens must register with the police within three weeks of moving into a new address.

[79] The Baltic countries have been a primary route for mineral smuggling. As such, the movement of nuclear materials through this same conduit is possible. See Oleg Blotskiy, "Illegal Nonferrous Metals Export Examined," *Literaturnaya Gazeta, FBIS Report: Central Eurasia*, February 3, 1993, pp. 56-59; John Deutch, Statement for the Record to the Permanent Subcommittee on Investigations of the Senate Committee on Government Affairs, March 20, 1996, p. 3; and James L. Ford, "Nuclear Smuggling: How Serious A Threat?," *Institute for National Strategic Studies Strategic Forum*, No. 59, January 1996, p. 3. During CBS's broadcast of "60 Minutes," September 1, 1996, it was claimed that three shipments of beryllium had been intercepted in Lithuania during the last year. Beryllium is used as a reflector shield to bounce neutrons back into the nuclear reaction of an exploding bomb. It acts to increase the nuclear yield or to allow a nuclear-chain reaction to be sustained using less fissile material.

the region, law enforcement agencies would pose less of a threat to shipments made using the North-South corridors than would be the case for East-West movements. Third, although U.S. officials claim that the known incidences of nuclear smuggling involve amateurs engaged in opportunistic theft and sale, and that there are no known organized criminal activities involving nuclear materials themselves,[80] there are indicators that those claims may be based on a lack of firm evidence rather than a lack of suspected activity.

For example, a German publication, citing a classified Russian document, reported that large quantities of weapons-grade plutonium apparently have disappeared from Arsamas-16 (now called Kremlev) and the Avangard plant.[81] When considered along with other indicators, there is reason to suspect that organized criminal elements may be pilfering nuclear materials in Russia. For instance, at Chelyabinsk-65, a facility where "bulk plutonium is stored in an old warehouse with glass windows and a padlock on the door,"[82] the deputy director was found dead of a crushed skull. The circumstances of his death carried the earmarks of a link to "mafia involvement [with] ... illegal nuclear trade activities" (although no definitive proof was forthcoming).[83] More curious is the fact that there are informed Russians who accept the existence of a "nuclear mafia" specializing in the theft of nuclear technologies and materials (e.g., a lengthy article on Russian mafia activity by a Russian academic expert referred to the nuclear mafia as an established fact).[84] As a further indicator of organized nuclear smuggling, the Russian Federal Security Service reportedly arrested nine members of a gang in Novosibirsk on December 28, 1995. They were trying to sell 10 kilos of U235 (believed to have originated in Kazakhstan) to a middleman believed to be involved in transporting nuclear materials to South Korea.[85]

Although the examples cited do not provide the type of evidence needed to make a case that could be presented in a court of law, when the information is considered in light of the rampant corruption that pervades Russia, the strength of Russia's organized criminal gangs (as outlined in the preceding section) and the dozens of reports that have the same tone as those cited above, it is difficult to believe that these crime groups would long overlook the potential for nuclear smuggling as a lucrative source of income.[86]

Unfortunately, there are not very many barriers standing in the way of those tempted to pilfer nuclear materials. As the U.S. General Accounting Office (GAO) documented, nuclear facilities do not have complete inventories of their nuclear materials. For example, the nuclear fuel elements shown in Figure 2-4 are part of an inventory of 70,000 to 80,000 disks located at the Institute of Physics and Power Engineering. The officials were not sure of the size of their stockpile and were in the process of taking inventory.[87] The controls and security system in place to protect this material were not judged by the GAO to be sufficient to prevent pilferage. Although the particular material in the figure is low-enriched uranium (LEU), it still rep-

80 John Deutch, Q&A answer to the U.S. House of Representatives Committee on International Relations, April 30, 1996.

81 Nikolayi Nor-Mesek, "Catastrophic State of Nuclear Plants Detailed," *Welt Am Sonntag*, translated in *FBIS-SOV-95-152*, August 6, 1995.

82 Paul Mann, "Nuclear Smuggling Called Direct Threat to U.S.," *Aviation Week & Space Technology*, June 17, 1996, p. 62.

83 Dorthy S. Zinberg, *The Missing Link? Nuclear Proliferation and the International Mobility of Russian Nuclear Experts*, Research Paper Number 35 (Geneva: United Nations Institute for Disarmament Research, August 1995), p. 22.

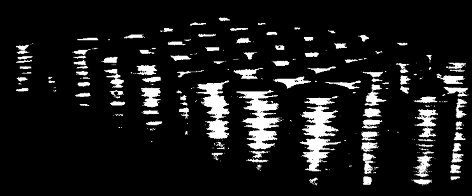
84 Olga Kryshtanovskaya, "Sociologist Surveys Russian Mafia, Official Links," *Izvestiya*, Translated in *FBIS-SOV-95-195-S*, September 21, 1995.

85 "Nuclear Smuggling Ring Apprehended in Novosibirsk," *Moscow Public Television, First Channel*, translated in *FBIS-SOV-95-250*, December 28, 1995; and Yelena Lashko, "Stolen Uranium Imported Into Russia," *Izvestiya*, translated in *FBIS-SOV-97-094*, April 4, 1997.

86 While there is a lack of agreement among security analysts on whether or not organized crime groups are currently involved in smuggling fissile materials, there seems to be a high degree of consensus regarding the position "that if organized crime groups are not yet involved in nuclear smuggling, they soon will be."

87 U.S. General Accounting Office, *Nuclear Nonproliferation: Status of U.S. Efforts to Improve Nuclear Material Controls in Newly Independent States, op. cit., pp. 20- 21.*

Institute of Physics and Power Engineering



70,000 to 80,000 small disks of nuclear material

resents a potential threat to nuclear proliferation. (Some of the disks included in the inventory are composed of weapons grade material.)

Low-enriched uranium (LEU) contains less than 20 percent of U235, with much of the material used in nuclear power plants enriched to only 3-5 percent. However, the enrichment of uranium for nuclear weapons is not a linear progression. If a country can use 20 percent LEU as a feed stock in its enrichment process, it achieves a starting point in which 70 percent of the effort required to develop weapons-grade uranium has already occurred (3 percent enrichment represents about 50 percent of the effort).[88] As a result, a country could develop an inefficient enrichment facility and still may be able to develop sufficiently enriched uranium for a nuclear device or be able to enrich the material in a shorter time frame than might otherwise be expected.

Of greater concern (than are the LEU nuclear fuel elements) are the nuclear fuel stocks for the Russian Navy. The naval stocks are enriched to higher levels than are the fuel stocks destined for power plant use. For example, several of the later-generation nuclear submarines, such as the *Typhoon, Oscar, Sierra,* and *Mike* classes, use nuclear fuel enriched to 45 percent U235. While the desirable degree of enrichment for weapons-grade material is 93.5 percent U235, critical mass can be achieved by using 75 kgs of 40 percent enriched uranium and a beryllium reflector.[89] However, most of the nuclear-powered ice breakers and the *Alfa* class of submarine use fuel elements enriched to 90 percent. These elements could be used to produce a nuclear device using less than 20 kg of uranium (with reflector)—54 kgs without a reflector.[90]

Much of the naval nuclear stocks are poorly secured. In a revealing article entitled "Potatoes Were Guarded Better,"[91] the theft of 4.5 kgs of nuclear material from the Sevmorput shipyard (near Murmansk) is described. The thief was an off-duty military officer who entered the storage facility through an unguarded gate, pried open the

Generation of Vessels (Class)	Assumed Level of Uranium Enrichment (%)
First & Second Generation Submarines: (November, Hotel, Echo I & II, Yankee, Delta I-IV, Charlie I & II, Victor, and Victor III)	21
Second Generation Submarines: (Alfa & 645 ZhTS)	90
Third Generation Submarines: (Typhoon, Oscar I & II, Sierra, Akula, & Mike-prototype)	45
Submarine Prototypes: (Papa & Uniform)	Unk.
Surface Vessels: (Kirov)	90
(Kapusta)	Unk.

Source: Bellona Report, Internet, http://www.grida.no/ngo/bellona/ehome/russia/nfl/index.htm.

Figure 2-5

[88] David Kay, former Chief Inspector, IAEA, during a phone conversation with author, August 19, 1996. Note: if the LEU is enriched to the 3 percent level, about 50 percent of the enrichment effort for weapons-grade material has already occurred.

[89] Congressional Research Service, *Nuclear Proliferation Fact Book*, S. Prt. 103-111, Prepared for the Committee on Governmental Affairs, United States Senate (Washington: U.S. Government Printing Office, December 1994), p. 619.

[90] Ibid.

[91] Oleg Bukharin and William Potter, "Potatoes Were Guarded Better," *The Bulletin of the Atomic Scientists*, May 1995, p. 46.

padlock on the door of the storage building, and took parts of three fresh fuel assemblies. He was caught six months later after asking a fellow officer for help finding a buyer. While the theft of the fuel assemblies was discovered by two roving guards about 12 hours after the break-in occurred, it is believed that the intrusion could have been concealed for months if the thief had taken some precautions to hide the evidence of his presence.

Of even greater concern is the security of Russia's 150-200 tons of weapons-grade plutonium. While plutonium is more difficult to smuggle due to its highly radioactive and toxic nature, it requires only about 4.5 kgs of this fissile material (the size of a baseball) to make a well designed nuclear weapon. Thus, plutonium is an ideal substance for use in a missile warhead (less weight, thus facilitating longer ranges). Considering the health dangers inherent in handling plutonium, it is logical to assume that organized criminals specializing in nuclear materials would pose the greatest threat to the plutonium stocks (i.e., it would be difficult and dangerous for amateurs to handle).

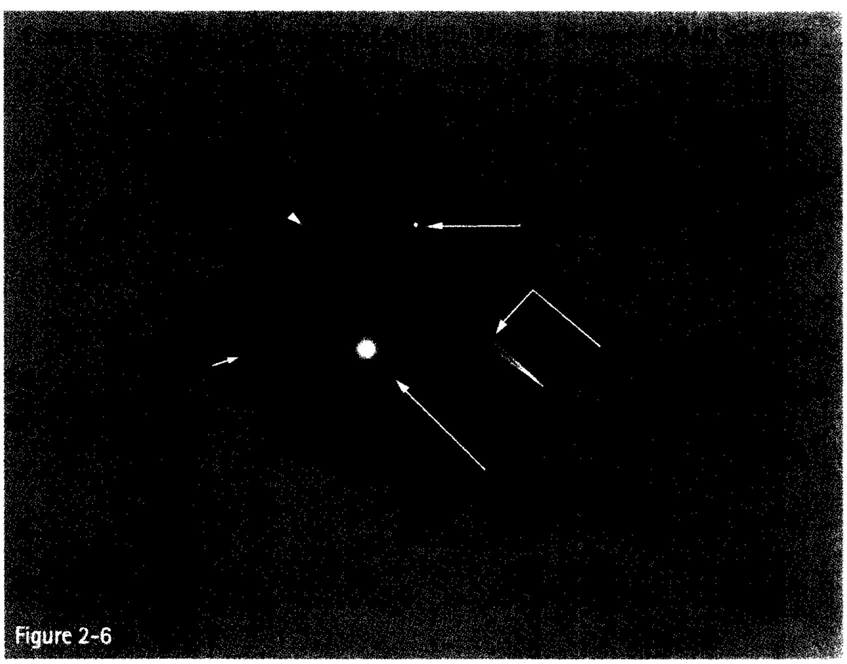


Figure 2-6

Chemical Proliferation Potential. Although chemical weapons are classified as a weapon of mass destruction, they are not nearly as destructive as a nuclear or biological weapon. Yet, against an unprotected population, they can create havoc. Russia, with about 40,000 tons of toxic chemical agents in its arsenal,[92] (about 32,000 tons are nerve agents) has the technology and chemicals that could be useful to a developing state that is trying to field a chemical weapons capability. They also would be useful to a terrorist organization planning to conduct a strike similar to the gas attack that occurred in the Tokyo subway in 1995 (noted earlier).

It should be noted that chemical weapons (CW) and biological weapons (BW) are best dispersed by systems that are able to spread the materials over a wide area (e.g., using spray tanks such as a crop-dusting airplane employs). *A unitary warhead on an ICBM is not a very efficient vehicle for dispersing chemical or biological agents to a broad-area target.* The concentration could be limited to the point of impact and its downwind pathway. Thus, it could be very expensive to use a ballistic missile with a unitary warhead to deliver this agent considering the limited amount of damage that would likely be inflicted (although it could spread panic and terror). In general, a cruise missile, equipped with spray tanks, would be a better platform for dispersing CW and BW agents because it could fly along a predetermined course releasing agent along a pathway upwind of the target. See Figure 2-6 for comparison of CW, BW, and nuclear weapons effects.

This situation could change early in the next century. It should be noted that "by the 1960s the United States had developed submunitions for ballistic missiles that would spread chemi-

[92] Nikolay Poroskov, "Daily Examines CW Elimination Issues," *Krasnaya Zvezda*, trans. in *FBIS-SOV-95-212*, November 2, 1995, pp. 43-44.

cal and biological agents more efficiently than would release at a single point."[93] It is the development of submunition technology that makes ballistic missile CW and BW warheads a greater threat since a single warhead could carry many bomblets which would scatter over a wide area. Each bomblet would originate a downwind pathway in which casualties would occur. It should be assumed that Russia has also developed CW and BW bomblet technology. (Russia has conventional submunition technology; it would be surprising if it had not developed submunitions for CW and BW agents.)

As discussed previously, some Russian chemical-weapon technologies and materials clearly have been transferred abroad—as illustrated by two incidences already cited in this report. *In one case, Lt. General Anatoliy Kuntsevich (former General of Chemical Troops) sold chemical warfare secrets and chemical weapon components to Syria;*[94] in the other, the Russian Federal Security Service facilitated a Japanese terrorist organization to gain access to Russian nuclear and chemical materials. Apparently, these two cases are not isolated incidents. During November 1995, another Russian officer was questioned about rumors of smuggling in toxic substances from the military. His response was revealing. *He claimed that "the relevant bodies are aware of several cases of theft from industrial enterprises of chemicals which can be used in the manufacture of toxic substances."*[95] Thus, it appears that the Russian Federal Security Service allowed a terrorist organization access to toxic materials, that the former General of Chemical Troops sold toxic chemicals and chemical weapon technologies belonging to the Russian military, and that chemical weapon precursor materials are missing from the known stocks of some Russian chemical enterprises.

Biological Weapons Proliferation Potential. Biological-warfare agents are easier to produce than are nuclear materials or chemical-weapon agents,[96] yet, they are capable of inflicting casualty rates comparable to that of a nuclear weapon. Since it does not require much infrastructure or a very large staff to develop BW agents, BW has often been called the poor-man's nuclear bomb.

The Soviet Union has maintained an offensive BW program despite its pledge to terminate its activity in this field. Following the demise of the Soviet empire, President Yeltsin acknowledged the existence of an offensive BW program and issued a decree in April 1995 terminating the program.[97] However, evidence suggests that the program continued to operate long after its announced termination, and there still remains some ambiguity regarding the status of Russia's offensive BW capability.[98] For example, although no reported transfers of BW agents or technology are known, reportedly, one Russian offensive BW facility has a sales catalogue of nutrient media that are used for the growth of bacteria for BW agents.[99] In addition, it seems reasonable to assume that the same problems that plague Russia's nuclear and CW programs may also exist in its BW program. The BW program employed thousands of Russia's top scientists.[100] *According to a reported Defense Intelligence Agency source, the flow of BW expertise from Russia to Iran, Iraq, Syria, and Libya is of particular interest.*

93 U.S. Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction,* OTA-BP-ISC-115 (Washington, DC: U.S. Government Printing Office, December 1993), p. 204.
94 "Russian Chemical Weapons Allegedly Sold to Syria," *FBIS-SOV-96-012,* January 18, 1996, pp. 21-22.
95 Nikolay Poroskov, *op. cit.,* p. 44.
96 U.S. Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction, op. cit.,* p. 8.
97 Office of the U.S. Secretary of Defense, *Proliferation: Threat and Response,* ISBN 0-16-048591-6 (Washington, DC: U.S. Government Printing Office, April 1996), p. 32.
98 Ibid.
99 Barbara Starr, "Iran Has Vast Stockpiles of CW Agents, Says CIA," *Jane's Defense Weekly,* August 14, 1996, p. 3.
100 Ibid.
101 Barbara Starr, "Iran Has Vast Stockpiles of CW Agents, Says CIA," *op. cit.*

Missile Proliferation Potential. It is clear from the positions expressed and comments made in Russian publications that there are many who believe that Russia should sell missile technology as a way of raising funds to support Russia's defense industries.[102] In addition, there are indicators that missile technology can be obtained from Russia through unofficial channels. As a primary focal point of this study is missile proliferation, it is of particular interest to examine some of the known and suspected transfers of Russian missile technology.

Perhaps the most publicized example has been the proposed Russian transfer of seven cryogenic rockets and its production technology to India. This deal caused much consternation in U.S. policy-making circles. As a result, the United States adamantly opposed this transfer, citing it as a violation of the Missile Technology Control Regime (MTCR) guidelines. Although U.S. pressure eventually caused Russia officially to cancel the technology transfer portion of the deal, it still plans to provide India with seven cryogenic boosters. According to Indian scientists, however, the drawings and technical specifications for the cryogenic technology package had already been transferred to India during the preceding year.[103]

More recently, *the Russian newspaper Pravda claimed it had two classified documents in which Russian representatives offered to sell India 45 of the new Topol-M ICBMs* (with related communications, spare parts, and training) within the next 10 years at a price of $3 billion.[104] Although a Russian spokesman denied the report, one publication quoted a secret Russian military report as stating that "India would no doubt become a nuclear power with its own strategic missiles," and so Russia could "extremely gain from this cooperation."[105] If this report is true, it would indicate a willingness on the part of official Russian military representatives to transfer modern ICBMs to other states.

In the Middle East, a shipment of gyroscopes and accelerometers bound for Iraq was discovered in Jordan in December 1995. The missile components apparently were designed for use on long-range missiles systems, being too sophisticated for use on a SCUD missile or one of its direct derivatives.[106] In this case, the illegal transfer was believed to have been a smuggling operation that was conducted outside of the Russian government's control.[107] However, the Russian Ambassador to Iran was cited as announcing that the two countries had signed an agreement under which Russia will help Iran to launch its first experimental space satellite within three years. For this effort, Moscow will transfer technology to Iran in three stages.[108] Obviously, this commercial venture will also help the Iranians to develop their missile expertise at a faster pace than might otherwise be expected.

In East Asia, an announcement was made on October 17, 1996, that South Korea had concluded an agreement with Russia for the transfer of 15 ultramodern military technologies. Included in this agreement were ICBM guidance device technology, photographic technology for military intelligence satellites, anti-aircraft radar systems, and technology on the design and manufacture of fighter aircraft, to include the MiG-29. The South

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102 For an example, see Carla A. Robbins, "Russia's Nuclear Stockpile Still Raises Concerns Despite Major Cutbacks and Improved Security," *The Wall Street Journal*, April 18, 1996, p. A20.
103 "Russian Rocket Engines for India," *The Financial Times*, July 26, 1994, p. 4.
104 "India With Russia, 4/7/95," *The Nonproliferation Review*, Spring/Summer 1996, p. 142.
105 "Russia Denies Supplying Missiles to India," *The Muslim, FBIS-NES-95-242*, December 18, 1995.
106 "Administration Pursues Possible MTCR Violations With Russian Government," *Inside the Pentagon*, March 10, 1995, pp. 1&4.
107 "Technology Smuggled," *Jane's Defense Weekly*, June 26, 1996, p. 6. The report was based on comments made by Robert Einhorn, U.S. Deputy Assistant Secretary of State for Nonproliferation.
108 "Iran To Launch Satellite," *Jane's Defense Weekly*, September 4, 1996, p. 4.

Koreans claimed that the ICBM guidance device technology would be used for "automatic navigation devices for ships and vessels."[108]

Turning to China, there are several reports of missile technologies being transferred to China from Russia. According to an article citing as its source two classified Pentagon intelligence reports, China is gaining much missile technology from Russia, with most of the transfers taking place outside of official channels.[109] Of particular interest to China has been the technology associated with Russia's SS-18 heavy-lift ICBM with MIRVed warhead.[110] This is the same system discussed earlier that was observed during testing releasing non-RV objects believed to have been penetration-aid decoys. Based on the number of technology transfer reports involving the SS-18, it seems most likely that China either already has, or will soon have, the missile technology associated with this ICBM.

As for China's efforts to develop a mobile ICBM, there is an unconfirmed report of an SS-25 mobile ICBM being exported to China (equipped with a conventional warhead).[111] If true, China now has a working model that can be used as it develops the DF-31 and DF-41 mobile missile systems (to be discussed in the next chapter). In addition, it should be kept in mind that Chinese scientists are in frequent contact with Russian institutes that deal with weapons technology. As a result, Russia's technological expertise is flowing to China via human channels that are uncontrolled by the Russian Government.[112]

Russian SS-25 Mobile ICBM

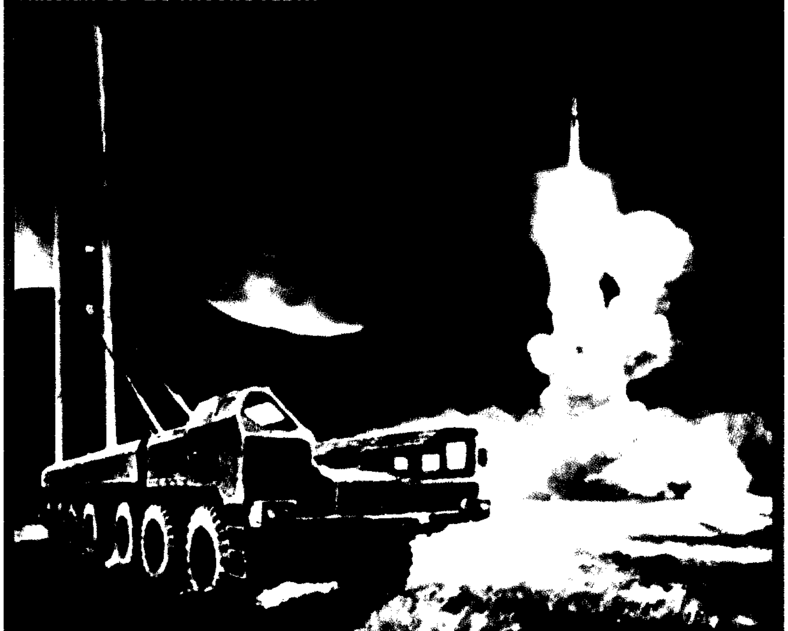


Figure 2-7

Security of Russia's Strategic Missile Force

One gnawing question that periodically arises is "How secure is Russia's offensive nuclear forces?" Do elements in Russia have the capability to launch a limited nuclear attack on the United States without permission of the central command authority, or does Russia's system of safeguards make that event unlikely? Of course, these questions cannot be answered with complete certainty as there is a great deal of secrecy that surrounds nuclear command and control systems. Nevertheless, a review of the evidence seems to indicate that the United States has reason for concern regarding Russia's system of controls over its strategic missiles.

The Russian nuclear command and control system reflects a still evident fear that the United States will launch a surprise nuclear strike against Russia, one that decapitates its national command authority and preemptively destroys the country's

[108] Son Yong-kyn, *Hanguk*, trans. in *FBIS-EAS-95-201*, October 18, 1995, p. 49.
[109] Bill Gertz, "China's Arsenal Gets A Russian Boost," *The Washington Times*, May 20, 1996, p. 1.
[110] Ibid.
[111] "Russian ICBM, *Forecast International/DMS Market Intelligence Report*, February 1996, p. 5.
[112] Bill Gertz, "China's Arsenal Gets A Russian Boost," *op. cit.*

retaliatory forces. This fear was acted out in January 1995 when a Norwegian sounding rocket was detected by Russian early warning systems. This rocket was larger than ones normally fired and followed a flight pattern that made the Russians falsely identify the missile as a U.S. SLBM that seemed headed for a high-polar detonation.[114] (Norway's advanced notice of the pending launch got lost in Russia's bureaucracy.)

With the warning of the missile's flight, *Kazbek*, the coded Russian nuclear command and control system was raised to a higher alert status and the *Chegets* were activated, sounding an alarm in all three cases. The *Chegets* are three black Samsonite suitcases that allow the President, the Minister of Defense, and the Chief of the General Staff to communicate with the command center of the Russian General Staff and send the coded signals that authorize the command center to launch a nuclear strike.[115]

Apparently, the Russians have long suspected that if the United States ever launched a preemptive attack against Russia, it would start with a high nuclear air-burst over the polar region with the intent of disrupting Russia's response capabilities as electro-magnetic-pulse (EMP) effects would disrupt Russia's command, control, and communication systems. Under this scenario, the main nuclear attack would follow shortly. Consequently, the Russians were extremely worried. There are some indications that Yeltsin was seriously considering launching Russia's strategic nuclear strike forces.[116] The lesson of this incident is that while the possibility of an inadvertent nuclear war with Russia is remote, it is not an impossibility.

The Russian nuclear command system was set up to allow its forces to execute a retaliatory strike even if the national command authority were to be destroyed by a surprise preemptive strike. The resulting system appears to have put the missile launch codes in the hands of many. In a revealing October 1991 interview, Major General Geli Batenin, a Russian Strategic Missile Force (SMF) officer and advisor on nuclear weapons to the Russian government (also a former commander of an SS-18 Brigade and former member of the Soviet General Staff), warned that the SS-25 mobile missile was vulnerable to unauthorized use as (like the submarine force) warheads were not safeguarded by permissive action link (PAL) devices and could be launched by the crews since the launch codes were kept on the launcher.[117] He also described a command and control system in which the strategic missile launch codes are kept at the nuclear command centers, claiming that there are 15 officers who have the ability to initiate nuclear missile launches.[118] While the submarine missile forces were only mentioned briefly by General Batenin, it is possible that the launch codes for the submarine-launched ballistic missile forces may also be held by officers on deployed vessels.

In a recent development, a top secret CIA report entitled *Prospects for Unsanctioned Use of Russian Nuclear Weapons,* September 1996, was leaked to Bill Gertz of *The Washington Times*. The CIA report added some new details to General Batenin's insights into the Russian nuclear command and control system. The nuclear "football" that the

114 Forthcoming book by Peter V. Pry, *War Scare: The Russian Nuclear Countdown After the Soviet Fall* (Atlanta, GA: Turner Publishing, 1997); and Markov, "The Russians and Their Nukes," *op. cit.*

115 Oleg Volkov and Vladimir Umnov, "Russia: Nuclear Suitcase Secrets Detailed," *Ogonek*, translated in *FBIS-SOV-96-212-S*, September 1, 1996.

116 Pry, *op. cit.*

117 Allen Levine, "Soviet General Says Unrest May Spark Nuclear Terror," *The Atlantic Journal/The Atlantic Constitution,* October 16, 1991, p. A2; and Pry, *op. cit.*

118 Ibid.

Russians call the *"cheget,"* does not send a launch code, but simply signals that a launch is authorized. The *cheget* was described as being largely symbolic, similar to the orb and scepter of the czars.[119] The real command and control resides with the Russian General Staff; however, the command posts of the Strategic Missile Forces (SMF) are also technically capable of launching the missiles under their command.[120] This would seem to coincide with General Batenin's October 1991 claim that there were 15 officers who could launch missiles at any one time.

Of particular concern, the CIA report claimed that the disarray in the Russian armed forces was spreading to the elite nuclear submariners, the nuclear warhead handlers, and to the SMF, with the greatest weaknesses being the security of the tactical nuclear weapons. Indicative of the problem is the fact that the nuclear submariners and SMF troops have been threatening to go on strike if pay and living conditions are not improved.[121] Russian officials were cited as being particularly worried about the nuclear units in Russia's Far East, where the troops are living in deplorable conditions *while holding strategic nuclear weapons in a location where they might easily fall into the wrong hands.*[122] Although the CIA report concluded that the odds of an unauthorized launch were low under normal conditions, it did spell out a number of situations that could raise the odds, to include a severe political crisis, or a military conspiracy to commit nuclear blackmail.[123] It should be noted that Russian nuclear command and control expert, Bruce Blair (who has read the report), claimed that the CIA's conclusions seemed to unduly play down the threat of rogue action up and down the chain of command.[124]

Of more than academic interest is the question of what would happen if a rogue element was successful in launching a missile. This issue has been a concern of the policy making community for several years and provided the impetus that moved the administration to conclude a nuclear detargeting agreement with Russia. However, even though both U.S. and Russian missile systems have been detargeted (unverified), according to Bruce Blair of the Brookings Institution, Russian nuclear missiles can be retargeted in about 10 seconds. More unsettling is his claim that if an unauthorized launch by a rogue unit should occur without reprogramming the missile with new targeting information, the missile system will use the default aim point of its last Cold War target.[125] Thus, an unauthorized launch might still strike the same U.S. target as it was programmed to hit before being detargeted.

In short, the Russian nuclear control system is weakening, and the ability to launch the strategic rocket forces and the submarine forces are in the hands of many. Considering the pressures that are racking Russia, the possibility of an unauthorized launch must be taken seriously.

Conclusions

Assuming the trends outlined in the foregoing continue along current paths, the U.S.-Russian

119 Bill Gertz, "Russia's Nuclear Football Easy to Block," *The Washington Times*, October 22, 1996, p. A18.
120 Bill Gertz, "Russian Renegades Pose Nuke Danger," *The Washington Times*, October 22, 1996, p. A1.
121 Bill Gertz, "Lebed Says Nuclear Problems in Russia Pose No Global Threat," *The Washington Times*, October 23, 1996, p. A11.
122 Bill Gertz, "Russian Renegades Pose Nuke Danger," p. A18.
123 Bill Gertz, "Lebed Says Nuclear Problems in Russia Pose No Global Threat,"
124 Jim Wolf, "CIA Rates 'Low' the Risk of Unauthorized Use of Russian Nuclear Warheads," *The Washington Post*, October 23, 1996, p. A6.
125 Bruce G. Blair, "Where Would All the Missiles Go?" *The Washington Post*, October 15, 1995, p. A15; and Bill Gertz, "Missile Defense Fails to Take Spot Among Campaign Issues," *The Washington Times*, October 22, 1996, p. A18. According to one unconfirmed report by a former Russian missile force officer, some of the PAL devices have been shut off as malfunctions have occurred and funds are not available for repairs. See Colonel Robert Bykov, "Russia: Missile Officer Says Strategic Forces Unsafe," *Komsomolskaya Pravda*, translated in FBIS-SOV-97-052, March 15, 1997.

relationship will be much more varied in the future than it was in the past. On economic issues, it is likely Russia will try to play the role of a friend. Russia well understands that the United States and the developed countries hold the key to its future economic health. In the security arena, Russia should be expected to vary its role to suit its own national interests. At times, Russia will act as a foe of the United States. This role is most likely to be seen as Russia pursues its national interests in the Middle East and Southern Asia. To the extent possible, Russia seems likely to attempt to use surrogate powers to protect its interests in these regions. In East Asia, Russia's role has the potential for being more flexible as it seeks to balance its vulnerabilities in that region. In all cases, the instability that currently characterizes Russia's internal situation poses the potential for it to be an accidental threat to the United States.

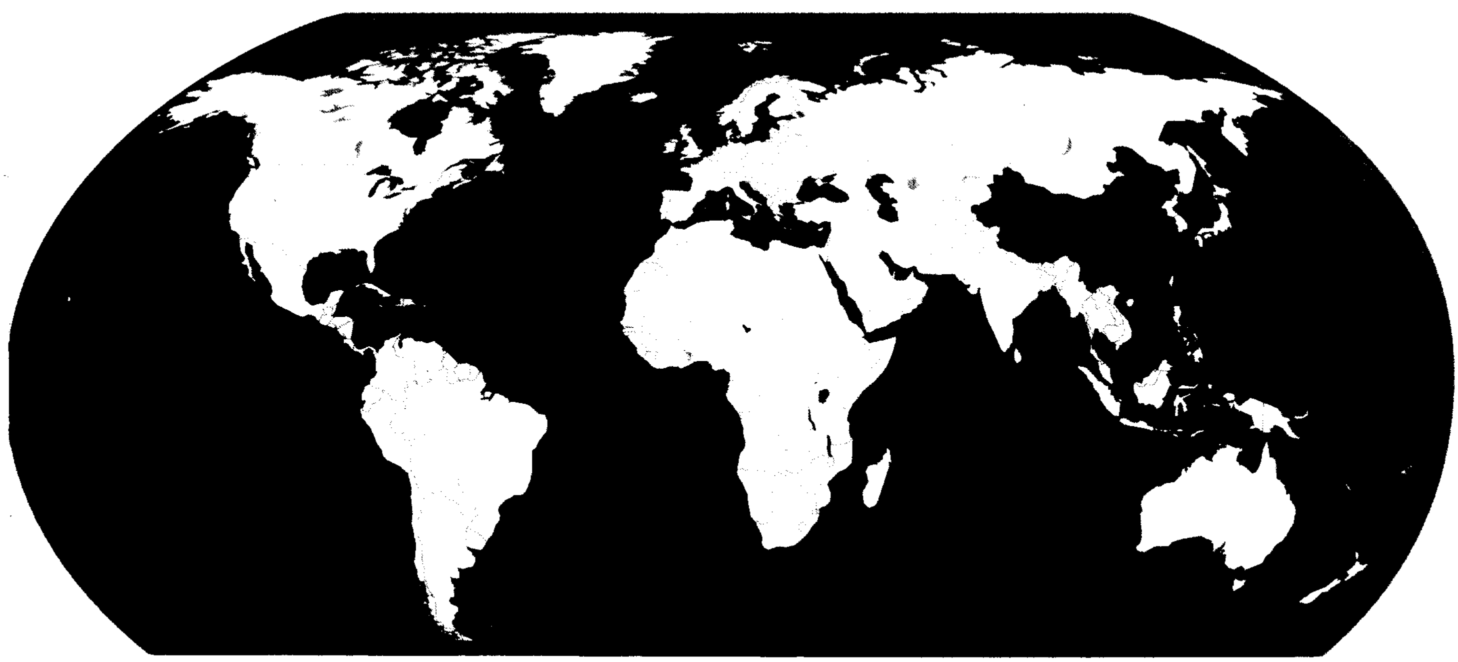
In the realm of missiles and missile defenses, Russia will remain a major threat to the United States: first, as a source of proliferation from which a threat to the United States could develop; second, as a holder of powerful strategic nuclear systems under the questionable control of its weak central government. As a complicating factor, the rampant crime and corruption that is exerting a powerful influence on Russian actions and activities is likely to result in a continued outpouring of sophisticated weapon systems, missiles and technologies, and weapons of mass destruction enablers that will change the nature of the international military calculus. Although the United States must continue to work with Russia in an attempt to stabilize Russia's security situation, it must also prepare for the potential failure of that effort. The problems that Russia faces are too serious to be easily and quickly resolved.

CHINA AND THE NORTHEAST ASIAN POWERS:

The Great Challenge of Tomorrow?

Introduction

The economic power that is expected to develop in Northeast Asia by 2010 also bears the potential to support the development of powerful military capabilities. Moreover, this region is riven with a legacy of bitterness and distrust imbued by past aggression and abuses of power. Thus, Northeast Asia contains many dormant seeds of conflict. Much depends on how the major players in Northeast Asia politically interact during the next decade or so as rapid change destroys the status quo. Will China, Japan, Russia, Korea, and the United States be able to balance their divergent national interests in this region in a peaceful manner, or will one or more of these powers make a miscalculation, one that triggers a crisis or perhaps even open warfare?



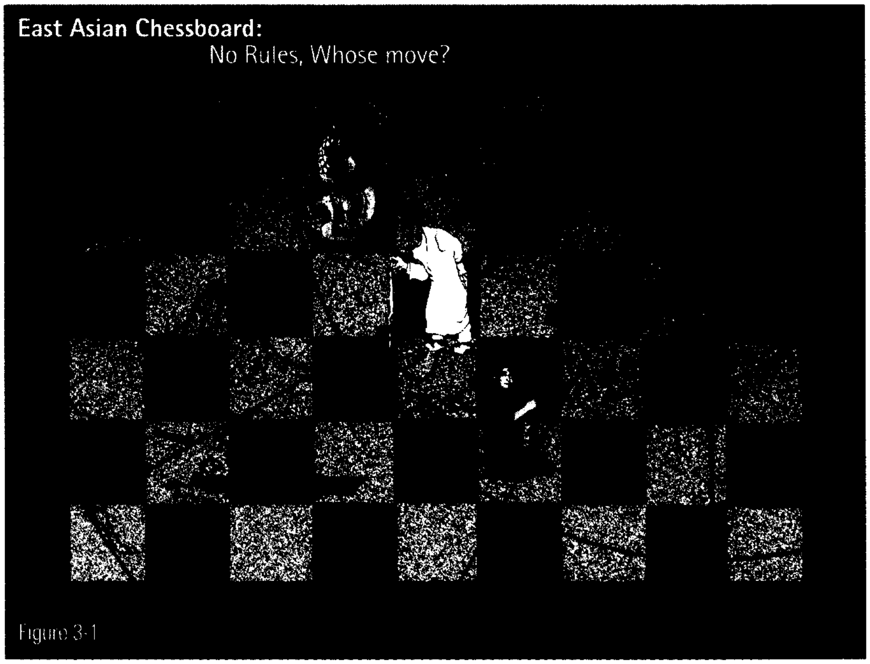


Figure 3-1

Adding to the complexity of this situation are the issues of Korean unification, the exploding energy needs of the region, the possibility that the rising tide of nationalism could sow the seeds of war, the uncertain nature of Taiwan-PRC relations, and the inescapable fact that the diversity of cultures interacting in Northeast Asia increases the possibility of an inadvertent confrontation.

It is against this backdrop that Chapter 3 will briefly review the situations in Korea and Japan, then concentrate on China. While any country has the possibility of triggering a crisis, China, with its prickly pride and excessive sensibilities, is judged to be the most critical piece of the puzzle with regard to the long-term prospects for stability in Northeast Asia and, as such, will be examined in greater detail.

Korea, the Paradox in Northeast Asia's Future?

As noted under the assumptions in Chapter 1, it is expected that the Korean peninsula will be undergoing the process of reunification by 2010. If events unfold according to the current thinking in Seoul's Blue House, the process of reunification could begin within the next 2-5 years and is almost a certainty within the next 10 years. If the reunification process goes according to South Korea's plans, the economies of the current two states will be kept separate initially, then merged slowly over a period of perhaps 10 years. (The South Koreans want to avoid the problems that Germany has encountered in reunifying too quickly.)[1] If this scenario plays out as described, North Korea will continue to be a source of short-term proliferation over the next 2-10 years. However, once reunification begins, the capabilities of both states will be merged and the balance of power in East Asia will likely shift. (Note: U.S. officials are not so confident that reunification will occur during this time frame.)

The North's Near-Term Proliferation Threat. In the near-term, North Korea poses a clear proliferation threat. It has developed an independent nuclear production cycle, an estimated 1-5 nuclear weapons,[2] biological weapons, and a huge stockpile of toxic materials (manufactured in eight military-owned chemical weapons factories).[3] In addition, aided by funding from Iran (since the mid-1980s),[4] Chinese training of up to 200 North Koreans in mis-

1 The summary of Korean reunification thinking is based on dozens of private background discussions among Drs. Charles Perry and Jacquelyn Davis, Institute for Foreign Policy Analysis, Inc., and various high-level South Korean officials in the Blue House (the South Korean equivalent to the U.S. White House), Ministry of National Defense, Ministry of Foreign Affairs, and Members of the National Assembly, June 1996.

2 Office of the Secretary of Defense, *Proliferation: Threat and Response*, *op. cit.*, p. 7; Jim Lea, "S. Korea Doubts North Has Four Nukes," *Pacific Stars and Stripes*, June 13, 1996, p. 3; Heritage Foundation,"Building A More Secure Asia Through Missile Defense," *Asian Studies Center Backgrounder*, October 24, 1995, p. 5, (Footnote 8); Akira Kato, "Classified Russian Document on DPRK Nuclear Weapons," *Tokyo Shukan Bunshun*, trans. *JPRS-TND-002-L*, January 27, 1994; and "Japan: Remarks Not Confirmed," *Yonhap*, reported in *FBIS-EAS-94-145*, July 28, 1994.

3 Office of the Secretary of Defense, *Proliferation: Threat and Response*, *op. cit.*, p. 7; Barbara Starr, "CIA Expects Nodong Deployment Next Year," *Jane's Defense Weekly*, November 11, 1995, p. 16; "DPRK Transferring Weapon Technology to Mideast," *Seoul KBS-1 Radio Network*, trans. *FBIS-EAS-94-110*, June 8, 1994; William Matthews, "Luck: Violent Collapse of North Korea Could Trigger War With South," *Army Times*, April 15, 1996, p. 28; and "Figures For North, South Military Provided," *The Korea Herald*, in *FBIS-EAS-95-194*, October 6, 1995, p. 68.

4 For example, see Richard Latter, "Ballistic Missile Proliferation In the Developing World," *Jane's Defense 96: The World In Conflict*, 1996, p. 76; and Greg Gerardi and Joseph Bermudez, Jr., "An Analysis of North Korean Ballistic Missile Testing," *Jane's Intelligence Review*, Vol. 7, No. 4, January 27, 1995, p. 189.

sile technologies,[5] imported Russian nuclear and missile technicians, and access to other Russian expertise via electronic mail,[6] North Korea is developing an indigenous missile industry. Beginning with a fledgling ballistic missile program in 1981 (with the reported acquisition of some *Scud* Bs from Egypt, which it then reverse-engineered), North Korea is in the process of developing a significant (if erratic) missile-production capability.

Since North Korea began full missile production runs in 1987, it is believed to have produced 80-120 *Scud* B/C missiles per year. Current *Scud* production is thought to be only *Scud* C models, which have a range of 500-600 kms. The *Scud* C has been sold to Iran and Syria, while *Scud* C components have apparently been sold to Egypt as feedstock for Egypt's indigenous missile production project. The shipments of *Scud* components to Egypt reportedly involved seven shipments, to include one shipment in April 1996 that was so large that the Egyptian military had to arrange for a larger freighter to deliver the goods.[7] Although unconfirmed, it is also possible that Peru tried to arrange the purchase of some *Scud*-C missiles and related equipment from North Korea.[8]

As for the new and more complex *Nodong*-1 missiles (now believed to be in production), it is expected that North Korea could generate an annual output of 30-50 units (if *Scud* production were halted).[9] The *Nodong-1* is a 15.5-meter-long redesigned missile based on *Scud* technology (the *Scud* C is 11 meters long), but incorporating a longer fuel tank and using a cluster of four engines to provide additional thrust giving it a range of 1000-1300 kms carrying a separating warhead payload of 700-1000 kgs.[10] From North Korea, the *Nodong's* range arc covers most of Japan, the obvious target country for this missile system. Just as worrisome is the possibility that a few *Nodong* missiles may have been exported to Iran, providing Iran with a potential capability for targeting Israel. (There is some uncertainty on the current status of the planned transfer. Although there has been speculation that a few *Nodongs* had already been transferred to Iran, General Peay, USCINCCENT, in a Spring 1996 interview, stated that Iran's recent efforts to buy a number of *Nodongs* were stymied due to funding problems.[11] Nevertheless, Iran still plans to deploy long-range ballistic missiles—possibly in a tunnel complex being constructed along the coast.)[12]

Looking to the future, North Korea is developing its next generation of missile systems which have been named the *Taepodong* (TD) 1 and 2. Although this missile is still under development (with available information sketchy and highly speculative), preliminary reports indicate that the TD-1 may be an 18-meter-long missile with a range of 1500-2000 kms. It is believed that the TD-2 version will be constructed by adding a 14-meter-long thruster on top of a *Taepodong* 1 missile body to create a two-stage system.[13] Although there is some controversy concerning the expected range of the TD-2, it seems likely that the missile will have a range arc that lies in the 4000-6000 km band (while carrying a 1000 kg warhead).[14] The TD-2 is expected to be ready for deployment sometime in the time frame

5 While there are multiple references possible, see Bill Gertz, "N. Korean Missile Could Reach U.S., Intelligence Warns," *Washington Times*, September 29, 1995, p. A1.

6 Greg Gerardi and Joseph Bermudez, Jr., "An Analysis of North Korean Ballistic Missile Testing," *Jane's Intelligence Review, op. cit.*, p. 190.

7 Bill Gertz, "Cairo's Missile Buy Violates U.S. Law," *The Washington Times*, June 21, 1996, p. A1

8 "Peru, Internal Developments, 1/8/96," *The Nonproliferation Review*, Spring-Summer 1996, p. 150.

9 Ibid., pp. 185-86; and conversation with Joseph Bermudez, Jr., March 7, 1997.

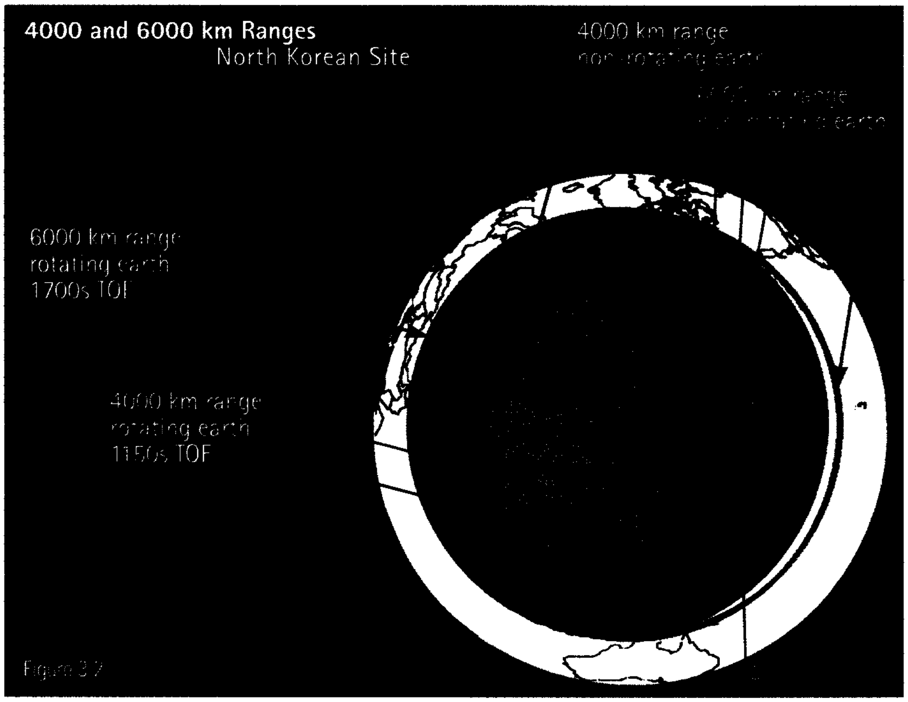
10 John Cunningham, "Third World Missile Proliferation Poses New Threats," *The Journal of Social, Political, & Economic Studies*, Summer 1994; and Son Tae-kyu, "North To Deploy Nodong Missiles By End of 1996," *Hanguk Ilbo*, translated in *FBIS-EAS-95-195*, October 10, 1995, p. 61.

11 "Iran's Tunnels Are Missile Sites, Say USA," *Jane's Defense Weekly*, May 1, 1996, p. 3; and Richard Latter, *op. cit.*, p. 77.

12 Ibid.

13 Pak Chae-pom, "U.S. Reportedly Within New North Missile Range," *Seoul Sinmun*, trans. *FBIS-EAS-95-175*, September 11, 1995, p. 49; and "Missile Threat: North Korea," *Centre for Defence and International Security Studies*, Internet, http://www.cdiss.org/country3.htm, 1996..

14 Ibid.; and "Artillery Rocket, Ballistic Missile, Sounding Rocket, and Space Launch Capabilities of Selected Countries," *The Nonproliferation Review*, Spring-Summer 1996, p. 163.



of 2000-2005.[15] This missile will be able to range the U.S. airbase at Guam and the critical early warning radar site at Shemya. It may also be able to hit the Prudhoe Bay oil fields east of Point Barrow, Alaska as well as the population and military centers at Anchorage and Fairbanks. See Figure 3-2.

To a large extent, the proliferation potential and long-term threat that the *Taepodong* family of missiles present are dependent on the speed with which these two missiles are developed and the rate at which North Korea collapses. Obviously, missile sales provide North Korea with desperately needed foreign exchange, oil, or food aid. Considering North Korea's willingness to sell missiles, the TD-2 is a major proliferation candidate if it should go into production prior to reunification.

As a related issue, North Korean technology and knowledge of weapons of mass destruction, missile production, and related equipment also pose proliferation concerns. For example, there are allegations that North Korea provided assistance to Iran and Syria in setting up missile production facilities and,[16] in the case of Iran, also helped set up a missile test facility at Shahroud and the related tracking station at Tabas.[17] Moreover, there are reports that North Korea is transferring technology on chemical and biological weapons, with Iran, Iraq, Syria, and Libya being specifically cited as recipient nations.[18] As North Korea is already believed to have the ability to manufacture bomblet technology for its ballistic missile warheads,[19] it seems likely that it has developed submunition packaging for CW and BW agents, which it may be willing to sell.

The South's Proliferation Potential. In the short term, South Korea is understandably concerned about the North's nuclear, missile, and military capabilities in general, but long-term, it is more worried about Japan's nuclear and missile potential. In a sense, however, these concerns complement and reinforce South Korea's growing desire to see a united Korean peninsula play an influential role in East Asia during the next century—an era that many in the Asian community believe will become known as "the Asian century."

South Korea has an extensive nuclear power industry that includes 11 atomic power plants. Moreover, the work that was done during the 1970s on developing a nuclear weapon reportedly reached the point where it was about 95 percent complete

15 The involvement of foreign missile technicians and related assistance make it difficult to predict system development speed since there is no way of judging the technical proficiency level of foreign personnel. As a result, reported intelligence estimates seem based on estimations of an indigenous development effort, with the caveat that development time could be shortened due to foreign assistance.

16 Richard Latter, *op. cit.*, p. 76.

17 Gerardi and Bermudez, *op. cit.*, p. 190.

18 For example, see "DPRK Transferring Weapons Technology to Mideast," *Seoul KBS-1 Radio Network*, trans. *FBIS-EAS-94-110*, June 8, 1994.

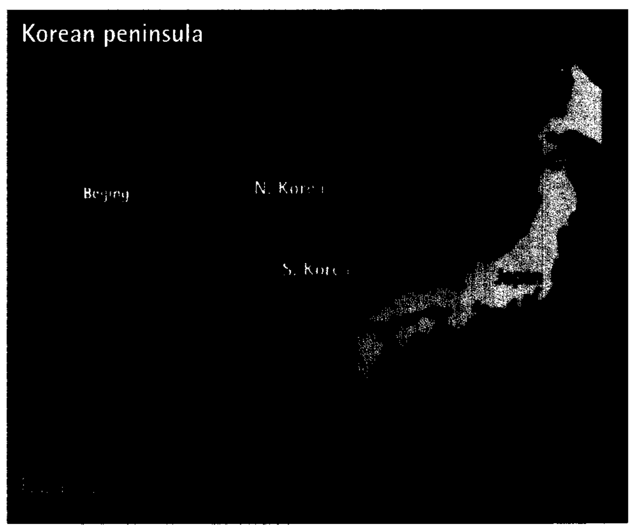
19 Duncan Lennox, Editor, *Jane's Strategic Weapon Systems*, in presentation to George C. Marshall Institute, Washington, DC, July 29, 1996.

before pressure from the United States halted its development.[20] Essentially, South Korea has the knowledge and skills to become a nuclear power very rapidly if it so chooses, but since its nuclear industry is under IAEA safeguards, its biggest obstacle to becoming a nuclear power is access to weapons-grade material. This obstacle could be overcome if South Korea gained access to Russian fissile material or was able to circumvent IAEA safeguards.

Coincidentally, there have been a few reports which indicate that South Korea may have been the intended destination for some intercepted weapons-grade fissile material that was being smuggled out of Russia.[21] When these reports are linked to other reports that indicate that South Korea is pursuing the development or acquisition of dual-use technology that would allow it to develop nuclear weapons (if required), it seems to show a circumstantial pattern of activity which indicates that South Korea may either be planning to develop a nuclear weapon or is taking precautionary action to ensure that it could assemble a nuclear arsenal within a short period of time.[22]

As for delivery systems, South Korea has been pursuing missile technology. Although hampered by a 1979 bilateral US-ROK accord (reaffirmed in 1990) which limited its right to develop ballistic missiles to those with a range of 180 kms or less, South Korea is working to abolish this accord and join the missile technology control regime (MTCR) which would limit its military missile development to 300 kms, but allow it to pursue space-launch vehicle development.[23] By 2015, South Korea has ambitions of having 19 space satellites in geosynchronous orbit (using its own launch vehicles).[24] Since studies have shown that space launch capabilities are not commercially viable (excess capacity exists among the established launch providers), there are suspicions that South Korea is interested in developing a commercial space launch capability as a way of hedging against an uncertain future in which it may need its own missile force.

It should also be noted that upon reunification, South Korea will gain access to the missile capabilities being developed by North Korea. As such, North Korea's CW, BW, and nuclear weapons and technology are likely to be joined to South Korea's advanced technological capabilities. (South Korea is believed to have conducted research on CW and BW.)[25] Consequently, a united Korea could well become a nuclear, chemical, and biologically armed power with IRBM or ICBM delivery capabilities sometime in the 2010—2015 time frame. Of course, how the reality of this potential capability



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20 "ROK's Nuclear Weapons Development Analyzed," *FBIS-EAS-94-181*, September 19, 1994.

21 For example, see John Deutch, Statement for the Record to U.S. Congress, Permanent Subcommittee on Investigations of the Senate Committee on Government Affairs, *The Threat of Nuclear Diversion*, March 20, 1996, p. Appendix 2.

22 A Foreign Broadcast Information Service (FBIS) summary of articles reflect a clear pattern of technology acquisition that would indicate preparation for development of nuclear weapons. See "South Korea: Acquiring Dual-Use Advanced Weapons Technology," *FBIS: Foreign Media Note—FB PN 94-27-So. Korea*, February 26, 1994.

23 "South Korea Seeks To Extend Missile Limits," *Jane's Defense Weekly*, June 26, 1996, p. 3.

24 Perry and Davis, *op. cit.*

25 Cunningham, "Third World Missile Proliferation Poses New Threat," *op. cit.*

plays out is highly dependent on the political moves and events that unfold during the next 10 or so years.

Future Role of a Reunified Korea. South Korean officials, looking beyond reunification, are focusing much thought on the role that a reunified Korean peninsula will likely play in East Asia. They seem to believe that Korea will be able to leverage its peninsular geographic position and its military power in ways that will allow it to play an influential role in the region. Many Koreans claim that a reunified Korea will be the France of East Asia—an ally of the United States, but one that charts its own independent course.[26] Within the new regional order, Korea sees for itself the role of mediator between Washington and Beijing. Within the new envisioned era, they seem to believe that China is a state with which Korea can deal. As one ranking official noted, China is "a benign giant" that could cause pain if he "accidentally stepped on you while walking through the neighborhood," but was unlikely—in the Korean experience—to strike out intentionally. According to this official, there are other smaller countries [implying Japan] that have more often acted like deliberate predators. As is repeated often in Seoul, Korea has had 5000 years of experience in handling its larger neighbor, all of which gives Seoul a more balanced perspective on the China threat than that being voiced in Tokyo or Washington.[27] It seems clear that Korean policy makers expect a united Korea to have close and friendly relations with China. (Korean officials are very conscious of the fact that China has existed on Korea's doorstep for the last 5000 years; they wonder where will the United States be 50 years from now since China will still be next door.)

As for its future relations with Russia, Korean thinkers still seem somewhat wary of the Bear, yet there does not seem to be much fear that an adversarial relationship might develop between the two countries. Rather, it is its historic enemy, Japan, which most concerns many Koreans. It is understood that relations between Japan and Korea may again turn hostile as the new regional order in East Asia evolves.[28] In the event that Japan and Korea find themselves at odds with each other, the United States could be placed in the role of playing peacemaker between these two states (i.e., another Greece-Turkey situation) or be forced to choose sides between them. In short, the United States might find itself facing a difficult situation in Northeast Asia as Korea, Russia, and China form a de facto alliance against Japan.

Japan, the Dark Horse of East Asia

Japan's defeat in World War II turned that historically militant country into a nation of pacifists. This transformation was strengthened by the shocking effects of the two atomic bombs that the United States employed to end the war. The survivors of that nuclear holocaust were also left with an acute abhorrence of nuclear weapons. The realigned public opinion eschewed military means as an instrument of policy. This opinion was frozen in time by an American-authored provision in the new Japanese constitution in which war or the threat of force were specifically renounced as a means of settling international disputes. Nevertheless, from a practical standpoint, Japan's ability to abide by its nonmilitary constitutional provision is clearly dependent on U.S. continuance as a reliable provider for Japan's external security.

The fear in East Asia is that Japan will eventually return to its militant, expansionistic roots, while in Japan there is a fear that the United States may be in decline as a world power and that the growing economic and military capabilities of other states in the region may force Japan to establish itself

26 Perry and Davis, *op. cit.*

27 Ibid.

28 An example of the potential for future confrontation may be foreshadowed in the recent account of a South Korean-Japanese dispute over some islands in the Sea of Japan. See Mary Jordan and Kevin Sullivan, "S. Korea Challenges Japan Over Islands," *The Washington Post,* February 13, 1996, p. A15.

again as an overt military power. Clearly, however, a rearming of Japan would be a two-edged sword as it would likely ignite an arms race in East Asia and could trigger the formation of alliances against Japan (a development that would not be in the United States' long-term national interest).

Obviously, missile and WMD capabilities will play a major role in Japan's future security situation. The growing military capabilities in China and on the Korean peninsula, coupled with the unstable political situation in Russia, have made the Japanese understandably nervous. As a result, the Japanese people have begun again to discuss military issues that have been heretofore taboo in modern Japanese society, to include the possibility of amending, rewriting, or reinterpreting their constitution to allow for military action.[29] Even the "N" word is beginning to be discussed as the Japanese public is slowly awakening to the potential implications of being surrounded by hostile nuclear powers.[30]

Japan has an extensive nuclear power industry with 36 operating reactors,[31] with another 15 planned for construction by 2010.[32] Japan, with little indigenous petroleum reserves, is in the process of developing a self-sustaining plutonium-based nuclear power industry that will include breeder reactors and a complete plutonium fuel-cycle processing capability. As a result of this activity, Japan will create large stockpiles of refined plutonium, a stockpile that is expected to amount to 45-90 tons by 2010.[33] (Although much of this material would be reactor-grade plutonium, see Figure 4-6, page 4.23.) The potential military threat represented by this capability is a matter of considerable concern to many regional statesman. They fear that Japan's current leadership actually is preparing the country for the day in which the World War II generation of Japanese pass from the scene and a new generation of leadership acts to arm the country.

Fears that Japan may "go nuclear" are reinforced by reports of Japanese activities that seem to be aimed at laying the groundwork for such a move. Reports that feed this fear include:

- Japan may have designed a nuclear device and developed it to the point where it only requires the addition of plutonium to make it an operable weapon.[34]

- About 3 percent of Japan's plutonium stocks cannot be accounted for at any one time.[35] While the methods of accounting for plutonium are inexact and lend themselves to some manipulation, studies seem to indicate that the hoped-for deviation in plutonium accounting is in the 2 percent or less range, while experts also acknowledge that the figure could legitimately be a higher in some cases.[36] As a result, some policy experts are concerned that Japan's 3 percent deviation figure could be concealing a covert nuclear weapons program (but without sufficient evidence to make such a charge).

- Japan is believed to have identified and developed within its commercial community the technology required to support a nuclear weapons program.[37]

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29 For examples of the smoldering debate, see Nicholas D. Kristof, "Finally, Japan May Have A Future In the Military," *The New York Times*, April 21, 1996, p. IV-5; Nicholas D. Kristof, "Japanese Look At the Possibility Of A Military Role In Asia," *The New York Times*, May 28, 1996, p. 8; and "USA and Allies Move Towards New Pacific," *Jane's Defense Weekly*, June 12, 1996, p. 29.

30 Ibid.

31 Vasiliy Golovin, "Possibility of Japan's Developing Nuclear Weapons Weighed," *Ekho Planety*, trans. *FBIS-TND-94-005-L*, July 18, 1994.

32 "Japan, Leakproof?," *The Economist*, January 20, 1996, p. 36.

33 Ibid.; and Christopher T. Heun, "China's Growing Military Clout Spurs Rising Security Concerns," *National Defense,"* April 1996, p. 23.

34 Nick Rufford, "Secret Report Says Japan Able To Go Nuclear," *The* [London] *Sunday Times*, January 30, 1994, pp. 1, 15.

35 "Japan, Leakproof?," *op. cit.*

36 U.S. Congress, "Nuclear Proliferation Fact Book," *op. cit.*, p. 546.

37 Vyacheslav Bantin, "Japanese Experts Claim Tokyo Can Develop Bomb," *Tass*, in *FBIS-SOV-94-021*, February 1, 1994.

Turning to missile delivery systems, Japan's space program is developing the technology that could be shifted rapidly into an offensive ballistic missile capability if Japan should so choose. Currently, Japan's H-II space launch vehicle is capable of launching a two-ton payload into geostationary orbit.[38] This two-stage missile has the potential for being used as an ICBM with a range of over 14,000 kms; however, as it uses cryogenic fuel that requires considerable time to upload, it would be vulnerable to a preemptive strike. Nonetheless, this vulnerability is of a fleeting nature. Currently, Japan is in the process of developing and testing the new solid-fueled MV missile system that will provide Japan with the capability of launching a 1.8-ton payload into a low earth-orbit of 250 kms.[39] Moreover, this missile, when fielded, holds the potential for being adapted as an IRBM.

In short, when considering Japan's economic and technological strengths, it is clear that this state could easily field a nuclear-tipped force of ICBMs by 2010—if it determined that it was in its national interest to do so. While it is not likely that Japan has yet broken its international obligations incurred under the various nonproliferation and export control agreements, it cannot be denied that Japan is located in a region that could become unstable and force it to reevaluate its military posture, to include whether or not it is in Japan's interest to continue to forego ICBMs and nuclear weapons. Clearly, for Japan, it will be the actions and interactions of the other major regional actors (i.e., the United States, Korea, China, and Russia) that will likely govern its future security policies. However, with provocation (and if the United States' security shield becomes viewed as being of questionable reliability), Japan could move to arm itself in a way likely to upset the current balance-of-power structure in East Asia.

China, the Great Conundrum Of the 21st Century?

The emergence of China as a great power has been expressed as being "the defining structural issue for the international system for the first quarter of the next century."[40] The evolution of such a colossus is bound to alter the global power structure as it is now understood. Although China is not an "evil empire" in the sense that the Soviet Union was so classified, it will still be a difficult state with which to deal, one that has the potential for triggering a nuclear confrontation.

Modern China is very patriotic, imbued with a collective sense of 5000 years of glorious history, a history blotted by 140 years of humiliation by the Western imperialistic powers (19th and early 20th centuries). Unfortunately, this sense of humiliation still irritates China's national psyche and colors its policy development. In essence, China's leaders govern by the principle, "Never again will China be dictated to by the Western imperialist powers—regardless of cost!" Thus, any Chinese leader who appears to bow to Western pressure on issues involving China's rights as a sovereign nation stands in danger of being purged. For practical purposes, this means that the United States tendency to conduct confrontational diplomacy via the news media puts Chinese leaders in the position of having to oppose U.S. initiatives for fear that acquiescence would appear as yielding to Western imperialistic power (a "loss-of-face" issue).

With Deng Xiaoping's passing, China's political leadership has been weakened. This weakness has allowed the People's Liberation Army (PLA) to increase its influence in China's political decision-making process. Deng, with his credentials as one of the old revolutionary leaders, was in a position to deal with pressure from the West in a fairly prag-

[38] Golovin, "Possibility of Japan's Developing Nuclear Weapons Weighed," *op. cit.*

[39] Ibid.

[40] Patrick M. Cronin, Testimony before the Committee on International Relations, Subcommittee on Asia and the Pacific, U.S. House of Representatives, April 17, 1996.

matic manner, secure from charges that he was unwilling to stand up to the Western imperialists.

The current leadership, lacking the stature bequeathed on their predecessors by their participation in China's revolution, has much less flexibility in handling international issues. For example, there are some China experts who believe that the Central Military Commission pressured the political leadership to take a hard line against Taiwan in retaliation for President Lee's visit to the United States. According to one report, the political leadership was not inclined to make an issue of the visit until the Central Military Commission applied pressure to President Zemin[41] (who never served in the military).[42] Similarly, China's internal political weakness increases the possibility that a Western power could try to pressure Chinese policy publicly and inadvertently trigger a military confrontation when China's leadership finds itself in an untenable position and refuses to yield on the issue (even in the face of disproportionate military power).

China's prickly national sensitivity toward sovereignty issues is coupled to a national legacy of Confucian values in which the world is viewed in terms of an absolute hierarchy. Within this philosophy, the idea of a relationship between sovereign equals is a foreign concept. In practical terms, as the Chinese view themselves as being the world's greatest civilization, the Confucian philosophy imbues this ancient civilization with a cultural orientation that suggests that China should lead the world. Thus, as China continues to grow in economic and military might, it should be expected that the country will exercise its power and become more assertive in international affairs. This could result in tense relations with the United States, especially as China sees the status of Taiwan as being its number one national sovereignty issue. Hopefully, China will mature and evolve in ways that allow it to assume this greater role without too much disruption to the international security structure.

It is questionable, however, if China will be able to integrate itself into the current U.S.-led international system without creating significant levels of turmoil. Complicating the process is the fact that China's leaders distrust the West. This distrust stems from three primary factors. The first is that China is governed by leaders who as a group tend to be very provincial in their thought processes and have little understanding of the West (they evolved in a political system isolated from Western thought). Second, these leaders feel personally threatened by American talk of a "peaceful democratic evolution" of China's government, an evolution that would displace them personally from power.[43] And lastly, the lessons of China's history over the past two centuries argue against being too trusting of the West, conditioning Chinese leaders to view the international system in terms of *realpolitik* (i.e., China's experience shows that countries usually pursue politics designed to advance their national interests regardless of the interests of others).

Against this backdrop of distrust and fear, the Chinese view the United States as having vast powers (far beyond reality) that enable it to manipulate events—a situation that possibly carries the seeds for future misinterpretations and confrontations.[44] For example, in the event that China is set back in its quest to modernize its economy and expand its global presence, it may well hold the United States responsible for its fail-

41 RADM Eric McVadon (Ret.), former U.S. Defense Attaché to Beijing, presentation at a workshop on *Post-Cold War Arms Control and Nonproliferation: A Challenge from China?*, sponsored by the Chemical and Biological Arms Control Institute, held at the Carnegie Endowment for International Peace, Washington, DC, February 29, 1996.

42 National Security Planning Associates, "People's Republic of China," *Asia-Pacific Issues and Developments* (Cambridge, MA: National Security Planning Associates, May 1996), p. 11.

43 Marvin C. Ott, Testimony before the Committee on International Relations, Subcommittee on Asia and the Pacific, U.S. House of Representatives, April 17, 1996.

44 Richard Grant, Royal Institute for International Affairs, presentation at a workshop on *Post-Cold War Arms Control and Nonproliferation: A Challenge from China?*, sponsored by the Chemical and Biological Arms Control Institute, held at the Carnegie Endowment for International Peace, Washington, DC, February 29, 1996.

ures, believing that the U.S. interfered with China's economic development for the purpose of eliminating its potential rival, China, from the contest for future global leadership.

Within this evolving situation, the question that is now occupying Western thinkers is, "How will China use its future military capabilities in pursuit of its national interests?" Historically, China has not been viewed as an expansionistic nation. As was pointed out in the section on Korea, the South Koreans see China as a benign giant that would not deliberately inflict harm. On the other hand, China has used force offensively on a number of occasions during the latter half of the 20th century: China forcibly colonized Tibet in the 1950s, attacked India in 1962 and Vietnam in 1979. More recently, it used military force to press its territorial claims in the South China Sea (to the consternation of the ASEAN nations that make up the major trading bloc in the region). Likewise, China demonstrated disregard for its economic interests with Taiwan when it attempted to use military intimidation to influence Taiwan's March 1996 presidential elections. These two recent events seem to indicate that China may not be much dissuaded by economic considerations in cases where it believes key national interests are at stake and the use of military force is judged to be a viable option. At the same time, there are many in China who are hesitant to see the country become too strong militarily because they fear it will antagonize China's neighbors and could affect commercial interests.[45]

China's Apparent National Objectives

Again, as was the case with Russia, it is difficult to define China's national objectives. However, the study of reports, leadership statements, and analysis of Chinese activities, taken together, provide sufficient insight into China's apparent national objectives to make an informed assessment. China's key objectives (that bear on future missile-defense issues) seem to be:

1. **To develop China's economic and technological potential under the continued leadership of the Chinese Communist Party (CCP).**

China, and particularly the members of the CCP, well understand that the future fate of the country and of the party is, to a large extent, dependent upon sustained economic growth rates in the vicinity of 10 percent per year. If economic growth declined to 6-7 percent, China could have difficulty creating the 10 million or so jobs it needs each year to keep pace with its growing population.[46] For China's leadership, economic growth is seen as necessary to validate the legitimacy of the government: the communist ideology has proven invalid; a Confucian-based nationalism and economic prosperity are now seen as the twin issues that are key to legitimizing the continued governance of China by the CCP.[47] Until now, however, China's political leadership has allowed economic growth to occur with little direction. China now hopes to change this situation.

The Japanese taught the world that it was not necessary to reinvent the economic wheel—that a country can buy new technology and leap-frog into the future. The Chinese hope to use Japan's example and develop a more disciplined economic policy for the future that will allow them to catch up to the developed world in 15-20 years (Japan took 30 years—1950-1980).[48] According to conversations with Chinese officials, China hopes to recentralize some of its economic planning activi-

[45] "Ambassador James R. Lilley: China Aims to Project Its Power," *Risk*, May 1995, p. 2.
[46] "East Asia Wobbles," *The Economist*, December 23, 1995-January 5, 1996, p. 36.
[47] Steven Mufson, "Maoism, Confucianism Blur Into Nationalism," *The Washington Post*, March 19, 1996, pp. A1, A12.
[48] Ronald Morse, University of Maryland, presentation at a workshop on *Post-Cold War Arms Control and Nonproliferation: A Challenge from China?*, sponsored by the Chemical and Biological Arms Control Institute, held at the Carnegie Endowment for International Peace, Washington, DC, February 29, 1996.

ties and has tasked the State Planning Commission to define China's economic trajectory for the rest of the decade and beyond. Apparently, China hopes to adopt an industrial policy for its commercial firms that is based on the Japanese model of grouping its industries and linking customer firms with captive supplier companies (*keiretsu* groupings). For China's defense industries, however, Chinese officials seem to believe that the United States' defense industrial policy provides the better model for China to emulate.[49]

2. **To secure future energy supplies** (South China Sea, Central Asia, and the Middle East).

As economies develop around the globe, the demand for oil will likewise increase. For China, which only has about 2.4 percent of the world's total oil and gas reserves,[50] future sources of energy supplies are going to be a key factor in its continued ability to sustain economic development as it feeds and supports 1.2 billion people, as it experiences the automotive revolution, as it meets the demand for expanded air travel, and as it engages in energy-intensive manufacturing. According to recent estimates, China's net external requirement for oil imports is expected to rise from the current daily level of 600,000 barrels, to 1 million by 2000, 3 million by 2010, and 7 million barrels per day by 2015.[51] During the next 15 years, East Asian oil imports from the Middle East could easily triple.[52] In the face of the expected demand, China is interested in securing its future supplies.

It is believed that China's concerns regarding its future energy supplies is also influencing many of its foreign policy decisions. For example, its 1992 announced sovereignty claims to about 80 percent of the South China Sea and its use of military forces to reinforce that claim are clearly aimed at securing oil and gas supplies.[53] Although the dispute over the Spratly Island area seems to be cooling somewhat (possibly due to ASEAN diplomacy and Chinese realization that drilling operations would take place in water 2,000-meters deep—deeper than current drilling technology supports), China has indicated that it would accept the provisions of international law and the Law of the Sea Convention to settle the dispute over the Spratly Islands.[54] Nevertheless, this region still holds the potential for conflict if oil supplies tighten during the next century and drilling technology advances sufficiently to make feasible the extraction of these deposits.[55]

Likewise, China's interest in Iran and Iraq (which together contain 20 percent of the world's proven oil reserves) seems clearly linked to its concern over future oil supplies,[56] while this same issue might also be coloring China's policy toward the states of Central Asia, states which hold the world's second largest reserves of oil, reserves only exceeded by those of the Middle East. The practical consequences of China's concern over its future oil supplies is that it will likely be difficult to ever gain China's cooperation on any U.S.-led effort designed to contain or to pressure Iran or Iraq (or any other major oil supplier) unless an overwhelming international consensus existed supporting such an action. In the case of such a consensus, China might be persuaded to abstain from voting in the UN Security Council, but it is unlikely that it would actively support such an action.

49 Ibid.
50 Juwono Sudarsono, "Official Views PRC Interests in Natunas," *Jakarta Merdeka*, trans. in *FBIS-EAS-95-127*, July 3, 1995, p. 65.
51 Kent E. Calder, "Asia's Empty Tank," *Foreign Affairs*, March/April 1996, p. 58.
52 Ibid.
53 Calder, op. cit., p. 61; and "Oil and Regional Stability In the South China Sea," *Jane's Intelligence Review*, November 1995, p. 511.
54 Note: Recent geological reports question the potential size of the oil deposits in the South China Sea. It may be that the smaller projections of wealth has allowed China to take a more relaxed position on this issue.
55 Shunji Taoka, "Article Reviews Asian Military Threats," in *FBIS-EAS-96-010*, January 16, 1996, p. 10.
56 Calder, *op. cit.*, p. 60.

3. **To reunify all Chinese lands by 2010** (Hong Kong, Macao, and Taiwan)[57] and to establish a secure zone along China's core geostrategic periphery.

The existence of Chinese areas, independent from China's control, are constant reminders of China's humiliation during its 140 years of weakness. While the issue of Hong Kong and Macao are settled and these two territories should revert the Chinese control in 1997 and 1999 respectively, the reintegration of Taiwan by 2010 is, of course, much more problematic.

Taiwan's movement toward successful implementation of democratic rule undermines the efforts of the Chinese Communist Party on the mainland to reestablish its legitimacy as the ruling party in China. As noted earlier, the CCP is using economic growth and Confucian-based nationalism to justify its rule since its communist ideology is no longer a viable underpinning for its existence. Under Confucian-based nationalism, the CCP can justify its rule as being good for China, with the Confucian philosophy justifying the CCP's hierarchical, authoritarian rule. In contrast, an economically successful Taiwan under a democratic government would demonstrate that there is a possible alternative to CCP governance.

Distribution of Overseas Chinese

in Thailand	6.58	million
in Malaysia	6.16	million
in Indonesia	5.05	million
in Vietnam, Laos, & Cambodia	2.46	million
in Singapore	2.36	million
in North America	2.32	million
in Latin America	800,000	
in the Philippines	760,000	
in Europe	620,000	
in Australia & New Zealand	490,000	
in Japan & South Korea	170,000	
in India & Pakistan	120,000	
in other places	100,000	
Total Chinese overseas (including Taiwan, Hong Kong, etc.)	55	million
[in mainland China	1.2	billion]

On the opposite side of the ledger, however, Taiwan offers China an opportunity (in business terms) to engage in a non-hostile takeover of one of the economic crown jewels of East Asia. Taiwan also has a very advanced electronics industry that would greatly benefit China as it enters the information era, especially in light of China's weakness in advanced electronics. In essence, the challenges and potential benefits that Taiwan presents to China ensure that Chinese-Taiwanese relations will remain a tense political issue until the reunification issue is resolved.

Along with the issue of reunification is the problem of securing China's geostrategic periphery. As one Chinese study quantified the threat along China's periphery, 70 percent of China's 21,656 kilometer-long border and 66 percent of its over 3 million square kilometers of territorial waters face some level of external threat.[58] In addition, some of the threat cited is a result of disputed territorial claims for islands in the China Sea. The countries with which China has disagreements over islands include Japan plus six other nations involved in the separate Spratly Islands' dispute (separate from a Japanese-Chinese dispute).

As an associated issue to China's national objective of regaining control of all Chinese lands is the influence that the global Chinese ethnic community and, in particular, the Chinese community in Southeast Asia, will have on trade, as well as on China's potential for exercising hegemony in East Asia. Figure 3-4 shows the distribution of that portion of the 55 million ethnic Chinese who are

57 Patrick Tyler, "China's Schedule For Taiwan," *International Harold Tribune,* January 31, 1996, p. 4; in private discussions with Chinese experts, 2010 is the commonly cited target date for reunification.

58 Cited in Alistair Iain Johnston, "China's New Old Thinking: The Concept of Limited Deterrence," *International Security,* Winter 1995/96, p. 28. This article is recommended reading for those interested in Chinese nuclear doctrine. It is well documented and based on primary Chinese sources.

Indonesia	3.5	73
Philippines	2.0	50
Thailand	10.0	81
Malaysia	29.0	61

scattered across the globe outside areas such as Taiwan and Hong Kong. Many of these individuals are wealthy and hold dominant positions in their countries of residence. According to one report, the Chinese ethnic community dominates the economies of all of the ASEAN states except for Brunei. Figure 3-5 illustrates this claim by showing the percent of population of each state that is ethnic Chinese, followed an estimate of how much of the private capital of each country is controlled by the ethnic Chinese community. Worldwide, the ethnic Chinese community may hold liquid capital assets of up to US $2 trillion.[59]

This greater Chinese ethnic community has actively supported China's economic miracle by funneling investments to the mainland, setting up factories in China, and establishing strong trade ties between their countries of residence and the Chinese mainland.[60] These ties could hold significant implications for the United States' future security and economic well-being, including:

- Preferential economic markets for goods and services. As noted in Chapter 1, a majority of the goods and services that the United States exports are not very high tech. Consequently, future East Asian trading patterns could develop in ways that favor Chinese ethnic connections and create a de facto trading bloc that effectively discriminates against U.S. firms (à la the Sterling bloc of the 1930s). The Chinese ethnic ties into the countries shown in the figures above could create unforeseen economic difficulties for the United States in this important emerging market.

- Weakening of nonproliferation restraints. The trading ties that are being established through the ethnic communities could make it easier to transfer sensitive dual-use technologies between parties in East Asia. In short, these ties may negatively affect U.S. nonproliferation efforts as China's technological capabilities advance and private trading conduits through the ethnic community move goods around the region.

4 **To increase China's regional and international influence and prestige.**

This objective was discussed in some detail in the introduction to the China section of this chapter. Although China does not currently aspire to be the world leader, it does expect to be accorded the international respect and leadership position commensurate to a great nation and ancient civilization comprising one-quarter of the world's population.

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59 The information in Figures 3-4 and 3-5 plus the $2 trillion estimate were extracted from Maria Hsia Chang, "Greater China and the Chinese Global Tribe," *Asian Survey*, October 1995, p. 966.

60 Sandra Sugawara, "China Market Set To Eclipse Its Neighbors: Asian Business Cashes In On Rapid Economic Growth," *The Washington Post*, March 18, 1996, pp. A1, A12.

China's Security Concerns

China believes in the value of military power. As recent writings on Chinese nuclear strategy point out, "the greater one's military capabilities, the greater the awesomeness of the state, and the more likely one is to determine conflict outcomes to one's advantage."[61] Nevertheless, the advantages that China might be able to gain from such capabilities are about two decades from realization. Consequently, the Chinese can be expected to use diplomacy where possible to achieve their national objectives. Nevertheless, China's basic use-of-force philosophy is neither to seek conflict nor to avoid it.[62] China's security concerns are believed to include:

- *The United States.* China's viewpoint that the United States is its most likely long-term security threat[63] has been reinforced by the growing U.S. public discussions regarding the need to limit or partially "contain" China. The subsequent dispatch of two U.S. carrier battlegroups to the vicinity of Taiwan in March 1996 apparently has been interpreted by the Chinese as affirming their fear that the United States is adopting a containment strategy for dealing with China.[64] (As discussed earlier, the Chinese are suspicious of these types of actions as they view them through a political lens that is focused by the belief that the United States has a hidden agenda to deny China its rightful role in the world.)

- *Japan.* China considers Japan, its number two security threat, to be the most likely to cause it difficulty in East Asia.[65] As such, at least during the near-term, China seems to accept continued U.S. involvement with Japan as a means of reassuring Japan and of limiting its inclination to establish a formidable military capability of its own.[66]

- *Russia.* Although apparently ranked as China's number three threat, for now, China sees Russia primarily as a source of technology. It also views Russia as useful in helping to limit the United States' international role. Both China and Russia are irritated with U.S. actions; therefore, each country gains mutual support from the other as they cooperate against their mutual adversary. In the December 1996 Chinese-Russian Summit, both countries made it clear that they oppose a unipolar world.[67]

- *Korea.* It is likely that China wants all U.S. forces off the peninsula once reunification occurs.[68] Obviously, a continued presence of U.S. forces in Korea after reunification would potentially limit Chinese influence in the peninsula. Those forces would also be useful to the United States in any effort to contain China. At a minimum,

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61 Johnston, "China's New Old Thinking," *op. cit.*, pp. 7-8. The summarized material quoted in this paper was attributed to a number of Chinese sources cited in footnote 7.

62 Morse, *op. cit.*

63 For one example, see Ross H. Munro, "Eavesdropping On the Chinese Military: Where It Expects War—Where It Doesn't," *Orbis*, Summer 1994, pp. 355-72. A primary theme in this work is China's need to avoid the coming war with the United States for as long as possible. This ranking of the U.S. as China's primary threat was also identified by Russian sources, see Sergey Repko, ""Russia/China: China's Military Concept, Relations With Russia Viewed," *Nezavisimoye Voyennoye Obozreniye*, translated in *FBIS-UMA-96-177-S*, September 11, 1996, p. 31.

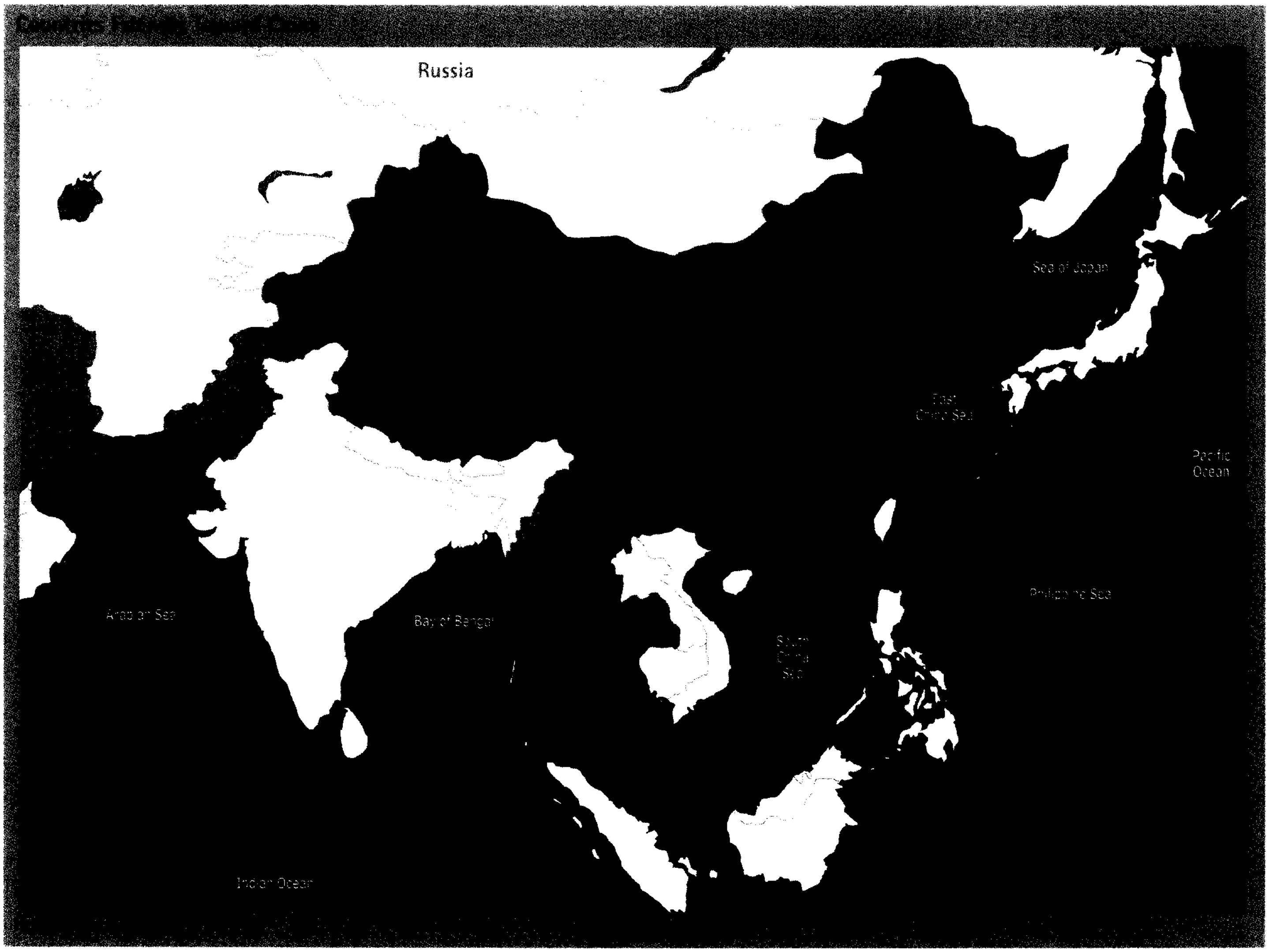
64 Steven Erlanger, "Chinese Cold War Forecast: Costly, Dangerous," *The New York Times*, February 25, 1996, p. IV-5; "Maturing Chinese Capabilities May Presage Larger World Role," *National Defense*, January 1996, pp. 24-25; and Eric A. McVadon, private communication based on conversations with Chinese officials, August 1996.

65 Repko, ""Russia/China: China's Military Concept, Relations With Russia Viewed," *op. cit.*, p. 31.

66 Larry M. Wortzel, "China and Strategy: China Pursues Traditional Great-Power Status," *Orbis*, Spring 1994, p. 160.

67 Repko, ""Russia/China: China's Military Concept, Relations With Russia Viewed," *op. cit.*, p. 31; and "China: and Li Peng, Yeltsin Vow to Promote Strategic Partnership," *Xinhua, transcribed in FBIS-CHI-96-251*, December 27, 1996.

68 U.S. House of Representative, Committee on International Relations, Subcommittee on Asia and the Pacific, Dr. Jonathan Pollack, "Q&A Response," *Hearing on Security In Northeast Asia: From Okinawa to the DMZ.*



China needs the Korean peninsula to be neutral, but preferably allied with China.

- *India.* Although China wants to limit India's national influence, it has taken steps to improve its own relations with that state. It is also still cultivating Pakistan as it is of value to China for its ability to divert India's political attention and to split India's military focus toward two different fronts. In regard to China's national objective of securing its future energy resources, China may have some concerns over India's future naval capabilities since the bulk of China's oil supplies increasingly will be routed through the Indian Ocean. Hence, China may have some concerns over the future security of that route.[69] (These concerns are likely ameliorated somewhat by its close relations with Singapore, Thailand, Burma [Myanmar], and Pakistan. See Figure 3-6.)

- *Iran.* China wants good relations with Iran for several reasons. First, Iran is viewed as a potential counterbalance to U.S. influence in the Persian Gulf. Second, it is a major source of energy needed for China's future economic development.[70] Third, China may fear the influ-

69 Larry M. Wortzel, "China and Strategy: China Pursues Traditional Great-Power Status," *Orbis*, Spring 1994, pp. 161-62.
70 Anthony Cordesman, Center for Strategic and International Studies, presentation at a workshop on *Post-Cold War Arms Control and Nonproliferation: A Challenge from China?*, sponsored by the Chemical and Biological Arms Control Institute, held at the Carnegie Endowment for International Peace, Washington, DC, February 29, 1996.

ence that Iran could exert on China's 40 million Muslims that live in the western provinces and hope to prevent Iran from inciting or supporting that minority faction in a bid for autonomy. And fifth, China needs Iran as a market for its defense goods.

China's General Military Modernization Efforts

China entered the 1990s with a limited strategic strike capability and an antiquated conventional military force—a force largely composed of light infantry units equipped with obsolete hardware, an air force with over 4,000 planes, all of which were seriously outclassed by Soviet and Western aircraft (at least 3,400 of its aircraft are based on 1950s technology),[71] and a navy equipped to perform limited coastal defense missions. Prior to the 1990s, military modernization was China's last major priority for development. Most modernization of the defense establishment was to be funded primarily through the sale of military and commercial products from PLA-controlled business activities. The Chinese had made a decision to focus their efforts on modernizing their economy first, then using the technology and resources that would evolve from that effort to modernize their armed forces.

Three subsequent events occurred which somewhat modified that plan. First, the PLA's actions in 1989 in crushing the pro-democracy demonstrators in Tiananmen Square indebted the CCP to the PLA. Second, the United States' military tactics and advanced weapon systems used in operation *Desert Storm* ended the debate among China's leadership regarding the need to modernize China's military establishment as U.S. successes disproved the hypothesis that had been held by some elements in the leadership that human factors could offset a military-technology edge.[72] As a result of these first two events, China began to put more emphasis on its military modernization program, but not at the expense of disrupting its overall economic modernization drive.

This shifting emphasis was further reinforced by a third event, the U.S. dispatch of warships to the Taiwan Strait during the recent China-Taiwan confrontation over Taiwan's Presidential elections in March 1996. The U.S. intervention seems to have convinced the Chinese leadership that military modernization must be pushed harder. Many fairly senior PLA naval officers became very emotional over the insertion of the two U.S. aircraft carrier battle groups into the region. They are apparently advocating firing on any future U.S. warships that interfere with the Taiwan issue, regardless of consequences.[73] This reflexive response to outside interference in an issue the Chinese view as involving its sovereignty is part of the national psyche discussed previously to "never again bow to the Western Imperialists."

Currently, in concert with its overall economic plan to import technology and leap ahead in its efforts to catch up to the developed world, China is pushing ahead on many fronts to modernize its military. This effort is being supported by a flow of dual-use technology from the United States,[74]

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[71] Barbara Starr, "New Contacts, But U.S. Arms Trade Ban Stays," *Jane's Defense Weekly*, January 31, 1996, p. 60.

[72] Geoffrey Kemp, "The Impact of the Gulf War Upon States Attitude and Behavior Towards Advanced Technology, *Unpublished Paper*, February 1994, p. 2.

[73] Tom Plate, "Is China's Army the Real Wild Card," *Los Angeles Times*, (Washington Edition), May 28, 1996, p. 11; and a non-attribution conversation with a ranking Chinese naval officer.

[74] For an example of U.S. dual-use exports to China, see Gerard White, Prepared Statement before the U.S. Senate's Subcommittee on East Asian and Pacific Affairs, Committee on Foreign Relations, October 12, 1995. For some insightful reading on China's methods of gaining dual-use technology, see Joseph Kahn, "McDonnell Douglas's High Hopes For China Never Really Soared," *The Wall Street Journal*, May 22, 1996, pp. A1, A12; and Stephen J. Hedges and Susan V. Lawrence, "Manufacturing Trouble in China: Were U.S. Machine Tools Illegally Diverted?," *U.S. News and World Reports*, February 5, 1996, p. 41.

France, Germany, the United Kingdom, and most other developed nations. In addition, Russia, Israel, South Africa and other states are selling military technology and hardware to China. As a result, China is in the process of upgrading its military potential across a wide spectrum of capabilities, including air and missile defense systems (to include purchase of the SA-10), *Kilo* submarines (along with the development of a new generation of indigenous models), advanced aircraft (e.g., the Su-27 purchases and pending co-production, and the indigenous development— with Israeli assistance—of the J-10, which may include illegally transferred U.S. avionics),[75] air-to-air refueling technology, cruise missile systems, and ballistic missile technology. These represent but a few examples.

China's efforts to develop advanced cruise missile systems is of concern. Although China has been making progress on developing more advanced cruise missiles, the help that is now available from Russian and other sources is likely to speed the process. For example, it is believed that about three years ago China successfully transplanted an entire Russian cruise missile plant, complete with research and development team, to a location near Shanghai.[76] As Russian cruise missile technology now supports land-attack ranges of about 4000 kms, China's capabilities in this field (currently limited to about 200 kms) will likely increase rapidly, reaching 600 kms within a couple of years, and probably exceeding 2,000 kms by the year 2005.[77] China's cruise missiles in the 2000-2010 time frame are expected to incorporate stealth technology and be equipped with conventional, CW, BW, and nuclear warheads.[78] As was noted in Chapter 1, cruise missile systems are proliferating widely; Chinese efforts in this field are part of that trend.

Apparent Ballistic Missile Developments

China's Military Doctrine and Missile Requirements. Until about 1987, China postured its nuclear capability to achieve "minimum deterrence." (Not all Chinese nuclear strategists will use the term "deterrence"; many prefer other terms such as "defense" or "self-protection.")[79] This term contrasted China's nuclear posture with that of the United States and the Soviet Union, which maintained "maximum deterrent" postures based on counterforce warfighting doctrines and technologies that provided a distinct first-strike advantage in disarming one's opponent. "For Chinese strategists, minimum deterrence requires only the ability to carry out a simple, undifferentiated countervalue strike."[80] Simply put, the fear of nuclear retaliation against a country's population centers by a few warheads is sufficient to deter a nuclear strike from being launched. Chinese strategists had also believed that by maintaining the nuclear strike force at a low number of warheads a country could avoid appearing too threatening.

Beginning in 1987, the Chinese began to use the term "limited deterrence." Initially, limited deterrence was defined in ways not much different from

75 Bates Gill, "Russia, Israel Help Force Modernization," *Jane's Defense Weekly,* January 31, 1996, pp. 54, 56, & 59; Nick Cook, "Lifting the Veil On China's Fighters," *Jane's Defense Weekly,* January 31, 1996, p. 52; and Bill Gertz, "Israelis Face Query On Sales To China," *The Washington Times,* June 19, 1996, p. 4.

76 Lu Tw-yung, "Beijing, Russia Said Developing Cruise Missiles," *Lien Ho Pao,* translated in *FBIS-CHI-95-167,* August 29, 1995, pp. 33-34.

77 Duncan Lennox, Editor, *Jane's Strategic Weapon Systems,* in presentation to George C. Marshall Institute, Washington, DC, July 29, 1996.

78 Robin Ranger, Humphry Crum Ewing, David Wiencek, and David Bosdet, "Cruise Missiles: New Threats, New Thinking," *Comparative Strategy,* July 1995, pp. 263, 268.

79 Johnston, "China's New Old Thinking: The Concept of Limited Deterrence," *op. cit.,* p. 11.

80 Ibid., p. 18.

minimum deterrence. Over time, Chinese strategists have defined the concept of limited deterrence much more sharply, giving it a limited counterforce, warfighting flavor. As it is now defined, limited deterrence falls on the deterrent scale between the extremes posited by minimum deterrence and maximum deterrence doctrine. Chinese writings on limited deterrence have been evolving, defining limited deterrence as:

- The ability to inflict damage with a few hundred warheads aimed at cities and other targets.

- The goal is to develop mutually assured destruction second-strike capabilities.

- More recently, as having the capability to deter conventional, theater, and strategic nuclear war and to control and suppress escalation during a nuclear war. In short, "a limited deterrent should be able to respond to any level or type of attack from tactical to strategic, and the initial response should be calibrated to the scope of the initial attack."[81] A consensus seems to have formed that a limited deterrent posture should allow China to strike both countervalue and hard and soft counterforce targets.[82]

> Chinese strategists argue that it [limited deterrence] requires a greater number of smaller, more accurate, survivable, and penetrable ICBMs; SLBMs as countervalue retaliatory forces; tactical and theater nuclear weapons to hit battlefield and theater military targets and to suppress escalation; ballistic missile defense to improve the survivability of the limited deterrent; space-based early warning and command and control systems; and anti-satellite weapons (ASATs) to hit enemy military satellites.[83]

As China's nuclear doctrine evolves and the counterforce requirements inherent in the doctrine of limited deterrence become obvious (i.e., the advantages to be gained from destroying threatening military capabilities before they can be used), many Chinese strategists are expressing frustration over the limits established by China's no-first-use-of-nuclear-weapons pledge. As a result, a number of recent writings are clearly aimed at qualifying China's no-first-use pledge to allow a retaliatory strike on warning or even a first strike when clearly threatened.[84] In short, although China's no-first-use policy has not yet been repudiated, it is under assault and its future may be in question.

As for battlefield and theater-level systems, the Persian Gulf war provided a breakthrough in Chinese doctrinal development. The Iraqi use of conventionally armed *Scuds* and the U.S. use of *Tomahawk* precision-strike cruise missiles led the Chinese to conclude that shorter-range cruise and ballistic missile systems can play an important role in demoralizing an adversary by inflicting unacceptable levels of losses on important political, economic, and military targets as well as to provide warning of further escalation of the conflict, perhaps by the delivery of a nuclear strike.[85] In essence, the Chinese have come to recognize the value of missiles in combat and see them as an essential component in establishing a credible escalatory ladder that ties those systems to the national strategic deterrent forces.[86]

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81 Ibid., p. 19.
82 Ibid.
83 Ibid., p. 20, to include footnote 51.
84 Ibid., pp. 21-22.
85 Colonel Viktor V. Stefashin, "Chinese Nuclear Strategy and National Security," *Mirovaya Ekonomika,* translated in *FBIS-UMA-95-206-S,* October 25, 1995.
86 Johnston, "China's New Old Thinking: The Concept of Limited Deterrence," *op. cit.,* pp. 26-29.

To summarize, China has adopted a new nuclear doctrine during the past 5-10 years of limited nuclear deterrence. This doctrine is not only guiding ongoing missile developments, it is also providing the rationale for China's future approach to warfighting. While the Chinese view strategic conflict as the most dangerous threat to China, they also expect that most future wars will be fought over limited objectives in regions surrounding China. Thus, China wants a force structure that allows it to fight the short, limited wars in the region while simultaneously posing a significant nuclear deterrent to those global powers that might be tempted to intervene. In addition, China wants to ensure that if a global power intervened in a local war, China can deter the escalation of that conflict to the strategic level by ensuring that it has a credible nuclear warfighting capability that includes a survivable second-strike potential, even if nuclear weapons are used at the theater level. In short, China does not accept the idea that nuclear weapons will have no utility in future wars. On the other hand, Chinese decision making is not a monolithic undertaking. There are many Chinese officials that also argue for the elimination of nuclear weapons.

Strategic Missile Forces. In the past (under its doctrine of minimum deterrence), China based its nuclear deterrent posture on a relatively small force of ballistic missiles. The first generation missile systems were liquid-fueled rockets (based on Soviet technology), each model of which was developed with a specific target area in mind. For example, the *Dong Feng* (East Wind) 2 was a mobile system with a range of 1250 kms so as to be able to strike Japan. As the DF-2 was China's first nuclear-armed missile, the United States designated it Chinese Surface-to-Surface (CSS) 1. China is believed to have built about 160 of these missiles. Likewise, the mobile DF-3 (CSS-2), range 2800 kms, was a single-stage system theoretically targeted at U.S. military bases in the Philippines. An estimated 90-120 DF-3s were deployed in the 1980s. (Some greater number were manufactured.) Reportedly, 36 of these missiles were sold to Saudi Arabia in 1988 (with conventional warheads).

Similarly, the two-stage DF-4 (CSS-3) was designed initially to hit the U.S. base at Guam and later modified to increase its range to 4750 kms so as to be able to strike Moscow also. An estimated 30 DF-4s have been constructed for ballistic missile use. The same booster is used for several space launch vehicles, including the CZ-2, the CZ-3, and the CZ-4. Many of the DF-4s are stored in caves and must be moved into the open and fueled prior to firing. The fueling operation apparently requires about two hours.[87]

Of greater significance is the DF-5 ICBM (CSS-4). This missile,first tested in September 1971,[88] had a range of 10,000 to 12,000 kms which allowed it to threaten the western portions of the United States. In 1983 the Chinese decided to improve this system to increase its range and provide it with a more accurate guidance system. The resulting missile was designated the DF-5A with a range of 13,000+ kms.[89]

The DF-5A is a liquid-fueled missile. Unfortunately, there seems to be a common misconception that all of China's liquid-fueled ICBM force requires up to two hours for fueling operations prior to launching. This assumption is not necessarily correct. For that portion of China's DF-5A ICBM force that is emplaced in silos or other shafts that may have been modified to allow missile firing from that position, there is no reason that those systems could not be maintained in a ready-

87 Norris, Burrows, and Fieldhouse, "Nuclear Weapons Databook," *op. cit.*, pp. 382-83.

88 Yan Kong and Tim McCarthy, "China's Missile Bureaucracy," *Jane's Intelligence Review*, January 1993, p. 38.

89 The foregoing material describing first-generation Chinese missile systems is extracted from Norris, Burrows, and Fieldhouse, "Nuclear Weapons Databook," *op. cit.*, pp. 360-64.

China's Ballistic Missiles (First Generation)

Missile (all liquid fueled)	Range (km)	Throw-weight	Yield	CEP	Remarks
DF-2/2A (CSS-1)	1250	1500 kg	20 kt	1-2 nm	Targeted at Japan. All retired as of 1990 (50 had been deployed).
DF-3 (CSS-2)	2650	2150 kg	1-3 Mt	?	Mobile single-stage missile; originally targeted at Philippines.
DF-3A (CSS-2)	2800	2150 kg	1-3 ?	.54 nm	3 MRV warheads(?), w/ each RV yielding 50-100 kt? 50 msls deploy.
DF-4 (CSS-3)	4000	2200 kg	3.3 Mt	?	Two-stage system targeted at Guam until 1971; tested for rail deploy.
DF-4A (CSS-3)	4750	2200 kg	3.3 Mt	.74 nm	6-20 based in caves, targeted on Russia and Guam; booster is a DF-3.
DF-5 (CSS-4)	10000-12000	3000 kg	3-5 Mt	?	Two-stage ICBM can strike Western U.S. For many years, four were believed deployed in silos. CZ2 space launcher uses same msl frame.
DF-5A (CSS-4)	13000+	3200 kg	?	.27 nm	Some may be MIRVed; DF-5A has larger booster/improved guidance.

Sources: *Nuclear Weapons Databook, Vol. V*; SPC's *Ballistic Missile Proliferation* Study; Jane's; and IISS's *Military Balance*.

Figure 3-7

to-fire status. It is only those DF-5A systems that might be stored in a horizontal position or in a location that is not also its launch pad that would likely require fueling operations prior to launch.

China's Long March 2C missile frame (used for space launches) also is the same rocket system that is used for the DF-5A ICBM. This system uses storable liquid propellent, nitrogen tetroxide/unsymmetrical dimethyl hydrazine (NDMH/N_2O_4). This fuel is of the same fuel family as was used in the United States' heavy-lift *Titan* II ICBM. Since NDMH/N_2O_4 can be stored in an aluminum/stainless steel missile for over 20 years without suffering any significant degradation of the fuel or corrosion of the missile structure, there is no reason that China could not maintain its silo-based ICBMs on an alert status that would allow launch on warning. About the only difficulties this fuel would give the Chinese is that it has a freezing point of about 30 degrees Fahrenheit (requiring an uploaded missile to be maintained in an environment above roughly 35-40 degrees) and that the welds used in missile construction would have to be well executed as the nitrogen tetroxide oxidizer (which is extremely toxic) is difficult to contain, easily leaking through porous points such as substandard welds.[90]

Turning to the naval systems, it should be noted that China developed a first-generation nuclear powered *Xia*-Class SSBN that carried 12 JL-1 missiles. (The JL-1 is the naval version of the DF-21.) This submarine is very noisy (and thus easily detectable), its missiles only have a range of 1700 kms, and the boat is difficult to maintain. In short, this submarine (Type 092) is not considered to constitute much of a threat to the United States.

Perhaps of greater interest is the direction in which China is moving with its future strategic force development. Strategic forces currently are a problem for China. China does not yet have any space-based early warning capabilities. Its current system is limited to some ground-based phased-array radars;[91] therefore, it is probable that most incoming missiles would strike their targets before the retaliatory strike could be launched.

China currently may be content to maintain at least some of its missiles unfueled if it is confident that it has a second-strike capability (a missile force

[90] The information on rocket fuel characteristics is based on a conversation with Joe Connaughton, Consultant on Liquid Rocket Fuels, Huntsville, AL, October 11, 1996. Joe Connaughton also noted news account of the difficulty that the USAF encountered a few years ago with a *Titan* II when one of its mechanics dropped a wrench in a silo causing the missile to begin leaking toxic fumes.

[91] Johnston, "China's New Old Thinking: The Concept of Limited Deterrence," *op. cit.*, p. 33.

protected from preemption). In an effort to increase the survivability of its missile forces, China has made a considerable effort to hide its missile capabilities. It uses dummy missile silos, hides missiles under civilian buildings with removable roofs, places them in mines, secures them in caves and tunnels, and has considered deploying the DF-5 ICBM inside of fake bridge towers and on rail cars.[92] (The Chinese believe that weak states should not be very transparent regarding its strategic capabilities; more advantage can be gained from ambiguity.)

Known DF-5 missile-site

Figure 3-8

Due to the emphasis that China has placed on concealment of its missile force, it is doubtful if any nation, to include the United States, has identified all of China's nuclear missile sites.[93] For example, for many years almost all sources credited China as having only four DF-5 missiles on alert, two of which are known to be deployed in silos in Central China (where they could be destroyed by a preemptive strike). See Figure 3-8. Yet, there was much evidence pointing to the fact that since 1978 China was producing 10-12 *Long March* missiles per year (the LM-2C missile frame is used by both the DF-5 ICBM and the space launch program). There are published photos that show at least nine of these types of missiles on an assembly line at one time.[94] Simple arithmetic would indicate that perhaps 180-216 of these missiles could have been produced between 1978 and 1996.

Many analysts claim that the space launch program consumes most of China's missile production. Yet, a July 1996 report of a Chinese launch of a satellite noted that it was the 47th launch since 1970 when China acquired satellite launch technology.[95] There is also a report that China tested the DF-5 seven times prior to its entry into service.[96] According to other reports, the modified DF-5 was tested for a MIRVed warhead in 1986.[97] Assuming this testing required seven more test shots, this would still indicate that China might have as many as 100-150 DF-5 and DF-5A missiles. Yet, according to recent statements by U.S. officials and press reports based on

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92 Norris, Burrows, and Fieldhouse, "Nuclear Weapons Databook," *op. cit.*, pp. 374, 383, & 385.
93 Ibid., p. 374.
94 In a private conversation with Duncan Lennox, Editor, *Jane's Strategic Weapon Systems*, July 29, 1996, he noted that he has missile-factory photos in his files that show many Long March systems under construction, many more than have been accounted for in estimates of Chinese capabilities. The 10-12 missiles per year figure is commonly accepted and has been used by such organizations as the U.S. Defense Intelligence Agency, *Jane's*, and *Aviation and Space Weekly*. For example, see "Launchers, Upper Stages, and Propulsion: China, People's Republic," *Jane's Space Directory, 1993-94*, p. 221.
95 "PRC: Roundup Views Achievements in Space," *Xinhua*, translated in *FBIS-CHI-96-131*, July 8, 1996, p. 43.
96 Yang Zheng, National University of Singapore, "China's Nuclear Arsenal," Kanwa Information Center (Internet), March 16, 1996.
97 Also see Norris, Burrows, and Field House, *Nuclear Weapons Databook*, Vol. 5, *op. cit.*, p. 375.

leaked classified material, China is now credited with having a force of an estimated 17-20 DF-5 ICBMs,[98] consisting of a mix of DF-5 and DF-5A missiles. Even considering the likelihood that some of the early missile models may have been scrapped, the question remains, "*Where are the missing missiles?*"

The possibility that China may have successfully duped the world as to the size of its ICBM capability has to be considered. Given China's concern over having its retaliatory missile force preempted and considering China's superior abilities to maintain secrecy, coupled with its military doctrine that places much importance on the value of deception operations, it would not be surprising to find that China may have fooled Western intelligence agencies regarding the size of its strategic nuclear forces.

For example, in a convincingly argued (but uncorroborated) paper by Yang Zheng, National University of Singapore, the claim is made that in early 1995 the Chinese media announced that the Great Wall Project for China's strategic missile force had been completed. The Chinese accounts reportedly claimed that "tens of thousands" of army engineers had been tunneling for over 10 years in a mountain range in Northern China. Based on a careful reading of the reports and through the use of topographical maps, Yang deduced that the mountain range in question is probably the famous Tai-Hang Mountain Range which lies about 400 kms Southwest of Beijing between Hebei and Shanxi provinces (see figure 3-9). The topography of this mountain range is characterized by 1,000-2,000 meter-deep gorges and steep bluffs. Using standard calculations for the production capacity of the engineer units involved, Yang determined that the Great Wall Project probably resulted in a network of tunnels up to 5000 kms long inside of the mountain range. The Project also must have included the construction of dozens of missile bases, to include those used for DF-15 launchings during recent operations against Taiwan.[99]

If this speculative claim were to be confirmed, it would indicate that China has or is planning to put much of its strategic missile forces deep underground in a tunnel system where they would be invulnerable to a preemptive strike, but from which its ICBMs could be easily moved from the tunnels into launch positions in the surrounding gorges. In short, the possibility cannot be dismissed that some of the unaccounted for DF-5A missile production has been secretively deployed, both in conjunction with the Great Wall Project and possibly in other similar locations.

These similar locations include the possible conversion of underground mines. For example, in 1994 China abruptly canceled some contracts with Western firms for selected minerals. The mines in question were huge underground complexes that had been in production for centuries in Yunnan and Hunan provinces in Southern China. The Chinese claimed that the mineral veins had played out and that the mines were being closed. In response, some of the Western firms offered to send mining experts to China to inspect the mines and attempt to re-find the mineral veins. The Chinese declined. When the offer was pressed, the negative Chinese response was so firm that it left no doubt that they did not want anyone in the mines.[100] The question is why?

Could the Chinese be converting these mines to missile sites? While speculative, it is interesting to note that Yang Zheng's paper also claimed that

[98] "Maturing Chinese Capabilities May Presage Larger World Role," *National Defense,* January 1996, p. 25; and Bill Gertz, "China's Arsenal Gets A Russian Boost," *The Washington Times,* May 20, 1996, p.A1.

[99] "Great Wall of Fire," *Far Eastern Economic Review,* December 21, 1995, p.14; and Yang Zheng, *op. cit.* Yang used news accounts to determine that a company of 100 army engineers can dig about 100 meters of tunnel per month when constructing railroad tunnels (no advanced drilling machinery). The Great Wall Project would have involved hundreds of companies for over a period of 10 years. China acknowledged the loss of nearly 100 lives during its construction.

[100] Unpublished letter from Dr. Daniel Fine, Massachusetts Institute of Technology, April 8, 1996.

The Great Wall Project (Suspected Site of Tunnel System)

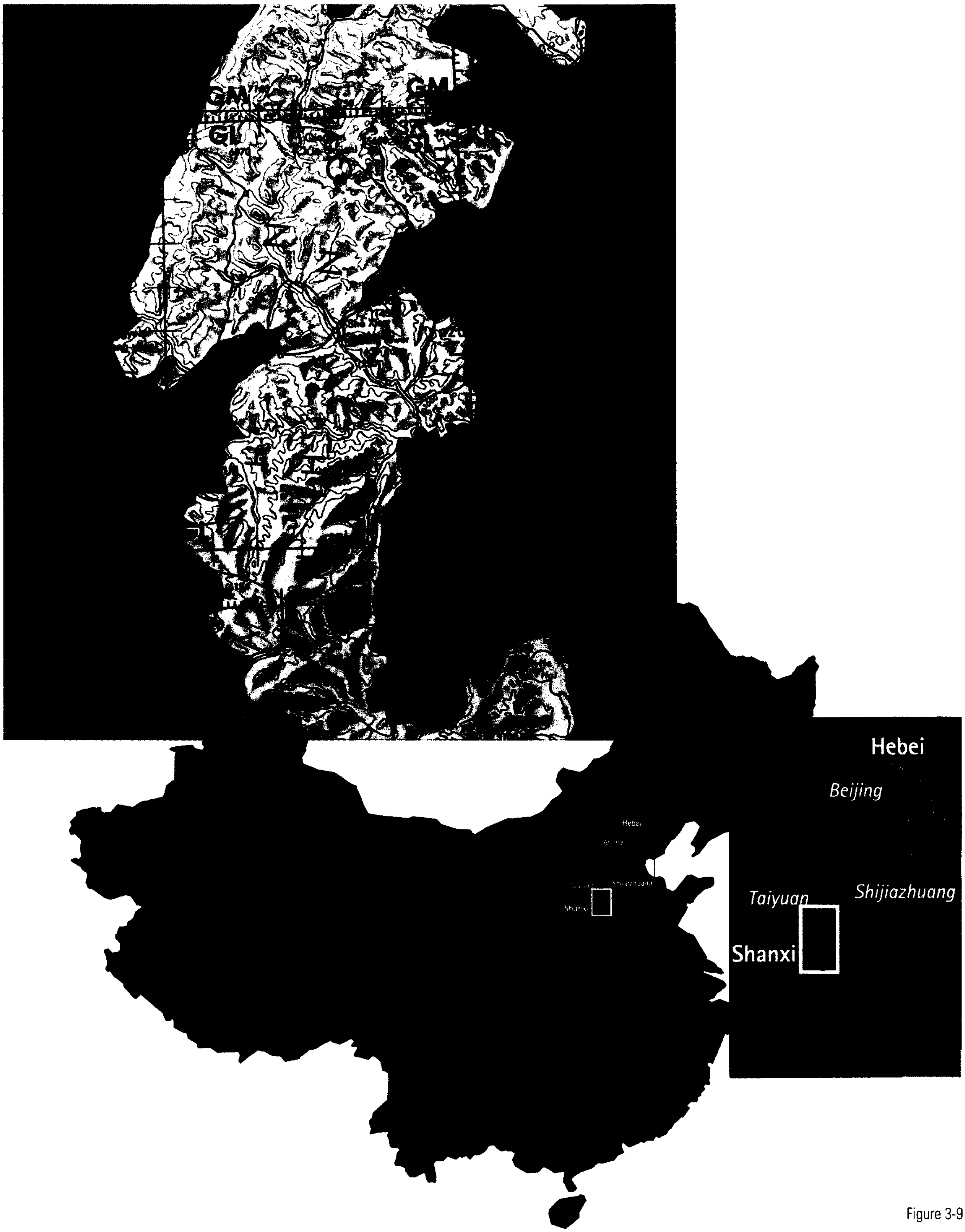


Figure 3-9

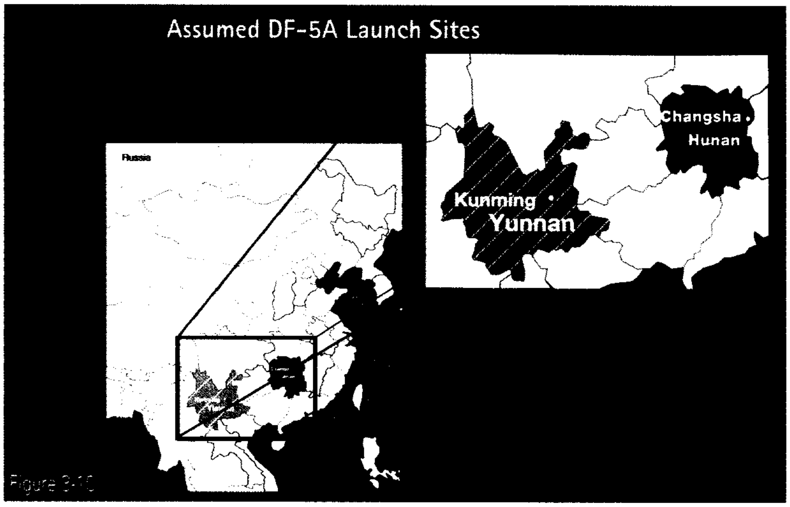


Figure 3-10

of 13,500 km was entered into the computer. The exclusion zones (inside of the circles shown in Figure 3-11) show that the only part of the world that *cannot* be attacked by the DF-5A (when launched from Southern China with a payload of 3200 kgs) is Latin America and a small slice of the West Coast of Africa.

(Note: the depiction on the left of figure 3-11 shows one calculation with an assumed non-rotating earth; the two additional excursions assume two different pitch angles—the missile's angle in relationship to the surface of the earth which is established at the end of the boost phase to establish the flight trajectory of the missile—plus adding the effects that occur as the earth rotates under the missile as it travels through space. (In essence, a missile's net effective range increases when fired west and shortens when fired east.) The depiction on the right side of Figure 3-11 shows the area that cannot be struck after calculating a series of possible flight profiles using different pitch angles to determine the optimum trajectory of each target area. That is, the right depiction is the integrated answer of many trial trajectories to determine best-case firing solutions. Missiles fired from the northern part of China would move this exclusion area further to the south.)

China had been digging tunnels in mountains throughout China since the 1960s and that other strategic missiles had been installed in mountain ranges in Central and Southern China. If his assertion is true, it could indicate that the mines that were abruptly closed in South China may have been appropriated for some defense project and perhaps even equipped as missile launch facilities.

To test the feasibility of firing DF-5A missiles at the United States from these Southern provinces, an advanced computer simulation of a DF-5A missile trajectory was conducted with launch points located in Yunnan and Hunan provinces. (See Figure 3-10.) Since the DF-5A is listed as having a range of *over* 13,000 km, for purposes of this simulation a range

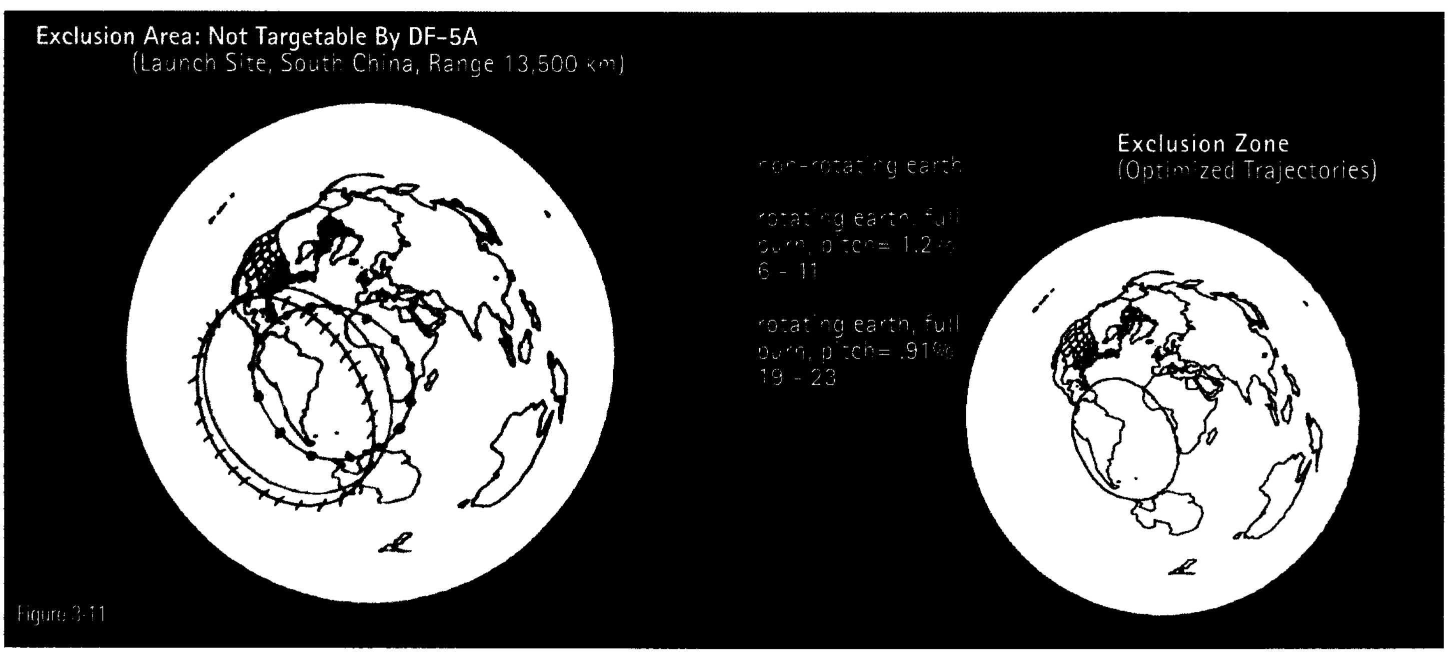


Figure 3-11

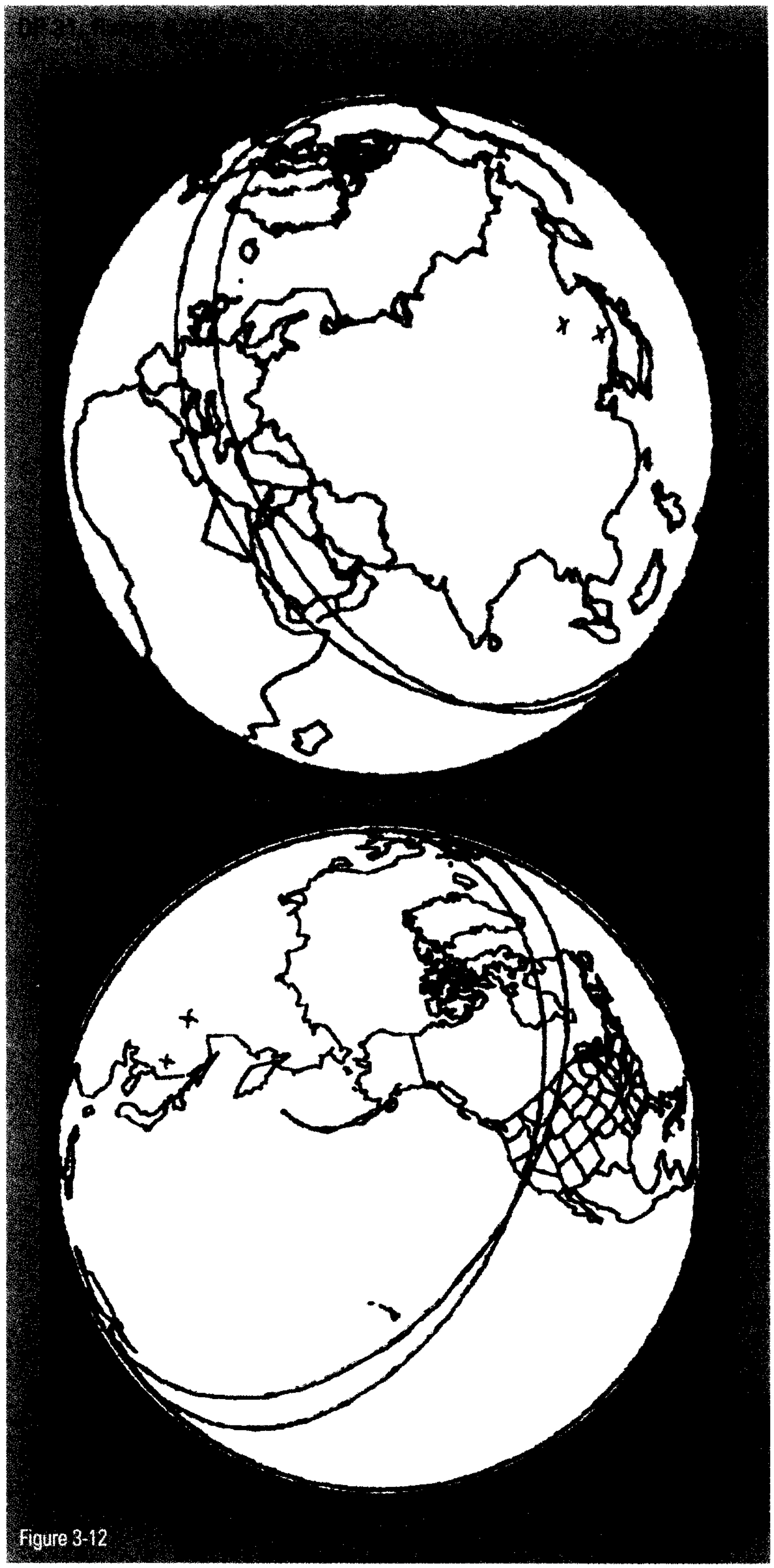
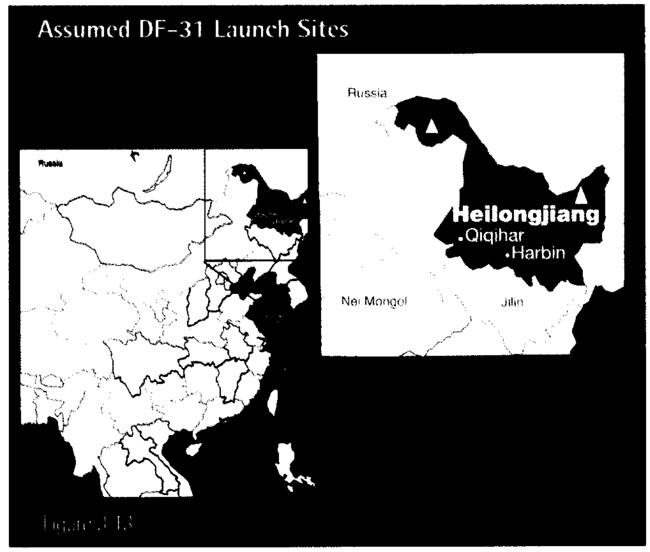


Figure 3-12



As China looks to the future, it is moving to increase its strategic missile-delivery capabilities. By 2010, China reportedly plans to replace many of its shorter-range ballistic missiles with long-range systems so that 75 or 80 percent of its ballistic missile force will consist of missiles capable of targeting the United States and all of Russia.[101] For the current force of DF-5A missiles, China is moving to arm these ICBMs with MIRVed warheads. Since the DF-5A apparently has four veneer engines on its second stage (which reportedly fire for 190 seconds after the main missile engine cuts off), the DF-5A should be able to point its warhead bus over a fairly large arc, which would allow it to aim its payload at an array of attack points that are widely dispersed in the target area.[102] Unfortunately, the exact status of this program is uncertain. One source calculated that based on throwweight and size of warhead shroud on the DF-5A it is being equipped with a 6-RV warhead with each RV weighing 600 kgs (the size of the single warhead on the DF-21).[103] There is also a Beijing press dispatch that talks about a 9 RV warhead for new missiles. As for the status of MIRVing, one source claims that at least four DF-5As have already been MIRVed.[104] This claim stands in contrast to a more common claim that no DF-5s have

101 Colonel Viktor V. Stefashin, "Chinese Nuclear Strategy and National Security," *Mirovaya Ekonomika,* translated in *FBIS-UMA-95-206-S,* October 25, 1995.

102 Ibid. The author notes that China has been advertising that it can deliver four satellites on a single launch. That capability is the same technology used to aim each of the RVs on MIRVed warheads. The pacing factor on MIRVed warheads is believed to be the process of downsizing the nuclear components.

103 Yang Zheng, National University of Singapore, *op. cit.*

104 "Special Dispatch from Beijing: New Nuclear Weapons Said Goal of Current Tests," Hong Kong, *Lien Ho Pao,* translated in *FBIS-CHI-95-218,* November 13,1995, p.29

yet been fitted with MIRVed warheads, but that MIRVing will occur within the next few years.

Between 2000 and 2010, China will add a new generation of strategic missile systems to its inventory. The first of these systems is the DF-31,[105] believed to have flown its fourth flight test on December 28, 1996. This system is a solid-fueled, three-stage mobile missile with a range of 8000 km carrying a 700 kg, one-megaton warhead.[106] This missile system is similar in form to the Russian SS-25 (one of which may have been transferred to China—discussed in Chapter 2). According to a Chinese missile expert, one of the objectives of the just completed series of Chinese nuclear tests was to miniaturize China's nuclear warheads, dropping their weight from 2200 kgs to 700 kgs in order to accommodate the next generation of solid-fueled missile systems.[107] The DF-31 is expected to be ready for deployment around 1998. Once this IRBM is deployed, China will have the capability to use it to strike targets in the northwest corner of the United States from launch sites in Manchuria (see Figure 3-12 and 3-13).

This same missile system will be produced in a naval model that is designated as the JL-2. It also will have a range of 8000 kms. This system will be deployed on 4-6 new Type 094 nuclear submarines (see Figure 3-14) that are expected to begin production between 2003-2005.[108] Each of the Type 094 SSBNs will mount 16 JL-2 ballistic missiles (DF-31s). These new submarines will incorporate extensive amounts of Western and Russian technology. Consequently, they are expected to be

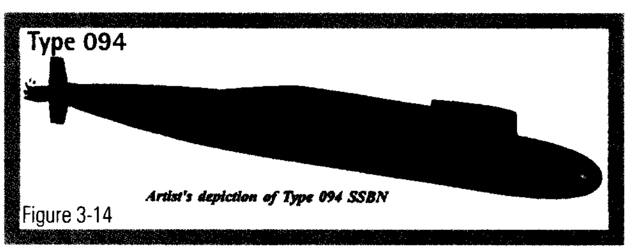


Figure 3-14

dramatically more capable than was the previous generation of Chinese SSBNs (Type 092). When equipped with the JL-2 8000 km-range missiles, the Chinese SSBNs would only have to patrol just to the northeast of the Kuril Islands to hold about three-fourths of the United States at risk.

As a follow on to the DF-31/JL-2 missile system, China is developing the 12,000 km DF-41 mobile ICBM which is expected to be equipped with a MIRVed warhead. For example, one source (a news dispatch from Beijing) claims that new solid-fueled missiles will be equipped with nine individual warheads (9 RVs).[109] However, as the DF-41 will have a throwweight of only 2000 kgs, it does not seem likely that China would be able to mount more than about 3-6 RVs on this ICBM (U.S. *Minuteman* III has 3 RVs and a throwweight of 1100 kgs at 12,900 kms; the MX carries 10 RVs and has a throwweight of 3950 kgs at 11,000 kms). So, if the Beijing dispatch contains any truth, it is likely that either the MIRV for the DF-5A contains 9 RVs or there is another new liquid-fueled system under development.

In pursuit of its objectives to improve its strategic nuclear missile force, China has been trying to acquire the technology for the SS-18 ICBM (a heavy-lift missile that can carry 10-14 RVs with a throwweight of 8800 kgs—2.2 times more throwweight than the MX *Peacekeeper's* and 2.75 times more than China's DF-5A ICBM). It has tried to steal the plans for the SS-18's engine from the Ukraine, and it has tried to buy that technology from both Ukraine and Russia.[110] What has puzzled some Western observers is the fact that China has also expressed interest in buying SS-18 boosters to use in its space program.[111]

Some seem to believe that the SS-18's engines would be incompatible with the sensitive electron-

[105] "China Tested Mobile Missile With Long Range, Japan Says," *The New York Times*, May 31, 1995, p. A3.
[106] International Institute for Strategic Studies, *The Military Balance, 1995/96*, pp. 169-70; and Chang Yi-cheng, "China: Article on China's High, New Military Armament," *Sing Tai Jih Pao*, translated in *FBIS-CHI-97-092*, April 2, 1997.
[107] Private conversation on a nonattribution basis.
[108] Office of U.S. Naval Intelligence, *Worldwide Submarine Challenges*, February 1996, p.27.
[109] "New Nuclear Weapons Said Goal of Current Tests," *Lien Ho Pao*, translated in *FBIS-CHI-95-218*, November 13, 1995, p. 29.
[110] "Ukraine: SBU Safeguarded Missile Design From Chinese Nationals," *Interfax*, in *FBIS-SOV-96-024*, February 2, 1996.
[111] Bill Gertz, "China's Arsenal Gets A Russian Boost," *The Washington Times*, May 20, 1996, p. 1.

ics of many satellite payloads.[112] Unfortunately for this argument, the SS-18's high G-force launch and payload vibration problem can both be adjusted or compensated for in ways that would make this missile capable of launching commercial payloads. Thus, China can claim a legitimate use for SS-18 boosters. Nonetheless, access to the SS-18 could provide China with technological information which could be of significant value in improving China's ICBM capabilities.

In addition to the challenge of improving and expanding their inventory of strategic missiles, the Chinese are very aware of the fact that they must also reduce the radar cross section of their warheads, harden them against electromagnetic pulse (EMP) effects, and improve their capabilities for penetrating missile defenses.[113] The Chinese clearly assume that additional missile defenses will be developed (in addition to Russia's nuclear-tipped defensive missiles around Moscow). Therefore, to facilitate the accomplishment of their national objectives, the Chinese are working to create a larger and more capable nuclear deterrent force, one that is more survivable and is sufficiently lethal to affirm China as an independent world power. In essence, China seeks to provide itself with an effective means of protection against attempts by other great powers and regional hegemonists to dictate rules of behavior to China in the international arena.[114]

Sub-Strategic Ballistic Missile Systems. As noted in the discussion of Chinese doctrinal development, China's assessment of the 1991 Gulf War provided them with a new insights into the potential value of battlefield and theater missile systems. Chinese strategists have concluded that these systems, when equipped with conventional warheads, provide a significant coercive capability when used to strike high-value targets. Reportedly, China has been working to develop a variety of warheads for these systems. In addition to nuclear, warheads that have been specifically cited in news reports include high-explosive, dual-purpose cluster munitions, scatterable mines, electromagnetic pulse (EMP), and deep-penetration warheads for underground fortifications.[115] Although China claims that it does not have CW or BW capabilities, informed sources routinely list China as having those capabilities. If China has BW and CW in its arsenal, it is also likely that China has CW and BW warheads for its sub-strategic missile systems. Its sub-strategic ballistic missile systems include the:

- **DF-21/21A** (CSS-5). This missile was originally developed as the two-stage JL-1. It was designed for deployment aboard China's SSBN. However, as the missile only had a range of 1700 kms, it was decided to also develop it as a land-based missile, which was designed as the DF-21 (first flight May 1985). Its range was later improved to 1800 kms (DF-21A) carrying a 600 kg warhead with a nuclear capability believed to be 200-300 kt. It is a solid-fueled system and launched from a transporter-erector-launcher (TEL) vehicle. It is believed that over 100 DF-21/JL-1 missiles have been built.[116] In addition, some DF-21s have been reconfigured with conventional warheads for use along China's southern and northwestern borders. From those firing locations, the DF-21 can hit targets throughout Northern India, the Republics of Central Asia, and most of Vietnam and Southeast Asia."[117] Work is believed to be ongoing to provide this missile with a sophisticated terminal guidance system.

- **DF-15** (M-9). The DF-15 is a sophisticated solid-fueled, single-stage mobile missile, similar in appearance to the U.S. *Pershing* I-A system, with

112 Ibid.
113 Ibid.; and Kong and McCarthy, "China's Missile Bureaucracy," *op. cit.*, p. 41.
114 Stefashin, "Chinese Nuclear Strategy and National Security," *op. cit.*; and Johnston, "China's Old New Thinking," *op. cit.*
115 Huang Tung, "PRC: PLA Weapons Used in Taiwan Strait Exercises," *Kuang Chiao Ching*, translated in *FBIS-CHI-96-097*, May 17, 1996, p. 28.
116 Norris, Burrows, and Fieldhouse, "Nuclear Weapons Databook, Vol. V," *op. cit.*, p. 388.
117 "National Briefings: China, Missiles in General," Internet, http://www.cdiss.org/chinab.htm, September 27, 1996.
118 Michael A. Dornheim, "DF-15 Sophisticated, Hard to Intercept," *Aviation Week & Space Technology*, March 18, 1996, p. 23.

a reaction-launch time of about 30 minutes. The 9.1 meter DF-15 is expected to be equipped with a variety of warhead types and to become the mainstay of China's sub-strategic missile force. The vertically-launched missile has a range of 200-600 kms, carrying a payload of 500 kgs, with a CEP of about 280 meters. The missile uses a strapdown inertial guidance system on the warhead section which guides the trajectory using small thrusters. The missile body is designed to trail behind the separated warhead and provide camouflage for the warhead (which is only one-tenth of the size of the missile body). The Chinese missile expert Hau Di does not believe the *Patriot,* PAC-2 or PAC-3, can hit the warhead of the DF-15.[118] It is anticipated that in the future the DF-15 will be equipped with a global positioning system that is coordinated with a new-type ring-laser gyroscopic inertial-guidance system, coupled to a faster on-board computer system so as to increase the accuracy of the missile's end-segment guidance system to achieve a CEP of 30-45 meters. As the missile has a terminal velocity of over Mach 6, it is probable that this system is being considered for deep-penetration strike requirements (against underground fortifications).[119] Of the 6-7 missiles fired off the coast of Taiwan in the July 1995 and the 4 others fired in the March 1996 incident, all were DF-15s. There is an unconfirmed report that Israel may have helped China develop the DF-15; ironically the missile may also have been exported to Syria (unconfirmed).[120]

- **DF-11** (M-11/CSS-7). The DF-11 is the Chinese replacement for their *Scud*-series of missiles. It was originally shown at the 1987 Beijing air show as a two-stage missile with 1000 kms range carrying a 500 payload. Due to MTCR considerations, China has exported the system as a single-stage, solid-fueled missile with a range of 120-295 kms carrying a 500 kg (or perhaps 800 kg) warhead.[121] This missile has been exported as the M-11 to Pakistan.[122]

Security of the Nuclear Force. China's 100 or so known ballistic missiles currently fielded are under the control of the PLA's 2d Artillery Corps (believed to be headquartered in the vicinity of Beijing). This corps, an organization that is the Chinese equivalent of the Soviet Union's Strategic Missile Forces, was organized as a strategic missile unit in July 1966. It now consists of 90,000 troops, believed to be organized into a headquarters, an early warning division, a communication regiment, a security regiment, a technical support regiment, and six ballistic missile divisions (each missile division probably averages around 10,000 troops—with some strength fluctuation based on missile types). The 2d Artillery Corps is under the operational control of the general staff, but de facto is often directly controlled by the Central Military Commission.[123] Its six divisions are independently deployed in the main military regions as follows:

- Shenyang Military Region, 2 divisions,
- Beijing Military Region, 1 division,
- Lanzhou Military Region, 2 divisions, and
- Chengdu Military Region, 1 division.[124]

As for China's *Xia*-class (Type 092) SSBN submarines, it is assigned to the 9th Submarine Fleet under the direct jurisdiction of Headquarters, People's Liberation Navy (PLN). In wartime, SSBN

119 Tung, "PRC: PLA Weapons Used in Taiwan Strait Exercises," *op. cit.,* pp. 27-28.

120 "Chinese Missile Sales: A Chronology," *Middle East Defense News,* Proliferation, Vol. 6, No. 15 & 16, May 17, 1993. Reports vary on the number of DF-15 missiles that were fired during these events.

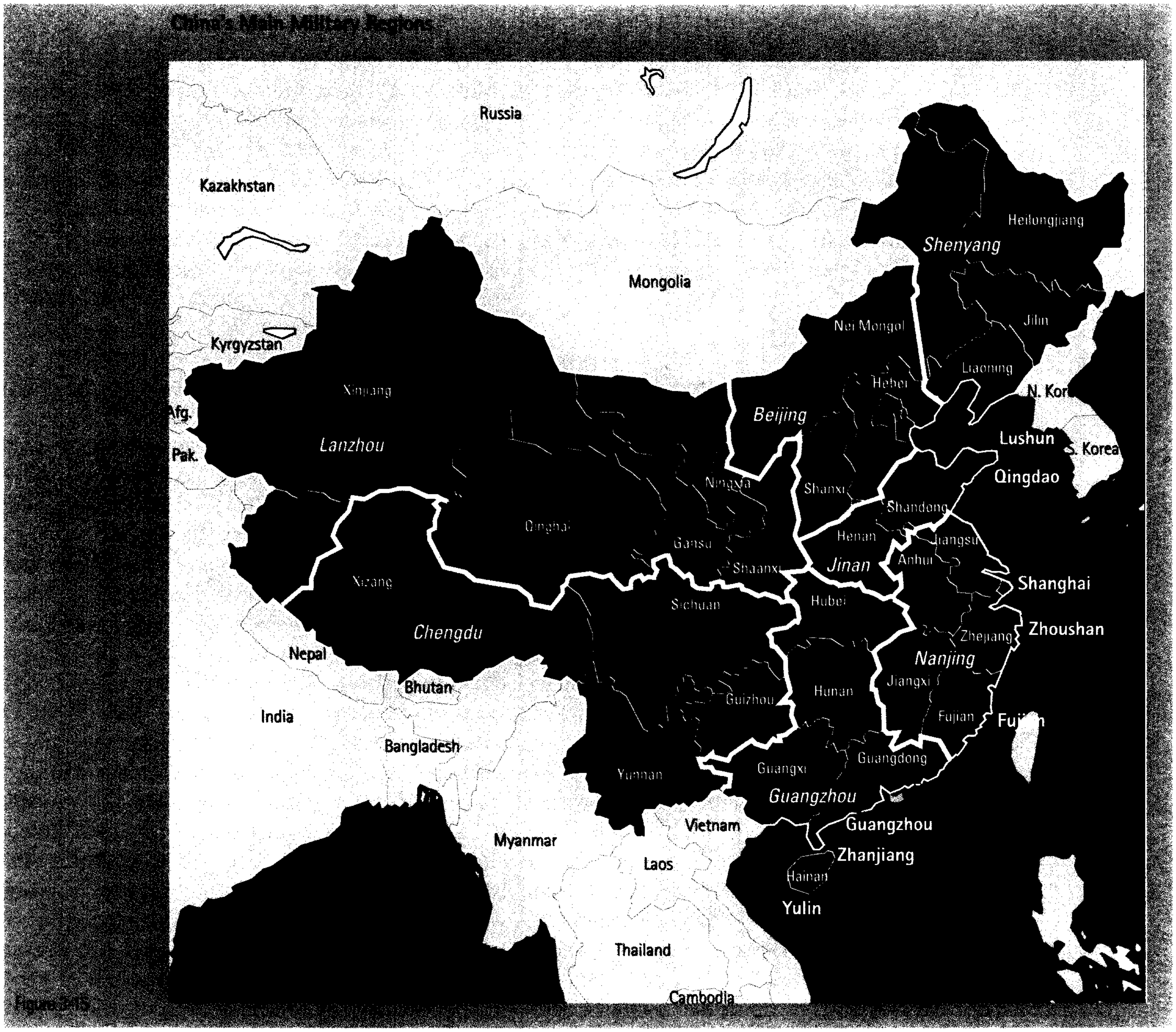
121 Norris, Burrows, and Fieldhouse, "Nuclear Weapons Databook, Vol. V," *op. cit.,* p. 387. There's disagreement regarding the payload capability of the DF-11.

122 "Briefing: Ballistic Missiles," *Jane's Defense Weekly,* April 17, 1996, p. 43.

123 Hisashi Fujii, "PRC: Tokyo Journal PRC Nuclear Forces, 2d Artillery Corps," *Gunji Kenkyu,* translated in *FBIS-CHI-96-036,* February 22, 1996.

124 Ibid.

125 Ibid.



assets would come under the direct control of the Central Military Commission.[125] Its SSBN is deployed with the Northern Fleet.[126]

Unfortunately, little is known regarding China's nuclear command and control system. It is believed that the authority to launch China's nuclear forces resides with the Chairman of the Central Military Commission, a position held by President Jiang Zemin. As of 1986, China's nuclear warheads were not secured by permissive-action-link (PAL) devices.[127] It is not believed that this situation has changed during the intervening years. Although China does not have PAL devices, it does follow a set of procedures that provide Chinese leaders with a lot of confidence that an

126 Ibid.

127 Dan Caldwell, "Permissive Action Links (PAL): A Description and Proposal," *Center for International and Strategic Affairs, University of California, Los Angeles*, Working Paper No. 56, 1986, p. 14.

unauthorized launch would be unlikely (i.e., two man rule, separate storage of warheads, etc.). However, as was the case with the Soviet Union, it is the communist party that maintains control in China. The possibility must be considered that a weakening of the CCP could also mean a weakening of the command and control system that secures China's nuclear forces.

Future Strategic Direction

Nuclear Weapons. China is publicly credited with a nuclear arsenal of 450 weapons composed of 300 strategic warheads and 150 tactical nuclear weapons. These figures are strictly educated guesses. U.S. officials acknowledge that China's nuclear arsenal could be two or three times larger than estimated.[128] It is believed that China could have produced as much as 15 tons of plutonium and up to 60 tons of uranium-235 over the years that they have been pursuing nuclear weapons.[129] The amount of fissile material that China has produced is sufficient to support a higher number of warheads than the 450 that it is credited with having built.

During the fall of 1995, an anonymous source sent a purportedly secret Chinese military document to a Hong Kong magazine, *Dong Xiang* (The Trend). The document showed a Chinese inventory of 2350 nuclear weapons, comprised of 1800 strategic warheads and 550 tactical nuclear weapons.[130] Although the numbers cited by the Hong Kong publication have not been corroborated by other sources and could well be a hoax, the claim has caused Western sources to begin to reexamine China's nuclear capability.[131] In short, regardless of China's current nuclear weapons count, it is clear that China has the capability of expanding its nuclear force to support the requirements of its limited deterrence doctrine. China could probably increase its inventory up to an estimated 3,000 to 5,000 nuclear weapons by 2010 if it so chooses (China's actual nuclear weapon objectives are thought to be less than the numbers cited).

Space. "Chinese strategists are seriously concerned about the need to incorporate space satellites and weapon systems into China's nuclear and conventional operational doctrines."[132] Space is considered to be one of China's strategic frontiers. Strategists are writing about the need to develop anti-satellite (ASAT) capabilities (both space-based and air-launched) to destroy enemy capabilities to direct military operations. In addition, China's military planners see a need to be able to strike space-based ballistic missile defense systems to increase the survivability of China's strategic nuclear forces.[133] These strategists are already thinking of what capabilities China will need. (Note: the strategists' vision of ASAT and space-based missile defense capabilities create tensions with China's official position on arms control which advocates banning ASATs and preventing weaponization of space. There seems to be a growing belief among Chinese strategists that China's official position is outdated.)[134]

128 Norris, Burrows, and Fieldhouse, "Nuclear Weapons Databook, Vol. V," *op. cit.*, p. 358
129 Ibid.
130 Zheng, National University of Singapore, "China's Nuclear Arsenal," *op. cit.*
131 Private conversation with Duncan Lennox, Editor, *Jane's Strategic Weapon Systems*, July 29, 1996.
132 Johnston, "China's New Old Thinking: The Concept of Limited Deterrence," *op. cit.*, p. 24.
133 Ibid., p. 23.
134 Ibid., p. 24, to include footnote 63.

"One plan envisions the creation of a space warfare headquarters" complete with a military-industrial infrastructure to support that capability.[135] Included under this command would be reconnaissance satellites, space stations and bases, satellites and weapon systems for fighting, early warning assets, etc. China's space capability would be designed to break the superpowers' monopoly on space, to protect China's space-based assets, and to intercept a portion of enemy ICBMs and thus reduce the destructiveness of an enemy attack.[136] Although China is many years from being able to achieve this type of space-based capability, it does have a space program that includes astronauts-in-training and plans of putting Chinese astronauts on the moon and conducting an extensive manned space-research program.[137] By 1999 China hopes to conduct its first manned space launch.

Ballistic Missile Defense. Chinese strategists also see a need to establish defenses against ballistic missile attack.[138] In the immediate future, these defenses will take the form of ground-based assets. Toward this end, China has been gradually moving to develop a rudimentary missile defense capability. In 1992, it apparently acquired technology for the U.S. *Patriot* system from Israel,[139] while in 1993 it purchased 100 SA-10B missiles (the Russian equivalent to *Patriot*) and related equipment from Russia. Reportedly, China intends to obtain a license to produce this system.[140] While China has far to go before it will have an effective missile defense system, it seems likely that China will develop such a system in the future.

Missile Defense Penetration Aids. Currently, only some of China's missiles have enhanced capabilities to penetrate missile defense systems. In the mid-1980s, in response to the U.S. strategic defense initiative, Chinese strategists examined the feasibility of using spinning or hardening of warheads to defeat beam weapon systems. They also examined systems capable of baffling enemy ballistic missile defense detection and tracking sensors.[141] According to Russian sources, China has not yet cracked the problem of penetrating missile defense systems, but sees it as a priority for this century.[142] According to *Jane's*, China is focusing its missile defense penetration efforts in the areas of stealth technology, EMP hardening, and other penetrability aids.[143] It is expected that China's next generation of strategic missile systems—the DF-31, the DF-41, and possibly an updated DF-5 system—will incorporate missile defense penetration aids.

New ICBMs. China is very difficult for intelligence agencies to penetrate; therefore, the U.S. must anticipate that some surprises could come out of China. Although it is widely expected that the DF-41 will replace the DF-5A ICBM when it is deployed around 2010, there is reason to be somewhat suspicious of that projection. First, the DF-41 is a 12,000 km missile capable of carrying about 2000 kgs (less than two-thirds of the throwweight at 1000 + kms less range than the DF-5A).[144] While the solid-fueled DF-41 will be mobile, it seems doubtful that China would completely replace its current ICBM force with one with less range and carrying capacity. At the same time, China is clearly working to obtain SS-18 booster technology.

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135 Ibid., pp. 23-24.

136 Ibid., p. 24.

137 "Secrets of China's Space Program Revealed," *Tuanjie Bao,* translated in *FBIS-CHI-95-165,* August 25, 1995, p. 29.

138 Johnston, "China's New Old Thinking: The Concept of Limited Deterrence," *op. cit.*, p. 25.

139 Bill Gertz, "Israelis Face Query On Sales To China: Re-export of U.S. Technology Cited," *The Washington Times,* June 19, 1996, p. 4.

140 Johnston, "China's New Old Thinking: The Concept of Limited Deterrence," *op. cit.*, p. 33; and Tung, "PRC: PLA Weapons Used in Taiwan Strait Exercises," *op. cit.*, p. 32.

141 Johnston, "China's New Old Thinking: The Concept of Limited Deterrence," *op. cit.*, p. 25.

142 Stefashin, "Chinese Nuclear Strategy and National Security," *op. cit.*

143 Kong and McCarthy, "China's Missile Bureaucracy," *op. cit.*, p. 41.

144 "Artillery Rocket, Ballistic Missile, Sounding Rocket, and Space Launch Capabilities of Selected Countries," *The Nonproliferation Review,* Spring/Summer 1996, p. 164.

The preceding assessment begs the question. Does China plan to upgrade the DF-5A system, or could it be planning to develop a new class of ICBMs based on SS-18 technology? If reports of the Great Wall Project should prove to be true, it would seem to be in China's best interest to place heavy-lift ICBMs in that protected environment. Although speculative, it must also be considered that the new 9 RV future warhead described by the earlier-cited Beijing dispatch as being for a solid-fueled missile system may, in fact, be intended for a new liquid-fueled ICBM of the SS-18 class.

If China should field an SS-18 class missile with 9 RVs plus extensive missile defense penetration aids, it would provide China with an impressive capacity to inflect severe damage on the United States with a relatively limited number of missiles. An example of the type of dispersion pattern that could be expected from a 9-RV warhead launched against the United States from a firing point in China is shown in Figure 3-16. The two illustrative MIRV footprint patterns shown reflect best- and worst-case delivery requirements. Regardless of the exact status of China's current MIRV program, it is clear that China's near-term ICBM force will be equipped with warheads likely to contain up to 6 (and perhaps 9) independently targeted re-entry vehicles. With this one action, China will increase its capabilities of attacking the United States by 6-9 fold. Thus, if China's current intercontinental capability is a 20-missile strike (which, as discussed, may be a low figure), that number could deliver 120-180 warheads if the entire DF-5 missile force were to be MIRVed by the year 2000. As China moves toward 2010, its capability to target the United States will increase substantially. Only time will reveal China's full intentions on this issue.

MIRV Footprints, Best & Worst Case
(9 RVs each -- launched from China)

Figure 3-16

China's Technology Transfer Potential

Official Activity. During the late 1980s, China was able to sell about $3 billion of arms a year to overseas customers. Much of its success was due to the demand of the Iran-Iraq war for munitions and other low-technology armaments. The termination of the Iran-Iraq War, the end of the Cold War, and the high-technology weapons demonstration of Operation *Desert Storm* all acted together to lower the demand for China's low-technology weaponry. In 1995, China only gained orders for about $200 million worth of armaments,[145] a level that is only one-fifteenth of its 1988 level. This drop in sales has been difficult for

[145] "Arms Transfer Agreements With the World by Supplier, 1988-1995," *Arms Trade News*, August/September 1996, p. 4.

China's defense industrial complex. China, like other weapon producers, needs to sell arms as a way of generating higher economies of scale, thus helping to subsidize some costs associated with running an indigenous defense industry. This has been even more important for the Chinese military in that much of its modernization plans are dependent on funding from profits generated from China's defense industrial sector (which also produces and sells many commercial goods and services).

Unfortunately for those concerned with proliferation, China's export control office is under the jurisdiction of the Ministry of National Defense,[146] which has a vested interest in maximizing arms sales. Given the lack of demand for low-technology armaments, the Chinese only have a few weapon systems that are in demand, with the biggest demand being for missile systems. At the same time, a majority of Chinese officials do not have any philosophical problems with selling missile technology. The Western argument that missiles can be used to deliver WMD weapon systems is countered by the Chinese argument that aircraft can also be used to deliver those weapons of mass destruction, but the West still sells a lot of aircraft to countries that are potential adversaries of China.[147] Of course, to the Chinese, with their limited early warning capabilities and inadequate air defense system, advanced aircraft potentially are as dangerous to them as ballistic missiles are to the developed world.

The Chinese also point out that the Missile Technology Control Regime (MTCR) is not an international treaty, nor is China a member-state of the MTCR. However, China did pledge to abide by MTCR guidelines on February 23, 1992, and later signed an agreement with the United States on October 4, 1994, in which it agreed not to export missiles having a range of more than 300 km while carrying a payload of more than 500 kgs. In return, the United States lifted the economic sanctions that it had imposed on China for violating MTCR guidelines.[148] Unfortunately, most Chinese officials are unhappy with the situation and view it as an imposed agreement. (Chinese officials undoubtedly find the U.S.-China agreement too similar for comfort to the agreements that were imposed on China by Western powers during the last century.) In short, China does not feel any real moral obligation to abide by any regime that it did not help create. Consequently, official efforts to ensure compliance with the MTCR are likely to be lukewarm at best.

The Role of Corruption. As was the case in Russia, China's brand of communism is also rife with corruption. As one Westerner who works in China noted, the corruption goes from top to bottom; there is no escape from it. Corruption is almost as deeply rooted in China's arms trade as it is in Russia's. The difference between the two systems was aptly put by one U.S. defense industrialist who noted, "We have a saying in the international defense industry: Russia has a lot of rules, but no control; China has a lot of control, but no rules." Russia now has a nominal rule of law, but poor enforcement conditions. China does not have a rule of law. The law is the CCP, which also provides the control organ. In China, this situation has given rise to a new class of entrepreneurs, the so-called "Red Princes."

The Red Princes are the sons and daughters of high-ranking party officials. They often sit on the boards of key industries, including the defense industries. In return for substantial commissions (i.e., perhaps 10 percent of the sale value), these

146 See arms control decionsmaking organizational chart by Wendy Frieman, "New Members of the Club: Chinese Participation in Arms Control Regimes 1980-95," *The Nonproliferation Review,* Spring/Summer 1996, p. 17.

147 Liu Huaqiu, "Analysis of Arms Control Policy," *Xiandai Junshi,* translated in *FBIS-CHI-95-246,* December 22, 1995, p. 10.

148 Ibid., p. 9.

elite entrepreneurs will peddle their influence to cut through bureaucratic red tape, to include arranging for products to be allowed through customs.[149] (In a country ruled by the party, it would require a very brave customs official to question an export order sponsored by a person whose parent was a powerful member of the CCP's Central Committee or the Central Military Commission.) Unfortunately, the sharp drop in military arms sales since 1988 has undoubtedly put more pressure on the system to allow the export of sensitive items. (No sales would mean no commissions for the leading families.)

Similarly, most lesser officials and many senior military officers are involved in corrupt activities that include bribery, kickbacks, and illicit sale of goods and services. This situation is complicated by the loss of central control that has gradually developed since the Chinese liberalized their economic system under Deng. As the provinces have gained more autonomy, they have also become less answerable to the center. Consequently, Beijing has less control over economic activity and exports than it had prior to liberalization.

Complicating the issue are the Six Great Triads that have existed in China for centuries. Five of these Triads had been headquartered in Hong Kong and Taiwan, but apparently are now moving to Shanghai, setting up operations in the same city where the headquarters of the sixth group, the Great Circle Triad, is located. The Triads have over 100,000 members, operate very secretively, have existed for centuries, are deeply rooted in Chinese society, and are represented in every Chinese ethnic community. In addition to the usual list of criminal activities, they are engaged in arms trafficking. While the amount of influence these groups have had on past Chinese proliferation activities is unknown, there is fear that China may also be in the process of developing a cooperative arrangement among the police-government-organized crime groups such as currently plagues Russia.[150]

The combination of these three elements, listed above, do not bode well for controlling China's future arms sales. There are too many factions in China that stand to benefit from the sale of arms. Worse, the only Chinese armaments for which there is likely to be a demand in the near future are missiles, weapons of mass destruction, future missile defense penetration aids, and some small arms and similar equipment. Consequently, the United States should anticipate a continuing problem with China in regard to the sale of sensitive technologies to developing countries.

Proliferation: Weighing China's Apparent Contributions

It is often difficult to determine if China's international transfers of sensitive military technologies are a result of an officially agreed-upon policy, an uncoordinated military decision, or an unsanctioned transfer coordinated by some Red Prince or party official acting outside of official channels. At the same time, the Chinese Triads also interject an organized criminal element that is difficult to predict. Regardless of reason or origin, China has provided a number of developing countries (particularly Pakistan, Iran, and Syria) with the technology and assistance that will help them in

[149] Patrick E. Tyler, "China's First Family Comes Under Growing Scrutiny," *The New York Times,* June 2, 1996, p. A3.

[150] Brian Sullivan, "International Organized Crime: A Growing National Security Threat," *Institute for National Security Studies Strategic Forum,* Number 74, May 1996, p. 3.

their efforts to develop missile-delivered WMD capabilities. Some examples, based on open source reports, illustrates this issue.

Pakistan. China has been a primary supplier of technology, equipment components, and technical advisors for Pakistan's nuclear and missile programs. For example, around 1982 China provided Pakistan with a 1966 design of a tested 25 kt nuclear weapon and enough fissile material for one or two nuclear devices.[151] (The nuclear weapon design is believed to have been leaked to Iraq.)[152] It also reportedly agreed to provide tritium gas (used for boosting fissile weapons) in the late 1980s and to help construct a nuclear power station in spite of a de facto international embargo on nuclear assistance.[153] In the mid-1990s, China transferred to Pakistan 5,000 ring magnets used in gas centrifuge systems for uranium enrichment and, reportedly, in August-September 1996 sold Pakistan some special vacuum furnaces (useful for melting fissile material in order to shape it for nuclear weapon cores as well as working titanium for missile nose cones). Other high technology diagnostic equipment was also included in this transfer.[154] In like manner, it is also believed that China has provided Pakistan with uranium-238 for enrichment and that Chinese scientists may technically check Pakistani nuclear weapon designs (i.e., a quality control check).[155]

As for missile systems, China helped Pakistan build its *Hatf* I and *Hatf* II missiles, transferred M-11 ballistic missiles to Pakistan, sold it bulk quantities of solid-fuel missile propellants, and provided it with M-11 missile components.[156] While not all of these actions violate the MTCR guidelines, China's actions contribute to the development of Pakistan's missile technology base.

Iran. Iran made a decision in 1985 to pursue the development of nuclear weapons.[157] China has provided Iran with some assistance in this endeavor (since Iran is a member state of the Nuclear Nonproliferation Treaty, much of this assistance is allowable). The alleged assistance includes:

- Trained Iranian nuclear technicians in China;
- Supplied a miniature subcritical nuclear facility;
- Provided Iran with tributylphosphate (useful in plutonium extraction);
- Transferred a calutron and a copper-vapor laser that could be used for uranium enrichment research;
- Contracted to sell 25-30 MW research reactor;
- Contracted to sell 300 MW reactor; and
- Has begun construction of a safeguarded uranium hexafloride plant (contributes to nuclear fuel-cycle development).[158]

As for assistance in missile development, there are reports that China provided Iran with:

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151 "Can the U.S. Rely On China's Export Promises?" *Risk,* May 1996, p. 8; and Leonard Spector, Carnegie Endowment for International Peace, presentation at a workshop on *Post-Cold War Arm Control and Nonproliferation: A Challenge from China?,* sponsored by the Chemical and Biological Arms Control Institute, held at the Carnegie Endowment for International Peace, Washington, DC, February 29, 1996.

152 "Can the U.S. Rely On China's Export Promises?," *Risk,* May 1996, pp. 8-9.

153 "Can the U.S. Rely On China's Export Promises?" *Risk,* May 1996, p. 9.

154 Bill Gertz, "Beijing Flouts Nuke-Sales Ban," *The Washington Times,* October 9, 1996, p. A1, A9.

155 Bates Gill, SIPRI, presentation at a workshop on *Post-Cold War Arm Control and Nonproliferation: A Challenge from China?,* sponsored by the Chemical and Biological Arms Control Institute, held at the Carnegie Endowment for International Peace, Washington, DC, February 29, 1996.

156 "Can the U.S. Rely On China's Export Promises?" *Risk,* May 1996, p. 9; "See No Evil," *Far Eastern Economic Review,* August 10, 1996, p. 20; "Chinese Missile Sales: A Chronology," *Middle East Defense News,* Section: Proliferation, Vol. 6, No. 15 & 16, May 17, 1993; and Gertz, "Beijing Flouts Nuke-Sales Ban," *op. cit.*

157 Statement made by a U.S. State Department official under rules of nonattribution, May 20, 1995.

158 "Can the U.S. Rely On China's Export Promises?" *Risk,* May 1996, p. 9; and Bill Gertz, "Iran Gets China's Help On Nuclear Arms," *The Washington Post,* April 17, 1996, p. 1.

- Help in building a missile plant at Semnan in 1989;
- Assistance in building the Semnan launch and missile test range in 1990;
- 50 short-range missiles in 1990;
- Technical assistance in two 1991 missile tests at Semnan; the two missiles tested had ranges of 700 kms and 1000 kms respectively;
- Help in building a *Silkworm* and M9 plant near Isfahan;
- *Silkworm* anti-ship cruise missiles in 1992;
- 20 CSS-8 ballistic missiles in 1994 (150 km range missile carrying a 190 kg warhead—not a violation of the MTCR);
- Hundreds of missile guidance systems and computerized machine tools, 1994-95; and
- A supply of rocket propellant ingredients, 1995.[159]

In addition, it should be noted that China apparently has been helping Iran develop chemical weapons. Between 1993 and 1996, there have been several reports that China was providing precursor agents to Iran, probably for the development of nerve and mustard agents, along with technical assistance on chemical weapon development.[160] Worse, China is also suspected by U.S. intelligence sources of selling Iran a complete chemical weapons factory.[161]

Syria. In the nuclear area, the relationship between Syria and China is still at an embryonic stage. Syria is shopping for Chinese nuclear reactors, and China has said that it will train Syrian nuclear technicians. (As long as safeguards are agreed to, this is not an NPT violation.) However, in the missile arena, China is believed to have provided Syria with a significant amount of assistance. Reports include:

- M9 missiles reportedly were tracked to Syria, June 1991. There was a subsequent report that a foreign intelligence source sighted 24 M9 missile launchers in Syria on August 22, 1991(unconfirmed–there is considerable debate on this point. Others claim China cancelled the M9 sale);

- A Chinese team may have helped Syria build a missile manufacturing plant for missile production in 1992 (unconfirmed);
- Chinese specialists are said to be working in Syrian factories in Hama and Aleppo to produce missile guidance systems (1992); and
- China sold Syria the ingredients for missile fuel.[162]

Others. In addition to the assistance noted above, China has sold DF-3 (CSS-2) missiles to Saudi Arabia, helped Algeria begin a secret nuclear program, and assisted Iraq in obtaining nuclear components and missile fuel ingredients.[163] In essence, China has demonstrated that it is not averse to selling sensitive technologies in its pursuit of arms sales or in support of its national objectives.

159 "Can the U.S. Rely On China's Export Promises?" *Risk,* May 1996, p. 9; Latter, "Ballistic Missile Proliferation in the Developing World," *op. cit.,* p. 76; "Chinese Missile Sales: A Chronology,", *op. cit.;* and Elaine Sciolino, "CIA Report Says Chinese Sent Iran Arms Components," *The New York Times,* June 22, 1995, p. A1.

160 "Can the U.S. Rely On China's Export Promises?" *Risk,* May 1996, pp. 1, 11; and "Foreign Ministry Denies PRC Chemical Warfare Aid," *Tehran Times,* transcribed in *FBIS-NES- 95-218,* November 13, 1995, p. 83.

161 Gertz, "Beijing Flouts Nuke-Sales Ban," *op. cit.,* p. A1, A9.

162 "Can the U.S. Rely On China's Export Promises?" *Risk,* May 1996, p. 9; and Elaine Sciolino, "CIA Report Says Chinese Sent Iran Arms Components," *The New York Times,* June 22, 1995, p. A1.

163 "Can the U.S. Rely On China's Export Promises?" *Risk,* May 1996, p. 9.

Conclusions

The future of East Asia is marked by a high degree of uncertainty. Within this environment, it would appear that the odds are very high that East Asia will move toward a structure dominated by five powers: China, Japan, Korea, Russia, and the United States. While the nonproliferation battle must and will be fought, it would seem that there is a high probability that in the end each of the five powers cited will have ballistic missile capabilities, weapons of mass destruction, and sophisticated conventional systems. In short, the United States should work for success, but also plan for the possibility that it will lose the nonproliferation battle in East Asia. (Unfortunately, if the nonproliferation battle is lost, it is likely that other regions may also follow the example of East Asia.)

As the power structure reshapes in East Asia, Korea is likely to stake-out a more independent role in regional affairs than it has it the past, but with a tendency to align with China on contentious regional issues, especially on issues involving Japan. For the foreseeable future, Russia is likely to try to remain friendly with China and Korea in an attempt to reduce its vulnerabilities in East Asia, while Japan, on the other hand, probably will try to remain aligned with the United States, which could put the U.S. at odds with the other three major players in the region.

As for the United States, it will continue to have difficulties dealing with China. Although China is pragmatic and has an interest in avoiding confrontation with the United States, it will not react well to public pressure, which will likely result in a series of confrontational situations between the two states. This tendency toward confrontational politics could well increase. As China grows in power, it will also demand larger regional and global roles which may often conflict with U.S. national interests. This conflict is likely to be further fueled by the unfortunate likelihood that China's internal political weaknesses, corruption, incentives for arms sales, and lack of salable nonsensitive military technologies will all continue to result in the transfer of missile and WMD technologies to states that stand in opposition to U.S. goals and objectives. This situation will ensure that U.S.-PRC relations are often strained.

As the 21st century unfolds, China's strategic deterrent posture will improve significantly. Unfortunately, China does not view nuclear weapons as being unusable. It does, however, hope to be able to create nuclear firebreaks in its military planning so that local battles can be contained without escalating them to the strategic level. This means that China would likely use its tactical capabilities in local wars, to include WMD if it should prove necessary, and then threaten the use of strategic forces if the conflict begins to escalate. Thus, if the United States should find itself in a future military confrontation with China, it should not assume that China will back down.

The Chinese see themselves as a tough race that can withstand more punishment than can the West. However, in an attempt to control the escalation of a confrontation, China envisions the development of some missile defense capabilities so as to be able to limit damage from a small nuclear strike, thus forcing any confrontation to a point that would require an overwhelming nuclear exchange and thus entail a high level of risk, which, presumably, would constitute an unacceptable level of risk for the other nuclear powers. In this respect, it should be remembered that the Chinese will try to avoid becoming engaged in a conflict that they do not believe is winnable, but if conflict is unavoidable, they are likely to prove implacable.

In addition, the possibility of political instability in China, coupled with a lack of PAL devices on China's nuclear systems, introduces the possibility of a future accidental or unauthorized limited nuclear strike against the United States. As was shown in the range-fan charts, China has the capability of striking the entire country. It is also expected that if a U.S.-PRC conflict occurred around 2010, China will be able to attack the United States with a strike consisting of several hundred or so nuclear warheads. Much of China's strategic forces may well be physically protected from preemptive attack; thus, China should be expected to maintain a secure second-strike capability. Moreover, its future missile systems will undoubtedly employ penetration aids (penaids) that may allow them to evade first-generation missile defense systems. China's role in the proliferation of sensitive technologies indicate that the United States should also expect penaid technology to proliferate along with missile and WMD technologies.

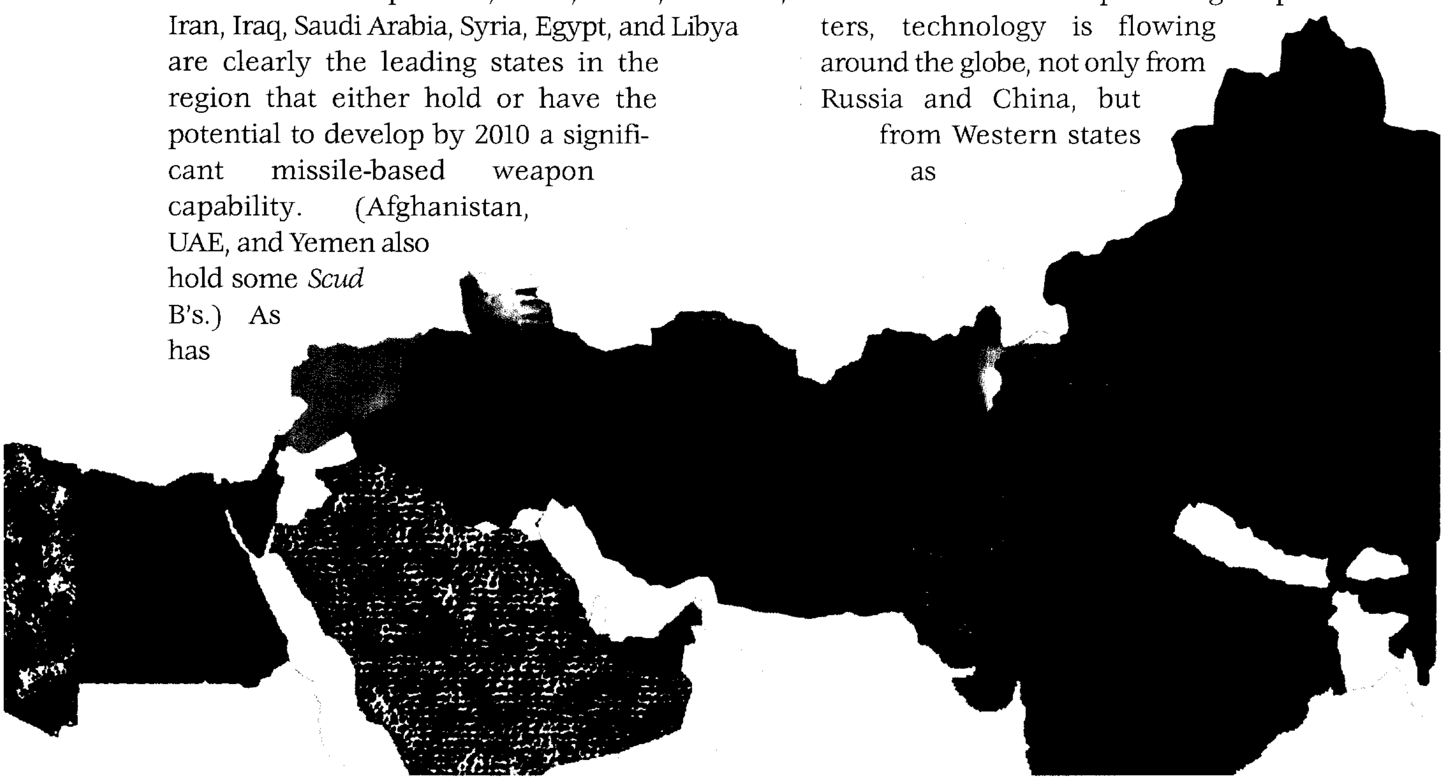
In short, the situation in East Asia points toward a future in which missile and WMD capabilities will become increasingly common and of growing importance for the security of the region. The issues that will have to be addressed will include the changes brought about by improved missile quality as well as the increased quantity of available systems. In addition, early warning requirements, missile defenses, and space warfare issues will all likely become key issues of concern as states increasingly turn to the strategic frontiers of space in an effort to deal with the realities of the revolution in military affairs.

FROM INDIA TO NORTH AFRICA:

SOWING A MISSILE CROP

Across the Southern edge of Asia and along the Northern tier of African states, missile capabilities are proliferating. Some of the states involved in this proliferation are currently considered friendly to the United States, others claim to be nonaligned, and three or four are considered hostile. Unfortunately, as time passes, the political alignment of these states could well change. At this point in time, it is impossible to predict with certainty how these changes will affect future U.S. security interests.

Within the area specified, India, Israel, Pakistan, Iran, Iraq, Saudi Arabia, Syria, Egypt, and Libya are clearly the leading states in the region that either hold or have the potential to develop by 2010 a significant missile-based weapon capability. (Afghanistan, UAE, and Yemen also hold some *Scud* B's.) As has been discussed in the preceding chapters, technology is flowing around the globe, not only from Russia and China, but from Western states as



well. This unprecedented flow of knowledge across state borders makes projecting a definitive trend line for the rate of future missile developments highly problematic. The amount and type of foreign assistance that will be provided to any or all of these states is also an incalculable variable.

Of the states cited, Israel clearly has the most advanced capabilities across the broadest spectrum of missile technologies. Its *Jericho* I and *Jericho* II missiles are known entities. In addition, Israel has developed a limited space-launch capability, a satellite production industry, a theater missile defense system (*Arrow*), and is using its access to both U.S. and Russian scientific expertise to help bolster its overall missile technology base. There is no doubt that Israel could field an ICBM capability by 2010 if it should so choose. Israel's *Jericho* system, and any future long-range missile systems that it may deploy, clearly will function as nuclear delivery assets since it is an open secret that Israel is an undeclared nuclear power. Indeed, much of the resentment felt in many countries regarding U.S. policies on MTCR adherence and on nuclear nonproliferation is rooted in Israel's immunity from U.S. censure for engaging in the sort of activities that earns other states U.S. condemnation.

Of the other states under consideration in this chapter, India is the nation that has the greatest potential of achieving great power status. It has the size, population, technical potential, and desire to emerge as a major player in the international system during the first half of the 21st century. As such, it will be the primary state considered in this chapter. The other states cited will be briefly reviewed; however, as much of the flow of technology to Pakistan, Iran, Iraq, and Syria has already been discussed in the previous chapters, briefer summations of these states will be offered.

India: Great Hopes, Limited Means—A Surprise In The Offing?

Introduction. India is a country troubled by internal dissent and separatist movements, marked by violent class and religious rivalries, over-regulated by a stifling bureaucracy, sensitive to perceived "color" discrimination, and resentful of its 300-year history as a colonized nation. Its sensitivities and resentments are exacerbated by its lack of international stature (as demonstrated by its inability to gain a permanent seat on the U.N. Security Council and the rejection of its bid to join ASEAN). As one of the world's oldest civilizations, comprised of the world's second largest population, India has long believed that it is entitled to global status with a major voice in international affairs. However, Indians typically complain, "We are a country of over 900 million people, but no one pays any attention to us!" Taken together, these factors have helped to shape India's national identity and to influence its national security policies.

As it looks to the future, many Indian strategists believe that the West has proven itself unprepared to deal with Asia's problems, that the international system as it has evolved is incapable of dealing with the challenges of a potential conflict in Asia.[1] They are also convinced that the world will develop into a multipolar security structure during the 21st century, thereby giving India an opportunity to claim its rightful place in international affairs and emerge as a major regional and international power.[2]

International recognition, Indian leaders have come to realize, will require more than just having a large population. As India's foreign minister noted in an address to the Royal Institute of

[1] K. P. Nayar, "Article Views U.S. Nuclear Apartheid Policy," *Indian Express*, transcribed in *FBIS-NES-95-244*, December 20, 1995, pp. 61-62. Reportedly, the inner circle of the Prime Minister Rao's office had adopted that viewpoint.

[2] J. Mohan Malik, "India Copes With the Kremlin's Fall," *Orbis*, Winter 1993, p. 87.

International Affairs on November 22, 1995, population cannot be the criterion of entry into any grouping—economic strength, military power, and definitive stands are.[3] Indian policymakers believe that India should have a role to play in the Central Asian Republics, Afghanistan, the Middle East, and Southeast Asia, expanding its influence in a centrifugal manner, expanding out from being a credible regional player to seeking a place on the world stage.[4]

India holds a major advantage over other states with similar goals. It has no regional rivals in South Asia that could challenge its emergence as a regional hegemon. For example, China is located in a region containing four other major powers (Russia, Japan, the United States, and Korea) that will contest any attempt on China's part to establish hegemonic domination. For India, there are no other states in Southern Asia that could challenge effectively Indian hegemony if India attains its goal of becoming a self-sufficient military power.

Although Indo-Chinese relations have improved since 1987, India still suspects China of being the country most likely to challenge its efforts to emerge as a regional power. Even so, it would be difficult for China to challenge India. While India and China share a 3500 km boundary (referred to as the "line of actual control"),[5] the obstacles involved in traversing the Himalayan Mountains make it difficult for these two nations to conduct large-scale warfare against each other by conventional means. It is more likely that any major military conflict between these two states would primarily involve punitive actions using aircraft, missile, and naval forces, coupled with limited border incursions. Thus, for India, missiles and naval forces represent key elements of its future security strategy vis-à-vis China.

As its strategists review India's national aspirations and the country's security situation, they occasionally express a vague irritation over the very existence of Pakistan as a separate nation. They recognize that if the British had not partitioned the country when it granted independence, India today would stretch from the Gulf of Oman to Burma, control the entire northern coastline of the Bay of Bengal, and encompass a population that is greater than even China's. It is clear that if the predominantly Muslim territories of East and West Pakistan (renamed Bangladesh and Pakistan) had not been carved out of British India, India would now be well positioned to gain access to Central Asia, perhaps to obtain oil supplies via a pipeline from Iran or across Afghanistan, and to focus its military efforts on balancing China and increasing India's role in Southern Asia without the distraction of containing Pakistan.

Nevertheless, Pakistan exists and India is forced to contend with it. Since independence was declared in 1947, India and Pakistan have fought three wars, conducted hundreds of other skirmishes and artillery exchanges, and supported separatist movements in each other's countries. As such, Pakistan is seen as being India's most immediate security concern, a concern that holds the possibility for nuclear conflict. Nevertheless, in the broader strategic context, China is still viewed as India's major competitor.[6]

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3 Pravin Sawhney, "Article Calls for Second Nuclear Test," *The Asian Age,* transcribed in *FBIS-NES-95-246,* December 22, 1995, p. 37.

4 Ibid.

5 For a detailed history of the boundary disputes between India and China, see Francis Watson, *The Frontiers of China: A Historical Guide* (New York: Frederick A. Praeger, Inc., 1966). It appears that India and China may be settling this dispute if the November 1996 agreement between the leaders of these two countries to resolve the issue bears fruit.

6 National Security Planning Associates, *International Conference Report: Dealing With the Spread of Nuclear Weapons,* The Hague, The Netherlands, May 19-20, 1995, pp. 5-7.

With regard to the United States, most Indian policymakers desire stronger relations with that country. This desire is evidenced by the fact that since the end of the Cold War Indo-American relations have warmed considerably. Yet, this warming has also had its chilly periods. Issues such as India's nuclear test ban stance, missile development, nuclear status, and other like issues frequently strain relations between these states, leading to a flurry of articles in the Indian press about America's "bullying behavior."[7] Adding to the air of uncertainty is the gradual re-emergence of Russia as a player in southern Asia, along with the warming of Indo-Iranian relations and the growing role of China in the region.

Thus, the emerging situation has once again provided India with some new avenues to explore as it tries to balance its competing national interests. One concept that is occasionally voiced is the idea that Russia, India, and China should explore the possibility of forming a triple entente as a check on U.S. power.[8] In essence, this is an echo of the same idea being voiced by some Russian and Iranian strategic thinkers, but with the addition of Iran to the formulation. Although the future course of Indo-American relations is still to be determined, the evidence indicates that India hopes for better relations with the United States, but also wants to be able to deter United States intervention in India's affairs if it should ever prove necessary. Indian thinkers are also very conscious of the history of Chinese-American relations. The United States changed its behavior toward China only after that state developed a strategic nuclear capability. They believe that model should be viewed as a lesson for India.

India's Apparent National Objectives

In simple terms, India's apparent national objectives are to develop its economy, to maintain its security (to include preventing national fragmentation), and to achieve regional and international recognition and influence commensurate with its size and population. The attainment of these objectives are identified in a number of specific goals that are assessed to include the following:

1. **Continue to develop and broaden its economic potential.**

India has a two-tiered economy. A minority of its population (150-175 million) is participating in the developing Indian economy that is generating an economic middle-class (primarily composed of upper-caste Hindus some Muslims who live in economically advancing urban areas), while the majority of its population remains locked in grinding poverty. In its efforts to develop its economy, India has put a significant amount of emphasis on developing a self-sufficient economic base. Toward this end, India has, until recently, restricted foreign investment and engaged in highly protectionistic economic practices.

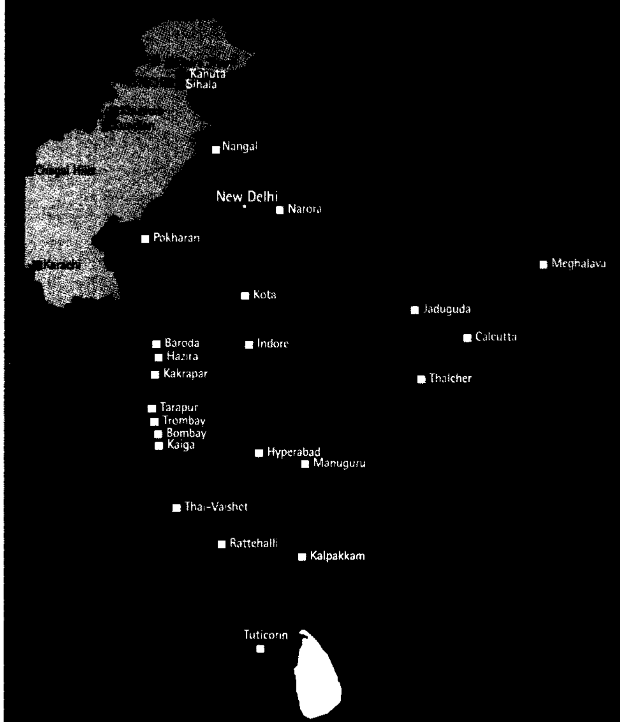
This situation began to change in July 1991 when, under the leadership of then-Prime Minister Rao, India began to reform its economic policies and open its domestic markets in an attempt to achieve the high economic growth rates needed to develop its potential. As a result, India has attracted some foreign investment and has allowed foreign firms to establish facilities in India. Overall, the economic effect of this policy change has been positive, but less positive than had been hoped.

7 For a good example see Amulya Granguli, "Article Criticizes U.S. for Authoritarianism," *Indian Express,* transcribed in *FBIS-NES-95-250,* December 29, 1995, p. 54.

8 Hiranmay Karlekar, "Article Views Ties With PRC, U.S. Design," *Indian Express,* transcribed in *FBIS-NES-95-250,* December 29, 1995, pp. 52-54. The key issue for such a consortium of powers would be the Indo-Chinese axis. It is questionable that if two states could long cooperate together.

India's nuclear infrastructure

Figure 4-1



Kota	220 MW PHWR-safeguarded; 220 MW PHWR-safeguarded; 235 MW PHWR (under construction)-unsafeguarded; 235 MW PHWR (under construction)-unsafeguarded; heavy water production facility-unsafeguarded
Pokharan	Nuclear test site
Baroda, Hazira, Thai-Vaishet, Tuticorin	Heavy water production plants-unsafeguarded
Kakrapar, Narora	235 MW PHWR-unsafeguarded; 235 MW PHWR-unsafeguarded
Tarapur	Two 160 MW BWRs-safeguarded; two 500 MW PHWRs (under construction)-unsafeguarded; Prefer reprocessing facility-unsafeguarded; fuel fabrication facility-unsafeguarded
Trombay	Bhabha Atomic Research Center (BARC): 1 MW research reactor-unsafeguarded; 40 MW research reactor-unsafeguarded; 30 KW research reactor-unsafeguarded; 100 MW research reactor-unsafeguarded; reprocessing facility-unsafeguarded; pilot-scale uranium enrichment plant-unsafeguarded; uranium conversion facility (UF6)-unsafeguarded; fuel fabrication facility-unsafeguarded; zirconium production pilot-plant; heavy water pilot-plant-unsafeguarded
Bombay	Tata Institute of Fundamental Research
Indore	Center for Advanced Technology: laser development site
Hyperabad	Nuclear fuel Complex: uranium purification site (UO2)-unsafeguarded; fuel fabrication facility-unsafeguarded
Kalpakkam	235 MW PHWR-unsafeguarded; 235 MW PHWR-unsafeguarded; Indira Gandi Center for Atomic Research (IGCAR); 50 MW FBR-unsafeguarded; reprocessing plant-unsafeguarded; reprocessing facility-unsafeguarded; Reactor Research Center; 30 KW research reactor-unsafeguarded
Kaiga	235 MW PHWR (under construction)-unsafeguarded; 235 MW PHWR-unsafeguarded
Rattehalli	Uranium enrichment plant-unsafeguarded
Nangal, Thalcher, Manuguru	Heavy water production facilities-unsafeguarded
Meghalaya	Uranium mine and deposits
Calcutta	Saha Institute of Nuclear Physics
Jaduguda	Uranium mining and milling site

Extracted from Nonproliferation Review, Spring/Summer 1996

The primary brake still dragging on India's rate of economic growth is its overly high tariffs and stifling bureaucracy, a bureaucracy that is able to smother in red tape all but the most stalwart of investors. However, India has some capabilities that make the hassle worthwhile.

From a technological perspective, India has tremendous potential for development. In terms of quantity, India has one of the world's largest scientific talent pools, weighing in at an estimated 3.8 million people.[3] Of these, only about three-fourths of them are employed in technical or scientific jobs at any one time, leaving India with a reserve pool

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[3] Mukul G. Asher and Ramkishen, "India and Singapore," *Asian Survey*, Vol. XXXV, No. 10, October 1995, p. 902.

of trained manpower for future growth. Qualitatively, India's best scientists are a match for the best anywhere.[10] As a result, foreign multinationals have begun to set up R&D laboratories in India to capitalize on India's competitive advantage in engineering services and natural sciences.[11]

Similarly, one of India's major technological strengths is software development. As of 1994, India had over 250 software development firms, plus another 350 startup organizations.[12] Of India's software production, half of it is exported, with the United States accounting for 58 percent of the software exports.[13] Since software can be written in India at perhaps one-tenth of the cost of software production in the United States, India is rapidly becoming one of the software capitals of the world as it enjoys a significant competitive advantage in this sector.

Likewise, India has worked to develop and apply its technological potential to solving its energy challenge. Clearly, if India is to achieve its economic potential, it must develop abundant sources of energy for its economy. The current situation that includes frequent electrical black-outs must be remedied. Moreover, by the middle of the 21st century, it is estimated that India will have to increase its electrical-generation capacity by 300,000 MWs (the equivalent of 1000 nuclear reactors of the 300 MW class).[14] Toward this end, India began commercial operation of two U.S.-built light water reactors at Tarapur in 1969. These two 160 MW reactors are the only civil reactors in India that require low-enriched uranium fuel. All of its other commercial reactors use natural uranium fuel (U-238) and heavy water (deuterium), both of which India produces indigenously. As a result, India does not yet have large-scale uranium enrichment facilities and must buy low-enriched uranium to fuel its two light-water reactors.

France had been providing the needed low-enriched fuel each of two reactors. However, when that contract came up for renewal, the U.S. coordinated with potential suppliers to make a common demand that India accept comprehensive full-scope nuclear safeguards as a condition of sale, safeguards which would have included India's entire nuclear industry.[15] China came to India's rescue and is now supplying the needed fuel under IAEA safeguard that includes only the two reactors involved. It seems probable that if China had not come to its aid, India might have temporarily shut down those reactors until it could have manufactured for itself the fuel needed rather than accept comprehensive full-scope safeguards. As it turned out, China's gesture has helped ease tensions between the two states.

To help meet its current and future electrical needs, India now operates 10 nuclear power reactors (Figure 4-2) and has an additional six research reactors.[16] It currently employs about 20,000 scientists and technical people at 16 sites in its nearly self-sufficient nuclear industry (figures include those working on military programs). As it looks to its long-term energy requirements, India has adopted a three-phased nuclear power program to meet its future power requirements.

The first and current stage is to deploy a series of pressurized heavy water reactors (PHWR), which are modeled on Canada's deuterium uranium reac-

10 Glenn Zorpette, "Technology in India," *IEEE Spectrum*, March 1994, pp. 24-25.

11 Asher and Ramkishen, *op. cit.*

12 Zorpette, *op. cit.*

13 Faqir C. Kohli, "Software: A Recognizable Export, At Last," *IEEE Spectrum*, March 1994, p. 35.

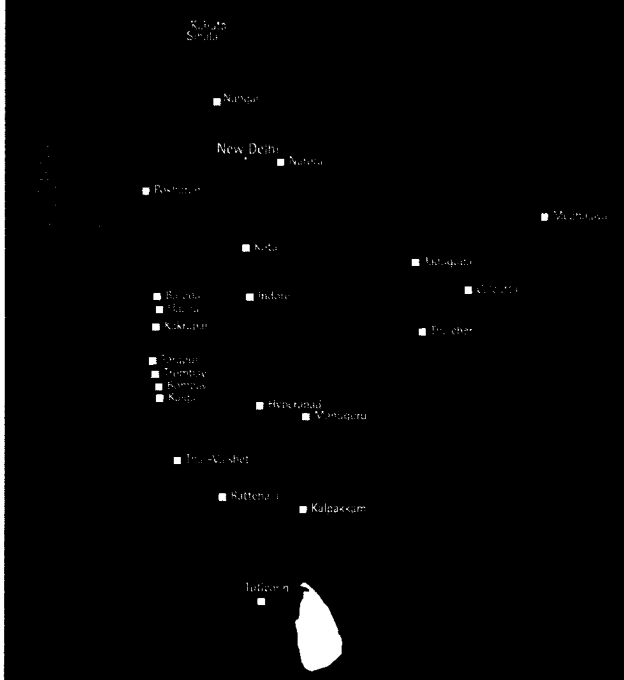
14 R. Chidambaram, Anil Kakodkar, and Piacid Rodriquez, "Nuclear Technology: Power to the People," *IEEE Spectrum*, March 1994, p. 36.

15 R. Ramachandran, "PRC Uranium Sale Seen as Significant Development," *Delhi All Indian Radio Network*, transcribed in *FBIS-NES-95-004*, January 6, 1995, p. 37, and Amitabh Mattoo, "India: Strategy on Nuclear Issue Examined," *The Telegraph*, transcribed in *FBIS-NES-97-038*, February 24, 1997.

16 *Nuclear Proliferation Fact Book, op. cit.*, p. 502; Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction*, OTA-BP-ISC-115, (Washington, DC: U.S. Government Printing Office, December 1993), p. 182.

India's nuclear infrastructure

Figure 4-1



Kota	220 MW PHWR-safeguarded; 220 MW PHWR-safeguarded; 235 MW PHWR (under construction)-unsafeguarded; 235 MW PHWR (under construction)-unsafeguarded; Heavy water production facility-unsafeguarded
Pokharan	Nuclear test site
Baroda, Hazira, Thai-Vaishet, Tuticorin	Heavy water production plants-unsafeguarded
Kakrapar, Narora	235 MW PHWR-unsafeguarded; 235 MW PHWR-unsafeguarded
Tarapur	Two 160 MW BWRs-safeguarded; two 500 MW PHWRs (under construction)-unsafeguarded; Prefer reprocessing facility-unsafeguarded; fuel fabrication facility-unsafeguarded
Trombay	Bhabha Atomic Research Center (BARC): 1 MW research reactor-unsafeguarded; 40 MW research reactor-unsafeguarded; 30 KW research reactor-unsafeguarded; 100 MW research reactor-unsafeguarded; reprocessing facility-unsafeguarded; pilot-scale uranium enrichment plant-unsafeguarded; uranium conversion facility (UF6)-unsafeguarded; fuel fabrication facility-unsafeguarded; zirconium production pilot-plant; heavy water pilot-plant-unsafeguarded
Bombay	Tata Institute of Fundamental Research
Indore	Center for Advanced Technology: laser development site
Hyperabad	Nuclear fuel Complex: uranium purification site (UO2)-unsafeguarded; fuel fabrication facility-unsafeguarded
Kalpakkam	235 MW PHWR-unsafeguarded; 235 MW PHWR-unsafeguarded; Indira Gandi Center for Atomic Research (IGCAR); 50 MW FBR-unsafeguarded; reprocessing plant-unsafeguarded; reprocessing facility-unsafeguarded; Reactor Research Center; 30 KW research reactor-unsafeguarded
Kaiga	235 MW PHWR (under construction)-unsafeguarded; 235 MW PHWR-unsafeguarded
Rattehalli	Uranium enrichment plant-unsafeguarded
Nangal, Thalcher, Manuguru	Heavy water production facilities-unsafeguarded
Meghalaya	Uranium mine and deposits
Calcutta	Saha Institute of Nuclear Physics
Jaduguda	Uranium mining and milling site

The primary brake still dragging on India's rate of economic growth is its overly high tariffs and stifling bureaucracy, a bureaucracy that is able to smother in red tape all but the most stalwart of investors. However, India has some capabilities that make the hassle worthwhile.

From a technological perspective, India has tremendous potential for development. In terms of quantity, India has one of the world's largest scientific talent pools, weighing in at an estimated 3.8 million people.[9] Of these, only about three-fourths of them are employed in technical or scientific jobs at any one time, leaving India with a reserve pool

9 Mukul G. Asher and Ramkishen, "India and Singapore," *Asian Survey*, Vol. XXXV, No. 10, October 1995, p. 902.

Status of India's nuclear power stations

Name and Location	MWe (per reactor)	Projected/Actual Commercial start date
Tarapur 3	470	8/00
Rajasthan 3	220	1997
Narora 1 Narora, Uttar Pradesh	220	1/91
Kaiga 1, Kaiga, Karnataka	220	1997

Source: Extracted from IEEE Spectrum, March 1994

Figure 4-2

tor (CANDU). In 1983, India commissioned its first indigenously designed PHWR. Since then, five more PHWRs have come on line, four are being constructed (projected completion date of 1997), and twelve more are planned.[17] These reactors can be used to generate both electricity and plutonium. PHWR systems are extremely efficient power generators which are also well suited for plutonium production—more so than are U.S. light-water reactors. Tritium can also be produced using HWRs.[18]

The plutonium generated in India's first stage will be used to fuel the second stage of its nuclear power program when a group of liquid-metal, fast-breeder reactors will be commissioned.[19] In preparation for activating this second phase, India began operating an experimental molten sodium 8

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17 See International Status of Nuclear Power, "Nuclear Issues Briefing Paper 7," http://www.uic.com.au/nip07.htm, September 1996, p. 4; and Chidambaram, Kakodkar, and Rodriquez, *op. cit.*, pp. 36-38.

18 *Nuclear Proliferation Fact Book, op. cit.*, pp. 480-81. For example, the United States produced tritium using heavy water reactors in its Savannah River nuclear complex.

19 Chidambaram, Kakodkar, and Rodriquez, *op. cit.*, p. 36.

(extracted from *IEEE Spectrum*, March 1994)

Source of Reserves (rank ordered by quantity available)	Energy Potential (in billion tons of coal equivalents)	Utilization	
		Annual Use Rate	Years of Use
Thorium	600	1000 GWe	244
Coal	150	500 GWe	122
Uranium (recycled in breeder reactors)*	100	350 GWe	116
Gas	1.5	NA	NA
Uranium (if not recycled)	1.2	15 GWe	32
Oil	.6	NA	NA

* Reuse of radionuclides in breeder reactors should extend India's uranium reserves by a factor of 80.

Figure 4-3

MW breeder reactor in 1985. It plans to develop fast-breeder reactors in order to obtain maximum utilization from its limited stocks of uranium, with the design for the first 500 MW reactor planned for construction at Kalpakkam now being finalized.

As for the third stage, India intends to develop a thorium-based fuel cycle to take advantage of India's thorium reserves found in abundant quantities in the monozite sands of the Kerala coast. Toward this end, in 1996 India activated an experimental 30-kWt reactor to learn how to burn thorium 232. This reactor is the first of its kind ever commissioned to burn this exotic fuel.[20]

Of interest from a potential proliferation perspective, when thorium 232 is radiated it converts to uranium 233. If weaponized, its characteristics resemble plutonium 239 (i.e., in explosive power, quantity required per weapon, etc.). India has recently signed an agreement with Brazil, a country which also has a significant quantity of thorium, to cooperate together on thorium technology development.

On the whole, India has the potential for supplying most of its electrical energy needs for several centuries (Figure 4-3). It has large coal deposits and contains the world's second largest reserves of thorium.[21] However, as shown in the accompanying figure, India only has a limited amount of proven uranium reserves (estimated at 67,000 metric tons), and its oil reserves are much smaller than China's.[22]

It is India's oil requirements that cause concern. India's oil consumption is growing at 9 percent a year; it is critical that India make an effort to ensure that it can supply its future oil needs. (Most of India's oil supplies will be provided by Islamic states. Currently, Iran is India's biggest oil supplier, providing India with four million tons per year, some of which it allows India to pay for by barter and soft currency.)[23]

Yet, for all of its raw scientific and technological capabilities, India is still well behind in developing the skills needed to integrate technologies into systems and produce those systems using advanced

[20] For more information on India's nuclear program, see Ibid., p. 38; and Biman Basu, "India: Commentary Views Breakthrough Achieved in Nuclear Field," *Delhi AllIndia Radia,* transcribed in *FBIS-NES-96-215,* November 3, 1996.

[21] India has an estimated 300,000 metric tons of thorium reserves, second only to Australia. Other major deposits are found in the United States, Canada, Norway, Brazil, South Africa, and Malaysia. See U.S. Department of Interior, Bureau of Mines, *Mineral Commodity Summaries,* 1993, p. 181.

[22] Ibid., pp. 36-38.

[23] Sandy Gordon, "South Asia After the Cold War," *Asian Survey,* October 10, 1995, pp. 886-87.

manufacturing techniques. Its industry is "spotty" in that it has the capability to produce world-class products in a few areas, but lacks the complete system needed to compete across a broad array of product lines. India is making a concerted effort to use its defense industries as an engine for development as it works to overcome industrial weaknesses. Gradually, progress is being made, but often its grand plans are implemented very slowly as target dates slip since the available funding is chronically less than that required.

India also has not yet solved the problem of how to elevate living standards for its population as a whole. The problem of rural development, the challenge inherent in overcoming the prejudices of the caste system, and the religious and ethnic rivalries that constantly tear at the fabric of Indian society also hinder its economic development. Considering the challenges that face India, it is difficult to develop much optimism regarding its future prospects as a whole, but in narrow areas of focus (particularly in technology), India has the potential for generating a few surprise developments.

2. **Hold the country together and withstand the forces of separatism that would tear India apart.**

India is a land of fierce emotions, growing nationalism, marked by separatist movements in Kashmir, Punjab, and Assam, and beset by a weakening political structure as the secular Congress Party, which was designed as a party of unity with appeal to all factions of India's political spectrum, has lost is pre-eminent position in Indian politics. This power shift has been gathering momentum for some time. The passing of the Gandhi family from India's political scene, coupled with a succession of corruption scandals, eroded popular support for the Congress Party. As a result, the parties representing factional interests have grown in strength at the expense of national unity. In the last national election, the strengthening Bharatiya Janata Party[24] garnered the largest bloc of votes (less than an absolute majority), but was unable to form a government because other parties shunned coalition with this strongly nationalistic Hindu party suspected of being religiously biased. This hawkish party advocates that India declare itself a nuclear power and proceed with the deployment of nuclear and missile forces.

The resulting situation is difficult to assess. Frequent visitors to India claim that nationalistic fervor is increasing even though India's political unity is fragmenting and its political future is growing more uncertain. Concurrently, domestic violence and armed separatist movements are common facts of life. As a result, military power is seen as important not only for inter-state relations, but also as a force with which to hold the country together.[25] Considering India's internal problems, it is likely that much of India's future political energy will remain focused internally as it grapples with the problem of preserving itself as a unified nation.

3. **Maintain India's external security and enhance its status in regional affairs and in the international community—perhaps someday to become a superpower.**

India's external security concerns and its desire to increase its stature in the international community are intertwined goals that cannot be easily separated for analysis. As such, they are best examined as part of a whole. India's security goals seem to include the need to contain Pakistan; to strategically balance China; to dominate events in the

[24] The Bharatiya Janata Party is the Hindu National Party, a party dominated by upper-caste Hindu.

[25] Malik, *op. cit.* p. 79.

Indian Ocean; to gain access to and expand its influence in Central Asia; to be able, if necessary, to deter U.S. intervention in the region; and perhaps, someday, to become a superpower.

Security Goal 1: Contain Pakistan and Gain Access to Central Asia. Pakistan sees itself as a bulwark against Indian hegemony over Southern Asia. Although Pakistan (population 130-140 million) is strategically inferior to India, the bitterness and hatred that exists between these two states increase the chance that a simple political dispute could flair into all-out war regardless of the logic behind the act. With tempers short, it is not surprising to find that India and Pakistan fought two wars (1947-48 and 1956) over the status of Kashmir and a third in 1971 over the issue of independence for East Pakistan (now Bangladesh).[26] Indian and Pakistani forces have engaged in sporadic battles over the control of Siachen Glacier in Kashmir, and the Indo-Pakistani border remains heavily militarized, with a possibility that the artillery duels that spring up frequently could ignite a fourth war.[27]

Although the exact details are in dispute, India and Pakistan reportedly came close to going to war with each other again in 1990. In that confrontation, there is evidence to indicate that if war had erupted, the conflict could well have involved the use of nuclear weapons. According to an investigative report on that incident written by Seymour Hersh, there is reason to believe that Pakistan may have had nuclear weapons uploaded on F-16 aircraft with pilots sitting in their fighters awaiting orders to launch.[28]

Of particular concern for India, Pakistan is armed with nuclear weapons with most open source estimates now crediting Pakistan with having 12-20 nuclear devices.[29] In addition, Pakistan's Chinese M-11 missiles (280 km) and indigenously developed *Hatf* I (80 Km) and *Hatf* II missiles (280-300 km?) provide Pakistan the capability of targeting major Indian troop formations. Looking to the future, Pakistan, with Chinese assistance, is currently believed to be developing a 600-1000 km range missile, the *Hatf* III,[30] which will put New Delhi and possibly Bombay in range of Pakistan's missiles. In the short-term, Pakistan's M-11 missile has a two-to-one range advantage over India's *Prithvi* I. (However, Pakistan's population centers are closer to the border than are India's, which leaves Pakistan in a more vulnerable situation.)

Nevertheless, in terms of all other key measurements such as size, population, resources, and general military strength, India holds an overwhelming advantage. For Pakistan, strength must be acquired by cultivating allies such as the United States and China, capitalizing on its geographic position as an historic route to the sea for the Central Asian republics, and trying to use its Islamic credentials to gain allies. With the end of the Soviet intervention in Afghanistan and the subsequent imposition of U.S. sanctions on Pakistan for developing nuclear weapons, Pakistan began to

26 Ibid., p. 78.
27 Ibid., p. 78.
28 Seymour M. Hersh, "On the Nuclear Edge," *The New Yorker,* March 29, 1993, pp. 56-73. Although some Bush administration officials have downplayed the seriousness of the confrontation, the Hersh article contains a report of an interview with Robert Gates (President Bush's on-the-scene representative charged with defusing the situation) that indicates the situation may have been closer to nuclear war than was publicly acknowledged at the time. In addition, follow up findings described by Amitabh Mattoo, "India's Nuclear Status Quo," *Survival,* Autumn 1996, pp. 44-45 (to include footnotes 22 & 23), seems to substantiate that a crisis occurred, but it may have been less serious than that described by Hersh.
29 "Pakistan: 5/28/96," *The Nonproliferation Review,* Fall 1996, p. 135.
30 "Artillery Rocket, Ballistic Missiles, Sounding Rockets, and Space Launch Capabilities of Selected Countries," *The Nonproliferation Review,* Fall 1996, p. 179.

entertain dreams of establishing a strategic Islamic bloc consisting of Pakistan, Iran, Turkey, Afghanistan, and some of the new Central Asian Republics to stand against U.S. pressure and to protect itself against the effects of a U.S. tilt toward India.[31]

To counter Pakistan's strategy, India has tried to isolate Pakistan somewhat by establishing solid relations and trade links with Afghanistan and the Central Asian Republics. Moreover, the Central Asian Republics are potential markets for Indian goods and services and have the potential of supplying India with uranium ore and oil, both of which India has only in limited quantities.[32] Facilitating India's achievement of these goals is the growing Southwest Asian rivalry between Iran and Saudi Arabia (with Pakistani-Saudi ties strengthening); the civil war in Afghanistan, which has become a battleground to determine whether future trade flows of Central Asian commercial goods are funneled through Afghanistan/Pakistan or through Iran (to be discussed in the Pakistan section); and Iran's cultivation of India in response to Western sanctions.

In this regard, Iran has hopes of becoming a viable outlet to the sea for the Central Asian Republics. Toward this end, it engaged India to help build a 165 kilometer rail link to join the Iranian rail network at Masad to the Central Asian rail system at Sarakhs, Turkmenistan.[33] This link was opened in May 1996.[34] Moreover, in January 1995, India and Iran signed a comprehensive set of agreements on trade and joint ventures, including one to develop multilateral agreements on transit and trade between India and the Central Asian Republics via Iran.[35] This agreement was broadened with the signature of *The Tripartite Agreement* among India, Iran, and Turkmenistan in February 1997, an agreement which specifies the rules for transit of trade goods among the parties concerned.[36]

Security Goal 2: Balance China as an Equal. China is the "yardstick" against which India measures itself. Both countries are underdeveloped, proud of their ancient histories, have huge populations, occupy large landmasses, and have had first-hand experience with Western imperialism. As countries sharing a common border, both states have a common security concern with the other. Within this relationship, India recognizes that China is the stronger power, especially at the strategic level. Consequently, one of India's aspirations is to develop sufficient military capability, especially in nuclear and missile forces, to emerge onto the world's stage as China's strategic equal.[37] (At the same time, it should be recognized that China and India are making progress in solving some of their differences. For example, they are working to resolve their border dispute and to increase trade levels between the two states. If this movement should continue to grow, it could eventually change the strategic outlook in Asia.)

Security Goal 3: Control the Indian Ocean. India is not secretive of its objective of being able to exercise military control in the Indian Ocean. Indian naval officers have spoken openly of their intent to check the expansion of Chinese naval power in the Indian Ocean by controlling choke points in the Malacca Straits. "The establishment of

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31 Malik, *op. cit.* p. 79.

32 Gordon, *op. cit.*, p. 886; and Tulegen Askarov, "New Strategic Nuclear Weapons Path Viewed," *Ekspress-K*, translated in *FBIS-SOV-95-224-S*, October 27, 1995.

33 "India: Radio Sums Up Vice President's Visit to Iran," *All India Radio Network*, transcribed in *FBIS-NES-96-209*, October 27, 1996; and "India: Opening of Ancient Links With Central Asian States Viewed," *The Hindu*, transcribed in *FBIS-NES-96-101*, May 21, 1996..

34 Ibid., p. 887; "Iran Woos India, Looking for Options In Asia," *Jane's Intelligence Review, Pointer*, September 1995, p. 6.

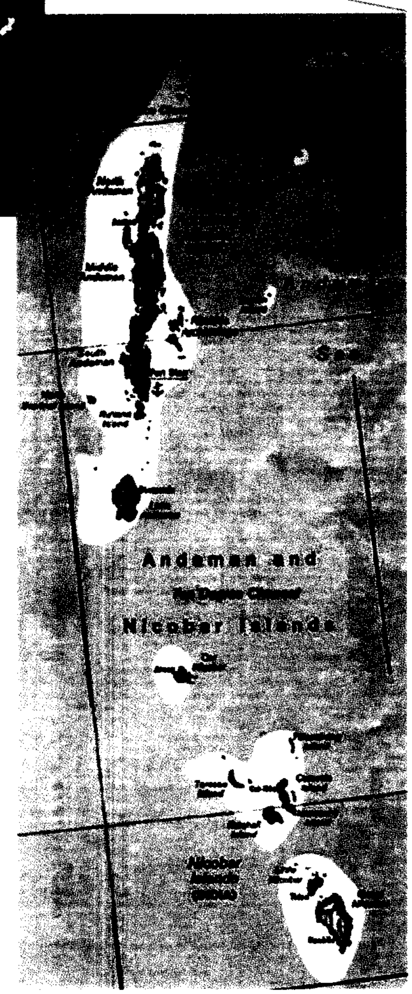
35 Ibid.

36 "India, Editorial Hails Strategic Tripartite Pact," *The Hindu*, transcribed in *FBIS-NES-97-038*, February 25, 1997.

37 For example, see Kathleen C. Bailey, *Doomsday Weapons in the Hands of Many*, (Chicago: University of Illinois Press, 1991), p. 21.

The Andaman Islands

Figure 4-4



a permanent naval presence in the Andaman Islands on the vital trade routes between Suez and Singapore is a step in that direction."[38] The expansion of Indian naval power supports the objective of expanding India's influence in South Asia. However, due to budget constraints, there are indications that India may have to use land-based aircraft and cruise and ballistic missile systems, coupled with reconnaissance satellites and remotely piloted vehicles (RPVs), to supplement its naval fleet as the rate of expansion of its blue-water naval capabilities may be unable to keep pace with India's national aspirations.[39] (Note: India is especially concerned that Chinese access to Myanmar port facilities might allow the People's Liberation Navy (PLN) to operate and confront Indian naval forces in the Indian Ocean.)

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38 Malik, *op. cit.* p. 75.

39 Ibid., p. 81.

Security Goal 4: Develop a Self-Sufficient Defense Industrial Base. In 1958, India established the Defense Research and Development Organization (DRDO) to steer India to self-reliance in weapons production through research and development. Essentially, India does not want to be dependent on foreign suppliers for military armaments, suppliers who could use that dependency to withhold parts and components and pressure Indian security policy. Indian policymakers recognize that India cannot be a major power as long as it is dependent on other countries for armaments.

Security Goal 5: If Deemed Necessary, Deter Future U.S. Military Intervention in the Region. India's elite are still smarting from the 1971 deployment of the U.S. aircraft carrier *Enterprise* and its task force in the Bay of Bengal during the Indo-Pakistani war over the independence of Bangladesh. The Indians repeatedly claim that the deployment essentially constituted a U.S. nuclear threat against India.[40] Even today, U.S. diplomats visiting India are reminded of this incident. As Indian strategists look to the future they envision possible contingencies in which India will need the capability of deterring outside intervention. As a result, India's strategic program contains a planning factor that appears aimed at achieving that objective.[41]

India's General Military Situation

The Indian Army inherited the traditions and professional standards of the British military. However, following independence, the Indian government began to appoint and promote its military officers based on political considerations. After the humiliating showing of the Indian Army against the Chinese in 1962, India reverted to its roots and largely depoliticized its military. Today, the Indian military is a fairly competent and professional organization of 1.2 million personnel, officered by people who gained their positions based on merit.

With 980,000 personnel, the Indian Army is the largest component of the Indian defense establishment. It enjoys the highest priority for defense funding, but often has up to half of its capabilities tied up with internal security operations. Hence, it is not surprising to find that a majority of the Indian Army is composed of low-technology light-infantry units, coupled with a mix of some more capable units, including armored divisions (inventory of 2400 tanks). One of India's major goals is to upgrade its military, which is equipped primarily with Soviet-designed equipment (75-80 percent, most of which is produced in India on license),[42] and to develop a greater military power projection capability.

India is also pursuing the development of a number of indigenously produced Army systems that will reduce its reliance on foreign suppliers. These efforts include such systems as the *Arjun* tank;[43] the tri-service radar-homing short-range (9 kms) *Trishul* surface-to-air missile (SAM), which has a 6-8 second reaction time and is effective against low-flying targets (to include sea-skimming missiles); the medium-range (25-30 kms) *Akash* SAM, which uses a strap-down inertial navigation system to hit aircraft and tactical missiles, and its related phased-array radar system, the *Rajendra,* which guides the *Akash* SAM and can track 64 air-

40 For an example of typical Indian comments regarding the 1971 incident and U.S. policy toward India, see Amulya Ganguli, "U.S. in South Asia Tilt Against Democracy," *Indian Express,* transcribed in *FBIS-NES-95-250,* December 29, 1995, p. 54.

41 For a good summary of Indian thinking on this issue, see Bailey, *op. cit.,* p. 22.

42 *Military Balance, 1995-96, op. cit.,* p. 154.

43 Not all of India's attempts to produce its own weapon systems is turning out successes. Apparently, the Indian Army is very unhappy with the *Arjun* tank. They claim it is too heavy and that technically it is only about as sophisticated as the Russian T-72 tank, thus not equal to current systems (e.g., the Russian T-80 and the U.S. M-1 *Abrams*).

craft/missiles simultaneously; the *Nag* fire-and-forget anti-tank missile, which is guided by a launch-vehicle radar; the *Nishant* UAV; and the *Lakshya* unmanned aerial vehicle (UAV), which with modifications can also be used as a cruise missile.[44]

As for combat aircraft and naval combatants, India has over 900 air force and naval combat aircraft. While the Indian aircraft fleet includes many obsolete airframes, India is pursuing upgrade programs to make selected models viable delivery platforms for modern munitions as well as procuring *Mirage* 2000-H, MiG-29s, and Su-30 aircraft, along with an expected purchase of Il-78 aerial refueling tankers.[45] Although the quantity of aircraft in India's inventory will decline in the future, their quality is expected to improve significantly. As for naval vessels, the Indian fleet numbers over 100 combat naval vessels, of which 15 are submarines, 2 are aircraft carriers, and another 23 are destroyers and fast frigates. Again, the problem with funding and the lack of spare parts means that only about one-half of India's warships are operable at any one time.[46]

Turning to cruise missiles, India has a number of foreign-produced cruise systems in its arsenal, to include *Exocet*, *Styx*, *Starbright*, *Sea Eagle*, and perhaps the feared Russian *Sunburn* supersonic missile. It also has some indigenous cruise missile systems under development to include the *Sagarika* and *Lakshya* variant.

- The *Sagarika* (Oceanic) began development in 1994 as a submarine-launched cruise missile (SLCM) which will have a range of at least 300 kms (a few claim 1000 kms); it is projected for deployment around 2005. According to one report, this missile will incorporate a terrain-matching guidance system for low-level flight.[47] Since none of India's current submarine fleet can test-fire this system, it seems clear that it is being developed for India's new indigenous nuclear submarine project (to be discussed later).[48] It is not known if this system will include a nuclear option.

- The *Lakshya* is a turbojet system designed as an RPV; India is also developing it as an air- or land-launched variant cruise missile system capable of carrying a 350 kg payload to a range of 600 kms. It is projected to enter service in 1998.[49]

It is also claimed that at least one of India's developmental cruise missiles will navigate to its target location using either U.S. Global Positioning System (GPS) signals or Russian GLONASS satellites.[50]

It should be noted that in the conventional realm, India has not been shy in using military force in situations involving its perceived national interests. It is likely that India will continue to follow that pattern in the future. Of greater interest to the United States, however, is the question of how India might view its emerging strategic capabilities.

Apparent Missile Developments

India's Military Doctrine and Missile Requirements. India's security, according to its

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44 "India: 1/28/96," *The Nonproliferation Review*, Spring/Summer 1996, p. 141; and Ali Abbas Rizvi, "Indian Missile Programme," *Asian Defence Journal*, May 1995, p. 20-23. Most of these systems are 2-4 years or so from being fielded.

45 Barbara Opall and Vivek Raghuvanski, "Su-30 Fighter Buy Will Boost India's Power in Region," *Defense News*, November 18-24, 1996, p. 4.

46 International Institute of Strategic Studies, *Military Balance, 1995-96*, p. 158.

47 Rahul Roy-Chaudhury, "India Developing Sea-Based Missile System," Inter Press Service, September 29, 1994.

48 Duncan Lennox, Editor, *Jane's Strategic Weapon Systems*, in presentation to George C. Marshall Institute, Washington, DC, July 29, 1996; and "India Developing Sea-Based Missile System," *Military and Arms Transfer News*, October 7, 1994, p. 12.

49 Ibid.

50 Ali Abbas Rizvi, "Indian Missile Programme," *op. cit.*, p. 22.

policymakers, can only be viewed in terms of the international hierarchy in which U.S. and Russian strategic capabilities drive China's nuclear requirements, which triggers a deterrent requirement for India, which, in its turn, drives Pakistan's nuclear development. Increasingly, this strategic hierarchy is spreading to include the Middle East. Thus, India cannot agree to forego its strategic options unless the same remedy is applied to the entire international structure, to include the United States, Russia, and China. Regional arms control that is aimed at limiting just South Asia is unacceptable.

Primarily, Indian policymakers believe that the real value of nuclear weapons is the added international stature that they confer on those states so armed, providing the international respect and influence that India desperately wishes to attain. In short, they see nuclear weapons as the currency of power in the international system. Although Indian strategic thinkers do not believe that nuclear weapons are usable warfighting instruments per se, they do think that the possession of nuclear systems makes other major powers moderate their behavior and limits the nature of any conflict between states that have nuclear weapon systems.

Within this framework, India is not believed to have gone much beyond a rudimentary level of thinking regarding the detailed objectives that it hopes to gain for its investment in strategic forces.[51] However, its planners understand that India's strategic deterrent forces will only be taken seriously if India develops a real capability that is credible to other states.[52] Toward this end, Indian planners have performed some conceptual work on determining how India's deterrent forces are likely to work against potential adversaries. Currently, India has a strategic doctrine based on non-weaponized deterrence.[53] Essentially, India is seeking to maintain strategic ambiguity, hoping to gain deterrent value without subjecting itself prematurely to intense international disarmament pressures. As noted earlier, India has hoped to equal China before it emerges onto the world stage as a declared nuclear power. However, considering that 62 percent of those surveyed in India expressed support for the idea that India should openly declare itself a nuclear power, future domestic political pressures could eventually change India's strategic objectives and its nuclear posture.[54]

Under its current non-weaponized deterrent posture, India hides its nuclear capacity while developing the wherewithal of upgrading its strategic forces to a minimum deterrent posture if or when a specific threat should emerge. In short, India does not maintain nuclear forces on alert, but it wants the option of upgrading its forces to a minimum deterrent posture if warranted by a specific threat situation. Under minimum deterrence, India would seek to be able to impose pain and destruction at a level considered to be unbearable by the adversary in relationship to the actions envisioned and objectives sought by the threatening state.[55] The authority to upgrade India's deterrent posture or actually to employ India's nuclear weapons is closely held by the prime minister.

It is interesting to note that India has maintained its claim of being a non-nuclear weapons state

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51 George Perkovich, "A Nuclear Third Way in South Asia," *Foreign Policy,* Summer 1993, p. 88; and Amitabh Mattoo, "India's Nuclear Status Quo," *Survival,* Autumn 1996, pp. 43-45.

52 W. P. S. Sidhu, "India's Nuclear Tests: Technical and Military Imperatives," *Jane's Intelligence Review,* April 1996, p. 172.

53 National Security Planning Associates, *International Conference: Dealing With the Spread of Nuclear Weapons,* The Hague, The Netherlands, May 19-20, 1995.

54 K.P. Nayar, "Rao Under Pressure To Declare Nation Nuclear Power," *Indian Express,* transcribed in *FBIS-NES-95-250,* December 29, 1995, pp. 51-52; and "Political Pressure May Change India's Course On Disarmament," *Jane's Defense Weekly,* January 31, 1996, pp. 27-28.

55 Ibid.

through the careful use of definitions and semantics. For example, Indian scientists are careful to state that India does not have nuclear weapons; they will only speak of nuclear devices, as they have persistently called the mechanism that created India's "peaceful nuclear explosion" in 1974. *They define a nuclear weapon as being a nuclear warhead mated with a delivery system.*[56] As a result, they can claim that India does not have nuclear weapons since none of its nuclear devices are attached to delivery systems.

At the same time, India has taken action to ensure that it can use its nuclear capability if necessary. For example, in the early 1980s, the Indian Air Force conducted fusing tests to verify that a nuclear bomb could be attached to and successfully released from its aircraft.[57] Then, in 1986, the Indian military conducted a large field exercise, code named *Brass Tacks,* during which it practiced the integration of its special weapons, including tactical nuclear bombs, into the day-to-day field maneuvers of the troops.[58] Likewise, as the *Prithvi* ballistic missile started to become available, the Indian Army began training the 333rd Artillery Group (part of the XIth Corps) in the use of the missile.[59] While the *Prithvi* is expected to be equipped with conventional warheads for day-to-day operations and will likely be so employed for most of its wartime missions, there is little doubt that it is also capable of mounting a nuclear warhead. The Indian military has taken steps to ensure that this weapon system can be used to deliver nuclear warheads if so ordered.

Looking to the future, India sees a requirement for missile systems that can be used to deter China and probably the United States as well.[60] In addition, Indian strategists understand that India's forces need long-range targeting capabilities as well as a second-strike capacity if India is to become a major international power. As a result, India sees a requirement to develop RPV systems, reconnaissance satellites, cruise missiles, and submarine-launched missiles. Indian thinkers are also concerned that, at some point, India must prove to the world that it has a viable nuclear capability.[61]

Strategic Missile Forces. In 1982, India successfully launched its space-launch vehicle-3 (SLV-3), which was "ostensibly carried out to exploit space for peaceful purposes."[62] The following year, the Integrated Guided Missile Development Programme (IGMDP) was established for the purpose of applying the technology acquired for "peaceful" purposes to military use. The IGMDP is a high-priority program within the DRDO. Since 1983, India has made steady progress in developing an extensive space-launch vehicle program that has been used skillfully, both to develop India's commercial space-launch capabilities and as a vehicle for developing a military missile program. It should be noted that in the earlier discussion of indigenous system developments, specific note was made of the *Trishul* and *Akash* SAM systems as well as the *Nag* anti-tank missile. These three developments are products of the IGMDP, as is also the *Prithvi, Agni,* and possibly the *Surya* ballistic missile systems, which will be examined in this section.

In the development of its missile forces, India received a quick start through technology transfers in the fields of satellite-launching vehicles and guidance systems from Germany, France, the

56 Sidhu, *op. cit.*, p. 170.
57 Ibid., p. 173.
58 Hersh, *op. cit.* p. 59.
59 Sidhu, *op. cit.*, p. 173.
60 Bailey, *op. cit.*, p. 22.
61 For example, see "Nuclear Test Reports Seen as Pressure Tactics," *The Hindu,* transcribed in *FBIS-NES-95-244,* December 20, 1995, pp. 63-64.
62 Ali Abbas Rizvi, "Indian Missile Programme," *op. cit.*, p. 20.

United States, and the Soviet Union, then built on that technology.[63] In addition, there is reason to believe that Israeli firms have been deeply involved in assisting Indian space industries.[64] This foreign assistance is complemented by India's extensive software development capabilities. As a result, it is reported that Indian scientists are working to integrate the U.S. Global Positioning System (GPS) data (and perhaps data from the Russian GLONASS as well) into its missile guidance packages, which suggests that India may be able to produce future missile systems that are quite accurate, to include development of the advanced software algorithms necessary to maneuver a warhead while in flight.[65] Currently, India's ballistic missile developmental efforts include the following systems:

- ***Prithvi*** (Earth). The 8.55 meter-long single-stage (containing two engines), liquid-fueled *Prithvi* is a road-mobile ballistic missile being developed in three models. The first, the *Prithvi* I, is now in production. At least 30 units are believed to have been built as of January 1996, but manufacturing and training difficulties involving the liquid fuel and guidance package were delaying the fielding. This missile can carry a 1000 kg warhead to a range of 150 kms. Five types of warheads have been reported, to include conventional high-explosive, prefragmented explosive, cluster munitions, fuel-air explosive, and nuclear. Its inertial navigation system reportedly guides the missile to target within a Circular Error Probable (CEP) equal to .01 percent of its range; however, one test may have achieved an accuracy of a 10-meter CEP, leading to speculation that the guidance system may also include the capability of feeding GPS inputs into the inertial navigation system. Its guidance system can be programmed to follow up to six different trajectories so as to avoid intercept by most missile defense interceptors. Likewise, India is applying a radar-absorbing coating to its aircraft and missiles in an attempt to reduce their radar signatures.[66]

- The second system, the *Prithvi* II, is designed for use by the Indian Air Force. It will have a range of 250 kms carrying a 500-750 kg warhead. It is also reported that a *Prithvi* III, with a range of 350 kms carrying a 500-750 kg warhead is in advanced development.[67] As the liquid fuel for the *Prithvi* is very toxic and must be uploaded just prior to launch, there are a few speculative reports that indicate the *Prithvi* III may be a solid-fueled version of the missile.[68] If so, it could be that India wants the solid-fueled version for its naval forces as Indian sources have noted that the *Prithvi* could also be deployed on ships.

- ***Agni*** (Fire). The *Agni* is planned to be a mobile two-stage solid/liquid-fueled IRBM launched from a transporter-erector-launcher (TEL), carrying a 500 kg warhead to a range of 2500 kms or a 1000 kg warhead to 1600 kms. It is an 18.4 meter-long by 1.3 meter-wide missile which uses as its first stage the same solid-fueled booster as that employed on India's SLV-3, while

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63 Gary Milholin, "India's Missiles ^X— With a Little Help From Our Friends," *Bulletin of Atomic Scientists*, November 1989, pp. 31-35.

64 In a private conversation with a ranking Israeli industrialist, a Washington-based defense analyst was told that the Israeli company was working in India, with indications that the work was extensive, and that Indian satellites have many Israeli components and labor included in their construction. This information was provided to the author on a nonattribution basis.

65 "India," *Ballistic Missile Threats: National Briefings*," Internet http://www.cdiss.org/countrya.htm#INDIA, September 27, 1996, p. 3. There seem to be hints in many of the publications that, in addition to GPS, India may also be using a "system similar to GPS," i.e., GLONASS?

66 "India: 10/23/95," *The Nonproliferation Review*, Winter 1995, p. 171.

67 Pravin Sawhney "Standing Alone: India's Nuclear Imperative," *Jane's International Defense Review*, November 1996, p. 28.

68 The information on the *Prithvi* is extracted from Ibid.; "Editorial: India's Missile Program Not Destabilizing," *The Times of India*, transcribed in *FBIS-NES-96-022*, February 1, 1996, p. 43; "10/15/95," *The Nonproliferation Review*, Spring/Summer 1996, p. 171; "India: 2/4/96," *The Nonproliferation Review*, Fall 1996, p. 157; John Cunningham, "Third World Missile Proliferation Poses New Threats," *The Journal of Social, Political, & Economic Studies*, Summer 1994; Ali Abbas Rizvi, "Indian Missile Programme," *Asian Defence Journal*, May 1995, p. 21; and "India Puts *Agni* Program On Ice," *Jane's International Defense Review*, January 1996, p. 5.

its second stage consists of a modified liquid-fueled *Prithvi* missile.[69] The missile is fitted with a single re-entry vehicle employing a carbon-composite ablative shield that Indian sources claim heats to 3000° C, while keeping the interior cooled to not more than 40° C.[70]

The *Agni's* first stage is guided using a secondary injection thrust vector system and a hydraulically actuated fin system. The second stage, like the *Prithvi*, uses gimbaled engines for thrust vector control (i.e., engine nozzles swivel to change the direction of the thrust). It has an advanced inertial navigation system that may include a stellar update capability, mid-course correction using GPS, and a terminal guidance system that will allow its re-entry vehicle to use its maneuvering fins to "porpoise" the warhead to avoid missile defenses while maneuvering to its target employing a terminal guidance radar operating in the C and S bands, patterned after the type used by the U.S. Army on the *Pershing* II missile.[71] The Indian press claims that the *Agni* may be able to achieve a CEP of about 60 meters.[72] (The accuracy claim is probably a gross exaggeration.)

The *Agni* missile was flight tested three times between 1989 and February 1994, with a fourth test scheduled for November 1994. The second and third flights involved testing re-entry and maneuvering characteristics of the warhead. As U.S. pressure against the *Agni* program mounted, the Indian government officially relegated the missile to the status of a technology demonstrator. Then, in August 1994, U.S., British, Swiss, and Australian MTCR officials met with Indian officials in an effort to try to persuade the Indians to cancel the *Agni*. Although the appeal was officially rejected, the government of Prime Minister Rao later formally suspended the program (the fourth *Agni* test was not conducted).

Subsequently, a series of public statements made during August and September 1996 by India's new government, led by Prime Minister H.D. Deve Gowda, indicated that the *Agni* program would once again be pursued. It is believed that at least five or six more test flights will be needed before this missile will be ready for production. At least four warhead variants have been discussed for use with the *Agni*. The first, developed in 1994, consists of a conventional warhead containing about 1000 bomblets (1 kg each), which will rain down on a target area one kilometer in diameter. The second, reportedly under development, is a warhead believed to contain an unspecified type and number of guided submunitions. The third is a fuel-air explosive (FAE) warhead,[73] while the fourth and primary warhead is generally believed to be a nuclear device, possibly using a thermonuclear design. Although the Indian government denies that the *Agni* will be nuclear-armed,[74] nevertheless, as many Indian publications point out, the *Agni* costs too much to develop for the sole purpose of delivering conventional payloads.

However, on December 5, 1996, India apparently again reversed direction, bowing to U.S. pressure. It announced that it was suspending

69 "Missile Forecast, *Agni*," *Forecast International*, The Teal Group, February 1996, pp. 1-2.

70 Sawhney "Standing Alone: India's Nuclear Imperative," *op. cit.*, p. 28.

71 Ibid.; the information on the "porpoising" maneuver to avoid missile defenses is based on a private conversation that a U.S. analyst had with an Indian scientist working on the *Agni* project.

72 Ali Abbas Rizvi, "Indian Missile Programme," *op. cit.*, p. 27. "The Nuclear Bomb and the Security of South Asia," *Asian Defence Journal*, April 1995, p. 27. An Indian report claims that in the last test of the *Agni*, the missile landed within a 50 meter radius of its intended impact point. See M. Ahmed, "India: *Agni* Far From Capped, Can Be Deployed in 3 Months," Delhi *Business Standard*, transcribed in *FBIS-NES-96-241*, December 12, 1996.

73 Ahmed, "India: *Agni* Far From Capped, Can Be Deployed in 3 Months," *op. cit.*

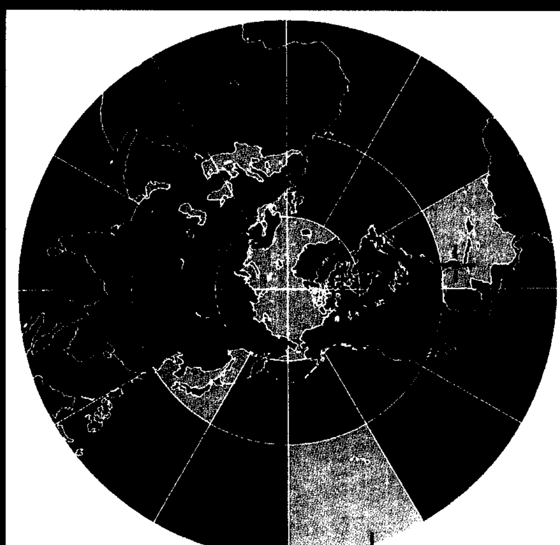
74 See "Missile Forecast, *Agni*," *op. cit.*, p. 3; "India Puts *Agni* Program On Ice," *op. cit.*; Ranjit Kumar, "India: Article Views Necessity for *Agni* Missile," *Navbharat Times*, translated in *FBIS-NES-96-170*, August 28, 1996; and "India," *Ballistic Missile Threats: National Briefings*," *op. cit.*, p. 3. Note: recently there have been a few vague Indian and Pakistani references to an *Agni* II system that may have a range of 4500 kms. No other open source information has been yet published on this potential development.

the *Agni* program.[75] After a series of conflicting reports, Indian Prime Minister Dave Gawda indicated in March 1997 that work on the *Agni* would proceed. His statement was subsequently expanded upon and reinforced by the Indian Minister of Defense.[76]

- ***Surya*** (Sun). While the status of the *Surya* ICBM program is unclear, there are many reports that indicate that the development of this system is underway, with development probably being initiated in 1994.[77] According to one Indian source, the *Surya* could be ready to begin flight testing as early as 1997. At this point, there are still several conflicting reports regarding the *Surya's* configuration. The most plausible report claims that the *Surya* will probably be based on the components of the polar space launch vehicle (PSLV).[78] As for its armament, the *Surya's* warhead is likely to be composed of essentially the same technology as that used in the maneuvering warhead of the *Agni*. In short, the only thing that seems to be agreed upon is that the *Surya* will be composed of components perfected for the *Agni* IRBM and for India's space-launch vehicles and that it will have a range between 8000 and 12,000 kms.

As discussed earlier, a significant number of Indian strategists believe that India needs a deterrent capability against the United States. If the *Surya* achieves a range of 12,000 kms, India would have the capability of positioning the missile at New Delhi and striking U.S. targets that lie on, and north of, a range-arc running from about Raleigh, North Carolina to Omaha, Nebraska to Eugene, Oregon. (See Figure 4-5). India's geography would also allow it to launch the missile 500-600 kms north of New Delhi and push the U.S. range-arc that much further towards the south or allow it to compensate somewhat for a system that may not be able to achieve a 12,000 km range.

Trajectory Ground Range
New Delhi to U.S. Cities



= Start point — = Target area

Start Point	Latitude	Longitude	End Point	Latitude	Longitude	Ground Range (km) Non-Rotating Earth	Rotating Earth* 2500s TOF		Rotating Earth* 2000s TOF	
New Delhi	28.62	77.22	Bangor ME	44.79	-68.77	11107	10648	Δ -4.1%	10748	Δ -3.2%
			Miami Fl	25.78	-80.20	13539	13047	Δ -3.6%	13158	Δ -2.8%
			Omaha NE	41.27	-95.97	12198	11997	Δ -1.6%	12013	Δ -1.3%
			Seattle WA	47.60	-122.33	11299	11165	Δ -1.5%	11441	Δ -1.3%
			Los Angeles CA	34.05	-118.2[illegible]	12823	12989	Δ -1.3%	12969	Δ -1.1%

Figure 4-5

[75] "India Vows Not to Deploy Mid-Range Agni Missile," *International Harold Tribune*, Reuters, December 6, 1996, p. 8; and "India Will Deploy Ballistic Missiles if Threatened," *FBIS-NES-96-235*, December 6, 1996.

[76] "Gawda Assures Full Support For Missile Development, *Delhi All Indian Radio Network*, transcribed in *FBIS-TAC-97-063*, March 4, 1997; and "India: Defense Minister: Agni Missile Won't Be Abandoned," *The Hindu*, transcribed in *FBIS-TAC-97-077*, March 18,1997

[77] "Briefing: Ballistic Missiles," *Jane's Defence Weekly*, April 17, 1996, p. 43.

[78] See "India," *Ballistic Missile Threats: National Briefings*," *op. cit.*, p. 3; Ali Abbas Rizvi, "Indian Missile Programme," *op. cit.*, p. 22; "India's Intercontinental Missile Program Criticized," *Jang*, translated in *FBIS-TAC-95-004*, July 28, 1995; and "Missile and Space Launch Capabilities of Selected Countries," *Nonproliferation Review*, Spring/Summer 1996, p. 193.

If the *Surya* should prove to have a range of 12,000 kms, its unveiling will pose problems for India since initially the United States can be expected to react harshly to its existence. Therefore, a pacing item for India's unveiling of the *Surya* likely hinges on the status of India's nuclear warhead development and the perfection of the *Agni* missile system. Once it has confidence in its thermonuclear warhead and the *Agni's* re-entry vehicle,[79] the *Surya* could be unveiled and tested quickly if Indian policy-makers judge that it is needed and are prepared to accept the international heat for such a development. At that point, India would not require very many years before it could field a small ICBM force. Obviously, the development of the *Surya* is tied to the *Agni*. As long as the United States can keep *Agni's* test program in a state of suspension, the development of the *Surya* will also be slowed.

Related Commercial Space Programs. As discussed earlier, India's commercial space program portends the future of its military missile developments. As such, three programs are of specific interest.

- **Polar Space Launch Vehicle (PSLV).** India has developed a four-stage PSLV. Of note is that its first stage consists of a one million pound thrust solid-fueled booster (claimed to be the third-largest solid booster in the world)[80] augmented by six solid-fueled strap-on boosters that were developed from the SLV-3 missile. The last two launches of this system have been successful. In the first successful launch, the PSLV boosted an 804 kg remote-sensing satellite into a polar orbit at an altitude of 825 kms above the earth on October 15, 1994; it repeated that success on March 21, 1996, putting a 939 kg satellite into a 817 km high sunsynchronous orbit, completing the missile's developmental test program.[81] The handlers of the system are now planning to make a few adjustments so as to increase the PSLV's throwweight slightly to qualify it for launching future Iridium low earth orbit communication satellite replacements.[82] It will be offering launches for $10-$12 million each.[83] Of particular interest, the PSLV is also believed capable of carrying a 1000 kg warhead to a range of 8000 kms.[84] By reducing the weight of the payload and making the improvements planned, this missile may be able to strike targets in the northernmost regions of the 48 contiguous states and Alaska.

- **Geostationary Satellite Launch Vehicle (GSLV).** India is developing a three-stage GSLV (of the *Ariane* class) that will allow payloads of 2500 kgs to be lifted to geo-transfer orbit (22,000 miles high) for about $70-80 million per launch. The GSLV is expected to provide India with a major competitive advantage in the space launch business.[85] The missile will use the first and second stages of the PSLV, but rather than use the six solid-fueled strap-on boosters used by the PSLV, it will have four more-powerful liquid-fueled strap-on boosters (adopted from the PSLV's second-stage) that will each provide 145,200 pounds of thrust. The third stage will be powered by a cryogenic engine, the first seven of these being provided by Russia, with India's Trivandrum Center developing indigenous cryogenic engines for subsequent launches. The GSLV is expected to conduct its first flight test in late 1998, with the first launch of a commercial

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79 For a discussion of possible testing regimes for India's missile warheads, see Sawhney "Standing Alone: India's Nuclear Imperative," *op. cit.*, p. 28.

80 Michael Mecham, "India Sees Commercial Future For New Booster," *Aviation Week & Space Technology,* August 12, 1996, p. 62.

81 "India Rockets Into the Big League," *Science,* October 28, 1994, pp. 546-47; and Biman Basu, "PSLV—Successive Successes," *India Calling,* June 1996, p. 2.

82 Mecham, "India Sees Commercial Future for New Booster," *op. cit.*, p. 62.

83 "India: 3/21/96," *The Nonproliferation Review,* Fall 1996, p. 158.

84 "Missile and Space Launch Capabilities of Selected Countries," *op. cit.*, p. 193.

85 Mecham, "India Sees Commercial Future for New Booster," *op. cit.*, p. 62.

satellite occurring in 2000.[86] Although not an ideal ICBM due to the time required to fuel its third-stage cryogenic engine, it could achieve a range of 14,000 kms carrying a payload of 2500 kgs.[87] (This missile could range all of the United States.)

- **Indian Remote Sensing (IRS) Satellites.** India has developed four IRS satellites, each of which has become increasingly more sophisticated.[88] These satellites download their data to a growing network of ground stations that then forward the information to the National Remote Sensing Agency in Hyderabad for processing. Although these sensing satellites are designed for commercial uses (agriculture assessments, water management, deforestation alerts, etc.), the newest also have the capability of providing militarily significant information as they orbit the earth 19 times a day, revisiting the same track every 22 days. This data can also be purchased as the Indian company, Antirx, has arranged for a U.S. company, EOSAT, to market the data from these satellites on a global basis.

Of particular interest are the second-generation IRS-1C (operational) and IRS-1D (soon to be launched) satellites which can provide images in the visual and near-infrared bands. Indian reports claim that objects as small as 5.8 meters can be seen with this system, while the panoramic coverage includes a swath 810 kms wide.[89] More specifically, an improved camera operates in three spectral bands of visible light (20 meter resolution) and in the near-infrared band (70 meters resolution). A separate camera provides panchromatic coverage of less than 10 meters resolution, along with a wide-angle coverage operating in visible and near-infrared colors with a resolution of 188 meters.[90] The satellite can be tilted 30 degrees to each side to improve its coverage of adjacent areas of interest.[91] In short, the second-generation systems are capable of providing India with targeting data for large targets such as ships, troop units, ports, bridges, etc. Although India's space reconnaissance capabilities are far behind those of the United States, they are improving and are likely to be considerably better by 2010.

Nuclear Submarines. India has been working since 1985 to develop an indigenously constructed nuclear-powered submarine, one that is based on the Soviet *Charlie* II-class design, detailed drawings of which are said to have been obtained from the Soviet Union in 1989. This nuclear submarine project provides a good example of India's industrial capabilities and weaknesses. Although India has the capability of building the hull and developing or acquiring the necessary sensors, its industry has been stymied by several system integration and fabrication problems in trying to downsize a 190 MW pressurized water reactor (PWR) to fit into the space available within the submarine's hull. To finish this project, India is depending on Russian assistance to help solve this problem.[92] Once the vessel is completed, around 2001-2005, it will be equipped with *Sagarika* cruise missiles and an advanced sonar system.[93]

The Nuclear Warhead Issue. India has conducted only one nuclear test (1974), a test which may have

86 Ibid.; and S. K. Seshachandrika, "Commentary Hails Success," *Delhi All India Radio Station*, transcribed in *FBIS-NES-95-144*, July 27, 1995, p. 55.

87 *The Nonproliferation Review*, Spring/Summer 1996, *op. cit.*, p. 163.

88 There are unconfirmed reports that India may have received considerable assistance from Israel in developing its remote sensing satellites.

89 Gayatri Chandrashekhar, "TV On Salient Features," *Delhi Doordarshan Television*, transcribed in *FBIS-NES-95-249*, December 28, 1995, p. 37; and K. Kasturirangan, "Aerospace Technologies: A Terrestrial Focus," *IEEE Spectrum*, March 1994, pp. 39-42.

90 Ibid. The IRS-1C was put into orbit in December 1995. The IRS-1D is to be launched in 1996-97.

91 "India: 6/12/96," *The Nonproliferation Review*, Fall 1996, p. 159.

92 "CIS with India: 6/30/96," *The Nonproliferation Review*, Fall 1996, pp. 119-20.

93 Vivek Raghuvanski, "Technical Snags Frustrate Indian Nuclear Sub Program," *Defense News*, June 24-30, 1996, p. 40; and "India: Early 1996," *The Nonproliferation Review*, Fall 1996, p. 122. Note: there is some confusion as to the type of system and the range capabilities that will be deployed on this submarine. Both ballistic missiles and cruise missiles have been discussed in press reports. Ranges for the weapon system of both 300 kms and 1000 kms have also been reported. See "India Developing Sea-Based Missile System," *Military and Arms Transfer News*, October 7, 1994, p. 12.

only been partially successful with a yield of perhaps 12 kt or less. In the intervening 22 years, India is believed to have produced some 60-200 nuclear devices and made significant progress in refining its bomb-making technology, to include overcoming the problems of miniaturization and boosted fission design (see Figure 4-6). Moreover, since at least 1989, it has been public knowledge that India was working on the development of a thermonuclear explosive device, but the program probably was started prior to 1980.[94]

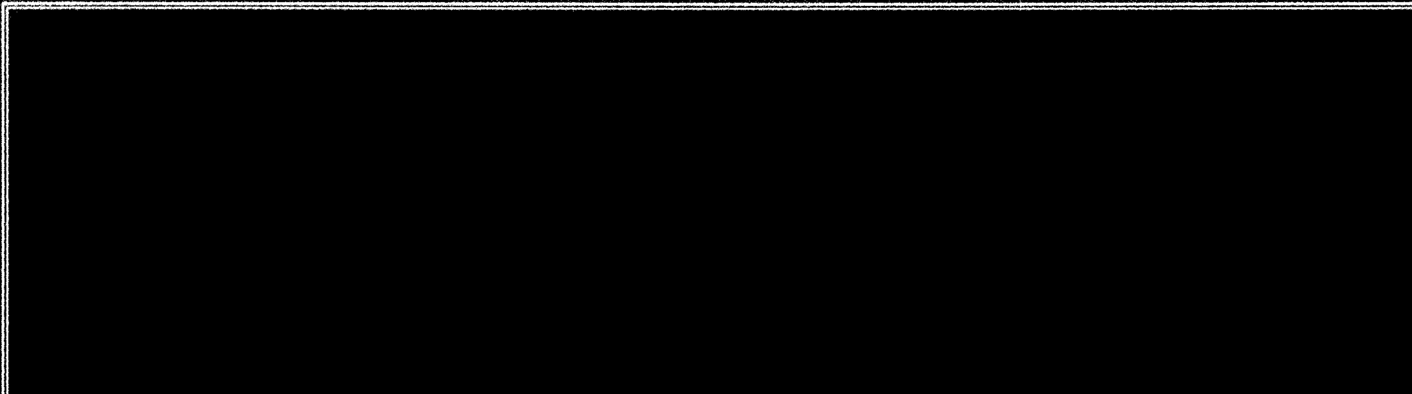
For example, in 1989 William H. Webster, then director of the CIA, testified before a Senate subcommittee that there were indicators that India was interested in developing a thermonuclear device. One indicator Mr. Webster specifically cited was India's effort to isolate and purify the lithium-6 isotope, a key requirement in the production of a thermonuclear system. He also testified that India had purchased beryllium from West Germany, a key indicator that India was producing advanced fission device designs that incorporated the use of a neutron reflector (important for miniaturization).[95]

Since then, there have been recurring reports that India has developed a thermonuclear weapon.[96] Considering the likelihood that the Indian thermonuclear device in question was indigenously designed, Indian leaders and strategists are facing a dilemma: they cannot be certain that their thermonuclear design works, nor will India have much credibility as an international nuclear power unless it demonstrates its nuclear capability.[97] Furthermore, comments by Indian strategists and nuclear scientists make it clear that they would feel more secure if their improved fission devices were also tested to prove their capabilities.[98] On the other hand, a nuclear test will undoubtedly trigger U.S. economic sanctions, which would hurt the country economically.

Regardless of the economic concerns noted above, India came close to conducting a nuclear test in December 1995. Apparently the test hole had been dug and the required instrumentation wiring had been completed at the Pokran nuclear test site in the Rajasthan desert.[99] According to one report attributed to a ranking Indian official, India had been planning to conduct a test of a "hydrogen" device on December 7, 1995, but that test was postponed until mid-December due to last minute snags.[100] In the meantime, U.S. intelligence discovered the preparations and apparently leaked the story. Washington put pressure on India, using threat of economic sanctions, not to conduct the test. Prime Minister Rao canceled the test, but still faced intense public and military pressure to declare India a nuclear power and to proceed as planned in testing its nuclear design.

Although it is believed that the test has not been rescheduled, this issue is not yet over. The pressure to test will grow as India's missile capabilities mature since there is a clear link between India's strategic missile programs and its nuclear capability. India's missile development is fast reaching the point where it must have a reliable nuclear warhead for its strategic missile systems if it is to proceed with the development and fielding of its missile program, a program that is important to achieving its national objective of becoming a major power.[101]

94 W. P. S. Sidhu, "India's Nuclear Tests: Technical and Military Imperatives," *Jane's Intelligence Review,* April 1996, pp. 172-73.
95 David B. Ottaway, "Signs Found India Building An H-Bomb," *The Washington Post,* May 19, 1989, p. A29; and Ali Abbas Rizvi, "The Nuclear Bomb and Security of South Asia," *Asian Defence Journal,* April 1995, p. 27.
96 For some examples see Ali Abbas Rizvi, "The Nuclear Bomb and Security of South Asia," *op. cit.*; and "India: 9/3/95," *The Nonproliferation Review,* Winter 1996, p. 106.
97 For example, see "Nuclear Test Reports Seen As Pressure Tactics," *The Hindu,* transcribed in *FBIS-NES-95-244,* December 20, 1995, p. 64.
98 For example, see Raj Chengappa, "Testing Times: India's Nuclear Policy," *India Today,* December 31, 1995, p. 50.
99 K. P. Nayar, "Roa Under Pressure to Declare Nation Nuclear Power," *op. cit.* p. 52.
100 K. K. Sharma, "India Said To Have H-Bomb, May Test It," *Newsday,* December 27, 1995.
101 Ibid.



India has two research reactors located at the Bhabha Atomic Research Centre (BARC) that produce weapons-grade plutonium. One is a Canadian designed CIRUS 40 MW heavy water reactor (HWR) that began operation in 1960, while the second, the Dhruva, is a 100 MW heavy water reactor of Indian design that began operating in 1985. These two reactors are of the same type that the United States used for plutonium and tritium production at Savannah River. For calculation purposes, a 30 MW reactor roughly produces enough plutonium to make one nuclear weapon per year. These two reactors provide India with perhaps 30 or more kgs of plutonium each year, enough for an estimated 4-5 nuclear weapons, depending on weapon sophistication, design yield, and degree of purity of its plutonium-239. Using moderately advanced designs, 4.5 to 5 kgs of weapons-grade plutonium with a beryllium reflector can generate the critical mass needed for a nuclear explosion; less advanced designs might require 8 kgs.

Most analysts credit India with having 60-85 nuclear weapons, but a few claim that India holds up to 200 nuclear devices. The difference in estimates is attributable to the unknown status of the plutonium extracted from India's six unsafeguarded heavy-water nuclear power plants.

Uranium fuel rods used for electrical power production are burned in a reactor for three to four years. The plutonium produced is radiated to the point where significant amounts of the Pu-239 initially created absorbs additional neutrons (instead of fissioning). As a result, the residual plutonium mix will consist of 60 percent or less Pu-239, 25 percent or more Pu-240, 10 percent or more Pu-241, and a few percent Pu-242. Since weapons-grade plutonium is at least 93 percent or more Pu-239, with the amount of Pu-240 not exceeding 6 percent, the fuel rods in a reactor have to be changed frequently, about every four months or less, to produce weapons-grade material.

The problem with reactor-grade plutonium is that the Pu-240 spontaneously engages in a high rate of fission (i.e., it is unstable and throws off neutrons). In a kilogram of reactor-grade plutonium the average time between spontaneous fissions is less than a micro-second (one-millionth of a second). When several kgs of reactor grade material are inserted into a nuclear device, the mean time between spontaneous fissions is a fraction of a micro-second, thus introducing a high risk that during implosion, the weapon will begin a nuclear chain reaction sometime after it reaches the prompt-critical state, but before it reaches the optimum implosion state. Consequently, a nuclear weapon with a high percent of Pu-240 will achieve an unpredictable yield that falls somewhere between a low of 1 kt and its calculated expected design yield (since the spontaneous fissioning of the Pu-240 will tend to trigger the nuclear chain reaction prematurely).

The United States sells light water reactors for commercial use. In contrast to heavy water reactors, light water reactors have to be shut down to change their fuel rods. Usually, one-third of the fuel rods are changed during each annual shutdown. Consequently, national intelligence assets are provided with visible evidence that fuel rods are being changed. Due to the shutdown requirement, changing fuel rods in light water reactors is expensive as the system is off-line during fueling operations. As a result, the design provides an its own incentive for keeping the rods in place as long as possible, thus producing reactor-grade plutonium.

However, the Indian reactors are based on the CANDU heavy water reactor design, which do not have to be shut down in order to change fuel rods, nor is there any signature visible outside of the reactor that indicates the fuel rods are being changed. Consequently, it cannot be determined with certainty the size of India's nuclear stockpile, since India could be harvesting weapons-grade plutonium from its commercial power plants by changing some of the fuel rods often.

Primary Source: Nuclear Nonproliferation Fact Book, *op. cit.*, pp. 471, 481, & 547-48.

Figure 4-6

Although a fission device will work well against potential targets in Pakistan, the sprawling urban areas of China warrant thermonuclear warheads that can deliver the big blasts needed to make India's missile program cost effective. Moreover, thermonuclear weapons have much lower weight-to-yield ratios than do fission devices because thermonuclear systems use a small 10-15 kt primary fission device to trigger a fusion secondary pit that can be built to produce blasts in either the kiloton or megaton range.[102] Since the deuterium-tritium fusion reaction gives 3.4 times more energy per unit mass than fission,[103] a thermonuclear warhead is ideal for missile systems due to their lighter relative weights and higher yields. Without a reliable thermonuclear warhead, India's nuclear capability could be limited to heavier weapons that use larger amounts of fissile material to produce yields below a maximum limit of about 500 kt.[104]

Other Weapons of Mass Destruction. India has the infrastructure required to develop chemical weapons (CW) and biological weapons (BW), but probably has conducted only research associated with defensive measures.[105]

Missile Defenses. India is concerned with establishing defenses against Pakistan's missile systems. Although the Indian *Akash* surface-to-air missile is being developed with an anti-missile capability incorporated, India is seeking a more advanced system. Consequently, it has been negotiating with Russia for an initial purchase of six S-300V (U.S. SA-12B *Giant* designation) missile systems. The deal apparently will include subsequent licensed production of some additional systems. India claims to want these systems for the defense of New Delhi and Bombay.[106]

India's Potential As a Source of Proliferation

India is interested in selling defense goods and services, space access (and derived products), and nuclear power plants. In seeking these sales, India has taken action to strengthen and better organize its export operations. As a result, several new organizations have been recently established and charged with the task of increasing India's exports in their respective areas of responsibility. These organizations include:

- **India Nuclear Power Forum**. The Nuclear Power Corporation of India launched this new consortium with the intent of building nuclear power projects in India and abroad.[107] As was explained earlier in Figure 4-5, India is not an NPT member, and its PHWRs are excellent plutonium producers that can be used to produce weapons-grade plutonium without detection from collection assets located outside of the power plant (unless special safeguard provisions are established). On the other hand, India's nuclear power plants also are plagued by quality control problems and safety concerns which may limit the appeal of these reactors abroad.[108] Unanswered is the question of how India might handle the nuclear safeguard issue on the nuclear reactors and related nuclear fuel-cycle technologies that it might export.

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102 The 10-15 kt figure is based on U.S. nuclear systems as noted in *Nuclear Weapons Data Book*, Volume V, *op. cit.*, p. 358.

103 *Nuclear Proliferation Factbook*, *op. cit.*, p. 477. This reference contains a very complete discussion of nuclear issues and is recommended reading for those who might wish to pursue the technical aspects of nuclear weapons beyond that discussed in this report.

104 W. P. S. Sidhu, "India's Nuclear Tests: Technical and Military Imperatives," *op. cit.*, p. 171. The author claims about 500 kt is the maximum yield that can be achieved with a fission device. An independent check with other nuclear experts confirmed that information.

105 U.S. Department of Defense Report: Proliferation, Threat and Response, April 1996, p. 38.

106 "India with Russia: 2/12/96," *The Nonproliferation Review*, Fall 1996, pp. 159-60; Anatoliy Yurkin, "Russia Prepared to Supply S-300 Missile System to India," *ITAR-TASS World Service*, translated in *FBIS-TAC-97-003*, March 4, 1997; and Vivek Raghuvanski, "India Mulls Russian Air Defense Deal," *Defense News*, February 24-March 2, 1997, p. 6.

107 "India: Consortium Will Be Launched To Build Nuclear Power Plants," *All India Radio Network*, transcribed in *FBIS-NES-96-189*, September 26, 1996.

108 Darryl D'Monte, "India: Nuclear Industry Seen As Unsafe," *The Telegraph*, transcribed in *FBIS-TEN-96-006*, May 16, 1996.

- **Antrix Corporation of Bangalore**. This autonomous organization is the commercial division of the Indian Space Research Organization (ISRO). Antrix was created to export space technology. An example of one of its operations was noted earlier with regard to its deal with EOSAT to market Indian satellite photography. Unanswered is the issue of how Antrix (and India) will handle the MTCR guidelines. Considering that India has been a bitter opponent of the MTCR and has had its own missile development program slowed by MTCR restrictions at considerable cost to the Indian government, the possibility exists that India may be willing to export missile technologies restricted under MTCR guidelines—either openly or covertly.

- **Defense Exports Board.** The creation of this board was approved by the Indian Cabinet in September 1995. The new board will be modeled on the Antrix Corporation (discussed above). The board's purpose is to sell weapons and technology produced by the DRDO, state-owned defense manufacturers, and ordnance factories.[109]

- **Joint Secretary (Exports), Ministry of Defense.** This post is believed to have been created in the early 1990s to coordinate the export of indigenously manufactured weapon systems.[110]

In an effort to better advertise its defense wares, in September 1994 the Indian Ministry of Defense published the first edition of a new catalogue entitled *Indian Defence Products.* In the forward, signed by the Defense Minister, prospective customers were directed to address requests for complete information on products to the Joint Secretary (Exports). Of interest is the entry on page 52 of the catalogue lists all of the *Prithvi's* ancillary equipment and missile fuel as being available for export.[111] It is generally believed that the missile itself will be offered for export. Although the *Prithvi I's* range is probably below the MTCR guidelines (of which India is not a member state), the reported sophistication of its guidance system and the maneuverability of its trajectory may make it an item of interest to other states with indigenous missile development programs. (Note: although the *Trishul* SAM system was listed as being available, the *Agni* was not mentioned.)

Long-term, India could prove to be a troublesome source of proliferation. Most of the defense goods that it manufactures are either not in demand, as they represent low-technologies that are available from many sources in excessive quantities, or they are sensitive technologies that the United States is trying to control to slow proliferation. In this sense, India will likely face the same problem that China is facing. If it wants to export defense industrial products, the greatest demand likely will be for missile and nuclear technologies.

Of particular concern is the growing relationship between India and Iran. Both countries have felt abused by the United States; both have needs supplied by the other. Iran needs and is receiving Indian assistance in maintaining its Russian-built *Kilo* submarines and the other $5 billion in weapon systems that it obtained from Russia under a 1989 agreement.[112] On the other hand, with Iran providing India access to Central Asia as well as being India's biggest supplier of oil, Iran is well-positioned to bargain for Indian assistance in missile and nuclear technology. Exacerbating the situation is the simple fact that India has a problem with corruption. Thus, a close relationship between these two states will also provide Iranian officials with added opportunities to gain unofficial access to

109 "India: Early 9/95," *The Nonproliferation Review,* Winter 1996, p. 171.

110 Dinesh Kumar, "Prithvi, Other Missiles Available for Export," *The Times Of India,* transcribed in *FBIS-NES-96-010,* January 16, 1996, p. 72.

111 Ibid., pp. 71-72.

112 "Iran Woos India, Looking for Options in Asia," *op. cit.*

some of India's more sensitive technologies, technologies they have already shown an interest in obtaining.[113]

While a number of these potential concerns are but suppositions at this point in time, it cannot be denied that India has a number of technologies that are fast becoming sufficiently advanced to attract the interest of the world's would-be proliferators. It is very possible that leakage of Indian technology could well become a growing issue for future Indo-American relations; it could also prove a very challenging situation with which to deal. Although India is vulnerable to U.S. threats of economic sanctions, this tool may only be effective if it is not actually used. The possibility exists that if the United States should ever impose blanket sanctions, India might assume that it no longer had anything to lose, declare itself a nuclear power, and begin nuclear testing.

Conclusions: India

India, a land rife with serious internal problems, appears capable of surprising the world by emerging as nuclear capable nation with ICBMs in the 2000-2010 time frame (depending on how much time the program is delayed due to U.S. diplomatic pressure and MTCR impediments). Even if the indigenous development effort is slowed, India has the technological capability of emerging as a nuclear armed power with ICBMs in a window of about 5 to 8 years from the time it makes a decision to do so. In addition, as discussed in Chapter 2, there seems to be some possibility that India might in the future be able to obtain the mobile *Topol* M ICBMs (SS-X-27s) from Russian sources.

Although it is not believed that India intends to use missile capabilities actually to strike the United States, it may be tempted to wave it as a deterrent gesture in cases where it feels the United States is interfering with its vital national interests. At the same time, India is a poor country that needs economic ties with the United States. Consequently, India would have to feel hard pressed before it engaged in direct confrontational actions. Of perhaps greater concern is the fact that India needs cash, but its options for exporting defense goods to help offset its security costs are limited.

Missiles, software, nuclear technology, and related products are among the most salable defense items that India will soon produce. Although India is not likely to act in a totally irresponsible manner in transferring these technologies, it is conceivable that its definition of acceptable transfers may well differ from that held by the United States. As a complicating factor, corruption in India is a significant problem, which raises the possibility that some of this sensitive technology could be transferred to other parties outside of official channels. Consequently, India could well become a contributing source to the spread of proliferation-related technologies. While the case should not be overstated, there is some risk that the Indo-American friction that may result from this situation could sour relations and push India into aligning its foreign policy with other states that are actively seeking to frustrate U.S. interests in Asia.

Pakistan: A Gateway to Westward Proliferation?

The term "Pakistan" is an acronym coined in 1933 in anticipation of the creation of a Muslim-dominated state separate from the political system that would govern Hindu-dominated India. The acronym represents *P* for Punjab, *A* for the

[113] See, for examples, Kenneth R. Timmerman, "Opportunities for Change in Iran," in *Fighting Proliferation: New Concerns for the Nineties,* ed. Henry Sokolski (Maxwell Air Force Base, Alabama: Air University Press, September 1996), pp. 232-33; and "India with Iran: 4/17/97," *The Nonproliferation Review,* Fall 1995, p. 94.

Pakistan

Afghanistan border states, *K* for Kashmir, *S* for Sind, and *TAN* for Baluchistan. With independence in 1947, these diverse ethnic groups were infused with Muslim immigrants from India (called Mahajir). Unfortunately, the resulting state is one that is still very fragile, a state that is highly fragmented by ethnic differences.

Even religion has not proven to be a totally unifying factor for the Islamic Republic of Pakistan. Sectarian violence is common between Pakistan's Muslim Sunni majority and its 15 percent Shia minority. This conflict has created a Sunni-Shia situation that is reflective of Protestant-Catholic relations in Northern Ireland. Shootings, killings, and beatings are the hallmarks of this relationship.[1] Yet, in spite of the strongly religious currents that influence Pakistani society, Pakistan's voters have made it clear that they want a secular government. For example, only 8 percent of the vote in the October 1993 election was won by religious-political parties.[2] Yet, Islamic fundamentalists still exert a major influence on Pakistan's political process as they have the capability of making themselves felt on individual issues, turning large crowds into the streets to demonstrate for their positions.

Economic factors have also added to the divisiveness that marks the country. Prior to independence, the areas that make up the current state of Pakistan were primarily based on agrarian economies, with most of the wealth held by about 300 families that owned large tracts of land that operated under a feudalistic system. Since independence these elites have continued to hold the reins of political power and have enjoy disproportional benefits from this state of affairs. This feudal hierarchy is now beginning to crumble.

Large numbers of people are migrating to the cities with, for example, the port city of Karachi now accounting for at least 10.2 million people and 30 percent of the nation's revenue.[3] Within the next 15 years, it is estimated that at least half of Pakistan's population may dwell in urban areas,[4] resulting in an emerging middle class which is agitating for a more equitable distribution of

1 Iftikhar H. Malik, "The State and Civil Society in Pakistan," *Asian Survey*, Vol. XXXVI, No. 7, July 1996, pp. 684-85.
2 Malik, "The State and Civil Society in Pakistan," *op. cit.*, p. 677.
3 Saeed Shafqat, "Pakistan Under Benazir Bhutto," *Asian Survey*, Vol. XXXVI, No. 7, July 1996, p. 670.
4 Malik, "The State and Civil Society in Pakistan," *op. cit.*, p. 679.

political power, power which is currently monopolized by Pakistan's landed elites.[5]

Even so, Pakistan's central government exercises only limited political control; it is held in general contempt by the public; its political process is characterized by crude political ploys to hamper opposition parties; and it has been ineffective in dealing with the rampant ethnic and sectarian violence that has claimed thousands of lives during the last few years.[6] In addition, even though Pakistan's military gave up direct rule of the country after General Zia was killed in a plane crash in August 1988, the military establishment and the related ISI (interservices intelligence) Directorate are only minimally responsive to the directions of the civilian controlled governments. Since 1988, the civilian governments in Pakistan have all been "guided" by the military with the prime minister's powers limited with regard to military matters.[7] As a result, security decisions, foreign policy-related actions, and decisions regarding the disposition of WMD systems have sometimes been taken or acted upon without the knowledge or consent of Pakistan's elected officials.[8]

In formulating its foreign policy, Pakistan's primary concerns are a reflection of its history and domestic situation. Of utmost concern is the Indian threat and the status of Kashmir (the *K* in Pakistan's name). Secondly, Pakistan is looking for commercial development opportunities, but its major prospect for commercial growth lies in opening a trade route to Central Asia which can only be accessed via Afghanistan. In seeking to become Central Asia's conduit to the world, Pakistan is entering into direct competition with Iran, which is also seeking this role. At the same time, Pakistan has long hoped to develop closer relations with other Islamic states, to include Iran. As will be briefly described, much of Pakistan's security policies flow from these factors.

India. As was discussed earlier, Pakistan and India have fought three wars and conducted confrontational diplomacy for most of their 50-year history as separate nations in South Asia.[9] However, in this match, Pakistan has only one-fourth of the land area and less than one-sixth of the population of India, putting Pakistan in the position of David facing the Indian Goliath. Based on its experience in the 1971 war over Bangladesh, Pakistani strategists believe that India could further dismember their country (perhaps by splitting the country through the restive province of Sind, separating the capital at Islamabad from the economic center at Karachi) and defeat Pakistan's conventional forces in about two weeks. Following the explosion of India's nuclear device in 1974, Pakistan became even more alarmed about India's military capabilities. At that time, Pakistan's then-Prime Minister, Zulifikar A. Bhutto, made his famous declaration that Pakistanis would "eat grass" rather than surrender

5 Pakistan has not conducted a census since 1981. The landed elites that hold political power do not want to determine a new official distribution of the population as they believe it would lead to a reapportionment that would erode their political power base. See Marcus W. Brauchli, "A Rising Middle Class Clamors for Changes in Troubled Pakistan," *The Wall Street Journal*, December 14, 1995, pp. A1, A6.

6 Ibid., pp. 670-72.

7 For example, see Malik, "The State and Civil Society in Pakistan," *op. cit.*, pp. 676-78.

8 For more complete insights into Pakistan's internal situation, see the series of articles published in *Asian Survey*, Vol. XXXVI, No. 7, July 1996, pp. 639-90; and Hersh, *op. cit.*, pp. 60-65.

9 It should be noted that India and Pakistan signed an agreement in 1988 not to attack each other's nuclear facilities. To this end, on the first of January of each year, they exchange lists of nuclear installations and facilities. See "New Delhi, Islamabad Nuclear Lists Exchanged," *Delhi All India Radio Network*, transcribed in *FBIS-NES-96-001*, January 1, 1996. There are also reports that India and Pakistan have become much more cautious in their actions toward each other since their confrontation in 1990, which was discussed in the section dealing with India.

their nuclear option. This idea that Pakistan's security rests on a nuclear capability has gained strength over the years.[10]

Iran. In the early 1990s, key Pakistani elements entertained hopes of establishing a strategic alliance with Iran and other regional Islamic states to offset an expected tilt of the United States toward India.[11] As a further incentive, Pakistan is concerned about the growing level of Hindu nationalism in India. While in pursuit of a strategic alignment with other Islamic states, the Pakistani Chief of the Army Staff, General Beg, became a great admirer of Iran's implementation of Islamic rule and subsequently got well out in front of the political process in promoting a strategic-military alliance with Iran.[12] As will be discussed later, this relationship probably included the transfer of sensitive information (and perhaps equipment) related to nuclear weapon development.

As the 90s unfolded, however, relations between Pakistan and Iran began to become somewhat strained:

- Pakistani officials began to suspect that Iran (the only Islamic state with a Shiite majority) was involved in agitating Pakistan's Shia community, thus feeding the growing unrest among its Shiite population;[13]

- Relations between Iran and India warmed, including formal cooperative arrangements between those two states to open trade routes through Iran to the Central Asian republics. This agreement put those states into direct competition with Pakistan for the role of providing the Central Asian outlet to the sea;

- Iran has long been uncomfortable with Pakistan's pro-American orientation. The strain between Iran and Pakistan appears to be exacerbating Iran's unhappiness with Pakistani-American ties as Iranian commentators increasingly claim that Pakistan acts as a conduit into the region for American foreign policy; and

- The development of events in Afghanistan placed Pakistan and Iran on opposite sides of the political fence. The Afghanistan situation included Indian, Iranian, and Russian cooperation with the Rabbani government of Afghanistan, raising the prospect that Pakistan was being surrounded by unfriendly states.

Afghanistan. Afghanistan is a key element in the relationships among Iran, Pakistan and, to some extent, India. The main elements of concern are trade with Central Asia and influence in those states. Pakistan is staking its commercial future in Central Asia on a Tashkent-Karachi transportation link and the enterprise of its businessmen.[14] Although Pakistan undoubtedly would enjoy having access to Central Asia via Afghanistan's main road that runs north from Kabul, in 1994 it explored

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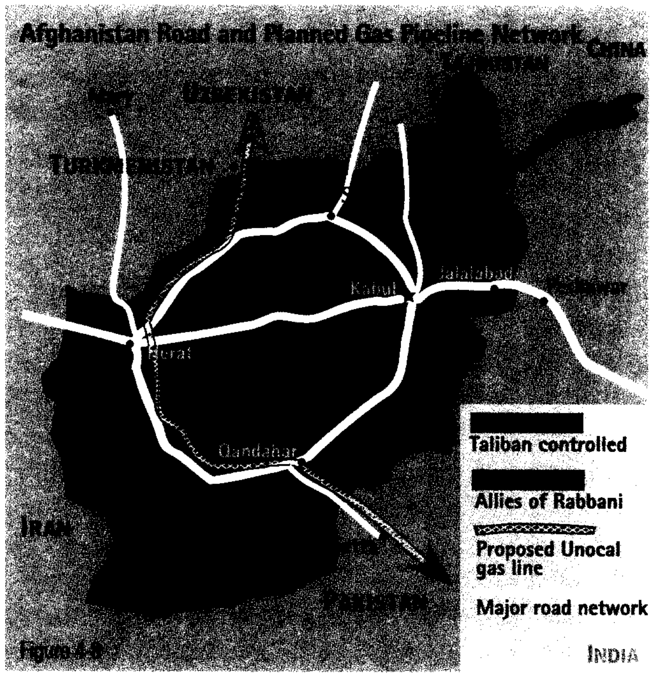
10 For example, see the comments of Pakistan's former Foreign Minister in "Pakistan: Editorial Urges Continuation of Nuclear Program," *Nawa-I-Waqt*, translated in *FBIS-NES-96-234*, December 4, 1996.

11 Malik, *op. cit.* p. 79.

12 Robert B. Oakley, "Opportunities and Prospects for Cooperation on Asian Security Issues—Central and West Asia," *The United States and India in the Post-Soviet World: Proceedings of the Third Indo-U.S. Strategic Symposium*, Institute for National Strategic Studies, National Defense University, 1993, p. 153; and Hersh, *op. cit.*, p. 62.

13 Private conversation with a South Asian expert, U.S. Department of State, under conditions of nonattribution, November 1996.

14 Oakley, *op. cit.*, p. 149.



and proved the feasibility of using the alternative western Afghanistan route to the north through Herat to Turkmenistan.[15] Pakistan hopes to repair and open this 550-mile road network. See Figure 4-8.

However, under Rabbani's administration of Afghanistan, Pakistan's aspiration of developing a trade route to Central Asia was being dashed. The key events that contributed to this situation included:

- Pakistan, under General Zia, had supported Rabbani's rival, Hekmatyar. When Rabbani took power in Afghanistan, Pakistan declared the Rabbani government illegitimate;[16]
- Pakistan's embassy in Kabul was subsequently sacked and closed by Rabbani supporters;[17]
- Iran, India, and Russia established close relations with the Rabbani administration[18] (Indian involvement with the Rabbani government was of particular concern);[19] and
- Pakistan found itself closed out of much of Afghanistan.

In 1994, Pakistan helped create the radically fundamentalist Taliban (literally means "Islamic students") faction, which was largely recruited from Afghan students attending Koranic schools in Pakistan.[20] As the situation between Afghanistan and Pakistan deteriorated, Pakistan seems to have increased its assistance to this group. According to some reports, this assistance was either covertly or tacitly approved by the United States and supported by Saudi Arabia.[21] Some believe that the $3 billion contract for Unocal and Delta Oil to build a gas pipeline from Turkmenistan, across Afghanistan to Pakistan helped influence U.S. support for a Taliban takeover in Afghanistan.[22] At the same time, other press accounts claim that U.S.-Pakistani relations soured over Pakistan's support of the Taliban.[23]

15 Alex Spillius, "Neighbours Seek Gains in Divided Afghanistan," *The Daily Telegraph,* October 16, 1996, p. 17.

16 "Editorial Views Tehran's Mediation of Islamabad-Kabul Talks," *The Nation,* transcribed in *FBIS-NES-96-016,* January 23, 1996.

17 Ibid.

18 Mariana Baabar, "Pakistan: Indian Delegations Hold Secret Meetings With Rabbani," *The News,* transcribed in *FBIS-NES-96-078,* April 21, 1996; and "India: Pakistan Seen as Conduit for U.S. Influence in Afghanistan, *Indian Express,* transcribed in *FBIS-NES-96-207,* October 21, 1996.

19 There are a number of unspecified reports of possible Indian assistance to the Rabbani government as, for example, "Afghanistan's Neighbours Carry On Playing the Great Game," *Jane's Defence Weekly,* December 9, 1995, p. 14; and Mariana Baabar, "Pakistan: Indian Delegations Hold Secret Meeting With Rabbani," Islamabad *The News,* transcribed in *FBIS-NES-96-078,* April 21, 1996. One interesting Pakistani press report, "Pakistan: Indian Efforts to Gain Influence in Afghanistan Reported," *The Muslim,* transcribed in *FBIS-NES-96-059,* March 23, 1996, cites specific details. It claims India provided selected military equipment assistance to the Rabbani government, positioned an assistance team of 60 Indians in Kabul, trained 28 Afghan pilots in India, *assisted Afghanistan in making their Scud B missile systems operational,* and detailed 9 Indian pilots to Kabul—pilots who reportedly took part in an air raid on December 9, 1995, in which 27 Talibans were killed.

20 See "Afghanistan: Taliban Official Claims India, Iran Supplying Alliance," *Hong Kong AFP,* transcribed in *FBIS-NES-96-214,* November 4, 1996; and K.K. Katyal, "India: Invitation to Tehran Conference on Afghanistan Viewed," *The Hindu,* transcribed in *FBIS-NES-96-211,* October 29, 1996.

21 For examples, see "U.S. Makes Bad Call On Afghanistan," *Intelligence Digest,* October 4, 1996; "India: Pakistan Seen As Conduit for U.S. Influence in Afghanistan, *Indian Express,* transcribed in *FBIS-NES-96-207,* October 21, 1996.

22 "Afghanistan: La Route du Gaz," *Le Figaro,* September 30, 1996. According to this French article, President Clinton wrote the President of Turkmenistan to request his support for this contract. The construction contract was signed on October 21, 1995, six weeks after the Taliban secured Herat on September 5, 1995. Other sources claim the U.S. supported the Taliban as part of its Iranian containment strategy.

23 "U.S. Accuses Pakistan of Supporting Afghan Taliban," Asian Defence Journal, March 1996, p. 88.

In 1995, the Taliban was successful in securing the five southern and western provinces of Pakistan, to include the city of Herat. In 1996, in a series of attacks that incorporated the use of armor, aircraft, and perhaps Pakistani advisors, the estimated 40,000-50,000 strong Taliban was successful in expanding its control to encompass 70 percent of Afghanistan, to include securing Kabul on September 27, 1996.[24] See Figure 4-9.

As of the end of 1996, the three main anti-Taliban groups (generally representing the Tajik-, Uzbek-, and Shiite-oriented factions) are holding northern Afghanistan under Rabbani,[25] who still enjoys recognition by Iran, India, and Russia as head of the legitimate government of Afghanistan.[26] It is questionable if the Pushtun-dominated Taliban will be able to subdue this northern sector (an ethnic/religious issue).

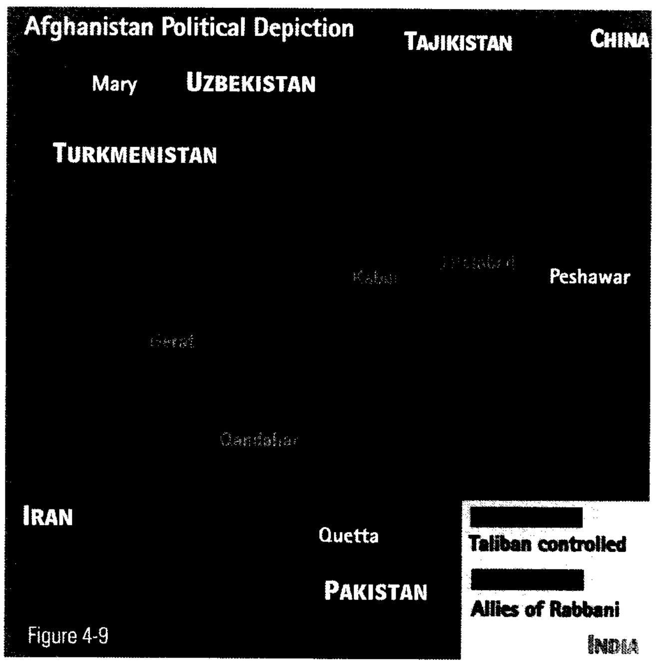


Figure 4-9

The successful results achieved by the Taliban hold some downstream risks. These include:

- Iran is unhappy with the extreme Islamic radicalism of the Sunni Taliban;[27] also, it is not in Iran's interest to have Afghanistan dominated by forces allied with Pakistan. Moreover, the Shiites, who are the predominant sect in the Persian-speaking area around Herat, are also upset with the Taliban's strict governance of that region and look to Iran for assistance.[28] For its part, Iran has been training and equipping a force reportedly consisting of an 8,000-member Shia-dominated Afghan group in eastern Iran (a group that was driven out of Afghanistan in September 1995 when Herat fell to the Taliban). Iran apparently is assisting that group in its preparation to try to retake the Herat area.[29] The accompanying tensions have caused some very discreet "saber-rattling" between Iran and Pakistan, while the two countries have maintained a public image of apparent friendly relations.[30]

- Roughly 90 percent of all Muslims are of the Sunni sect. The only major Islamic country which is controlled by the Shia branch of Islam

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24 For examples, see Ibid.; Spillius, "Neighbours Seek Gains in Divided Afghanistan," *op. cit.*; "Afghanistan's Neighbours Carry On Playing the Great Game," *op. cit.*; and "Commentary Accuses Pakistan of Interfering in Afghanistan," *Delhi All India Radio Network*, transcribed in *FBIS-NES-96-034*, February 17, 1996. There is one unconfirmed report that Russian military sources claim that Taliban has 40,000 men, 200 tanks, and 20 combat aircraft. See "Big Dangers Ahead in Afghanistan," *Intelligence Digest*, October 11, 1996.

25 "Afghan Factions: Shifting Alliances in Continuing Civil War," *The Washington Post*, October 23, 1996, p. A29; and Anthony Davis, "Rabbani Drops National Army for Guerrilla War, *Jane's Defence Weekly*, November 27, 1996, p. 14.

26 "Afghanistan: Taliban Officials Accuses Russia, Iran, and India of Aggression," *Hong Kong AFP*, transcribed in *FBIS-NES-96-207*, October 24, 1996.

27 Ibid.

28 For example, see Spillius, *op. cit.*

29 "Afghanistan: Taliban Official Claims India, Iran Supplying Alliance," *op. cit.*; and "Big Dangers Ahead in Afghanistan," *Intelligence Digest*, October 11, 1996.

30 For example, see "Pakistani Envoy to Tehran Discusses Afghan Problems," *Tehran Times*, transcribed in *FBIS-NES-96-013*, January 10, 1996.

is Iran. As such, Iran and its Shia beliefs have only limited appeal to other Islamic countries, all of which are dominated by Sunnites. Unfortunately, the Sunni Taliban, according to one report, contains a powerful faction that would like to become the leader of a worldwide Jihad (holy struggle) movement.[31] For Iran, this has to be a disturbing development. It sees the Taliban as hostile towards Iran and perhaps the Shia sect.[32] If the Taliban should eventually lead a successful Jihad movement, it could have the potential of being more potent than Iran's efforts because it might better appeal to the dominant Sunni majority. A Sunni-led Jihad could also earn the Taliban and Pakistan the enmity of both Russia and China if the Islamic populations of Central Asia and western China should come under the influence of such a movement.

- Reportedly, the Islamic movement in Kashmir has been encouraged by the success of the Taliban in Afghanistan.[33] Perhaps more importantly, there is some worry that a Taliban victory may well inspire other Islamic movements that are fighting to oust secular pro-Western governments throughout the Middle East.[34]

Pakistan and the "Bomb"

Pakistan has been successful in collecting much of the foreign technology and equipment that it needed to support its nuclear program. Its nuclear support operations have included a combination of theft, smuggling, and deliberate foreign assistance.

The head of Pakistan's nuclear weapons program is Dr. Abdul Qadeer Khan, the German-educated metallurgist who is the director of Pakistan's nuclear-weapon laboratories at Kahuta.[35] Previously, Dr. Khan was employed at the uranium enrichment facility, Urenco, in Almelo, Netherlands. It is suspected that he stole a copy of uranium centrifuge blueprints from this facility in 1975,[36] one year after India exploded its "peaceful" nuclear device. Armed with these blueprints and a list of Urenco's key suppliers of components,[37] he returned to Pakistan and shortly thereafter was appointed to his current position.

Pakistan established an extensive international network of suppliers in order to acquire the technology and specialized equipment needed in its nuclear program. Much of this material came from the West, to include Germany, Switzerland, Sweden, Canada, and the United States.[38] In this effort, Pakistan successfully established a number of dummy companies, trans-shipped dual-use materials through multiple countries, or outright stole or smuggled needed components.[39] Of interest, during the 1980s Pakistan is believed to have obtained some stocks of tritium gas.[40] More importantly, in 1987, it successfully imported the technology needed for collecting and purifying indigenously the tritium needed for its nuclear pro-

31 "The Taleban and the Arab Afghans," *The Intelligence Digest*, October 25, 1996.

32 For example, the Iranian-backed Afghan Shiite leader died while in Taliban custody. "South Asia: Nuclear Report Adds to South Asian Jitters," *op. cit.*

33 "U.S. Makes Bad Call On Afghanistan," *op. cit.*

34 Ibid.

35 Hersh, *op. cit.*, p. 59.

36 "Early Warnings on Pakistan," *Middle East Defense News*, October 12, 1992.

37 Kathleen C. Bailey, *Doomsday Weapons in the Hands of Many* (Chicago: University of Illinois Press, 1991) p. 24.

38 For examples, see Ibid.; "Early Warnings on Pakistan," *op. cit.*; Hersh, *op. cit.*, p. 57; and Marcus Warren, "Pakistan's Nuclear Program at a Screwdriver Level," *The Washington Times*, February 20, 1996, p. A1.

39 For examples, see Bailey, *op. cit.*, p. 25; Rai Singh, "Indian Commentary Views Alleged Nuclear Smuggling by Pakistan," *All India Radio General Overseas Service*, transcribed in *FBIS-TAC-96-003*, February 6, 1996; and E.A. Wayne, "Bhutto Denies Pakistan Has Nuclear Weapons," *The Christian Science Monitor*, June 9, 1989, p. 7.

40 Wayne, "Bhutto Denies Pakistan Has Nuclear Weapons," *op. cit.*, p. 7; and "Can the U.S. Rely On China's Export Promises," *Risk*, May 1996, p. 8. The first report claims the tritium came from Germany, the second states that China provided the tritium according to German officials.

gram.[41] (Tritium is a hydrogen atom with two added neutrons in the nucleus. It is used in a mix to boost the yield and lower the weight of fission devices by adding additional neutrons to the chain-reaction process of a nuclear detonation, thereby greatly increasing the number of U-235 or Pu-239 atoms that are split prior to the disintegration of the weapon's integrity.)

Similarly, Pakistan has harvested a significant amount of international nuclear knowledge. As alluded to in the preceding paragraph, Pakistan gained a significant amount of nuclear-related equipment from Germany. It is instructive to examine a case study of the outcome that occurred when a government cracked down on the exports of a company providing dual-use technology to a proliferator. In this case, a Germany company, Leybold, had been engaged in questionable sales to Pakistan. When this company showed up on the U.N.'s December 1991 list of 13 companies that had provided supplies to Iraq's nuclear program, the German government increased its scrutiny of Leybold's operations. Subsequently, Leybold's overseas nuclear-related sales dropped as much as 30 percent and the company was forced to layoff up to 1000 employees, including nuclear engineers. Many of the nuclear specialists gravitated to private consulting companies. U.S. intelligence sources are said to regard these consultants as a threat because many of them are still working with their former clients.[42] Although the client countries are not named, it would be surprising if Pakistan were not included.

Likewise, nuclear and missile specialists in Russia are working with Pakistan via computer modem to solve problems associated with nuclear and missile development.[43] When this picture is linked to the help Pakistan is receiving from Chinese technicians, some of whom have been present at Kahuta since the mid-1980s,[44] it becomes clear that the international flow of nuclear and missile knowledge, in concert with the overall global flow of technology and equipment, is also contributing to Pakistan's development of an indigenous nuclear and missile capability.

In addition (as noted in the Indian section), in 1982 or 83, Pakistan's nuclear program received a big boost from China when it apparently provided Pakistan with the blueprints for a 1966 design of a U-235 nuclear-implosion device.[45] Reportedly, U.S. intelligence was able to obtain a copy of this design when it clandestinely searched the briefcase of Dr. Abdul Qadeer Khan.[46] According to one report, the design was for the warhead that China exploded during its fourth nuclear test on October 27, 1966,[47] when a DF-2A missile was live-fired a distance of 894 kilometers to detonate its nuclear warhead at the Lop Nur test site.[48] This particular missile warhead weighed 1290 kgs and produced a yield of about 12 kt (about the same yield as India's 1974

41 Bailey, *op. cit.*, p. 25; and Andrew Koch, "Nuclear Testing in South Asia and the CTBT," *The Nonproliferation Review*, Spring/Summer 1996, p. 102 (end note 5).

42 "Early Warnings on Pakistan," *op. cit.*

43 Alan Cooperman and Kyrill Belianinov, "Moonlighting by Modem in Russia," *U.S. News and World Report*, April 17, 1995, p. 45.

44 Presentation by a noted nonproliferation expert, February 29, 1996. The information was provided on a nonattribution basis.

45 Ali Abbas Rizvi, *op. cit.*, p. 22; "Can the U.S. Rely On China's Export Promises," *Risk, op. cit.*, p. 8; and private conversation with Leonard Spector, Carnegie Endowment for International Peace, February 29, 1996. The date that China transferred the nuclear design plans to Pakistan is usually cited as occurring during the early 1980s. Leonard Spector's research indicates the date was around 1982. The article in *Risk* claims that U.S. intelligence discovered in 1983 that China had transferred the design to Pakistan. The *Risk* article also states that "American agents even learned the catalog numbers of some of the weapon's parts and produced a model of the bomb to show Pakistani diplomats."

46 Ian Brodie, "Spies Proved China Helped Pakistan Get Nuclear Bomb," *The Times*, April 2, 1996, p. 14. According to this report, U.S. nuclear specialists constructed a model of the Pakistani bomb based on Khan's blueprints; the model was shown to Prime Minister Benazir Bhutto.

47 Pravin Sawhney, "Standing Alone: India's Nuclear Imperative," *Jane's International Defense Review, " November 1996*, p. 27.

48 *Nuclear Data Book*, Vol. V, *op. cit.*, p. 420.

nuclear explosion).[49] (The warhead's potential yield apparently was rated at 20-30 kt.)[50] Using the technology and information gained, according to one U.S. official's reported comment, Pakistan has had the ability to make a nuclear bomb with a "few turns of a screwdriver" since 1990;[51] Pakistani sources claim that status as of October 1991. Based on other evidence and comments made by former Chief of the Pakistani Army, General Beg, there is an unsubstantiated claim that Pakistan may have been capable of producing a nuclear weapon as early as 1987.[52]

To counter this proliferation problem, the United States expended a lot of effort trying to get Pakistan to cap and roll back its nuclear program. During the first half of the 1990s, Pakistani elites claimed that Pakistan had voluntarily capped its nuclear program. Although generally echoed by U.S. officials, this claim is now suspect. According to General Beg, while Pakistan cut back on its nuclear production in 1989, the program was never stopped.[53] Beg's point seems substantiated by Dr. A.Q. Khan's claim that "no government has ever yielded to international pressure to close down the project or freeze the nuclear program."[54]

This program, as discussed earlier, has provided Pakistan with an air-deliverable nuclear weapon (a bomb). What has been more problematic is whether or not Pakistan has been able to configure the weapon for delivery by missile. As stated previously, when China tested the nuclear design believed to have been passed to Pakistan, it was missile-delivered, with the packaged warhead weighing 1290 kgs. However, Pakistan's missile ranges are all based on a throwweight of 500-800 kgs. Warheads above those weights would significantly shorten the missiles' effective ranges. On the other hand, based on Pakistan's efforts to obtain tritium during the 1980s (more yield for less weight) and considering that it has had 15 years in which to improve its nuclear design argues that Pakistan has had sufficient time in which to reduce the weight of its nuclear device and to package it for missile delivery. Based on the length of time Pakistan has been trying to develop a nuclear warhead capable of being delivered by ballistic missile, the U.S. intelligence community reportedly is now assessing that Pakistan has a nuclear missile delivery capability.[55]

As the next step in further developing its nuclear capability, Pakistan is working to increase its production capacity of fissile materials. (See Figure 4-10, a map of Pakistan's nuclear infrastructure.) One major step in this direction was taken in March 1996 when Pakistan, reportedly with Chinese assistance,[56] completed the construction of a 40- to 50-MW heavy-water nuclear reactor near Khushab.[57] Once in operation, this unsafeguarded reactor will provide Pakistan with its first source of

49 Ibid.

50 Ibid., p. 333.

51 Hoagland, "Briefing Yeltsin on Iran," *op. cit.*, p. A23. It has become common for U.S. diplomats to refer to clandestine nuclear weapon capabilities has being but "a few turns of a screwdriver" away from a nuclear weapon. In reality, that claim means nothing. For safety reasons, early generation nuclear weapons routinely are stored in two or three separate canisters that contain various components of the weapon. Nuclear assembly teams put the components together just before the weapon is to be mated with its delivery system. If having the weapon assembled is a criterion for being a nuclear-armed power, the United States spent a number of years after World War II being just "a few turns of a screwdriver" away from having a nuclear weapon.

52 Hersh, *op. cit.*, p. 59; and Rehul Bedi, "U.S. Hesitancy Over Bomb Regarded as Confirmation," *South China Morning Post*, March 8, 1996, p. 15.

53 Bedi, *op. cit.*

54 "Pakistan: Renowned Nuclear Scientist Comments on Nuclear Program," *Nawa-I-Waqt*, translated in *FBIS-NES-96-151*, August 1, 1996..

55 R. Jeffrey Smith, " Pakistan Has A-Weapons For Missiles, U.S. Fears," *The Washington Post*, June 14, 1996, pp. A1, A12. Both India's and Pakistan's nuclear programs have the reputation for being very secretive. It seems doubtful that the details of these programs are completely known by U.S. intelligence agencies.

56 Bill Gertz, "China Aids Pakistani Plutonium Plant," *The Washington Times*, April 3, 1996, p. A4.

57 Ashraf Mumtaz, "Pakistan: First Indigenously Developed Nuclear Reactor Completed," *Dawn*, transcribed in *FBIS-NES-96-048*, March 7, 1996. It should be noted that many other sources claim the size of this reactor as being 40 MWs. A couple of sources cite higher figures—up to 100 MWs. For example, see Sawhney, "Standing Alone, India's Nuclear Imperative," *op. cit.* p. 27.

Pakistan's nuclear infrastructure

Karachi	137 MW PHWR-safeguarded; heavy water upgrading plant; Karachi Nuclear Power Training Center
Multan	Heavy water production facility-unsafeguarded
Lahore	Uranium milling site
Wah	Potential nuclear weapons assembly site
PINSTECH	Pakistan Institute of Nuclear Science and Technology 10 MW research reactor-safeguarded; 27 KW research reactor-safeguarded; experimental-scale reprocessing facility (running?)-unsafeguarded; small scale reprocessing facility-unsafeguarded; Center for Nuclear Studies
Golra Sharif	Uranium enrichment facility (under construction?)-unsafeguarded
Kahuta	Uranium enrichment plant-unsafeguarded; Dr. A. Q. Khan Research Laboratories
Sihala	Pilot-scale uranium enrichment plant-unsafeguarded
Khushab	40 MW PHWR under construction-unsafeguarded; (may be site of tritium production facility)
Chashma	300 MW PWR under construction-will be safeguarded; partially built reprocessing plant
Kundian	Fuel fabrication facility-unsafeguarded
Chagal Hills	Possible nuclear test site
Dera Ghazi Khan	Uranium hexafluoride (UF6) conversion plant-unsafeguarded; uranium milling site; uranium mining site

Figure 4-10

plutonium. (All of Pakistan's current nuclear systems are based on uranium.) Apparently, U.S. intelligence agencies believe that Pakistan is having trouble increasing the range of its missiles. Plutonium would allow Pakistan to modernize its nuclear arsenal and produce smaller and lighter warheads, which would result in longer effective ranges for Pakistan's nuclear-armed missiles.[58]

As for its capability to produce U-235, Pakistan is in the process of increasing its production capacity for weapons-grade uranium. The famous 5000 ring-magnets that China transferred to Pakistan in 1995 apparently were intended to replace the magnets on Pakistan's current gas centrifuges with more powerful magnets, which would increase the productivity of the current enrichment program at the A.Q. Khan research labs in Kahuta.[59] In addition, in 1987 U.S. intelligence sources reportedly claimed that satellite photography indicated that a uranium enrichment plant was being constructed at Golra. It is not clear from open source material if this facility was ever completed.[60]

As a parallel operation, it seem clear that Pakistan is trying to increase the level of sophistication of its nuclear and missile production. For example, in September 1996, Pakistan imported some diagnostic equipment and a specialized furnace (believed to be a vacuum furnace or "skull") from China. It is

58 Gertz, "China Aids Pakistani Plutonium Plant," *op. cit.*

59 Sawhney, "Standing Alone, India's Nuclear Imperative," *op. cit.* p. 27; and Bill Gertz, "Beijing Flouts Nuke-Sales Ban," *The Washington Times*, October 9, 1996, pp. A1, A9. There is some uncertainty on the intended use of the magnets. Some articles asset that the magnets were intended to upgrade the current system, one alleges the new magnets were to replace worn-out magnets, another claims that the magnets could be used to increase the number of centrifuges in the cascade. Most assessments seem to lean in favor of an upgrade to the productivity of the system by using more powerful magnets.

60 Koch, "Nuclear Testing in South Asia and the CTBT," *op. cit.*, p. 102 (end note 5).

thought that the furnace is the type used to melt plutonium and uranium for nuclear weapon cores, titanium for missile nose cones, and other related critical parts.[61] Similarly, in late 1995, a shipment of specialized laser equipment was intercepted in London's Heathrow airport as it was being trans-shipped between Sweden and Pakistan.[62] The pursuit of these types of lasers, coupled with the purchase of diagnostic equipment and the specialized furnace, indicate that Pakistan is probably in the process of upgrading the precision and sophistication of its nuclear- and missile-manufacturing programs.

Clearly, unless some unforeseen event slows or stops the Pakistani nuclear program, Pakistan will increase its nuclear capacity considerably by 2010. Although the status of Pakistan's nuclear arsenal is a very well-kept secret, presumably the sophistication of its nuclear devices should also improve during the intervening time frame as Pakistan acquires more advanced manufacturing technologies for its strategic-weapons programs.

Looking at the Missile Issue

Pakistan is at a clear disadvantage to India in terms of strategic depth. Much of Pakistan's major economic and population centers lie in a band between 50 and 250 kms from the Indian border. Conversely, India has much greater strategic depth, with its key western cities of New Delhi and Bombay located *over* 350 kms and 600 kms respectively from Pakistan's nearest border. Although Pakistan can air-deliver its strategic weapon systems, it has a strategic need to be able to hold India in a position of vulnerability similar to itself, especially since India is now producing the *Prithvi* (i.e., issues of power and assured deterrence). In short, Pakistan requires longer-ranged missiles than India needs to hold India's key assets as vulnerable as Pakistan's.

There are indicators that Pakistan's indigenously developed *Hatf* I and *Hatf* II missiles, which were based on U.S. *Honest John* technology, are less capable than desired by Pakistan's military leadership. The *Hatf* I is fairly crudely machined, has a range of perhaps 80 kms carrying a payload of 500 kgs, and is very inaccurate. As a result of its limitations, the *Hatf* I may have been fitted to deliver a chemical warhead.[63] Similarly, the *Hatf* II, reportedly tested in 1989, was apparently unable to achieve the 300 km range that Pakistan's military leadership expected. It is doubtful that Pakistan's indigenous *Hatf* II missile has been put into mass production. In fact, a number of reputable analysts believe that Pakistan's original model of the *Hatf* II may never be fielded.[64] It is also likely that it was Pakistan's inability to field an effective *Hatf* II that led to the transfer of China's M-11 ballistic missile system to Islamabad.

The single-stage M-11 (CSS-7) was first test-fired by China in 1990; it entered service with the Chinese military in 1992.[65] The missile was originally designed as a replacement for the *Scud* B and was aimed primarily at the export market. Since its advent, there has been an ongoing public dispute between China and the United States regarding the exportability of the M-11 under the guidelines of the MTCR. China claims it has a range of just under 300 kms when carrying a 500 kg warhead, which makes it MTCR compliant. Early reports of the M-11's capabilities listed it as having a throwweight of 800 kgs at 300 kms range, which would put it above the MTCR limits. Some U.S. analysts believe China artificially listed its throwweight at 500 kgs to avoid the MTCR issue.

61 Gertz, "Beijing Flouts Nuke-Sales Ban," p. A9.
62 Warren, "Pakistan's Nuclear Program at a Screwdriver Level," *op. cit.*
63 For an example, see Aabha Dixit, "India: Article Views Pakistan's Missile Program as Serious Threat," Calcutta *The Telegraph,* transcribed in *FBIS-NES-96-173,* September 2, 1996.
64 Pravin Sawhney, "India: Chinese Missile Technology Transfer Alleged," *The Asian Age,* transcribed in *FBIS-NES-96-168,* August 27, 1996.
65 Danny Lee, "Ideal Weapon for Surprise Attack," Singapore, *The Straits Times,* June 14, 1996, p. 19.

Regardless of the disagreement over the M-11's ability to comply with MTCR guidelines, the M-11 has been exported to Pakistan; its packing boxes were first reported to have been seen there in 1991.[66] Since then, several subsequent reports of M-11 shipments into the country have been reported. Most reports now claim that more than 30 M-11s are located at Sargodha Air Force Base,[67] just west of Lahore;[68] while Indian sources put the figure higher with at least one report claiming that a total of 84 M-11s have been delivered to Pakistan.[69] Although the M-11s provide Pakistan with a limited capability against India, the single-stage system does not have the range needed to threaten India's high-value targets.

Consequently, as a national priority, Pakistan is pursuing the development of a medium-range missile system. Using blueprints and equipment supplied by China, Pakistan is building a medium-range missile factory in a Fatehgarh (just to the south of Islamabad).[70] This complex, called the National Defense Complex, reportedly is being staffed by specialists from all of the related missile and nuclear developmental organizations in Pakistan, supplemented by at least 10 full-time Chinese technicians who work at the facility, six on missile guidance and control and four on solid-fuel production.[71] It is believed that other Chinese specialists visit the plant as needed to provide technical assistance.[72]

There is a great deal of confusion regarding Pakistan's missile production plans. A number of the open source reports claim that Pakistan is planning on building a 600-1000 km range *Hatf* III missile that is based on M-11 technology.[73] Other sources assess that the *Hatf* II is essentially an M-11 and that the *Hatf* III will be based on the Chinese M-9 (DF-15) missile.[74] If the latter claim should prove correct, then the Pakistani missile factory might produce a couple of different models of M-family missiles. Based on what is known, and considering the fact that Pakistan is sensitive to perceived technological failures, it is likely that Pakistan will field a missile that it calls the *Hatf* II as well as a different system known as the *Hatf* III. While the situation is still confused, it seems likely that at least one of these missiles may have a range of 600 kms or greater.

It is also clear that Pakistan has aspirations of developing even longer-ranged systems in the future. It established, with U.S. assistance, a civilian space research organization (SUPARCO) in 1961.[75] This organization "has developed two rockets: *Shahpar*, a seven-meter solid fuel two-stage rocket that can carry 55 kgs to an altitude of 450 kms, and the

66 Presentation by a noted nonproliferation expert, February 29, 1996. The information was provided on a nonattribution basis.

67 "Missile Story Old Hat," *Intelligence Newsletter*, July 13, 1995; and Smith, Pakistan Has A-Weapons For Missiles, U.S. Fears," *op. cit.*, p. 12.

68 R. Jeffrey Smith, "Pakistan Is Building Missile Plant, U.S. Says," *The Washington Post*, August 26, 1996, p. 23.

69 Ranjit Kumar, "India: Article Views Need for Russian Antimissile System," *Navbharat Times*, translated in *FBIS-TAC-96-004*, February 18, 1996. Many Indian articles make exaggerated claims regarding Pakistan's missile capabilities. On the other hand, the recurring reports of new shipments of M-11s into Pakistan would indicate that the number of systems now in country is probably above the 30 commonly mentioned in press reports. Based on a survey of estimates, it is likely that Pakistan now has 38-58 M-11s.

70 Smith, "Pakistan Is Building Missile Plant, U.S. Says," *op. cit.*

71 "China and Pakistan's Missiles," *Foreign Report, Jane's Information Group*, May 2, 1996, p. 2.

72 Ibid., p. 3.

73 For example, see Ibid.; and Smith, "Pakistan Is Building Missile Plant, U.S. Says," *op. cit.*

74 For example, see "Indian Claims on Pak Hi-Tech Missile Factory," *Intelligence Digest*, June 1996; Atul Aneja, "India: Sources Report China, Pakistan Working on New Missile, *The Hindu*, transcribed in *FBIS-NES-96-180*, September 13, 1996; Pravin Sawhney, "India: Chinese Missile Technology Transfer Alleged," Delhi, *The Asian Age*, transcribed in *FBIS-NES-96-168*, August 27, 1996; and Dixit, "India: Article Views Pakistan's Missile Program as Serious Threat," *op. cit.* The *Nonproliferation Review* has long shown the *Half* III to have almost the same weight and characteristics as the Chinese M-9. If Pakistan is building an M-9 missile, it will result in a diplomatic firestorm when it is unveiled. If U.S. intelligence agencies should suspect that a Pakistani version of an M-9 is in the works, they probably would not reveal that suspicion until they could prove the allegation. At the same time, it should be remembered that the M-11 was originally designed as a two stage missile with a 1000 km range. Logistically, it would make sense to build the *Hatf* II (M-11) as a single-stage system that can be stacked with a second-stage to form the *Hatf* III.

75 Dixit, "India: Article Views Pakistan's Missile Program as Serious Threat," *op. cit.*

Rakhnum, which can lift 38 kgs to a distance of 100 kms. SUPARCO has also tried to develop a small satellite launcher, but the project has been stalled for want of technology."[76] Clearly, Pakistan's civil program is far behind that of India's. However, there is an ongoing investigation in India that indicates that Pakistan may have been successful in penetrating the ISRO in 1994, obtaining documents and plans related to India's polar space launch vehicle (PSLV).[77] If so, Pakistan could have the information needed to move its long-range missile program ahead fairly rapidly if it could obtain the technology base needed to apply the information gained.

Pakistan as a Proliferator

Pakistan is suspected of providing assistance to both the Iraqi and Iranian nuclear programs. In addition, it has long been rumored that Saudi Arabia and Libya have helped finance the Pakistani program. It so, the question becomes: what have these two countries received in return? Of similar concern, Pakistan has become a major terminal for illegally smuggled goods from the former Soviet Union. This trade reportedly includes arms and nuclear materials.

Iraq. In the case of Iraq, U.N. inspectors working to dismantle the Iraqi nuclear program after *Desert Storm* reportedly discovered diagrams of the Iraqi nuclear weapon that were very similar to the drawings Pakistan received from China.[78] The link between Iraq and Pakistan appears to have been Dr. Khan, the director of Pakistan's nuclear weapons program. According to a German report, citing Western intelligence services as its source, Dr. A.Q. Khan is credited as being the mastermind behind the Iraqi bomb.[79] Thus, the flow of sensitive technology from Pakistan west seems probable in the case of Iraq.[80]

Iran. A driving force behind the establishment of a Pakistani nuclear assistance program to Iran seems to have been General Beg (discussed earlier). Based on the special report that President Clinton provided to President Yeltsin in May 1995, Pakistan is believed to have provided Iran with the list of foreign companies which it used to obtain the infrastructure and weapon components necessary for a nuclear weapons program (Iran has approached the same suppliers as Pakistan used).[81] This cooperation may have been further spurred by a reported December 1992 Iranian offer to pay Pakistan $3.5 billion if it would share its nuclear know-how. This offer was repeated to Prime Minister Bhutto in December 1995.[82] Based on all of the indications of Pakistani nuclear assistance to Iran, Iran's December 1992 offer may have been accepted.

The U.S. briefing to Yeltsin in May 1995 made the claim that Pakistan was believed to have halted all nuclear cooperation with Iran once Bhutto became Prime Minister (December 1993).[83] Curious, however, is the report that Prince Turki ibn Faycal, head of Saudi Arabia's secret services, visited Prime Minister Bhutto in March 1995 to try to persuade her to halt Pakistani contacts with Iran on nuclear activities.[84] At this time, it is unclear if Pakistan and

76 Ibid.
77 "India With Pakistan, 6/19/96," *The Nonproliferation Review*, Fall 1996, p. 159.
78 *Risk, op. cit.*, May 1996, p. 8.
79 Thomas Scheuer, "Pakistani Called Mastermind of Iraqi Nuclear Program," *Focus*, translated in *FBIS-TAC-96-003*, January 29, 1996.
80 According to Rizvi, "The Nuclear Bomb and Security of South Asia," *op. cit.*, p. 22, the purported nuclear weapon blueprints discovered by U.N. inspectors in Iraq revealed a bomb design so unstable that the resulting weapon could have detonated on the workbench. First generation nuclear weapons are not noted for their safety devices.
81 Jim Hoagland, "Briefing Yeltsin on Iran," *The Washington Post*, May 17, 1995, p. A23.
82 "Iran with Pakistan, 12/21/95," *The Nonproliferation Review*, Fall 1996, p. 113.
83 Hoagland, "Briefing Yeltsin on Iran," *op. cit.*
84 "Pakistan with Iran and Saudi Arabia, 3/95," *The Nonproliferation Review*, Fall 1995, p. 116.

Iran are continuing to cooperate on nuclear development. However, in May 1995, General Beg claimed that Pakistan had canceled 11 production agreements with Iran under U.S. pressure.[85] If true, this may help to explain the claim that Iran again offered Pakistan $3.5 billion in December 1995 to share nuclear know-how (cited above).

Considering the fragmented nature of Pakistan's society and the level of corruption that governs behavior in that country, it would not be surprising to learn that some cooperative efforts are still continuing regardless of the official position on the issue. However, with the growing competition between these two countries over Afghanistan and Central Asia, it seems likely that any cooperation now taking place is probably doing so at a reduced level from that of the early 1990s. This is not to say that the level of cooperation might not increase in the future as the underlying political situation changes.

FSU/Afghanistan Smuggling. The northern territories along Afghanistan's border are essentially ungoverned. Pakistani checkpoints have been established at points that separate the northern tribal territories from Pakistan proper.[86] Consequently, the areas bordering Afghanistan have become a smuggler's paradise with the border town of Peshawar acting as the hub of the activity. Materials originating in the FSU and Afghanistan are transported to these territories. Included in this traffic are *Stinger* anti-aircraft missiles, opium, nuclear weapon components, missile parts, antiquities, strategic steel alloy, and radioactive materials purported to be weapons-grade fissile material. These constitute but a few examples of the types of items being offered for sale in this uncontrolled region.[87] Much of the nuclear materials being offered is believed to be rubbish, but occasionally included in the rubbish are some high-quality materials and components that are of great value.

Shoppers are out in force. Iranian majors and colonels are said to be walking around Peshawar with Samsonite suitcases full of $100 bills buying selected nuclear-related materials.[88] They are joined by Indians and Pakistanis who are also shopping for similar deals.[89] Complicating this scene are dealers who have also moved into the region that may be acquiring items on consignment or for resale. In short, Peshawar and its neighboring towns are becoming major clearinghouses for the world's nuclear arms bazaar.[90]

In essence, Pakistan has been a significant source of proliferation. It likely provided assistance to both Iran's and Iraq's nuclear programs, and it may also be providing help to other would-be proliferators. In addition, with the smuggled items coming out of the FSU now being concentrated in northern Pakistan, a second source of proliferation potential is being established.

With regard to its missile capabilities, Pakistan is, with foreign assistance, gradually developing a missile technology base. Of equal concern, however, is the potential that Pakistan could use the extensive technology collection organization that it has established globally to garner advanced missile design secrets. The pending case in India with reference

85 "Pakistan with Iran, 5/3/95," *The Nonproliferation Review,* Fall 1995, p. 168. It was not clear how many of the agreements included WMD or missile technologies.

86 Tim McGirk, "A Year of Looting Dangerously," London, *The Independent on Sunday,* March 24, 1996, pp. 4-8.

87 Ibid.

88 Ibid. Considering the fact that the United States adopted the new Franklin hundred dollar bill, partially due to Iranian high quality counterfeiting of standard $100 bills, it may be that Iran is buying nuclear material for the price of paper and printing ink.

89 Ibid.

90 "China, with Afghanistan, Iran, Kazakstan, Pakistan, Russia, and Turkmenistan, 1/96" *The Nonproliferation Review,* Fall 1996, p. 117.

to the alleged spying scandal that may have led to the transfer of PSLV design information is a case in point. Based on Pakistan's apparent past record of transferring nuclear information, clearly there is a possibility that it could also pass on missile design information to other states that are currently in a better position to capitalize on that type of data. Iran, Iraq, China, and other similar states are all possible candidates.

In short, Pakistan is well on its way to becoming a nuclear power of some limited importance. How far it will be able to develop its missile capabilities by 2010 is highly dependent on the foreign assistance and technology flow it receives from abroad. It appears likely that Pakistan will have a significant regional missile capability by 2010, but it also seems doubtful that it would be able to field an ICBM by that date. What may be more worrisome is the possibility that Pakistan could provide ICBM-related information to other states that are more able to put that information into use by 2010 or shortly thereafter.

Iran: Headed for a National Deterrent?

Iran is an ancient civilization, proud of its Persian heritage and steeped in Shia Islam (less than 10 percent of the population are non-Shiites). In assessing this proud state, Iran's size and population potential must be understood. First, Iran is the most highly populated country in the Middle East; nearly one-third of the region's population is Iranian (Egypt through Iran). Second, of its 66 million people, about half are under 18 years old. As this population moves toward adulthood, Iran is beginning to experience a lot of domestic pressure as these young adults seek higher education and economic opportunity. Third, with a population growth rate of 2.3 percent a year—down from almost 4 percent in the late 1980s—Iran's population is still expanding, adding about one-million people a year to the country.

Consequently, Iran has a significant future military potential as it will have a large number of military-aged citizens for the foreseeable future. This is a potential that other states in the region cannot ignore. However, Iran's population structure is also adding to the strains that are pressuring its over-burdened economy. Many analysts expect that Iran's economic difficulties will force that country to limit its future military expenditures. However, Iran's military spending reportedly absorbs only 2 percent of its GDP, compared with 17 percent in the last days of the Shah. Iran's military expenditures are also considerably less than those of Saudi Arabia and Israel. According to a recent survey by *The Economist*, Iran's citizens, which are disenchanted with their government and "criticize their government on almost every score, do not berate it for wasting its wealth on military toys."[1] Some of this silence may be attributed to the freshness of the memory of the one-million Iranians who were killed in the Iran-Iraq war.[2] In short, Western hopes that economic pressures will prevent Iran from pursuing long-range ballistic missiles and WMD systems may be wishful thinking.

Much of the tensions pulling at Iran are a result of a foreign policy that is at odds with itself. On the one hand, Iran provokes some states by sponsoring terrorist groups and engaging in hostile activities.[3] Contributing to this unfortunate state of affairs is the fact that the Shia sect follows two additional pillars of faith (above the five it shares with the Sunni branch) deemed necessary for Shiites to demonstrate and reinforce their Islamic faith. One of these additional pillars is *jihad* or crusade to protect Islamic lands, beliefs, and institutions.[4] Thus,

1 "Iran Survey," *The Economist*, January 18, 1997, p. 11.
2 Ibid., p. 1.
3 Jack Kelley, "Iran's Terrorism Network Grows In Sophistication," *USA Today*, August 2, 1996, p. 10A.

Shia faith contains a predisposition for conducting holy war against the infidels. On the other hand, Iran remains fretful over its national security, concerned about the possible aggressive intentions of other states. Its experiences in the Iran-Iraq War, which included extensive Iraqi use of chemical weapon and ballistic missile attacks against Iranian targets, graphically demonstrated the vulnerabilities Iran faces from adversaries armed with missiles and weapons of mass destruction.

It is instructive to review the Iranian experience of modern warfare. For example, during 1983, Iraq fired at least 33 *Scud* missiles at Iranian targets and is also believed to have used mustard gas against Iranian forces in November of that year.[5] During the subsequent years of the war, the use of CW and ballistic missiles grew so that by the time the fifth and last war of the cities occurred during March-April 1988, Iraq fired about 200 *Scud* missiles at Iran during that two-month period;[6] one-quarter to one-half of the residents of Tehran fled the city fearing that some of the missiles might carry poison gas. To counter the overwhelming Iraqi advantage in these areas, Iran acquired and began using ballistic missiles and a limited array of chemical weapons (the first planned Iranian use of CW may not have occurred until 1988).[7]

The Iran-Iraq War made a deep impression on Iranian policymakers. First, the effect of an international embargo demonstrated the importance of becoming militarily self-sufficient to the extent possible. For example, after the first year of war, Iran only had a few operational aircraft. Most of its aircraft were of U.S. origin and the United States was not providing repair parts. In addition, the war established Iran's outlook toward the development of WMD systems. Although the actual damage inflicted on Iran by those types of systems was relatively low in comparison to the entire scope of the conflict,[8] its psychological impact and ability to disrupt operations colored the Iranian outlook toward its significance. A statement made by President Rafsanjani in 1988, while he was still the speaker of the Iranian parliament, well outlines Iranian thinking on the issue. In his address to some soldiers he stated:

> With regard to chemical, bacteriological, and radiological weapons training, it was made very clear during the war that these weapons are very decisive. It was also made clear that the moral teachings of the world are not very effective when war reaches a serious stage and the world does not respect its own resolutions and closes its eyes to the violations and all the aggressions which are committed in the battle field.
>
> We should fully equip ourselves both in the offensive and defensive use of chemical, bacteriological, and radiological weapons. From now on you should make use of the opportunity and perform this task.[9]

Iran's orientation toward the development of a WMD deterrent capability was further strengthened in 1991 when U.S.-led forces easily destroyed the Iraqi military machine that had stymied Iran for so long. Apparently, Iranian policymakers determined that conventional military forces would not be able to stand against a determined assault by U.S. forces. In short, the problem for Iran was how to develop a defense capability that would deter the United States from doing to Iran what it had done to Iraq. Consequently, Iranian efforts to develop WMD and ballistic and cruise missile capabilities are believed to have increased.

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4 Federal Research Division, Library of Congress, *Iran: A Country Study* (Washington, DC: U.S. Government Printing Office, 1989), pp. 115-16.

5 Efraim Karsh, "Rational Ruthlessness: Non-Conventional and Missile Warfare in the Iran-Iraq War," *Non-Conventional-Weapons Proliferation in the Middle East*, ed. by Efraim Karsh, Martin S. Navias, and Philip Sabin (New York: Oxford University Press, 1993), pp. 36, 41.

6 Ibid., p. 42.

7 Ibid., p. 40; Iranian soldiers sporadically may have employed limited quantities of captured or dud Iraqi artillery/mortar chemical rounds prior to this date.

8 Ibid., pp. 45-47.

9 Quoted by Leonard S. Spector, "Nuclear Proliferation in the Middle East: The Next Chapter Begins," *Non-Conventional-Weapons Proliferation in the Middle East*, ed. by Efraim Karsh, Martin S. Navias, and Philip Sabin (New York: Oxford University Press, 1993), p. 143.

Iran's Security Policy Objectives

Iran appears to have three security objectives of particular interest to the United States:

- **Ally with the key Asian powers.** It is Iran's policy to form an alliance that includes India, China, Russia, and Iran to coordinate regional policy and create a strong alliance against the United States.[10] From the Iranian perspective this alliance would create a fourth pole in international affairs, in addition to the United States, Europe, and Japan.[11] Iran also sees this policy as a means of countering U.S. attempts to isolate Iran in the international community.

- **Deter foreign powers with WMD systems.** As discussed in the introduction, Iran wants to be able to deter other powers, to include Iraq and the United States, from threatening the country. Moreover, the Sunni-Shia division in Islam predisposes other Islamic states to view Iran with suspicion, thus creating additional tensions. Since, in terms of conventional forces, Iran is not a particularly strong country (Iraq is still the area's strongman), Iranian leaders view WMD and missile delivery systems as being essential to Iran's security.

- **Dominate the Strait of Hormuz.** Iran is working to establish a military capability to deny transit through the Strait of Hormuz. This effort includes the layered deployment of cruise missile-equipped patrol boats, submarines, underground shore-based missile sites, long-range anti-ship ground- and air-launched cruise missiles, and a manufacturing base with the resulting stockpile of anti-ship mines.[12] A military capability to disrupt shipping through the strait, which carries 20 percent of the world's oil, could provide Iran with a powerful tool with which to intimidate other Gulf oil producers. In addition, this capability could also make it difficult for the United States and its allies to ship military equipment into the vital Persian Gulf ports during a crisis if Iran should oppose that action.[13] Moreover, if the West should in the future contemplate a land-based military intervention in Iran, such an operation would be difficult to conduct if the Persian Gulf ports were inaccessible to military cargo ships. Essentially, the potential ability to interdict the Strait of Hormuz provides Iran with both regional political leverage with OPEC members and a logical strongpoint for national defense against outside intervention.

Weapons of Mass Destruction (WMD)

As signaled by Rafsanjani's 1988 statement, Iran's WMD aspirations include all three categories of weapon systems that are grouped under the term WMD: chemical, biological, and nuclear. In the first two categories, Iran already has some capability; for the last category, it is still working to develop indigenous nuclear weapons.

Chemical Weapons. Iran's stockpile of chemical weapons developed out of its experience as a CW victim during the Iran-Iraq War. Currently, Iran is believed to have a large stockpile of chemical weapons on hand, including nerve and blister agents.[14] A CIA statement claims that Iran has several thousand tons of agents including sulfur

10 There have been a number of reports that make it clear that Iran hopes to form an alliance of major Asian powers to counter the United States. For example, see "Iran: Velayati Says Afghanistan Key To Control Region," *FBIS-NES-96-046,* March 7, 1996.

11 "Editorial Sees Need for Asian Alliance to Oppose U.S.," Tehran *Hamshahri,* translated in *FBIS-NES-94-173,* September 7, 1994, p. 77.

12 Dale R. Davis, "Iran's Strategic Philosophy and Growing Sea-Denial Capabilities, *The Marine Corps Gazette,* July 1993, p. 21; and Philip Finnegan and Robert Holzer, "Iran Steps Up Mine, Missile Threat," *Defense News,* November 27-December 3, 1995, p. 1.

13 "Implications of Iranian Naval Build-Up," *Intelligence Digest,* August 9-23, 1996, p. 1.

14 Andrew Rathmell, "Chemical Weapons in the Middle East," *Jane's Intelligence Review,* December 1995, p. 560.

mustard, phosgene, and cyanide agents. Its production capacity is estimated at 1000 tons a year,[15] with its major production facilities located at Damghan, 300 kms east of Tehran.[16] The CIA claims that Iran is working on developing a self-sufficient CW production capacity that includes more effective nerve agents. Along with shell and bomb delivery systems, Iran may also be producing CW warheads for its *Scud* missile systems.[17]

Biological Weapons. Based on various U.S. government reports, Iran has most likely investigated both toxins and live organisms as BW agents, produced some agents, and probably weaponized a small quantity of its production.[18] In this technology, Iran is judged to be able to support an independent BW program, which is now in the late stages of research and development, with little foreign assistance (although some foreign BW expertise, especially from Russia, is flowing to Iran).[19] It is reported that the country has collocated a BW lab near its CW production facilities at Damghan. Unfortunately, the dual nature of biomedical technology, which can also be used to produce BW agents, provides Iran with an in-house capacity for large-scale agent production.[20] An Iranian-developed BW warhead for ballistic missile use could be available around the year 2000.[21] Based on the discussion in Chapter 1, it should be expected that Iran's BW warheads will be configured to package the agent in submunitions which will deploy out of the warhead during the ascent phase of a ballistic missile's trajectory at about 60 kms altitude. It is expected that the agent will also be packaged for future delivery by cruise missiles and other means.

Nuclear Weapons. There is a major dichotomy in the picture that has been created of Iran's nuclear weapons program. Unclassified assessments based on Iran's known nuclear infrastructure reflect a technology and production base inadequate to the task of producing nuclear weapons for many years.[22] Yet, it is also clear from various statements made by U.S. government officials that, in addition to Iran's legitimate efforts to develop its nuclear power-generation industry, it is believed to be operating a parallel clandestine nuclear weapons program, with the Isfahan Nuclear Center acting as the "nerve center" for the development.[23] U.S. officials estimate that with extensive outside help, Iran might be able to produce a nuclear weapon by about the year 2000.[24]

Iran's nuclear weapons program is broadly based, according to former CIA Director John Deutch. During congressional testimony, Deutch stated that "Iran is attempting to develop the capability to produce both plutonium and highly enriched uranium. In an attempt to shorten the timeline to a weapon, Iran has launched a parallel effort to purchase fissile material, mainly from sources in the former Soviet Union."[25]

Although speculative, there are a number of reports that seem to signal the type of infrastruc-

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15 Barbara Starr, "Iran Has Vast Stockpiles of CW Agents, Says CIA," *Jane's Defence Weekly,* August 14, 1996, p. 3.

16 "Devil's Brew Briefings: Iran," *Centre for Defence and International Security Studies,* Internet, http:/www.cdiss.org/cbwnb1.htm, 1996.

17 Ibid.

18 Tony Capaccio, "CIA: Iran Holding Limited Stocks of Biological Weapons," *Defense Week,* August 5, 1996, p. 15. This article quotes from documents published by ACDA, CIA, and DoD.

19 Starr, "Iran Has Vast Stockpiles of CW Agents, Says CIA," *op. cit.*

20 Capaccio, "CIA: Iran Holding Limited Stocks of Biological Weapons," *op. cit.*

21 Ibid.

22 Breg J. Gerardi and Maryam Aharinejad, "Report: An Assessment of Iran's Nuclear Facilities," *The Nonproliferation Review,* Spring/Summer 1996, pp. 207-213. For a similar article, see David Albright, "An Iranian Bomb?," *The Bulletin of Atomic Scientists,* July/August 1995, pp. 26.

23 Con Coughlin, "London Paper Details Deal," *The Sunday Telegraph,* transcribed in *FBIS-NES-95-166,* August 28, 1995, p. 83.

24 Barbara Starr, "CIA Expects Nodong Deployment Next Year," *Jane's Defence Weekly,* November 11, 1995. Deutch claimed that Iran could produce a nuclear weapon in about four years, but that he was not forecasting that this would actually occur.

25 John Deutch, "The Threat of Nuclear Diversion," *Statement for the Record to the Permanent Subcommittee on Investigations of the Senate Committee on Governmental Affairs,* March 20, 1996.

Iranian Nuclear and Missile Infrastructure

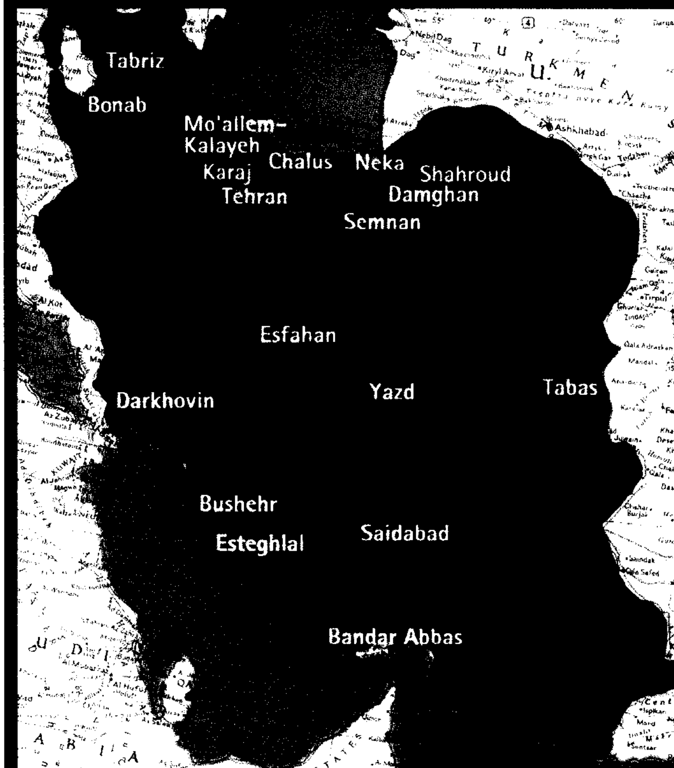

Figure 4-11

Bandar Abbas:
Site of Chinese-built cruise missile production facility where Silkworm cruise missiles are reportedly being upgraded with Chinese assistance.
Bonab:
Reported site of the "Bonab Atomic Energy Research Center".
Bushehr:
Site of the "Nuclear Energy College" as well as two partially-completed German-built Siemens 1300 MWe power reactors. The Russians are helping to complete this site and train Iranian technicians. The plant is scheduled to operational by 2000-01.
Chalus:
Possible nuclear weapons development site located inside a mountain. Reportedly staffed by nuclear experts from the former Soviet Union, China and North Korea.
Damghan:
Site of major chemical weapons production facilities. Also reportedly the site of a biological weapons lab that has Russian assistance.
Darkhovin:
Reported to be a site where two 300 MWe Qinshan-type nuclear reactors are to be built by the Chinese. (May be confused with Esteghlal). It is now under the administration of the Islamic Revolution Guard Corps and is suspected by the U.S. of being the site of an underground nuclear facility.
Esfahan (Isfahan):
Said to be the "nerve center" of the Iranian nuclear weapons program. The site includes an uncompleted Chinese-supplied 27 kilowatt "Miniature Neutron Source Reactor", a hexafluoride plant (which is being built by the Chinese) and a North Korean-built ballistic missile plant which can produce liquid fuels and structural components.
Esteghlal:
Reportedly a site where the Chinese agreed to assist Iran build the twin Qinshan-type 300 MWe "Esteghlal" nuclear power plant which to be operable by 2005.
Karaj:
Site of the Karaj Agricultural and Medical Research Center which has a Chinese calutron and a 30 MWe Belgian-supplied Ion Beam Applications cyclotron; there is some question if this particular equipment can be used for uranium enrichment.
Mo'allem Kalayeh:
Reported site of uranium enrichment gas centrifuges being installed by Chinese and Pakistani experts in facilities under the control of the Republican Guards.
Neka:
Believed to be an important site for a network of nuclear research facilities. Reportedly, two Russian 400 MW reactors are to be delivered an underground bunker at the site. This site was also rumored to be a prime target of a "Western-led coalition" that was to have launched a pre-emptive attack to hinder the Iranian nuclear program.
Saidabad (Sirjan):
Site of North Korean-built ballistic missile plant which can produce liquid fuels and structural components.
Semnan:
Site of a missile test range and a Chinese-built ballistic missile plant.
Shahroud:
Site of missile test facilities.
Tabas:
Possible site of a nuclear reactor of North Korean origin.
Tabriz:
Possible site of a nuclear weapons research facility.
Tehran:
Site of the Tehran Nuclear Research Center which has a five megawatts thermal research reactor. Core was due to be upgraded and replaced by Argentina in the late 1980s. Rumored to have a plutonium extraction laboratory and uranium ore extraction facility which aren't in operation.
Yazd:
Site of a planned uranium production plant to process into concentrate the 5,000 tons of high-grade uranium ore found in the area. Iran has denied that the underground mines are being used to conduct underground nuclear detonation tests.

ture that Iran is establishing in support of its clandestine nuclear weapons program. Many of the facilities are being built underground. Going underground would be a relatively natural inclination for the Iranians who, in addition to mining, have over the centuries dug and maintained a network of perhaps 60,000 tunnels, each of which carry irrigation water for long distances from the mountains down to the fields of Eastern Iran.[25] Consequently, Iran has a long-established brotherhood that does nothing but tunnel as a hereditary occupation.[26]

It is generally thought that Iran has at least 10 locations devoted to nuclear activities and may be developing an 11th site south of Tabriz (with Chinese assistance).[27] While some of these sites contain legal activities, several are also believed to hold clandestine nuclear weapons facilities. Examples of unconfirmed reports that are believed to be related to Iran's nuclear program include the following:

[25] *Iran: A Country Study, op. cit.*, p. 179.
[26] As an aside, according to a Western source who lived in Iran during the days of the Shah, the families who maintain the irrigation tunnels pass the art from father to son. Apparently, an ancient secret is involved in steering the direction and angle of the tunnels underground so as to be able to link an irrigation tunnel to other tunnels at a precise point and grade (key to water flow).
[27] "Iran with PRC, 12/13/95" *The Nonproliferation Review*, Spring/Summer 1996, p. 113.

- Reports based on information from the Iranian exile community in Europe claim that Iran has built a secret facility for developing nuclear weapons inside of a mountain at Chalus. See Figure 4-12. Local residents inside Iran have been told by the authorities that the facility, which from the outside is seen as two large doors covering the mouth of a tunnel, is an electrical power station staffed by Canadian specialists. However, exiles claim that the specialists working at the site are actually from the FSU, China, and North Korea.[29]

- Neka, in northeast Iran near Turkmenistan, contains a network of nuclear research establishments of which little is known. In 1995, a secret deal was reportedly signed for Russia to deliver two 400 MW reactors to an underground facility at that site.[30]

- Uranium enrichment centrifuges are believed to be housed in facilities at Ma`allem Kelayeh under the control of the Revolutionary Guards.[31] In addition, at least one report indicates that Pakistan may have supplied gas centrifuges to Iran.[32] This potential raises concern that some of the uranium hexafluoride that will be produced by the hexafluoride plant being constructed by the Chinese at Esfahan (NPT compliant)[33] could be diverted to a clandestine enrichment program to create weapons-grade uranium.[34] (Note: Iran may also be following Iraq's pattern, enriching uranium by using two or three different technologies.)

- Iran established its own uranium mines in eastern Iran during the 1980s.[35] In addition, a ship carrying 200 tons of enriched Brazilian uranium disappeared while enroute to Canada in late 1994. According to a Brazilian magazine, officials apparently determined that the ship may have been diverted to Iran following their discovery that the Canadian company which was to have received the uranium did not exist.[36]

- The Iranian journalist, Freidoun Sahebjam, claims that Iran has constructed several secret nuclear weapon facilities with North Korean assistance, to include two underground reactors and possibly an underground calutron enrichment facility. One of the reactors is said to be in the nuclear complex near Tabas.[37]

- As discussed in earlier chapters and sections, Chinese, Russian, North Korean, and Pakistani technicians all have been reported working in Iran, in addition to a healthy representation of Western specialists and non-Russian FSU citi-

Iranian Nuclear and Missile Infrastructure

29 "Washington Whispers: Tehran's Magic Mountain," *U.S. News and World Report*, May 1, 1995, p. 24.
30 Coughlin, "London Paper Details Deal," *op. cit.*
31 Kenneth R. Timmerman, "Iran: Ever More Threatening," *National Security Quarterly*, vol. 1, no. 3, 1993, p. 32.
32 Jonathan Rynhold, "China's Cautious New Pragmatism in the Middle East," *Survival*, Autumn 1996, p. 107.
33 Bill Gertz, "U.S. Fears Iran's Use of China's Know-How," *The Washington Times*, April 18, 1996, p. 7.
34 Ibid.
35 Timmerman, "Iran: Ever More Threatening," *op. cit.*
36 "Brazilian Enriched Uranium to Iran?," *Defense & Foreign Affairs Strategic Policy*, April 30, 1995, p. 3.
37 "Iran with North Korea and PRC, 11/6/95," *The Nonproliferation Review*, Spring/Summer 1996, p. 113.

zens.[38] While the national representation cited is generally accepted as fact, there is little open-source material that indicates either the quantity or the quality of the foreign personnel involved. However, the Iranians apparently were offering Soviet scientists $5000 a month in 1992 to work on special projects in Iran. Considering that the average Soviet scientist was only making $70 per month at home, it seems likely that more than a few of them may have accepted positions in Iran.[39]

Although the veracity of the reports cited above cannot be confirmed through open-source materials, it seems likely that at least some of them reflect fact. For Iran to be able to develop a nuclear weapon within the next few years, as the CIA claims, some clandestine operations to produce fissile materials has to be ongoing. Likewise, of particular concern are the continued rumors that Iran has acquired 2-4 nuclear weapons from the FSU. The first report to surface claimed that in 1991 Iran had acquired at least two of the warheads reported missing from Kazakhstan.[40] That reported sale was later largely discredited with at least one article claiming that the pending deal had been foiled by agents of the CIA.[41]

Yet, there are other recent reports that insist that Iran has, in fact, managed to acquire at least three nuclear devices of unknown utility/operational capability. These reports, pointing to the recent change in official U.S. government statements as supporting their contention, claim that various Western intelligence services now privately acknowledge that Iran does possess a few nuclear weapons. It has become fairly standard for recent U.S. official reports to be worded so as to restrict the statement to discussing Iran's *indigenous* nuclear weapons program.[42]

In reality, it is very unlikely that any source in the Western world knows for certain what nuclear materials or weapons the Iranians may have managed to acquire. However, if Iran has gained access to some number of Soviet warheads, those warheads would provide the Iranians with models of tested weapon designs that may incorporate the miniaturization and sophistication that is usually gained only after years of effort and testing. In essence, if Iran has possession of an advanced nuclear warhead, it could reverse engineer the design and arm its future missiles with light, powerful, modern warheads, thus helping to achieve longer missile ranges (due to lighter payloads) much earlier than would otherwise be expected.

On the other hand, press reports of Iran's nuclear technological backwardness and developmental difficulties also indicate that even if it has a proven nuclear weapon design, its scientists may have trouble with the applied engineering and manufacturing process, thus slowing Iran's emergence as a nuclear power. This situation is the result of a self-inflicted wound. Many of Iran's elite, to include many of its scientists, fled the country or were executed in the early 1980s. An estimated 4 million Iranians are still in exile.[43] Over the last few years, Iran has been working (with limited success) to entice these exiles to return home. A key variable in this equation is how well Iran has been able to cover its internal technological weaknesses through the use of foreign talent and outside assistance.

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38 There are numerous reports of various Western citizens working on Iranian defense technology programs. For an example, see "Iran With Germany, 3/95," *The Nonproliferation Review,* Fall 1995, p. 161.

39 Thomas Orszag-Land, "How to Keep Soviet Science Out of the Wrong Hands," *The Christian Science Monitor,* November 8, 1995, p. 9.

40 "Newspaper Says Iran Got Two Nuclear Warheads from Kazakhstan," *AP Wire Service,* April 30, 1992, AM Cycle.

41 Coughlin, "London Paper Details Deal," *op. cit.;* and Albright, "An Iranian Bomb?," *op. cit.,* p. 25.

42 For examples, see "Brazilian Enriched Uranium to Iran?," *op. cit.;* and Gregory Copley, "Crisis Mismanagement," *Defense & Foreign Affairs Strategic Policy,* June 30, 1995, p. 7.

43 "Iran Survey, *op. cit.,* p. 8.

Iranian Missiles: A Sought-After Capability

Iran views Israel and the United States as its primary enemies. Thus, its ballistic missile interests would be to hold Israel at risk, to be able to deter the "Great Satan" from intervening in the Middle East, and to discourage potential European allies of the United States from entering into U.S.-led military coalitions that are contrary to Iranian interests. In addition, Iran has a clear need to be able to deter its neighbors and prevent the recurrence of the type of situation it found itself facing during the Iran-Iraq War. Many security analysts also suspect Iran of having hegemonic aspirations with respect to the Persian Gulf region. To accomplish these goals, Iran is following an active program to develop both cruise and ballistic missile delivery systems. Its procurement program includes the outright purchase of complete systems coupled to the development of in-house production capabilities.

Ballistic Missiles. Much of Iran's ballistic missile-related issues have been covered earlier during discussions of supplier-country activities. For example, the import of Chinese M-7 (CSS-8) and the possible construction of an M-9 missile plant was discussed in Chapter 3.[44] As also noted, Iran has a missile test range and missile production facilities. Its indigenous missile production efforts include the manufacturing of various short-range ballistic systems, to include a large quantity of *Scud* Bs and some *Scud* Cs.[45] Some of these *Scud* Bs may now be undergoing upgrade to the 500-km range *Scud* C system.[46] What is less clear is whether or not Iran is yet producing missiles with ranges beyond that of the *Scud* C.

Currently, Iran's missile production structure includes the Chinese-built missile plant near Semnan, the larger North Korean-built plants at Isfahan and Sirjan which can produce liquid fuels and certain structural components, and missile test facilities at Shahroud in the northeastern part of the country. Iran is making progress in mastering missile production. In the past, most of Iran's indigenous missile production has been heavily dependent upon the assembly of "knock-down" kits. This lack of indigenously produced components is changing. For example, Iran's *Scud* B system is now produced using a significant proportion of indigenously manufactured components.[47] This development is consistent with Iran's objective to move towards self-sufficient missile production. It may have some 100 facilities that produce missile components of different kinds.[48]

As discussed in the North Korean section of Chapter 3, Iran helped finance North Korea's missile development. Reports have claimed that Iran intends to field a 1300-km range *Nodong* system that will provide it with the capability of targeting Israel, and that Iran expected North Korea to provide it with the means to manufacture that missile.[49] Several reports had indicated that a few *Nodongs* had been shipped to Iran in 1994-95, but when General Peay, USCINCCENT, claimed during a Spring 1996 interview that a recent attempt by Iran to buy *Nodongs* from North Korea had failed

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44 "Briefing: Ballistic Missiles," *Jane's Defence Weekly,* April 17, 1996, p. 43; and "Missile and Space Launch Capabilities of Selected Countries," *The Nonproliferation Review,* Fall 1996, p. 178; and Wyn Bowen, Tim McCarthy, and Holly Porteous, "Ballistic Missile Shadow Lengthens," *Jane's IDR Extra,* February 1997, p.1.

45 Ibid. The quantities of *Scud* Bs held by Iran are cited as being between 200+ and 1000, depending on source.

46 For examples, see Bill Gertz, "China Sold Iran Missile Technology," *The Washington Times,* November 21, 1996, p. A14.

47 "Missile Threat: Iran," *Centre for Defence and International Security Studies,* Internet, http://www.cdiss.org/country2.htm, 1996.

48 Ibid.

49 For some examples, see Richard Latter, "Ballistic Missile Proliferation in the Developing World," *Jane's Defence 96: The World in Conflict,* January 1996, p. 77; and Greg Gerardi and Joseph Bermudez, Jr., "An Analysis of North Korean Ballistic Missile Testing," *Jane's Intelligence Review,* Vol. 7, No. 4, 1994, pp. 189-90.

for financial reasons,[50] uncertainty was cast on the earlier reports of *Nodong* shipments to Iran.[51] However, Iran's delay in obtaining longer-range missiles is seen as a temporary situation. Iran has already invested in the expense of digging extensive tunnel complexes for the protected deployment of *Scud* and *Nodong* missile systems at numerous locations along its littorals on the Persian Gulf and the Gulf of Oman.[52] Even if Iran should forego acquisition of the *Nodong* itself, it is still expected to field a missile system of similar or better capability.

There are unconfirmed reports that Iran is working on the development of some longer-range missile systems. For example, the *Zelzal* 3 is believed to have been in development for the past 5 years. It is based on a combination of technologies including Russian, Chinese, North Korean, and German; it is expected to have a range of 1000-1500 kms (e.g., Iran may have been involved in the development of China's two-stage 1000-km range M-18 missile, thus giving it access to Chinese missile technology). According to a report in *Iran Brief,* Iran's Revolutionary Guards hope to have a prototype of their new missile ready for a test launch in 1998.[53]

Of greater interest, in May 1996 UNCINCCENT claimed that Iran is expected to increase the range of its missiles to make them capable of reaching targets in Europe.[54] USCINCCENT's hint seems to lend credence to a December 1996 news report, based on respected German sources, which claims that Iran is developing a 3500-mile (5600-km) missile that will be capable of striking Europe. The technology for this system was cited as coming from Russia and North Korea.[55] It is possible that this missile is a *Taepodong* 2 derivative.

Of more concern for the United States, however, is the potential that Iran could gain access to ICBMs (or "knock-down kits" for their assembly) from countries such as Russia, Ukraine, or China. In considering the possibilities, several factors need to be assessed:

- Iran has been shopping in Ukraine and Russia for advanced missile technologies. For example, in 1992, Iran offered to provide Ukraine with oil in exchange for missile technologies.[56]
- Iran's internal economic conditions are weak. If Iran could locate a supplier, it would be more cost effective for it to purchase rather than build an ICBM capability.
- As discussed, Russian sources may have already provided an SS-25 to China and offered 45 *Topol M* ICBMs to India. If so, the taboo on transferring ICBMs may be weakening, establishing a precedent for exporting these systems. The recent reports of Russian SS-4 technology and components being transferred to Iran strengthens this fear.
- Some Russian strategists hope to use Iran to check U.S. influence in the Middle East. Iran is viewed as a potential ally. Some future Russian government could find it expedient to provide Iran with an ICBM capability (particularly if Iran already had missiles capable of targeting Russia).
- Russia's control over its missile forces is weakening. If political stability in Russia should decline further in the future, some of Russia's ICBMs could find their way to Iran as corrupt officers look to fund their retirement accounts.
- Iran, in a bid to become Central Asia's outlet to the sea, built a rail link between Iran and the Central Asian rail system (opened in May 1996) and improved the parallel highway link as well. The new transportation links provide an easy

[50] Ibid.; and "Iran's Tunnels are Missile Sites, Says USA," *Jane's Defence Weekly,* May 1, 1996, p. 3.

[51] Unknown is whether or not Iran received some prototype *Nodongs* prior to 1996. A few reports also speculate that Iran's version of the *Nodong* was to have a longer range than that being produced by North Korea (distance from Iran to Israel issue). Unknown is how much *Nodong* technology is being used by Iran to develop missiles under other names?

[52] "Iran's Tunnels are Missile Sites, Says USA," *op. cit.*; and General J.H. Binford Peay, USCINCCENT, "Middle East/North Africa," *Presentation: Fletcher Conference* (Cambridge, MA), November 13, 1996.

[53] "Special Report: The Zelzal Missile Program," *Iran Brief,* September 9, 1996, pp. 1-2; Eric Arnett, "Iran's Missile Ambitions Scaled Down, Says SIPRI," *Jane's Defence Weekly,* April 16, 1997, p. 16; and "Israel Says Iran, Russia Ground Test Missile," *Reuters World Report* (wire service), April 13, 1997.

[54] "Iran, 5/23/96-5/24/96," *The Nonproliferation Review,* Fall 1996, p. 161.

[55] "Report Says Iran Developing New Missiles," *Reuters, Ltd.,* December 20, 1996, 11:36 AM EST.

[56] Jacquelyn Davis, based on a private conversation with a Ukrainian official in Kiev, 1992.

conduit for either legal or illegal export of missiles or their components from the FSU to Iran.

- Considering how entrenched organized crime and corruption is in Russia, it is becoming increasingly questionable if the Russian government will be able to control future missile exports, to include ICBM systems.
- If the central government in China should weaken further or lose control, more missile exports could be the result. Since Iran is viewed as a friendly state by most Chinese, missile technology transfers might increase over their current levels.

Cruise Missiles. Iran has been acquiring an array of short-range sophisticated cruise missiles, many of which are anti-ship systems. Since 1989, it has also indigenously manufactured HY-1 *Silkworm* and HY-2 *Seersucker* cruise missiles,[57] and is currently in the process of developing an improved *Silkworm* system at its Chinese-built plant at Bandar Abbas.[58] Allegedly, the *Silkworm* upgrade is being conducted with Chinese assistance. The improved missile will have a range of 450 kms, giving it the capability of reaching Saudi Arabia and all Persian Gulf states.[59] As Iran continues to develop its cruise missile capabilities, it is expected to incorporate GPS into its guidance system, develop improved propulsion systems for longer ranges, and add stealth technologies to reduce the radar cross-section.[60] Of particular interest with regard to future cruise missile capabilities is the unconfirmed report that Iran has a U.S. *Tomahawk* cruise missile which was forwarded to Iran from Bosnia. The report claims the missile was one of three fired at Bosnian targets that failed to explode.[61] If this report should prove true, then U.S. cruise missile technology could be reverse engineered. It must also be considered that North Korea, China, Russia, and perhaps Syria and others may also have been given access to that missile.

Iran Conclusions

Assuming current trends continue, Iran will be a nuclear power with IRBMs and long-range cruise missile delivery systems by 2010. Considering Iran's current state of missile development, it is unlikely that it could develop an indigenous ICBM capability within this time frame unless the missile's components were made available as kits by an outside party (a possibility that cannot be ruled out). Similarly, it must also be considered that Iran could acquire an assembled ICBM, such as an SS-25 or a *Topol M*, especially if the level of disorder and corruption should increase in the FSU. As far as CW and BW systems, Iran should be expected to package them in submunitions for use in theater ballistic missile warheads or in spray tanks for cruise missile employment.

Iraq: Awaiting Resurrection

Although the U.N. efforts to eliminate Iraq's WMD and longer-ranged missile capabilities has reduced the Iraqi arsenal and slowed its rate of progress in these areas,[62] it has by no means stopped the programs (to include the nuclear program that was within months of producing a nuclear weapon when interrupted by *Desert Storm*). It is also believed that Iraq has been able to conceal some of

[57] Duncan Lennox, Editor, *Jane's Strategic Weapon Systems*, presentation to George C. Marshall Institute, Washington, DC, July 29, 1996.
[58] "Missile Threat: Iran," *op. cit.*
[59] Robin Ranger, Humphry Crum Ewing, David Wiencek, and David Bosdet, "Cruise Missiles: New Threats, New Thinking," *Comparative Strategy*, July 1995, p. 263.
[60] Ibid.; and "Iran With PRC, 12/13/95-12/19/95," *The Nonproliferation Review*, Spring/Summer 1996, p. 143.
[61] Anatoliy Yurkin, "B-H Muslims Said to Sell Missiles to Iran Via Russia," *ITAR-TASS*, translated in *FBIS-SOV-95-195*, October 9, 1995.
[62] For insights into how Iraq originally was able to build its nuclear program, see David Kay, "The Lessons of Iraqi Deceptions," *The Washington Quarterly*, Winter 1995, pp. 85-105.

its prohibited systems, to include perhaps 40 *Scud* missiles and their associated CW, BW, and conventional warheads.[63] Of long-term concern is the simple fact that Iraq has the knowledge, trained personnel, and sufficient production equipment available to restart its WMD and missile programs once U.N. sanctions are lifted.[64] It still has the designs for the powerful TC-11 gas centrifuges and the personnel trained in building them.[65] Considering the effort that Iraq is taking to protect its residual capabilities in these areas, there can be little doubt that Iraq intends to pursue these programs again in the future.

Of particular interest, Iraq is still believed to be working on the design for a new missile system that may have a range in excess of 2000 miles (3200 kms). According to a senior U.N. official, this missile will be able to reach London.[66] In addition, Iraq may be researching the technology for advanced re-entry warheads that would be compatible with small thermonuclear devices. These warheads are a real advance over *Scud* technology in which the entire missile body flies the entire trajectory. Essentially, Iraq is suspected of developing warheads which are designed to separate from the upper stage of a missile at the end of the ascent phase of the trajectory.[67] Apparently, Iraq flight-tested stage separation technology during the Gulf War and continues to refine the design.[68] U.N. inspectors also "believe Iraq has obtained an advanced space guidance system that could be adapted for controlled warhead re-entry."[69] The advanced guidance systems in question may have originated in France and Germany.[70]

In short, current trends indicate that if the limitations imposed by UN sanctions should be lifted within the next few years, Iraq could arm itself with CW, BW, and nuclear weapons by 2010. This capability would likely be matched to missile delivery systems that may include IRBMs. The possibility that Iraq's delivery capability will also include MRV warheads cannot be ruled out.

Syria

Syria has several motivations for the development of a missile-delivered WMD capability. These include:

- Syria has felt intimidated (and believes the Arab world in general has been intimidated) by Israel's nuclear capability. Arab WMD systems are required to restore the balance.

- Syria views Israel as an aggressive state that seeks to expand in fulfillment of biblical promises to occupy the land from the Nile to the Euphrates:[71]

    - Syria suffered a lot of damage from Israel's strategic bombing campaign during the 1973 war, a campaign in which Syria was unable to respond in kind.[72]

    - The development of WMD capabilities is a necessary hedge against defeat in the face of Israel's expansionist designs.

63 "Iraqi Missile Accusations," *Intelligence Digest*, July 12, 1996; "Iraq, 5/5/96," *The Nonproliferation Review*, Fall 1996, p. 163; and "Iran's Tunnels are Missile Sites, Says USA," *op. cit.*

64 Latter, *op. cit.*, p. 77; and "Iraq Rebuilding Its Covert Procurement Network," *Centre for Defence and International Security Studies*, Internet, http://www.cdiss.org/country2.htm, January 22, 1997; and "The Whore of Babylon and the Horseman of Plague," *The Economist*, April 12, 1997, p. 79.

65 "Iraq, 1/22/96," *The Nonproliferation Review*, Spring/Summer 1996, p. 115.

66 "Iraq, 2/14/96," *The Nonproliferation Review*, Fall 1996, p. 162.

67 "Iraq's Space & Missile Programs Move Ahead," *Military Space*, September 30, 1996, p. 1; and R. Adam Moody, "Reexaming Brain Drain From the Former Soviet Union," *The Nonproliferation Review*, Spring/Summer 1996, p. 94. The latter reference notes that 50 specialists from Arzamas-16, to include a Ukrainian MIRV specialist and a Russian laser specialist were reported to be working in Iraq in late 1992.

68 Ibid.

69 Ibid., p. 7.

70 Ibid.

71 Michael Eisenstadt, "Syria's Strategic Weapon's," *Jane's Intelligence Review*, April 1993, p. 168.

72 Ibid., pp. 168-69.

- The survivability of Iraq's mobile ballistic missiles during the 1991 Gulf War greatly impressed Syria. Although the physical damage these missiles inflicted on Israel was small, Israel paid a much larger price in economic and psychological terms.[73] Consequently, Syria views missile systems as key strategic assets for assured penetration of Israel's defenses.

- Syrian missile systems are also assets that could be used against Israel's tactical and operational nodes during the early stages of mobilization. For example, missile- and air-strikes delivered against Israel's equipment storage depots, communication centers, and airfields could degrade and delay Israel's warfighting preparations, which are highly dependent on the mobilization of reserve forces.

Currently, Syria is believed to have about 600 ballistic missiles in service along with roughly 60 transporter-erector-launchers (TELs).[74] *Scud* missiles, which Syria now manufactures in both the B and C versions, are the most commonly represented missiles in Syria's arsenal. The *Scuds* are manufactured in Syria's two underground missile factories located near *Aleppo* and *Hamah*. See Figure 4-13. These facilities are believed to have been constructed with Iranian, North Korean, and Chinese assistance.[75] It is uncertain whether or not Syria will in the future produce the Chinese M-9/DF-15 missile in these same factories. As noted in Chapter 3, some Chinese specialists are thought to be working in these plants.

Syria

Figure 4-13

Syria's missile forces are equipped with conventional and CW warheads; the country is considered to be the leading nation in the Arab world in chemical weapon development, with indigenous production of Sarin and VX nerve agents occurring in three centers located near Damascus, Hims, and the village of al-Safirah.[76] As for BW capabilities, according to a U.S. government official. The Damascus Biological Research Facility is engaged, with foreign support, in BW research involving Anthrax, Cholera, and Botulism.[77] Its research efforts may have reached the weaponization stage. For example, ACDA's 1996 report on arms control compliance states that Syria probably has offensive BW systems. Although Syria currently does not have a nuclear weapons program, its recent interest in acquiring nuclear power technology has raised some concern that the country may be beginning to move toward the eventual development of the nuclear option.

Of particular interest is Syria's relationship with Iran. The two countries are cooperating extensively in the development of their strategic programs. For example, Israeli sources claim that Iran and Syria shared the cost of setting up domestic plants to produce the North Korean *Scud* C. They are also cooperating to develop CW and BW, to ship and exchange missile parts, and to exchange technicians and specialists in unconventional

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[73] Ibid., p. 169.

[74] "Briefing: Ballistic Missiles," *Jane's Defence Weekly,* April 17, 1996. p. 43.

[75] Eisenstadt, *op. cit.,* p. 170.

[76] Ibid., p. 169; and Alex Fishmand and Arye Egozi, "Sources Comment On Syrian Scud C Tests, Chemical Warheads," Tel Aviv *Yedi 'ot Aharonot,"* translated in *FBIS-TAC-97-064,* March 5, 1997.

[77] Briefing by a U.S. government official to a 1995 workshop. The briefing was presented on a nonattribution basis.

[78] Amy Dockser Marcus, "U.S. Drive to Curb Doomsday Weapons In Mideast Is Faltering," *The Wall Street Journal,* September 6, 1996, p. A1.

weapons.[78] Considering the fact that Syria was impressed by the performance of the U.S. *Tomahawk* cruise missile during the Gulf war,[79] it cannot be ruled out that if Iran did acquire a *Tomahawk* missile from Bosnia, the technical information on that system may have been shared with Syria. Syria is also believed to be developing its own cruise missile system for future deployment.

Other Players

There are, of course, many other countries that are engaged in developing or exporting WMD and missile delivery technologies. Some examples (not all inclusive) include Libya's well publicized progress in developing CW and missile delivery systems (currently it has *Scud* C missiles, with the indigenous 950 km range *Al Fattah* missile in development); Ukraine is under severe economic stress, it is suspected of exporting some sensitive missiles and missile components, to include sales to Libya;[80] Egypt also has a missile development program (discussed earlier); and there is leakage of advanced missile technologies from Latin America, which in the cases of Brazil (and potentially Argentina) have the potential themselves for developing ICBMs.[81] In addition, as was made clear by a December 1996 *U.S. News and World Report,* the United States itself is also a major source of sensitive military technologies.[82]

Conclusions

In short, missile technology is being widely shared throughout the world. Although the MTCR has slowed the migration of missile technology, it has not stopped the flow. The same can be said about the NPT. Nuclear proliferation has been slowed, but not stopped. By 2010, more states will likely hold nuclear, chemical, and biological systems than is now the case. Ballistic and cruise missiles are also proliferating as countries seek assured penetration capabilities.

Of particular concern is the number of countries in which foreign WMD and missile technicians are working. For example, various Western countries, Russia, Ukraine, North Korea, China, Egypt, India, Pakistan, Syria, and a host of other states all have citizens that are involved in WMD and missile projects in other countries. In the course of executing these projects, a cross-leveling of knowledge is occurring as these specialists share information. Much of this information is undoubtedly making its way back to the home counties. For example, North Korean assistance to Iran undoubtedly involves a feedback loop to North Korea. Thus, the knowledge that North Korean specialists gain from other technicians while working on joint projects in Iran gets reported back to North Korea for incorporation into its own programs. It is this new foreign assistance element that is making it so difficult for intelligence agencies and academic country specialists to predict the speed at which future missile and WMD capabilities will evolve. Thus, the U.S. could find itself surprised in the future as new capabilities emerge more quickly than expected.

79 Eisenstadt, *op. cit.*, p. 172.
80 Bill Gertz, "Ukraine Imperils U.S. Aid with Libya Arms Deal," *The Washington Times,* December 9, 1996, pp. A1 & A12.
81 "Intelligence Chiefs Warn of High-Tech Proliferation," *Arms Trade News,* April 1996, p. 1.
82 See "Weapons Bazaar," *U.S. News and World Report,* December 9, 1996, pp. 26-39.

CHAPTER 5

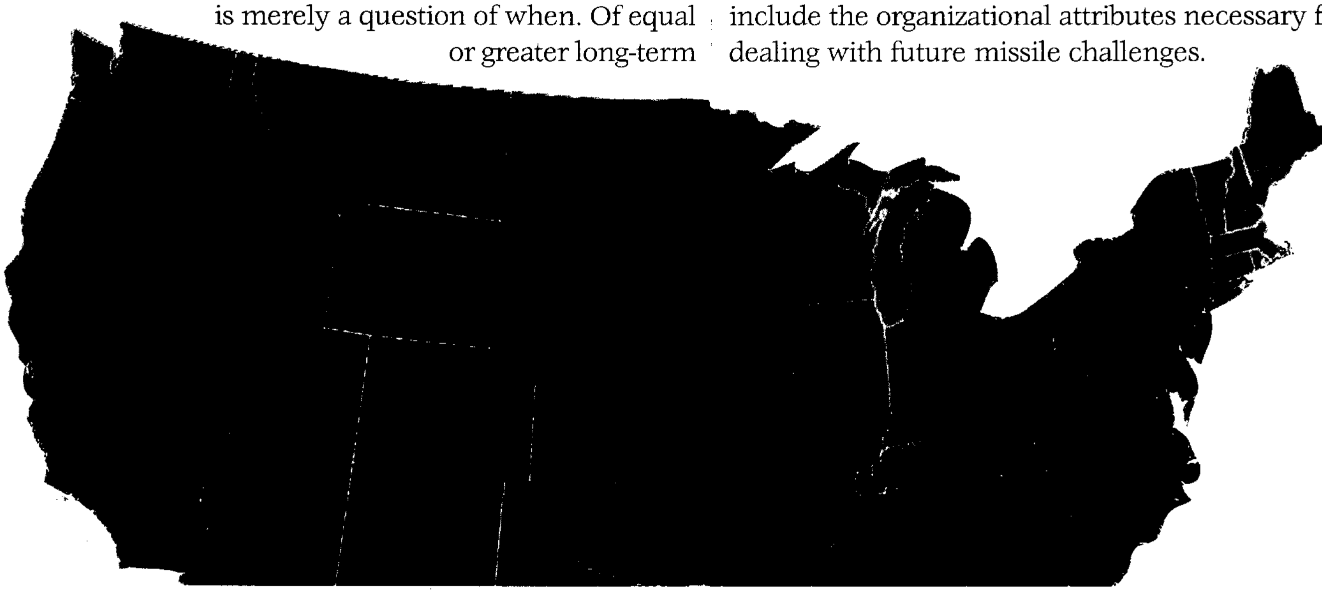
Assessing the U.S. Missile Defense Program

Introduction

As outlined in the first four chapters, it is clear that both ballistic and cruise missiles are proliferating. It is also obvious that such capabilities as stealth technologies, missile and warhead maneuverability, decoys, and radar volume maskers will increasingly be incorporated into the world's offensive missile delivery platforms as nations, which have and are investing large sums of capital in missile technologies, seek ways of insuring that their missile forces can penetrate the expected defense environments.

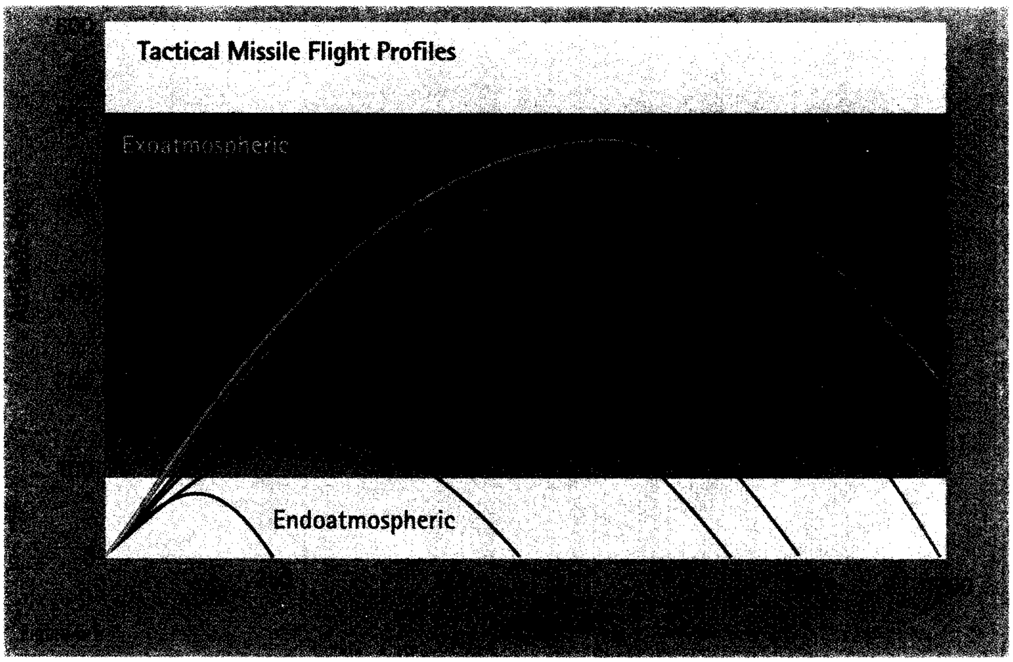
Essentially, the whole issue of missile defenses represents but an opening gambit in the struggle for security against missile-delivered weapon systems that are expected to be in use during at least the first half of the next century as the revolution in military affairs changes the warfighting environment. Denial of the evolving challenge will not make that challenge disappear. At some point, the United States must address the full spectrum of the world's evolving offensive missile capabilities; it is merely a question of when. Of equal or greater long-term importance, however, is the challenge of insuring that the defenses the United States does develop are flexible enough to be adapted quickly to counter emerging offensive missile capabilities on a timely basis.

In this chapter, the technological issues associated with missile defenses will be reviewed, and the United States' program for dealing with these issues will be assessed. The assessment will include the organizational attributes necessary for dealing with future missile challenges.



Ballistic Missile Penetration Options

In planning offensive missile countermeasures to anticipated defenses, missile planners try to select the highest-payoff methods that can be packaged within the limits of the throwweight available for countermeasure devices. It is somewhat ironic that at the ICBM level agreements such as START II, which eliminate U.S. and Russian MIRVed warheads on land-based missiles, also mean that those missiles will, in the future, have a great deal of excess throwweight that could be used to carry penetration aids or extra fuel for warhead maneuvers to avoid interception by missile defenses.



Ballistic missiles with ranges longer than about 350 kms face two distinct environments: exoatmospheric and endoatmospheric. Each environment provides its own set of opportunities and challenges for evading missile defense systems. Many of the possible missile defense countermeasure options were outlined at the end of Chapter 1, but without much reference to the environments in which they operate. In this chapter, countermeasures tailored to the endo- and exo- atmospheric environments will be assessed separately.

Exoatmospheric. Exoatmospheric flight occurs in very cold temperatures while the missile's payload is flying through a vacuum. Objects traveling through a vacuum are neither slowed nor heated by air-molecule friction; however, these objects also lose the aerodynamic maneuverability and lift that is imparted by flight through an atmosphere. Thus, maneuvers in space require a high expenditure of fuel since the maneuvering thrusters do not have any air molecules to push against, and the resulting maneuvers are gradual and gentle in comparison to atmospheric flight. However, all objects that are part of the missile's payload of weapons and penetration aids, be they metallic-coated balloons, aluminum chaff, full-scale warhead decoys, or warheads themselves, will travel through this vacuum at the same velocity, thus making it difficult to identify and target a specific item within the cloud of objects that are released from the missile once it clears the earth's atmosphere at the end of the ascent phase of its flight.

Successfully targeting missile defenses against incoming missiles during the mid-course phase, while the offensive warheads are exoatmospheric, is one of the most difficult tasks inherent in the missile defense mission. This difficulty has several aspects.

First, the target must be specifically identified by one or more sensor systems. The current U.S. national missile defense program envisions the use of U.S. early warning satellites and radar systems to alert

Maneuver efforts in space result in turns of only 2-3 G forces and would require external instructions to initiate the maneuver at the correct moment necessary to avoid intercept. The maneuvers would have to be executed either as a very large change in direction after the interceptor's booster had burned out or as evasive maneuvers just prior to arrival at the calculated intercept point.

the U.S. Space Command (SPACECOM) of an incoming missile threat. SPACECOM would then orient the battle-management radar located near the launch site at Grand Forks, ND, to detect, discriminate, and identify the specific targets to be attacked. The battle-management radar is likely to be an advanced ground-based, frequency-hopping, x-band microwave radar system. For theater-wide systems, the same general type of radar will be used, one with only slightly over one-fourth of the number of transmit/receive modules as will be included in the NMD's Ground Based Radar (GBR). In addition, the land-based theater-wide missile defense system is not planned to include outside cuing from other radars or space-based sensors (an ABM Treaty consideration).

Although the envisioned x-band radar systems will be able to search large areas (with the NMD-related system having the capability to track up to 1000 objects simultaneously), their effectiveness might be degraded by the use of stealth technologies and other similar efforts designed to enhance the survival rate of the offensive warheads. To improve U.S. capabilities to handle the anticipated missile threat, the Space and Missile Tracking System (SMTS–formerly called *Brilliant Eyes*), will be developed as a space-based infrared suite of sensors that will augment the ground-based radars.

Second, the intercepting missile must be able to find the target identified by the ground- or space- based sensor. The target's location will be passed from the ground- or space- based tracking systems to the intercepting missile's seeker system, which will identify the target's infrared signature and determine the vector to the target. The relationship between IR and radar sensor technologies is very complex. One of the challenges in making the missile defense system work involves the refinement of the radar-infrared interface. In short, the challenge is how to develop a way of transmitting the three-dimensional (3-D) radar target object map (TOM) in a format that is recognizable to a two-dimensional (2-D) infrared seeker, a seeker that may not be able to detect the same objects as the radar system (due to differences in sensor capabilities and angle of view).

Third, there are many potential ways to try to deceive the radar-infrared targeting system in the exoatmospheric environment. As discussed earlier, Russia, China, the United Kingdom, France, the United States, and probably Israel and Ukraine have all researched this problem. In addition, it would not be surprising to learn that Iran, Iraq, North Korea, and several other states have also begun to address the issue. Exoatmospheric countermeasures that seem likely to be incorporated into missile systems against which the United States may have to defend include:

1. **Exoatmospheric Penetration Aids.** Penaids range from low-technology, low-cost countermeasures to sophisticated high-technology measures that either add many more signatures to the puzzle or act to mask the signatures of the re-entry vehicle(s).

Figure 5 2

- **Low-Technology Penaids**. Aluminum chaff, metallic-coated balloons, and separation debris are low-cost means of greatly increasing the number of "signal returns" that the radar systems receive, essentially creating an electronic "shell game" to try to make the missile defense system guess which of the radar returns represent the actual re-entry vehicle(s). These types of penaids are within reach of even fledgling missile powers. For example, a country can use detonating cord to cut the upper stage of the missile body into pieces after burnout so as to increase the debris field in which the RV is located. As these types of penaids begin re-entry, they will slow, become separated from the re-entry vehicle, and burn-up in the earth's upper atmosphere. (Balloons and chaff "strip-off" the RV at 90-100 kms altitude; objects with more mass or better aerodynamic characteristics may penetrate somewhat deeper before becoming separated from the RVs.)

- **High-Technology Penaids.** These aids use active measures to assist RV penetration of defenses, including escort radar volume maskers, infrared decoys, and radar decoys. The latter two decoy systems will generate the radar or infrared signals normal for an actual warhead so as to provide the defensive battle manager with false targets. Some of these penaids are fairly inexpensive, but may be quite effective.

  For example, in 1996 a University of Pennsylvania professor built a radar volume masker using commercially available microwave technology. The masker mounted two spiraling microwave antennas mounted about 4 inches apart. The antennas were able to respond over the 2-18 gigahertz range without interfering with each other. With this equipment, one antenna received the microwave radar signal, the signal was amplified and elongated, then retransmitted back to its receiver as a stronger and longer signal, thus creating a void in the radar coverage behind the masker. Use of such maskers on the front of escort decoys could blind the radar to the objects trailing the volume maskers. Other countries could use similar techniques to try to jam or degrade the effectiveness of sophisticated frequency-hopping radars.[2]

2. **Signature-Masked RVs.** The second way of avoiding interception during exoatmospheric flight is to alter or mask the radar and/or infrared signature of the re-entry vehicle itself. This technique could be especially effective if radar/infrared decoy(s) were included in the package so as to provide logical targets for missile defenses.

- **Radar.** The shape of the RV can be structured to minimize the radar cross-section; it could also be coated with a radar-absorbing material (sold commercially) or put inside a shroud or otherwise camouflaged by adding materials to the outside of the RV such as strips of aluminum chaff or similar reflecting materials that will result in a non-standard signature being returned to the radar. (Materials attached to the skin of the RV would burn off during re-entry.) As for shrouding, something as simple as putting the RV inside of a metallic-coated balloon would make the warhead appear like a decoy, possibly rendering the RV unrecognizable as a target since radar cannot "see" through an electrical conductor. (The British *Chevaline* project reportedly incorporated this technique).[3]

- **Infrared (IR).** During the ascent phase, the nose of the missile becomes extremely hot, which in turn increases the temperature of the already warm warhead payload. The payload gives off this heat as it is exposed to the frigid coldness of space, thereby providing a thermal signature for infrared sensors seeking exo-atmospheric targets. The IR sensor faces a challenging task. It must locate the correct IR

[2] The volume masker experiment was related to the author during a telephone conversation with Dr. Ted Postal, Massachusetts Institute of Technology, June 20, 1996. The experiment was pending publication.

[3] Norris, Burrows, and Fieldhouse, *Nuclear Weapons Databook,* Vol. V, *op. cit.*, pp. 382-83.

signature against a background that includes many stars and suns that provide their own IR signals. Complicating the problem is the fact that the IR signature of the RV can be altered by using a special IR paint, thus changing the expected thermal characteristics of the target. The payload can also be insulated to reduce the amount of heat absorbed during the ascent, thus allowing the re-entry vehicle(s) to chill to near ambient temperature soon after burnout. In short, the parameters of the RV's IR signature can be changed so that the infrared sensors and seekers have difficulty recognizing the RV as a target.

3. **Salvage Fusing.** States may incorporate salvage fusing into their strategic nuclear warheads. Salvage fusing means that if an offensive nuclear warhead is struck while enroute to its target, a backup fuse will detonate the warhead. Since extremely fast fuse reaction speeds are required to detonate the nuclear device before an impact shockwave is able to destroy the integrity of the warhead, salvage fusing is unlikely to be incorporated into first-generation missile systems. However, more advanced systems may well include this capability. In cases where salvage fusing is encountered, the resulting nuclear detonation will be detrimental to U.S. missile defense efforts.

   A nuclear warhead that explodes exoatmospherically creates a lot of thermal and radiation effects (without an atmosphere, blast effects are not an issue). In addition, the electro-magnetic pulse (EMP) generated by the explosion will fry the electronic circuits in all but the most hardened of the satellites and sensors within line-of-sight of the detonation. Radiation and thermal effects will also destroy or degrade selected hardware components for a considerable distance,[4] and a significant portion of the surviving space sensor systems will experience increased electronic "noise," report false tracks, or be otherwise unable to perform their missions even if exposed only to the persistent radiation from enhanced electron belts and gamma-emitting debris collecting on the focal plane.[5]

   As an aftereffect, a significant proportion of the world's satellite inventory in low earth orbit which was not destroyed by the initial explosion will fail prematurely as most are not hardened against higher levels of radiation. Studies by the Defense Special Weapons Agency (DSWA—formerly DNA) "show that the explosion of a single high-altitude low-yield nuclear weapon could destroy $14 billion worth of low-earth orbit satellites" (damage inflicted by the event and subsequent satellite transit through the enhanced radiation belts produced by that explosion).[6]

   From the missile defense perspective, a nuclear explosion will also create "blooming" in infrared sensors as well as temporarily disrupt radar signals. Some space-based sensor systems will be damaged by the effects of the detonation allowing the follow-on offensive missiles to avoid early detection as they are likely to be shielded by the residual effects of the nuclear detonation. In short, salvage fusing is expected to provide some penetration assistance to those missiles that follow an intercepted warhead.

Endoatmospheric. Endoatmospheric flight will be characterized by extreme heating of objects re-entering the earth's atmosphere, the ability to use the atmosphere for maneuver, and the slowing of penetrating objects as drag reduces the speed of the objects. Many active signal transmitters, such as radar jammers, will suffer some degradation in their capacity to transmit during re-entry. As a result, the means of evading missile defenses in

4 R.C. Webb, Defense Special Weapons Agency, presentation to U.S. Army Space and Strategic Defense Command, "The Effects of Radiation on Space Systems," September 26, 1996.

5 Ibid.

6 R.C. Webb, Les Palkuti, Lew Cohn, Glenn Kweder, and Al Costantine, "The Commercial and Military Satellite Survivability Crisis," *Defense Electronics,* August 1995.

the atmosphere are more limited than they are exoatmospheric. However, due to the aerodynamic maneuverability that the atmosphere provides, maneuvering capabilities are enhanced during endoatmospheric flight.

Endoatmospheric countermeasures likely to be incorporated into missile systems against which the United States may have to defend include:

1. **Endoatmospheric Maneuver**. This is the primary means that most states will use to evade missile defenses in the atmosphere. There are three deliberate maneuver techniques that could be used, along with a couple of unplanned maneuvers.

   - **Aerodynamic maneuvers.** Essentially, this is the use of wings, fins, or thrusters to maneuver a warhead in the atmosphere. Russia's *Project X* and India's *Agni* warheads are examples of systems that incorporate aerodynamic maneuvering. In many ways, the technique used is very similar to that employed by air-to-air missile systems that use small wings and/or thrusters to maneuver to target. Warheads with this capability can be programmed to follow a series of complex maneuvers in the atmosphere. These types of warheads may include terminal position correction technology and be highly accurate.

Maneuvering Target

Figure 5-3

- [illegible]
- [illegible]

   - **Coning or Corkscrewing.** Many re-entry vehicles, such as those used in MIRVed systems, are built as long, smooth, coned-shaped objects. If they are to fly smoothly, these cones must be balanced, much as the wheels on a car must be in balance, or they will wobble or "shimmy." If an RV is unbalanced, either through faulty design or deliberate engineering, the results can be a re-entry vehicle which engages in a corkscrewing maneuver during its endoatmospheric flight. This same motion can also be introduced by the use of fins or something called a "split-flap." The resulting maneuver resembles a corkscrewing motion around the axis of the RV's planned trajectory in a pattern that may be 30-40 meters in diameter, with turns of 10-15 G forces.

   - **Acceleration/Deceleration**. To an interceptor that is approaching a re-entry vehicle at a slant angle, the acceleration or deceleration of the target provides as much of a targeting challenge as does a lateral maneuver. As an RV penetrates the earth's atmosphere, the effects of drag will slow the vehicle. Unfortunately, the rate of slowing varies between different systems depending on their "beta" rating. For example, early-generation ICBM warheads re-enter the atmosphere at a velocity of around 6 or 7-kms per second, slow rapidly beginning at 25-55 kms altitude (depending on their beta), then impact at a velocity of less than 1-km per second. However, the latest Russian and U.S. ICBM RVs are are very aerodynamic, low-drag systems (high beta) that maintain most of their velocity until reaching about 12 kms altitude before slowing rapidly to perhaps 3.5 to 4 kms per second at impact.[7] The different rates at which RVs decelerate must be compensated for by endoatmospheric interceptors.

Complicating the situation is the possibility that the RV could have a small acceleration booster incorporated into its system that would increase the velocity of the RV above the norm as it penetrated the atmosphere. This booster might be employed in cases where the RV was built as an earth penetrator (targeting underground facilities) or if the warhead designers decided to use boosted descent as a form of endoatmospheric maneuver, making the RV behave in an unexpected manner to missile defense interceptors.

- **Breakup or Tumbling.** The warhead can also act in an unanticipated manner if it should breakup or tumble. This is, of course, what happened with the Iraqi *Scud* systems. The *Scud* does not have a detachable warhead. The warhead and missile body remain attached throughout the entire trajectory. During *Desert Storm,* it was found that the re-entry stresses sometimes caused the elongated missile models to breakup between 12-18 kms altitude. Unfortunately, U.S. radar systems were not programmed to identify the broken-up missiles as a threat to be reported for attack. (Since radar collects data on everything moving, to include birds, the software is programmed to ignore returns that fall outside the parameters determined to represent target characteristics—such as a *Scud* not following a ballistic trajectory.) In essence, the subsequent movement of the *Scud* after breakup represented an unintended maneuver.

2. **Endoatmospheric Decoys.** Ballistically matched decoys can accompany the RVs to increase the number of possible targets with which the missile defenses must cope. Some decoys can also be accelerated to match the velocity of the actual RVs.

3. **Stealth.** Efforts to reduce the radar cross section of the RVs help to degrade radar coverage in both the exoatmospheric and endoatmospheric phases of the trajectory. As seen in Chapters 1-4, most countries doing research on missile development are also working to decrease radar cross section profiles. This work is projected to bear fruit by 2010.

Assessing the Target Array

As was seen in the country reviews, Chapters 2-4, a number of states are working to develop tactical missile systems that can be employed against high value targets in the theater of operation (i.e., copying U.S. AirLand Battle Doctrine). Many of these countries also seem interested in the acquisition of strategic missile systems capable of deterring outside intervention into their region. It is likely that many of these states also seek the international prestige that is conferred on nuclear-armed nations, especially those that also have ICBM delivery systems.

Tactical Missile Defenses. The target array that missile defense systems must cope with differs somewhat between the tactical and the strategic levels. At the tactical level, shorter-ranged missile systems, such as China's DF-15/M-9 missile and India's *Prithvi,* will be equipped with a wide spectrum of warheads, warheads with both WMD and conventional capabilities: nuclear, chemical, biological, fuel-air explosives, explosive bomblets, smart independently targeted submunitions, electro-magnetic-pulse generators, scatterable mines, etc. Unfortunately, when the missile is launched, the defenders may not know what type of warhead is incoming. Consequently, the missile defense

[7] Endoatmospheric flight characteristics were discussed with a number of ballistic missile specialists on a nonattribution basis. Also see Paul Zarchan, *Tactical and Strategic Missile Guidance* (Washington, DC: American Institute of Aeronautics and Astronautics, December 1994), p. 365.

More importantly, MIRVed warheads are being developed in other countries that heretofore have not had MIRV technology. China is expected to MIRV its ICBMs within the next couple of years (and may have already begun the process); Iraq, as was discussed in Chapter 4, is also suspected of working on a multiple-warhead capability. (Many of these states are likely to introduce multiple re-entry vehicles—MRVs—to their inventories first and later introduce the independent targeting option. MRVs act like a shotgun, with all RVs following a trajectory to the same target area, but forming a dispersion pattern that increases the lethality of the strike.) As ballistic missile capabilities spread early in the next century, their related MRV or MIRV warhead packaging also seems likely to proliferate as technical knowledge spreads.

Through 2010, it seems probable that the vast majority of warheads on ICBM systems will remain nuclear. Chemical weapons lack the lethality necessary to provide an effective national deterrent. In comparison to the cost of an ICBM delivery system and the certain retaliation from the United States that such an attack would provoke, a CW attack would not be sufficiently damaging to sway the United States from the pursuit of its key national interests. On the other hand, BW bomblets could create havoc, not only from the initial lethality, but also from the potential that the contaminated area could remain unusable for decades to come.[10] In a similar vein, radiological weapons (radioactive material dispersed by a conventional explosive) could be used to contaminate important economic or military sites.

Comparison of Nuclear, Biological, and Chemical Damage contours

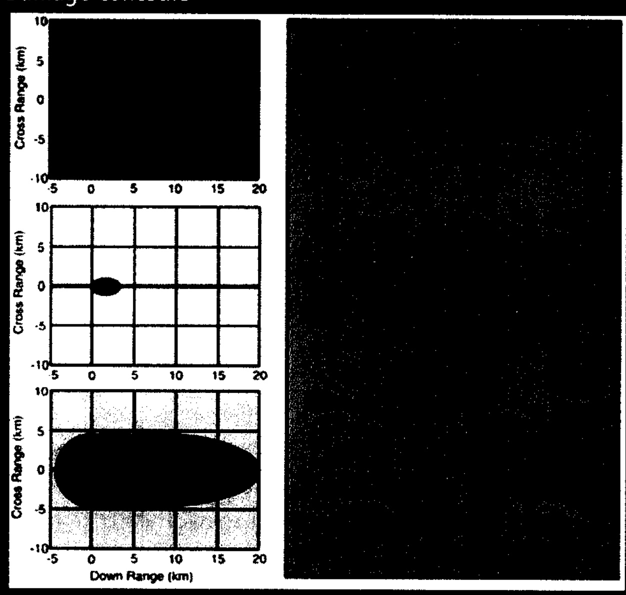


Figure 5-5

However, there is a major shortcoming to using either CW and BW agents as a strategic weapon system delivered by ICBM. This shortcoming is the simple fact that the effectiveness of the strike is greatly influenced by weather conditions and wind direction. Thus, a warhead that delivers the agent at the edge of a target could result in most of the potential effects being wasted if local wind conditions were opposite that expected when the strike was planned. In addition, other weather conditions, such as high winds, could spread the agents too thinly to be effective. Likewise, a lack of wind in conjunction with temperatures and pressure conditions that encouraged surface air to rise can also dissipate the agents with minimal casualties. Consequently, CW and BW warheads do not make very predictable deterrent weapons as they can be employed effectively only under certain weather conditions and BW has an incubation period which delays its effects.

As a result, through the year 2010, the most common ballistic missile warhead types that will threaten the United States will be unitary or MIRVed nuclear devices, many of which will incorporate or be accompanied by penetration aids. Considering the delayed effects and uncertainty of results inherent in BW systems, the nuclear option

[10] Under normal conditions, anthrax spores (the most popular agent of choice for BW systems) can remain potent for up to 20 years in animal hides and soil. Under abnormal conditions, they can survive even longer. For example, the British dropped some experimental anthrax bombs on an island off the coast of Scotland during World War II. The bombs were inefficient and compacted the spores into the soil. The spores remained in the top 6-8 inches of the soil for over 40 years. U.S. Congress, Office of Technology Assessment, *Technologies Underlying Weapons of Mass Destruction,* OTA-BP-ISC-115 (Washington, DC: U.S. Government Printing Office, 1993), pp. 78-79.

remains the more likely weapon of choice for an ICBM warhead. The probable exceptions to this prediction might be those cases where a country of limited means obtains or develops more ICBMs than it has nuclear warheads to deliver. In that situation, it might develop BW or radiological warheads to make up the difference. On the other hand, at the theater level, U.S. missile defenses can expect to face a target array that includes a wide variety and number of conventional and WMD warheads and submunitions that will threaten high-value targets. However, in the longer term, the challenge that BW agents pose will grow as the biotechnology revolution evolves.

U.S. Missile Defense Program

The *Patriot* missile of Gulf War fame (the PAC-2) was essentially an anti-aircraft missile system composed of 1970s-era technology with a 1980s-era software upgrade to provide it with a limited anti-missile capability. The real importance of PAC-2's *Desert Storm* performance was not its record of hits and misses, but the demonstration of the fact that ballistic missiles could be intercepted. In context, its performance was the equivalent of the Wright brothers' first flight at Kitty Hawk. While that first flight was brief and far from perfect, it proved powered flight was possible.

With the realization that missile intercept was possible, coupled with the experience of trying to deal with offensive ballistic missile launches (i.e., Iraq's *Scuds*), the United States developed a program to field tactical missile defenses. Although there is general agreement regarding the need for tactical missile defenses, what is still hotly debated is whether or not the United States needs a national missile defense and, if judged necessary, should that defense be fielded within the limits prescribed by the ABM Treaty.

ABM Treaty Limiting Issue. If the country attempts to build a limited national missile defense within the constraints of the ABM Treaty, there are some restrictions that pose special difficulties. The first restriction is that no more than 100 interceptors can be fielded at only one site. The designated site for the United States is Grand Forks, ND. Prior to the addition of a protocol to the original ABM Treaty (added at U.S. insistence), each party was permitted to deploy its defensive missiles at two locations. A few defense strategists are now advocating that the U.S. negotiate a termination of the ABM Treaty's protocol, thus re-establishing the ABM Treaty's original provision which allowed two deployment sites. Others would either abrogate the ABM Treaty entirely or negotiate some major revisions to that agreement to allow for missile defenses at multiple sites.

The second restriction of note is that each ABM interceptor missile can only be equipped with a single warhead/kill vehicle. This provision makes it impossible to develop cost effective missile defenses, defenses that are not disproportionately more expensive than offensive forces. For example, a single Chinese missile with a 9-MIRV warhead would require a minimum of nine U.S. interceptor missiles to eliminate the threat. In reality, considering China's reported work on penetration aids and the probability that some number of U.S. interceptors would miss their targets, the number of actual interceptors required to prevent nuclear disaster would be considerably higher than nine.

The third difficulty is the limitations on ABM radars. Essentially, the ABM radar must be within 150 kms of the ABM site at Grand Forks, ND. Since the NMD radar is expected to have a range of about 4000 kms, this means that the potential for intercepting offensive missiles launched against Alaska or Hawaii will be very fragile. Although early warning radars are allowed to be deployed on the periphery of each country, the radar handling the intercept must be located within 150 kms of the ABM launch site.

The fourth difficulty is that it makes a number of potential theater missile defense systems legally questionable (e.g., airborne lasers and fast intercept missiles deployed on ships). Essentially, this fourth point revolves around the issue of what systems are subject to being counted against the

Treaty's limits and which can be considered theater-level assets.

Planning Factors/Concepts. Missile defenses, like air defenses, usually are constructed by developing layers of defensive belts, with each belt thinning the number of incoming warheads. It is understood that some warheads will get past the initial line of defense. Ideally, the best place to destroy ballistic missiles is either prior to launch or while the missile is still in the ascent phase of its trajectory before its payload of munitions and penaids are deployed. Those missed in the ascent phase should be destroyed while in mid-course, and those that survive that effort, destroyed by endoatmospheric terminal defense systems.

Reentry Vehicle Velocity as a Function of Altitude and Beta (based on a range of 9,000 kms)

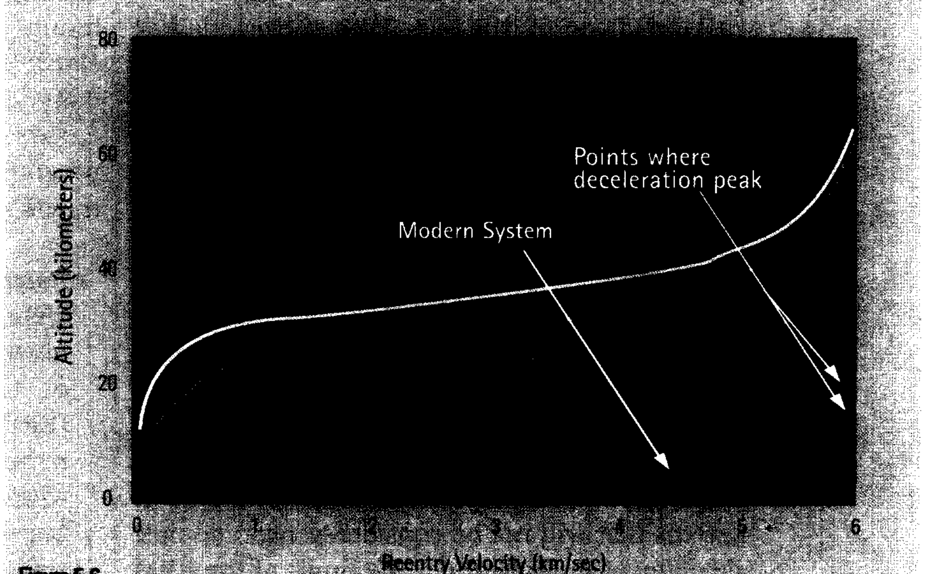


Figure 5-6

One of the key issues has been trying to determine the demarcation line between a theater missile defense system and a national system that is subject to ABM restrictions. Although decision makers do not like to acknowledge the issue, the truth is that a theater defense missile, if properly placed, can engage missiles of greater ranges or speeds, to include ICBMs. The two key variables to the success of this effort are the speed of the intercepting missile (i.e., how fast it flies out) and the amount of time that can be provided to the interceptor for its flight to target. Of these two issues, the length of flight time is the more critical factor. For example, a slower missile that is cued early enough to fly a long distance to an intercept point can defend a considerable area. On the other hand, a very fast missile that only receives local targeting information will not be able to defend as large an area as the slower interceptor that is connected to a wide-area sensor network.

As a general rule, the intercepting missile should have at least half the speed of its target for a reasonable expectation of an interception. A slower missile might still make the interception, but the probability factor would be lower. Thus, the issue of velocity becomes a key planning factor.

For example, Figure 5-6 shows the penetration profiles for warheads of varying beta ratings (higher beta ratings reflect more streamlined warheads with lower drag effects in relationship to their respective weights). For example, if a primitive warhead were developed without much shielding, it could be designed as a bulky payload that "belly-flops" through re-entry with deceleration peaking at 40-50 kms altitude. Its flight profile might resemble that shown by the beta 10-20 lines in Figure 5-6. If the warhead is based on 1950s missile technology (systems like the Soviet SS-6--similar to the *Scud*), the lines showing beta ratings of 100-200 reflect the re-entry profiles for that level of technology. It is likely that the first generation Chinese systems are also close to those profiles. On the other hand, the new Chinese systems, Russian warheads, and U.S. re-entry vehicles will have re-entry profiles similar to those reflected by the bottom two lines. In the chart shown, the missiles are hypothetically fired to a range of 9000 kms and re-enter the atmosphere at 6 kms per second. Notice that the modern warheads maintain the 6 kms per second velocity down to an altitude of about 18-20 kms before the higher atmospheric densities encountered at 21 kms begin to slow the warhead. Even so, the beta 2000 warhead is still travelling at 5.5 kms per second at 12 kms, with an impact velocity of about 3.7 kms per second. For ICBM flight ranges above 9000 kms, the re-entry velocity would be higher. Thus, the issue of TMD velocity limitations became an issue of debate with regard to the TMD demarcation negotiations with the Russians.

To resolve the issue of the demarcation line between theater missile defense (TMD) and national missile defense (NMD) systems, the U.S. administration reached a tentative agreement with Russia in June 1996 specifying some of the TMD systems that will not be considered national missile defense systems under the limits of the ABM Treaty.[11] The agreement specified the limitations on the *Theater High Altitude Area Defense* (THAAD) system. The interceptor will be restricted to a speed of 3 kilometers per second or less; it also cannot be tested against targets traversing ranges greater than 3500 kilometers or at velocities in excess of 5 kilometers per second. Of perhaps greater significance, THAAD will not receive targeting data from satellites or adjunct radar systems, a restriction that could reduce the system's protective footprint by roughly half. Although the status of the Navy theater wide system and the Air Force's boost phase intercept systems have not yet been negotiated, and the U.S. administration reportedly opposes limitations on these systems, Russia is expected to try to have those two systems restricted as well. Russia is linking its continued participation in the START treaties to the ABM Treaty.

Area Defense Programs. The immediate priority in the post-Gulf War era was to add some near-term improvements to U.S. missile defense capabilities. This included deploying an updated version of the *Patriot,* the PAC-2 Guidance Enhanced Missile (GEM), which added a new seeker and a faster-acting warhead fuse to improve fragmentation coverage on the target. In addition, some improvements were also applied to the Marine Corps' *Hawk* missile system to add a missile defense capability, along with some improvements to the Air Force's early warning systems. The area defense programs that are underway for future improvements to U.S. missile defenses include:

- ***Patriot* Advanced Capability (PAC)-3.** In 1999, the PAC-3 will begin to be fielded. The heart of the PAC-3 program is the incorporation of the new Extended Range Interceptor (ERINT), which will use a hit-to-kill principal rather than the current explosive fragmentation warhead. The PAC-3's sensors are also much improved over those of the PAC-2, with a refined ability to identify, detect, and track low-altitude threats among ground clutter, an especially important feature when defending against cruise missiles and depressed trajectory ballistic systems. The system will provide for local defenses and be effective against *Scud* and M-family types of missiles with ranges up to about 600 kms, providing coverage over roughly a 25 mile (42 kilometer) wide front. Its defensive footprint is about 10 times larger than that of the PAC-2. Six battalions will be fielded initially with another three battalions possible, depending on the outcome of the MEADS program.

- **Navy Area Defense** (formerly known as Navy Lower-Tier). Essentially, this program will provide the Navy's *Aegis* systems with an area missile defense capability similar to that provided by the Army's PAC-3 program. To fill the Navy's requirements for the defense of ports, harbors, and amphibious operations, the Navy will modify *Aegis* sensor systems and the *Standard* Missile-2 Block IV-A (a version of the service's basic fleet defense missile) to detect, track, and engage ballistic missiles. The SM-2 Block IV-A uses a shaped-charge warhead to increase its destructive effects. *Aegis* ships are

[11] The agreement reached in the Standing Consultative Commission (SCC) was the first of a two-part negotiation. The lower-tier area defense systems and the THAAD system were negotiated in phase one; the Navy Theater Wide (NTW), Airborne Laser (ABL), and the Space and Missile Tracking System (SMTS) are to be negotiated in phase two. The Russian's refused to sign the final phase one agreement until phase two is also negotiated and ready for signature.

scheduled to begin being equipped with the modified missile by 2002.

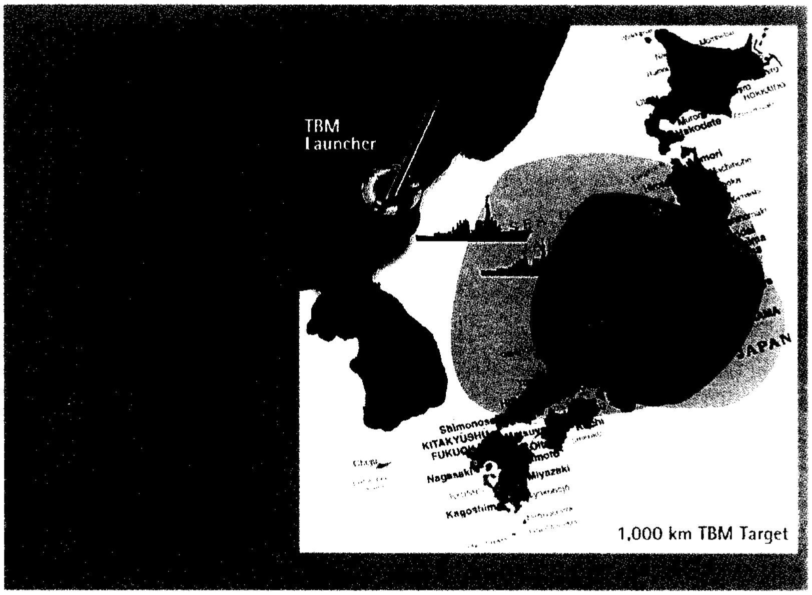
- **Medium Extended Air Defense System (MEADS).** The *Patriot* system has two major constraints. First, it is difficult to move. For example, the U.S. Army's VIIth Corps' deep assault during Operation *Desert Storm* could not be supported by the *Patriot. Patriot* units cannot be moved forward quickly enough to support that type of maneuver. Considering the agile mobile missile systems being developed around the globe (Chapters 2-4) and the speed with which cruise missiles are proliferating, this limitation will pose a major vulnerability to U.S. forces early in the next century. Second, the *Patriot's* radar systems only orient and search in one direction, limiting its potential contribution to futuristic cooperative engagement systems (such as the Navy is developing).

  The solution to these limitations is MEADS, a multinational program, previously known by its U.S. program designation as Corps Surface-to-Air Missile (Corps SAM). The MEADS program is designed as a mobile anti-aircraft, anti-cruise missile, and anti-ballistic missile system capable of moving with maneuvering forces, offering all-azimuth protection. MEADS is planned to begin fielding in 2005, starting with the three *Patriot* battalions not upgraded to the PAC-3. MEADS will eventually supplant the *Patriot* as the U.S. Army's primary lower-tier air defense system. It possesses a slightly larger footprint than the PAC-3 and is capable of destroying targets at higher altitudes, up to 30 kms.

Theater Defense Programs. Theater missile defense systems are designed to protect areas hundreds of kilometers wide against ballistic missile attack. While the area defense systems described in the preceding section will be capable of defending against aircraft and cruise missile systems as well as ballistic missiles, the theater systems are specialized for employment against ballistic systems. The United States has two programs that are designed to provide theater-wide coverage. The more mature program is the Army's Theater High Altitude Area Defense (THAAD) system, while the Navy Theater Wide system (formerly called the Navy Upper-Tier) is the least mature of the TMD programs.

- **Theater High Altitude Area Defense (THAAD).** The endo-exoatmospheric THAAD remains the centerpiece of the "core" TMD programs and should be fielded by 2004. It is designed to protect against the full spectrum of theater-class threats, including higher velocity ballistic missiles such as the North Korean *Nodong* and the Chinese CSS-2. Although it will be untested, THAAD should also have a limited capability against some ICBM-type targets. Like the PAC-3, the THAAD warhead is designed for hit-to-kill target engagement, but with a much higher ceiling, able to attack targets in both the endo- and exo- atmospheric environments. Essentially, THAAD has a robust exoatmospheric engagement capability that extends downward to low endoatmospheric altitudes. Being able to first engage the target exoatmospherically allows an increased number of shot opportunities when operating in a "shoot-look-shoot" mode. For example, the THAAD might fire an interceptor at an RV in the 120-150 kms altitude band, assess the results and, if necessary, fire a second missile to intercept the RV at 40 or 50 kms after many of the penaids, if present, are stripped off (an altitude that is above the "density wall" at 21 km which sometimes causes incoming missiles to breakup). The overall system is composed of a TMD Ground Based Radar (GBR); 2-2.5 km per second interceptors; launchers; and a ballistic missile command, control, and communication (BMC^3) system.

  - The kill vehicle for THAAD uses an uncooled sapphire window through which it searches for IR signatures in the medium-wave infrared (MWIR) wavelengths. At launch, the kill vehicle is protected by a clam-shell shroud to prevent excessive heat build up on the seeker window during flight through the dense atmosphere of the lower altitudes.



- The TMD radar system is an x-band phased-array microwave system that uses 25,344 solid-state transmit/receive modules of the type that will be used in the NMD's GBR (which will incorporate over 80,000 modules of 6-8 watts each). The TMD radar will have a range of about 2000 kms. More work is still needed to improve the efficiency of these transmit/receive modules.

- **Navy Theater Wide (NTW).** The preliminary concept for an NTW system envisions deploying improved *Standard* missiles on *Aegis* platforms for exoatmospheric theater-wide missile defense. The NTW missile is anticipated to fly at a velocity of 4 to 4.5 kms per second, carry a kinetic hit-to-kill warhead, and be able to engage targets outside the atmosphere up to a reported altitude of perhaps 500 kms. Of the four kill vehicles under consideration, the most likely candidate is one derived from a BMDO technology demonstrator, the Hughes-Rockwell Lightweight Exoatmospheric Projectile (LEAP). The LEAP destroys its target by hovering in its path.[12] As an exoatmospheric system, Navy Theater Wide would intercept ballistic missiles at ranges and altitudes greater than that of THAAD. The NTW may have some ability to intercept ballistic missiles while in boost or ascent phase, if the operational situation and the availability of water allows *Aegis* ships to position close enough to the launch site. The NTW system will leverage much of its technology requirements from the NMD R&D effort. It is expected to be operational by 2006.

Such capabilities, especially the missile's speed and its interface with a wide-area sensor network, have raised Russian concerns. They claim the system has a significant potential to intercept ICBMs and would violate the ABM Treaty. Like THAAD, any restrictions on external targeting information would substantially reduce NTW's effectiveness. Because these ship-launched missiles can greatly extend the range at which they can make an intercept (if cued by external sensors to begin their flight prior to the threat being visible on the *Aegis* radar system), an external sensor ban would reduce NTW's capabilities to a greater extent than the June 1996 agreement will do to THAAD. According to some analyses, restrictions on external targeting data supplied to NTW interceptors could reduce their probability of a successful kill by a factor of ten or more.[13]

- **The Airborne Laser (ABL) Boost-Phase Intercept (BPI) Concept.** The BPI concept would mount a long-range, multi-megawatt chemical laser aboard a Boeing 747-400. The laser would be able to target boost-phase and possibly midcourse phase ballistic missiles from standoff ranges. Using either its own sensors, or cued from off-board sensors, the ABL would be capable of engaging missiles from any angle at ranges of 450 kms or more while flying above the clouds at 40,000 feet.[14] It is envisioned to have an enhanced capability to defend against salvo-fired missiles, hopefully being able to

[12] LEAP is a small, highly maneuverable kill vehicle which is designed to hover in front of an incoming RV or missile, using the resulting kinetic energy of the impact to destroy its target. Some concerns have been raised, however, that the kill vehicle may be of insufficient mass to destroy or disable larger ballistic missile warheads, such as the SS-18 Mod 6 (although as a TMD system, it should not have to kill ICBM warheads).

[13] "Limits on Cuing are Unnecessary, Former SDIO Chief Says," *Defense Daily*, September 27, 1996.

[14] Mark Hewish, "Scudkillers: Tough Choices For Boost-Phase Intercept," *Jane's International Defense Review*, January 1996, p. 31.

engage three or more missiles that have been fired simultaneously.[15] Possible additional roles for the ABL include anti-cruise missile, anti-aircraft, and perhaps anti-satellite.[16] Although adverse weather limitations and beam propagation within the atmosphere have long been difficult obstacles for long-range lasers, some aspects (but not all) of these problems have been solved. An ABL test against a boosting ballistic missile is planned for 2002; the first three aircraft could achieve an initial operating capability by 2006, with the operation of a seven aircraft fleet possible by 2008.

- **BMC⁴I.** Distributing relevant targeting information to the proper recipients has long been a difficulty challenge in military operations, but particularly so in missile defense operations. During Operation *Desert Storm*, despite the fact that sensors could detect Iraqi missile launches and build track files almost immediately, no existing communications infrastructure existed which could have provided the data to would-be interceptors. While systems such as the Army's Joint Tactical Ground Station (JTAGS) and the Air Force's Combat Integration Capability (CIC)[17] do a great deal to bridge existing gaps, more seamless sensor-to-shooter links are required.

The NMD Deployment Readiness Program (NDRP). This program reflects the United States' NMD policy and is generally known as the "three plus three" plan. That is, in the initial three year period of the program's implementation (1997-2000), the Defense Department will develop technologies and options for a National Missile Defense system which could be deployed within another three year period if a sufficient threat to the United States exists. In the event the intelligence community determines that a requisite threat has not materialized, research and development of more advanced missile defense technologies will continue and threat reviews will be conducted annually. If a review determines a that there is a clear missile danger, deployment will commence to achieve an initial operating capability within three years, with 2003 representing the earliest possibility. A key advantage of the NDRP policy, according to its proponents, is that it will ensure that the United States deploys the most technologically advanced system available commensurate with existing adversary missile capabilities.

National Missile Defense (NMD) Elements. The main elements of the NMD program revolve around three projects. The first is to prepare a ground-based interceptor, sensors, and related BMC^3 for deployment within three years of being directed to do so; second, to develop a space-based sensor system for early warning and cuing of missile defense assets; and third, eventually to develop a space-based laser system for defense against ballistic missile attack.

- **Ground-Based Interceptor (GBI) System.** The Army proposes to emplace 20-100 commercial interceptors in the Safeguard Missile Defense site at Grand Forks (built in the mid-1970s). These interceptors would be tipped with an exoatmospheric kill vehicle (EKV) and would have a fly-out velocity of some 8.2 kms per second, allowing, for example, a missile launched from North Korea to be intercepted prior to its reaching Hawaii, a flight time of roughly 30 minutes. This system would be cued initially by the Defense Support Program (DSP), an existing geosynchronous-orbit satellite constellation capable of reporting the launch and direction of flight soon after the missile breaks through the clouds. The missile's flight would be tracked by upgraded U.S. early warning stations. The collection of exact targeting information and intercept data would be handled by the NMD's 4000-km range ground-based radar (GBR).

  As an alternative to the Army's proposal, the Air Force has suggested using 20 *Minuteman* mis-

[15] General Ronald R. Fogleman, USAF, Air Force Chief of Staff, "Theater Ballistic Missile Defense," *Joint Force Quarterly*, Autumn 1995, pp. 75-79.
[16] David A. Fulghum, "USAF Aims Laser at Antimissile Role," *Aviation Week & Space Technology*, August 14, 1995, pp. 24-25.
[17] Frank Oliveri, "USAF Finds Low-Cost Key to Scud Fight," *Defense News*, November 27-December 3, 1995, pp. 1/29.

siles as the NMD launch vehicles. There are also some other differences in the proposed sensor suites that must examined to determine which option or combination of the two options would best meet the nation's requirements. The alternative proposal also contains some START Treaty compliance/inspection considerations.

To determine which elements of these two programs provide the best choices for the United States' missile defense program, BMDO is contracting for a lead system integrator to determine which elements from these two proposals will be incorporated into the national program to provide the United States with an initial NMD capability.

- **Space and Missile Tracking System (SMTS).** The Space and Missile Tracking System, formerly known as *Brilliant Eyes*, is the space-based infrared surveillance system designed to supplement and eventually supplant the existing geosynchronous-orbit Defense Support Program (DSP) constellation. There is also some speculation that a laser radar could be added to this satellite if it proves feasible.[18] Along with improved resolution, in part due to its ability to have satellites in both low and high orbits, SMTS will have the capability to provide cuing data directly to interceptors (an ABM Treaty discussion issue). This is a feature not found in the DSP, which must first relay the information to a ground station.[19] The SMTS will be hardened against the effects of radiation and is expected to achieve an initial operating capability by 2006.

- **Space Based Laser (SBL).** BMDO has kept alive the SBL program with very limited funding. In briefings by BMDO personnel, the SBL is shown as a program, but few seem to believe that the system will ever be deployed. In any event, the SBL is a long-term NMD possibility, but could require another 15-30 years to prepare for deployment.

Future Missile Defense Program Requirements

As noted in Chapter 1, if the current U.S. missile defense program is fielded around 2003, it will deploy a system that is most capable of intercepting well-behaved missiles flying a standard ballistic trajectory.[20] The standard ballistic trajectory aims the warhead during the ascent phase of the missile's flight, with the warhead then gliding on a "ballistic" trajectory (unguided) to its impact point. However, as was shown in the preceding chapters, many of the current and most of the future so-called ballistic missile systems are not truly ballistic systems since they either now or in the future will incorporate terminal endoatmospheric maneuver capabilities which, along with penetration aids, assist the RVs in evading interception by first-generation missile defense systems.

In assessing the U.S. missile defense program against the evolving situation, there appears to be four major areas that will require rapid upgrades as ballistic missile capabilities evolve.

- New technologies need to be developed that will facilitate missile defense forces in identifying and engaging exoatmospheric warheads that incorporate advanced penetration aids.

- A cost-effective means of defeating multiple re-entry vehicles or submunition payloads from a single missile must be developed, particularly for the TMD systems.

- Future intercept missiles are likely to need a capability to determine range-to-target to improve their probability of hitting maneuvering re-entry vehicles.

- The x-band radar needs to be miniaturized and made more power efficient, particularly with regard to the tactical systems (to improve system mobility, reduce power generation

18 Phone conversation with George Lewis, Massachusetts Institute of Technology, June 20, 1996.
19 This, of course, presumes that the ABM Treaty will not proscribe such targeting information.
20 This point was confirmed by Lieutenant General Malcolm R. O'Neill, "Statement Before the Committee on Appropriations, Subcommittee on National Security, U.S. House of Representatives," April 17, 1996.

requirements, and improve ease with which the system could be airlifted).

Each of these concerns warrant a more detailed discussion.

Target Discrimination Technology Needs. There is agreement in the technical community that new technologies are needed to help solve the target discrimination problem. Microwave radar and IR sensors have some difficulty discriminating between closely spaced objects; some other technology may be needed to augment these systems. Moreover, the planned family of IR sensors, while extremely capable, will likely require augmentation and improvements as offensive missile defense penetration systems further evolve. The solutions to these challenges are believed to include such actions as the perfection of a laser radar system, development of multicolored IR sensors, the possible adoption of optical signal processing or similar technology, and the exploration of computer integration of multiple signals from small "slices" of each band of the electro-magnetic spectrum (hopefully providing insights not now obtainable).

- **Laser Radar.** A laser radar has the capability to determine an object's size, shape, and activity to an accuracy of less than a centimeter. Essentially, this technology would improve the defense's capability to see inside of the debris and penetration aid clusters that are expected to be incorporated into most advanced ballistic missile warheads. Of the two types of laser radars commonly developed, the laser radar system sought by BMDO would include the capability of measuring angle, range, and range rate, with the latter feature enabling the system to track maneuvering RVs, to include those coning or tumbling. In cases where salvage fusing of offensive warheads result in exoatmospheric nuclear explosions, laser radars will be affected, but are believed to have more potential than their microwave counterparts for "seeing" through some of the disturbance. However, laser radar systems cannot be used to conduct general searches of large spaces looking for targets. By nature, a laser is a very focused beam that must be directed to a precise point. Clouds or smoke degrade, or defeat, laser systems.

  Currently, the laser radar is still under development. Although technology demonstration laser radars have been built in the past, none have yet had the power to operate over the long distances required by the missile defense mission.

  Multicolored IR Sensors. A number of advanced technology projects are aimed at developing two-color sensors for future missile seekers (will be discussed later). The problem is that the IR band used to identify targets against the coldness of space becomes overloaded if the sensor or seeker rotates so that the "hot" earth appears in the background of the search pattern. When this happens, the target is lost. The opposite also occurs. The IR band needed to track a target against the background heat of earth cannot find the target against the coldness of space. By developing two-color IR sensors, the seeker/sensor can track the target regardless of background. Further development of multicolored IR capabilities is expected to yield improved target tracking and discrimination advances.

- **Advanced Sensor Technology Program (ASTP).** The ASTP is a BMDO-managed technology demonstrator designed to learn how to process and merge the information gained from microwave radars (Navy project), laser radars (Army project), and wide-area and narrow-search IR sensors (Air Force project). Sensor data from this project are collected and fused while in flight (introduces sensor movement). This program is a key component in developing U.S. missile defenses that are more capable of targeting stealthy missiles by improving discrimination capabilities between the accompanying penaids and the RVs. The program is based on the idea that although stealth can be achieved in a single frequency, it is impossible to achieve it across all frequencies. Displaced air-molecules, engine heat, etc. all leave a measurable signal. The key is to have a suite of integrated sensors that can read the signals that are broadcast. The "reading" is accomplished by a fusion processor that builds a composite picture based on multi-sensor inputs (BMDO-managed project). Currently, the components involved in ASTP have not yet been miniaturized, but eventually are expected to be used in ground-, air-, and space-based missile defense sensor suites.

- **Discrimination Interceptor Technology Program (DITP).** DITP essentially is aimed at size reduction. This technology demonstrator is miniaturizing and integrating two of the systems being developed in ASTP (discussed above). The program will integrate a passive, narrow-field (1-2 degrees) infrared sensor and a laser radar, with both sensors sharing a common optical train (i.e., one 20 cm aperture). A key challenge is making the laser radar small enough to fit into an interceptor. If successful in this effort, combining the range and vector capabilities of these two sensors in a common seeker should increase the hit probability of defensive missiles trying to intercept maneuvering targets. The on-board processor will also improve the seekers' capabilities to discriminate between penaids and RVs.

- **Optical Signal Processor.** One of the techniques (discussed earlier) for evading missile defenses was the use of radar jammers or volume maskers (illustrated by the example of the University of Pennsylvania professor elongating 2-18 gigahertz radar signals). These jammers and volume maskers work because radars have long used linear frequency modulation. One option that could be developed to defeat these types of active radar penetration aids would be to develop an optical signal processor that would generate arbitrary or random wave forms of radar signals which would be nearly impossible to jam or fool. (The technology is similar to that being used in experimental computer systems that use light to transmit data.) Adoption of this type of technology would eliminate one of the tools that missile designers may be considering adding to offensive missiles in order to aid their penetration of anticipated future missile defenses.

- **Spectral Band Processing.** The technical community dealing with earth resource satellites discovered that splitting spectral bands provides new information for remote identification of objects. It is believed that band slices could be identified that, when combined into a composite picture using powerful processors, could overcome and defeat stealth efforts and better discriminate among penetration aids, decoys, and RVs. This potential solution to target discrimination for mid-course intercept is still futuristic and will require more research to identify which spectral bands hold the most promise for identifying the lethal RVs. Currently, the earth resources community at the U.S. Jet Propulsion Laboratory has been leading this effort. It is an area in which the missile defense community is likely to become increasingly involved.

- **On-Board Sensors and Processors.** Missile defenses cannot be much more expensive than offensive missile capabilities or potential adversaries could engage in an arms race that would be lost by the defense. Thus, the missile-defense community is sensitive to the need to limit the per missile cost of the interceptor fleet. This need drives the question, how much of the information needed for a missile intercept should be transmitted to the missile's guidance system by high speed communication links to external sensor suites versus the preferred incorporation and use of on-board sensors and processors? The real question behind this issue is cost. Can a miniaturized multi-capable on-board sensor suite with integrated processor be developed at an acceptable price? This issue has not yet been fully resolved.

A key obstacle to the development of future missile defense sensor technologies is the challenge of developing the processing capabilities needed to integrate the outputs of several different kinds of sensors. For example, how does a processor receive several different images of an area, some in a 2-D format and others in 3-D, and determine how these different forms fit together, what information is key to the targeting problem, and what data should be ignored when resolving the differences between inputs? The software algorithms for this task have yet to be developed, and once developed, will undoubtedly prove to be an area that will need constant upgrades as new approaches to solving this complex problem are discovered.

Likewise, there still remains many unanswered questions regarding the interaction of the hardware with its environment. This area of research, called phenomenology, must be further developed if U.S. missile defenses are to be optimally programmed. In essence, phenomenology studies provide the critical measurements necessary to program missile defense sensor suites with the software decision matrices needed to guide the interceptor as the physical environment changes.

For example, if a missile is hit and creates a cloud of debris, what are the effects on the sensor suites and on the signatures of the follow-on missiles? In the same light, phenomenology research measures the precise signatures for various sensors so that a missile launch can be determined from space. It is also this type of investigation that discovers that debris from a broken-up missile provides a brighter infrared signature than does the RV. This type of data is critical if the interceptor's seeker is to discriminate correctly the valid targets from the clutter.

Weapon Technology Needs. The weapons technology should evolve in several directions. First, smarter kill vehicles will need to be deployed on future defensive missile systems as quickly as the technology can be matured. This technology may include integrating multiple sensors into the seeker unit, improving on-board processing, and increasing warhead agility. At the same time, a means must be developed to deal with submunition and bomblet technology. Yet, as the twenty-first century unfolds, it seems clear that directed energy weapons will eventually emerge that can play key roles in defense against missile-based attack. Inquiries need to continue into heretofore unheard of technologies that could provide the type of breakthrough needed to revolutionize missile defenses. As for now, the technologies that are being pursued or that show promise include:

- **Atmospheric Interceptor Technology (AIT) Program.** The AIT program is designed as a demonstrator for the development of a common kill vehicle that could be mounted on all endoatmospheric missile defense interceptors. The kill vehicle (which has only been ground tested) is being built with sufficient flexibility to allow it to be used as a future test platform for technologies still to be developed, such as on-board laser radar. In its current version, the system will feature a strapdown two-color IR seeker, incorporate high density electronics packaging, use advanced algorithms for guidance and aimpoint selection, be built with lightweight materials, and feature a new technology for achieving a cooled window. See Figure 5-8.

- The new cooled window feature is of particular interest. Lockheed Martin, the prime contractor for the AIT program, has developed a new silicon window for the IR sensor that includes etched channels that run through the thickness of the window, channels through which a coolant circulates to reduce the temperature of the aperture, while at the same time, wind tunnel experiments indicate that it seems to retain the strength necessary to withstand the tremendous shock and pressure inherent in rocket flight.

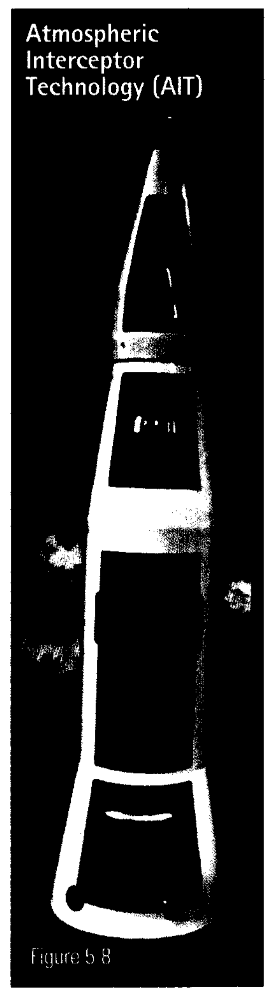


Figure 5-8

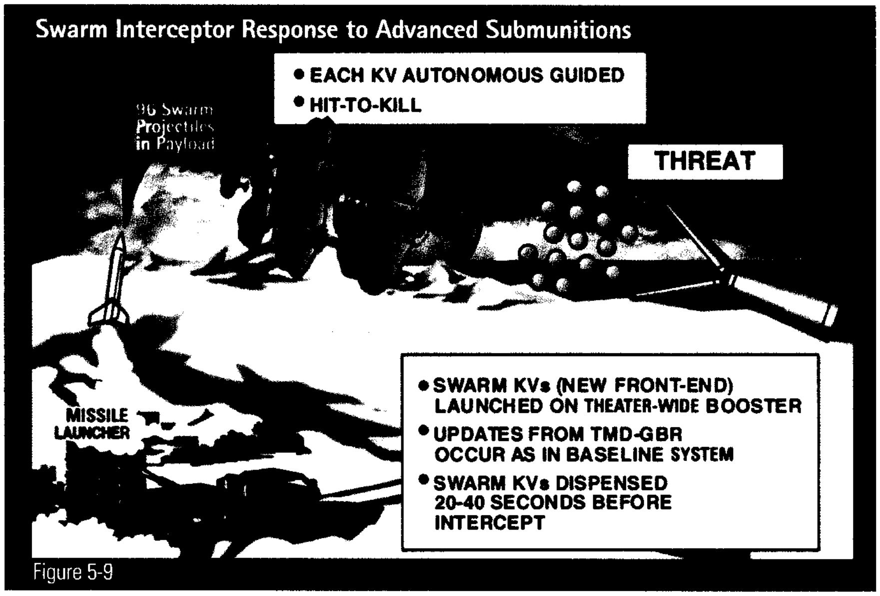


Figure 5-9

This breakthrough is significant in that it has the potential of nearly doubling the sensitivity of the atmospheric IR sensors on tactical missile defense interceptors. The tremendous heating that occurs as a missile races through the atmosphere baths the seeker's window in so much heat that it is difficult for the on-board infrared sensors to "see" through its own IR signal. This problem may have been diminished if flight tests prove the validity of this new cooled-window technology.

- ***Swarm* Interceptor Program.** The *Swarm* program is designed to develop an effective kill vehicle for submunition payloads. Under the *Swarm* concept, some theater missile defense interceptors would be equipped with warheads filled with low cost *Swarm* kinetic-kill munitions (see Figure 5-9), each of which would be autonomously guided using a seeker built on a single chip that processes information from a simple photo detector. The 4-inch wide *Swarms* would maneuver transversely to get in front of their submunition or bomblet targets through the use of a series of small explosive charge detonations. These charges are embedded around the outer ring of the munition (see divert module in Figure 5-10). Since the *Swarm* munition will close with its target at a velocity of about 5 kms per second, the energy generated from impact will destroy CW, BW or conventional submunitions. Although most of the current technology effort is aimed at exoatmospheric intercept, the *Swarm* could also be adapted for endoatmospheric use. However, due to ABM Treaty provisions *Swarm* munitions cannot be deployed on NMD interceptors.

- **Laser Weapon System Projects.** Laser knowledge, as a field of research, is expanding rapidly as medical and other commercial uses for laser technology are discovered. Some of this commercial work, such as that involving beam focus and miniaturization, is feeding back into military research efforts. Nonetheless, some research for laser applications will never be con-

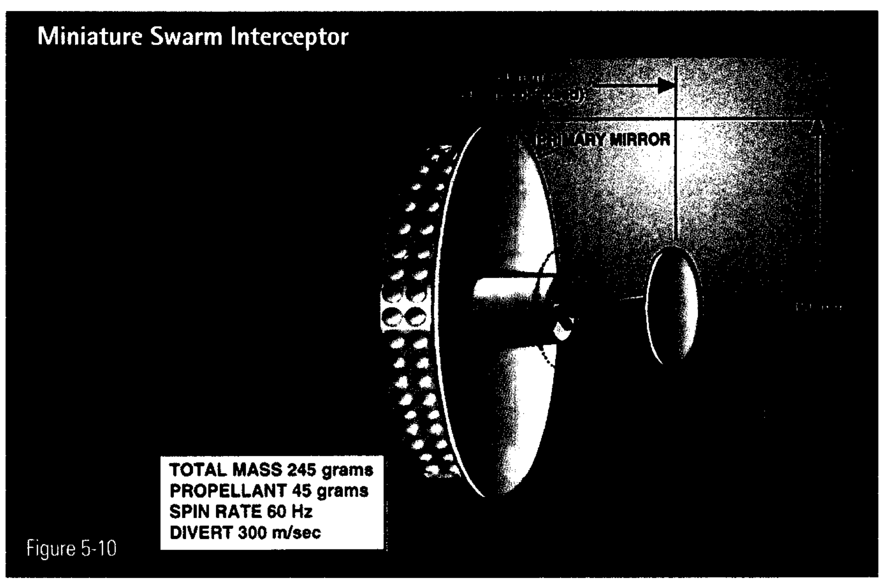


Figure 5-10

Of perhaps some human interest, the embedded explosive charges that maneuver *Swarms* are an improved derivative of a charge initially developed as a government-funded missile defense advanced technology demonstrator in the 1980s. The charges were later perfected by industry and are now used to deploy automotive air-bag safety restraints. The improved charge has now returned to the government for use as the divert mechanism for *Swarm*.

MIRACL

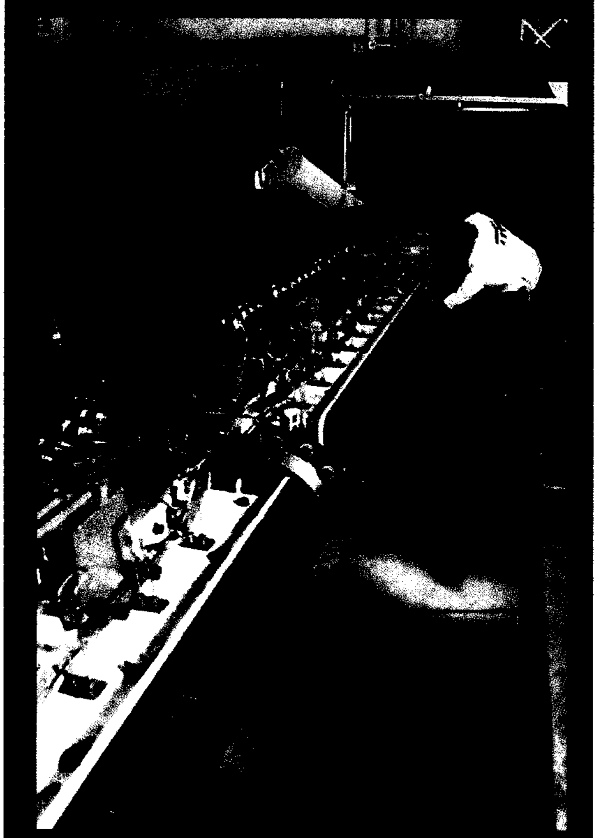


Figure 5-11

ducted by the civil sector. Key among the areas of non-interest are laser weaponization programs. Although there are a number of laser-weapon projects being pursued, four are of note with regard to missile defense weaponization programs. Two of these programs, the Air Force's Airborne Laser and the BMDO's Space-Based Laser, have already been discussed and will not again be covered. The other two are weapons-related technology projects that warrant some attention.

- **Mid Infrared Advanced Chemical Laser (MIRACL).** This is the most powerful continuous wave laser in the Western Hemisphere. It is located at the U.S. Army's High Energy Laser Systems Test Facility near White Sands, New Mexico, a facility that is also used extensively in support of the Air Force's Airborne Laser and the BMDO's Space-Based Laser programs. The MIRACL is a prototype system that is being worked to overcome obstacles to laser weaponization. However, until such time as the technology matures to the point that will allow powerful lasers to be miniaturized and maintain a focused beam over great distances, systems such as MIRACL will remain too large to be put into orbit (see Figure 5-11).

As a related note, NASA has proposed a test that would use MIRACL to try to destroy space debris in low earth orbit below 300 kms altitude. If successful, this proposed FY98 test would open the prospects for using this system to clear space junk without the need of launching a system into orbit.[77] Of course, the military potential for such a capability is also apparent.

- **Tactical High Energy Laser (THEL) Demonstrator (related to the *Nautilus* Program).** *Nautilus* is a technology program designed to research tactical laser technology capable of providing short-range point defense against rockets, artillery projectiles, and missiles. On February 9, 1996, a successful intercept was made of a short-range rocket at White Sands, NM. See Figure 5-12. The February intercept was made using the MIRACL laser on a scaled-down power setting. As a result of the success of the *Nautilus* program, a new joint U.S.-Israeli effort was

Nautilus: Laser beam heats nose causing detonation

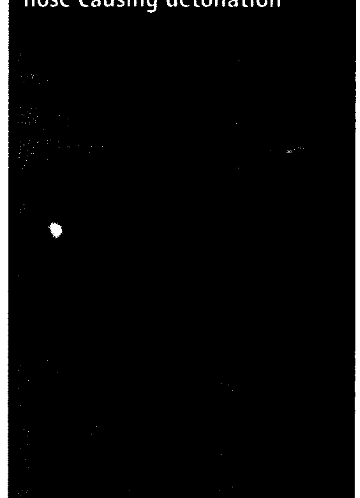


Figure 5-12

[77] "Special Alert," *Military Space*, October 14, 1996, p. 1.

launched in July 1996 to further develop this potential capability. Under the agreement, the THEL program was chartered to design, fabricate, and test a demonstrator by about April 1998. The system will have a fairly limited range and require a few seconds of beam focus to detonate each target tracked. In the near-term, the system is seen as having the potential to defend limited-sized areas in northern Israel against sporadic rocket attacks; long-term, it may evolve into a weapon system that is useful under demanding combat conditions.

- **Microwave Directed Energy Weapons.** Russia inherited the microwave anti-ballistic missile defense research program that was begun during the Soviet era. The reported aim of this effort was to develop a microwave "plasma" missile defense system capable of destroying incoming warheads at 50 kms altitude.[23] Technologically, microwave weapons would work on a similar principle to the laser, directing high amounts of energy to a focused point. The major advantage that a microwave system might have over the laser is that microwaves, in selected frequency ranges, penetrate cloud cover—an obstacle that tends to defeat laser technology. It would seem that microwave weaponization technology should be investigated to determine its feasibility.

Cruise Missiles. Although not discussed in depth during the course of this study, cruise missiles are obviously becoming a major threat. To deal with the cruise missile threat as part of a unified program, BMDO was assigned the management responsibility for that program element in 1996. This assignment was a natural evolution. As was pointed out in Chapter 1, future military operation will require active defenses against the entire spectrum of air-delivered threats, be they cruise or ballistic missiles, aircraft, or advanced precision-guided munitions. Within these mission areas, there are obviously a number of areas in which the technology requirements will overlap. This is particularly true with regard to command and control and radar detection systems. At the same time, ballistic missile defense is heavily dependent on infrared technology, a technology that does not work well detecting a low-flying cruise missile, for example, in the middle of a rainstorm. Furthermore, cruise missiles flying low to the earth cannot be seen by radar systems unless the radar is positioned so as to look down on the flight path. This requirement spawned initiatives such as the aerostat program to provide platforms for anti-cruise missile radar systems.

The different requirements between portions of the programs raised concerns of defense planners working these issues. Their concern is that after the cruise missile defense portfolio passed to BMDO, administration and congressional budget analysts might remain focused on the previously established budget line for BMDO, without any real increase for the cruise missile element. Since cruise missile defense has heretofore been funded by the services, primarily the Navy, such an action could result in an overall decrease in the amount of funding available for ballistic missile defenses. Although there is a natural confluence among the various missile and air defense missions, the issue of funding requires careful attention.

[23] For example, see Mikhail Rebrov, "Russia: Discussion of Plasma ABM Weapon," *Krasnaya Zvezda,* translated in, *FBIS-UMA-96-123-S,* May 18, 1996; and "Russian Claim On Secret Weapons,' *Intelligence Digest,* March 29-April 5, 1996, pp. 2-3. The latter article claims that Russia is 6-7 years ahead of the United States in this field.

Other Technology-Related Issues

The preceding descriptions and discussions were not intended as an all-encompassing report on the current state of the missile defense program. Rather, the intent was to provide a flavor of the types of challenges and requirements that are still to be overcome. Although many technology development program directors provide very "upbeat" assessments of their particular program areas, when pushed, many admit that in a number of critical areas only token amounts of research is ongoing due to limited funding. Consequently, some of the technology still needed to develop a missile defense capability beyond that of intercepting first generation ballistic missiles may not be ready for insertion in a timely manner. In this regard, it is interesting to review BMDO's list of unsolved challenges (see Figure 5-13).

Major Technical Challenges Still Unsolved

- Algorithms To Fuse Multimode Sensors
- Safe, Throttleable Solid Propellant
- Submunition Kill Strategies/Methods
- Efficient, High-Power X-Band Transmit/Receive Modules
- Lightweight, Tunable LADAR Seeker
- Discrimination/Aim Point Selection Algorithms
- Efficient, Short Wavelength Chemical Laser
- Integrated, Fault Tolerant, Distributed C

Source: BMDO, June 1996

Figure 5-13

There are several reasons for this state of affairs:

- DoD-wide, Congressional authorization language usually allocates about 12 percent of the budget for advance technology research. BMDO has been allocating about 6 percent to advanced technology.

- One explanation provided by a senior BMDO employee is that the organization is "gun-shy" about funding technology development. In the past, during the days of SDIO, all efforts were aimed at technology. BMDO does not want to be portrayed as a "technology only" organization. It may be over-reacting to that concern.

- Another explanation offered by a ranking service official is that the missile defense community is afraid to program dollars against technology. When it does, Congress often rejects the request and pockets the cut as cost savings. Consequently, requesting funds for technology research simply "throws away" DoD's programming allocation to the organization.

- The pressures on BMDO to be prepared to execute the "three plus three" NMD program (now approaching "two plus three") are also blamed. According to a couple of governmental sources, when additional research funding is obtained, it is usually targeted at the technology needed by the Program Managers to execute their programs. Consequently, much of the research funding is absorbed developing hardware needed "next year."

The resulting situation is an impasse. Under constrained funding levels, Congressional demands for accelerated system deployments are pulling most of the available funding into the procurement process. This trend is reinforced by a fear that Congress is most likely to reduce missile defense budget requests by cutting technology funding. Conversely, the administration is claiming that missile technology is not yet mature and that NMD deployment should be delayed until the technology does mature. Hence, on the one hand, are those who are reluctant to fund future technology requirements but want national missile defenses; on the other hand are those who advocate waiting to deploy national defenses until the underfunded technology program yields mature missile defense technologies.

Organizational Considerations

Historically, the relationship between technology developers and product production engineers (in government, program managers) has been adversarial. Technologists have long complained that applied engineers ignore cutting edge technology in favor of "tried and true" methods and that the production process is heavily infected with a "not invented here" (NIH) syndrome. Conversely, the applied engineering community has long scorned technology demonstrator products, claiming most of them are far from ready for production. They assert that technologists pass off products as "being ready for insertion" much too early in the development process. The applied engineers fear they will accept a new technology and discover later that it contains major problems or that it cannot be downsized or that the end product may be too expensive to manufacture.

In the commercial world, much progress has been made in breaking down the walls that have separated the advanced technology and the applied engineering/production communities. The programs involved in forcing their integration have been given many names. Concurrent engineering and integrated product production teams are but two of them. The other recent change is that companies are increasingly looking outside of their own organization for the new technologies required. In short, technology is becoming a commodity for purchase.

The Department of Defense is also taking steps to try to better integrate and improve its product development process. First, it is establishing registries of government-funded technology projects and expertise. One common complaint has been that it is too difficult to make prime system contractors aware of the work that has already been accomplished and of the technology that is already available. Second, DoD has implemented the use of Integrated Product Teams (IPTs) to manage program development. The team members represent the various governmental offices, agencies, and laboratories that have an interest in the products governed by that particular IPT. The establishment of the IPT process improves the probability that the government will act with one mind when it states its requirements to the contracting community.

Despite the government's efforts to improve its procurement process, it is hampered by its special circumstances. First, the procurement system is governed by hundreds of laws. Although the procurement reform act of 1994 addressed about one-fourth of the laws that the Department of Defense identified as requiring modification, much of the recommended reform was left undone. Second, the commercial enterprises are highly motivated by cost factors. They look outside of their organizations for technology because it makes financial sense to do so. On the other hand, most government contracts are cost plus contracts. As a result, the contractor does not have much incentive to look for technology outside of the corporation. The more work kept inside the company, the better the earnings statement.

Third, the inclusion of government laboratories and program managers (PM) adds a layer of complexity not found in commercial operations. The resulting relationships make it difficult to implement a workable concurrent engineering program. For example, there are several ways that technology can be inserted into a new product. The government usually provides to the prime contractor some components that are contracted directly. Usually these include such items as aircraft engines, black boxes that control classified projects, communications equipment, etc. The government can also specify the use of some technology, such as what kill vehicle will be used on a missile interceptor. However, there are a number of other practical reasons that make it difficult for the government to insert technology into a system that is under development. Understanding the role of the PM is key.

The Program Manager (PM). The PM is the person who drives the program to produce a product that is delivered in accordance with a specified production schedule at a specified cost and within specified performance standards. The careers of program managers rise or fall based on their ability to deliver products according to these criteria.

For the PM, determining the needed elements of the program as early as possible allows that program to be stabilized and prepared for production. Once the program is frozen, its costs can be calculated and the production schedule arranged. Program change is a situation to be avoided. Consequently, insertion of new technology into a product that is being prepared for production is difficult:

- **Cost Factor.** The PM has a budget based on the current program and its integral technologies. To insert advanced R&D usually means more dollars since there is usually a cost penalty for changing the configuration baseline of a product. Contractors call these types of changes "feeding the contract," since it is a factor that allows them to raise the price. Consequently, PMs are reluctant to accept a new technology that would require contract modification.

- **Funding Uncertainty.** Advanced technology program funding is prone to disappear. If a PM commits to an advanced technology and the program is cut, the PM's program is also jeopardized. PMs, therefore, prefer to limit risks to their programs by managing their own technology initiatives.

- **Schedule Risk.** Accepting a new technology can put the production schedule at risk. If the estimates on the technology's maturity prove overly optimistic (a common situation), the PM could produce the product late because of the new technology insertion.

- **Performance Risk.** Advanced technologies usually provide enhanced performance characteristics, but at a risk. If the new technologies do not work as specified, the PM delivers a dud. PMs are usually reluctant to take that risk.

- **Previous Contractual Commitments.** A new technology may cause the PM to have to cancel a previous commitment for the component that will be replaced by the new technology. This could entail a cost penalty. In addition, the prime contractor may be resistant to the new technology, particularly if it displaces an in-house technology. Often, the prime contractor bids proprietary technology that gives them a competitive edge, making it difficult to insert outside technology into the system. Perhaps worse is the possibility that the contractor could later deny responsibility for poor product performance based on claimed affects of inserted technology.

- **Performance-Based Contracting.** In the new streamlined acquisition environment, PMs find it more difficult to direct the prime contractor's technology selection. It is akin to telling them how to build the system. On the other hand, the involvement of the government's new Integrated Product Teams (IPT) in the development process may provide more leverage in persuading prime contractors to look at other potential sources of technology for system needs.

The Technologist. Technologists often become frustrated with PMs because they think the PMs are always resisting better ways and new technologies for accomplishing the task at hand. To them, PMs do not want to use the best technologies, nor do they look beyond the task at hand.[24] The technology community seems to believe that missile defenses must be managed differently if the country is to have a chance of fielding a system that stays effective against a rapidly evolving threat. Some of the ideas expressed include:

- **Do not "reach so far" for missile defense technologies.** Technologists agree that missile defense systems should be modular so that they can be easily upgraded. A 4-5 year development cycle will just ensure that U.S. missile defense capabilities are always obsolete in terms of the

[24] Personal interview with a senior government official on a non-attribution basis, February 23, 1996. The chapter contains information from interviews with 15 government officials or senior employees, four senior industrialists, and two academics. Almost all did not want to be quoted by name or organization.

threat. Offensive forces have the initiative to improve penetration technologies and techniques. Defensive systems must be designed for quick upgrades to meet the evolving challenge. Prime contractors must be required to design their systems to facilitate easy product improvement.

- **A concern with the current missile defense programs is that PMs are trying to freeze them in preparation for production.** Several technologists interviewed expressed unhappiness with the idea that the missile defense systems the U.S. fields will contain technology that is 5-6 years old (since the PMs are now positioning themselves for system production).

- **Small and medium-sized companies produce the best technology, but the big companies are required to make the system work.** The challenge is to get the large companies to use the innovative technology produced by smaller firms. This problem has no apparent solution and will not be easily solved.

- **Require PMs to first shop for technology already developed at government expense prior to contracting for outside development.** Currently, PMs are not required to assess the in-house technology products prior to contracting for product development. A number of specialist in the field believe that if the PMs were required to first formally assess the technology already developed or under development (a system used by Ford Motor Company), that a higher rate of technology absorption would occur, benefiting the government in terms of both cost and possibly reduced development time.

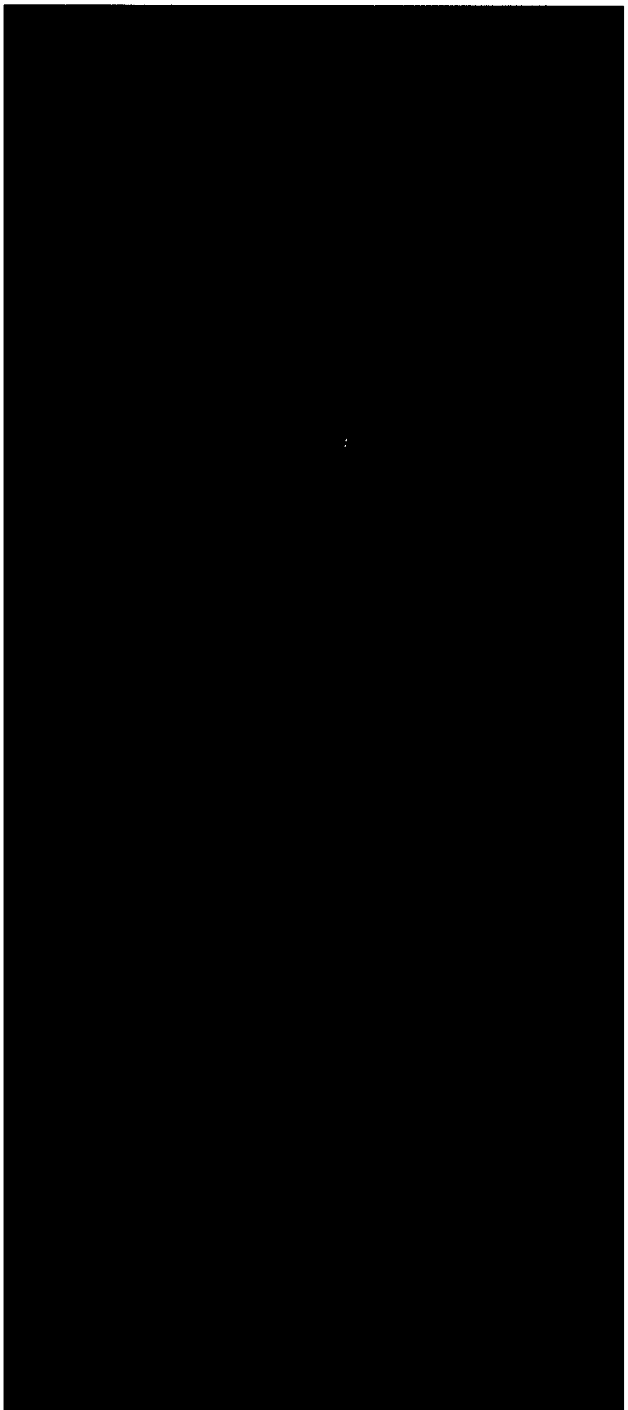
- **To the extent possible, merge technologists and PM organizations**. A general belief was expressed that artificial organizational splits that separate technologists and PMs cost the government in lost efficiency and, sometimes, in increased program costs to develop the same technologies twice. There was general agreement that the efforts of the program management operation and the technology development effort needed to be drawn closer together and operate with more unity of effort.

Conclusions

Many technologies are available that offensive missile designers can use to assist their missile systems to evade anticipated U.S. defenses. A number of countries are now including penetration devices or missile maneuvers as integral elements in their missile development programs. Consequently, U.S. missile defense systems will soon confront offensive systems that have enhanced capabilities to evade missile intercept. Since the need for missile defenses does not appear to be a requirement that is going to disappear, a key factor in the fielding of the United States' defenses is how easily can they be upgraded and are those upgrades now in train? Toward this end, the United States needs to ensure that its missile defense program is balanced for sustained operations and that the organizations supporting this effort work as a cohesive whole with a common unity of purpose.

The major focus of the United States' missile defense program should be the establishment of a well-balanced program, a program that is managed with a view that it will still be required 50 years from now. This means that the chain that feeds the technology, develops and applies the upgrades, and services the fielded systems must be maintained with a view towards long-term sustainment. Without that sort of vision, the United States may always be one-step from being able to mount an effective defense against hostile missile systems.

FINDINGS AND RECOMMENDATIONS



Trying to predict the future of international political conditions is a task that has long frustrated intelligence departments and international relations scholars. For example, who, in 1948, when current U.S. attention was focused on the difficulties in Europe, predicted that the United States would fight its next two major land wars in Asia? Even more outlandish was the idea that within two years over 800,000 troops from a then non-existent Communist China would be battling U.S. forces in Korea. Nor was there any prior prediction that in 1956 the U.S. would be in a military confrontation with Britain and France over the Suez Canal. In 1960, who predicted the Cuban missile crisis, the expulsion of U.S. and NATO forces from France, or even the pending massive U.S. involvement in the Vietnam War? Conversely, the long-feared assault by the Red Army into Western Europe never occurred, and a number of political initiatives and arms control agreements acted to slow predicted proliferation trends. The fact that those failures to predict international events occurred during a relatively stable era of history, when global events were dominated by a bipolar structure, carries its own lesson for trying to predict future political behavior.

The difficulties in predicting the political course of the upcoming era are many. For example, How well will state parties deal with the changes expected to occur in the emerging era? The current unipolar international structure is almost certain to be challenged. If international relations scholars such as Henry Kissinger and Kenneth Waltz are correct, the current unipolar situation is a transition phase to some new multipolar international structure. This transition could introduce a great deal of political instability into the international political system. Secondly, the power of economic factors to induce good behavior or punish recalcitrant states is another uncertainty in an era dominated by an international economy.

As a result of these types of issues, the future era has the potential for being considerably more uncertain than was the case during the Cold War. It was common during the Cold War to hear claims that Soviet intentions were unpredictable and could change rapidly, but as its capabilities were fairly predictable (especially under an inflexible centrally planned system), capability assessments provided the best indicator of that country's potential to act militarily. In reality, the caution used by the Soviet leadership in exercising power made both its intentions and its military capabilities relatively predictable (computer models could easily provide accurate projections of future military capabilities).

In the next century, the number of actors involve in international activities will increase. When considered against an environment which will permit technology and advanced armaments to be transferred to other actors very rapidly, means that both indicated intentions and assessed military capabilities may be unreliable indicators upon which to base future threat assessments. Consequently, U.S. military planners can no longer rely on past planning factors to determine the type and rates at which a threat will likely develop in the future. This emerging situation has some serious implications for future military force structure planning.

With regard to this study effort, its breadth and complexity open the possibility for the elaboration of a large number of findings. However, since the subject of this effort is the missile defense challenge in the next 7-15 years, with a particular focus on 2010, the findings and recommendations will be limited to those areas which are directly related to missile issues.

Findings

Finding 1: Export control regimes are expected to become increasingly ineffective as nonproliferation tools. The evolving international political and technological environment will continue to erode the utility of this approach to security.

As described in Chapters 1-4, the control that states can exercise over the flow of people, information, technology, and manufactured products is declining as the information age develops. Common graduate school study opportunities, the lowering barriers to overseas travel and employment, the explosion of Internet use, the globalization of the manufacturing base, the weakening of political control in Russia and China, the flow of missiles and WMD systems and technology from North Korea, the explosion of international organized crime, the pressures on arms producing industries to export or perish, and the loss of international political consensus since the end of the Cold War all point to a continued erosion of the effectiveness of traditional export control systems.

As was discussed in detail in Chapters 2 and 3, the international export of sensitive technologies from Russia and China are particularly troublesome issues. At heart, the governments of these two countries resent many of the existing international export control regimes; they often view their interests as being best served by building the capabilities of client states that the United States categorizes as international pariahs (e.g., North Korea, Iran, Libya, Syria, etc.). In addition, elite groups in both Russia and China have vested interests in exporting goods that the United States has been working to restrict, many of which are missile system-related. The collaboration between these elites and government officials (or their family members) undermines attempts by US officials to pressure the Russian and Chinese governments to restrict trade in sensitive technologies. Even when successful at the government-to-government level, criminal activity continues to ensure the flow of sensitive technologies.

To some extent these same problems are evident in states other than Russia and China. Many Western European counties, Latin American countries, selected East Asian states, South Africa, and Israel all contain industries that are heavily involved in clandestine international technology transfer schemes that are contributing to the growing missile and WMD capabilities of many third world countries. Some of this trade is also aimed at trying to protect their international market share of defense sales, particularly as declining sales volume in traditional defense goods has tightened markets. Indeed, as pointed out in Chapter 1, some of this international flow of sensitive technology is also originating in the United States, both in terms of questionable sales from U.S.-based international corporations and by the transfer of materials salvaged from sophisticated U.S. weapon systems.

In short, while technology control regimes have slowed proliferation, they have not stopped it. It appears that technology control schemes are likely to become increasingly ineffective as the information age develops in the 21st century.

Finding 2: Missiles, both ballistic and cruise, will likely proliferate at an accelerating rate, along with warhead technology. Within the overall proliferation trend, it is becoming more difficult to predict the rate at which a specified country will emerge as a holder of ballistic missile and WMD capabilities since the foreign assistance aspect is an incalculable variable.

The fundamental reason that missiles and their warheads will proliferate is because there is a high demand for such technology, and many of the potential suppliers of such technologies and capabilities are under strong economic pressures. They desperately need export opportunities. Their willingness to trade sensitive technologies upsets the status quo of existing market dynamics and encourages other states and industries to follow suit in order to preclude loss of market share. Chapters 1-4 detailed some representative examples of these types of transfers.

Furthermore, cruise missiles are proliferating widely since they are easy to build, using basic aircraft technologies and guidance systems. Although not mentioned in the study, basic airplane technology is globalizing. The same technology that can be used to navigate airliners from point to point (inertial navigation and GPS) can also be used in cruise missile guidance systems. With a current global inventory of over 75,000 cruise missiles, many more are being built. By 2010, many countries may have cruise missiles with ranges in the 2000-4000 km class.

It is interesting to note that to a large extent the demand for missiles and missile technology was fueled by *Desert Storm*. This has been discussed at some length, especially in the sections dealing with China and Iran. CNN's coverage of the difficulties that *Scud* missiles posed for Western forces and the utility of the *Tomahawk* cruise missile to attack defended targets, coupled with the relative ease with which Iraq's traditionally equipped military machine was destroyed, persuaded many of the world's states that the acquisition of missile systems armed with advanced precision-guided munitions or WMD warheads was essential to their security. These states also recognized that these missile capabilities required command, control, communications, and intelligence/targeting assets to make them operate as an effective system. As a result of this shift in emphasis, the global demand for missile system-related technology and weapons has grown, while the sale of traditional military equipment has declined.

Another lesson taught by *Desert Storm* appears to have been the effectiveness of the United States' AirLand Battle Doctrine. Under the precepts of the doctrine, the military focus is on the selected destruction of high-value targets at the critical juncture of the operation. Thus, attacking a port may be important, but attacking the port just as the ships are arriving to use the facility is the timing portion of AirLand Battle. Premature attacks allow the adversary to repair the damage or make alternate arrangements in time to maintain its combat operational tempo.

Furthermore, there are indications that some countries (for example, China), are borrowing some AirLand Battle techniques for use in conjunction with a more robust deterrent strategy that appears to contain a nuclear and missile warfighting element. Consequently, at the tactical level, China can be expected to make extensive use of cruise and ballistic missile systems to attack critical high-value targets, using WMD warheads if necessary. China's strategic nuclear forces would then be used to deter outside interference. Likewise, as discussed in Chapter 4, Iran seems to be working to develop the military capability to do the same.

What is surprising is the apparent willingness of so many states to provide assistance to these efforts. As detailed earlier in this report, many countries have large delegations of foreign missile and WMD experts actively assisting them in the development of indigenous production capabilities. Although the most active and obvious assistance is coming from Russia, China, and North Korea, most other countries of the globe that have capabilities in these areas also have citizens contributing to the process. Consequently, the trend lines that could be used in the past to project when a country would be able to develop a certain level of capability are no longer valid. This problem can be clearly seen if one examines the unclassified excerpts from the 1996 U.S. National Intelligence Estimate (NIE). The language reflected a distinct uneasiness with the foreign assistance aspect of the issue. Essentially, the foreign assistance aspect is an incalculable variable when trying to estimate lead time for missile and WMD developments.

Within the situation outlined above, it is clear that missiles will emerge as one of the core weapons-delivery platforms that will dominate military operations in the twenty-first century.

Finding 3: The probability is increasing that ICBM missiles (either assembled as systems or as part of "knock-down kits" for assembly) could be transferred to other states prior to 2010.

There are two primary factors that are increasing the probability that ICBM systems could be transferred to other states prior to 2010. One factor is the deteriorating control that Russia has over its industries and elements of its armed forces. The other factor is Russia's and China's geographical location in Eurasia and their perceptions of what kind of systems constitute strategic threats, coupled with a developing sense that their respective national interests might best be served with the development of a multipolar international security structure.

With respect to control in Russia and, to a certain extent, Ukraine, sensitive technologies are flowing out of these countries at a growing rate. As discussed in Chapter 2, central control over Russia's mobile ICBM systems, such as the SS-25, is increasingly uncertain as living conditions and discipline in those units decline. There is also no guarantee that this system, or some other ICBM model, could not be exported directly from factory representatives as knock-down kits for assembly. As was discussed in the report, it is relatively easy to bribe materials out of Russia.

As was also pointed out, one SS-25 may have already been sold to China, and there are unconfirmed reports that 45 of the SS-25's replacement, the *Topol* M, may have been offered for sale to India by Russian military officials. This concern is further reinforced by recent reports that Russian SS-4 ballistic missile technology and components may have been transferred to Iran. If these three reports should prove true, it would indicate that the international taboo against transfer of long-range ballistic missiles may already be weakening.

It should be kept in mind that the view of the ICBM as a strategic system is a perspective held most strongly by the United States. That thinking is heavily influenced by the existence of the Atlantic and Pacific Oceans and friendly neighbors. To Russia and China, shorter-range missile systems on their borders are strategic systems. As medium-range missiles proliferate on the peripheries of these two countries, it could well be that the decision makers involved will no longer see a reason for withholding ICBM technology from the states along the Eurasian rimland. From their perspective, since they will already be threatened, there will be no reason to protect the United States at the expense of losing potential missile sales that could benefit their own economic well-being; although, consideration of the political and the economic repercussions that would arise might exert a restraining influence.

Based on December 1996 public statements by leaders of Russia and China (previously cited), these two countries are becoming convinced that their respective national interests would be best served in the context of a multipolar security structure. Assisting more countries in developing the capability to target the United States with strategic systems could be seen by these two countries as a positive development. Consequently, the United States should not automatically assume that the future transfer of ICBMs to hostile countries is an implausible scenario.

One of the more serious scenarios that should be considered might involve the transfer of ICBMs to North Korea. If North Korea made a decision to reunify the Korean peninsula by military conquest, it could make a major effort to acquire some ICBMs as a deterrent against U.S. intervention in defense of South Korea. Although the missiles could be mobile SS-25s moved across the border from Russia, they could just as well be missile component assemblies acquired from Russian factories for final assembly in North Korean facilities (for example, components from the new *Topol M* assembly line). Since North Korea has hundreds of underground fortified sites, it could easily hide this missile force undetected until needed to try to force the United States to leave South Korea to its fate.

Such a development would pose a major quandary for U.S. decision makers. If they decide the U.S. will fight, several U.S. cities might well be destroyed. If they decided the risks were too great, and the U.S. sat on the sidelines of the subsequent fight, U.S. credibility as a reliable strategic partner would be destroyed, current allies would move to make alternative security arrangements, and many existing trading patterns would change (to the detriment of the United States) as countries sought to develop and strengthen new security relationships. The United States' global position of leadership would be weakened.

Finding 4: Currently, four states can target the United States with either ICBMs or SLBMs: Russia, China, France, and the United Kingdom. Prior to 2010, India and North Korea will almost certainly join this group. Ukraine, Japan, Israel, Germany, Sweden, Italy, Brazil, Argentina, and South Korea (or a unified Korea) could join this group if they decided to do so. More problematic are the Arab states of the Middle East. Iran and Iraq will likely be able to target London and Moscow. The unknown variable is the foreign assistance factor.

Most of the states listed are not currently expected to be hostile to the United States in 2010. However, as missile technology spreads to new states, its practical implications are that in addition to representing a greater potential for an accidental or a deliberate launch against U.S. forces or U.S. territory, the number of potential suppliers of missile technology will also have grown. As noted throughout the study, a key variable in missile proliferation is the foreign assistance factor. How much assistance, how effective is the assistance, and how well can the assisted country absorb the technology provided? As the technology spreads, it should be expected that it will likely breed another round of increases in missile proliferation.

Finding 5: By 2010, penetration aids, maneuvering warheads, low radar cross sections, and similar technologies will become increasingly common in ballistic missiles. Most newer versions of cruise missiles will also incorporate some level of stealth technology.

The United States' tactical missile defense program has been influenced by the difficulties encountered in dealing with the *Scud* threat during *Desert Storm*. Naturally, as *Scud*-based missiles are the most highly proliferated tactical ballistic missile system currently in the world, missile defense designers have tended to measure the effectiveness of their technologies against the *Scud* system. However, the *Scud* is a crude missile with limited upgrade potential. Since the entire missile (warhead and attached missile body) flies the entire length of the trajectory, the system is buffeted by the forces of re-entry resulting in a large loss of accuracy and sometimes the breakup of the modified versions of the system, which have been elongated to add more fuel for extended range. Due to their large radar and infrared signatures, *Scuds* cannot be hidden by penetration aids or techniques designed to mask IR and radar signatures. The most serious problem that missile defense designers have to deal with is the unexpected maneuvers and associated debris that occurs when the *Scud* breaks up in the 12-18 km altitude range. Of course, defense systems that make their intercepts above the 21 km altitude air-density "wall" that induces *Scud* breakup avoid this problem.

Unfortunately, most countries have already assumed the United States will deploy missile defense systems and a number of them are developing missile capabilities that incorporate counter-missile defense technologies and strategies designed to evade the assessed capabilities of future defense systems. This trend is evidenced in the development of the Chinese M-family of missiles, the Russian SS-X-26 and 27, and the Indian *Prithvi* and *Agni* missiles.

The DF-15/M-9 missile firings into the Taiwan Strait in July 1995 and March 1996 demonstrated that China's M-family missiles add a whole new dimension to the tactical missile intercept problem. As one general officer later recounted, it was obvious that the Chinese had "gone to college in California. We saw a lot of our worst fears come true as we looked at the M-9 missile." As pointed out in Chapter 3, the M-9 has a detachable warhead that China tries to mask by the shadow of the trailing missile body to hinder the detection of the warhead by radar or IR sensors. There are hints that these masking technologies may include active measures as well. Since the M-9 and M-11 (which shares some of the M-9's technology) were developed as commercial ventures aimed at the export market, China has been anxious to export these systems. The M-11 has been exported to Pakistan; the M-9 may have been exported to Syria and perhaps Iran, and either the M-11's or the M-9's technology is probably being incorporated into Pakistan's *Hatf* 3 missile system, currently under development. Regardless of the current (much disputed) export status of the M-family of missiles, by 2010 it would be prudent to anticipate that the technology incorporated in these systems will have proliferated to a significant number of states.

As for tactical ballistic missiles incorporating advanced maneuver systems, India's *Prithvi* and Russia's SS-X-26 are prime examples of emerging maneuver technology. There is a strong likelihood that the capabilities represented by these two systems will proliferate prior to 2010.

In the case of the *Prithvi*, the short-range version of the system is probably below the guidelines established by the Missile Technology Control Regime (MTCR), which may permit India to sell this system without being subject to U.S. sanctions. India has already listed the *Prithvi's* support equipment as being available for export. Although the United States has been working to prevent the *Prithvi's* export, it seems only a matter of time until either the missile or its technology migrates to other states.

Likewise, the technology incorporated into Russia's SS-X-26 could also proliferate. Unfortunately, in addition to its maneuver capabilities, this extremely accurate system contains a number of additional features, such as low radar cross section (stealth), penaids, and similar sophisticated technologies that will make it a difficult missile to detect and intercept. Although this missile currently cannot be exported legally under MTCR guidelines, as was discussed in Chapter 2, it is possible that an export version could be produced that is MTCR compliant. In addition, as discussed previously, there are also few technologies that cannot be purchased "under the table" in Russia.

Consequently, it seems quite likely that the SS-X-26 will proliferate in some form by 2010.

In addition to maneuver and masking, countries are increasingly packaging their missile warheads to deliver submunitions or bomblets. These multiple-target warheads provide a separate set of challenges for missile defenses. When considered in light of the trend toward packaging CW and BW agents in bomblets, it is clear that this type of warhead will not only improve the distribution of agents in the target area, it also will serve to defeat missile defense systems that are based on unitary warhead intercept concepts.

At the strategic level, the United States, the United Kingdom, France, and Russia all have penetration aids incorporated into their warheads. China is believed to be in the process of doing likewise as it designs its new generation of warheads. India, in its *Agni* technology demonstrator, has incorporated endoatmospheric maneuvering and terminal guidance systems. Some reduction of its radar signature should also be anticipated. If India should field an ICBM (the *Surya*), it is likely that the warhead technology being tested in the *Agni* would be used in the *Surya*.

Reportedly, the next generation of Russian strategic systems will be much more sophisticated at evading missile defenses. The new *Topol M,* which in its mobile version will replace the current SS-25, will be a system of particular concern. Russian Strategic Missile Force officers have bragged that this missile will have the capability to penetrate any defense system. As a mobile system, it will be the missile most likely to be involved in an unauthorized launch. In addition, it is the system that could most easily be driven across a border by disaffected troops and sold. Lastly, as a missile in active production, it is a system that could most easily be sold as components for assembly, either as part of an official decision or as an illegal transfer involving factory managers or organized crime groups.

In short, counter-missile defense efforts are well advanced. These technologies are sure to proliferate along with missile and WMD technologies. U.S. missile defense programs must be structured to deal with this problem.

Finding 6: Tactical missile defenses must be able to defeat an array of warhead types: unitary, submunition, and bomblet. National missile defenses should be able to defend against MIRVed nuclear warheads. There is a limited possibility that BW agents might be packaged in submunitions for ICBM delivery.

The warhead types available for missile delivery are increasing, especially for the tactical missile systems. Nuclear, biological, and chemical technologies are proliferating, along with an array of advanced conventional capabilities. All three WMD weapon types are likely to be developed and deployed for tactical missile delivery, along with a wide array of conventional warheads: fuel-air explosive, scatterable mines, electromagnetic pulse generators, fragmentation submunitions, etc.

On the other hand, ICBMs, with their multimillion dollar price tags, must be equipped with warheads that justify the cost of delivery. Most states capable of developing an ICBM will also likely be able to develop nuclear weapons. As shown in Chapter 5, the only cost-effective warheads for an ICBM are nuclear warheads and possibly biological agents packaged in submunitions. A conventional or chemical option would not be sufficiently lethal to deter a contemplated U.S. action necessary to defend key national interests. Since the effectiveness of a BW strike is weather dependent and considering that biological agents have an incubation period, nuclear warheads remain the most likely weapon that national ballistic missile defense systems will have to defeat in the first decade of the next century.

The most likely exception to this possibility would be if a non-nuclear state acquired an ICBM from a third party or if an emerging nuclear power, such as North Korea, were able to acquire more ICBMs than it had nuclear warheads to mount. In those types of situations, the acquiring state(s) might load warheads with BW submunitions if a nuclear option were unavailable.

Finding 7: The initial missile defense systems deployed by the United States will have some difficulties defending against the more advanced classes of missiles discussed in the foregoing findings.

The initial missile defense system will be built around two sensor systems: single-color infrared, which only measures an angle to the heat source (a 2-D picture), and microwave radars, which will paint the 3-D picture. The seeker on the warheads will use infrared sensors that will be directed to lock onto a specified IR source identified by the ground-based radar system. However, as discussed at length in the first portion in Chapter 5, microwave radar and infrared sensors have some difficulty distinguishing among closely grouped objects. Thus, the initial interceptors fielded by the United States will have some limitations in distinguishing a target that is embedded in a field of penaids or debris. Either the ground-based radar (GBR) or the on-board IR sensor could be deceived by advanced decoys, stealth, or some similar penaid.

These limitations mean that the United States' planned first generation intercept systems might require a high number of shots to ensure that a single re-entry vehicle is destroyed (particularly if accompanied by advanced penetration aids or if the target is located at the edge of the GBR's range capabilities). This relative inefficiency vis-`a-vis offensive missiles needs to be overcome if missile defenses are to be cost effective. The other major unsolved limitation, particularly against endoatmospheric targets, is the difficulty of trying to intercept a maneuvering target. Since the IR sensor only provides directional data (no range to target), a target maneuver just prior to interception will tend to make the defensive missile miss the target. The solution is believed to be the addition of an on-board ranging capability and processor that could combine the signals to calculate the intercept. Until such time as this capability is added, maneuvering targets will likely remain a difficult challenge to missile defenses.

In addition, all first generation U.S. missile defense programs will produce systems capable of intercepting only a single object. Multiple submunitions, bomblets, or multiple re-entry vehicles (MRVs) will require a separate missile for each individual target. Although the ABM Treaty prohibits multiple warheads on national defense interceptor systems, tactical systems could be equipped with optional warheads, some of which could be designed for interception of multiple targets.

Finding 8: The developmental process and related funding allocations are not well balanced for long-term technological growth and system sustainment.

Unfortunately, missile defense systems do not determine the nature of the missile intercept problem. The initiative, thus the control, is in the hands of the offensive missile designers who determine when and what penetration tactics and technologies will be incorporated into the systems that they design. For the United States' defense establishment and its still rather ponderous research, development, and acquisition (RDA) system, responding rapidly to changing offensive missile capabilities could be a significant challenge.

The United States, as the world's most technologically advanced nation, usually has been able to set the pace of technology development for the rest of the world to follow. Typically, a defense project is systematically designed and executed, then as the rest of the world begins to catch up, the system is upgraded to the next generation. Missile defenses, however, will always be in the position of having to respond to offensive missile system innovations. A ponderous, plodding approach will ensure that U.S. missile defenses are always one generation too late to be effective.

In interviews conducted throughout much of the missile defense community, the question was asked about the status of planning and programming for upgrades to the systems now under development. All claimed that the upgrades that will be needed have not received much attention. Several suggested that the U.S. missile defense systems would require the insertion of new technologies every two-three years along with software upgrades once or twice a year. Areas that were noted as currently needing more research effort if future missile defense systems are to remain viable included multispectral processing, advanced radar technology, ultra-high data processing and communications, more capable kill vehicles, and directed energy weapon systems (laser and microwave).

It should also be understood that a number of underlying technical breakthroughs are needed in such areas, for example, as more efficient power sources, power generation technologies, and electrical storage systems if futuristic missile defense technologies are to become feasible. Thus, research in a number of advanced technology sectors will need to be pursued if the United States is to be prepared to upgrade its future missile defense capabilities.

Finding 9: The technology community and the program management organizations are not well integrated; their respective operations are too independent from each other so that the flow of technology from conception through procurement is not a smooth process.

The technology development community and the acquisition program management process function as two nearly independent operations. Although the technology community develops many of the concepts needed by next generation systems, their products are not always developed to the point where they are useful to the procurement process. Conversely, program managers sometimes ignore or fail to examine the technical development work that has already been developed prior to contracting for system development. This means that (as pointed out at the end of Chapter 5), too frequently, there is too much wasted motion between these two communities. Although the implementation of the government's Integrated Product Teams (IPT) is proving to be a step in the right direction, more effort is needed to ensure unity of purpose in the RDA process.

Recommendations

Recommendation 1: Develop and deploy a robust system of tactical defenses against ballistic and cruise missile systems; field a first-generation national missile defense in the near-term, one capable of incorporating frequent upgrades without major system rework. Begin now to develop the upgrades needed to increase the capability of these initial systems.

The spread of missile and WMD capabilities and the uncertainties that surround predictions regarding the rate that these systems are likely to proliferate requires that the United States develop missile defenses to protect itself from limited strikes or unauthorized launches, thus helping to maintain U.S. options of being able to act militarily in defense of its national interests or to prevent unchecked international aggression.

Missiles of all types are emerging as core weapons delivery platforms for a wide array of weapon payloads. At the tactical level, these delivery platforms hold the potential for inflicting large numbers of casualties on deployed forces that may be called upon to conduct intervention operations in defense of U.S. national interests or to check international aggression.

As the 21st century unfolds, missile proliferation of long-range systems will likely increase the potential for unexpected confrontations that could result in situations reminiscent of the Cuban Missile Crisis of 1962. More importantly, as discussed in the findings, the possibility that limited ICBM capabilities could be exported to other states raises the prospect that the United States could be issued an ultimatum to "stay home or else" as aggressive states attempt to remedy domestic or regional problems via military means. When these issues are coupled with the increased potential for an unauthorized launch, it is clear that the United States needs to establish a capability to defend itself against the unexpected. Because the acquisition of missile-based capabilities is a growth industry, the efforts that America puts into developing its initial capabilities can later be expanded if it should prove necessary. Since exoatmospheric missile intercept technology relatively is at about the same point of development as airplane technology was in 1918, the United States needs to structure its missile defense program so that the resulting capabilities can and will be continually upgraded as more advanced technology becomes ready for insertion. The country cannot wait 50 years for a gradual evolution of missile defense technologies.

Recommendation 2: Balance the missile defense programs for indefinite sustainment. The program focus should be on the delivery of capabilities that can grow and develop over the decades ahead. Let the funding levels appropriated determine system deployment dates.

As previously described, it will do the United States little good to deploy missile defenses that cannot be sustained over time. Missile defense research should probably be pegged at about 12 percent of the missile defense budget to sustain the rate of progress that will be necessary to meet the emerging requirements.

Areas needing more research effort include multi-spectral processing, advanced radar technology, ultra-high data processing and communications, more capable kill vehicles, directed energy weapon systems (laser and microwave), and the enabling technologies needed to make futuristic missile defense concepts viable.

Recommendation 3: The technology community and the program management organizations should be better integrated to facilitate an improved flow of technology from conception through procurement.

The technology development community and the program management operations must be better integrated and focused so that technology is developed, demonstrated, engineered, and embedded into missile defense projects in an efficient and cost effective manner. As discussed at the end of Chapter 5, currently there is too much wasted motion between these two communities. If the missile defense systems are to be upgraded frequently and at reasonable costs, the inefficiencies resulting from the separation of these two operations must be addressed.

Program managers should be required to conduct a search for already developed technology prior to contracting for new developments. Suitable technology that has previously been developed at government expense should have priority for consideration for insertion into acquisition projects. At the same time, technology labs that state that a technology is ready for insertion must be held accountable for the performance of that technology. In short, the technology and program acquisition communities should be better coordinated to ensure unity of effort.

Recommendation 4: Require all future missile defense systems to be designed for easy upgrade and technology insertion. To the extent possible, avoid proprietary architectures that would be expensive to replace as new technologies are developed.

With the level of technology needed to defeat ballistic missile systems still in its infancy, the United States should avoid the procurement of systems that would require very expensive rework costs to insert next generation sensor or guidance packages. It is also not in the government's interest to limit future upgrade possibilities due to excessive use of proprietary architectures that might not be compatible with future technological innovations that could have otherwise been inserted into the system at some future date.