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The South Korean Case: A Nuclear Weapons Program Embedded in an Environment of Great Power Concerns

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This report considers the possible role of nuclear weapons that might be possessed by new nuclear powers. It identifies the incentives for acquiring or, possibly, using such weapons. The study concludes that in many countries that could be candidates for nuclear proliferation, regional concerns usually dominate. However, apart from the national incentives, the repercussions of acquisition or use of nuclear weapons would be worldwide. The report is in three volumes, each addressing one key region of interest: the Arabian

20. (continued) Sea--Iran-Pakistan-India; Northeast Asia--PRC-Korea-Japan; and the South China Sea--Taiwan-PRC-ASEAN (with focus on the Philippines)-Australia. The study recognizes that regions are, of course, not isolated from the larger world and some countries have an impact beyond a single region. This is most obviously true of the great powers. But Japan's interactions in the South China Sea and beyond are almost as critical as in Northeast Asia; similarly, India's actions impact strongly on Indonesia and the ASEAN nations; Iran is being watched by Arab neighbors to the west. However, the focus of the research is on regional interrelationships, with the larger interactions touched upon only lightly.

Attention is focused on the particular circumstances facing each country, how these might influence the decision to acquire nuclear weapons, the kind of weapons systems that might be acquired, possible types of weapons deployment both for deterrence or possible actual use, the impact on regional security of weapons acquisition, and the policies that might be adopted by states in the region and by the United States to deter acquisition and to mitigate the consequences if acquired.

The combinations of technological, economic, and political factors rapidly grow unmanageable as one moves from some known and many imperfectly known facts about the present situation. The report avoids extending these speculations much beyond the time period where we have evidence on which estimates or extrapolations can be made--in general the late 1980s.

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INTRODUCTION

In considering the possible role of nuclear weapons possessed by new nuclear powers, a useful first step is to identify the incentives for acquiring--or possibly even using--such weapons. An examination of the situation in many countries that are candidates for such acquisition suggests that regional concerns usually dominate. However, whatever the parochial nature of the incentives, the acquisition--and even more the use--of nuclear weapons would have worldwide repercussions. Several recent analyses of the proliferation problem have examined these.* Less attention has been devoted to the tighter process of actions and reactions within a region. This study considers 3 regions: the Arabian Sea--Iran-Pakistan-India; Northeast Asia--PRC-Korea-Japan; and the South China Sea--Taiwan-PRC-ASEAN (with focus on the Philippines)-Australia. Regions are, of course, not isolated from the larger world and some countries have an impact beyond a single region. This is most obviously true of the great powers. But Japan's interactions in the South China Sea and beyond are almost as critical as in Northeast Asia; similarly, India's actions impact strongly on Indonesia and the ASEAN nations; Iran is being watched by Arab neighbors to the west. However, the focus here is on regional interrelationships, with the larger interactions touched upon only lightly.

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*For example, H. S. Rowen, "Life in a Nuclear Crowd," in A. Wohlstetter et al., Moving Toward Life in a Nuclear Armed Crowd? Los Angeles: Pan Heuristics, April 1976; and Lewis A. Dunn and Hermann Kahn, Trends in Nuclear Proliferation 1975-1995, Croton-on-Hudson, N.Y.: Hudson Institute, October 1975. Both reports prepared for ACDA.

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II. THE SOUTH KOREAN CASE: A NUCLEAR WEAPONS PROGRAM EMBEDDED IN AN ENVIRONMENT OF GREAT POWER CONCERNS

OVERVIEW

From a security perspective, the stability within a region denotes a balance of military power among adversaries such that the advantages to any country of not threatening or launching an attack--nuclear or nonnuclear--outweigh those of attacking in response to a wide range of shocks or disturbances. This involves a comparison between "doing nothing" and "doing something" when such disturbances occur. More precisely, it implies acting in a manner that is less aggravating to other nations in the region than was the disturbing action. However, doing nothing may cause a serious deterioration in a country's military or political posture and short of actual conflict, a perception of an unfavorable trend in power might induce political responses that unsettle relations within the region.

History, geography, present political alignments, and military capability all affect regional stability. In considering the possible role of nuclear weapons for countries that do not yet have them, the first step is to identify the incentives for acquiring--or possibly even using--such weapons.

In Northeast Asia, the Republic of Korea has given various indications that it might seek nuclear weapons. However, the impact of any program of nuclear weapons development on its neighbors--particularly on Japan--would affect regional stability and the delicate political balance between the U.S., Japan, the USSR and the PRC. Furthermore, if its action induces Japan to acquire nuclear explosives, it would affect various balances throughout the world. Given this danger, it is important to examine briefly the elements of stability as they apply generally and to Korea specifically.

It should also be noted that regional stability is typically defined in terms of power relations among neighboring countries, but there can be disagreement about which nations are perceived to be actors in a region. The United States, which is normally not thought of as an East Asian power, is very definitely a Western Pacific power and therefore bound to be concerned in developments taking place in the region, or at least in its offshore areas. And the Soviet Union, with the industrial development of Siberia, the prospective completion of a second transcontinental railroad, and its naval expansion in the Pacific, is certainly no longer a European or continental power. The role the Soviet Union and the U.S. choose to play bears importantly on the balance among the countries in the region.

In the future, a marked reduction in Sino-Soviet hostility might be a condition for permitting Chinese moves against Taiwan and elsewhere in Southeast Asia. Furthermore, the breaking of relations between the U.S. and Taiwan could have an even greater destabilizing effect on events and actions to the north. (In terms of regional stability, the sets of countries considered in Volumes I and III of this study are effectively two halves of a single East Asian region--but too much complexity is introduced in a detailed consideration of more than four or five nations simultaneously.)

Throughout this study, the Soviets have been treated as the disrupting rather than the stabilizing force. In fact, this may not strictly be true. The Soviets have in the past behaved relatively responsible with respect to spreading the capacity to make nuclear weapons (its nuclear help to China aside). They may well continue to do so. There is no evidence to think that they will fail to do all in their power to inhibit overt spread of nuclear weapons. But there is good reason to believe that their words and possibly some actions may not be consistent with the general thrust of their foreign policy.

Call Susan Mineir

First of all, stability is enhanced when it is perceived that a conflict if initiated is likely to extend over a considerable period of time. The need to risk all on a single act of belligerency is likely to produce rash decisions of far-reaching consequence. In a nuclear context, this means that the ability to mount or to defend against an initial attack is not enough. For stability, political cohesion, size of country, and industrial strength generate forces that can be mobilizedin the long run. The other actors in Northeast Asia--Japan, the PRC, USSR and the U.S.--meet these criteria for the promotion of regional stability; neither North nor South Korea do.

Regional stability is strongly influenced by the nature of the alliance ties. Viable ones benefit not only the formal members of the alliance but frequently and to varying degrees nonmembers both friendly and unfriendly. Probably the msot important factor in causing countries within the region to move toward and possibly to acquire nuclear weapons is the lowered confidence in outside guarantees and the weakening of their alliance ties. This is most obviously true of the ROK. The announced withdrawal of U.S. troops and the consequent perceived weakening of the U.S.-ROK defense agreement have been viewed as destabilizing by the Koreans. Nonetheless, there are powerful internal forces working against these shifts as well as for them, suggesting that several alternative patterns that could emerge in the next decade need to be considered.

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The first possibility would be more or less an extension of present relationships. Bilateral ties would continue between the U.S. and Japan and Korea--as well as with Taiwan, the Philippines and Australia--at a level that provides each with a sufficient sense of security in the Western Pacific. This is not to suggest that these ties would again be as robust as they had been prior to U.S. withdrawal from Vietnam; only that at each point in time, doing nothing to change existing ties would appear preferable to changing them. In particular,

this presumes that neither China nor Russia would behave sufficiently aggressively to arouse further acute apprehensions and bring about a structural shift. China, as well as the United States, might exert pressure to quash any moves toward acquisition of nuclear weapons. Japan would continue its economic ties with the ROK, possibly based on warmer political relations than exist today, and would assume a broadening political role throughout the region. With this evolution it is possible that no country in the area with the potential to develop nuclear weapons would do more than shorten the lead time for such a program and that such a climate would forestall moves by the ROK in particular. From the U.S. point of view--and probably from that of most of the other nations--this might be the most desirable course; however, its likelihood is now in question.

The second pattern is one that has been widely predicted and underlies much of the analysis in these sections. This rationale foresees that Korea and many, perhaps all, of the countries that have the technical capacity to do so would move closer to a weapons program during the 1980s by closing the fuel cycle and stockpiling plutonium, by developing or acquiring delivery systems that would be capable of carrying nuclear weapons, and even, possibly, by doing preliminary weapons design and basic research on implosion.* They would do so because it would be permitted by the international rules for the use of nuclear energy. Some analysts have also predicted that several countries would go ahead and acquire weapons.** Such a pattern is predicated on the reduction of U.S. interests in armed forces being deployed to East Asia and the Western Pacific. Under such circumstances, a crisis in the region, or even outside the region, say in the mid to late 1980s,

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* A. Wohlstetter et al., Moving Toward Life in a Nuclear Armed Crowd? Los Angeles: Pan Heuristics, April 1976, prepared for ACDA.

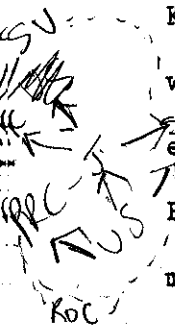
**Lewis A. Dunn and Hermann Khan, Trends in Nuclear Proliferation 1975-1995, Croton-on-Hudson, N.Y.: Hudson Institute, October 1975. Prepared for ACDA.

could cause a scramble for nuclear weapons. As these regional monographs stress, any of these embryonic forces would probably be vulnerable to preemptive attack by the USSR or the PRC. Moreover, isolationist tendencies in the U.S. and perhaps Japan might well be reinforced by such a nuclear spread and this reaction in turn could reinforce incentives to acquire atomic bombs. Korea, in particular, is likely to be left still further exposed.

A third mode of evolution in Northeast Asia could involve a new set of alliance ties. However, it is hard to discern a pattern that would be both politically possible and stable. It has been demonstrated over the past 20 years that countries often will refrain from getting nuclear weapons once they reach the technical level to do so, either through confidence in their security or coercion. In Western Europe, the NATO alliance has provided sufficient confidence, in conjunction with other restraining factors, to forestall nuclear weapons development. In Eastern Europe, these same factors have been at work in a rather different mix--a sufficient one being the coercive role of the Soviet Union.

The withdrawal of U.S. ground forces from Korea has raised questions in the region about the permanence of the U.S. commitment to Korea. A collective security system, even of the loose and evolving nature that might emerge in the South China Sea region (see Volume III, p. III-4), appears difficult to create in the North. Yet ROK independence is criticalto the stability of this area. What then is the best form in which to underwrite ROK independence if it has neither U.S. forces stationed on Korean soil nor an independent nuclear capability? One possibility is a Japanese-Korean security tie. This is unlikely to be acceptable to the Koreans, and there is little evidence so far that the Japanese would prefer it. Another would be based on the triangular relation among Japan, the PRC and the USSR. It is conceivable that Japan and China could reach an agreement to guarantee

Korea's neutrality.* Neither wishes to see a unified Korea under strong Soviet influence. They could presumably each be counted on to see that the other did not step over some defined or implied line in their bilateral relations with Korea. Japan does not want the PRC just across the Tsushima Straits. Koreans would not welcome back the Japanese. It is not easy to conceive of a series of events that could lead to such a drastic reduction in U.S. concern in the Western Pacific that this kind of neutrality guarantee could be made without a U.S. commitment as well.



In the fact of potential nuclear proliferation, stability might be promoted by technological as well as political design--design of guidelines for nuclear export policies of the "supplier" nations, acceptance of safer fuel cycles, and the implementation of safeguards that will give reasonable warning of not just an ultimate weapons program but movement along the path toward a future nuclear weapons capacity. Each of these is affected by and affects nuclear power development within a country. These could help in the case of Korea. However, in an era where access to energy has become a matter of high policy concern, measures which seem to affect this access are valued with great wariness and apprehension. Yet the relation of nuclear power development to nuclear proliferation is central to the stability of this region and to the security of the United States.

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*For a discussion of the not very encouraging history of great power joint guarantees, see H. Rowen and B. Rowen, In the Face of Nuclear Proliferation, Los Angeles: Pan Heuristics, February 15, 1977, pp. 12-14.

POLITICAL OVERVIEW

For two decades following the signing of the 1953 Korean Armistice, South Korea's military capabilities lay so far behind those of the United States that questions of potential Republic of Korea (ROK) interference with American security interests in the area never arose. The influence of the half-million man South Korean army, as contrasted with the much smaller force the United States was willing to station in South Korea, was outweighed by South Korean dependence on American weapons. South Korea also depended on American tactical-strategic capabilities that include land-based air power, the Seventh Fleet, and readily available nuclear weapons. Against the threat of USSR or Communist Chinese backed North Korean attack, ROK capabilities seemed small; American ones, great.

The period of South Korean dependence on the United States for the preponderance of its own defense is now ending and along with it the American ability to control the Korean balance of power. Henceforth, the U.S. must deal with the ROK more as a partner in Northeast Asian security matters. The South Koreans have gained a measure of independence in financing their defense and in providing for some of their weapons needs through domestic production. ROK resources and defense production ability relative to American support and to North Korean capabilities will increase still further. South Korean capability to project power or to upset the balance in Northeast Asia will also grow, albeit slowly, and this new potential will force the United States to consider such a factor in the context of overall regional stability.

This section concentrates on that potential action of South Korea most likely to disturb Northeast Asian security relationships: development of a nuclear weapons capability. South Korea still has clear and substantial security needs. The American military presence--and nuclear guarantee--is central in promoting that security. The total removal of that presence would surely raise questions about the credibility of the guarantee.

One response by the ROK may be to acquire nuclear weapons. Developing the technology so that nuclear weapons could be rapidly developed, tested and deployed--but not actually doing so--is not much less destabilizing. Nuclear weapons which South Korea could develop in the next ten to fifteen years, however, may not fit its security needs well at all: First, because they might not add significantly to the capacity of the ROK to defend itself at the nonnuclear level. Second, because a ROK nuclear or near-weapon status could generate counterproductive responses leaving the ROK worse off than it would otherwise have been.

The American-Japanese-South Korean Security Triangle

The main focus of South Korean planning is on American security arrangements, protecting the ROK from a perceived Communist military threat. Futhermore, the American guarantee has been the basis for South Korea's economic development and for its political recognition as a noncommunist state which legitimately governs half of a divided nation-peninsula. There are significant differences of perspective within each of the parties--the U.S., the ROK, and Japan--about the noncommunist security arrangements in Northeast Asia. And there are important distinctions between the relationships of the ROK with each of her Communist neighbors.

ROK Relations with North Korea, the USSR, and the PRC

The ROK and the Democratic People's Republic of Korea (DPRK) do not recognize each other. Each insists that it is the sole legitimate government in Korea and that the Korean division is strictly a domestic matter. Each Korean government officially seeks reunification of the peninsula. Trade, unofficial communications, and movement of individuals between the two Koreas are nil; and only limited ROK-DPRK governmental contacts have taken place. In those discussions that have taken place, the ROK has insisted that formal peace arrangements be made prior to the reduction of military forces (including American forces). The opposing North Korean stand has been that the peninsula be cleared of foreign troops and that the large ROK and DPRK armies be demobilized before political talks on reunification proceed.

ROK-DPRK talks reached a brief zenith on July 4, 1972, when joint communiques on the independent South and North Korean efforts toward eventual reunification were issued, but tangible evidence of further political cooperation has since been lost in cold-war maneuvering on the peninsula. For the last two decades, the principal manifestation of ROK-DPRK relations lies in the two states' assemblage of massive armed forces which are largely deployed near the 3-mile wide DMZ.

Since the mid-1960s a secondary political theme has developed. The ROK (a UN observer since the Korean War) and the DPRK (a member of satellite UN bodies as a result of a political drive during the 1960s) have competitively engaged in lobbying and in press battles to aggrandize themselves at each other's expense. As the ROK and DPRK struggle for recognition, each state pursues maximum exchange of diplomatic relations internationally without

taking umbrage at dual recognition of the two Koreas. Taiwan on the other hand, and the PRC have spurned dual recognition discussed in Volume III. As of 1975, the DPRK had embassies in 80 nations while South Korea was recognized by 95 countries, 46 of whom also extended recognition to the DPRK.*

The USSR recognizes its Communist dependent, the DPRK, as the only legitimate government in Korea. However, there has been restraint in the hostility between the Soviets and the ROK. The ROK suffers that measure of verbal attack which derives from its role as an ally of the United States. Moscow also complains periodically due to its suspicion that the ROK is developing nuclear weapons. The Soviet Union has neither called for the violent overthrow of the present South Korean government nor shut the door to contact such as trade. However, economic interaction between the two nations currently is negligible.

For its part, the ROK regards the Soviet Union as non-hostile and desires to be recognized by and to establish trade with the USSR.** The DPRK would be politically outflanked if the ROK and the USSR established ties. Such a move would dilute North Korean hopes for Soviet support of communist reunification of Korea. Furthermore, South Korea sees itself surrounded by great and not wholly friendly powers: the Soviet Union, Japan, China, and, since World War II, the United States. Good relations with as many of these nations as possible is seen as promoting ROK security. So far, the ROK has not achieved tangible progress in establishing diplomatic relations with the USSR.

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* Area Handbook for North Korea, DA Pamphlet 550-81, 1976, p. 196.

**Area Handbook for South Korea, DA Pamphlet 550-41, 1975, p. 195.

The ROK has not established diplomatic ties with the People's Republic of China (PRC) either, each nation preferring to recognize the other's sundered half. Although there is a potential for fishing or oil exploration competition between the ROK and the PRC, the latter may find that the ROK's increasing industrialization makes trade between the two countries useful in a future of better relations. However, the current political situation keeps economic interaction at a very low level. Despite China's direct and costly role in supporting the North Koreans in the war of 1950-53, the PRC presently advocates only non-military pressure to effect the removal of the ROK government and its replacement with Communist rule. It has not joined in the provocative cold-war actions of the North Koreans in the years since the 1953 armistice ending large-scale hostilities. This Chinese attitude might qualify the PRC as "non-hostile" in South Korean eyes, but progress toward recognition seems unlikely in the foreseeable future.*

The American Security Structure

Against the direct hostility of the DPRK and the more remote but potentially more critical military involvement of the USSR and the PRC, American military policy in Northeast Asia has been to increase cooperation between Japan and the ROK and to maintain the credibility of parallel U.S.-Japanese and U.S.-ROK defense treaties. These treaties have remained in force through a number of political and military changes, including: economic development in Japan and South Korea, a substantial lessening in tensions between the United States and the PRC, buildup of the Soviet Pacific Fleet, and loss of

*Area Handbook for South Korea, p. 195.

Indochina to communist forces after costly American intervention. There is a triangular security relationship among the Americans, South Koreans and Japanese. The arrangement between the ROK and Japan is secured only by a peace treaty signed in 1965 and by unofficial understandings concerning the role of the United States in ROK defense--not by a formal security treaty.

The American Guarantee

Fundamental to South Korean freedom from Communist pressure has been the ROK-U.S. security treaty of October 1, 1953.* The treaty provides U.S. military assistance to the ROK, stations U.S. armed forces--presently two TACAIR squadrons and an Army division--in ROK territory, and assures the ROK of U.S. intervention in the event of outside attack. These conditions have established the framework within which the South Korean armed forces (which presently arm themselves almost entirely with American weaponry) have developed. The Koreans responded to their commitment to terms of this treaty by sending forces to Vietnam.

Also relevant to the operation of American-ROK security arrangements is the Mutual Defense Assistance Agreement of January 26, 1950. This agreement articulates the goal of economic development of the ROK to enhance its security.** American sponsorship of expanded trade with the ROK followed. Trade with the United States now accounts for almost 34 percent of its $21 billion*** over-all foreign trade. American cooperation in South Korea's

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* U.S. Treaty, 5 UST 2368.

** U.S. Treaty, 1 UST 137.

***Asia 1978 Yearbook, p. 228.

program of constructing civilian nuclear power reactors to partly displace imported petroleum as an energy supply has fit directly into this framework.*

As a consequence of ROK economic growth, its responsibility to contribute increasingly to its own defense has been recognized by both the U.S. and the ROK. At the end of the Korean War, the ROK was one of the poorest countries in Asia, with a per capita GNP of less than $100. She had no greater ability to maintain an adequate defense against aggression from Soviet or Chinese-armed North Korea than she had in 1950, before the start of the Korean War. Accordingly, the U.S. supplied the ROK with military equipment for its own armed forces and also stationed American troops in South Korea on a semi-permanent basis. In 1977, with South Korean GNP at over $25 billion and military spending nearing $2 billion annually, this military investment is being made with internally generated ROK funds rather than with grants or special loans from the United States. As a consequence, American aid has dropped significantly and now constitutes a small part of annual South Korean defense expenditure. The largest single military aid grant to South Korea in recent years, the $800 million package held up in the House of Representatives since November, 1977, would provide the transfer of American equipment to the ROK as the U.S. withdraws its 2nd Infantry Division over the next several years. Even as a single-year grant, however, the package would not amount to half of the current South Korean military budget.

A more meaningful measure of American military support to the ROK is the commitment to provide supplies and even combat forces should North Korea attack.

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*Christian Science Monitor, June 15, 1977, p. 3. One-half of ROK power capacity is oil-fired, and all ROK petroleum is imported.

Up to now, that commitment has been realized in several ways. American combat personnel, aircraft, and nuclear weapons have been stationed on South Korean soil. The U.S. 2nd Infantry Division in Korea is between Seoul and the DMZ, astride the classic invasion route to the ROK's capital city. Outside the ROK, the Seventh Fleet and U.S. Air Force assets at bases in Japan and Guam are on call to intervene in a renewed Korean conflict. With the announced decision of the Administration to withdraw U.S. ground forces from South Korea, the American commitment to uphold the U.S.-ROK security treaty will be visibly secured by the two tactical air squadrons stationed in South Korea, plus Navy, Army, and Air Force units stationed elsewhere in the Pacific.

American-Japanese Security Arrangement

American-Japanese security cooperation is also closely connected with South Korea's defense. Although the U.S.-Japanese security treaty protects Japan from attack or coercion, many Japanese worry about instability in Korea. Japanese leaders state that their interest is in preventing the outbreak of violence on the Korean peninsula, but they are also affected by Korea's internal politics. Korea certainly remembers the decades of harsh Japanese colonial rule before and during World War II. For the Japanese, the most desirable state of affairs on the Korean peninsula may be the present situation, where the opposing halves of Korea are preoccupied with their ideological struggle and military standoff. As long as such a schism can be kept from generating another conflict or an uncontrolled Korean arms build-up, Japan will not have to fear vengeance from a united and prosperous Korea. Should Korea be unified under one of the two governments, the Japanese Liberal-Democratic Party (LDP)

leadership would be better able to relate to that of the ROK, whose economic development program Japan has materially aided and whose non-communist ideology it shares. The DPRK government in Pyongyang maintains a vehemently anti-Japanese ideological tone, although it has traded with Japan since its inception. Japanese leaders wonder what a Communist Korea might do should the ROK be vanquished and should the Communist government continue to spend fifteen percent of GNP on defense.* Safely assuming that the PRC and the USSR will not permit a ROK takeover of North Korea and that no peaceful reunification of the Korean peninsula soon will occur, Japan has chosen to cooperate with the United States in protecting the ROK's interests against the North. American bases in Japan, which serve the general purpose of enhancing the island nation's early warning and air defense strength, have for the past 25 years been available for rapid support of South Korea should conflict occur. Major naval bases in the southern Japanese islands are but a few sailing hours from the principal South Korean port of Pusan. Moreover, American long-range attack aircraft operating from Japanese bases could carry out missions over all of the Korean peninsula. Two-thirds of a U.S. Marine Division on Okinawa stands ready for quick deployment to a Korean conflict. Furthermore, if an extended Korean engagement were to occur, the Japanese industrial base would stand the United States in good stead in providing the supplies the American and ROK forces would require.

Japanese-South Korean Cooperation

Least explicit of the sides of America's Northeast Asia security triangle is cooperation between Japan and the ROK. The formal basis of Japanese-ROK

*A situation which in many respects parallels that giving concern to the ASEAN nations with respect to Vietnam today. See Volume III.

relations is the peace treaty of 1965, signed at the initiative of ROK President Park. Park was able to overcome strong domestic opposition to reconciliation with the despised Japanese, and the government of Japan took the peace treaty as justification for beginning a major program of investment for South Korean economic development. Since the mid-1960s, the ROK economy, which stagnated for more than a decade after the 1953 Armistice, has sustained rapid economic growth to the present time, continuing unabated through the 1974-1975 petroleum recession. The ROK Economic Planning Board, accurate in its past forecasts of Korean growth, claims average 1976-1981 real GNP growth will be 9.2 percent annually, yielding a ROK GNP of $33.5 billion ($1975) by 1981.* Although Japan has enjoyed a trade surplus with the ROK during South Korea's largely export-led growth, the role of Japanese capital investment and industrial organization has been critical in permitting this resource-poor country to develop a trade-oriented and industrial structure.

Japanese-ROK military cooperation presently is insignificant. Arranging joint Japanese-ROK military operations would probably violate each nation's popular sentiment, and deploying Japanese forces to South Korea, moreover, breaches current Japanese anti-mobilization statutes. However, as long as the U.S.-ROK and U.S.-Japanese security treaties are in force, Japanese forces are not likely to be required for ROK defense.

Changes in the American Security Relationship in Northeast Asia

The primary force working for change in the Korean standoff (and influencing the defense treaties surrounding it) is the announced reduction in the

*Business Week, December 12, 1977, p. 35.

level of American presence in Korea. Although other important changes have occurred in the region--economic growth in Japan and South Korea, the Sino-Soviet split, Chinese development of the atomic bomb, reduction in U.S.-PRC tensions, and Japanese recognition of the PRC in favor of the ROC on Taiwan--the United States has maintained the ability to prevent the North Koreans from overrunning South Korea. However, preservation of the treaty structure that has lasted twenty-five years and the maintenance of a relative advantage in total military power in northeast Asia does not guarantee that the U.S. will choose to deploy its forces or maintain the political ties necessary to defend South Korean and Japanese interests with the robustness of the past. This reduction in tangible evidence of guarantees has had an impact on all parts of America's security structure surrounding South Korea.

The Administration's troop withdrawal plan for Korea has not been released in full detail, although official statements have revealed its general outline. The plan appears to have three main features. First, 31,000-33,000 of the personnel in the 2nd Infantry Division and associated support groups will be withdrawn over a five-year period to 1982. Second, American air units, presently two F-4 squadrons, will remain in the ROK for the foreseeable future. Third, all American nuclear weapons may be removed from Korea.

The U.S. troop withdrawal plans make it necessary to remove nuclear munitions along with such U.S. Army nuclear-capable systems as 155-mm and 8-inch howitzers and Sergeant and Honest John missiles. The rationale for withdrawing the ground forces while preserving the USAF presence is that the South Korean army is better prepared than the ROK air force to deal with

DPRK threats. Furthermore, making the South Korean air force self-sufficient could give it a greater deep-strike capability than the United States may want it to have. Some ROK observers interpret the American move differently, pointing out that the USAF squadrons are being left in South Korea only because they can be more quickly withdrawn in a crisis than can ground forces. Although the assertion bears some truth, the removal of F-4 deliverable nuclear weapons, if a part of the plan, would constitute a further reduction in American military presence in the ROK.*

South Korean officials have implied that their country's decision on proceeding with nuclear weapons development depends in part on whether or not American tactical nuclear weapons are withdrawn from Korea,** even though American nuclear capability is clearly evident in the Western Pacific in such assets as the Seventh Fleet and bases on Guam, and the ability to reach the region from continental United States.

The objective of keeping an adequate level of military strength in the ROK links American arms-export policy to the ROK with U.S. troop deployment decisions. In air defense, the U.S. is retaining most of the Allied deep strike capability while providing the ROK with additional F-5 squadrons to offset the DPRK's numerical advantage in aircraft. Certain ROK facilities and territories also are receiving new terminal air defense systems, while area-defense Hawk and Nike-Hercules SAMs have partially been transferred to ROK control. (It is uncertain if Nike-Hercules installations close to the DPRK border will be turned over to the South Koreans, as this long-range

* Washington Star, June 14, 1977, p. 2.

**Nihon Keizai Shimbun, June 6, 1977, p. 5.

missile is nuclear-capable.) The U.S. is providing upgun and night-fighting kits for ROK tanks and has transferred many antitank guided missiles to increase the ROK's antiarmor capability and, thus, to give Seoul a greater measure of security against a sudden North Korean assault. On the naval front, ROK vessels are being fitted with U.S.-made Harpoon antishipping missiles.*

Current American arms transfers to the ROK are doing much to redress the threats posed by recent DPRK additions to their armor and aircraft inventories, and many analysts believe the resulting South Korean military will be adequate in the near term to defend against North Korean attack. However, in the ROK's longer-range plans to 1990 and beyond, relatively less weight must be placed on current American arms receipts than on U.S. guarantees to intervene and on continued access to modern U.S. weapons to counterpoise further North Korean buildups. Over the past 25 years, the earlier generation of U.S. supplied arms such as F-86 fighters have become obsolete, but the American presence and new arms supplies helped deter the North Koreans. To the South Koreans, continued access to American weapons appears even more vital in the light of U.S. ground force withdrawals, and they fear the possibility of hasty decampment of the F-4 squadrons in the ROK. Many South Koreans think that once the American troops are gone, the United States will have less incentive to keep up arms shipments. In assessing the ROK propensity to acquire nuclear weapons, the thesis that ROK military planners may be preparing for the future under the assumption that the current American

*See Military Balance 1977-78, London: IISS, pp. 60-61, for ROK-DPRK order of battle.

shipments represent merely a quid pro quo for the troop withdrawal and may not be followed in the 1980s and 1990s by new arms which the ROK will need, must be taken seriously.

To a sensitive and vulnerable South Korean government, the soundness of the American commitment may, in spite of U.S. official guarantees, be questionable. First, the demise of American-supported governments in South Vietnam and Cambodia comes to mind.* Since South Korean troops fought alongside Americans in Indochina, ROK leaders may find this example of failure of America to continue to maintain a commitment particularly stinging. Second, over the quarter of a century of American military presence in Korea, U.S. policy has been exceptionally tolerant of North Korean provocations. It has endured humiliating incidents, such as the 1968 capture of the Pueblo and the 1976 murder of American officers at Panmunjom, without forceful retaliation against the DPRK. Third, the Carter Administration's initial pronouncement on withdrawing American forces from Korea was sharply flavored by the simultaneous criticism of ROK "human rights" violations, although the Administration's position was subsequently softened with words about Korea's special political and military significance. Finally, in the U.S. Congress, further American military aid to the ROK has become entangled in Congressional attempts to investigate alleged South Korean influence-buying. All of these events form a pattern of uncertainty as seen from Seoul.

To view the American commitment to the ROK in this way may be natural, but mistaken. American leaders have not challenged the U.S.-ROK security

*Newsweek, June 30, 1975, p. 39.

treaty, and the year 1977 has allowed the new Administration to become cognizant of ROK, Japanese, and latent domestic beliefs about the importance of Korean security guarantees. The significant popular American support of Korean independence does not seem to have weakened, although American feelings have been adjusted in the light of authoritarian ROK government acts, acts which some American political groups have denounced. Within the Republic of Korea, the American military force is a guest--not a viceroy--and it must behave with appropriate restraint given that the welfare of the Soviet, Chinese, and Japanese nations are also involved. Thus, the U.S. force in Korea can neither serve as the instrument for retaliation against such DPRK blows to the ROK government as the "Blue House Raid" of 1968, nor freely escalate violence in Korea in response to North Korean affronts to its own personnel. Transient American political events, furthermore, may lead an outside interpreter to discount the value of the American security commitments to Korea. Congressional action in freezing the $800 million aid package to Korea as a prod to ROK cooperation on investigating the influence-buying scandal probably reflects recognition of the best available lever over the South Koreans rather than intention to abandon them to Kim Il-Sung's armies. Similarly, the early Carter Presidential campaign resolve to pull U.S. forces out of Korea is best evaluated by understanding the then-candidate's position as challenger and his use of the Korean example to flesh out his general use of "human rights" as a campaign issue.

Strains in the Japanese-American Understanding Over Korea

To the Japanese government, one of the principal indicators of the American military commitment in Asia is U.S. policy in South Korea.* It is

*"Joint Japan-U.S. Announcement," Survival, XVII, No. 5, September-October 1975, p. 244.

arguable that it is for the purpose of ROK defense that the U.S. has maintained bases in Japan in greater number and at higher levels of activity than would otherwise have been allowed. Japanese government leaders have taken stances in support of American bases in Japan and of American positions on South Korean defense that exposes them to attack by leftist Japanese parties. However, LDP advocates of security cooperation with the United States and support for South Korea voiced the strong feeling in early 1977 that they had not been properly consulted about the U.S. troop withdrawal, considering Japan's own important contributions to the ROK's security.*

Japanese leaders are disturbed by the idea that the U.S. may be reducing its practical commitment to South Korea.** This unease takes several forms. They see that a ROK-DPRK conflict could erupt in an atmosphere of reduced American restraint and deterrence, leaving them open to strong pressure from either (or both) the USSR or the PRC to cooperate in their competing interests on the peninsula--or even to belated American pressure to support South Korea. ROK military setbacks could trigger an exodus of South Korean refugees fleeing possible Communist rule, and many of these might head for Japan, the nearest noncommunist sanctuary. Communist rule over all of Korea would be unpalatable to the Japanese leadership, but so would be ROK development of nuclear weapons in an attempt to compensate for reduced American support.***

Even more pessimistically, general U.S. withdrawal from the area--and from Japan--might follow a Korean pullback and leave Japan militarily more

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* Los Angeles Times, June 8, 1977, p. 7B; Yomiyuri June 22, 1977, p. 1.

** Yomiyuri, September 5, 1977, p. 2 citing JDA Director Mihara.

***See Washington Post, July 28, 1977, p. 14.

exposed to Soviet or PRC coercion. The USSR might even assume the role of the dominant Northeast Asian power, forcing first the PRC, then Japan, to accede to Soviet wishes and, in Japan's case, to break the security tie with the United States. Certainly, the Japanese government prefers the present arrangement with a vigorous non-communist (not non-nuclear) neighbor in Asia. Japan probably wonders why the United States desires to weaken its support of the South Koreans.

Already, it is felt in Japan that the U.S.-Japanese security treaty is not all-protecting and that the Sino-Soviet split contributes as much to Japanese security as does the American military guarantee.* Japan is finding that military support or capability is useful in maintaining a balance between Soviet and Chinese pressures,** and it seems likely that Japanese military expenditures will rise well above present levels in the next ten to twenty years. Whether any increased Japanese military role in East Asia will be coordinated with the U.S., independent of it, or in league with some other power may be influenced by current American decisions over military support to Japan's neighbors.

Japan favors continued cooperation with the United States because of the past success of the security arrangement and because of the obvious advantages such a policy offers in an environment which potentially could put great pressure on a Japan attempting to change its foreign policy foundations. However, closely following American policy on East Asia has recently been difficult

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* See Henry S. Rowen, "Japan and the Future Balance in Asia," Orbis, Volume 21, No. 2, Summer 1977.

**Soviet World Outlook, Vol. 2, No. 6, June 15, 1977, p. 6 (Japan Chief Cabinet Secretary Sonada).

for Japanese leaders. The U.S. has inadequately consulted the Japanese over matters of mutual interest. In some cases Japan had already made a significant commitment. American support of South Korea has recently become such an issue as a result of an early Carter Campaign decision, made before he was in a position to consult Japanese or ROK leaders, to reduce the American presence in South Korea and to remove the ground forces there. Discussions with Japanese and South Korean leaders followed announcement of the program shortly after the 1976 elections, but they were more a presentation of the American troop-withdrawal decision than consultations as to whether and how such withdrawals would be made.*

These misunderstandings both resemble and differ from the "Nixon Shock" of 1972 when the U.S. caught the Japanese by surprise by suddenly lowering American-PRC barriers. Japan, in that case, was ultimately relieved by the American policy shift because it freed the Japanese to pursue a more natural relationship with China and to conduct more balanced diplomacy between the PRC and the USSR. Nevertheless, the episode caused the Japanese government severe short-term discomfort, because its difficult policy of defending close adherence to an anti-PRC foreign policy against domestic opposition was suddenly undermined by the American move. Present Korean misunderstandings contrast with the "Nixon Shock," because the apparent change in American policy is not easy for the Japanese to accept, either in the short or in the long run.

One area of unresolved Japanese-American differences over changes in U.S. policy toward Korea is the role of American bases in Japan. Examination

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*See Washington Post, July 27, 1977, p. 14.

of a map reveals that installations in Japan must be relied upon for rapid American support and resupply of positions in the ROK. However, by withdrawing ground troops from South Korea while maintaining that American commitment to South Korea's defense will continue, the U.S. implies that Japanese bases will be more critical than before in the initial support of ROK forces. This suggests an implicit increase in the Japanese commitment to South Korea (by permitting greater American reliance on bases on their soil); yet this was not requested of the Japanese before the American troop withdrawal decision was made. The Japanese LDP thus is caught in an American-made dilemma. As explained above, the Japanese government justifiably fears erosion of the American commitment to the ROK, American promises notwithstanding, and the possibility that Japan may someday have to face Korean instability with little American presence. On the other hand, should the U.S. try to sustain its hitherto effective support of the ROK, but from Japanese soil to a greater degree than before, the Japanese may be drawn against their will into the military aspect of South Korean security--an uneasy host to American tactical strike forces in the event of Korean conflict. It is somewhat presumptuous to ask the Japanese to bear the increased risks caused by growing U.S. reliance on bases in Japan; still more to shift, essentially, some of the risk and responsibility of support for South Korea from American shoulders to Japanese without detailed prior negotiations. The Japanese government sees the American promise to protect South Korea from Communist attack as closely related to its own dependence on American protection. However, American policy changes with respect to Korea have reduced the degree, the diversity, and the predictability of this commitment. Since the troop withdrawals from the ROK

emphasize the need for rapid U.S. reinforcement capability, Japan is more and more uncomfortably linked to contingent American efforts to defend South Korea. To the extent that the American capability to deliver on its commitment to Korea has been reduced, the Japanese may feel more exposed to future pressure from the large Communist states of Asia and more vulnerable to uncontrolled Korean instability. These impacts upon Japan may, in turn, cause them to re-evaluate their relations with the ROK and with the United States.

Japanese-ROK Disputes

The American concept for Northeast Asian security rests on the belief that incentives for the U.S. and her allies to cooperate will outweigh any differences that may come between them. Between Japan and the ROK, however, centrifugal forces exist and have done so since the formation of the South Korean state. The tension between Japan and South Korea stems from memory of bitter decades of Japanese rule between 1910 and 1945. The several hundred thousand expatriate Koreans living in Japan, descendants of laborers imported for an empire's convenience, now constitute a clannish and economically disadvantaged minority in this industrial republic. Many of them are members of the leftist Chorosen, an activist organization influenced by Pyongyang. Since Japanese businessmen imperfectly hide the attitudes of past imperial masters and present economic superiors, they are resented as visitors to the ROK even though they perform vital services of maintaining and expanding the infusion of Japanese development capital. Because of the deep mistrust between the two cultures, any incident involving Japanese in Korea or Koreans in Japan can take on an unpleasant emotional content.

South Korean president Park's authoritarian actions in reducing domestic political dissent have caused severe friction with the Japanese government and have thrust the issue of cooperation with South Korea deeper into Japanese party politics. In 1973, Kim Dae Jung, a South Korean politician noted for his energetic opposition to Park and for a nearly successful challenge to him as a presidential candidate, was kidnapped from a Tokyo hotel and spirited away to trial and prison in South Korea. Other Japanese residents of Korean stock have been convicted in ROK courts of crimes of dissent and, by some accounts, have been tortured. At times the Japanese government has been the object of ROK ire. In the aftermath of the 1974 assasination of President Park's wife by an expatriate Korean who resided in Japan, South Korea demanded greater Japanese control of their leftist Korean residents and forced the issue nearly to the point of breaking diplomatic relations. Japanese officials' angry reaction to this perceived ROK intercession in their domestic affairs gave rise to fears that Japan might deny the use of American bases for the support of South Korea. Although Japanese-South Korean political tensions have relaxed since the ROK's troubled period of 1974-75, differences in the two countries' political makeup, including differences in the concept of due process, of liberality, and of civilian government, may combine unfavorably with cultural prejudice and diplomatic propriety to produce more antagonistic episodes between these neighbors.

Economic proximity has also set the scene for Japanese-ROK misunderstandings. The vital Japanese role in South Korea's development has been accompanied by a close and dependent ROK trade relationship with Japan; but this relationship has not been governed by protocol protecting the interests

of their respective domestic economies. In the aftermath of the oil shock, Japan--arguably less threatened by the world recession than the ROK--severely cut back on imports from East Asian nations, the ROK included. South Korea, with a less diversified trade pattern than Japan, soon fell into international payments difficulties and barely extracted herself from a reserves shortage in early 1975. An ROK export drive of textiles and other goods, part of South Korea's attempt to maintain its international credit, has been resisted by Japan in an apparent move to protect Japanese domestic manufacturers. By 1976 it became clear that the ROK would weather the international recession, but the 1974-75 economic dislocations have caused the ROK to rely less on trade cooperation with Japan and instead to develop commercial ties with other partners in the Middle East and Europe. As a consequence, the percentage of Japanese trade conducted with South Korea has fallen and is expected to continue to do so.* That change may be accompanied by a reduction in any Japanese perception of responsibility for the ROK's economic well-being.

An American-backed defense arrangement for South Korea and for Japan decreases the impact of these divisive feelings. Japanese business investors are less likely to invest further in the ROK if the stability of its government is not certain. Furthermore, the LDP, the voice of business interests, has lost strength recently. Should the Japanese government drift to the left, ideological conflict with the present ROK government might increase. In turn, uncertainty about external security may cause the Park government to continue its harsh domestic policies and further alienate the Japanese. In such an

*Wall Street Journal, August 30, 1977, p. 30.

environment, South Korean leaders may be less inclined to take Japanese antipathies into account when deciding whether to proceed with a nuclear weapons program.

THREATS AND UNCERTAINTIES: THE ROK'S DEFENSE PLANNING

Geographical and Historical Framework

South Korea now faces a distinct military threat from a large, capable North Korean army and air force in a highly complex political and strategic setting. The present military situation reflects only some of the potential causes of conflict in the Korean peninsula. ROK decisions to acquire new hardware, such as nuclear weapons, could create important new ones.

The Divided Nature of the Korean Nation

Because Korea is ethnically and linguistically homogeneous, each of its incompatible governments aspires to reunify the nation and is tempted to do so forcefully under its own terms. North Korea especially has advocated a policy of reunifying the nation as soon as possible. The ROK conditions its terms for reunification on a political settlement between ROK-DPRK. The Korean people, too, regard the nation's division as repugnant and only the latest expression of Korea's vulnerability to pressure from powerful outside forces. Ideological differences and military tensions, however, have dominated the Korean scene since the late 1940s and have prevented the peninsula's halves from enjoying contact even as limited as that afforded East and West Germans.

Korea functioned as a unified nation, both during the period of independence before the twentieth century and as a Japanese province until 1945, and developed geographic differentiation of her economic activity. Agriculture is concentrated in the climatically more favorable south. The North became more

industrialized because it had a store of mineral and hydromotive resources like neighboring Manchuria. From the outset of the 1948 estrangement, North and South Korea both suffered from being cut off from the other's production. The agricultural ROK continued to stagnate after the 1953 Armistice and remained poor until the 1965 peace treaty with Japan. Since 1965, the resource-poor ROK has accumulated an industrial structure with more per capita investment than the once-preeminent North possesses and, consequently, a different kind of North-South division has emerged. North Korea's economy is markedly more self-reliant than the ROK's. Despite its trade with the USSR, the PRC, Japan and, to a lesser extent, with other states, its aggregate trade does not approach South Korea's. If Korea were nonviolently reunified now, the South would benefit from lessened dependence on imports of raw manufacturing materials and energy sources, and the North's economic development would be enhanced by better exposure of foreign markets and sources of investment capital.

Both Korean governments can probably see advantages in directing the economic efforts of a reunified Korean nation toward securing good living arrangements among their larger neighbors rather than expending large sums guarding against each other's military forces. Of a combined national product of approximately $35 billion annually, the two Koreas spend close to 9 percent, or $3 billion, on defense. Assuming the incremental capital-output ratio in Korea is 3:1 and that military investment is 50 percent as efficient in expanding the capital base as nonmilitary investment, a cut in defense spending from 9 percent of the peninsula's GDP to 4-1/2 percent could

result in an additional 3/4 of 1 percent of annual economic growth for the combined economies. This translates to $250 million per year. The reduction in national independence that South and North Korea must undergo to obtain support from their great allies also clashes with the nationalistic Korean spirit. Neighboring nations probably would not appreciate the greater political maneuverability of a united Korea, but Korean leaders would welcome such a change from previous decades' external constraints on their nation.

The Strategic Exposure of Seoul

Seoul's location just 35 kilometers from the DMZ, together with the concentration of ROK population and industrial assets around the Seoul metropolitan area, constitutes a major strategic liability to that nation. It lies so near an enemy border that long-range guns on the other side of the DMZ can shoot halfway to the capital, and various field rockets, such as the FROGs that Soviet allies possess, can hit the city from firing positions within the DPRK. Seoul is dangerously exposed to an air strike as well. An aircraft flying Mach 0.8 could be over the city just three minutes after crossing the DMZ. The ROK capital is also vulnerable to swift occupation by unresisted enemy ground forces. Presumably, the DPRK's mechanized divisions follow Soviet doctrine and are prepared to cover twenty to forty kilometers per day. At the beginning of the Korean War in 1950, North Korean troops, traveling a longer route from the 38th Parallel than they might from the current DMZ, were in Seoul in 72 hours.

Should an enemy capture and hold the Seoul metropolitan area, the remainder of the ROK would be in poor condition to resist further enemy pressure. The capture of an unevacuated Seoul would enlarge the North Korean

population from 16 million to 24 million and reduce the South's to 28 million. Furthermore, the Seoul metropolitan area generates a very large share of South Korea's GNP. Even if large portions of the population were able to flee, the fixed resources could be useful to the DPRK's economy and denied to the South. The immediate economic impact of Seoul's loss might be a 40 percent reduction in ROK GNP (from $25 billion to $15 billion). In the long run the DPRK could double its own $10 billion GNP by adding much of the Seoul area's $10 billion annual product. Seoul is the principal military prize. South Korea's second-largest city, Pusan, on the southeast corner of the peninsula more than 400 kilometers from North Korea, contains only seven percent of the ROK's population (although it is a principal South Korean port and a manufacturing center of growing importance).

In comparison with Seoul's strategic exposure, North Korea's capital, Pyongyang, is neither dangerously close to the DMZ nor does it contain a predominant part of the DPRK's national assets. Situated 140 kilometers from the ROK, Pyongyang could not be captured with the same economy of force as Seoul. With only six percent of North Korea's population its loss would not be as heavy a blow. North Korea's other principal cities lie even farther to the north.

The Strategic Position of the Korean Peninsula in Northeast Asia

North Korea, which has not allowed any large presence of foreign troops nor major naval basing rights, shares the long Yalu River border with the People's Republic of China. The Chinese have been anxious about this boundary. When U.N. forces encroached upon it in October 1950, the PRC entered the Korean

War in force. Any adversary of the PRC can take advantage of a military position on the PRC-DPRK border with its proximity to the industrial center of Manchuria. For example, Shenyang (Mudken) is only about 200 kilometers from the Korean border but more than 500 kilometers from the closest Soviet territory. Manchuria is largely protected by mountainous terrain on both sides. Should the North Koreans change their stance regarding the stationing of foreign troops on their territory and accede to Soviet pressure at some future date, Chinese security would be significantly reduced through the virtual encirclement of Manchuria.

Such pressure is not out of the question. The southern outlet to the Sea of Japan now is jointly controlled by Japan and the ROK, and the preferred northern exit from this sea, the La Perouse Strait, is bordered by Soviet and Japanese coasts. Thus, Japan has the potential ability to bottle up the Soviet fleet in the Sea of Japan, and the Soviets might foresee the value of a port on the south or west coast of Korea. Freed from dependence on the port of Vladivostok and the remote and inclement Pacific Ocean port of Petropavlovsk on Kamchatka, a Soviet fleet would be able to operate at will in the East China Sea. It could easily negotiate the gap in the Ryukyus southeast of Okinawa to move into the Philippine Sea and thence into the open Pacific or toward the Indian Ocean. Such Korean port facilities would also make naval actions the Soviets might contemplate against the northern Chinese coast more feasible, as well as provide shorter submarine transit distances to Japan's sea lines of communication. The oil tanker exits to Japan from the Indonesian archipelago are 3500 kilometers from Korean ports and 7000 kilometers from Petropavlovsk.

The Possible Value of Offshore Economic Zones

Territorial disputes resulting from the mutual non-recognition of the two Korean states, and of the ROK by the PRC, will assuredly result in double claims to seabed territory in the Yellow Sea. Although exploratory drilling in the regions off South Korea's shores so far have failed to turn up any important petroleum deposits or other mineral reserves, uncertainty over the worth of the region's offshore mineral rights may persist for a decade or more. One of the Yellow Sea littoral states may in the meantime act to secure a position in these waters, much as the PRC did in occupying the disputed Paracel Islands in the South China Sea while North Vietnam was still occupied with fighting the South. The 1977 declaration by North Korea of a 50-mile offshore economic zone, ignoring the garrisoned South Korean-held islands off its southwest coast, could serve as basis for future conflict over offshore rights.*

South Korean Dependence on Sea Lines of Communication

As of 1977, some 40 percent of South Korea's GNP, about $10 billion of goods, was exported, 80 percent to nations other than Japan. Correspondingly, some 70 percent of South Korea's $10 billion of imports came from nations other than Japan. This included substantial amounts of the ROK's energy supply which came from the Middle East. Unlike North Korea, whose trade consists largely of exchanges with the PRC, the USSR, and Japan, much of the ROK's necessary imports and financially sustaining exports must make their way through the East China Sea and across the Pacific Ocean to the

*New York Times, August 2, 1977, p. 2.

Western Hemisphere or across the Indian Ocean to the Middle East and to Europe. With such a large amount of the ROK's economic activity moving beyond Japan, protection of sea lanes is critical to the ROK's economic viability.

Legitimacy and Recognition of the South Korean Government

With the Seoul government under criticism by the ROK's two strongest allies, the U.S. and Japan, the future of the present South Korean government's international acceptance is open to some question. European financial circles have from time to time judged the South Korean government's creditworthiness based on guesses about the strength of American support. On the whole, however, the ROK has been successful in enlarging the size and lengthening the term of its foreign debt. The breadth of South Korean diplomatic recognition (much greater than that of, for instance, the ROK on Taiwan), its growing commercial prominence, its successful industrial development program, and even President Park's continuing tenure, have made international challenges to the Park government's legitimacy less and less important. However, should a major reversal in the ROK's international commercial connections take place, or should the ROK government engage in internationally unpopular acts such as increasing domestic repression or making overt moves toward acquiring nuclear weapons, the broadbased support for the ROK is likely to decrease--which in turn would tend to accelerate both types of action.

National Threats or Uncertainties

The Threat from North Korea

The North Korean threat to the ROK presently assumes four forms: direct invasion and capture of Seoul, guerilla and subversive tactics to weaken the South Korean government at home, encouragement of international political isolation in an effort to prevent the ROK from receiving foreign support to resist the North, and small-scale maritime battles in the course of disputes over offshore territorial rights.

A sudden invasion across the DMZ by North Korean ground forces, coordinated with a disarming North Korean air strike against the concentrated ROK and U.S. airfields in South Korea, could threaten Seoul in short order. Because of the hilly terrain surrounding the ROK capital, invading troops would have to proceed through one or more of several valleys running south from the DMZ. In 1950, when the North Koreans attacked across the 38th parallel, enemy troops arrived at Seoul after proceeding through the corridor leading through Uijongbu, northeast of Seoul. The present DMZ was drawn on 1953 front lines, not the 38th parallel, and in some ways leaves Seoul more exposed to attack than it was in 1950. The North Koreans now occupy a salient, containing the city of Kaesong, that lies between the 38th parallel to the north, the DMZ to the east, the Han River estuary to the south, and the Yesong River to the west. At its closest point, this territory lies within 30 kilometers of Seoul; thus, the North's heavy artillery could fire halfway to the ROK capital from DPRK territory. Frog 5/7 missiles, present in limited quantities in the DPRK inventory, could strike Seoul from this salient with

their 1000-lb warheads. Heavily defended against South Korean assault with artillery emplacements carved into mountainsides, the Kaesong area also stands ready to support an attack on Seoul via the South Korean town of Munsan.

The possibility of North Korean unconventional warfare against the South compounds the threat of direct invasion. According to North Korean and PRC doctrine, guerrilla and subversive tactics play a part in any standard military campaign. Thus, the South Koreans could expect North Korean sabotage and infiltration along with an invasion. Since the 1953 armistice, North Korea has sporadically threatened ROK political stability through subversive action. North Korean actions against the South have included sabotage, jailbreak, and attempted subversion of the rural population. Efficient patrols and a cooperative populace have helped the South Koreans contain most of these incidents, but close calls have occurred. In 1968, a team of thirty North Korean commandos approached within a kilometer of the ROK Presidential Palace on a mission of assassination. A second assassination attempt against President Park in 1974 claimed his wife's life. The Parks were fired upon by a young expatriate Korean who stole a .38 revolver from a police box in Osaka, Japan, made passage to Seoul, and sought out the ROK president as he spoke at a public gathering.

The South Korean leadership thus fears for its safety both from random attacks during times of "ordinary" North-South tension, and due to its vulnerability to attack by a large North Korean commando force in the first stage of an assault on Seoul. The North Koreans, with eight commando brigades, may feel that by destroying the ROK's national command at the outset, they can discoordinate South Korean resistance and possibly inhibit the United States

from supporting its "decapitated" ally. The South Korean leadership also notes that the DPRK's government, with its airtight security, is less vulnerable than the ROK's to such a blow at the command structure.

The results of a third kind of North Korean attack on the ROK's security--diplomatic isolation--seem to be less fruitful. As has been noted, the ROK's controversial government activity has been overshadowed by its commercial success. Concurrently, North Korean diplomacy sometimes has been noteworthy in its misunderstanding of Western sensibilities. In international forums, especially those of "unaligned" nations, North Korea has used American troop presence to indict the legitimacy of the Park government. North Korean spokesmen have also called attention to Park's cooperative role as a soldier under the World War II Japanese colonial administration. Recent South Korean police and KCIA (Korean C.I.A.) action against political opponents makes arguing the North's case easier. At the same time, any North Korean violation of human rights can be kept well out of the international press's eyes. A stepped-up political offensive by the North seems to be more a potential danger for the future than a weapon ready for current use against the ROK.

Fourth, the ROK-DPRK naval arena has recently seen an arms race. A cold war between the two Koreas has often been fought at sea in running gun battles between the two navies' warships, in harassment of fishing vessels, and the landings of armed agents on South Korean soil. North Korea's limited numbers of ex-Soviet and ex-Chinese submarines and of Styx-armed Soviet missile patrol boats pose a threat to South Korean shipping and to future offshore drilling platforms. In response to the North and in keeping with its recent military improvement program, the ROK has procured longer range (100 km) Harpoon antishipping missiles from the United States.

The Possibility of a DPRK Nuclear Program

If the DPRK became sufficiently alarmed about ROK military capabilities, especially nuclear ones, it might start its own program to move closer to the development of nuclear weapons. Although such an effort would not be impossible, North Korea presently is behind the ROK in nuclear-related expertise and faces some difficult obstacles in realizing any nuclear ambitions. Foremost among these is restraint that the PRC and the USSR would be likely to impose on the North Koreans. Although the PRC and the USSR competitively seek the DPRK's favor by providing conventional military aid, each Communist giant probably wishes to minimize the possible consequences of bellicose and unpredictable North Korean behavior. They may be aware that allowing the Kim regime a nuclear capability would weaken their influence over the DPRK. They are in a strong position to bargain, for between them they supply all of North Korea's arms imports and provide the security guarantee protecting the DPRK from aggression.

Remote, but possible, is the surreptitious DPRK acquisition of materials and technology from some third-world nation. The form of any such effort is totally speculative, but it certainly would be subject to detection by the PRC, USSR, or the United States, and to countervailing pressure by the Soviets and Chinese. Furthermore, in a competitive effort the DPRK would start several years behind a South Korean weapons development program.

Brief note may be made of a DPRK nuclear delivery system. Seoul is within range of DPRK FROG 5/7 rockets placed immediately north of the DMZ, but this delivery system might be vulnerable to a disarming strike and would also require a warhead weighing 1000 lbs. or less. DPRK aircraft could quickly

be over Seoul if they could penetrate ROK air defenses. However, the only North Korean aircraft with the 2000-4000 lb. capacity required for first generation weapons are the antiquated Il-28 and the Su-7. The DPRK has not been provided more modern Soviet aircraft with large capacities, such as the MIG-23. (Note the parallel with Taiwan, where the United States has ensured that its ally lacks a satisfactory nuclear weapons delivery capacity.)

Comparison of DPRK-ROK Economic Resources for Defense

The ROK's ability to internally generate funds for defense expenditures has been increasing over the past several years and is expected to continue to do so into the 1980s. A consequence of the ROK's rapid post-1965 economic growth, this increased military spending may enhance South Korea's confidence in its self-defense capability and further stabilize its investment environment. Because the American financial contribution to ROK defense has declined in relative terms (held steady in dollar amounts), the ROK may gain some bargaining strength with the U.S. over its military hardware acquisitions. Further, the ROK economy is likely to continue to grow faster than North Korea's. Since the ROK's economic base already is more than twice as large as the DPRK's, South Korea can expect to support a larger defense establishment at a lower relative cost than the DPRK--one that is larger than any they will probably choose to bear.

The ROK's record of real economic growth has been quite remarkable. Since 1965, its average real rate of expansion has been over ten percent per year, and the growth shows little sign of falling soon.* As the South Korean

*See Wall Street Journal, August 30, 1977, p. 30.

GNP per capita rises, further investment alternatives may become more restricted by increasing labor costs, but the country's economic planners have shown good judgement in maintaining high capital investment rates for new areas of industrial activity. South Korea has also diversified its export pattern which, until recently, concentrated heavily on the U.S. and Japan.* Steps also are being taken to reduce the industrial concentration around Seoul and the dependence on imported petroleum as an energy source. Capital investment for nuclear power plants as a partial solution to South Korea's energy problem utilizes both domestic and foreign credit but does not now strain the ROK's external debt capacity.**

One dividend of the ROK's successful growth policy is the opportunity to spend more heavily on defense. In 1975, ROK planners, possibly motivated by concern over the U.S. security guarantee, decided to increase defense spending from the previous level of approximately 4 percent of GNP to about 8 percent in 1977--that is, roughly $2 billion out of $25 billion GNP. If there is no further budgetary change and ROK military spending continues at the 8 percent level, it will reach $3 billion by 1982.

American military aid to the ROK has stayed in the range of $100-$200 million per year since 1970. Consequently, its size relative to the ROK's own expenditures has sharply fallen. After the U.S. 2nd Infantry Division leaves behind its equipment to the ROK army, U.S. aid may become merely symbolic or disappear entirely. Thereafter, the U.S. will have to

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* Wall Street Journal, August 30, 1977, p. 30.

**Asia 1978 Yearbook, p. 228.

exert control over ROK military acquisitions by refusing to sell equipment rather than by denying funds for it. This may be slightly more difficult politically, but will be in line with the general reduction in military sales that the Carter Administration has proposed. Increasing financial independence will thus give the ROK a greater measure of maneuverability in the ROK-U.S. security relationship. Their improving manufacturing and technical skills also will gradually enhance that leverage.* Although it is unlikely that the ROK will soon replace the U.S. with some other country as its principal source of imported weapons, the ROK already has introduced the Swiss Oerlikon antiaircraft gun into its terminal air defenses. As the DPRK presently owns a limited number of submarines and the U.S. does not presently sell submarines to foreign countries, the ROK is a potential customer of such vessels from Great Britain or other manufacturers.** The ROK might approach another country for long range missile system components that the U.S. appears unwilling to supply because of their possible utility for developing a ROK nuclear delivery vehicle.

The ROK's domestic weapons manufacturing capability will also improve. The country presently is deficient in the advanced electronic and metallurgical technologies required for development of such weapons as guided missiles, but the ability to build components possibly useful to such an effort has already been acquired. One such purchase was of a used, rocket-motor facility from

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* New York Times, October 10, 1977, p. 7.

**Note Taiwan in The Military Balance 1977-78, op. cit., with three SX-404 Midget submarines.

Lockheed in 1975.* Combinations of technology acquired from the U.S., bought from other foreign sources, and provided by Korean technical experts, may materially add to the choice of weapons the ROK might otherwise have had relying solely on supplies from the U.S.

As mentioned above, the growth in the ROK defense budget also seems significant when compared to the DPRK's military financing capabilities. For the past ten years, the DPRK has maintained a much higher level of defense spending--9 to 15 percent of GNP--than has the ROK. Now, however, the growing South Korean economic base is beginning to outweigh the effects of the DPRK's willingness to spend heavily on defense. In terms of percentage of GNP expenditure, the ROK's 1977 GNP of $25 billion gives it a substantial advantage in comparison with the DPRK's GNP base of $10 billion. The prospect that the ROK's economic growth rate will exceed that of the DPRK implies that this margin will grow. Moreover, by expending 8 percent of its national income for defense, the ROK will be investing more in absolute terms than the DPRK would by spending 20 percent.

Forecasting or even measuring the comparative growth rates of the ROK and DPRK economies is difficult. However, there are good reasons to believe that the ROK will continue to have an economic growth rate higher than that of North Korea. The ROK has first-class access to foreign markets for investment capital and for technology, whereas the DPRK is closely linked industrially to the PRC and the USSR and has damaged its relations with Western capital markets by defaulting on some terms of foreign loan repayment. A further inhibition to DPRK economic growth may come from the restrictions

*Wall Street Journal, December 18, 1975, p. 8.

imposed by high defense spending itself. The North Koreans deny themselves possible investment opportunities by spending on defense. Even if their defense investment is partially--say 50 percent--as efficient as normal capital investment, high defense spending can chill economic growth. With a defense expenditure of about 12 percent of GNP, rather than the ROK's 8 percent, the economic growth would be reduced by 2/3 of 1 percent. (Compared to South Korea's early rate of 4 percent, the growth rate differential has been 1-1/3 from this cause alone.)

Possible Soviet Threats to the ROK

A variety of influences affect possible Soviet threats to South Korean security. From 1953 to the present, the Soviet Union has pursued a generally cautious stance on the Korean question. The later Soviet leadership has given North Korea relatively low priority in terms of political and military support.* Notably, the North Koreans have not received the sophisticated military equipment that has been provided the Poles and East Germans in the Warsaw Pact and the Egyptians and Syrians in the Middle East. For example, the DPRK has not received T-62 tanks, as have Poland, Egypt, and Syria. Nor has it been given SA-3, SA-4, SA-6, SA-7, or SA-9 surface-to-air missiles or the Su-20 or MiG-23 aircraft that Poland, East Germany, Syria, and Egypt, variously, have received.**

On the other hand, those weapons the North Koreans have received are provided in quantity. The DPRK has upwards of 1000 T-54/55 tanks, more than

* Washington Post, August 9, 1977, p. 4.

**The Military Balance 1977-78.

100 MiG-21 aircraft, and thousands of artillery pieces. The general pattern of Soviet weapons distribution to the DPRK suggests it is a medium priority recipient of one-weapon-generation-old equipment retired from the European theatre or other more sensitive fronts.

The degree of Soviet military support for North Korea is influenced by DPRK and by PRC policies. The North Korean government has so implacably insisted on military preparedness against ROK-U.S. forces that it has virtually maintained the country on a war footing since the 1950s and demands substantial quantities of military hardware. Although North Korean politics are marked by an ideology of "chu'che," or self-reliance, DPRK leaders have pressed the USSR and the PRC for military capital in light of North Korean defense production limitations. The Chinese are eager to limit Soviet influence in Korea as elsewhere in Asia; they have provided the DPRK with tanks and aircraft. Because of Soviet interests in maintaining a presence in Korea, however, the DPRK has been able to play them off against the Soviets. The U.S. Arms Control and Disarmament Agency (ACDA) notes that in the 1965-1974 period the USSR provided 70 percent of North Korea's arms imports, while the PRC gave 30 percent.*

Meanwhile, the Soviets have not been active in exhorting the North Koreans to violent acts against the ROK or against American forces in Korea. Moscow's public criticism of the ROK seems restrained, taking the form of Pravda articles on poor economic conditions in South Korea and reports attributed to DPRK sources on the ROK-U.S. military buildup. Moscow's official

*World Military Expenditures and Arms Transfers, Washington, D.C.: ACDA, 1965-74, p. 74.

position appears to be that the Korean military problem is second-class and requires no immediate redress.

The realities of American, Japanese, and Chinese interests in Northeast Asia and the priorities of other Soviet foreign policy objectives weigh heavily in current Soviet restraint on Korea. The fabric of Soviet foreign policy does not, in itself, now demand strong pressure against the ROK. The USSR has undertaken no public pledge to force an advantageous Korean territorial or military solution.

American interests in protecting South Korean independence force Moscow to consider the potential impact of its Korean actions on the entire spectrum of U.S.-USSR interaction. If the Soviets perceive pressure in Korea could generate negative American reactions in Europe, on strategic arms issues, in the Middle East, Africa, or other sensitive Soviet foreign policy areas, their actions will be more judicious. The USSR may also refrain from exerting pressure at present for fear of reversing the apparent American withdrawal from Korea while the U.S. presence is still considerable. The USSR could perceive that time was on its side and wait for a deterioration in American support of the ROK (possibly followed by reduced Japanese support) to provide it with a more opportune time to institute a rapid military buildup of the DPRK and otherwise support a takeover of South Korea.

But increased Soviet support of the DPRK could also damage Soviet-Japanese relations. The Soviets value possible Japanese cooperation in industrializing the Soviet Far East. They have keenly sought Japanese assistance for building a second trans-Siberia rail line and for increasing the petroleum and natural gas production in their eastern territories. The Soviets are also

trying to work through Japan to place political pressure on the PRC and are attempting to influence the Japanese stance on certain provisions of the Japanese-PRC peace treaty currently under negotiation. If Soviet acts should be seen in Japan as destabilizing for Korea, their already uneasy relations with Japan could be worsened and one or more of these medium-term Soviet objectives jeopardized.

Potential negative Chinese reaction might also discourage the Soviets from increasing their Korean military involvement. Although Chinese high-technology military resources are limited, the PRC might offer the DPRK additional low-medium technology military support to prevent the Soviets from tipping the ratio of military aid too much. The Chinese would have a strong incentive to thwart any prospective Soviet action in Korea that would leave the USSR in a position to coerce the PRC. Although the Chinese are unlikely to be able militarily to deny the Korean theatre to Soviet forces in the foreseeable future, the PRC could have the option of competitively intervening in Korea to insure a Chinese military presence in the aftermath of any Korean crisis. The PRC might even try to form a Chinese-Japanese-American entente to persuade or otherwise prevent the Soviets from establishing hegemony over Korea. Again, the USSR might feel it best to wait if the Chinese potential to interfere appeared to be waning.

On the other hand, if some of these constraints on Soviet behavior in Korea were weakened, the USSR might be attracted to supporting the DPRK in military moves against South Korea. Preconditions might be Sino-Soviet reconciliation, the inability of the PRC to prevent closer DPRK-Soviet relations, or a substantial deterioration in American support to the ROK, possibly

followed by weakening of the Japanese-South Korean connection. The USSR then might feel a military move would increase its power potential in East Asia by giving it greater influence over China or by increasing its bargaining strength with Japan.

Given such a Soviet opportunity, the most likely form of intervention would be through heavily increased arms shipments to the DPRK to improve the quality and size of the North Koreans' weapons inventory. There is not a large technological overhang of Soviet weapons now denied the DPRK, and the Korean military balance could be readily upset by the introduction of enough new hardware. As stated earlier, candidates for transfer would be the MiG-23/27 and Su-20 fighter-attack aircraft, Mi-24 helicopter gunships, T-62 or T-72 medium tanks, mobile air defense weapons such as the SA-3, SA-4, SA-6, SA-7, SA-8, SA-9, and the ZSU-23/4 quad gun, and advanced anti-tank weapons. The Soviets would hope for political collapse in the ROK or that the DPRK would achieve principal objectives in a sudden military strike before the U.S. had a chance to react.

A higher level of Soviet involvement might follow a military engagement between the two Koreas. Relevant to such a speculation are USSR actions in the 1973 Middle East conflict, where Soviet forces continuously resupplied Arab armies, threatened to intervene to prevent the destruction of the Egyptian Third Army, and carried out extensive reconnaissance and, reportedly, limited air-air combat missions. However, the use of Soviet ground forces in Korean combat, the threat to do so in the Middle East notwithstanding, would constitute a degree of Soviet involvement much more serious than that of providing arms supplies or flying occasional sorties. Past examples of Soviet combat

troop involvement suggest that although only limited military objectives might be sought, the move would be carried out in a fashion that insured a high probability of success.* As the Soviets would probably introduce ground forces through North Korea, one might also infer from past Soviet army foreign deployments that initial presence would become semi-permanent in order to prevent Japan, China, or the U.S. from re-establishing influence over the region. The Korean peninsula's proximity to Soviet territory makes it all the more likely that a Red Army intervention would be carried out with enough force to guarantee success and that ground forces might not quickly be withdrawn after hostilities ceased.

This proximity to the USSR also suggests that a direct Soviet military action in the peninsula would include air and naval forces. Even now, the USSR's regional naval and air capabilities outclass those of any other Northeast Asian state, but the relative abilities of the United States and the USSR to project power into the Korean area may also be changing in the Soviet Union's favor. American planners project the spectre of Soviet ability to coordinate efficiently its ground forces, its Pacific Ocean surface and subsurface assets, its continental air defense, its air transport capacity, and new weapons such as the long-range naval "Backfire" bomber in simultaneous use against U.S. forces in the Western Pacific.** In such an event, the U.S. might thus be able to do little to prevent the Soviet Union from enveloping the Korean Peninsula and driving the Seventh Fleet as far away as the southeastern corner of the Philippine Sea.

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* Thomas A. Brown, and Henry S. Rowen, Topics in International Violence: Soviet Use of Force, Flexible Options, and Problems of a Nuclear Crowd, Prepared for ISA, Los Angeles: Pan Heuristics, January 15, 1977.

**Worth A. Bagley, "The Decline of U.S. Sea Power," Orbis, Summer 1977.

USSR employment of nuclear weapons in a Korean contingency is very unlikely. Its conventional forces could easily overpower the South Koreans, even if they were to possess a small nuclear arsenal, and could indeed defeat any other conventional force except, perhaps, the most determined American intervention. Such use is further inhibited by the risks of arousing U.S. or PRC escalation and the costs of damaging relations with other nations, notably Japan. Soviet employment of nuclear weapons would be justifiable only in the event the nuclear taboo had already been broken by South Korean use of nuclear weapons against the DPRK. Even under circumstances where the USSR felt compelled to use nuclear weapons as punishment and to demonstrate support for its allies, a Soviet reply is likely to be limited, i.e., a single detonation chosen for maximum political effect and followed by the renewed use of conventional forces to complete military objectives.

Possible PRC Threats to South Korea

The PRC has strong reasons not to upset the present Korean power balance. Since 1953, it has benefited significantly from Northeast Asian stability and has been able to contribute to that stability at relatively low cost. To attempt to expand its sphere of influence in this area would be expensive in the short run and would strain its ability to project power beyond its borders. However, there are limits to PRC restraint, and Chinese military action may be invited if they are crossed. The further withdrawal of American influence may make instability, resulting in Chinese military intervention, more likely.

Possibilities for increased military involvement in the Korean peninsula at the present time must look very unattractive to PRC leaders. The current security arrangement has kept the peninsula generally peaceful since 1953, and renewed violence seems unlikely for the time being. The costs of China's contribution to that stability have not been high. Competition with the USSR over influence with the DPRK has obliged the PRC to provide military aid to North Korea; but at less than $100 million annually, the level is rather low and is markedly less than what the North Vietnamese required in their protracted war in Indochina.* Although Kim-Il-Sung may in time ask the Chinese for more hardware to help offset the ROK's recent acquisitions, it is unlikely that the PRC will find it necessary to give Kim enough to start an arms race. Evidence of Chinese bargaining strength comes from the PRC's successful 1975 resistance to North Korean requests for possible military action against the South Koreans.**

On the other hand, the price to the Chinese of a Korean military engagement could be very high indeed. The ROK army already has significant potential to resist an attack, and American support could make the costs to China of fighting on a Korean front extremely high. Chinese territory might even become the target of limited American strikes. Furthermore, a major PRC troop commitment to a Korean conflict could divert assets from the guarded Soviet border, and such a period of relative weakness could invite an opportunistic Soviet military strike against China.

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* See World Military Expenditures and Arms Transfers, p. 74.

**New York Times, April 29, 1975, p. 5.

Chinese military acts in a Korean conflict could also harm China's broader foreign interests. The PRC has worked hard to get the Japanese to "tilt" toward it rather than the Soviet Union. It hopes to broaden these cordial relations through greater trade and, perhaps, to get some assistance in its own national development. Gaining a measure of U.S. trust has also been a hard-bought prize for the Chinese; future American support may help them to resist Soviet military and political pressure. The Chinese also need American cooperation in arranging a favorable solution to the Taiwan problem. Chinese opposition to Japanese and U.S. interests in a Korean conflict could isolate the PRC from important political and economic support.

Even if the Chinese could effect the replacement of the ROK government with an allied Communist regime, the act might not serve the dominant PRC foreign policy objectives and would not significantly increase Chinese power potential in East Asia. It would, at most, gain access to the Sea of Japan. Southern Korea's immediate proximity to the Japanese home islands would be militarily desirable largely in terms of outright invasion of the Japanese islands--an ambitious policy that the Chinese have not adopted for several hundred years and have never found successful.

Unlikely as the PRC is to <u>initiate</u> change in the security relationship of the Korean peninsula, it may be forced to <u>react</u> if the power balance is disturbed. A Korean buffer state protects its Manchurian border. It hopes to achieve this at minimum cost by satisfying the DPRK with military aid and preserving the Korean peace but is probably ready to act more strongly if necessary. For instance, should the ROK invade North Korea, the PRC would be expected to move in swiftly to prevent the DPRK's collapse. Experience has

demonstrated that the Chinese have been prepared to fight a costly war, even against U.S. forces, in order to preserve a buffer state on the Yalu frontier. The current Sino-Soviet enmity makes it even more important to the Chinese that they maintain North Korea's integrity, for the Soviet Union might be eager to intervene on North Korea's side in renewed Korean fighting if it felt it could thereby secure a new front on Manchuria's Yalu boundary. The prospect of having its industrial heartland thus surrounded on three sides by Soviet forces strongly encourages the PRC to keep open the option of sending in troops to help defend North Korea.

Even short of an ROK invasion of the DPRK, the PRC would be obliged to increase arms shipments and otherwise support the DPRK in renewed Korean fighting. It would be unrealistic for ROK military planners to expect that they could outrun the DPRK in military equipment as long as Soviet-Chinese competitive pressures to support North Korea exist.

Certainly, the PRC would consider ROK development of nuclear weapons as very destabilizing and be prepared to react strongly if their Northeast Asian policy objectives seemed threatened. Although the Chinese would weigh the possible negative reaction of the U.S. and Japan should the PRC strike against ROK nuclear facilities or retaliate against an ROK nuclear strike, they could readily claim superior and more immediate interests as justification for acting. First, the PRC has a treaty commitment to defend the DPRK and would feel required to honor it if the North Koreans suffered an unprovoked nuclear attack. Furthermore, the Soviets might take the opportunity to intervene in Korea if the Chinese failed to react swiftly to a South Korean nuclear provocation. They might anyway. Finally, the PRC might fear for

Chinese cities that were within reach of ROK nuclear delivery systems if the ROK leadership were believed capable of attacking the PRC. Thus, self interest suggests that the Chinese would probably be prepared to disarm or respond with a nuclear strike against the ROK if it appeared that South Korea was coming dangerously close to a nuclear weapons capability.

A continued strong American stabilizing influence in Korea reduces the burden on the Chinese of being prepared for Korean contingencies. Signs of future reduction in the U.S. presence are not completely encouraging to the Chinese. As long as the DPRK leadership retains its unpredictable and bellicose character, the Chinese may anticipate being reluctantly committed to support the North Koreans if they attack the South in a future of reduced American presence. Degradation of the American commitment may likewise reduce South Korean restraint and increase the chance that they could initiate a conflict or introduce nuclear weapons into their arsenal. The PRC may even fear that the Japanese would, militarily or politically, adjust to American withdrawals in a way that opposed Chinese foreign policy goals. Therefore, the Chinese may quietly encourage the continued presence in Korea of the U.S. forces that they fought to a standstill a generation ago.*

The Risks of Weakening the Japanese Connection

South Korea's partial dependence upon Japan for its external security has made for a somewhat artificial relationship currently shaped by influences that outweigh traditional Japanese-Korean mistrust. Although it is remotely

*This is even voiced by ROK President Park; see Time, June 30, 1975, p. 35.

possible that the current Japanese contribution to ROK security could be ended by Japanese accession to strong outside pressure--such as from the Soviet Union--the most likely source of such change is from within the U.S.-Japanese-ROK security agreement.

In a broad sense, Japanese foreign policy in East Asia, as elsewhere, is governed by the American security tie and by the Japanese balance between the USSR and the PRC. The first relationship encourages Japan to further support the ROK, and the second does not greatly interfere with Japanese-ROK relations as long as South Korea remains on a second echelon of prominence. It is possible, but unlikely, that the USSR will gain the ascendancy in Northeast Asia and, in conjunction with an American withdrawal, come to force Japan to alter its basic foreign policy ties.* There might even be a Chinese-Soviet reconciliation forcing Japan to cut its tie with the U.S. or, at least, to cease following American foreign policy leads in East Asian matters. In either case, Japan might withdraw support, and there would be little the ROK could say or do to prevent it.

A more likely alteration of Japanese-ROK relations would come from changes in the U.S. security tie to South Korea and the degree to which Japan and the ROK feel they can continue to cooperate with each other in the absence of the U.S. Presently, the U.S. guarantees Japanese security and expects Japanese cooperation on Korean security as part of the bargain. Furthermore, Japanese-ROK economic ties have been critical to ROK development, but they have also been profitable to Japanese investors and promise

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*Henry S. Rowen, "Japan and the Future Balance in Asia."

to continue to be. Japan has benefited from the last quarter-century of Korean peace and certainly should be disinclined to increase the risks of war. As long as these influences dominate, the Japanese probably will continue to do their part to support South Korea.

From the ROK itself, however, two discordant influences have arisen and may yet harm the tie to Japan. First, the ROK government has committed extraterritorial acts, such as the kidnapping of Kim Dae Jung from a Tokyo hotel, which offended the Japanese because of its scoff-law nature--and reinforced their low opinion of Koreans. The ROK pledged after the Kim Dae Jung case not to repeat such actions in Japan, but many of the political pressures that underlie the incident persist in South Korea, and there is no guarantee against similar acts in the future.

Second, the ROK is suspected of harboring nuclear ambitions, a vice to which the Japanese are uniquely sensitive. The farther the ROK develops its nuclear capability, the more volatile a domestic political issue the question of support for South Korea will become for the Japanese. Japanese politics now prevent association with nuclear weapons, even those of an ally. Not only have the Japanese maintained they will not become a nuclear power, but they insist that no American nuclear weapons be allowed on Japanese soil or even aboard U.S. Navy vessels as they call in Japanese ports.

It is even less likely that the Japanese would tolerate ROK nuclear weapons status and stick to their current degree of cooperation with the ROK. A strong Japanese reaction would almost certainly take place if an actual ROK weapons deployment were revealed. However, the earlier signals that betrayed a developing ROK weapons program might pass with relatively little

Japanese reaction as long as the ROK did not overtly move into weapons status. The Japanese might be too tolerant, then panic. The Japanese themselves have described their method of policy formation as crisis oriented.*

The sanctions open to the Japanese are easily identified and have been broached in past periods of Japanese-ROK tensions. The Japanese could take economic sanctions against the South Koreans by restricting tourism, cutting off sources of investment capital, or by restricting the importation of Korean goods. At a more serious level, the Japanese might temporarily refuse to let Americans operate from Japanese bases for the support of South Korea.

Once American military operations and the security-balance in the Western Pacific became encumbered by an ROK-Japanese dispute, the U.S. would have to act to reduce tensions. At that point the problem might be resolved, or it might be converted into a broader and more troubling re-evaluation of the U.S.-Japanese security tie itself. Thus, the ramifications of nuclear development might force that issue and the correlated one of national security beyond the control of the South Korean government leader.

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*Beverly C. and Henry S. Rowen, "Japan's Security and Its Nuclear Future," Monograph 4, in Albert Wohlstetter et al., Can We Make Nuclear Power Compatible with Limiting the Spread of Nuclear Weapons? PH 77-04-370-23, Los Angeles: Pan Heuristics, May 1977.

POSSIBLE SOUTH KOREAN NUCLEAR WEAPON PROGRAMS

In the past several years, South Korean officials have hinted that the ROK might take steps to move closer to possessing nuclear weapons. Such statements have generally been equivocal, have occurred in response to leading questions from the press, and have been couched in terms of the ROK's long-range defense planning for the next ten to twenty years.* As current evidence of the lack of South Korean nuclear ambitions, one may point to ROK ratification of the Nonproliferation Treaty as well as the responsible stance the ROK has taken in negotiations with Canada and the U.S. over its purchase of nuclear facilities.

On the other hand, the ROK's entry into the nuclear era, with the startup of its first power reactors, has been a source of considerable national pride. It is recognized that the plutonium output from this installation is a potential source of nuclear weapons material and that the facility might contribute in other ways to the progress of a nuclear weapons program.** Ostensibly as a move to bolster its nuclear fuel independence, the ROK contracted in 1975 with France to purchase a plutonium reprocessing facility. This transaction--whose expected utility to a civilian nuclear power program relative to its possible contribution to a nuclear weapons program made it seem suspect--reportedly drew sharp and and successful opposition from the U.S.*** It is evident, furthermore,

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* Christian Science Monitor, June 15, 1977, p. 3; Hanguk Ilbo, June 30, 1977, p. 1.

** Asahi Shimbun -- Haptong News Agency, June 22, 1977. E.g., "A western diplomat [in Seoul] said the Koreans had been 'impeccable' in such assurance [not to use Canadian materials in weapons]." (New York Times, February 1, 1976, p. 11.)

***New York Times, February 1, 1976, p. 11.

that such South Korean weapons systems as the F-4 aircraft and the Nike-Hercules SAM could be used to deliver a moderately sophisticated nuclear state's weapons. As noted earlier, the ROK's growing economic resources will widen the South Korean's options in further future weapons acquisition. All of these developments and their potential implications are no doubt not only being carefully scrutinized in Washington, but also in Tokyo, Peking, Moscow and, perhaps most anxiously, in Pyongyang as well.

However, the specific objectives of a possible South Korean nuclear weapons program have been left ill-defined, despite comments by ROK officials and outsiders alike. Extant semi-official ROK statements about nuclear weapons are understandably vague, filled with qualifications and lacking time-specificity. ROK officials have pointed to the current American nuclear deployment in South Korea as a desirable arrangement but have failed to distinguish between the two contributions of that force: the deterrent role and the weapons' direct military utility. The South Koreans are unable themselves to reproduce the deterrent value of American nuclear weapons--certainly not to the Chinese or Soviets and probably not to the North Koreans. In particular, they do not accede to the Gallois view that a small nation can deter a great one--their force would be specifically designed to counter an equal--or even a nation half their size. Furthermore, at least for the rest of this century, any possible South Korean nuclear capability will be well behind the contemporaneous tactical potential of American nuclear forces deployed or operating in Korea. Even the current potential of American nuclear weapons deployed in South Korea will remain far beyond the ROK's

reach for the decade of the 1980s and probably well after that.* It is a questionable--and underanalyzed--issue whether any feasible ROK nuclear program can materially enhance the ROK defense posture or threaten the DPRK with an unacceptable level of retaliatory damage.

This section will address four major areas. It will delineate the principal political, technical, and economic constraints that now stand between the ROK and nuclear weapons status. Military objectives that might be served by ROK nuclear weapons will be examined and compared with the capability of ROK conventional forces to perform the same tasks. Third, the possible form of ROK nuclear delivery systems will be described. Finally, the section will outline possible consequences to U.S. interests of ROK nuclear weapons development and use.

This analysis assumes a Northeast Asian security environment in the 1980s that is not very different from the present one. To be sure, no American troops would be present in the ROK, for it is hard to imagine the ROK developing nuclear weapons unless tangible U.S. support had shrunk. Otherwise, the principal elements of the Northeast Asian balance--the Sino-Soviet split, moderate Chinese and Soviet support of an unfriendly, militarized North Korea, and formal U.S. security ties to the ROK and to a non-nuclear Japan--are assumed to remain as they are now. The relative wealth of the ROK and DPRK is presumed to stay roughly the same as in 1978, with both states continuing to industrialize.

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*See Defense Monitor, January 1976, for a particularly detailed hypothetical description of deployed U.S. weapons in the ROK.

Also, Boston Globe, July 10, 1977, p. 19, discusses Undersecretary of State Philip Habib as go-between for U.S. President Carter and ROK President Park on retaining a token number of U.S. nuclear weapons with U.S. F-4 squadrons in the ROK.

Restraints on a Possible South Korean Nuclear Weapons Program

Three types of constraints--political, economic, and technical--currently impede South Korean movement closer to possessing nuclear weapons. Taken in isolation, the political barriers are probably the severest; the economic problems of weapons development seem least troublesome for this prospering country. In an actual ROK program these constraints would interact. For instance, in the course of political action to discourage the ROK from making nuclear weapons, the U.S. might take steps that made the ROK's nuclear option technically more difficult and hurt the ROK's economy as well.

Political Restraints

There are several types of political restraints on ROK moves towards nuclear weapons. Formal non-proliferation clauses are written into agreements that govern transfer of American and Canadian nuclear power reactor technology to South Korea.* In any future dealings with the French, a default clause to prevent unauthorized use may come to be written in sales agreements. However, France's nonproliferation restrictions relating to nuclear technology export have a shorter history than U.S. and Canadian policies, and are currently less clearly expressed. Unauthorized use of fuel or facilities by the ROK would be grounds for U.S. and Canadian cancellation of fuel supplies and nuclear technical assistance.

There may also be moves toward blanket, sovereign policies on nonproliferation by suppliers of nuclear technology. Canada has been following a policy of evaluating a proposed recipient state's entire attitude on nuclear

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*New York Times, February 1, 1976, p. 11.

proliferation before selling its technology; the lesson of the Indian nuclear explosion that was aided by the presence of Canadian facilities was a bitter pill for the Canadian authorities. Recent American moves to impose blanket rules on states receiving U.S. nuclear technology may become a significant restraining force. A recently passed bill* would impose sanctions on a recipient state's nuclear transactions with the U.S. if any part of its national nuclear facilities were used for the purpose of developing nuclear explosives. Such policies as the Canadian and the recent American one may be more comprehensive than the bilateral purchase and fuel-supply agreements with nonproliferation clauses that commonly are negotiated with foreign purchasers of nuclear facilities.

Finally, the ROK has ratified the Non-Proliferation Treaty. Its direct enforcement provisions are negligible, but it provides a public barrier, albeit vague, which would draw international attention should the ROK violate its intent. Broad attention would similarly be drawn should the ROK formally withdraw from the treaty "for supreme reasons of national interest" prior to overtly deploying or testing nuclear weapons. The NPT's international acceptance would, in either case, direct pressure upon the ROK or upon its supporters, such as the U.S. and Japan, to bring a halt to the weapons program.

In the case of the American (or at some future date, French) reactors, the South Koreans would then have to substitute their own plutonium or enriched uranium fuel to keep them operating; the Canadian "CANDU" design uses natural uranium. The technical difficulty of making each of these substitutions will

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*Wall Street Journal, February 8, 1978, p. 7.

be discussed below. Supplying countries could also severely interfere with ROK operation of nuclear reactors by withdrawing their continuing technical assistance. Nationals of the U.S., Canada, or France might ordinarily have a day-to-day role in operating the reactors. If such foreign-staffed positions were critically placed, the South Koreans, unassisted, might have problems maintaining the reactor's normal operations. A more serious ROK manpower insufficiency would arise if and when a South Korean reactor malfunctioned. However completely the South Korean technicians could perform routine duties, they probably could not diagnose malfunctions in their power reactors with confidence. The expectation of such breakdowns is high, judging from power reactor operating records in almost every other country. Even were the ROK technicians able to locate a malfunction, repairs might require replacing a massive or sophisticated component which the ROK domestic industry is not capable of producing. Another problem of autonomous reactor operation applies to the Canadian "CANDU" design which requires heavy water as its coolant fluid. Were Canada and the U.S. to shut off South Korea's heavy water supplies, the ROK would have to procure this material elsewhere. Like the problem of power reactor malfunctions, the heavy water requirement would become more serious the longer the shutoff of Western supplies became.

In their role as ROK trade partners or as parties to Northeast Asian stability, foreign countries might also find ways to demonstrate objections to ROK nuclear weapons ambitions. The combination of trade and--especially--security relations is convertible leverage. Both the U.S. and Japan now extensively trade with South Korea, and an embargo by either one could

strongly press ROK leadership to change its nuclear policies. The U.S. could not cut off trade without first abrogating its security treaties with the ROK, but pressure on discretionary components of U.S.-ROK trade might accompany American action on the nuclear technology front. The U.S. Executive Branch could readily manipulate exports of military and high-technology hardware to the ROK, restrict imports of ROK goods that are now subject to volume quotas, and cut-off U.S. ground servicing of potential ROK nuclear delivery systems, such as F-4 aircraft. Executive action on these fronts could precede more comprehensive measures taken by the Congress and the President together to further restrict trade in the face of Korean intransigence. Recent House holdup of the 1978 Korean arms-aid bill in connection with its investigation of ROK influence-buying on Capitol Hill makes threats to act strongly on the trade front more credible.

To react even more strongly by cutting the security tie to South Korea as a punitive measure in the event of ROK moves toward nuclear weapons might confirm ROK feelings of isolation and force an even greater weapons effort.

Since Japan and South Korea currently participate in no joint nuclear power programs, Japan lacks a direct channel by which it can restrain the ROK from developing nuclear weapons. It is possible that in the 1980s Japan will begin to export nuclear facilities such as power reactors and nuclear services such as uranium enrichment and plutonium reprocessing. Such an export program would be more likely to be directed toward areas considered low in military-proliferation potential, but it could help Japan lower its domestic nuclear power costs through economies of scale and experience.

However, it is rather questionable whether Japan would engage in nuclear commerce with South Korea as long as it suspects the ROK is interested in nuclear weapons. At a minimum, the Japanese would insist on clear legal restraints on unauthorized ROK use of exported Japanese nuclear fuel or facilities. The Japanese might also expect the South Koreans to submit to such practical safeguards as low inventories of nuclear fuel, rigorous site inspection and stockpile auditing, and participation of Japanese technicians in power plant operations. Unless the ROK seeks and obtains such nuclear trade with Japan and, thus, gives the Japanese nuclear technology leverage over the South Koreans, Japanese leaders may have to rely on more general tools such as diplomatic channels, trade restraint, or even pressure on U.S. forces in Japan, to inhibit ROK moves to nuclear weapons.

ROK oil imports are the only important concentration of South Korean trade, aside from its commerce with the U.S. and Japan. But use of an oil embargo to influence a South Korean nuclear weapons policy decision seems far fetched. South Korea could secure its entire oil needs from any one of several exporting states, and the South Koreans have moved to broaden their relations with Persian Gulf states by providing them with favorably priced construction services.

Technical Constraints

A series of technical challenges--although not a seriatim set of turnstyles along a single path--would confront South Korea if it tried to develop nuclear weapons. Discussed in detail below, these obstacles break into several major categories: obtaining fissile material for weapons,

designing and detonating, and completing a nuclear device and delivery system. Each of these includes some steps or aspects that could be accomplished covertly; each also includes portions that probably would be detectable by a major or regional power's intelligence system.

It is important to realize that a nation such as the ROK may prepare years in advance of the possible development of nuclear weapons. Thus, it can shorten the time between its decision to openly develop weapons and actual possession of a small nuclear force. Other studies* point out that a non-nuclear state may, without breaking the current multilateral and bilateral agreements covering nuclear technology, come within weeks or days of possessing an atomic weapon. Nor need South Korea, when it first comes to within weeks of nuclear weapons status, be compelled to immediately proceed or to abandon its efforts. Instead, its preparations might lie dormant for several years without aggravating the difficulty of the final step toward weapons. For example, the ROK might frame its bomb design around a delivery system already available in its conventional arsenal--the F-4 aircraft, for example. Design and construction of a test device or weapon might advance far--even to the point of standing ready for final insertion of the nuclear materials--before the government moved to physically isolate sizeable amounts of refined plutonium or U_{235}. Alternately, the South Koreans might accumulate large stockpiles of unrefined plutonium or U_{235} collateral to their civilian nuclear power program before acquiring the enrichment or reprocessing facilities that permit extraction of weapons-

*Albert Wohlstetter, et al., Moving Toward Life in a Nuclear Armed Crowd?

usable material. Such tasks are made easier for the South Koreans because many facilities or systems relevant to the weapons are commonplace in conventionally-armed military forces and in civilian nuclear power programs.

One clear requirement of a South Korean weapons program is a source of refined plutonium or highly enriched U_{235}. Since both materials are widely recognized as weapons ingredients, the South Koreans might not plan to hold them overtly before acknowledging nuclear weapons status. Instead, they could opt for covert possession of facilities, i.e., maintain a secret capability to quickly extract these materials from such sources as spent nuclear fuel.

In addition, fresh fuel for nuclear reactors is a possible source of U_{235}. In the Korean reactors, slightly enriched uranium (normally about three percent U_{235}) is utilized. The size of the ROK fuel stockpile determines the amount of such U_{235} available at any one time. One nuclear power reactor currently is in operation in South Korea, and two more are under construction:

Name	Net MWe	Type	Source Nation	% Completed	Comp. Date*
Ko-Ri 1	564	PWR	USA	100%	11/1977
Ko-Ri 2	605	PWR	USA	12.9*	11/1982
Wolsung 1	629	PHWR	Canada	19.1*	4/1982

*As of August 1977.

Furthermore, two more power plant contracts are currently being let for facilities the ROK government tentatively schedules for completion by 1984 or 1985.**

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* Nuclear News, August 1977, p. 77.

**Wall Street Journal, February 9, 1978, p. 11.

Light water reactors require reloading approximately once a year. In the United States it is customary to acquire this reload about 90 days ahead of need to allow time to examine fuel for any defective rods and to reorder if required. Elsewhere this lead time is doubtless longer, but economic operations would dictate keeping high-cost uranium fuel inventories to a minimum. The usual practice, however, is to keep rather large inventories. U.S. agreements specify that nothing shall be done that would interfere with efficient operation of the nuclear power plant--in other words, the United States could not prohibit South Korea from keeping one or more reloads ahead at all times. The U.S. is trying to increase confidence in fuel sources to discourage use of plutonium. The Japanese regard this as prudent policy (whether they practice it or not is uncertain).

Plutonium as a weapons material is potentially available to the ROK in spent fuel from its power reactors, from fresh MOX power reactor fuel--should its use become standard industrial practice--or from a plutonium production reactor. Spent-fuel plutonium is one source that will certainly be available to the South Koreans. Present to the extent of .6 percent to .7 percent in optimally burned-up reactor fuel (for the two principal American civilian reactor designs), a GWe-year of spent fuel, or some 30 metric tons, contains approximately 200 kg of plutonium. The size of the ROK civilian nuclear power program and the inventory turnover of spent fuel before it is exported from the country will govern the total amount of plutonium in spent fuel that might be available at any one time to the South Koreans.

Year	MWe - Installed	Plutonium in 1 Load (one year) of Spent Fuel Rods in Storage Pools (kg)	Bomb Equivalents*	Average Plutonium in Core (Bomb Equivalents)
1980	564	100	(20)	(10)
1985	1800	320	(64)	(32)
1990	3400	610	(122)	(61)

Furthermore, since plutonium is produced continuously in power-reactor fuel burnup, reactor fuel with an average one-year burning period could be expected to yield about as much plutonium as a six-month inventory of that reactor's spent fuel. (See chart above.) Since reactor shutdown and premature fuel removal are not uncommon in power plant operation, plutonium in an operating reactor potentially could become available to the South Koreans for weapons well within the 90-day notification period for abrogation of the NPT.

Another potential source of plutonium for the ROK is an unsafeguarded research reactor run as a plutonium production reactor. It has two TRIGA reactors--one 250 KWe and one 2 MWe. These are much smaller than the Israeli reactor at Dimona (26 MWe capable of producing perhaps eight kg of plutonium per year) or those of Taiwan and India (40 MWe-NRX type capable of producing 12 kg of plutonium per year), and they could make only a trivial contribution to bomb production. The TRIGA reactors are fueled with 20 percent enriched uranium; as such, they could be tapped for marginal amounts of enriched uranium in a crisis--but it is hardly likely.

Finally, if the ROK ever uses mixed-oxide (MOX) nuclear fuel, that fresh fuel could serve as a weapons-grade plutonium source. The amount of such

*For the discussion that follows, one bomb equivalent will be assumed to be 5 kilograms of fissionable plutonium or 15 kilograms of U_{235}.

plutonium available at any one time would depend on the proportion of total capacity fueled by MOX and by the length of time the fresh fuel was held in inventory. Since MOX fuel is approximately one percent plutonium, one GWe-year of fuel (about 30 metric tons) would contain some 300 kg of plutonium, enough for approximately 60 weapons. It is indeed a somewhat richer source of plutonium than spent fuel rods and probably less difficult to separate.

Year	MWe Installed	1-Year Inventory of Pu in MOX (kg)	Bomb Equivalents	3-Month Inventory of Bomb Equivalents
1980	564	170	(34)	(8)
1985	1800	540	(108)	(27)
1990	3400	1000	(200)	(50)

Separating plutonium from spent reactor fuel involves a chemical technique known as reprocessing. Commonly, reprocessing problems are simplified somewhat by allowing newly removed fuel elements to cool down for several months before the plutonium is extracted. When the shorter-lived fission products have decayed, the process of chemically separating the plutonium from the other still dangerous material can proceed. This reprocessing activity is most difficult for fuel elements that have stayed in the power reactor for economically optimum burnup periods. Rods removed prematurely from a power reactor or material from the core of a plutonium production reactor would be somewhat less difficult to reprocess. However, MOX fuel (which has presumably been produced from spent fuel rods) has already had the dangerous irradiation product removed; chemical separation presents less hazard or technological difficulties.

It is unclear whether the ROK currently is capable of building its own reprocessing facility. As of 1975, when South Korea contracted with France to purchase a reprocessing plant for the ostensible purpose of closing the fuel cycle for its forthcoming power reactors, the ROK evidently felt it could not do a good job of building a large reprocessor. However, such a plant would have been capable of extracting the plutonium from approximately 50-100 metric tons of spent fuel per year, thus producing several hundred kilograms of plutonium annually. Several years of such output devoted to weapons would be far beyond South Korea's military requirements because of limitation on delivery ability. An ROK weapons program might be adequately served by an even smaller plant producing around 50 kilograms of plutonium annually--provided the plant was allowed to run for a period of months or years in advance of anticipated refined plutonium requirements. The annual spent fuel supply for such a reprocessing plant corresponds to the turnover from a 250 MWe power reactor. Any of South Korea's present or planned power reactors are more than twice that size. Such a small reprocessing plant might resemble the Indian facility, a 100 tonne plant, used to extract plutonium from spent fuel for that nation's nuclear explosive program.

Since one GWe of power plant capacity requires an annual supply of about 30 metric tons of fuel, or about one metric ton of U_{235}, even a few months' stockpile of fuel for the current (600 MWe) South Korean nuclear reactor would contain several bomb-masses of U_{235}. As the ROK nuclear

power program grows, the U_{235} in fresh fuel stockpiles will also grow:

Year	MWe Installed	U-235 in One Reload kg	(Bomb Equivalents)	Three Months' Supply of SEU on Hand (Bomb Equivalents)
1978	564	510	(34)	(8)
1980	564	510	(34)	(8)
1985	1800	1600	(106)	(26)
1990	3400	3100	(206)	(51)

Another potential source of U_{235} is South Korea's natural uranium deposits. As of October 1977, ROK government estimates claimed approximately 3.1 million tons of confirmed uranium deposits, with an additional unconfirmed 2.5 million tons.* At the ROK's reported average assay of 0.045 percent, the confirmed figure of 3.1 million tons represents some 1400 tons of natural uranium, or some 9.7 tons of U_{235}. In turn, this is about 590 bomb-masses of fissile uranium. This quantity of uranium could supply about ten GWe-years of nuclear power plant capacity. Such a quantity of fuel would, according to the chart on page 8, represent some three years of operation at the ROK's planned nation-wide level of power plant capacity.

Uranium enrichment facilities would be necessary to raise the U_{235} from the three percent level of the LEU or the 0.7 percent level of natural uranium to the 80 percent or better normally required in a uranium fission weapon. Theoretically, the ROK could build an enrichment facility. Of the

*Haptong News Agency, October 18, 1977 (News Bulletin).

four technologies currently used commercially or under development, gaseous diffusion is probably beyond the technical and financial capability of the Koreans. Reported statements by American CIA chief Stansfield Turner indicate that, compared to a centrifuge (or perhaps laser) approach, a gaseous diffusion facility in the ROK would be easy to detect.* The newer approaches (centrifuge and laser) also seem to have advantages of smaller unit size and of lower power requirements than does gaseous diffusion. At the moment, a jet nozzle plant which South Africa reportedly has been developing and which is under development in Western Europe may be a more realistic ROK option than the still experimental laser process. However, either the centrifuge or jet nozzle approach could strain the ROK's ability to produce precision, ultra high-speed machines. The South Africans are already encountering delays in purchasing high technology materials and parts for their prototype plant. It is likely that the development of an enrichment plant would have to be entirely indigenous.

Weapons Design

Designing a nuclear weapon and its delivery system may also be a challenge for the South Koreans. At the earlier stage of a weapons program, the ROK would have to assemble a competent design team.** When enough

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* The Economist, July 23, 1977, p. 57; Washington Star, July 17, 1977, p. 12.

** Some ROK sources say such a design team can readily be assembled. (New York Times, February 1, 1976, p. 11.)

fissile material was available, the test of a device would help the further refinement of proposed weapons. Ideally, then, the tested device should be miniaturized and made sufficiently rugged for its expected mission environment. Although working within the present system of international treaties and safeguards, the ROK might have a lead time of several years before it would be forced to make its program public. The design stage of a weapons program would nevertheless be difficult and further complicated by requirements for secrecy.

Although the ROK is an efficiently-governed nation industrializing rapidly, it may be deficient in manpower relevant to nuclear weapons design. Only a limited number of the 1000 "atomic energy experts" at the ROK's nuclear power reactors and the scientists at its research reactor have the background in nuclear engineering to assist in development of an atomic weapon (some 56 have doctorates in nuclear science or related fields).*

For international reasons, South Korean officials may find that testing a nuclear device is unwise. Consequently, an ROK nuclear weapons program may be hindered. Proceeding from scratch to a bomb or warhead, the most efficient means for South Korean scientists to conduct a weapons program would involve one or a series of nuclear explosions, particularly if South Korea's goal is to produce a lightweight and compact weapon. The miniaturization process would doubtless require major design modifications from an initial, bulky, explosive device. Although miniaturizing a weapon may still be possible without testing (as may be the case for possible Israeli efforts),

*Korean Times, June 27, 1975.

the project would require more highly skilled manpower inputs--in computer simulation, for example--to compensate. Perceived political constraints on testing might also influence the South Koreans to guide their weapons development program in ways that lessened the engineering demands and the uncertainty of the nuclear weapons program, such as choice of fissile material and delivery system payload constraint.

An alternative to development of an atomic weapon in the ROK is acquiring one already assembled. Such a possibility seems unlikely. The atomic weapons closest at hand to the ROK military are the ones deployed by U.S. Army and USAF units in South Korea. It can be assumed that these are neither easy to abscond nor to activate and use. Furthermore, the U.S. has such strong reasons to prevent the unauthorized appropriation and use of its atomic weapons--in the ROK or anywhere else--that it probably would intervene immediately to prevent ROK use of any such weapon.

Economic Constraints

The incremental economic cost of an ROK nuclear weapons program--barring unfavorable foreign intercession--probably would be relatively small. The South Korean GNP, now $25 billion per annum, has been growing at better than eight percent annually in real terms and is expected to continue doing so well into the 1980s. At the current level of seven to eight percent of GNP, ROK military spending will soon reach $2 billion per year, if it has not already done so. The additional several hundred million dollars annually of capital investment in the ROK civilian nuclear power program also contributes to the base for a nuclear weapons capability. In 1975, the ROK was

prepared to purchase a $100 million-plus French plutonium reprocessing facility. This would hardly have made the ROK power reactor program more economical but would have simplified diverting plutonium for weapons use. It thus appears that the ROK is able--and perhaps consciously willing--to spend several hundred million dollars spread over several years to move closer to nuclear weapons status.

A nuclear weapons program cost must be considered incremental. A weapons delivery system, in particular, may already be a sunk cost if it is drawn from the current ROK arsenal. If it is a new weapon, it may be justified as an addition to ROK forces because of its utility as a conventional system alone. Correspondingly, the civilian power program may someday provide special weapons materials at little extra cost. Thus, the most relevant expenses for an ROK weapons program are the price for special nuclear materials refinement facilities and for weapon design and production. Although the costs of such items may only be estimated, a simple example follows for a plutonium reprocessing facility [facility cost is assumed to be proportional to (plant capacity)$^{0.7}$]:

Plant Type	Annual Capacity Spent Fuel: T/Year	Cost
Commercial	100 Tons	$200 Million
Weapons	7 Tons	$30 Million

Similarly, the cost of a uranium enrichment facility producing weapons quantities of highly enriched uranium might be in the tens of millions of dollars, although a commercial facility might run to the hundreds of millions or even more.

An aggregate estimate for the incremental cost of one possible ROK nuclear weapons program is $500 million, spread over several years. A breakdown might be as follows:

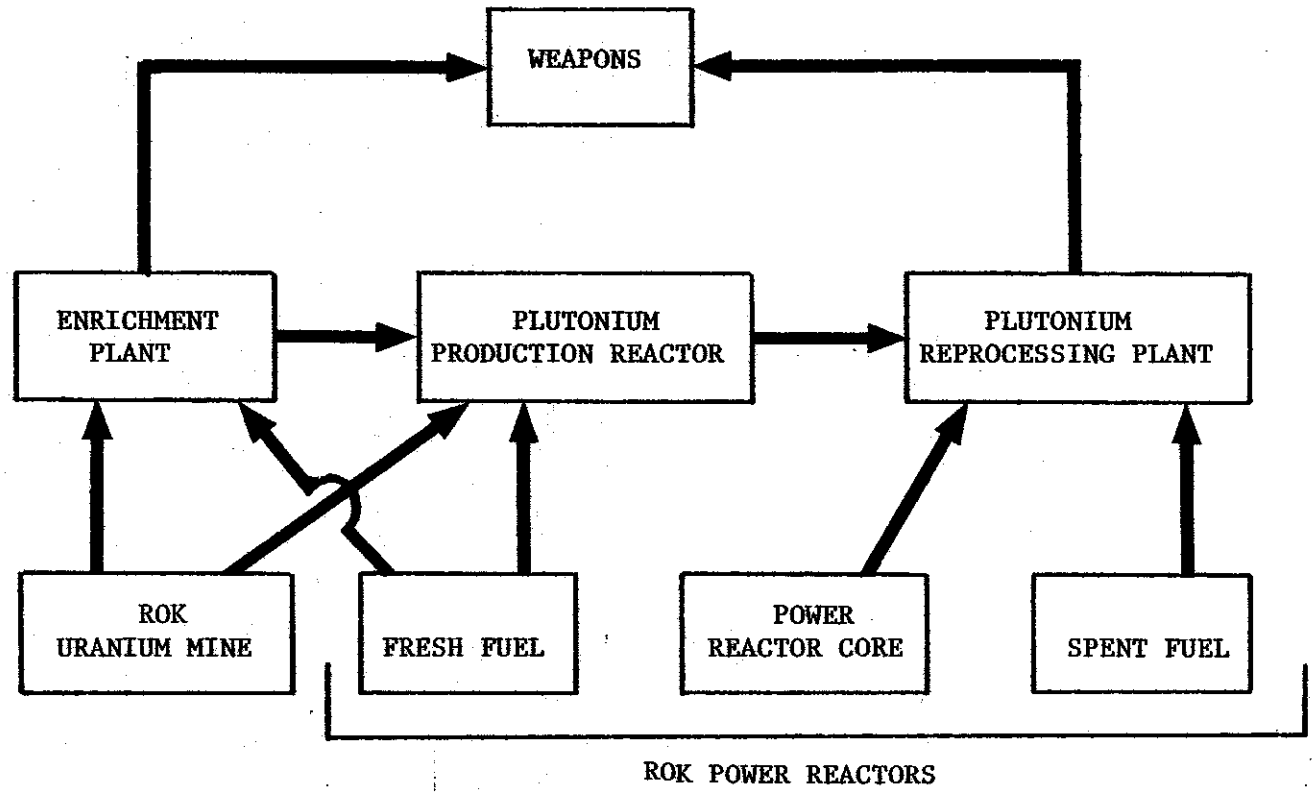
Reprocessing facility	$ 50 million
Enrichment plant	100 million
Uranium mining	100 million
Small production reactor	100 million
Weapons design	100 million
10 devices @ $5 million	50 million
	$500 million

It is noteworthy that India's reported costs for its nuclear explosives program have been considerably lower than the above figures, which contain redundant facilities to provide several semi-independent paths to a bomb. Spread over five years, the annual cost of the above program would be $100 million and would not strain the South Korean government's budget.*

In closing the discussion on barriers to an ROK nuclear weapons program, it is important to bring out some of the strategies the ROK may wish to pursue. First, the South Koreans might try to diversify their path to nuclear weapons by ensuring multiple sources of weapons material. Doing so may reduce the system's vulnerability to a technical hangup or cost overrun in a single facility. A redundant path to nuclear weapons may also make external political intercession less likely to succeed and might even discourage it. Furthermore, the ROK reportedly is conducting research on fuel fabrication. Should the ROK come to partially supply its own fuel elements

*The Australians, with a slightly larger over-all military budget and no civilian nuclear power base, have estimated that more than twice this amount might be required for a fully deployed weapons system. See Volume III, p. III-120

POSSIBLE FORM OF A MULTI-PATH ROK NUCLEAR WEAPONS MATERIAL SOURCE



(perhaps using American-enriched uranium), the opportunities to camouflage premature refueling during "unscheduled" plant shutdowns for repairs would be enhanced. The fuel could then be diverted to a reprocessing plant. The more facilities the South Koreans have available to them, the more opportunities they may have to use one facility to cover for the use of another in a weapons program.

A Future ROK Nuclear Force: Employment and Delivery Systems

Should South Korea develop a small nuclear force capable of delivering up to several dozen weapons, what would its mission be? Given the ROK's conventional warfighting capabilities, where would nuclear weapons add the most strength? This section discusses several ROK nuclear weapons employment opportunities and contrasts the effectiveness of conventional weapons to perform the same tasks. The Military Balance 1977-78 has been used as the standard Korean order-of-battle reference in the following discussion.

Use of Nuclear Weapons to Blunt a North Korean Advance on Seoul

Although present South Korean ground forces are structured to handle a North Korean armored drive across the DMZ to Seoul, the ROK may wish to add a measure of surety to the crucial mission of preventing Seoul's occupation. The South Koreans would have six to ten divisions in the Seoul district, with perhaps 500 tanks and several hundred TOW launchers. It could call upon several squadrons of F-5, F-4 and a squadron of A-10. In what fashion could nuclear weapons be used to augment these forces?

Possibly the most obvious nuclear weapons application is to attack North Korean forces as they make their way down narrow corridors of valley toward Seoul. Although these invasion passages are constricted and give the advantage to the defending forces, it is conceivable that a rapid attack by the North Koreans, combined with an air strike to steal temporary air superiority from the South, would be able to overwhelm defenses. In such a North Korean assault, success would dictate a high density of combat units along the corridors, a high rate of advance, and also high vulnerability to nuclear attack.

Taking a typical corridor (one of perhaps three the DPRK might use to advance toward Seoul), DPRK forces would have to proceed along a constricted valley extending at least 30 kilometers from the DMZ to the outskirts of Seoul. The corridor would average less than 1-1/2 kilometers in width, narrowing in places to as little as a half a kilometer between steep valley sides. Assuming a DPRK force density of one division per 20 kilometers^2, and that the 30-kilometer corridor had an area of at most 45 km^2, 2-1/4 divisions of DPRK forces would be in the corridor at any one time. With a rapid rate of advance against opposition, such as ten km/day, the troops could clear the corridor at the rate of 3/4 division/day, faster than the ROK might be able to bring reinforcements from the South to defend Seoul. The ROK's most urgent requirement would be to slow the divisions' rate of advance, to attrit them as much as possible, and to increase the effectiveness of conventional means of destroying the enemy. Three methods are indicated: (1)

1. Cut off the advance of the division: Nuclear weapons have never been used on the battlefield. No one knows the psychological effect on

slow down NK advance - uncertain effect

soldiers of having a nuclear weapon go off in adjacent ranks, not to mention that of seeing a nuclear explosion ahead in a valley into which there are orders to march. If the explosion is "dirty" (and it can be so arranged by controlling the height of burst), the contaminated ground can be made unsafe to cross for a period of days. A further question then might be, would DPRK troops be ordered to cross, and would or could they cross this contaminated ground? A crossing could be made as little as a few hours after the explosion, in which case a sick but still temporarily effective force would be able to advance and engage in combat after a short delay. Alternately, a period of days might pass before DPRK troops could cross through the barrier of radiation and debris, but such a delay would effectively give the initiative back to the ROK.

2. Destroy parts of the enemy force in the corridor: An assumption of the following effective radii against exposed troops for three sizes of nuclear weapons yields (in the right-hand column) the expected fraction of DPRK division destroyed per nuclear weapon correctly targeted.

Weapon Size	Effective Radius	Lethal Area	# Divisions (1.5 km Corridor)
10 KT	1.27 km	5.1 km^2	.19
20 KT	1.7 km	9.4 km^2	.26
40 KT	2.0 km	12.0 km^2	.29

The blast radii cited above are large compared to the corridor half-width. When the corridor narrows to a half kilometer wide, the casualties would be one-third of the above figures, assuming that the troops were no more densely packed. To saturate the 30 km corridor with adjacent nuclear blasts would

require twelve 10-KT or eight 40-KT devices; each combination would destroy all the troops in the corridor.

In comparison, the amount of bombing or shelling with conventional weapons to achieve the same destruction as would be created by each of three sizes of nuclear weapons and, alternatively, to devastate 20 km^2 are given below. (Generous weapon sizes of 2000 lb. bombs and 155-mm artillery shells are used in this illustration.)

Equivalent Conventional Weapons

Nuclear weapon in 1.5 km wide corridor	2000 lb. (1 ton) bomb Pk = 50%*	(MAE=2000 m^2) Pk = 90%**	Artillery shell Pk = 50%	(MAE=100 m^2) Pk = 90%
10 KT	1300	4,400	26,000	88,000
20 KT	1700	5,500	33,000	110,000
40 KT	2100	6,900	42,000	140,000
20 km^2	6900	23,000	140,000	460,000

Thus, in order to deliver enough 2000 lb. ordnance to cause 50 percent casualties* over the area destroyed by a 20 KT weapon in a 1.5 km wide corridor, 1700 bombs would have to be used--in other words, 425 F-4 sorties. A 90 percent attrition over the bombarded area, more closely approximating the military effect of the nuclear weapon, would require 5500 weapons of the 1-ton class, or 1375 F-4 sorties at four tons/sortie. Fifty percent attrition with artillery shells would require 33,000 rounds, enough to occupy 70 guns firing at 20 rounds/hour for 24 hours.*** Ninety percent attrition would require 110,000 rounds.

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* A damage level large enough to cause the unit to be taken out of action under most conditions.

** More closely approximates the military effects of a nuclear weapon.

***The ROK currently has 2000 guns of 105, 155, 175, and 205 mm size. (Military Balance 1977-78, p. 61.)

Should ROK forces use cluster munitions as an area weapon, the effectiveness of conventional artillery or air attack would be greatly increased. In a recent survey, Cecil Hudson and Peter Haas indicate, for example, that the lethal area of a 2000-lb cluster weapon may be approximately four times that of a general-purpose bomb of the same weight, or some 8000 m^2 per weapon compared to slightly over 2000 m^2 per standard bomb.*

It thus appears that artillery bombardment--provided the assets are close at hand--is a satisfactory alternative to the use of nuclear weapons to destroy DPRK infantry. True, the ROK would have to move a large volume of ammunition to the artillery pieces; but when adequately supplied, the 2000 large ROK guns have a daily firing potential approximately equal to thirty 40 KT weapons and perhaps several times that number if cluster munitions are used.

Conventional air bombardment, although it has greater tactical flexibility than artillery fire, appears less attractive as a "substitute" for nuclear weapons to destroy infantry. Even flying multiple sorties and using cluster munitions, the entire ROK air force could deliver only on the order of one 40 KT weapon of destructive potential every several days. Obviously, the ROK should allocate its attack aircraft to high-value targets such as tanks and depots rather than infantry, even in the confines of the corridors north of Seoul.

Although DPRK troops in tanks would be outnumbered by their infantry colleagues, the armor force is an important part of the hypothetical DPRK

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*Cecil I. Hudson, Jr., and Peter H. Haas, "New Technologies: The Prospects," in Beyond Nuclear Deterrence, ed. Johan J. Holst and Uwe Nerlich, New York: Crane, Russak & Company, 1977, p. 132.

invasion army. Because the tank armor offers considerable blast and shrapnel protection but is poorer against radiation (high-energy neutrons), the case of effectiveness against tanks should be taken separately. Assuming 300 tanks per DPRK armored division, or 15 tanks/km^2 at the assumed division concentration, and assuming that the effective radius of the nuclear weapons for crews in tanks is one-half that for exposed personnel, the expected kills while the tanks are restricted to the 1.5 km corridor are as follows:

To Kill (i.e. crews killed or disabled)	Single Weapon Requires	With Lethal -OR- Radius	# Laser-Guided Conventional (one-ton) Bombs		Delivered in # A-10 Sorties	
			# bombs (SSPK=.5)	w/ reliability of (SSPK=.9)	6 kills/ sortie	3 kills/ sortie
19 tanks	10 KT	.6 km	38	21	3	6
30 tanks	20 KT	.9 km	60	34	5	10
47 tanks	40 KT	1.0 km	94	52	8	16

With specialized assets for killing high-value targets such as tanks, the ROK air force, using conventional weapons, can fare well without having to resort to nuclear weapons. A squadron of general-purpose attack aircraft such as F-4 or F-5, armed with laser-guided bombs or special-purpose tank-killers such as the A-10 could, in a day's work, match the tank-killing potential of a single nuclear weapon if all the targets were in a confined area. It would be superior to the nuclear weapon if the targets were distributed in an area larger than the effective area of the nuclear weapon.

3. Cut off forces for convenient destruction by others: It may be possible to use nuclear weapons to cut off the vanguard of a force attacking through a corridor and then engage it with conventional forces incapable of

resisting the undivided DPRK column but capable of handling an isolated segment. In such a situation, a division of emplaced ROK troops or a large TOW nest that would be overwhelmed by an uninterrupted DPRK advance could attrite a large North Korean advance unit if the following troops were detained by a nuclear blast.

Attacking DPRK Forces in Rear/Assembly Areas

Utility of ROK nuclear weapons against North Korean assets not directly engaged in the invasion will be decreased, as the DPRK forces would be less inclined to concentrate them in dangerously exposed formation, except in battle. A division might well bivouac over an area of 100 square kilometers, so the percentage of destruction from a single well-delivered ROK nuclear weapon might be as follows:

ROK Nuclear Weapon		Percent Casualty in DPRK Division Bivouac Area	
Yield	Area km^2	50 km^2	100 km^2
10 KT	5.1	10	5
20 KT	9.4	19	9
40 KT	12.0	24	12

Against such targets as rail intersections or port areas, one well-delivered ROK device in the 10-40 KT class would be expected to put one North Korean facility out of commission for several weeks. There are three major rail centers in the southern part of the DPRK: Pyongsan, the only rail connection from Kaesong to the northern part of the DPRK, and Sepo and Sariwon, which connect Pyongsan to Wonsan and Pyongyang, respectively. Destroying these three rail centers, plus Kaesong, would severely limit rail transportation along all of the southern boundary of the DPRK.

Logistics dumps and other support targets are harder to enumerate, but it may be assumed that North Korean support facilities presently are dispersed so that a single nuclear blast at each of several types of facilities would not greatly disrupt North Korean reinforcement and logistics capabilities. Likewise, ROK planners would be optimistic if they estimated that they could destroy one North Korean division in the rear areas with less than four to twenty nuclear weapons, as indicated in the table above--and the North Koreans have more than twenty army divisions.

Although area bombing with conventional weapons would be a relatively inefficient way for the ROK to attack rear/assembly areas of DPRK forces, precision-guided munitions (PGMs) could be an adequate means of carrying out such an attack without resorting to nuclear weapons. The relative utility of nuclear weapons and PGMs would vary from case to case in these attacks, depending on whether the target was a rail facility, a warehouse, a bridge, or some other DPRK asset. In general, ROK use of nuclear weapons on North Korean territory--not as a direct defense of Seoul in the invasion corridors south of the DMZ--would be especially likely to attract intervention by the USSR or China.

Attack on North Korean Airfields

Although available maps do not clearly indicate the number and location of North Korean airfields suitable for basing modern fighter aircraft, one report states* that there are 14 DPRK military airfields with bombers stationed in the northern bases, MiG 21s in the middle fields, and short range aircraft

*Area Handbook for North Korea, 1976, p. 323.

near the DMZ. Generally, these airfields are well-equipped with aircraft shelters and underground control facilities. If the critical factor for a successful attack on a DPRK airfield is judged to be aircraft destruction, an attack geared to destroying aircraft in shelters must be carried out. Unlike the case of nuclear weapons against ground forces, wherein damage is imputed in an area fashion, dispersed groups of hardened aircraft shelters must be considered point targets. Thus, the delivery error of the nuclear weapon becomes significant. Without further information on DPRK airfield layout, the development of attacks on air bases used in the Taiwan section of Volume III can be used (see page III-51 and Appendix C, Table C-4). In that case, five nuclear warheads of the 40 KT class delivered with a half-kilometer accuracy (presumably by aircraft) and 80 percent delivery probability would be required for a 90 percent probability of destroying a single 50 psi hardness aircraft hangarette cluster. If no retargeting capability were available to the South Koreans, to attack 10 such hangarette clusters (2 each in 5 airfields) in this fashion would require 50 nuclear weapons. Some strike-look-strike capability might reduce this requirement somewhat. In the case of less accurate delivery (2 kilometer accuracy, as by missile), 65 weapons would be required for each hangarette cluster to give the same 90 percent kill probability. The low delivery accuracy case can easily be dismissed as impractical when the target is hardened aircraft shelters. However, it is also an exacting requirement for the ROK to attempt to wipe out most of the five to ten North Korean air fields by air strike. Several dozen aircraft would be required, each with nuclear weapons, to fly deep into North Korean air space in what probably would have to be a single well-coordinated strike.

An attack with conventional weapons against North Korean airfields, even with PGMs, might require an even greater commitment of ROK air force assets than would the above nuclear strike. Because of DPRK hangar hardening, PGMs rather than unguided conventional bombs would be required to efficiently attack targets such as individual hangarettes and the entrances to underground aircraft shelters.

Attack on a DPRK Population Center

Since North Korea's capital, Pyongyang, is also its most populous city, it is not clear whether an "attack on Pyongyang" in the minds of ROK military planners would mainly be a blow at the Communist leadership of North Korea or at their greatest population center. The distinction seems less important when a possible ROK nuclear strike on Pyongyang is considered in retaliation for loss of Seoul, which is both the South's capital and its largest city. The South is unlikely to use nuclear weapons against a city like Pyongyang, except in retaliation for a severe military setback such as the sudden destruction or capture of Seoul.

Available information on North Korean city populations and population densities is poor. The following tables present estimated casualties for nuclear attacks with single weapons on the six largest North Korean cities. Simplistic assumptions have been made on their population distribution: their overall density is alternately placed at 10,000/km^2 and 5,000/km^2; a power-curve density distribution with a parameter of 1.416 is applied for population density (for explanation, see Appendix A).

City name	Population	Density estimate: 10,000/km^2			Density estimate: 5,000/km^2		
		10 KT	20 KT	40 KT	10 KT	20 KT	40 KT
Pyongyang	840,000	120,000	160,000	220,000	71,000	97,000	140,000
Hamhung	480,000	98,000	140,000	190,000	60,000	83,000	120,000
Chongjin	310,000	86,000	120,000	170,000	53,000	72,000	100,000
Kimchaek	270,000	83,000	110,000	160,000	51,000	69,000	98,000
Wonsan	220,000	78,000	110,000	150,000	48,000	65,000	92,000
Sinuiju	170,000	72,000	99,000	140,000	44,000	61,000	85,000
	2,280,000	540,000	740,000	1,030,000	330,000	450,000	640,000

Source:

Estimated casualties from use of a single weapon against each of these cities (six weapons total) range from 330,000 - 540,000 if ten KT devices are used, to 640,000 - 1,000,000 if 40 KT weapons are used--at most, seven percent of the total North Korean population of approximately 16 million. If the attacks were made while the North was on an alert footing, which is quite possible, some of the civilian population would be dispersed to underground shelters and to suburban or countryside areas, and civilian casualties would be considerably lower. It is important to note, however, that even these higher estimates of North Korean losses in a nuclear attack are lower, both relative to total population and absolute numbers, than the loss to the South Korean society if Seoul were to fall permanently to the North, or if it were to be destroyed by some outside power (in retaliation for aggressive use of nuclear weapons on the part of the ROK).

Like the problem of destroying enemy infantry with conventional air power, the task of using aircraft with conventional bombs to duplicate the area-weapon effect of nuclear weapons on cities is well beyond the ROK's convenient reach. Reducing a city like Pyongyang with artillery would be more feasible than conventional air strikes provided that such a ground force could

penetrate the 20-odd North Korean divisions that would oppose such an invasion. It is thus for threatening North Korean cities that a hypothetical ROK nuclear capability would have one of the clearest "advantages" compared to South Korea's conventional military options.

Delivery System Options for an ROK Nuclear Force

General considerations relevant to a nation's nuclear force posture are the resources available and spent, the maturity of effort, and the missions contemplated. The missions have been discussed above, and weapon development details will be alluded to in this section before being developed later. Possible ROK delivery systems can be grouped into five categories:

Atomic Demolition Munitions (ADMs). These devices, basically pre-implanted atomic bombs, could be used as "atomic mines" to crater restricted areas, to block them by landslide, to contaminate territory, or to destroy enemy forces with a combination of blast and radiation. The invasion corridors to Seoul are the optimal locations for their use. Capability to build such weapons would be achieved at the earliest point of a weapons development program. An ADM would differ from a test device (or a PNE) only in that it would have to be kept operable throughout long periods (perhaps months) of lying inert. There would be no weight or size limitations in packaging the device. Although limited to ground-burst application, ADMs can be roughly tailored for cratering, released radiation, and fallout effects by choosing the ADM's burial depth and the composition of its housing.

Air-Delivered Bombs. The most promising nuclear delivery aircraft the ROK now possesses is the American-made F-4, whose range, speed and maneuverability, and payload are sufficient for carrying a moderately heavy--2000-4000 pound--nuclear weapon on a strike deep into North Korean territory. The South Koreans would have to produce a bomb design dimensionally small enough to fit under the wing of the F-4; a device as crude as the American "Fat Man" plutonium weapon of 1945 would not do. The most notable shortcoming of the F-4 and of other South Korean aircraft is the lack of electronic countermeasures (ECM) and electronic counter-countermeasures (ECCM) to increase penetration against the North Koreans' substantial SAM defenses.

Other South Korean aircraft appear less suitable for nuclear strike missions than the F-4. A commercial jet aircraft could be modified for such a purpose, but its survival chances in a hostile air environment--considering its large physical and radar cross-section, its lack of maneuverability, and its vulnerability to attack in the air and on the ground--would be markedly less than the F-4's. The F-5 interceptor, which the ROK possesses in quantity, has a much smaller payload than the F-4. A disadvantage common to all U.S.-supplied military aircraft and, potentially, to U.S.-made commercial jets, is that these planes are subject to a cutoff of American service and spare parts supplies should the ROK be suspected of modifying them for a nuclear weapons delivery mission.

Short-Range Surface-To-Surface Missiles (Ballistic). Considerable miniaturization would be needed before nuclear weapons could be delivered in surface-to-surface missiles against battlefield targets. Furthermore,

the missile would need a CEP small in comparison to the weapon's lethal radius (on the order of a kilometer or less). With an available warhead, a modern version of the Honest John battlefield rocket which the South Koreans have in their inventory, could be used to deliver an atomic weapon against a target up to 20-30 kilometers distant. Such missiles would form a less vulnerable system than an air-delivered one. (See this discussion in the Taiwan section, Volume III, and Appendix C.) Designing the missile itself should be within South Korean capability (the ROK purchased a rocket motor factory from Lockheed in 1975),* and it would cost less than the nuclear portion of the weapons program.

Long-Range Ballistic Missiles. For reaching deep North Korean targets such as Pyongyang or North Korean airfields, a missile with a range of more than 200 km is required. One possibility is the Nike-Hercules missile, already present in South Korean hands. To be used for nuclear weapon delivery against Pyongyang, however, this venerable missile would have to be boosted or re-engined. Furthermore, the atomic warhead would have to be miniaturized to 500-1000 pound and be packaged to fit within the Nike nose cone or some redesign of it.

Heavy Cruise Missile. A more remote delivery system possibility, but one that the ROK might realize before 1990, is a heavy aerodynamic or cruise missile. Most of the cruise missiles currently being deployed in military forces worldwide, including the U.S.-made Harpoon in the ROK navy, are too small to carry an unsophisticated nuclear warhead. This does not eliminate

*Wall Street Journal, December 18, 1975, p. 8.

use of the cruise missile concept, however. The South Koreans could employ larger jet engines and other components to make a vehicle weighing several thousand pounds and carrying a 2000 lb. warhead. Moreover, the possible economics of using such a weapon to deliver cluster munitions as a substitute for longer-range artillery might provide cover for the development of a potential nuclear weapons delivery vehicle. The great range flexibility of a cruise missile, as opposed to ballistic or other non-aerodynamic missiles, offers the ROK the opportunity to develop a single vehicle which can be a short-range conventional weapon or a long-range (up to several hundred kilometers) nuclear delivery vehicle. Perhaps the single most significant ROK shortcoming in developing the cruise missile as a long-range delivery system is the absence of technical expertise in precision in-flight and terminal guidance.

Possible Impacts of ROK Weapons Programs on U.S. Interests in Northeast Asia

Alarm Japan. The U.S., as the military guarantor of both Japan and South Korea, is vulnerable to being caught between these nations' conflicting priorities and occasional flashes of hostility. Perhaps no other issue is as likely to inflame U.S.-Japanese-ROK relations as South Korean development of nuclear weapons. Because the Japanese attitude toward the ROK generally is that of a superior--culturally, economically, and politically--ROK development of nuclear weapons, or blatant moves closer to that state, would be interpreted in Tokyo as a serious inversion of the proper relationship between the two countries. It is very likely that Japan would suspend acts of "benevolence" to the ROK, should the latter actually reveal nuclear weapons capability.

Moreover, the Japanese government might well hold the U.S. partly to blame for "allowing" the ROK to go nuclear. Since such a letdown of Japan by the U.S. would seem to conflict with the American security guarantee of Japan, realignment of the U.S.-Japanese military arrangement might follow, especially in terms of American military support of South Korea from Japanese soil. Extreme Japanese reactions such as developing their own nuclear weapons or completely severing the U.S.-Japanese security treaty are unlikely. However, unless the ROK nuclear deployment seemed hostile to Japan, the Japanese probably would act with increased independence from the United States. In part, the Japanese might move to diversify their weapons procurement and seek political arrangements to reduce their dependence on U.S. military deployments in the Western Pacific. They could become less amenable to special American constraints on their domestic nuclear power program.

Alarm North Korea. It would be difficult to convince the North Koreans that any South Korean development of nuclear weapons did not constitute an imminent threat to Pyongyang, to their other major cities and to DPRK forces. The relative ease of use and utility of ROK nuclear weapons for anti-city rather than for battlefield missions would reinforce that concern. If DPRK military planners had concluded that ROK conventional forces were strong enough to defeat a North Korean attack, they would be even more inclined to see an ROK nuclear force or capability as a threat to their cities.

For 20 years the North Koreans have made heavy use of their propaganda and clandestine resources. These tools might not yield any relief from the

nuclear threat from the ROK, except to exploit the ill-will that the ROK would generate with a nuclear program and to bring political pressure on Seoul. However, North Korea might be able to make practical military preparations for war with a nuclear-armed South Korea, enlisting substantial support from the Soviet Union or China.

The most obvious move would be to assemble a strike force capable of attacking South Korean nuclear facilities and depots. To attain the strike posture necessary to do so, both active and passive defenses would have to be reinforced. This might be accomplished by increasing and modernizing the whole air force, installing more--and more sophisticated--SAMs, and accelerating current programs of decentralizing and hardening military, industrial, and civilian facilities.

Collateral to such general improvement in DPRK war-fighting capabilities might be an increase in DPRK belligerence. If the North Koreans were satisfied that the Chinese or, especially, the USSR, would retaliate to an ROK nuclear strike on DPRK cities, they might behave more recklessly despite ROK nuclear capability. More probably, they would anticipate a sharp reduction in American and Japanese support of the ROK. If they then could be assured of Soviet support for a massive military build-up in an attempt to defuse the ROK nuclear weapons capability, they might easily tip the conventional military balance in their favor and trust the great powers and world opinion to successfully prevent ROK use of nuclear weapons.

On the other hand, North Korea might develop its own nuclear weapons. The political and technical difficulty of such a move has been discussed earlier, and a non-nuclear military buildup is more likely.

Soviet and Chinese Responses. The probability is nearly one that both the USSR and the PRC would target ROK military facilities and, perhaps, South Korean cities should the ROK reveal a nuclear weapons program. Their primary purpose might be to deter the South Koreans from a nuclear attack on the DPRK, but such action could readily be justified as protecting Chinese and Soviet territories within range of South Korea. The moves probably would preclude any but a suicidal ROK attack on North Korean cities. Even a single Soviet or Chinese nuclear weapon targeted against Seoul could cause very high casualties, both in absolute terms and compared to the likely result of an ROK population attack on important North Korean cities. Moreover, the danger would be greater than in the case of a hypothetical North Korean nuclear attack, for both the Chinese and the Soviets would be in a position to use more and larger weapons. Calculations as described in Appendix A give estimated casualties in Seoul for a single accurate weapon of various yields.

Weapon Yield (KT)	Estimated Casualties*
10	320,000
20	480,000
40	710,000
1000	3,600,000

Development of a targeting strategy by the Soviets or Chinese that would be an effective deterrent against defensive or other battlefield use of atomic weapons by the ROK in the case of a North Korean invasion would probably depend on the circumstances of the battle and on the residual value of the U.S.-South Korean security guarantee. It is unlikely that the Soviet

*Assuming population has not dispersed.

Union would strike ROK cities in response to ROK use of nuclear weapons to stop invading North Korean forces, but the Soviets probably would make some response. One possibility is that--after having made a peacetime declaration that Korea was a nuclear free zone and subsequently condemned the ROK for violating this status--the Soviets would prepare a conventional strike on ROK nuclear facilities, to be unleashed either immediately after first ROK battlefield use of nuclear weapons or in anticipation of their imminent use. Such an act might well be militarily adequate for North Korean needs, and at the same time be acceptable to the Japanese. It could, with suitable USSR posturing, be carried out without inviting an effective American response.

The PRC might be caught in a dilemma. To back the Soviet move would be a step toward acknowledging Soviet hegemony in Northeast Asia. To offer even moral support to the South Koreans would acknowledge the legitimacy of "two Koreas" and be at complete odds with its own "one China" policy. However, if the PRC were to initiate the conventional strike against the ROK, the Soviets could more easily do nothing. Indeed, the Soviets might be able to turn any ROK nuclear weapons program to their clear advantage in the Northeast Asian power balance. The USSR could reinforce the North Korean conventional capability and could use its own nuclear and conventional assets to restrain the growth of a South Korean nuclear force. Should a Korean war break out--and the USSR might relax its restraining influence in that regard--the DPRK and the Soviet Union could act in coordination to neutralize the ROK nuclear force, fend off the United States under the guise of intervening to protect the DPRK from a nuclear threat, and then proceed to secure military objectives (possibly limited) against the South.

On the other hand, the current security balance in Northeast Asia would better suit the Chinese, who would prefer to have the U.S. maintain some influence over South Korea and over Japan. Futhermore, should the Japanese people not react emotionally to South Korean development of nuclear weapons, the government would be in a position to act cooperatively with the United States to preserve Japanese foreign policy flexibility. As a result of continued Japanese involvement, the Soviet Union would have less leeway to influence Korean affairs.

Possible U.S. Responses to These Shifts

In general, the power shifts that could follow ROK development of nuclear weapons might have a significant effect on the stability of Northeast Asia. Because South Korea would become an even more inviting target for combined Soviet--DPRK military and political pressure, the United States could no longer maintain an arms-length relation with events in Northeast Asia--the posture it is presently adopting. The U.S. would be impelled into active intervention or formal withdrawal. The ROK nuclear weapons capability, a possible deterrent against the DPRK alone, loses much of its effectiveness if Chinese support of the DPRK is considered. It becomes an absolute liability if the USSR supports North Korea. The United States, faced with a choice between two evils, might find it necessary to support the PRC more strongly and, consequently, be more willing to acquiesce to Chinese moves--on Taiwan, at first, and later in littoral Southeast Asia. Such a move might alienate Japan even more than the immediate events on the Korean peninsula. Because a ROK nuclear program could put pressure on China to

commit itself to a "safer" course in Northeast Asia, and because such a course could lead to more explicit support of the U.S., Japan and the ROK, unified actions could tranquilize other areas of potential instability in Asia and provide time for a balanced solution to the various competitive forces. On the other hand, if the Chinese, in opting for a "safer" course, swung towards the Soviets, the United States might be forced to institute some of its firmest cold war policies--this time not from a position of unquestioned world dominance.

A weakening of the American-Japanese-ROK bond in Northeast Asia would be both a cause and an effect of any ROK nuclear program. Military coordination would become difficult in the extreme. Cooperation between any two nuclear armed nations is difficult, as exemplified in U.S.-French relations. As the entire foregoing discussion has demonstrated, there is little reason to believe that ROK-Japan-U.S. cooperation could achieve even that level of coordination that the U.S. has maintained with the French; and loss of harmonious security arrangements with the Japanese would force the U.S. to make the sort of critical choices in its Pacific policy that led to its entry into World War II.

Clearly, most of these responses have a negative effect on overall U.S. policies. A more detailed examination of their ramifications here and in other areas of the world is beyond the scope of this paper. However, the cost to the United States of failing to deter nuclear weapons development on the Korean peninsula is great. Steps to eliminate them once their presence is undeniable would be more difficult.

Present U.S. policy in Asia can have varying impacts on the likelihood of the South Korean implementation of a nuclear weapons program. Troop withdrawal is still seen as an American move to reduce its degree of commitment in future Korean violence. In varying degrees, the withdrawal has three effects: It weakens the glue with Japan; it sends an ambiguous signal to the Chinese about the utility of cooperation with the U.S. and Japan for mutual interest; and it says to the DPRK and the Soviets that a military buildup in the North will at best, be met with a proxy military buildup of the ROK, and not a reinforcement of American troops. All these actions would reinforce those elements in South Korea who argue for nuclear weapons development. The withdrawal of American nuclear weapons would be largely for symbolic effects on the world scene because of the relative ease with which the U.S. could reintroduce them from the Seventh Fleet or from more distant bases. It could also, however, offer a symbolic excuse for the ROK to create an independent nuclear capability. Although probably the least valid of all of the reasons, this might be the one that Park would use with the South Korean people when the time came to publicly demand the considerable sacrifices a deployed nuclear system would entail. Moreover, the nuclear weapons deployment issue may have been developed* by ROK leaders as a bargaining chip after they accepted the likelihood of further American troop withdrawals.

Two potential changes in U.S. policy in Northeast Asia could also impact on the South Korean decision. At some future date, the U.S. is almost

*They began to speak of this option well after Richard Nixon first suggested the possibility in 1969, but before President Carter formally announced the troop withdrawal in early 1977.

certain to recognize the PRC. Properly handled, this move might make it easier for the Chinese to cooperate in support of South Korean security and remove pressures toward nuclear weapons development. However, the South Koreans would need to be carefully prepared to avoid interpretation of the American moves as a prelude to abandonment of the ROK in addition to Taiwan. In panic, they could move or threaten to move toward nuclear weapons; or they might be motivated by Taiwan's actions. If, in its isolation, Taiwan successfully developed nuclear weapons, the Koreans might feel more confident that they could do likewise.

A less imminent change in U.S. policy is recognition of North Korea. According to the Soviet Union, mutual co-recognition is a prerequisite for a permanent Korean solution. Efforts to this end have been fruitless, despite years of work. Success seems remote now, but if achieved under conditions that have the support of the ROK, its needs for a nuclear weapons program could be largely eliminated. Recognizing the DPRK without ROK cooperation would certainly promote nuclear development.

Thus, there are a range of political and military policies which will affect the South Korean decision to acquire nuclear weapons--both if and when. Equally important are the non-proliferation measures that have been carefully detailed in the foregoing pages which will determine when and how much. The non-proliferation measures, in turn, impact on how the Koreans interpret the political and military "imperatives." In particular, the answer to how much may be not enough. And careful consideration of optimal solutions to Korean military needs show that many, and possibly all, non-nuclear solutions

are preferable. To convince the South Koreans of these realities, U.S. policy will have to be finely and sympathetically tailored to accommodate the subtleties of the interactions in Northeast Asia and, particularly, the Korean peninsula.

DNA FINAL REPORT

APPENDICES

APPENDIX A

Damage From Nuclear Weapons Used Against Complex Targets

Estimates of the level of damage from nuclear weapons against selected complex target types are developed in this appendix. The computational techniques used are approximate, but this is not the limiting factor in the accuracy of the results. The greatest uncertainties arise from the inability to know in advance the degree of dispersal, the protection of people and material and related factors whose uncertainties dominate the computational approximations.

Yields of Interest for Urban Attacks

Urban attacks with weapon yields ranging over four orders of magnitude are relevant to this study. At the lower end, a value of 100 tonnes has been cited as the possible yield of a crudely constructed device that might be assembled by terrorists. Even in a national program, such a yield might result from a severe design failure. (However, it should be noted that every nuclear power so far has been able to detonate a device in the Hiroshima-Nagasaki range on its first try.) At the upper end of the range, a one megaton weapon could be used in a regional context if it were used or supplied by a developed nuclear power as a response to a nuclear attack by a lesser power.

Within this range other yields are also of particular interest. One kiloton is at the low end of the range of yields that might be achieved with a Hiroshima-type weapon made from so-called "reactor-grade" plutonium, if pre-initiation began just as criticality occurred. Ten and twenty kilotons represent nominal yields of first-generation fission weapons, and 40 and 100 kilotons are representative of the improvements to be expected as the natural growth of even a modest weapons development program.

Weapon Effects

Tables A-1 through A-3 give the distance from ground-zero at which various effects occur for weapons in the 0.1 to 10 kiloton range. Quoted are the "mid-lethal" and "mid-burdening" ranges. These are the distances from ground-zero at which there would be 50 percent probability of death and 50 percent probability of injury serious enough to require medical treatment as a result of the particular effect. The values in Tables A-1 through A-3 are based on the assumption that the weapon is detonated at a scaled height of burst of 61 $m/KT^{1/3}$ (200 $ft/KT^{1/3}$), i.e. the actual height of burst in meters is 61 times the cube root of the yield in kilotons. Most of the ranges would be somewhat smaller for a surface-burst weapon. Some, in particular the blast distances, could be increased if a greater height of burst were used. Of most interest in each case is the dominant effect, the one whose mid-effects range is greatest. This varies from situation to situation. Thus for a 10 kiloton weapon, thermal radiation is the dominant effect for people in the open outside and its mid-lethal range is over 1800 meters (Table A-1). Inside buildings above ground (Table A-2) and in home basements (Table A-3), however, the dominant lethal effect is prompt radiation for which the mid-lethal range is about 1200 meters. This distance is reduced to about 650 meters for the basements and sub-basements of multi-story buildings (Table A-3). A shelter which provides adequate protection from blast and heat for conventional high explosives (or a 100 tonne nuclear "dud") may not provide protection from radiation. Thus a home basement (Table A-3) 120 meters from ground zero which provides a 50 percent chance of surviving the blast damage from a 100 tonne nuclear explosion will be able to provide this probability of survival to initial radiation effects only if it is over 490 meters from the ground zero.

For the purposes of the calculations, the populace is assumed to have an intermediate level of protection--i.e., most people are not outside nor are

Table A-1

Range to Mid-Lethal and Mid-Burdening Environments, By Shelter Category

SHOB = 61 m/KT$^{1/3}$ (200 ft/KT$^{1/3}$)

Yield (KT)	Mid-Lethal Range — meters (feet) — Initial Radiation	Thermal (Exposed)	Blast	Mid-Burdening Range — meters (feet) — Initial Radiation	Thermal (Exposed)	Blast
			Outside, Open Area			
0.1	616 (2020)	206 (677)	81 (265)	762 (2500)	262 (860)	156 (511)
1.0	991 (3250)	634 (2080)	204 (670)	1170 (3840)	847 (2780)	335 (1100)
10.0	1414 (4640)	1890 (6200)	533 (1750)	1564 (5130)	2545 (8350)	835 (2740)
			Outside, Built-up Area			
0.1	613 (2010)	184 (605)	120 (395)	759 (2490)	262 (860)	184 (603)
1.0	985 (3230)	604 (1980)	296 (970)	1164 (3820)	847 (2780)	415 (1360)
10.0	1396 (4580)	1859 (6100)	744 (2440)	1558 (5110)	2545 (8350)	1091 (3580)

Notes: SHOB = Scaled Height of Burst = Actual Height of Burst/(yield in KT)$^{1/3}$. Draft Nuclear Weapon Effects Handbook for the Long Range Research and Development Program, M. K. Drake and M. P. Fricke, Science Applications, Inc., SAI-75-101-LJ, March 1974, La Jolla, Calif., Table 4.1-2, p. 4-31. Source data are in feet.

Range of dominant effect is underlined.

Table A-2

Range to Mid-Lethal and Mid-Burdening Environments, By Shelter Category

SHOB = 61 m/KT$^{1/3}$ (200 ft/KT$^{1/3}$)

Yield (KT)	Mid-Lethal Range meters (feet)			Mid-Burdening Range meters (feet)		
	Initial Radiation	Blast	Blast, Glass	Initial Radiation	Blast	Blast, Glass
			Residences, Aboveground			
0.1	570 (1870)	120 (395)	139 (455)	692 (2270)	184 (603)	500 (1640)
1.0	908 (2980)	296 (970)	299 (980)	1100 (3610)	415 (1360)	1079 (3540)
10.0	1295 (4250)	744 (2440)	643 (2110)	1475 (4840)	1091 (3580)	2326 (7630)
			First Three Floors of Weak-Walled Multistory Buildings			
0.1	558 (1830)	120 (395)	139 (455)	680 (2230)	184 (603)	500 (1640)
1.0	893 (2930)	296 (970)	299 (980)	1076 (3530)	415 (1360)	1079 (3540)
10.0	1241 (4070)	744 (2440)	643 (2110)	1405 (4610)	1091 (3580)	2326 (7630)
			First Three Floors of Strong-Walled Multistory Buildings			
0.1	558 (1830)	120 (395)	139 (455)	680 (2230)	184 (603)	500 (1640)
1.0	893 (2930)	283 (930)	299 (980)	1076 (3530)	415 (1360)	1079 (3540)
10.0	1241 (4070)	643 (2110)	643 (2110)	1222 (4010)	1091 (3580)	2326 (7630)
			Fourth and Higher Floors of Multistory Buildings			
0.1	600 (1970)	120 (395)	139 (455)	722 (2370)	184 (603)	500 (1640)
1.0	954 (3130)	296 (970)	299 (980)	1128 (3700)	415 (1360)	1079 (3540)
10.0	1317 (4320)	744 (2440)	643 (2110)	1506 (4940)	1091 (3580)	2326 (7630)

Notes: SHOB = Scaled Height of Burst = Actual Height of Burst/(yield in KT)$^{1/3}$. Draft Nuclear Weapon Effects Handbook for the Long Range Research and Development Program, M. K. Drake and M. P. Fricke, Science Applications, Inc., SAI-75-101-LJ, March 1974, La Jolla, Calif., Tables 4.1-3, 4.1-4, 4.1-5, pp. 4-32, 4-33, 4-34. Source data are in feet.

Range of dominant effect is underlined.

Table A-3

Range to Mid-Lethal and Mid-Burdening Environments,
By Shelter Category

SHOB = 61 m/KT$^{1/3}$ (200 ft/KT$^{1/3}$)

Yield (KT)	Mid-Lethal Range meters (feet)		Mid-Burdening Range meters (feet)	
	Initial Radiation	Blast	Initial Radiation	Blast
	Home Basements			
0.1	494 (1620)	120 (395)	604 (1980)	156 (511)
1.0	805 (2640)	283 (930)	981 (3220)	335 (1100)
10.0	1158 (3800)	643 (2110)	1347 (4420)	722 (2370)
	Basements and Sub-Basements of Multistory Buildings			
0.1	172 (563)	120 (395)	257 (843)	156 (511)
1.0	363 (1190)	283 (930)	491 (1610)	335 (1100)
10.0	649 (2130)	643 (2110)	805 (2640)	722 (2370)

Notes: SHOB = Scaled Height of Burst = Actual Height of Burst/(yield in KT)$^{1/3}$. Draft Nuclear Weapon Effects Handbook for the Long Range Research and Development Program, M. K. Drake and M. P. Fricke, Science Applications, Inc., SAI-75-101-LJ, March 1974, La Jolla, Calif., Tables 4.1-3, 4.1-5, pp. 4-32, 4-34. Source data are in feet.

Range of dominant effect is underlined.

many in the basements and sub-basements of multi-story buildings. Excluding these extremes, there is not too much variation among the shelter types in the mid-lethal ranges of the dominant effect, initial radiation, for yields of 10 kilotons or less. Specifically, the mid-lethal ranges for residences above-ground of Table A-2 are used.

For sufficiently high yields and for conditions in which most of the populace is inside, blast induced effects are the dominant fatality causing mechanisms. The peak static overpressure occurring at the mid-lethal radius is generally a decreasing function of yield. For people above ground in residences, the source for Tables A-1 through A-3 estimates that this overpressure would be about 9 psi (pounds per square inch) at 20 kilotons, 8 psi at 40 kilotons, and 7 psi at 100 kilotons.* For this overpressure region the maximum weapon radius will occur with a high scaled height of burst on the order of 274 $m/KT^{1/3}$ (900 $ft/KT^{1/3}$).** However, a reduction to an intermediate level of 183 $m/KT^{1/3}$ (600 $ft/KT^{1/3}$) reduces the radius at these overpressures only by about 10 percent and greatly increases the radii at higher overpressures. For instance, the radius for 15 psi is more than doubled. Another reason for using less than the "optimum" height of burst is to hedge against a weapon going off at less than the expected yield since for a given <u>actual</u> height of burst a lower than expected yield implies a higher than expected <u>scaled</u> height of burst. Hence a scaled height of burst of 183 $m/KT^{1/3}$ is used for 20 KT and above.

Both prompt radiation and blast would contribute significantly to fatalities in residences above ground from a 20 kiloton weapon detonated at 183 $m/KT^{1/3}$.

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* Read from Figure 4.1-8, p. 4-23, of M. K. Drake and M. P. Fricke, <u>op. cit</u>.

**Distances from ground zero for peak static overpressures are taken from Figure 3.73c, p. 115, of <u>The Effects of Nuclear Weapons</u>, S. Glasstone and P. J. Dolan, ed., Third Edition, United States Department of Defense and United States Department of Energy, 1977.

This would also be true, but to a lesser extent, at 40 kilotons. Hence, mid-lethal radii for these two cases have been computed based on combined weapon effects.* For 100 KT and 1000 KT, the mid-lethal radius is the distance at which 7 psi peak static overpressure would occur. Table A-4 summarizes the mid-lethal ranges used.

Damage Functions

Estimates of the mid-lethal and mid-burdening effects are subject to uncertainty, and estimates in the variation of response about these median values are even more so. However, to make damage calculations, it is necessary to make assumptions on the form of this variation. The probability of damage as a function of distance from actual ground zero is called the "distance damage function." (It should not be confused with the probability of damage as a function of distance from desired ground zero, which takes aiming error into account.) Where appropriate, these calculations use a cumulative lognormal function (CLNF) approximation to the distance damage function, but for certain calculations, it is more convenient to use the circular coverage function (CCF) approximation used by DIA up to 1969.** With either approximation, the relative deviation of the damage function, σ_d, must be specified. The smaller σ_d, the more sharply the damage function decreases--from almost 1.0 inside the mid-effects range (denoted as r_{50}) to almost zero--as the distance from ground zero becomes greater than r_{50}. The terminology "sigma-30 damage function" is often used for a distance damage function with $\sigma_d = 0.30$ and so forth for other values of σ_d.

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* Using the methods of Section IV of Mathematical Background and Programming Aids for the Physical Vulnerability System for Nuclear Weapons, 1 November 1974, DI-550-27-74, Defense Intelligence Agency, Directorate for Intelligence.

**See DI-550-27-74, ibid.

Table A-4

Mid-Lethal Ranges Used for Urban Attacks

Yield (kt)	Mid-Lethal range (km)
0.1	0.57
1.0	0.91
10.0	1.30
20.0	1.70
40.0	1.95
100.0	2.7
1000.0	5.5

Source: See text.

DIA notes* that for $\sigma_d = 0.30$, the difference between the CLNF and CCF damage functions is less than 6 percentage points and states that this difference does not cause significant differences in calculated probabilities of damage when weapon delivery error is included.

For smaller values of σ_d the differences are less, but for larger values of σ_d, noticeable differences in calculated probabilities of damage can occur.

Although DIA recommends** that $\sigma_d = .20$ be used for targets primarily sensitive to static overpressure ("P targets") and $\sigma_d = 0.30$ for targets primarily sensitive to dynamic overpressure ("Q targets"), the larger value, $\sigma_d = 0.30$, is warranted for urban targets because an urban area is made up of many different types of structures and is best modeled by a parameter that shows larger variation in response. In any event the effect of this assumption is minute in comparison to the tremendous uncertainties faced in estimating damage to urban areas and their populations.

For $\sigma_d = 0.00$, i.e. for a "sigma-zero" damage function, the probability of damage jumps discontinuously from 1.0 just inside r_{50} to 0.0 just outside. Such a damage function is also called a "cookie-cutter" damage function and it can be an adequate approximation in many circumstances. Generally if a cookie-cutter is being used as an approximation to a damage function with non-zero σ_d, it is marginally better to use a parameter slightly larger than r_{50} as the cookie-cutter radius. However, in the main body of this report, the mid-lethal radii have been used as the cookie-cutter radii.

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* Ibid., p. 5.

**Ibid., p. 34.

The "mean area of effectiveness" (MAE) of a weapon is the integral of the distance damage function over area. The "weapon radius" (WR) is the radius of a circle with area equal to the MAE. If target value (population, productive or replacement value of structure, etc.) were distributed with uniform density over the area, then the total target value destroyed would be just the MAE times the value per unit area. Thus for a uniform distribution of target value, a cookie-cutter damage function with radius WR gives the total value destroyed. It also gives a good approximation for area targets such as population, even when the distribution of target value is not uniform. For the CLNF, $WR = r_{50}/(1-\sigma_d^2)$. Thus, for $\sigma_d = 0.30$, $WR = r_{50}/0.91$, and hence, $MAE = \pi WR^2 = \pi r_{50}^2/0.8281 \simeq 3.79\, r_{50}^2$.

A further simplification can be made as long as the CEP is much less than WR, say less than one-half WR. In this case, using the simple cookie cutter with zero CEP gives an adequate approximation to the expected damage against area targets. These approximations are compared in a subsequent section.

Distribution of Population

In order to estimate the vulnerability of urban population to attack by nuclear weapons it is necessary to account for the spatial distribution of inhabitants into less and more-densely populated areas within individual cities. Most of the urban areas of interest for this study are in Asian countries or in lesser developed countries or both. Only limited information is usually readily available on population distribution in these countries and analogies based on U.S., Russian, or European cities may not apply.

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*Ibid., p. 14.

For many urban areas, the only information that is readily available is the populations of the cities or towns and an estimate of their area. Usually it is unclear how the area has been calculated or when it was calculated, and generally there is no information readily available on how population is distributed within the given area. A determined research effort, particularly if it can be extended to statistical material in the country in question, can often lead to better results.* Even when accurate and up-to-date census data is available, it only gives people's residences, not where they might be at the time of attack. There can be a substantial diurnal variation of population (one would expect more of this in cities built around good transportation systems). Perhaps more important, population might disperse before the attack.

Perhaps the simplest and most obvious estimate of fatalities is simply to multiply the population by the ratio of the lethal area (mean area of effectiveness for fatalities) of the weapon (or weapons) to the area of the city. This is the same as multiplying the lethal area of the weapon times the average population density and is labeled "average density" estimate in tables throughout this study.

The ratio of the lethal area of the weapon to the area of the city is of independent interest, since it is a useful parameter for judging whether the estimate is too small or too large. If the ratio is small, as is likely to be the case with a small weapon, the average density estimate is likely to provide an estimate of fatalities that is too small because population densities in a city vary widely and the attacker is likely to aim for the more densely built up areas.

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*E.g., the authors of this study had available to them the Census data for the city of Seoul and transportation data for Sydney.

If that ratio is large, as occurs in many cases with megaton-range weapons, the average density estimate is likely to overestimate the number of fatalities because it may not be possible to "fit" the lethal area of the weapon into that of the city.

The average density method models the population distribution by assuming it is uniformly spread over the area in question. One way to model the variation in density within a city is to assume the population density is proportional to a circular normal distribution with appropriately chosen center in the urban area and a standard deviation chosen to best fit the characteristics of the area's spread. This model has some empirical basis. It has been observed that for many cities, it is possible to pick a center for a polar coordinate system such that the integral of the relative population density with respect to the angular coordinate leads to a function of the radial coordinate not too different from that gotten by using a circular normal distribution with suitable standard deviation. A method often used for picking a center and standard deviation for the circular normal approximation is to base it on a so-called "R-95 circle," which is defined as that circle with minimum radius which contains 95 percent of the population. The radius of this circle is called R-95. The standard deviation of the circular normal approximation is then taken as $(R\text{-}95)/[\ell n(400)]^{1/2}$, since that is the correct relationship if the distribution is truly normal.

If the circular coverage function is an acceptable approximation to the distance damage function, it is easy to compute the expected damage from one weapon aimed at the population center. In this case, the expected fraction of the target damaged is simply

$$1 - \exp(-x/2)$$

where

$$x = \frac{WR^2}{\sigma_d^2 WR^2 + CEP^2/\ell n(4) + (R-95)^2/\ell n(400)} .$$

Pan Heuristics has obtained 1974 census data for the city of Seoul which gives the data by dong, a small administrative unit with an area as small as 0.1 km^2 in the more densely populated regions of the city. This permits comparison of fatality calculations using accurate population density distributions with the crude "average density" estimate and with other analytical models of population density such as the circular normal model.

Some caveats are in order, however:

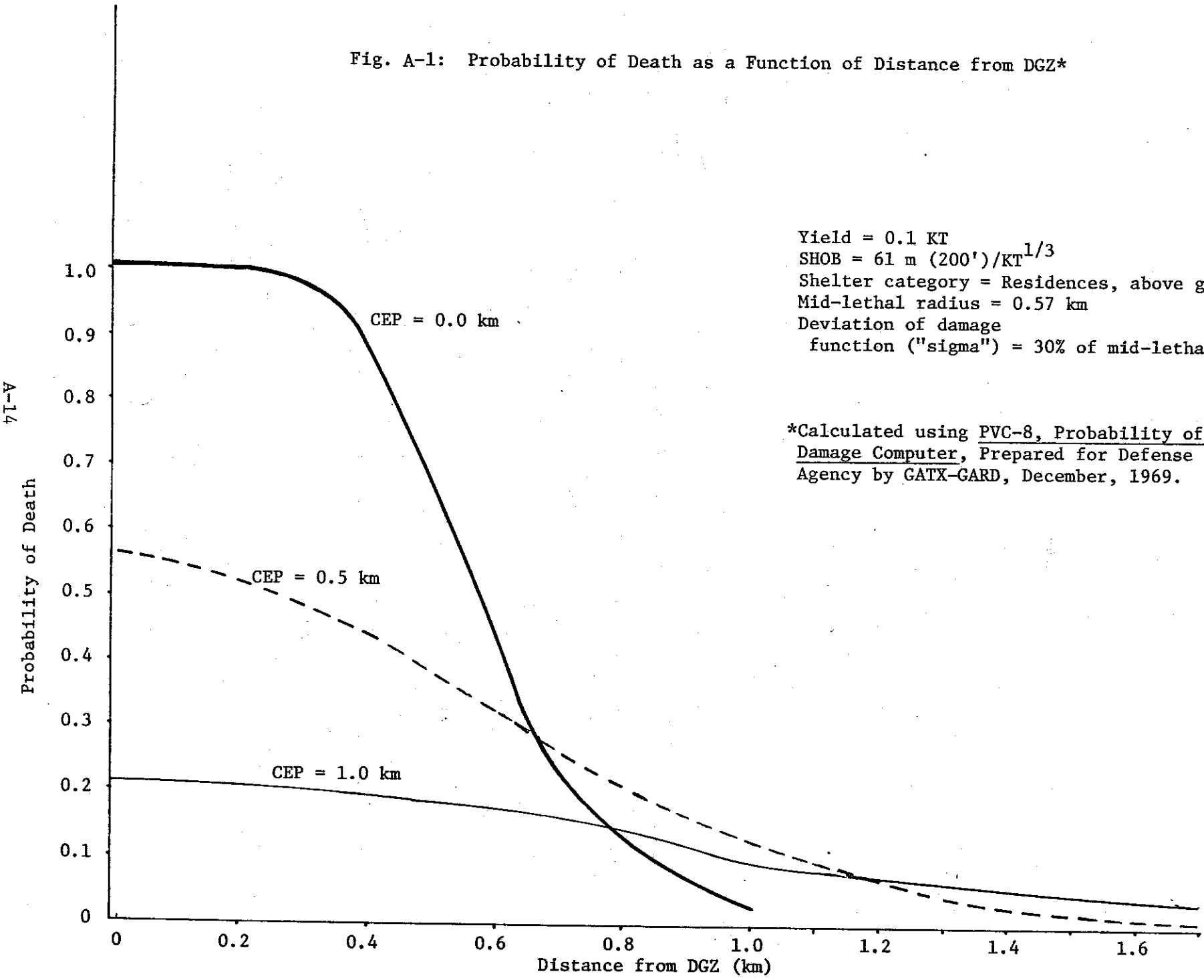
1. As noted before, the population distribution at the time of the attack may not be well represented by even accurate census information.

2. Cities differ markedly in character. In particular, Seoul was virtually leveled in the Korean War and has been rebuilt since. Its population distribution may not be typical--particularly of Asian cities.

3. The attacker may not choose to maximize destruction to population. Instead, the center of government, industry, or commerce in the city may be chosen. Small shifts in aim point can have a sizable effect on expected damage if the weapon is small and accurate.

Figure A-1 shows the probability of death as a function of CEP for the smallest weapon yield treated, 0.1 KT. Curves for three CEPs are shown: 0, 0.5 km, and 1 km. The shape of this function gives some idea of the degree of fineness to be sought in the representation of population and sensitivity to aim point. For a perfectly accurate weapon, the probability of death drops off from 0.75 at about 0.45 km to 0.25 at about 0.7 km suggesting that the attacker would like to have population representation with at least 0.25 km resolution for this case. But for accuracies likely to be achieved by smaller

Fig. A-1: Probability of Death as a Function of Distance from DGZ*



*Calculated using PVC-8, Probability of Blast Damage Computer, Prepared for Defense Intelligence Agency by GATX-GARD, December, 1969.

powers the probability of damage function will have a more gradual slope. Thus for a CEP of 0.5 km, about the best that can be expected with air delivered weapons, something like 0.5 kilometer resolution appears adequate, and for a 1 kilometer CEP, roughly 0.8 km would do. In each case this is the distance over which the probability of damage varies from 75 percent of its maximum to 25 percent of its maximum. As a rough rule of thumb for other cases, the formula $[(0.3 \cdot R)^2 + (0.8 \cdot CEP)^2]^{1/2}$ gives some idea of the degree of resolution required.

Table A-5 gives the results of a map exercise in which successively larger areas in Seoul were located with the objective of maximizing the total average population density in the area. The areas were kept as closely circular as possible, but the center of the circle was allowed to shift. In fact, Seoul's population distribution is bimodal and so, for small areas, the area is centered about one of the two peaks in the distribution while for larger areas it is centered to capture both peaks. Figure A-2 is useful, however, because an attack planner whose objective was maximizing fatalities would, to a first approximation, aim a weapon so that the area of high probability of lethality would have the greatest population in it.

The data of Table A-5 can be fit quite well by the power curve $y = ax^b$, $a = 59{,}470$, $b = -0.486$ as is shown in Figure A-2. Multiplication of this function by πx^2 thus gives a good analytic fit to the total population within a circle of radius x.*

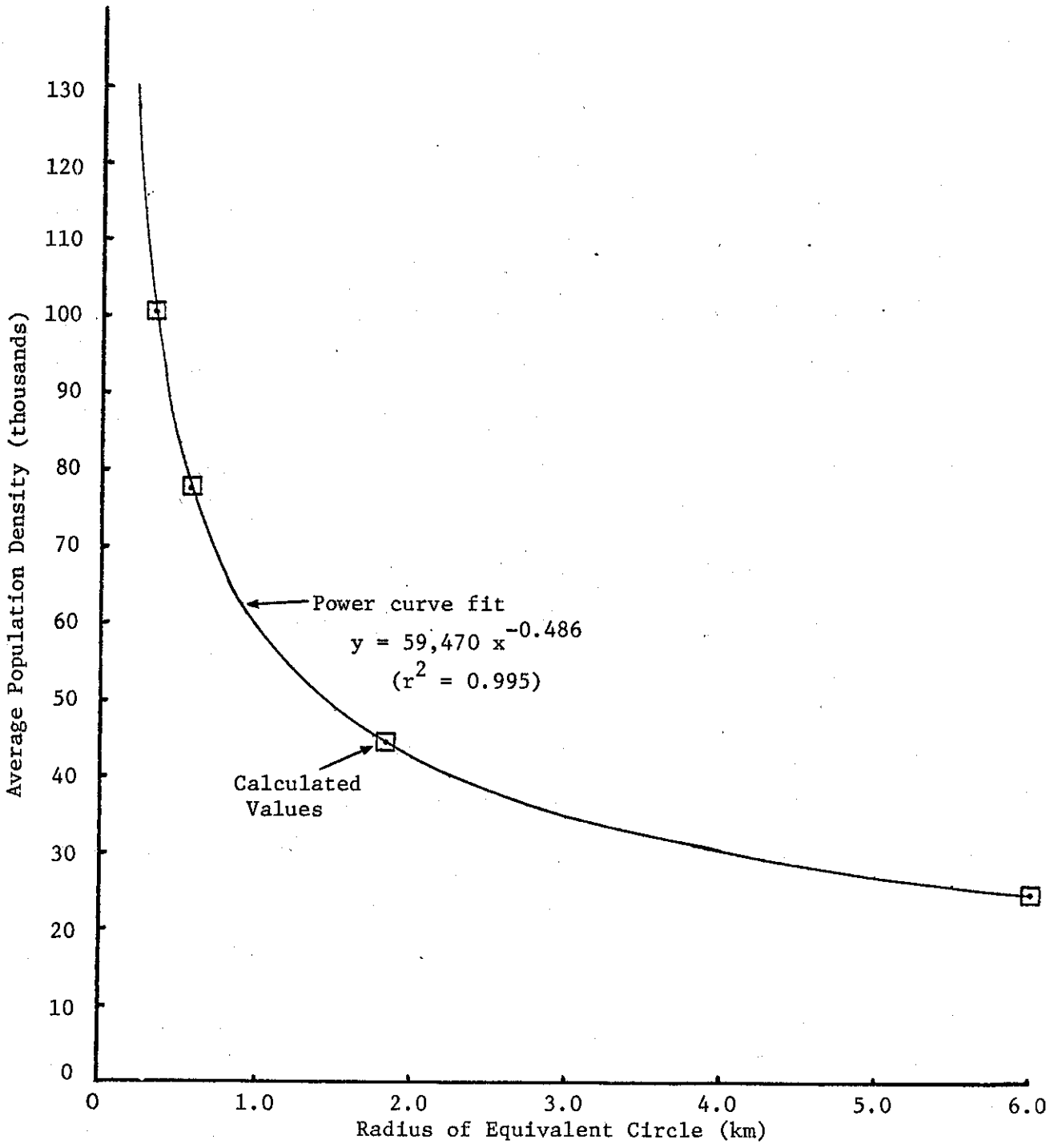
*In a preliminary draft of this appendix, a slightly different fit, with a = 61,600, b = -0.584, was obtained using a data point with extremely small area (area = 0.1 km^2, radius = 0.178 m, average density = 200,000 km^2). This point has subsequently been rejected as probably spurious due to inaccuracy in measuring the area. This preliminary fit has been used in various places in the main report, but resulting differences would be small.

Table A-5

Average Density of Most Densely Populated Areas--Seoul Korea

Area (km^2)	Radius of Circle of Equal Area (km)	Average Total Population Density
0.33	0.324	100,000
1.08	0.586	77,300
10.8	1.85	47,000
113	6.0	24,000

Fig. A-2: Average Density of Most Densely Populated Areas--Seoul, Korea



Comparison of Damage Functions Using the Seoul Population Distribution

Table A-6 shows estimates of the expected fatalities from a 0.1 KT weapon with a 0 and 0.5 km CEP calculated using the appropriate damage function from Figure A-2 and the power curve fit to the population. (The calculation is not strictly correct since it assumes the circles of maximum population density are concentric. This is not judged to be a significant source of error, however.) Table A-6 also shows the results of using a cookie-cutter approximation to the damage function. The result 92,000 agrees quite well with the result for a CEP of zero of 89,000.

This is the case for which the result should be most sensitive to the choice of damage function. Hence, use of the cookie-cutter approximation to the distance damage function appears justified. Moreover, the cookie-cutter, zero-CEP, result overestimates the 500 m CEP result by less than 30 percent. This is a case in which the CEP is about 80 percent of the weapon radius. For cases in which the ratio of CEP to weapon radius is small, say less than one-half, there should be no significant error introduced by simply using a zero CEP cookie cutter.

Comparison of Different Population Representations

It is possible to use the detailed census data for Seoul to compare the results of damage estimates made using gross approximations to the population distribution with results using the finer-grained census distribution. The results give some idea of how reliable estimates are that are made using, say, just the total population and area of a region.

For most urban regions of interest, an estimate of total population is available and the area enclosed either by the corporate limits or by the "built-up" region can be found or estimated from maps. Using either corporate-limit or built-up regions has its problems. The built-up regions shown in

Table A- 6

Expected Fatalities From a 0.1 KT Weapon Aimed at Seoul
Population Distribution: Power Curve Approximation

Damage Function	CEP(m)	Expected Fatalities (thousands)
CLNF	0	89
CLNF	500	72
Cookie-Cutter (Area = MAE)	0	92

atlas maps are often out of date and generally no information on how they were estimated or for what date they are applicable is given. Moreover, it is necessary to then estimate how much of the reported population is in the area. Corporate limit areas, on the other hand, can generally be definitely associated with population data, but corporate limits often contain substantial regions of little or no population.

In the case of Seoul, the 1974 census reports a total population of 6,541,500 with a population density of 10,432 per km^2.* The total incorporated area is 627 km^2. The total "built-up area" indicated in a widely available atlas is about 100 km^2.** Assuming that 90 percent of the reported population is in the built-up area, the average density in the built-up area comes out to be 59,000 per km^2. With nothing to go by, it would be unjustifiable to assign 90 percent of the population to 16 percent of the area. Hence, a substantial range would have to be assigned, say, 30-60,000 per km^2. (Other aggregate density figures are available in this case, of course. For instance, a 1975 population study reports a density of 30,000 per km^2 in the central business district, with a substantial increase in the immediately adjacent residential areas.***)

For purposes of using the circular normal approximation to population distribution, an R-95 radius is usually specified. If only the atlas information were available, a "plausible" assumption would be that the R-95 circle is the smallest circle containing the built-up area shown in the map. This

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* Report on Census, 1 October 1974, Special City of Seoul, p. 8 (in Korean).

** The International Atlas, Rand McNally and Co., 1974. Area estimated from map on p. 261. This atlas gives 4.8 million as the population of Seoul on p. 261, 5.5 million (for 1970) in a table (p. I.18) and 5.9 for the "metropolitan area, including suburbs" in the same table.

***A Study on the Population of Seoul, YOON, Jong-Joo, Seoul Women's College, 1975, p. 157.

leads to an estimated R-95 radius of 9 km.* Using detailed census data, however, gives an estimate of the R-95 radius of about 13 km.

Table A-7 presents the results of calculations of expected fatalities computed using different assumptions for the population model and compares them to calculations using the power-curve fit, which closely matches the actual population distribution.

One would expect that for the correct value of R-95, the circular normal approximation would work well for weapons whose mid-lethal radii were close to the R-95 radius. This is because the R-95 radius is, in effect, the distance at which the distribution is "fitted" to the data. As it turns out, the circular normal approximation with the "correct" R-95 of 13 km works remarkably well even for quite a bit smaller weapons. Thus, even for 40 KT, with a mid-lethal radius only 15 percent of R-95, the relative error is only 13 percent. However, the circular normal distribution does not peak enough at the center to reflect the very high density that can be found in regions comparable to the mean area of effectiveness of the 0.1 and 1 KT weapons. Hence for these yields, <u>if</u> accurately delivered to maximize fatalities, almost twice as many fatalities could be inflicted than estimated using the circular normal distribution.

For the circular normal distribution to work well for the yields at which it should, it is necessary to have a good estimate of R-95, and that implies a better knowledge of the population distribution than can be gotten from general reference works such as atlases. Thus in the present case, our

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*This would not be inconsistent with the assumption that the built-up area contains only 75-90 percent of the population, since the resulting R-95 circle contains more than just the built-up area.

Table A-7

Expected Fatalities Computed with Different Population Models and Damage Functions--Seoul Korea

Expected Fatalities -- Thousands

Yield (kt)	Mid-Lethal Radius (R_{50}) (km)	Population Model	Power Curve Fit to Census Data		Circular Normal		Average Density		
					R-95= 13 km	R-95= 9 km	Density= 10,432/km^2	Density= 30,000/km^2	Density= 60,000/km^2
		Damage Function:	Cookie Cutter	CLNF	CCF[a]	CCF[a]	Cookie Cutter	Cookie Cutter	Cookie Cutter
0.1	0.55		92	72-89[b]	45	93	13	37	74
1.0	0.90		190		110	230	33	94	190
10.0	1.30		320		230	460	67	190	380
20	1.70		480		390	770	110	330	660
40	1.95		600		520	980	150	430	870
100	2.7		970		900	1700	290	830	1700
1000	5.5		2800		2800	4200	1300	c	c

[a] Calculations for CEPs of 0.5 and 0 km agree to two figures.

[b] Range is for CEPs of 0.5 to 0 km.

[c] Use of this model is patently unreasonable in this case since the largest circle that could be contained in the "built-up area" has a radius of less than 4 km, whereas R_{50} for 1 Mt is 5.5 km.

"plausible" estimate that R-95 = 9 km based on a map showing the "built-up area" doesn't do too well. With a 100 KT weapon, it overestimates fatalities by 75 percent, and at 1 MT, it overestimates by 50 percent. At the low end, it happens to work well, but there is no basis for predicting that this would occur. The R-95 distance that happened to be picked was just small enough to compensate for the fact that the circular normal distribution tends to have too gentle a central peak.

Simply going to the atlas and finding a population and an area and applying the uniform density method can result in reasonably accurate results (say within a factor of two) but it is likely to lead to results that are off by a wide margin unless a great deal of care is taken to make sure that the area chosen is roughly comparable to the area over which lethal effects will be felt. Furthermore using a density based on the incorporated area can lead to results that are too low by almost a factor of seven in the lowest yield case and by over a factor of two in the highest yield case. By exercising more care and using an estimate of the built-up area and limiting application to yields tailored to this area, it is possible to greatly improve the results with this technique. But even here, the uncertainty in how much population to assign to the built-up area lessens the amount of reliance that could be put on these results. The estimates presented in this appendix bracket the "correct" values in most cases by introducing a wide range between the lower and upper bounds and also probably because the reasoning as to what it would be plausible to do only with atlas information was somewhat contaminated by knowledge of the census data.

Area Military Targets

Estimates of the number of low yield nuclear weapons required to achieve significant levels of damage against army units are presented in several places in the main text. These units are treated as nominal circular targets, with the radius taken as a compromise between the desires of the army commanders to disperse the forces to lessen their vulnerability to attack and the need to keep them compact enough to function as effective military units. Results in any actual military situation could vary considerably from the nominal results developed here. The ability of the nuclear attack forces to locate targets, the effect of terrain and the course of the battle on the location and dispersal of units, the degree of exposure of the units at the time of attack, and the effects of terrain and meteorological conditions on weapons effects would all play a role and their cumulative effects could be large.

Table A-8 presents the damage criteria, mid-lethal radii and target radii used.

Table A-8

Vulnerability of Army Units

Target	Target Radius	Damage Criteria	Mid-Effects Radii 1 KT	10 KT
Infantry Battalion (prone, in open)	1100 m	Severe injury[a]	1000 m	2000 m
Armored Battalion (in tanks or APCs)	1100 m	Immediate incapacitation of personnel (8000 rads)[b]	500 m	850 m
Medium Tank Company	300 m	Moderate damage to tanks[c]	160 m	415 m

[a]Dominant early effect would be thermal radiation. At 1 KT, incapacitation due to nuclear radiation would occur at a greater radius, but the effect would be delayed. Source: "New Technologies: The Prospects," C. I. Hudson, Jr., and P. H. Haas, in Beyond Nuclear Deterrence: New Aims, New Arms, J. J. Holst and U. Nerlich, eds., copyright 1977 by Pan Heuristics. Crane Russak and Company, New York, Fig. 14, p. 139 and discussion. SHOB = 61 $m/KT^{1/3}$.

[b]Source: Hudson and Haas, ibid., Fig. 13, p. 138. SHOB = 61 $m/KT^{1/3}$.

[c]Major repair needed. In the absence of a public source for tank vulnerability estimates, data for severe damage to "earth moving engineering equipment" were used. Source: The Effects of Nuclear Weapons, 1977 edition, op. cit., pp. 222-224. "Optimum" airburst used.

APPENDIX B

Some Theoretical Calculations of the Vulnerability of Nascent Nuclear Weapons Systems to Nonnuclear Attack

Nascent nuclear weapons systems are fragile; they can be vulnerable to nonnuclear as well as nuclear attack. In estimating the vulnerability of critical weapons systems to nonnuclear attack, it is useful to examine in sequence the elements of nuclear weapons development and delivery systems, the types of conventional weapons that might be employed to attack them, and the delivery accuracy of these weapons. Included also are comments on the carrying capacity of delivery vehicles.

It is assumed that a country entering upon a development program will have some or all of the following critical nuclear weapon system elements:

- sheltered aircraft
- runway areas
- aircraft control towers
- storage bunkers for bomb element
- bomb assembly areas
- cruise or ballistic missile launch pads

The elements of an aircraft-delivered nuclear weapon system would include secluded and hardened bunkers for weapons or their ready-to-assemble elements, a set of readily identifiable aircraft shelters which might be empty or occupied by aircraft not equipped for nuclear delivery, a control tower (for tactical missions without predetermined targets, the control tower and other communications facilities are more important than for well rehearsed "strategic" missions). The elements of a missile

delivered system would have storage bunkers, as above, as well as launch pads or rails. A bomb assembly area or areas for final pre-field assembly of the weapons would be required by both systems. These would resemble hardened individual facilities.

Table B-1

Numbers of High Explosive Weapons Required per Target

Target	1 tonne	1/4 tonne
A/C Shelter	1	-na-
Runway	138	554
Control Tower	1	1
Bunker	1	-na-
Bomb Assembly Area		
Missile launch pad/rail	1	1

Before going further, three observations need to be made regarding relationships between larger or smaller conventional weapons. For cratering runways, there are quantitative differences between 1 tonne and 1/4 tonne bombs' effectiveness. For targets such as aircraft shelters which need to be hit by a heavy weapon, there are important qualitative differences, i.e., 1/4 tonne bombs are useless. For small, soft targets, such as launch rails, small or large bombs, if they hit, are equally effective.

The expected number of bombs dropped to achieve desired damage on the target classes follows. (Aircraft shelters and bunkers are assumed to be either destroyed or not; i.e., are point rather than area targets.)

Table B-2

Number of High-Explosive Weapons Required to Give Varying Probabilities of Kill for Critical Targets
(Only the one-tonne bomb case is taken)

	pk	CEP			
		200 m	100 m	10 m	1 m
A/C shelter or bunker	.99	4200	1000	10	1.
	.95	2700	680	6.8	1.
	.90	2100	520	5.2	1.
	.50	630	160	1.6	1.
Runway	.99	15300	3900	140	140
	.95	14500	3700	140	140
	.90	14000	3600	140	140
	.50	13000	3200	140	140
Control twr., radio, or launch rail	.99	930	230	1.	1.
	.95	520	130	1.	1.
	.90	350	90	1.	1.
	.50	59	15	1.	1.
Bomb asmby. areas	.99	680	170	3.6	3.4
	.95	490	125	3.5	3.4
	.90	410	100	3.4	3.4
	.50	210	54	3.4	3.4

Using the above table as a rough guide, the requirements for attacks on two hypothetical nuclear weapons systems under total tonnage constraints are calculated in the following; Each system is assumed to have 20 nuclear weapons.

Aircraft Delivery System: The country in question has five airfields that could accommodate nuclear strike aircraft, but only two of these are used for basing purposes. Each airfield has five control towers or other radio communication facilities, and 40 hardened aircraft shelters. The two nuclear bases also have ten strike aircraft each, and ten bunkers that the weapons are stored in. The country has one bomb assembly factory. Thus the target inventory is:

Target	Five Airfields	Two Airfields
A/C shelters	200	80
Weapon bunkers	20	20
Control towers	25	10
Runways	5	2
Bomb assembly areas	1	1

Missile Delivery System: The country has a missile farm with 20 SSMs that have nuclear warheads. For each missile there is a launch pad or launch rail and a missile/warhead storage bunker. There are also five command bunkers, five radio facilities, and a bomb assembly area. The target inventory in this case is:

	Missile Farm
Launch areas	20
Weapon bunkers	20
Control bunkers	5
Radio units	5
Bomb assembly area (B.A.A.)	1

Table B-3

Impact of 10 KT High Explosive Attack*
Assuming Various Levels of Accuracy

(Note: With precision guidance, destruction is total with less than 10 kilotonnes)

CEP	Aircraft System	pk	Number of tonnes	Missile System	pk	Number of tonnes
200 meters	14 A/C	50%	8820	20 missiles	99%	4000
	10 control towers	50%	590	5 radios	95%	2600
	1 B.A.A.	95%	490	1 B.A.A.	90%	410
			9900			10010
100 meters	40 A/C	50%	6400	20 missiles	99%	4600
	10 control towers	95%	1300	25 bunkers	50%	4000
	13 bunkers	50%	2080	5 radios	99%	1150
	1 B.A.A.	99%	170	1 B.A.A.	99%	170
			9950			9920
10 meters	200 A/C	99%	2000	20 missiles	100%	20
	20 bunkers	99%	200	25 bunkers	99%	250
	25 control towers	100%	25	5 radios	100%	5
	1 B.A.A.	100%	4	1 B.A.A.	100%	4
	5 runways	100%	700			279
			2929			
1 meter	200 A/C	100%	200	20 missiles	100%	20
	20 bunkers	100%	20	25 bunkers	100%	25
	25 control towers	100%	25	5 radios	100%	5
	5 runways	100%	700	1 B.A.A.	100%	4
	1 B.A.A.	100%	4			54
			949			

*Ten thousand tonnes of high explosive can be delivered in upwards of a week of steady bombing assuming 100 planes making three successful sorties per day.

APPENDIX C

Calculation of Nuclear Attack Requirements Against A Nascent Nuclear Force (Taiwan Case)

In considering possible Peoples Republic of China (PRC) attacks on a Taiwanese nuclear delivery system, various forms of the Taiwanese targets and of the PRC attack have to be distinguished. Among the characterizing factors are the following: composition of Taiwanese system, whether aircraft or ballistic missile, and how well these vehicles are sheltered; what delivery accuracy, yield and weapons reliability the Peoples Republic of China (PRC) has or will have achieved, and the sophistication of the PRC's reconnaissance and retargeting system.

Target Protection. Taiwan can significantly improve the protection of its nuclear forces against attack by providing aircraft shelters or hardened missile silos. However, protecting its delivery systems, particularly ballistic missiles, could tax Taiwan's military resources and be time-consuming as well.

Table C-1 gives the criteria for severe damage from nuclear weapons used for the calculations of this appendix. Damage criteria for a hypothetical force are, of course, somewhat arbitrary and not too much should be made of specific numerical values used. This arbitrariness is further compounded by the necessity to make arbitrary assumptions about the number of targets, the characteristics and number of attacking warheads, and the number of surviving aircraft or missiles that the attacker or defender might deem adequate to his objectives.

The resulting calculations, however, are meaningful if they are interpreted sensibly.

Table C-1

Criteria Assumed for Severe Damage to Aircraft and Missiles

Target Type	Peak Static Overpressure (pounds per square inch)
Aircraft - open	3[a]
Aircraft - in hangarettes	50[b]
Missiles - towed	10[c]
Missiles - silos	150 - 1000[d]

[a] Criterion for severe damage to parked transport aircraft from Table 5.153, p. 226, of The Effects of Nuclear Weapons, Samuel Glasstone and Philip J. Dolan, eds., third edition, 1977, prepared and published by the United States Department of Defense and the United States Department of Energy.

[b] See text. Although shallow-buried structures which can withstand 100 - 200 psi are possible (see The Effects of Nuclear Weapons, Ibid., p.229) the most vulnerable element of the hangarettes would probably be the doors.

[c] The static overpressure associated with effects from a 40 KT weapon sufficient to overturn a motor vehicle. Vehicles are primarily sensitive to dynamic overpressure and the correct criterion would be yield sensitive. See The Effects of Nuclear Weapons, pp. 189, 191, 222-224.

[d] The upper range is probably unattainable for the first or second generation missiles and silos of a smaller power without extensive technical assistance from a nation with advanced forces. See text.

The criteria of Table C-1 are expressed in peak static overpressure. In actuality some targets may be more sensitive to other weapon effects, such as dynamic pressure, electromagnetic pulse (EMP), or ground-shock. Moreover, overpressure-sensitive targets may be sensitive to the duration of the blast wave as well as its maximum. In such a case, the appropriate peak overpressure criterion will be a decreasing function of yield. But this effect is less than the degree of uncertainty or arbitrariness in our calculations, and hence we have not attempted to include it in our calculations.

Table C-2 gives the distance from ground zero at which these damage criteria will be met for nominal 40 kiloton and 1 megaton weapons.

Table C-2

Effects Radii

Target damage criterion - overpressure (psi)	Yield:	Effect Radius (Meters) 40 KT	1 MT
3		3400	9900
10		1500	4400
50		510	1500
150		350	1000
1000		170	510

Note: Weapons assumed to be detonated at a height of burst to maximize the desired effect radius.

Source: D. C. Kephart, Damage Probability Computer for Point Targets with P and Q Vulnerability Numbers, R-1380-1-PR, Santa Monica, Calif.: The Rand Corporation, February 1977.

Aircraft parked in the open are quite vulnerable to damage by a nuclear blast's overpressure. Properly constructed hangarettes can provide some blast protection. Nuclear blast shelters must be distinguished from ones constructed for resistance to conventional weapons only, as the latter type may protect against impacting objects yet still allow a nuclear weapon's damaging overpressure to enter through such openings as vents. As Table C-1 indicates, a blast protection factor of up to 50 psi can be expected from a properly constructed hangarette. However, these aircraft shelters are costly and are, to a degree, inconvenient for operations. Commonly, each hangarette must be built to contain a single aircraft, and sheltering a fleet of several aircraft thus may be expensive. This would be particularly so if a nation attempted to use relatively large aircraft, such as commercial transports instead of more compact fighters or fighter-bombers.

Quick-reaction time of a sheltered aircraft may be significantly less than for alert, but exposed, aircraft parked on a runway. The sheltered aircraft would undoubtedly have to ride out an attack. If blast shelters are utilized, however, they may reduce tenfold the area over which an enemy nuclear weapon is effective.

Missile silos potentially can offer their contents even greater blast protection than can nuclear aircraft shelters. Table C-1 includes peak overpressure resistance for exposed missiles--such as on a truck or trailer, and for missile silo hardness of 150 psi and 1000 psi. The 1000 psi case used here is primarily illustrative, as it approaches the hardness of contemporary Soviet and American ICBM silos and probably will be beyond Taiwanese means for some years to come. Even for the 150 psi case, however, silo design,

testing, and construction could be an arduous task. Structures designed for high degrees of peak overpressure protection must also be built with a mind to other nuclear weapon effects associated with the design overpressure. Ground motion, nuclear radiation, and electromagnetic pulse (EMP) all are nuclear explosion phenomena that may temporarily or permanently disable a missile silo, its contents, or associated personnel and facilities. It might take the Taiwanese several years and some large-scale tests to perfect the design of a silo system resistant to all these nuclear weapons effects. Once accomplished, a ballistic missile sheltering system would significantly reduce the expected damage area from a given size nuclear weapon, but whether this would help will depend on factors such as the accuracy of the attacking weapons.

The PRC might attack with either bombers or missiles. In either case they would undoubtedly have the capability to arm these with thermonuclear warheads in the megaton range if this were required for a successful attack. We include calculations with 40 kiloton weapons as well, however, to illustrate what might be needed against other nascent nuclear forces by adversaries who have only fission weapons.* If bombers are used, a CEP of 500 meters seems reasonable. The PRC might achieve about this accuracy with missiles as well, but we take as our basic case the more modest achievement of a 2 kilometer CEP. Table C-3 presents calculated probabilities of severe destruction per delivered weapon for the assumed yields and CEPs.

The PRC would not want to count on all its bombers penetrating defenses, nor could they assume that all their missiles would prove reliable. In either case we assume an overall delivery probability of 80 percent. Table C-4 presents

*These are used, for instance, in the study of Korea.

Table C-3

Single Shot Kill Probability

(Delivery Probability = 100%)

Target Hardness (psi)	Yield CEP	Weapon: 40 KT 500m	40 KT 2000m	1 MT 500m	1 MT 2000m
3		1.00	0.82	1.00	1.00
10		0.98	0.32	1.00	0.93
50		0.49	0.044	0.98	0.31
150		0.28	0.026	0.90	0.16
1000		0.080	<0.01	0.49	0.044

Source: Kephart.

Table C-4

Single Shot Kill Probability and Number of Shots for at Least 0.9 Cumulative Kill Probability

(Delivery Probability = 80%)

Target Hardness (psi)	Yield CEP	Weapon: 40 KT 500m	40 KT 2000m	1 MT 500m	1 MT 2000m
3		0.80(2)	0.65(3)	0.80(2)	0.80(2)
10		0.79(2)	0.25(8)	0.80(2)	0.74(2)
50		0.39(5)	0.035(65)	0.79(2)	0.25(8)
150		0.22(10)	0.016(139)	0.72(2)	0.13(17)
1000		0.064(35)	<0.01	0.39(5)	0.035(65)

Note: Number in parentheses is the number of weapons per target required to achieve at least a 90% cumulative probability of destroying the target.

the overall probabilities of severe destruction per weapon assigned, i.e., the product of delivery probability and terminal kill probability. The number of weapons that must be assigned to a target to accumulate at least a 90 percent probability of severe destruction is also given. These must come from different carriers, since it is assumed that each shot is an independent event in the probability sense.

Aircraft shelters can, as Tables C-3 and C-4 indicate, significantly improve survival probabilities against inaccurately delivered or fission-yield (40 KT) weapons. Likewise, against attack by all but accurately delivered megaton weapons, missile silos can reduce the probability of destruction by a factor of three or more.

Requirements to Attack Sheltered Aircraft

Suppose the Taiwanese protected their nuclear strike aircraft in hangarettes hardened to 50 psi--with two hangarettes at opposite ends of the runway on each of five airfields. The two hangarettes on a field would have to be well separated so that one large weapon detonated between them wouldn't destroy aircraft in both. This would require a separation distance of something over twice the weapon radius for the largest weapon considered a threat--thus a separation on the order of 30 or more kilometers against megaton yield weapons. From Table C-4, to achieve a kill probability of 90 percent against a single target the following weapon needs are generated:

	Sheltered Aircraft; psi = 50			
	Aircraft: CEP = 500 m		Missile: CEP = 2 km	
	40 KT	1 MT	40 KT	1 MT
No. weapons	5	2	65	8

Thus using aircraft-delivered weapons, twenty 1-MT or fifty 40-KT weapons would be required to have an expected destruction level of 90 percent, i.e., nine out of ten of the hangarettes. For a missile attack the corresponding numbers are 80 and 650 (the use of the latter by the CPR--a 40 KT warhead on a ballistic missile of low accuracy--seems improbable).

The above estimates are based on the assumption that the attacker makes no attempt to gather information during the course of the attack and uses this information to guide the rest of the attack. In some cases post-attack reconnaissance or so-called "shoot-look-shoot" tactics can greatly reduce the weapons required to achieve a given outcome or can, for a fixed weapon inventory greatly reduce the expected number of targets surviving or the probability that the number of targets surviving is at or below a given level.

Thus the PRC might want to try to destroy all the protected aircraft and have a high probability of success. Assume they use aircraft with one megaton bombs, so each weapon used would have an overall single-shot probability of kill of 0.79.

For these conditions, three different degrees of targeting freedom can be described.

- Blind. Weapons allocated in advance; and no subsequent retargeting opportunity.
- Limited Shoot-Look-Shoot (SLS). Weapons easily retargeted from one hangar cluster to another at a single airfield, but not to a different airfield.
- Unlimited Shoot-Look-Shoot (SLS). Weapons easily shifted from one target to another.

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*At present the ROC has two airfields with runways at least 3.66 km long (12,000 feet) and ten with runways over 2.44 km (8,000 ft) and less than 3.66 km long. (National Basic Intelligence Fact Book, CIA Publication GCBIS 77-002(U), July 1977, p. 40.)

Suppose the mission objective is to have a 90 percent chance that all ten targets are destroyed. If all targets are attacked in a symmetric fashion, this means the kill probability against each target must be at least $(.9)^{.1} = .9895$. The three degrees of targeting freedom then generate the following weapon requirements:

Weapons Required
(90% chance all hangarettes are destroyed.)

Blind	30
Limited SLS	25
Unlimited SLS	15

Silo-Sheltered and Mobile Missiles

In calculating the PRC's requirements to destroy 20 Taiwanese nuclear missiles in silos the following single-target requirements for 90 percent probability of destruction are taken from Table C-4:

Missile silos; psi = 150

	Aircraft: CEP = 500 m		Missile: CEP = 2 km	
	40 KT	1 MT	40 KT	1 MT
No. Weapons	10	2	139	17

Obviously either good delivery accuracy or large yield and preferably both is necessary to keep the total requirement of achieving 90 percent kill probability on each of 20 such targets to a reasonable level. If the CPR used shoot-look-shoot tactics the weapon requirements would be cut about in half. But it could be difficult to ascertain whether the attack on a particular target had been successful or not.

If or when a nascent nuclear power can construct a combination of missiles and hardened silos it will be able to tax the requirements of another nuclear

power unable to deliver accurate or very high yield weapons. However, in the case at hand, the CPR should be able to muster the required forces in aircraft, if not in missiles. Although the Taiwanese have formidable air defenses, these could be destroyed by a precursor attack with missiles. Any attempt to launch the Taiwanese missiles during this precursor could be thwarted by the use of "pindown" tactics.

The Republic of China (ROC) might consider concealing the location of its missiles, either by hiding them or by moving them around. Attempting to hide them would be of uncertain effectiveness since Taiwan would never know if their security had been penetrated. When one considers the problems of maintaining security, reliable communications and control, and the exotic requirements for maintenance of nuclear warheads, rocket motors and fuels, and guidance systems, it seems doubtful a country such as Taiwan would find it practical to attempt to conceal the location of its missiles.

Another approach is to deny the attacker knowledge of the exact location of missiles by making them mobile. It would probably not be practical to try to maintain road or off-road mobility on a day-to-day basis. There would then be the problem of depending on warning to move the missiles out of their depots. Even if the missiles were out, they would probably be vulnerable to search and destroy missions, particularly if the missiles are to be held for a last-ditch effort. As a practical matter, land-mobile nuclear missiles do not seem to be a reasonable alternative for Taiwan.