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# How Dark Might East Asia's Nuclear Future Be?

Edited by Henry D. Sokolski

September 2016

NPEC

Nonproliferation Policy Education Center

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Series Editor: Henry D. Sokolski

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Cover images, from top left clockwise: 1) Rokkasho reprocessing plant in Japan; 2) a Chinese DF-41 intercontinental ballistic missile; 3) the Wolsong Nuclear Power Plant in South Korea; and 4) a North Korean underwater missile launch.

## Nonproliferation Policy Education Center

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# Introduction

## How Dark Might East Asia's Nuclear Future Be?

Long considered unlikely, the prospect of South Korea and Japan getting nuclear weapons and China and North Korea significantly ramping up their arsenals has become the next big worry. This June, CIA Director John Brennan testified that nuclear proliferation was "a blinking red light" and spotlighted North Korea's nuclear misbehavior as a key concern.[1] His testimony came only weeks after a *The New York Times* interview of Donald Trump in which the Republican presidential hopeful emphasized the inevitability and possible benefits of Japan and South Korea going nuclear.[2] Since then, the question of whether or not it is in Washington's interest to push nonproliferation in East Asia has been a hot topic in and outside the Beltway.

The debate could not be more timely—decisions will be made over the next 36 months in Tokyo, Beijing, Pyongyang, Seoul, Washington, and Paris that could easily lock East Asia into a fissile material arms race. Japan already has over 2,000 weapons' worth of nuclear explosive plutonium stored on its soil. In addition, it plans to open a large reprocessing plant late in 2018, which is designed to chemically separate enough plutonium from Japanese civilian power reactor fuel to make roughly 1,500 nuclear weapons' worth of plutonium a year.[3] China, meanwhile, continues to modernize and expand its nuclear weapons arsenal and is currently negotiating with the French government-owned firm EDF-AREVA to buy a reprocessing plant similar in size to the Japanese one.[4]

All of this has gone down poorly in Seoul: Officials there have made it clear that when it comes to dangerous nuclear activities, South Korea should be allowed to do whatever Japan does. Then, there is North Korea, whose own provocative nuclear misbehavior is yet another worrisome driver of tensions in a region already ripe with historical and territorial disputes. Unless proper actions are taken now, a much more nuclearized East Asia is likely.

How tolerable a more nuclear-armed East Asia might be, of course, depends on just what it would look like. This brief volume is dedicated to trying to find out. Each section offers detailed projections of what the future holds for a more nuclear-armed China, Japan, North Korea, and South Korea. None are predictions. Instead, their purpose is to encourage deeper debate about the security implications of where we

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1. Ellen Mitchell, "CIA chief outlines 'blinking red lights' for White House hopefuls," *Politico*, June 16, 2016, available at http://www.politico.com/story/2016/06/john-brennan-trump-clinton-224434.

2. Maggie Haberman and David E. Sanger, "Transcript: Donald Trump Expounds on His Foreign Policy Views," *The New York Times*, March 26, 2016, available at http://www.nytimes.com/2016/03/27/us/politics/donald-trump-transcript.html.

3. Henry Sokolski, *Underestimated: Our Not So Peaceful Nuclear Future,* Arlington, VA: NPEC, 2016, pp. 71-72 available at http://www.npolicy.org/books/Underestimated/2edition.pdf.

4. "Chinese reprocessing plant to start up in 2030," *World Nuclear News*, September 24, 2015, available at http://www.world-nuclear-news.org/WR-Chinese-reprocessing-plant-to-start-up-in-2030-2409155.html.

are headed.

In the first chapter, Ian Easton, a research fellow at the Project 2049 Institute, presents three different possible nuclear futures for Japan: Tokyo acquiring a small arsenal that would support U.S. nuclear targeting plans, Japan building a much larger independent force, and Japan remaining nonnuclear but investing heavily in active and passive defenses to undermine North Korea's and China's nuclear strategies. Easton projects costs, deployment numbers, target sets, and offers explanations of why Japan might take these courses of action.

Mark Stokes, Executive Director of the Project 2049 Institute, then describes why and how China might greatly expand its nuclear arsenal. A key driver, independent of current regional tensions, he argues, is China's move toward more land and sea-based mobile nuclear systems that demand greater delegation of launch authority.

This then brings us to the case of North Korea. As Shane Smith, Senior Research Fellow at the National Defense University's Center for the Study of Weapons of Mass Destruction, notes, Pyongyang has a number of reasons to upgrade its arsenal. All of them require more and better nuclear weapons, which North Korea is now developing.

South Korea is considering its options. Late in July, Representative Won Yoo-chul of South Korea's ruling Saenuri Party and a staunch supporter of President Park Geun-hye, announced his formation of a parliamentary working group to create a consensus on when and how Seoul should acquire nuclear weapons.[5] His concern is that the U.S. may abandon South Korea if Donald Trump becomes president, giving Seoul no other choice but to get its own bomb. How South Korea might do this is examined by Charles D. Ferguson, President of the Federation of American Scientists. In his chapter, Ferguson details how South Korea could readily exploit its civilian nuclear infrastructure to make scores of nuclear weapons relatively quickly.

In a separate concluding chapter, I offer a series of graphics originally presented at the RAND Corporation detailing how Japan, South Korea, and China could use their civilian nuclear sectors to make more bombs. The numbers of bombs that could be made are both large and stunning.

Will East Asia go far more nuclear than it already has? Much will depend on how reliable the U.S. is seen as a nuclear ally to Japan and South Korea. Will France seal a deal to sell China a large reprocessing plant? Yet another question is when might Japan open up its planned reprocessing plant and what reaction this might prompt by South Korea. All of this is in play. What ultimately will happen is unclear. What is not is what is at stake. That much this volume makes clear.

Henry D. Sokolski
September 2016

5. Jun Ji-hye, "Pro-Park lawmaker planning forum for nuclear armament," *The Korea Times*, July 25, 2016, available at http://www.koreatimes.co.kr/www/news/nation/2016/07/116_210230.html.

# Chapter 1

## Japanese Strategic Weapons Programs and Strategies: Future Scenarios and Alternative Approaches

*Ian Easton*

*Introduction*

The balance of power in Northeast Asia is shifting in ways that are dangerous to the security of Japan. That is certainly how the picture has appeared to the eyes of many observers in recent years.[1] The reasons are many, and they are compelling. First, China's emergence as a regional military power has taken place in a far more disruptive fashion than was expected. Attempts to shape China into a "responsible stakeholder" have failed. Beijing now threatens Tokyo with a growing number of coercive air and maritime operations around the Japan-administered Senkaku (Diaoyu) Islands. Chinese fighters, bombers, ships, and submarines have greatly expanded the scope of their training operations. They now frequently pass through Japan's Ryukyu Island Chain on their way out into the Philippine Sea where they conduct exercises that undermine confidence in the ability of the U.S. Navy to intervene in a regional conflict.[2]

At the same time, China's strategic rocket force, the Second Artillery, has deployed new ground-launched missile systems capable of holding air force and naval bases in Japan at risk. One missile variant, the anti-ship ballistic missile, even appears capable of striking American aircraft carriers and command ships at sea from the sanctuary of China's mountainous interior. In addition, the Second Artillery is expanding its nuclear weapons stockpiles and deploying new intercontinental and submarine-launched ballistic missiles at a time when the United States, Russia, and other nuclear powers are reducing their strategic capabilities in compliance with arms control agreements.

Making matters worse, the 2014 Ebola epidemic in Africa and intermittent but serious fighting in Ukraine, Syria, Afghanistan, Iraq, Central Africa, Gaza, and elsewhere have drawn the attention of American policymakers away from Japan. When the American foreign policy elite does focus on the Asia-Pacific region, it tends to fixate on mounting tensions in the South China Sea, instability in Thailand, and potential reforms in Burma. Too often Japan's critical importance to the United States' interests is overlooked, and the alliance becomes just one more issue for busy American leaders to manage. There is precious little time

1. Chief of Naval Operations Public Affairs, "Japanese Prime Minister and CNO Discuss Maritime Cooperation," *U.S. Navy*, May 27, 2014, available at www.navy.mil/submit/display.asp?story_id=81247; and Minister of Defense Itsunori Onodera, *On the Publication of the Defense of Japan 2013*, Tokyo: Ministry of Defense, 2013, available at www.mod.go.jp/e/publ/w_paper/pdf/2013/01_Foreword.pdf.

2. Marina Malenic and James Hardy, "Chinese strategic capabilities expanding, a US government report warns," *IHS Jane's Defence Weekly*, November 20, 2014.

for long-term strategic thinking in Washington in the midst of perpetual crisis.

North Korea is a shared concern for both Washington and Tokyo.[3] Its young leader, Kim Jung-un, has demonstrated an even greater penchant for nuclear blackmail than his deceased father, and Pyongyang may soon press forward with more nuclear tests. However, in spite of the mounting tension, South Korea has been gripped by a wave of anti-Japanese sentiment, and Seoul often refuses to work with Tokyo to advance their shared bilateral security interests. The troubled relationship between South Korea and Japan has even spilled over to the United States, making their bilateral disputes disruptive to America's relations with its two key Asian treaty allies.[4] Ironically, Japan and South Korea do share one thing: a strict adherence to their respective "One-China" policies. This not only stifles their ability to cooperate with Taiwan, which has a capable military and shared security interests, it further erodes their ability to work in concert with the United States to balance against an increasingly well-armed and aggressive China.

Perhaps the most worrisome aspect of the Asian security situation is being generated from outside the region itself. A series of dysfunctional congressional actions in Washington have drastically cut the U.S. defense budget and left America's top military leadership powerless to properly allocate funds for the rebalance to Asia.[5] This has affected Japanese confidence in American security commitments. Confidence has also been weakened by the ongoing reductions in the United States' nuclear force posture, and this situation has been further exacerbated by a series of embarrassing scandals within several components of the U.S. Strategic Command.[6] At a time when North Korea is defiantly engaging in nuclear testing and China is rapidly building up both its nuclear and conventional warfighting capabilities, the United States is evincing signs of national security overload and strategic paralysis. What seemed impossible just a few years ago appears to be coming to pass: American primacy in the Western Pacific is fading. Japan finds itself at a strategic inflection point.

This chapter will present the reader with three future scenarios that illustrate alternative pathways Japan could take to improve its long-term national security outlook and enhance its defense capabilities. These scenarios are neither exhaustive nor predictive. There are always many possible courses of action a powerful state like Japan has available to it, and many more courses that are plausible. For the sake of simplicity, we will explore only three scenarios and leave judgments regarding how probable or plausible they are to the reader. The first scenario will posit that Japan might decide to acquire a small number of nuclear weapons in the relatively near future. The second scenario will posit that Japan might pursue a large-scale nuclear weapons program. The third scenario will posit that Japan might invest more into advanced conventional capabilities and remain a nonnuclear weapons state.

All three of these scenarios rest upon several basic assumptions that are important to identify. The first and most important assumption for these scenarios is that Japan's ally, the United States, will be constrained in its ability to rebalance toward Asia, and, as a result, America's military predominance in the Pacific will

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3. Dennis Blair, "The Ally America Needs," *Politico Magazine*, July 3, 2014, available at www.politico.com/magazine/story/2014/07/the-ally-america-needs-108560.html#.U8lbcvldVIc.

4. Samuel J. Mun, "'Destined to Cooperate': Japan-ROK Naval Cooperation and its Implications for U.S. Strategic Interests in Northeast Asia," Futuregram 14-001, Arlington, VA: Project 2049 Institute, March 4, 2014, available at www.project2049.net/documents/Japan_ROK_naval_cooperation_Sam_Mun.pdf.

5. John T. Bennett, "Carter: Budget Cuts Threaten US Interests," *Defense News*, March 3, 2015, available at www.defensenews.com/story/defense/policy-budget/congress/2015/03/03/isis-ukraine-pentagon-budget/24330491/.

6. Holly Yan and Faith Karimi, "U.S. Nuclear Weapons: Military Nuke Officers Beset by Recent Scandals," *CNN News*, January 16, 2014, available at www.cnn.com/2014/01/16/us/military-nuclear-scandals-timeline/.

decline. The second assumption is that the People's Republic of China (PRC) and the Democratic People's Republic of Korea (DPRK) will continue to pose growing threats to Japan's security. The third assumption is that Japan will fail to work successfully with the Republic of Korea (ROK or South Korea) and the Republic of China (ROC or Taiwan) to meet shared security interests.

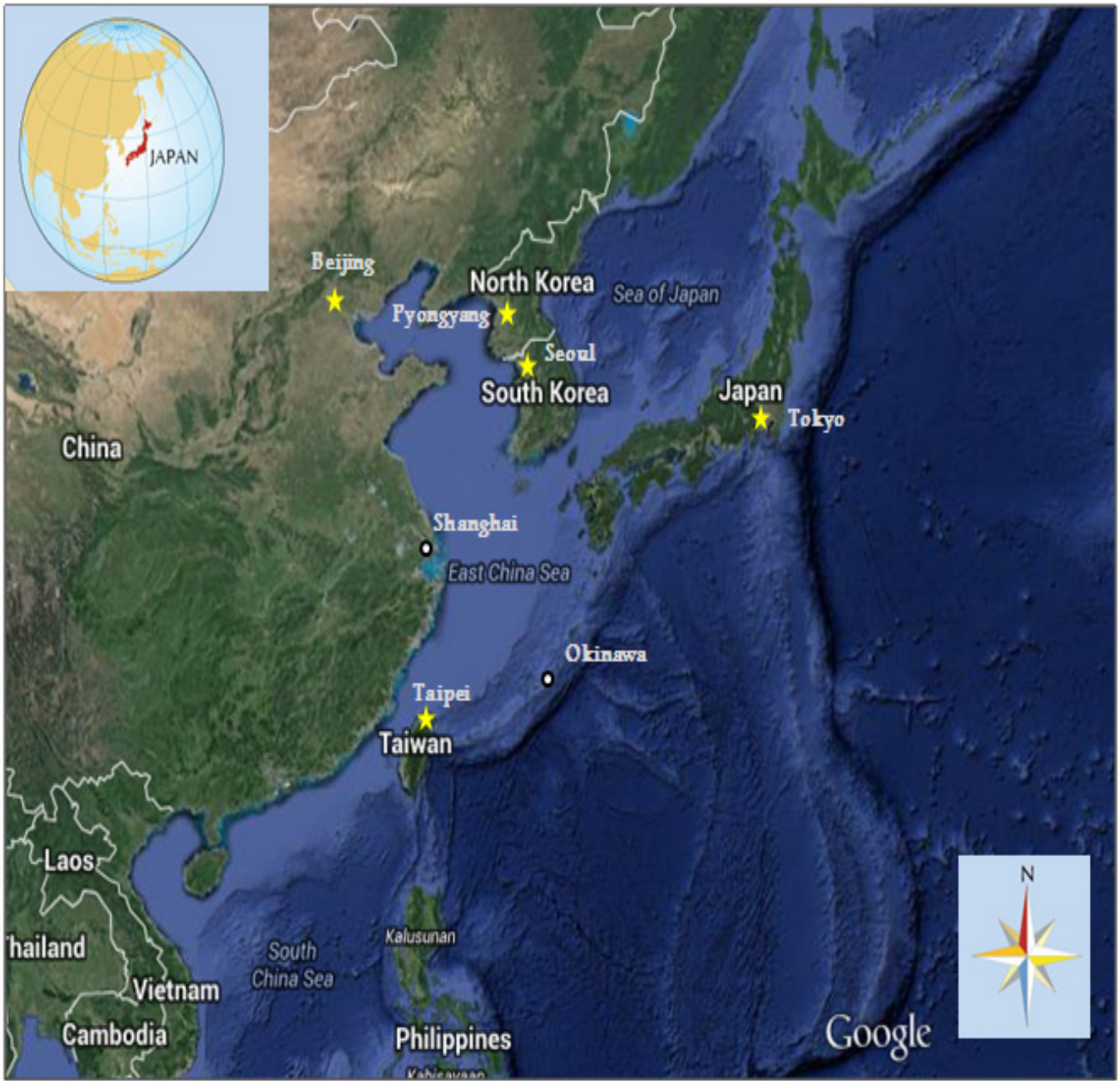


**Figure 1: Map of Japan and Northeast Asia**

The fourth assumption is that Japan would prefer to have a strong relationship with its American ally even if the alliance becomes strained by crisis. The final assumption is that Japan will not concede to the demands of China or North Korea when important issues are at stake.

This chapter will attempt to briefly evaluate the respective implications of the three scenarios for Japan's long-term defense. It will ask the following questions: (1) What would Japan's overall strategy be in each scenario? (2) What doctrine and operational targets might Japan select to realize its strategy? (3) What new weapons would Japan need to neutralize the targets it selected? (4) How much might those weapons cost? (5) What would the American and regional reactions be to Japan's new weapons programs, and what action-reaction dynamics could follow?

### *Three Scenarios*

The three scenarios discussed in the following section all assume that Japan will, at least to some degree, increase its defense spending and change the nature of its defense posture over the coming years. This is not a sure thing. Japan's defense budget and posture has remained more or less static for decades. Long-standing policies, even bad ones, carry with them the weight of institutional inertia, so it is possible that Japan could attempt to maintain its current "status quo" pacifist strategy and keep defense spending to a mere one percent of its GDP. However, if it does, Japan's security situation will almost certainly continue to worsen, perhaps fatally. It therefore seems improbable that Tokyo would choose this option, so it will not be discussed in detail.

This chapter assumes Japan is changing and will continue to change. The notion that everything will stay more or less the same tomorrow as it is today runs counter to the five assumptions that drive this study. Put another way, a long-term "status quo" Japanese defense policy is incongruent with the trends and provides little comparative value. This chapter is interested in exploring new strategic approaches. While not often discussed in the existing literature, Japan might actually decide to develop nuclear weapons. This could happen if Japan becomes disappointed by the United States and concludes that it needs to take serious steps to deter China and North Korea – and force American attention to its legitimate security concerns. Or Japan, for a variety of reasons, could feel compelled to field a large, independent nuclear force that might number in the hundreds of warheads at first, but then eventually reach well into the thousands. Finally, Japan might decide that its nuclear option remains too risky and unpopular, and instead Tokyo might pursue an improved nonnuclear strategy. These are our three scenarios.

### *Scenario One: Small Nuclear Force*

As Graham Allison and Philip Zelikow point out in their classic book *The Essence of Decision*, states make history altering decisions for reasons that are often difficult to assess in the after light, even for the principal decision makers who were there.[7] As such, it may be useful to avoid an exhaustive discussion of why Japan might develop and field nuclear weapons. Indeed, there are many ways in which Japan might decide to acquire nuclear weapons. Some are explored in the appendices. For the purpose of this section, however, we will simply assume that Japan does decide to go nuclear in the relatively near future. Having made the leap, we can then consider what that might entail and what might follow.

#### Strategy

The Japanese government is as cautious, rational and logical as any in the world. As such, if it did go nuclear, Japan's policy could be expected to be established on top of a well-laid, strategic foundation.

7. Graham Allison and Philip Zelikow, *The Essence of Decision: Explaining the Cuban Missile Crisis*, New York: Longman Publishing, 1999.

One possible and perhaps attractive strategy for Japan might be to build a small nuclear force to serve as a minimal deterrent and, if deterrence failed, a modest second-strike capability. Japan's political objective might be to integrate its nuclear weapons into the U.S. nuclear umbrella as soon as conditions allowed. That way Japan could both improve its ability to deter China and North Korea, and increase its strategic value and importance to its ally, the United States. Naturally, Japanese military strategists might not consider the nationalistic utility of nuclear weapons, but national pride would also be a factor in such an important political decision. Strong politicians in a democracy like Japan's make decisions with the popular will of voters in mind. They could hardly be successful otherwise.

## Doctrine and Targeting

Once the overall strategic objective had been established, Japanese military planners would want to begin thinking about how they could realize the nuclear ambitions of their political leaders. It would be logical for the military to be desirous of keeping weapons requirements within the limits of their political guidance. If the strategy was to field the smallest nuclear force possible, and in such a way as to elicit the minimal international (or at least American) concern possible, target selection would be important. One option might be to target specific locations in central Beijing and Shanghai, the respective political and economic hearts of China, and Pyongyang, the capital of North Korea. Small-yield warheads, it might be thought, could be delivered with precision to increase strategic and operational effects. One of the attractions of this scheme would be to initially avoid unnecessary civilian deaths, while holding out the chance for city centers to be completely destroyed. These would not be large "city busting" nuclear weapons. Such a targeting policy might be judged to maximize potential strategic effects, while minimizing potential pitfalls in alliance relations and the chance for radioactive fallout to devastate Japan.

China would be the most challenging operational target for Japanese military planners, so it is here they would likely focus their cardinal energies. After a period of detailed study, Japanese planners might notionally select eight important targets around Beijing and six in greater Shanghai. Target categories might include leadership compounds, national command and control facilities, key military headquarters and government ministries, airports and seaports, and symbolic cultural sites. Each possible target would be measured for its strategic importance and attendant level of strike priority during a war. Strategic games and studies would be conducted to test various options and ideas. Great importance would be placed on research into how nuclear weapons might affect the decision making of the Chinese Communist Party's top leadership in a way favorable to Japan. In the context of contemporary Chinese politics, Japan would be mistaken only to focus on operational or tactical level details. With so few nuclear weapons notionally available, each target would have to count for a lot in order for the strategy to work, at least until such a time as Japan could form joint targeting plans with the United States.

## Weapons

Once Japanese leaders, both civilian and military, had an idea of what they wanted their nuclear weapons to do, they could then provide basic requirements to the designers and manufacturers tasked with producing the weapons. The questions those building Japan's nuclear weapons might ask would be: how many do you want, and how big do you want them? The answers to those questions would vary depending on the level of optimism or pessimism felt by Japan's Joint Staff. Their operational plans would likely be highly conservative, as is generally the case. Japanese staff planners would probably assume that the enemy's

capabilities would all work, perhaps even to the point of making giants out of those enemy systems whose performance is suspect. Japanese war plans might also intentionally underestimate what Japanese forces could achieve, even when fighting alongside their American allies.

With highly conservative planning assumptions, Japan might decide it would require up to six low-yield (5-20 kiloton) nuclear weapons per target to have a sufficiently high probability of hitting and neutralizing each. This may seem like a lot of bombs per target, until one considers the details. First, Japan would have to plan on suffering a surprise first strike against its nuclear force. Some weapons would be knocked out. Next, Japan would have to assume it would suffer some force attrition related to technical problems. In addition, some of Japan's nuclear weapons might not be available when they were needed because they were undergoing periodic repairs or maintenance-related upgrades. Not every bomb in a nuclear weapons arsenal is ready for war all the time. Finally, Japan would have to plan on losing some of its weapons before they could reach their targets. Not all could be expected to make it through China's thick screen of air and missile defenses, especially around Beijing and Shanghai, China's most vital cities. The planning situation would be vastly better with North Korea, but again, a China scenario would have to drive Japanese operational planning because it is the most challenging. Responsible defense establishments must always assume for the worst and think tragically to avoid tragedy.

If the Japanese Joint Staff's study results led them to feel more optimistic, or if Japan's political or financial situation allowed for only a very few nuclear weapons, a less conservative planning assumption could be used. Here a critical question would be what delivery vehicle or vehicles Japan plans on using. Obviously, the more survivable and reliable the means of delivery, the fewer nuclear weapons would be required by operational planners. Japan today does not have long-range cruise missiles or ballistic missiles. But even if it did, it seems very unlikely that its first generation nuclear warheads would be miniaturized to the extent required for ease of missile-borne delivery. As is the case for nearly all young nuclear states, Japan would look to aircraft to deliver its nuclear bombs until something better became available. Such an approach would save Japan time and money.

The only aircraft Japan has in its current inventory for striking surface targets is its indigenous F-2 fighter, which is a modified variant of the American F-16. These fighters could hardly be expected to defeat China's air defenses around Beijing and Shanghai, except if used in close coordination with large fleets of Japanese F-15s and decoy drones. Even then, the losses would likely be staggering, though that may not matter much in a nuclear war scenario where the life of Japan was hanging in the balance. Improving the situation considerably, Japan will stand up one or two squadrons of new F-35 joint strike fighters by 2020 (assuming that the aircraft is not further delayed in its production). Japan is also developing its own indigenous F-3 stealth fighter. Stealthy strike fighters would be a far better choice than F-2s for the nuclear delivery mission.

In any event, Japan's Joint Staff planners might, under political pressure, posit that two nuclear bombs would be sufficient to hold a single Chinese strategic target at risk. Japanese planners could therefore notionally require somewhere between 28 and 84 nuclear weapons if they assume for only 14 notional targets. Japan could deliver these weapons with anywhere between two to six squadrons (roughly 40 to 120 airframes) of strike or multirole fighter aircraft (F-2s, or future F-35s or F-3s). Given the unfavorably high probability of force attrition, each Japanese fighter would likely carry one nuclear bomb so that no more than one strategic weapon would be lost with each fighter shot down.

## Budget

The next question is how much a Japanese nuclear weapons program, as described above, would cost the taxpayers of Japan. Here nothing but speculation is available. It is impossible to accurately assess the cost of a notional Japanese nuclear weapons program because so little unclassified data exists that could be used to make a useful comparison. It must also be recognized that weapon costs vary greatly between countries. For illustrative purposes, however, Table 1 provides a notional estimate of what a small nuclear force might cost Japan. Note that these estimates do not include the cost of future conventional capabilities Japan would also need to acquire in support of its nuclear force. Note also that budget numbers tend to be highly misleading in even relatively transparent weapons programs. It should be understood by the reader that these estimates, like all defense budget estimates, may be of little value other than to give a false sense of certainty. Yet there is no question that Japan, which is the second most prosperous country in the world after the United States, could very easily afford a modest nuclear weapons arsenal if it wanted one.[8] That much, at least, should be clear.

**TABLE 1. Notional Costs of Capabilities Required in Japanese Nuclear Force, Scenario One**

| | ***Weapon (Unit Cost, USD)**** | ***Number (Subtotal)*** | ***Cost Estimate*** |
|---|---|---|---|
| Scenario One | Low-Yield Nuclear Bomb ($20 million) | 28-84 ($560 million to $1.68 billion) | **High Force Number**<br>$8.34 billion --plus $350 million in reoccurring costs for personnel, and some additional training and maintenance costs<br>**Low Force Number**<br>$3.68 billion --plus $350 million in reoccurring costs for personnel, and some additional training and maintenance costs |
| | Nuclear Storage and Assembly Bunker Site ($200 million) | 2-4 ($400-800 million) | |
| | Nuclear Engineers and Related Personnel ($350k per person a year) | 1,000 ($350 million per year) | |
| | Related Modifications and Training for One Fighter Squadron ($500 million) | 2-6 ($1-3 billion) | |
| | SATCOM for Survivable Command and Control ($500 million) | 1-2 ($500 million to 1 billion) | |
| | Survivable National Fiber Optic Command and Control System ($550 million) | 1 ($550 million) | |
| | Hardened Aircraft Shelter ($8 million) | 40-120 ($320-960 million) | |

*All notional costs are highly speculative estimates. For illustrative purposes only. In 2014 U.S. Dollars. **Note that all total costs listed (except for personnel and maintenance costs, which are annual) would likely be spread out over a 5 to 10 year timeframe.

8. Japan's defense budget for the year 2013 was estimated to around 60 billion U.S. dollars. The budget available to Japan's military could increase significantly in the years ahead as Japan begins to export defense goods and services abroad, and reexamines its long-standing policy of restricting defense spending to one percent of GDP. Even if GDP growth over the next five years is slower than expected, and Japan does not lift its defense spending restrictions, it will still have one of the world's largest defense budgets. See, Deloitte, "Global Defense Outlook 2014: Adapt, Collaborate, and Invest," p. 16, available at www2.deloitte.com/content/dam/Deloitte/global/Documents/Public-Sector/gx-ps-global-defense-outlook-2014.pdf; also *The Military Balance 2013*, London: International Institute for Strategic Studies, March 2013, p. 306.

Implications

Japan's top political leaders, strategists, and diplomats would have to assess the impact that its new nuclear bombs would have on its neighbors' perceptions and actions. Japan would weigh the response of the United States and the international community heavily. It would be reasonable to expect that Japan's goal would be to control information regarding its nuclear weapons program so that information release could be calibrated to maximize deterrence and minimize political "blowback." The level of secrecy Japan decided to maintain would depend upon these factors as well as on perceptions of likely domestic opinion and reaction. Japan is one of the most transparent and legalistic countries in the world, so expectations of total secrecy could be ruled out. Moreover, it is difficult to see how Japan could effectively achieve its strategic aims of deterring Chinese and North Korean attacks (and attracting American support) if Tokyo did not make its nuclear program public to the greatest extent military and security considerations allowed; although a high degree of ambiguity might be desirable for political reasons.

Japan might assume that its discussions and early work towards its nuclear options could be ambiguous. When and if Tokyo did decide to make a bomb, it would be very difficult to keep secret. Japan would probably have to assume its program would leak, so Tokyo would want to have a force it could field quickly. Once Japan's nuclear weapons program was widely known (if indeed it was not able to have a policy of strategic ambiguity like Israel), tension would certainly follow. Most important would be the American reaction, which would likely be mixed.

Japan would want to have its top diplomats ready to make four promises to Washington: 1) to promise a no first-use policy; 2) to promise it would integrate its weapons into the American nuclear umbrella if allowed; 3) to promise to keep its nuclear weapons capabilities small; and 4) to promise it would not proliferate to other countries.

Regardless of these or any other commitments Japan could make, a period of bilateral tension driven by the arms control community in the United States and elsewhere could be expected. On the other hand, many American leaders would sympathize with democratic Japan and readily "forgive" its actions. Here the evolution of the U.S. policies toward India and Pakistan (countries which, unlike Japan, are not even close treaty allies) would be instructive. Japan might have confidence that it would be able to successfully integrate its small nuclear force into the U.S. extended deterrent structure sooner or later. The principal question might be how long that could take. The answer would only be found in an accurate assessment of the then-U.S. president's worldview and relationship with Japan's prime minister. As in any alliance, trust matters a great deal, especially in moments of crisis.

Proliferation would be a serious concern regardless of how the United States responded to the notion of a nuclear-armed Japanese ally. It can be confidently assumed that South Korea, if it found out what Japan was doing, might quickly develop a nuclear weapons force at least as large as that of Japan for reasons of national pride. However, this would likely matter very little to Japan and may actually be seen as positive. With the Chinese and North Korean threats presumably looming large for Japan, having another Asian democracy with strategic weapons might be helpful from Tokyo's perspective.

China, for its part, would react very negatively and a crisis would ensue in Japan-China relations (or more likely, the on-going crisis between them would simply worsen). Chinese over-reaction would be the largest risk facing Japan in this scenario. North Korea's reaction would also be unpredictable and would likely lash out in some way. These adversaries' responses, however, might only further justify Japan's need for a nuclear weapons program in the eyes of the world. Japan's diplomats might make the argument that whatever Chinese proliferation followed its moves was already on-going and would have happened anyway.

Given the extreme opacity surrounding China's nuclear weapons programs and the inherent impossibility of proving a counterfactual argument, Japan's argument might win favor with many international observers in the democracies of the world. Elsewhere the scene would be different and more hostile, especially in China. Nonetheless, an overtly hostile China would only work to convince many in the Japanese public of the need to have nuclear weapons for their protection. If Japan began to develop a small nuclear force and China over-reacted, and then the United States refused to integrate with it, domestic politics in Japan could drive Tokyo to seek a larger nuclear force. This brings us to the next scenario.

### *Scenario Two: Large Nuclear Force*

Another Japan than the one we know today could, for reasons that might not currently exist, decide to develop a large nuclear force. It is not within the scope of this section to discuss at length what might drive such a momentous decision, only to note that it could happen. As can be seen in the appendices, crisis and fear have a way of quickly bringing unexpected futures to pass in the history of nations. Should the United States' rebalance to Asia reverse course in a dramatic fashion, the Japanese public might lose faith in their security situation. The results of that could be profound. While Japan has been a deeply pacifistic country since 1945, its policies might change radically if the nation's life was thought to be at stake. It is well understood in Asia, but sometimes forgotten in Washington, that the only reason Japan is not already a significant nuclear power is because its faith in the protective power of United States has been near absolute.

#### Strategy

The question then is what Japan's strategy might be in a case where it felt the need for a large nuclear weapons force. The Japanese government would certainly have a strategy or quickly develop one in a crisis. Assuming Japan did feel it must go nuclear in a big way, its strategic objective would presumably be to build an independent and survivable deterrent against a Chinese first strike on its cities. Japan is less likely to feel compelled to have a large nuclear force for a war with North Korea. The threat from that corner is smaller, and it is not an existential one. Therefore, Japan's strategy might be to build a large nuclear force to deter China. It might hope to conduct nuclear operations, if that became necessary, with the United States (and perhaps other friendly countries) in a coalition fashion. However, Japan may judge that it might have to fight on its own, and plan accordingly.

#### Doctrine and Targeting

Given the above assumptions, Japanese military planners might decide to target every possible element of China's nuclear warfighting infrastructure. There are compelling arguments for this. Japan is a densely populated island nation with little strategic depth. Once a war broke out, even a limited nuclear first-use by Beijing might prompt Tokyo to want the ability to counterattack with a "disarming" nuclear second strike. In Japan's mind this could ensure that China could "never again" engage in an act of nuclear aggression against it. Given the situation, Japan may perceive even a small number of Chinese nuclear attacks directed at its major cities as an existential threat. Countries who feel their life is at danger will often take any measure available to them to ensure their survival.

Chinese cities would make for poor targets in a nuclear war. There are too many, and they are too big to

easily knock-out. More importantly, the Chinese Communist Party has a well-established track record of disregarding the welfare of "the masses" during times of crisis. Japan could perhaps threaten to kill over four hundred million civilians and the CCP leadership retort might be, "We have another billion where they came from. And the fallout from your attacks on us would kill you." China is simply too huge and undemocratic to deter with a "counter value" targeting strategy. Japan therefore might feel that it has to shatter China's entire nuclear strike force in order to survive. Target types would include national command and control centers, nuclear warhead storage and assembly sites, missiles silos, submarine bases, and all known and suspected missile launchers. If it was suspected that Chinese bombers were equipped with nuclear weapons, their airbases would be targeted too. To avoid excessive fallout that would harm Japan and others, plans might call for striking targets with extreme precision, using relatively small, deeply penetrating warheads, and airbursts when required for area targets. Surface bursts would not be allowed because of the poisonous clouds and winds they create.

Decapitating strikes against China's top leadership might be favored in theory because only the seven men on the Politburo Standing Committee would probably have the authority to order nuclear strikes against Japan. However, Japanese planners might assess that they would have little ability to know if decapitating attacks were successful given China's vast networks of tunnels and bunker complexes. China's top communist leaders could disperse to numerous underground locations and communicate through buried fiber optic cable lines during a war. Just neutralizing a few of them would not suffice.

A safer option for Japan might be to target every possible Chinese nuclear weapon and delivery vehicle. This would be a herculean task, and one that would require a tremendous effort to improve Japan's foreign intelligence collection enterprise. Finding all of China's nuclear weapons in a timely manner during a crisis would be difficult at best, and could be completely unfeasible, but it might be judged as Japan's only hope once a nuclear exchange started.

Weapons

Assuming the Japanese Joint Staff makes its operational planning assumptions relatively conservative, but with an eye to what is politically and financially possible, Japan might require an initial force of approximately 400 nuclear warheads. These would consist of a combination of low-yield (5 to 20 kiloton) and higher yield (20 to 150 kiloton) weapons. Notionally, 200 Chinese strategic targets might be selected during the first phase of the Japanese build-up. Two warheads might be dedicated to each target to reach the total requirement of 400 warheads. Japanese planners would, no doubt, recognize that China might very likely respond by increasing its nuclear forces, and developing countermeasures to hold Japanese nuclear forces at risk. As such, Japan might plan to double or triple the number of its warheads during the second phase of its build-up. Within ten years from the time it started, Japan could require well over a thousand nuclear warheads to sustain an arms race with China.

Delivery vehicles would notionally include air and submarine launched cruise missiles. Japan would arguably want a submarine and bomber heavy strategic force. Notionally, it might need anywhere from 12 to 36 submarines and 40 to 120 penetrating bombers, depending on Joint Staff planning assumptions, studies, and war game results. Submarines would be a natural choice because Japan produces some of the best diesel-electric boats in the world. Silent and stealthy, they could be modified to launch missiles from just off the Chinese coastline. Penetrating bombers, on the other hand, would require changing current Japanese laws which view bombers as purely offensive and therefore illegal. However, if Japan felt desperate enough to build a large stockpile of nuclear weapons, it would presumably have little trouble repealing

those restrictions on bombers and other "offensive" weapons. A complete paradigm shift would have already taken place. From an operational perspective, penetrating stealth bombers would be required to hit those targets deep within the Chinese interior that were out of the effective range of submarine delivered strikes. Offensive or not, bombers would likely be needed and built in this scenario.

Ballistic missiles would also be considered by Japanese strategists. These probably would be assessed as less effective than cruise missiles. This is because ballistic missiles generate a large heat bloom upon launch, and are generally easier to track and intercept in flight because they travel hot through the cold background of space on predictable trajectories before reentering the atmosphere. Stealthy, new cruise missiles could be far more difficult to track and shoot-down. Ballistic missiles have other shortcomings too. They are larger than cruise missiles, making them ill-fitted to a Japanese society that prizes the efficient use of space and admires miniaturization. Moreover, ballistic missiles are associated in the Japanese military mind with "bad guys" like China, North Korea, and Iran, whereas cruise missiles, especially American "Tomahawks", are seen as "good guy" weapons.

Budget

The reader is invited to see Table 2 for a notional estimate of what various large nuclear forces might cost Japan. As was emphasized with the budget numbers seen in scenario one, it is important to remember that these are for illustrative purposes only. They may give the unwary reader a false sense of certainty. That is not the intention. Rather, what should be clear is that Japan could afford to build a large number of nuclear weapons (and their supporting infrastructure and associated delivery vehicles) if it wanted, but the burden would be heavy. The real issue is whether or not such large defense expenditures would be seen as worth it, and there is no way to assess the unknown details of this hypothetical situation. However, it might be noted that the Japanese public has shown itself remarkably willing to sacrifice for the collective good of the society during times of trouble. This makes Japan different than most other democracies. Moreover, these societal traits would probably be vastly heightened during a severe crisis.

| **TABLE 2. Notional Costs of Capabilities Required in Japanese Nuclear Force, Scenario Two** | | | |
|---|---|---|---|
| | ***Weapon (Unit Cost, USD)**** | ***Number (Subtotal)*** | ***Cost Estimate*** |
| Scenario Two | Cruise Missile, each with Low-Yield Nuclear Warhead ($30 million) | 200-600 ($6-18 billion) | **High Force Number**<br>$149.25 billion --plus $2.5 billion in reoccurring costs for personnel, and some additional training and maintenance costs. This would include up to 1,200 nuclear weapons on an equal number of cruise missiles. However, the number of nuclear weapons could increase rapidly over time and might ultimately go well into the 1000s. |
| | Cruise Missile, each with High-Yield Nuclear Warhead ($50 million) | 200-600 ($10-30 billion) | |
| | Nuclear Storage and Assembly Bunker Site ($200 million) | 6-12 ($1.2-2.4 billion) | |
| | Nuclear Engineers and Related Personnel ($250k per person a year) | 10,000 ($2.5 billion per year) | |
| | Modified Soryu-class Submarine ($800 million) | 12-36 ($9.6-28.8 billion) | |
| | Penetrating Bomber ($500 million) | 40-120 ($20-60 billion) | **Low Force Number**<br>$52.35 billion --plus $2.5 billion in reoccurring costs for personnel, and some additional training and maintenance costs. This would include a minimum of 400 nuclear weapons deployed on an equal number of cruise missiles. |
| | SATCOM for Survivable Command and Control ($500 million) | 1-2 ($500 million-1 billion) | |
| | Survivable National Fiber Optic Command and Control System ($550 million) | 1 ($550 million) | |
| | Hardened Aircraft Shelter for Bomber ($50 million) | 40-120 ($2-6 billion) | |
| *All notional costs are highly speculative. For illustrative purposes only. In 2014 U.S. Dollars. | | | |
| **Note that all total costs listed (except for personnel and maintenance costs, which are annual) would likely be spread out over a 5 to 10 year timeframe. | | | |

Implications

In contrast with scenario one, Japan's political leaders, strategists, and diplomats might assess differently the impact that a large, independent nuclear force would have on its neighbors' perceptions and actions. They might still weigh the response of the United States and the international community, but probably only a little. This would be a Japan that had already lost faith in the ability of others to help it survive a war.

The American reaction that followed would likely be difficult to gauge, and it could be mixed. American

leaders who no longer felt completely able to guarantee Japan's security might sympathize with Tokyo's self-defense impulses. There would probably be some sense of relief in Washington that Japan was doing something to deter China and North Korea. Yet this would be combined with deep anxiety that a dangerous regional nuclear arms race could break out. Here the evolution of U.S. policies toward Israel might be instructive.

Large-scale regional proliferation would be a serious concern no matter how the United States responded to the notion of a strong and independent nuclear-armed Japan. It can be assumed that South Korea would develop its own nuclear weapons force. As was the case in scenario one, this possibility would probably matter very little to Japan's decision-making calculus. With a potentially lethal Chinese threat looming large for Japan, having another Asian democracy with strategic weapons might be diplomatically helpful from Tokyo's perspective.

China, it can be confidently asserted, would react with hysteria, both real and affected. The unique nature of China's political system would strongly affect its reaction. China's communist leaders, like totalitarians everywhere, generally care more about appearances than reality. China might accelerate its nuclear weapons buildup and deploy more countermeasures to ensure its second-strike capabilities could survive a Japanese first strike, which it would genuinely fear. A full-scale nuclear arms race would ensue between Japan and China.

North Korea's reaction would be similar to China's, but it would probably know (and care) less about what Japan was doing. North Korea is, after all, a highly insular country living on what is essentially "borrowed time." It always might lash out violently at Japan regardless of pretext. Negative Chinese and North Korean behavior, however, might only further harden the resolve of Japan to build up its nuclear forces with all possible speed and to the largest scale resources allowed.

After a period of time, the United States might change the nature of its military posture in Asia, and work to correct whatever problems undermined its reputation in the Japanese mind. Eventually Japan and the United States might be successful in positioning both their large nuclear forces for combined operations. In any event, the deterrent value of Japan's nuclear force might be tested by events before that day came. Japan might have to begin planning for a force size of thousands of nuclear weapons well before 2030 if it got into a nuclear arms race with China.

*Scenario Three: Improved Conventional Force*

Today it is safe to assert that few in Japan want their country to have nuclear weapons. Japan is still a pacifistic country in spite of the growing external threats it faces. Most in Japan abhor weapons of mass destruction, especially nuclear ones, to a degree perhaps not seen anywhere else in the world. The public even appears to struggle with the notion of "normalizing" Japan's self-defense policies so they can meet internationally accepted United Nations standards. Yet Tokyo clearly sees that the trends are not favorable for its national security, and it is working hard within the framework of the U.S.-Japan alliance to improve its situation. Tokyo knows the United States needs Japan to do more to defend itself and strengthen the alliance. There are simply too few resources available – and the challengers too great – for the United States to rebalance alone. America needs Japan (and others) to help keep the regional peaceful.[9]

Japan may now be somewhat constrained in its ability to contribute more defense resources to the U.S.-

9. See Blair.

Japan alliance, but public sentiment is changing. Japan's defense policies today are already stronger than they have been in seventy years. In the near future, the government will likely be empowered to have even stronger policies still. Assuming Japan is not willing to consider nuclear options, what might it do conventionally to help protect itself and its ally?

### Strategy

One wise strategy for Japan might be to selectively reinforce its conventional war-fighting capabilities with the long-term political aim of undermining and defeating China's missile force.[10] Such a strategy might give Japan greater confidence in the American ability to project power in the region, and also allow the U.S. military breathing room to focus on shoring up its extended deterrence posture. While Washington has the ability to modernize and strengthen its nuclear and conventional forces both at the same time, its capacity to do so under the current conditions is decidedly questionable. A Japanese strategy that focused on delegitimizing and eventually defeating China's conventional threats would contribute to regional stability.

### Doctrine and Targeting

Japan would not plan on attacking China first in a war. It would assume that China would strike it first in a large-scale surprise attack. Chinese strikes might involve large numbers of ballistic and cruise missiles, aircraft, ships, and submarines. Japan would have to survive the first strike before it could do anything else. Japan's military is not well positioned to do this today. Japanese military bases are too poorly defended. Tokyo's first priority would be to invest in base hardening and resiliency at perhaps 15 to 20 critical sites to include command and control facilities, airbases, and naval bases. Then Japan might invest in cyber and electronic warfare weapons capabilities designed to counter Chinese reconnaissance operations. China's conventional missile strikes would be ineffective without timely information regarding targets.

Once Tokyo was relatively confident that its military command and control system and key allied bases could survive and recover from a Chinese surprise attack, it might want to acquire a limited conventional counterstrike force. Potential targets in China might include Chinese military bases or units that were engaging in (or directly supporting) attacks on Japanese and American territory or fielded forces. Target categories would include strategic air defense sites, airbases, regional command posts, communications facilities, naval ports, missile launch sites, satellites, and logistics centers supporting offensive Chinese operations. This could notionally include some 200 to 300 targets and thousands of individual aim points that would be apportioned between U.S. and Japanese forces according to resources and capabilities available.

### Weapons

Tokyo might seek to acquire modest counterstrike forces including air, ship, and submarine-launched

10. For a more detailed look at this possibility, see the author's *China's Evolving Reconnaissance-Strike Capabilities: Implications for the U.S.-Japan Alliance*, Arlington, Virginia: Project 2049 Institute, February 2014, available at www.project2049.net/documents/Chinas_Evolving_Reconnaissance_Strike_Capabilities_Easton.pdf. The following discussion in scenario three draws from this study.

Tomahawk cruise missiles.[11] The type and number of counterstrike capabilities acquired would depend heavily upon the dynamics of the U.S.-Japan alliance, Tokyo's political considerations, and Japanese domestic sentiment. Japan might also want to increase its inventories of guided air-to-surface missiles, BMD missiles, and coastal defense missiles.[12] In addition, Japan might want to train and field a large force of military hackers that could conduct cyber operations. Non-kinetic space weapons might be considered as well for blinding Chinese satellites if Beijing began to launch attacks against Japan or its ally.

## Budget

Table 3 attempts to show the costs of a notional Japanese conventional force as described by this scenario. Note that these estimates do not include the cost of conventional capabilities Japan already plans to acquire. These are new systems and capabilities that Japan arguably needs and does not possess or plan to get anytime soon. It can be confidently asserted that the numbers seen in Table 3 are significantly more "realistic" than those we saw for the first two scenarios. Some open source data was available for reference. This informed the cost estimates. Nonetheless, caution is still required because the available data was not always authoritative or necessarily even applicable for Japan where a unique government, financing, and defense industrial complex exists. As always, actual weapons costs could vary considerably.

11. Nobuhiro Kubo, "Exclusive: Japan, U.S. discussing offensive military capabilities for Tokyo – Japan officials," *Reuters*, September 10, 2014, available at www.reuters.com/article/2014/09/10/us-japan-usa-military-idUSKBN0H500B20140910.

12. Sam LaGrone, "Report: Japan Interested in Aegis Ashore for Ballistic Missile Defense," *USNI News*, September 16, 2014, available at news.usni.org/2014/09/16/report-japan-interested-aegis-ashore-ballistic-missile-defense.

| **TABLE 3. Notional Costs of Capabilities Required in Japanese Nuclear Force, Scenario Three** | | | |
|---|---|---|---|
| | ***Weapon (Unit Cost, USD)**** | ***Number (Subtotal)*** | ***Cost Estimate*** |
| Scenario Three | Deeply Buried or Hardened Command and Control Center ($300 million) | 3-6 ($900 million to 1.8 billion) | **High Force Number**<br>$31.2 billion --plus $200 million in reoccurring costs for personnel, and some additional training and maintenance costs<br><br>**Low Force Number**<br>$ 9.5 billion --plus $100 million in reoccurring costs for personnel, and some additional training and maintenance costs |
| | Airbase Improvement Package ($500 million) | 3-7 ($1.5-3.5 billion) | |
| | Naval Base Improvement Package ($500 million) | 2-4 ($1-2 billion) | |
| | Additional Runway Repair Personnel ($200k per person per year with training costs) | 500-1,000 ($100-200 million per year) | |
| | Modified Soryu-class Submarine SSG ($800 million) | 3-12 ($2.4-9.6 billion) | |
| | Additional Electronic Warfare Capability Package ($500 million) | 2-10 ($1-5 billion) | |
| | Additional Cyber Warfare Capability Package ($500 million) | 2-10 ($1-5 billion) | |
| | Cruise Missile ($2 million) | 150-500 ($300 million to 1 billion) | |
| | Hardened Aircraft Shelter for fighter ($8 million) | 100-200 ($800 million to 1.6 billion) | |
| | Hardened Aircraft Shelter for large airframe (E-767, P-3C, KC-135) ($50 million) | 10-30 ($500 million to 1.5 billion) | |
| *All notional costs are highly speculative. For illustrative purposes only. In 2014 U.S. Dollars. | | | |
| **Note that all total costs listed would likely be spread out over a 5 to 10 year timeframe (except for personnel, training and maintenance costs, which are annual). | | | |

Implications

The conventional capabilities Japan might build according to this scenario would help undercut the coercive value of China's long-range ballistic and cruise missiles, and would strengthen the U.S.-Japan alliance. Japan might drastically reduce the emerging regional power imbalance. It might also take away Chinese incentives for engaging in offensive first strikes against U.S. forces deployed in Japan. From the American perspective, these would be positive developments. They could help reduce the possibility that a regional nuclear arms race might break-out.

The reaction from South Korea is likely to be relatively moderate. Few of the Japanese capabilities listed could affect Korea's interests. The exception would be Japanese cruise missiles. However, South Korea is already deploying its own conventionally-armed ballistic and cruise missiles, so it could hardly complain if Japan does some of the same things. Moreover, even a moderate Japanese counterstrike capability, properly integrated into the U.S.-Japan alliance, might contribute to deterring future Chinese and North Korean adventurism or aggression. This would clearly be in South Korea's interest.

China might react to an improved Japanese conventional force by increasing the pace of its already fast build-up of conventional and dual-capable missiles. It may also speed up its other armament programs. However, China's principal focus is aimed at defeating Taiwan. The ROC military on Taiwan already has most of the defensive capabilities listed above (and many other effective ones that are not included). Japan's acquisition of capabilities like those of Taiwan might be deemed reasonable since both countries face many similar threats.[13] Japan's conventional build-up would probably not fundamentally change the nature of China's actions. However, it might discourage the Chinese military and add complexity to its operational plans.

*Implications*

This section will briefly address the implications and key "take-a-ways" from the above three scenarios. Indeed, the three scenarios are designed to explore the implications of alternative future pathways that Japan could take to meet its defense and security needs. As was mentioned, the three scenarios were each based upon five driving assumptions. Beyond these five assumptions, however, each individual scenario otherwise differed. What happened in one did not happen in another. These scenarios try to show how different future events might lead to different outcomes, but they do not rigorously test any particular thesis regarding which events or series of events are more or less likely to lead to Japan going nuclear or staying nonnuclear.

So what do these scenarios tell us about potential Japanese strategies? U.S. Naval War College professors Toshi Yoshihara and James Holmes have previously argued that "a strategy of calculated ambiguity that at once played up Japanese capacity to go nuclear and remained noncommittal on Japanese intentions of doing so would offer Tokyo its best diplomatic option should security conditions continue to decay in East Asia."[14] These scenarios agree with this assertion. Strategic ambiguity would probably have been pursued to varying degrees in at least two of the three scenarios. Especially in the second scenario – this chapter's

13. For example, see the author's *Able Archers: Taiwan Defense Strategy in an Age of Precision Strike,* Arlington, VA: Project 2049 Institute, September 2014, available at www.project2049.net/documents/Easton_Able_Archers_Taiwan_Defense_Strategy.pdf.

14. Toshi Yoshihara and James R. Holmes, "Thinking About the Unthinkable: Tokyo's Nuclear Option," *Naval War College Review* Vol 62, No. 3, Summer 2009, p. 65.

most daring – Japan might have initially attempted to maintain some ambiguity.

The first two scenarios both paint pictures of nuclear breakout events in Japan. They emphasize the point made by Yoshihara and Holmes that "even barely perceptible signs of weakness in the U.S. nuclear posture (either perceived of real) could trigger alarm and overreaction in Japan."[15] Given Japan's utter dependency on the U.S. extended nuclear deterrent for neutralizing strategic threats to Japan's security, it holds that the greater the crisis of confidence Tokyo has in Washington's commitments, the greater the Japanese push toward proliferation is likely to be in the future.

In the first scenario, Japan probably went nuclear as the result of a series of serious crises, but the situation did not ultimately reach the threshold where Tokyo felt the need to "go it alone." Instead Japan wanted to quickly fold its capabilities into the preexisting, U.S.-led strategic deterrence structure. In the second scenario, the situation was clearly far worse from Japan's perspective. Japan ultimately felt compelled to become a full-fledged, independent nuclear power – even as it worked to maintain its alliance with Washington. In the third scenario, which is arguably the chapter's most optimistic, Japan did not lose faith in its American ally's nuclear umbrella, and so chose to invest in conventional capabilities to strengthen Japan's indigenous defense capabilities while simultaneously bolstering the U.S.-Japan alliance.

It can be seen in the three scenarios that Japan's security calculations can and almost certainly will change over the coming 15 to 20 years based upon the actions of China and North Korea. Japan's domestic political and economic situation will also impact its strategic policies. Bureaucratic and individual leader interests can be expected to influence outcomes as well. However, it would appear that the single most important factor impacting Japanese decisions regarding whether or not to go nuclear will be the behavior of the United States during periods of regional crisis. Strong displays of American leadership and commitment, not only to Japan, but also to the defense of others in the region, are likely to have reassuring effects. In contrast, any signs of weakness, either real or imagined, could have outsized effects on long term Japanese decision making.

What do these scenarios tell us about what doctrines, targeting schemes, and weapons Japan might develop? It might be noted by the reader that Japan gets strike capabilities in all three of the scenarios. In the first scenario, these capabilities are limited to a small number of low-yield nuclear bombs intended for delivery by F-2s and future F-35/F-3 strike fighters. Presumably, Japan also develops other forms of conventional strike capabilities in this scenario, but these are not discussed and probably would not be significant compared to its nuclear bombs. Scenario one assumes that Japan would only target two key cities (Beijing and Shanghai) in a fashion that holds symbols of power that the Chinese Communist Party leadership would value at risk. This is not a traditional "counter value" strategy that targets cities for the sake of threatening the wholesale slaughter of innocent people. Given the limited range of its delivery platforms and weapons – and China's dense array of integrated air defense systems – China's nuclear strike force is not considered as a target.

The second scenario presents the reader with an unlikely "black swan" type event where Japan feels compelled to develop numerous nuclear strike capabilities. Here Japan risks a nuclear arms race with China. Given the presumed severity of Japan's strategic situation in this scenario, it is posited that Japan would choose to invest in a large-scale program to outfit modified diesel-electric submarines with nuclear cruise missiles. The scenario also sees Japan building penetrating stealth bombers with air-launched cruise missiles. This gives Japan a two-legged nuclear deterrent. In terms of targeting, this scenario does not provide specifics. However, it suggests that Japan, as an independent nuclear power facing a rapidly growing Chi-

15. Ibid.

nese nuclear force, would probably quickly move toward a counterforce approach. This approach might assume that China's rigid military organizational system could have single nodes of failure, and Japan could affect paralysis-inducing strikes without targeting every Chinese strategic launch system. However, it might be assumed from this scenario that China's own ability to target Japanese nuclear strike capabilities could quickly place Tokyo in a reactive position. This scenario could see Japan attempting to achieve strategic parity with China, but with little prospect of long-term success.

The third scenario, in contrast with the first two, presents the reader with a more moderate and "realistic" alternative future for Japan. This scenario assumes that the coming two decades will not be marred by any major regional security crisis that might shatter Japan's confidence in U.S. extended deterrence. As a result, this scenario sees Tokyo decide to forego the option of developing nuclear weapons in favor of increased investments into capabilities to ensure allied power projection from bases on Japanese territory. Japan also develops its own counterstrike capabilities alongside the U.S. in order to strengthen the alliance and maintain superiority against China at the conventional level of warfare.

What do these scenarios tell us about Japanese defense budgets? Not that much, although Japan does increase its defense budget in all three. Barring some kind of dramatic economic setback or disaster, it is difficult to imagine any future scenario where Japan would not choose to incrementally raise its heretofore stagnant defense budget from its current level of slightly over one percent of GDP. Tokyo will need to keep spending more if it wants to keep a favorable balance of power against China. The U.S. defense budget is unlikely to see any significant improvements for several years to come. Put another way, Japan's government recognizes it is falling behind, and it might logically seek to correct the situation to the greatest extent which resources and public opinion allow.

In the first scenario, Japan develops a small scale nuclear program that does not appear to create undue stress on its defense budget. This scenario posits that Japan could become a nuclear state without spending too much more than it does already on defense. The credibility of the cost estimates this scenario utilizes could be called into question. The cost problem was grossly oversimplified because so little data was available for reference. It is entirely possible that the weapons programs this scenario posits would actually cost many times as much…or far less.

The second scenario represents a sharp departure in terms of the defense budget that Japan is willing to accept. This scenario assumes that Tokyo might be willing to increase its military spending in order to support a large nuclear weapons build-up. It is careful to note that the Japanese populace would probably only support this if the nation's life seemed imperiled. This scenario ignores the possibility that public sentiment might eventually turn against large spending increases if there appeared to be no end in sight to the nuclear arms racing and costs began to spiral out of control. As was the case with the first scenario, the credibility of the cost estimate this scenario utilizes could be called into question. It grossly oversimplifies the problem, and does not offer a program-by-program breakdown of potential costs. While such an exercise is outside the scope of this paper, it is important to note that the programs posited could actually present Japan with costs that are difficult (if not impossible) to accurately predict and control over time.

The third scenario is more sanguine in its projections because it does not see Japan engage in a sharp departure from its current defense spending patterns in order to develop, field, and maintain a nuclear deterrent forces. In this case Japan might make important budgetary trade-offs that improve its defensive position. For example, Japan could decide to purchase a marginally smaller number of F-35 strike fighters in order to make investments that would maximize the protection and strategic utility of its fighter fleet. After all, more advanced aircraft and pilots are of little use if they cannot survive an adversary's first

strike. Scenario three argues that investments into key capability areas such as airbase hardening and resiliency, counter reconnaissance, and counterstrike could enable Japan and the U.S. to maintain a qualitative advantage over a larger adversary. However, some moderate defense budget increases would be needed to realize all the programs this scenario envisions.

While not previously discussed in detail, technology developments would be important for these three scenarios because they all take place in the future. Given that, what might these scenarios tell us about the impact of technology? Each of the three scenarios might be thought to assume that the evolution of defense technology will matter for Japan's strategic developments. Yet the scenarios appear to assume that technological change might occur in a rather predictable and manageable fashion. They do not go as far as they might in terms of demonstrating the full extent of disruptive technologies. Inside the time horizon of the three scenarios, several technology-related problems can be forecast for the defense of Japan. The protection against offensive cyber weapons, advanced missiles, unmanned aircraft, space and "near space" weapons, long-range small submarines, and electromagnetic pulse (EMP) weapons are just a few. Other technological factors also deserve the reader's consideration, including the impact three-dimensional printing will have on defense production; the potential for highly energetic, lightweight propellants or batteries to be developed; and the role that semi- and fully-autonomous robotics systems will play.[16] Suffice it to say that technological change is likely to play a more important role in Japan's defense than these three narratives account for. Numerous defense technology changes can be foreseen over the coming 15 to 20 years that will factor into any Japanese future nuclear or conventional weapons program. Many other changes are not foreseeable, but will happen nonetheless. All technological change will force new requirements and budgetary costs upon the military, and all will influence the fluid balance that exists between offensive (revisionist) and defensive (status quo) powers and their associated militaries.

### *Conclusion*

This chapter has presented the reader with three scenarios that are designed to show alternative future pathways that Japan could take to meet its defense and security needs. For illustrative purposes, the three narratives were each based upon the following five assumptions: 1) American military primacy in Asia will wane; 2) China and North Korea will remain growing threats; 3) Japan will not be able to effectively partner with South Korea and Taiwan; 4) Tokyo will generally prefer a close alliance with Washington; and 5) Japan will not concede to Chinese and North Korean demands on issues of importance.

The three scenarios show us that there are a large number of independent variables involved in any future strategic course that Japan charts. Assuming Japan departs from its current path, one can imagine it developing a requirement for a nuclear force as small as 28 or as large as several thousand. See Table 4 for a summary of the targets and nuclear weapons (or conventional defenses) Japan might require in each scenario. One tentative conclusion these scenarios might hold is that a nonnuclear strategy focused on undercutting the coercive value of a Chinese first strike offers Japan's best hope of contributing to a more secure region in the decades ahead. Scenario three would be the best of the possible outcomes.

It must be noted that this chapter and all the findings that follow from it are incomplete and tentative. The analysis is incomplete because it rests partly on speculation and partly on currently observable trends; and straight line projections of the future (to say nothing of speculation) are notoriously misleading. The complexity of the international system is so extreme that any judgment regarding the probability of future

16. Ibid.

events happening, or not happening, must always be considered tentative at best. Yet by not imagining what the future could be analysts deny themselves the opportunity to evaluate the merits and risks associated with different options that are available to government leaders. This chapter might therefore be considered useful if it helps provide a glimpse into what alternative futures might play out over the next 15 to 20 years. That way policymakers can take better stock of their options and being preparing for the future today.

# Appendix 1: Table Four

| Summary of Scenario Results for Targets, Weapons, and Other Capabilities | | | |
|---|---|---|---|
| ***Scenario*** | ***Chinese Targets (#)**** | ***Weapons and Capabilities*** | ***Details*** |
| Scenario One | Beijing Area (8)<br>Shanghai Area (6) | Low-yield (5-20 kiloton) nuclear bombs delivered by tactical fighter aircraft | 28 to 84 bombs, depending on planning assumptions and number allotted to each target; 2 to 6 squadrons of F-2s and/or F-35s (40-120 aircraft) depending on planning assumptions and number carried by each aircraft |
| Scenario Two | Command and Control Centers (30-40) | Low-yield (5-20 kiloton) and higher yield (20-150) nuclear warheads | Phase One: 400 warheads on equal number of cruise missiles. 12 submarines (12 missiles per submarine, with 1/3 of fleet constantly at sea); and 40 bombers (6 ALCMs per bomber) |
| | Nuclear Warhead Storage Sites (10-30)<br>Nuclear Submarine Bases (2-6)<br>Missile Silos (45-90)<br>Known Missile Launch Units (100-300) | | Phase Two: at least 800-1200 warheads on up to 36 submarines (12 missiles per sub with 1/3 fleet constantly at sea), and 120 bombers (6 ALCMs per bomber) |
| Scenario Three | Strategic Air Defense Sites (30-60)<br>Airbases (15-25)<br>Regional Command Posts (15-30)<br>Communications Facilities (15-25)<br>Naval Ports (3-6)<br>Missile Launch Units (40-75)<br>Satellites (20-30)<br>Logistics Centers (50-60) | Base hardening and resiliency at 15-20 sites in Japan, electronic and cyber warfare capabilities, and conventionally-armed Tomahawk-like cruise missiles and other precision strike munitions | Base hardening and resiliency efforts would include burying or constructing shelters for command and control centers, aircraft, power stations, fuel tanks, water tanks, personnel spaces, etc. It would also include intensive training for dispersal operations and rapid runway repair and airfield damage repair |
| *All notional targets and target numbers are highly speculative. For illustrative purposes only. | | | |

# Appendix 2: Narratives to Going Nuclear

This final appendix section will present the reader with a companion reader to the three scenarios seen in the chapter. Three "narratives to going nuclear" will appear as vignettes. All three narratives are based upon the same following five assumptions that drove the chapter's three scenarios: 1) American military primacy in Asia is waning; 2) China and North Korea will remain growing threats; 3) Japan will not be able to effectively partner with South Korea and Taiwan; 4) Tokyo will continue to prefer a close alliance with Washington; and 5) Japan will not concede to Chinese and North Korean demands on issues of importance.

Beyond these five assumptions, each individual narrative will otherwise differ in content and context. By design, what happens in one will not happen in another. These narratives are intended to help the reader imagine how different future events in Asia could influence or lead to different outcomes for Japan's defense strategy. It is hoped that the narratives will be viewed as at least somewhat credible. Certainly an effort has been made to make them "realistic" pieces of creative fiction.

*Narrative One: Small Nuclear Force*

It is 2014, and Tokyo's national security elite view their surrounding security environment as "increasingly harsh" due to North Korea's ballistic missile and nuclear weapons testing programs and China's intrusions into Japan's territorial waters and airspace. There are deep misgivings in Tokyo and across the region regarding the ability and willingness of the U.S. government to meet its rhetorical commitments to Asia. Affirming the unpleasant reality that the U.S. military predominance in the Pacific is waning, Admiral Blair, the former commander of U.S. Pacific Command, calls upon the government of Japan to authorize its military commanders to form joint task forces with the United States in times of crisis. Washington's best strategic thinkers no longer believe that they will be able to balance against China's growing military power without more Japanese help.

Despite some claims to the contrary from their American counterparts, Japanese leaders become convinced that Tokyo will have to build its own strategic deterrent capabilities if the status quo is not to be altered in ways unfavorable to Japanese interests. To meet this challenge, Prime Minister Abe decides to push the Japanese legislature to adopt his cabinet's reinterpretation of the country's constitution and moves to renegotiate the bilateral defense guidelines between the Japan and the United States. In tandem with these efforts, he orders a classified year-long study to examine options for the indigenous development of nuclear weapons and their associated delivery vehicles.

In March 2016, after a prolonged internal debate, the government of Japan reluctantly decides to move forward with a nuclear weapons development program as a hedge against the strategic unknown. However, these moves are tentative. As a result, the year 2018 finds Japan's program still in an embryonic state. Tokyo's overriding policy goal is to attract U.S. attention to Japanese security concerns, and many believe that nuclear weapons will not be needed to protect Japan. Despite its concerns, Tokyo holds out hope that the United States will do more to ensure Japan's defense, especially against an increasingly unpredictable China.

Three things happen over the next several months that radically change Japan's decision-making calculus. First, at a bilateral summit in Beijing the new U.S. administration moves to realize a "new great power relationship" with China and announces an arms sale freeze to Taiwan and significant reductions in RC-135 and EP-8 surveillance flights along the Chinese coastline. In return, Beijing arrests several military hackers it claims were illegally engaged in cyber warfare against the United States and greatly scales back its known cyber espionage activities. China then begins to deescalate tensions in the South China Sea with the Philippines and Vietnam, making symbolic concessions to both. Appealing to the American president's vanity, China's Chairman Xi Jinping promises a new era of Sino-U.S. relations in which the two superpowers work together to shape the international system in mutually beneficial ways. The implication is that American allies and security partners will largely be shutout from the process.

Not long after, a U.S. Marine Corps V-22 Osprey tilt-rotor aircraft crashes into a farming community in northern Okinawa during a nighttime training exercise. With several local Okinawan residents killed, violent public protests follow the crash. This forces the U.S. government to shut its Marine Corps air station at Futenma and cancel plans for a relocation facility elsewhere on the island. The Third Marine Expeditionary Force moves its headquarters and several other facilities from Okinawa to Tinian and Guam in the Northern Mariana Islands, even as provocative Chinese maritime and air activities around the Senkakus and in the Philippine Sea continue apace.

During this transition, Japan's left-leaning Asahi Shimbun publishes a leaked U.S. Department of Defense planning document that states if a large-scale war with China was believed by the Pentagon to be imminent, U.S. air and naval forces would temporarily evacuate their vulnerable bases in Japan to get outside the range of Chinese ballistic and cruise missiles. This revelation creates a profound sense of betrayal in the Japanese public, and many media pundits begin to question the validity of U.S. extended deterrence. If the United States is not willing to put its troops in harm's way to defend Japan, what chance is there that it would risk its cities?

In an attempt to shore-up the damage this leak does to the alliance, Washington holds a series of defense consultations with Tokyo and agrees to harden its air bases in Japan against missile attack and to invest more in operational resiliency measures such as rapid runway repair. However, during the course of the talks, it becomes clear to the Japanese side that the United States would still be reluctant to put its only forward-deployed aircraft carrier at risk. Tokyo must expect that the USS Ronald Reagan and most of her strike group would not be immediately available for the defense of Japan in the event of conflict with China. The venerable U.S. Seventh Fleet suddenly looks less reassuring. Making matters worse, several weeks later the U.S. Congress decides not to give the Pentagon additional funding for hardening its military bases in Japan. Instead Congress votes to allocate the additional money to Andersen Air Force Base on the American territory of Guam.

This series of events creates a sense of panic in Tokyo's foreign policy and defense communities. From the perspective of Japan's policymaking elite, the United States is no longer in a position to guarantee Japan's security. In an emergency session on New Year's Day 2019, Japan's National Security Council votes unanimously to support the development of a nuclear deterrent as soon as possible. Within five months, Japan manufactures and deploys a 1,700 pound implosion fission bomb with an estimated yield of 11 kilotons.

Stored in an underground bunker at Chitose Air Base in Northern Japan, the weapon is initially intended for air delivery aboard modified F-2 and F-35s fighters. Over the course of the following 20 months, Japan produces another thirty-five weapons. These nuclear bombs are kept unassembled in a newly constructed hardened tunnel complex adjacent to Chitose Air Base, with the trigger mechanisms stored separately at

a different facility on the base itself. Using mock weapons, the Japanese Air Self Defense Force (JASDF) practices nuclear missions that stage out of the airbases at Komatsu, Tsuiki, and Naha. The actual nuclear bombs are not tested.

It is now the year 2021, and up until this point the direct budgetary costs of Japan's nuclear weapons program have been limited. Costs associated with the program include those related to: 1) the manufacture of the thirty-six nuclear bombs; 2) the modernization of one secure underground bunker facility and the construction of one secure tunnel facility; 3) the installation of a "fail-safe" command and control system with both dedicated fiber optic and satellite communications networks linked to the Ministry of Defense Headquarters and the Prime Minister's Office; 4) the operation of one dedicated supercomputer for modeling and simulation; 5) the training of pilots, maintenance crews, and security personnel, etc.; and 6) the expansion of Japan's nuclear emergency response teams. Japan has become a nuclear state by spending well under two percent of its previous defense budget, or just over one billion dollars per year.

In 2022, Japan finds itself at another strategic crossroads. Washington has presented it with an attractive proposal: Tokyo can either begin the next phase of its nuclear weapons program, the development of an independent (and expensive) submarine launched, nuclear cruise missile deterrent, or it can accept American offers to integrate its small strategic forces into the U.S. extended deterrence structure. Japan, encouraged by the efforts of the United States to bolster its security and further encouraged by the success of America's stunning post-2020 economic growth, readily opts for the latter choice. Soon Japan's limited strategic capabilities are fully integrated into joint command structures and formalized in planning documents.

Japan's strategy is to use its limited nuclear weapon capabilities in coordination with the United States only as a last resort during periods of high tensions. In staff level planning sessions, it is decided that both Japan and the United States would respond to an enemy nuclear attack on Japanese territory with a joint campaign against the aggressor nation. Military targets could include critical enemy airfields, naval port facilities (including submarine pens), ballistic missile base headquarters, and air defense facilities. Strategic targets could include national command centers, major urban population centers, and critical national infrastructure. The timing, scope, and intensity of the joint nuclear counterattacks would depend heavily upon the political situation, threat perceptions, available assets, and strategic objectives.

The United States and Japan decide that, as a matter of principal, urban population centers would only be targeted in a reciprocal and proportional fashion. For example, if the PRC destroyed Tokyo with nuclear attack, the United States and Japan would destroy Beijing in return. If three major Japanese cities were destroyed, three of the aggressor's cities would be destroyed. The allies also decide that under most circumstances, Japan's cities will probably (read: hopefully) not be targeted by its adversaries. As a result, strikes on potential military, not strategic, targets are given priority during annual war game exercises held by U.S. and Japanese strategic forces.

The joint U.S.-Japanese strategic force continues to evolve through the 2020s, and it proves particularly valuable in November 2027 during a major nuclear crisis on the Korean Peninsula. Despite a dangerous close call, the crisis deescalates within weeks and nuclear attacks on Japan are ultimately deterred. Several years pass, and by 2030 China and the DPRK are both fully engaged in multi-lateral disarmament talks with the United States, Japan, South Korea, Taiwan, and others. A process begins whereby East Asian countries steadily disarm, and relations between former adversaries begin to warm. The 2030s offer the prospect of a more stable and prosperous region, although many old animosities still linger.

*Narrative Two: Large Nuclear Force*

A series of crises occur in the lead up to the year 2020 that shatters Japanese confidence in U.S. extended deterrence and creates a sense of panic in Tokyo. The nature and severity of this situation is far worse than anything previously imagined by Japanese leaders. Several elements are at play that leads to the crises. First, the U.S. economy fails to recover from the Great Recession, and in 2016, a critical election year, isolationism washes over Washington. The U.S.-led Trans-Pacific Partnership (TPP) agreement falls apart, and trade discussions underway with European Union countries are halted. Interest groups move to curtail the export of U.S. shale gas in the name of "energy independence." This negatively impacts markets and economies around the world, and in Asia the ensuing spike in the price of oil and gas combines with a number of domestic factors to drastically weaken an already teetering Chinese economy.

China's communist leadership in Beijing decides to create a crisis with Taiwan as a last resort measure to shore up its weakening grip on internal social stability and distract public attention from the domestic economic failure. The People's Liberation Army (PLA) mobilizes its reserve forces in preparation for conflict, and China's internal security forces declare all public assemblies to be "illegal acts of Taiwanese fifth columnist and counter-revolutionary separatists." A state of martial law descends on China, and all foreign and social media coverage of events is blocked. When Taiwan's president refuses to enter into political negotiations based on a "One China, Two Systems" framework, Beijing responds by first shelling and then invading several of Taiwan's offshore islands in the Taiwan Strait. Several of these islands are captured with relatively few casualties on either side. However, China encounters an unexpectedly fierce battle on Tungyin Island, where Taiwanese troops fight inside a fortified network of tunnels that honeycomb the solid-granite island fortress.

During the battle, the local ROC commander orders the launch of the island's 125 ballistic and cruise missiles as well as several hundred guided rockets. These strike several Chinese airfields and naval bases supporting the invasion. Entire brigades of Chinese fighter jets are put out of action, and several surface ships and submarines are sunk in port. In addition, many of the large amphibious ships being used for the assault are sunk. Tungyin Island is finally captured at an estimated cost of 14,000 dead and wounded PLA soldiers, sailors, and pilots. Follow-on plans for a maritime blockade and invasion of Taiwan's major ports and beaches are suspended, pending a Politburo Standing Committee investigation into the disaster.

Meanwhile, Taiwanese technology companies, banks, and investment groups in the Kunshan District of Shanghai flee for Canada, the United States, England, and Australia, leaving millions of Chinese middle class urban workers unemployed in their wake. Despite the tight grip of China's internal security forces, riots and looting break out in neighborhoods across the greater Shanghai area. Ultimately order is restored, but at the cost of large scale and brutal police violence that deepen public disaffection. Several prominent provincial government leaders and two central committee members are purged in the aftermath that follows.

For its part, the U.S. response to the 2016-2017 Taiwan Strait Crisis is found to be wanting by Japan and several other regional nations that rely on American security commitments. The White House was unusually slow to react, and the Pacific Command appeared to Japanese observers to be unwilling to respond, as it did in the 1995-1996 Crisis, with overt shows of force. To the contrary, PACOM canceled planned military exercises near Okinawa during the crisis and reduced the number and quality of its forward deployed forces in Japan to avoid appearing "unnecessarily provocative." The U.S. Congress is outraged, but powerless to change the China-friendly administration's weak response.

It soon emerges that during the height of the crisis one U.S. Army Major at Kadena Air Base ordered air

defense missiles to be fired at a flock of migratory birds that he erroneously identified as a possible swarm of armed Chinese drones. One of the missiles narrowly missed a civilian passenger jet landing at Naha International Airport. The Japanese national media begins to label the American military forces in Japan as unprofessional and dangerous.

Several months later an even more serious crisis develops in U.S.-Japan relations; this one involving the DPRK. It begins when Japan's National Police Agency seizes tens of millions of dollars in illegal North Korean mafia assets in Osaka. In reprisal, a group of DPRK naval commandos conducts a nighttime sabotage mission against Sado Island in the Sea of Japan, killing nearly a dozen coastguard and civilian personnel. The next morning, five of the DPRK commandos are captured alive in a fishing boat on the way back to North Korea.

When Tokyo refuses Pyongyang's demands to release its prisoners, North Korea mobilizes several No Dong ballistic missile launch units and publically threatens to turn Japan into a "sea of nuclear fire." That same day Japan's air force collects signals intelligence suggesting that North Korea plans to launch its missiles at Kanazawa, Tokyo, and Yokohama within 48 hours – and at least one of the mobilized launch units is affiliated with the DPRK nuclear program. The government of Japan desperately requests that the U.S. military conducts a preemptive strike on the North Korean launchers and missile base headquarters. But Washington dithers. The United States only commits to increased Aegis ballistic missile defense (BMD) ship patrols in the Sea of Japan.

Three days later North Korea fires nine conventionally-armed ballistic missiles at Japan. Of these, one suffers from engine failure and splashes into the sea shortly after launch; five are intercepted by Japanese and American Aegis ships; and two are successfully intercepted by a Japanese Patriot battery near Tokyo. However, one makes it through the defenses and slams into a public housing complex in greater Tokyo, killing a large number of civilians. There are also some cases of serious injury and damage to private property from falling fragments of the other "intercepted" missiles. The attacks (and North Korean threats to conduct follow-on attacks) create a panic across Japan. The crisis eventually deescalates without further violence, but the credibility of the U.S. extended deterrence is deeply affected. Japan is now in a state of shock.

Weeks later Japan's National Security Council votes to "turn-the-key" on its latent nuclear weapons capabilities program, and soon Tokyo produces its first weapon, a relatively low-yield, 30 kiloton device designed to be mated to submarine-launched cruise missiles. By June 2020 Japan has produced 12 submarine-launched, nuclear cruise missiles, and the program reaches initial operational capability a year later. Tokyo informs Washington of its plans to have at least one submarine conducting deterrent patrols at all times. This fails to elicit the hoped-for American response. The U.S. Secretary of State, fearing another crisis with China and North Korea, privately labels Japan's moves as: "unproductive and unhelpful for regional security…potentially even disaster inducing."

Japan is quietly pressured by the United States to drop its proposed nuclear deterrent patrols, but while bilateral consultations are still underway, details of the emerging submarine capability are leaked to the press. This leads to an outpouring of domestic sentiment that ultimately compels Tokyo to go forward with the program. The majority of the Japanese public, now gripped by a deep fear of future enemy attacks and distrustful of American security guarantees, strongly supports the government's plan. Moreover, vociferous protests from Beijing, Pyongyang, and Seoul against the program and multiple cases of violence directed at Japanese businessmen, diplomats, and students abroad, serve to further bolster the Japanese public's strong desire for an indigenous nuclear deterrent. The United States attempts to stay neutral amidst

the controversy, fearing that its respective regional alliances and partnerships could be damaged. In the end, however, its reputation is damaged on all sides. Little comes of its halting attempts to calm tensions.

In February 2022 Japan begins a series of underground and underwater nuclear tests on its uninhabited islands and sea territory in the North Pacific. These are detected and then actively covered up by the U.S. administration which is seeking to maintain a tenuous hold on the Comprehensive Nuclear Test Ban Treaty. Months later, however, the details of the tests are leaked to the Japanese media. Soon Japan conducts its first deterrent patrol with its new cruise missile submarine (SSG), a heavily modified Soryu-class boat with twelve vertical launch tubes capable of firing cruise missiles that have a range of at least 1,500 kilometers (930 miles). These are equipped with a 200 kilogram (440 pound) warhead containing 6 kilograms (13 pounds) of plutonium.

Blue crews and green crews switch places aboard the boat every month, allowing Japan to keep its first submarine at sea most of the year on extended war deterrence patrols. To decrease time in port for crew change and replenishment, several large hatches are installed to provide space for rapid resupply and repair access. In addition, a special submarine tender is built for supporting crew changes and resupply operations at sea. A second SSG is launched the following year, and a third the year after that. By 2024, Japan has one boat at sea at all times, and often two for overlapping coverage in case of combat attrition. When in port, most of the submarines are based in a hardened, wet-dock tunnel complex that has been built in Ominato Bay, near Matsu in northern Honshu, and some are stationed at the Kure Submarine Base.

By the mid-2020s, Japan's air force has successfully lobbied the Tokyo government for nuclear missions. The Japanese Air Self Defense Force soon begins fielding an indigenous, unmanned, stealth strike fighter capable of launching long-range, hypersonic (Mach 5+) nuclear cruise missiles. These aircraft are home-based inside hardened aircraft shelters at Misawa Air Base and frequently dispersed to other airbases around Japan to increase their survivability in the event of an enemy first strike.

By 2029, Japan has some 1,100 nuclear warheads and an equal number of penetrating missiles for delivering them. Throughout the 2020s, Tokyo has repeatedly approached the United States with proposals on joint targeting, but reactions in Washington are mixed, and the allies are unable to come to an agreement. Japan's growing nuclear forces, while on good-terms with their American counterparts, stay completely independent of U.S. command and control. China's strategic forces have been growing rapidly since 2020. By 2029 Beijing commands an estimated 1,900 nuclear weapons that are able to strike Japanese territory.

China's buildup puts pressure on Tokyo to greatly accelerate its armaments production to reach near parity with Beijing by 2033. Fears are high that China could deliver a knockout first strike against Japan using a combination of nuclear weapons and conventionally-armed precision strike capabilities. New Chinese stealth drones and near space vehicles threaten Japanese airbases and ground force missile garrisons. Making matters worse, Chinese nuclear powered attack submarines and improved anti-submarine warfare capabilities threaten even Japan's most secure submarine launched nuclear deterrent. Quantity begins to matter much more than before.

A secondary strategic threat comes from the Korean Peninsula. North Korea and South Korea have both developed nuclear weapons and associated delivery vehicles capable of targeting Japan. However, internal issues on the peninsula distract from what would almost otherwise certainly be a highly unstable, multilateral nuclear arms race. Russia's economy, long in steady decline, is suddenly buoyed by new Siberian resource deposit finds and further aided by the large and growing volume of sea traffic along the Northern Passage. When Moscow accelerates its strategic détente with Beijing, even more stress is placed upon Japan's nuclear forces.

Funding Japanese nuclear forces becomes an issue that stresses the government of Japan. Tokyo has had to increase its military spending from 1.15 percent of GDP in 2020 to 2.95 percent by 2030 in order to support its strategic buildup. In the early 2020s, when the shock of North Korean missile attacks was still fresh in the public's mind, the budget increases were of little issue. However, by the end of the decade, the public sentiment has turned. There appears to be no end in sight to the nuclear arms race with China, and costs, due in large part to the development of cutting edge unmanned technologies, appears set to spiral out of control.

Making matters worse, Japan's defense exports (principally to Southeast Asia, Australia, and North America) are in decline due to the high price of the Yen, and personnel costs have skyrocketed for reasons relating to the price of caring for retired officers and troops. The average Japanese male now lives to see his 91st birthday, and Japanese females regularly live past their centennial year. Yet the medical advances making this possible are expensive and do not greatly improve the economic productivity of the elderly. Military personnel still retire at a relatively young age. Japan's "graying society" compels the military to invest in systems operated by relatively small numbers of young Japanese officers and highly educated TCTs (technical and cyber troops) that have responsibility over arrays of unmanned autonomous and semiautonomous systems.

Hopes are high in Japan for future arms control agreements, but the number and instability of the nuclear armed actors involved make coming to any diplomatic agreement a long and arduous task. The Korean Peninsula, unified under a federal government in 2030, is particularly unstable because so much of Seoul's attention is focused on the need to nation build at home while simultaneously protecting against a Chinese or Russian land invasion. Moreover, Beijing is embroiled in yet another domestic political purge, and its foreign affairs stance oscillates wildly to reflect the views of the pro-business and pro-military factions that cycle through high positions of power. Taiwan, now recognized internationally as an independent country under its revamped Republic of China constitution, is also reluctant to enter into nuclear arms control talks. The verification protocols could give Beijing unwanted leverage, and an excuse to re-insert itself into Taiwan's domestic affairs. The 2030s offer little prospect for peace and stability in East Asia.

*Narrative Three: Improved Conventional Force*

The alliance that binds the United States and Japan has served as an anchor of peace and prosperity in the Asia-Pacific region for over half a century, but by 2014 it is widely recognized that American power projection capabilities, enabled by military bases on Japanese territory, are under threat. While airbases and air stations in Japan could allow hundreds of American fighters and bombers to deliver strikes around the clock during a conflict, their size and static nature renders them easy to target. In contrast, U.S. aircraft carriers, which typically each support 44 strike aircraft and produce 120 sorties in their twelve hours of daily operation during a conflict, are highly mobile and difficult to target, and therefore more survivable. However, when compared to airbases on land, carriers have little built in resiliency. Aircraft carrier decks, once damaged, are generally unusable again for the duration of any conflict.

This situation has led Japanese strategists to worry that China's rapidly emerging precision strike capabilities could give Beijing conventional strike parity in the foreseeable future and, by so doing, undermine the U.S.-Japan alliance. U.S. airbases and fleets in and around Japan are so potentially vulnerable to the PLA's long-range precision strike capabilities that some American observers have begun calling for a strategy to conduct "off-shore control" and abandon the U.S. commitment to a robust forward deployed presence in Japan. Others have suggested that the United States should appease China by limiting its arms sales to

security partners like Taiwan. These developments, while not reflective of official policy in Washington, have served to heighten Tokyo's sense of a looming security crisis.

Japan's security situation, while serious, gets a boost in 2015 when the United States agrees to bilateral talks on increasing Tokyo's access to American "strike" capabilities previous deemed to be "too offensive" by the Japanese. These talks include possible offers to provide Japan with advanced submarine and ship launched Tomahawk cruise missiles and offensive cyber warfare capabilities. Japan also expresses interest in shore based Aegis systems for next generation missile defense. The following year, Washington and Tokyo release an important document, the *2015 Guidelines for U.S.-Japan Defense Cooperation*. This agreement modernizes the U.S.-Japan alliance and allows for a new era of joint strategic development. However, these measures, while necessary, are not sufficient by themselves. In order to assure the long-term health of the alliance–and with it regional security and prosperity–there are three additional areas of investment that decision makers in Washington and Tokyo begin to make in the 2015 to 2025 timeframe: (1) base hardening and resiliency, (2) counter reconnaissance, and (3) conventional counterstrike.

Base Hardening and Resiliency

The vulnerability of command and control centers, airbases, port facilities, logistics nodes, and other critical military installations in Japan is a serious problem. Tokyo leaves the vast majority of its air combat power sitting on parking ramps in the open or in unhardened hangars at its airbases. That begins to change in 2016. For the price of five F-35 fighter aircraft, the Japanese Air Self Defense Force begins to construct 100 advanced hardened aircraft shelters on Okinawa and Kyushu capable of protecting up to 200 fighters. This equates to spending some 500 million dollars to protect 10 billion worth of combat assets. Similarly, for the cost of one littoral combat ship, the Japanese Maritime Self Defense Force and the amphibious component of the Japanese Ground Self Defense Force work to construct shelters and hardened hangars capable of protecting a combination of up to 188 navalized fighters, helicopters, and tilt-rotor aircraft by 2020.

Other exposed aircraft are protected inside revetments designed to mitigate the effects of small submunitions and near misses. These prove particularly useful for protecting large, high value aircraft unable to fit inside most hardened shelters, such as Global Hawk UAVs, P-8s, P-3Cs, etc. Revetments are also constructed to protect living and work facilities for the thousands of personnel that are required to keep combat aircraft wings operational. Dozens of miles of revetments are constructed for the cost of a small number of hardened aircraft shelters. Likewise, investments are made into redundant and deeply buried command and control centers; extra or alternate runways, taxiways, and parking ramps; and hardened power, fuel, and logistical facilities. Electro-magnetic and visual deception techniques–combined with force dispersal–are also invested in to confuse enemy intelligence.

The United States and Japan begin to develop the potential to operate effectively in a dispersed manner across nearly 100 civilian airfields in Japan that have long enough runways to support combat aircraft, and a particular focus is accorded to Ishigaki Airport and Shimoji Airport in the Ryuku Islands. However, investing in hardening, dispersal, deception, and other relatively affordable and effective defense measures is not enough. Once adequate preparation is made for all critical platforms and personnel to survive missile raids, investments begin to be made in maintaining the capacity to quickly recover from attacks and get back in the fight.

The Japanese bolster their military engineering teams for heavy repair missions by providing them with

rapid runway repair and airfield damage repair kits and extra funding for frequent training exercises. Engineering teams at Naha Air Base and Kadena Air Base become some of the fastest and most effective in Asia. The Japanese demonstrate their ability to drastically reduce the impact of potential missile attacks and show that they can quickly retake and retain the initiative after being attacked. This has the effect of undercutting the PLA's strategy through the disruption of its core planning assumptions, and it alters incentives to engage in first-strike operations. More importantly, these investments in hardening and resiliency demonstrate resolve in the face of a serious adversarial threat and send the message that the U.S.-Japan alliance is fully committed to regional defense.

Counter Reconnaissance

Another critical but previously overlooked and underemphasized element required for protecting the allied ability to project power in the face of China's emerging capabilities is counter reconnaissance. In 2016 the United States and Japanese militaries begin a joint program to develop the means to wage a "blinding" campaign against the sensor and communications networks that are foundational to PLA missile operations. The United States and Japan develop a range of capabilities for denying the PLA access to its reconnaissance capabilities.

At the low end of the spectrum, this includes special operations missions to board and detain the crews of suspected surveillance vessels, and to attack coastal radar sites. It also includes programs for engaging airborne sensors, land based radars, and other relatively "soft" PLA targets with electronic warfare or cyber attacks. At the higher end of the spectrum, it includes capabilities for disabling critical sensors onboard Chinese reconnaissance satellites in low earth orbit. Initially, the easiest way for the United States and Japan to assure the incapacitation of Chinese satellites is to engage them directly with specially modified SM-3 missiles. However, the threat of producing an unacceptably high level of space debris argues against such attacks, and by the early 2020s a number of non-kinetic weapons are secretly developed and deployed for the mission.

Once developed, high-powered lasers and other directed energy weapons are employed by the United States and Japan for the counterspace mission. Ultimately the allies decide that the priority targets for any counter reconnaissance campaign waged against the PLA would be the command and control nodes where the PLA integrates its reconnaissance and strike capabilities. These command and control nodes are generally located in remote areas in deeply buried bunkers. Nonetheless, they are closely studied and found to be vulnerable to cyber attacks as well as some forms of physical sabotage. The allies begin "preparing the battlefield" to the greatest extent possible with both cyber and human assets. During a conflict, it is thought that something as simple as sending an intelligence asset (or penetrating cruise missile) to cut shallowly buried PLA fiber optic lines could make a significant contribution.

Conventional Counterstrike

Beyond base hardening and counter reconnaissance, conventional counterstrike capabilities become viewed by Japan as essential for deterring and defeating potential PLA missile attacks. While missile defense and counter reconnaissance capabilities serve to mitigate the worst effects of enemy strikes, they are unable to respond to them in a proactive manner. Only conventional counterstrike capabilities against Chinese forces would allow American and Japanese forces to quickly regain the initiative after a PLA first strike. In the era of missile-centric warfare, targeting the "archer" as well as the "arrow" is a deemed es-

sential.

To deter China from exploiting its capabilities for launching potentially devastating attacks on Japanese targets and forward-deployed U.S. targets, military and political leaders in Tokyo and Washington slowly develop a consensus on conventional counterstrike. After something of a late start, from 2020 to 2025 the Japanese military develops and demonstrates a credible capacity for holding selected PLA's command posts and missile launch units at risk while maintaining allied air superiority and sea control.

Tokyo studies options for deploying conventionally-armed ballistic and cruise missiles. However, Tokyo opts against ballistic missiles in favor of a less controversial program to partner with American defense companies to produce next generation, long range cruise missiles. This program benefits from Japan's cutting edge aerospace engineering capacities and has the added benefits of increasing joint operability and bringing allied unit costs down.

An unprecedented strengthening of the alliance follows in the 2020s. While several small crises occur that involve China and North Korea, Japan does not seriously consider developing nuclear weapons. The U.S. extended deterrence holds. Japan continues to invest in conventional capabilities to address gaps in the ability of the U.S.-Japan alliance to maintain a favorable balance against China. This includes a number of initiatives to improve the hardening and resiliency of essential command posts, air bases, and naval bases.

Japan also invests more into developing other forms of ballistic missile and cruise missile defense including rail guns, high powered energy weapons, electronic warfare, and cyber warfare. With Japan's help shoring up its otherwise eroding conventional superiority, the United States is better placed to concentrate on maintaining its extended nuclear deterrent and does so successfully throughout the 2020s and into the 2030s. By 2030, the threat of a major conflict in Asia seems increasingly remote. The 2030s open with the prospect for an unprecedented level of prosperity, freedom, and strategic stability in the region.

# Chapter 2

## China's Future Nuclear Force Infrastructure: A Notional Breakout Scenario

*Mark Stokes*

As the United States and Russia continue a concerted effort to reduce the role and importance of nuclear weapons, the People's Republic of China (PRC) is the sole original nuclear weapon state that is proceeding with significant improvements to its nuclear arsenal. Conventional wisdom holds that the Chinese People's Liberation Army (PLA) is expected to double the number of warheads capable of striking targets in the United States by 2025. China's declared policy is maintenance of a minimum deterrent and a no-first-use pledge. However, little public information is available describing how PLA planners define minimum deterrence, and the assumptions that guide development of future nuclear force structure requirements remain the current and future scope of its nuclear warhead inventory.

To be sure, the PLA is expanding its arsenal, including development and deployment of new nuclear-capable delivery vehicles, yet questions remain as to the extent and intention of China's nuclear force modernization. While external factors, such as threat perception and operational effectiveness are important, domestic political considerations, including bureaucratic rivalries, may also influence requirements. Which factors might drive a future force structure larger than currently envisioned? How might the PLA proceed? What are the implications? This paper attempts to address a scenario involving a significant expansion of China's nuclear weapons inventory.

### *Baseline Force Structure*

A preliminary assessment of the PLA command and control structure sets the stage for a scenario describing a significantly expanded nuclear force. Authority over China's nuclear force resides with the Chinese Communist Party (CCP) Political Bureau (Politburo) and its seven-member Standing Committee. The Politburo delegates control of nuclear forces to the Central Military Commission (CMC). The CMC Chairman is dual hatted as CCP Secretary General and exercises direct authority over China's nuclear arsenal with the advice of two CMC vice chairmen. In addition to the Minister of Defense, the seven CMC members that report to the chairman include the Chief of General Staff (COGS); directors of the General Political Department (GPD), General Logistics Department (GLD), and General Armaments Department (GAD). Since 2004, commanders of the PLA Navy, Air Force, and Second Artillery Force were elevated CMC members.

Each of the eight members carries equal authority within the CMC, but the Minister of Defense traditionally has been first among equals, followed by the COGS. The COGS oversees the PLA General Staff

Department (GSD), a powerful organization that not only functions as joint staff headquarters, but also as ground forces headquarters. The COGS also oversees seven military regions that are roughly comparable to U.S. combatant commands.

While the PLA Navy and Air Force have been nominally independent, the COGS exercises considerable control over the two services. As two of eight CMC members, service commanders now enjoy a grade equal to the COGS. However, Navy and Air Force component commands are operationally subordinate to the military region commander. For example, the Navy South Sea Fleet commander is dual hatted as one of five deputy commanders of the Guangzhou Military Region. As a result, the CMC chairman exercises command authority over Navy and Air Force operational assets through the COGS.

Unlike the Air Force and Navy, nuclear forces under Second Artillery fall outside of the command authority of the COGS and the GSD-led military regional command system. The CMC chairman exercises direct command authority over Second Artillery nuclear assets. The Second Artillery's six corps-level regional commands have been fully independent from military regions. While the PLA Navy and Air Force may operate platforms capable of delivering nuclear payloads, Second Artillery most likely has retained exclusive custodianship of China's nuclear warheads. Centralized management is facilitated by a minimal deterrence doctrine, which limits the number of warheads that must be stored and secured.

The Second Artillery also has functioned as the CMC's executive authority for nuclear policy, future requirements development, and acquisition of nuclear weapon systems. The China Academy of Engineering Physics (CAEP), a defense industrial enterprise under joint civilian-military management, supplies Second Artillery with nuclear warhead sub-systems. Other defense industrial enterprises are responsible for engineering and production of ballistic missiles capable of delivering nuclear warheads out to intercontinental range.

Since production of China's first nuclear device almost 50 years ago, the CMC has maintained separate organizational systems for missiles and warheads. The Second Artillery leadership oversees six regional missile armies, referred to as bases. A missile base consists of between three and seven launch brigades and a number of support regiments responsible for training, transportation, warhead assembly, and communications. Each brigade is comprised of six battalions that each manages at least one mobile launcher or missile silo.

A separate organization, equal in grade to a missile army (base), functions as central custodian for Second Artillery nuclear warheads. Base 22, the central nuclear warhead complex, is located in Taibai County, deep in the Qinling Mountains of Shaanxi Province. Between 1965 and 1979, the CMC's defense acquisition and technology department fulfilled this function. In 1979, Base 22 was resubordinated to Second Artillery. While Base 22 retains control over most of the PLA's inventory of nuclear warheads, a small number are distributed to each of the six missile bases. A specialized regiment with a dual chain of command (missile base and warhead base) is responsible for warhead inspection, assembly, and other prelaunch preparations. According to one authoritative Second Artillery account, depots under each of the six missile bases only store a minimal number of nuclear warheads at any one time.[1]

The PLA is focused upon a survivable nuclear second strike involving deployment of expanded range and submarine-launched variants of the DF-31 intercontinental ballistic missile (ICBM) and possible introduction of a mobile ICBM capable of delivering multiple independently targetable re-entry vehicles (MIRVs). For many years, the silo-based DF-5 was the principle flight vehicle for strikes against targets

1. Yu Jixun, ed., *Second Artillery Campaign Science* (第二炮兵战役学), Beijing: PLA Press, 2004, p. 202.

in the continental United States. In addition to possible introduction of a MIRV variant of the DF-5, the Second Artillery is increasing the number of brigades equipped with the DF-31A and introducing a variant of the DF-31 ICBM—the JL-2—that is capable of launch from PLA Navy submarines. The Second Artillery also appears to be investing in research and development (R&D) on a mobile ICBM capable of delivering MIRV payloads.

Guided by a principle of minimal deterrence and overriding concern over stockpile security, most public assessments conclude that the PLA maintains a relatively limited number of nuclear weapons, perhaps around 250 warheads. In a 2006 statement before the Senate Armed Services Committee, a senior Defense Intelligence Agency (DIA) authority assessed that China currently has more than 100 nuclear warheads and that "the number of deployed Chinese nuclear-armed theater and strategic systems will increase in the next several years." DIA assessed that China likely has fewer than 50 intercontinental ballistic missiles (ICBMs) that could strike the U.S., but that figure could double by 2025.

Based on fissile material and delivery vehicle estimates, the Federation of American Scientists (FAS) assesses that around 240 nuclear warheads are available for delivery on approximately 180 missiles and aircraft. As many as 140 of the operational missiles are land-based, and 50 of those can reach the continental United States. The remaining warheads are believed to be spares or earmarked for submarine-launched ballistic missiles and bombers. While these estimates appear reasonable, a margin of error exists, particularly with regard to future inventory.

### *Drivers for an Expanded Force Structure*

In 2002, U.S. Secretary of Defense Donald Rumsfeld highlighted a scenario in which a nuclear force, such as China's, could "sprint to parity" as U.S. and Russia reduce the number of nuclear weapons and launchers.[2] There are a number of plausible reasons why China would not make that choice. While unlikely, thinking through a breakout scenario or "rush to parity" could be a useful exercise. In evaluating a rush to parity scenario, a first question relates to motives: Why would the CCP Politburo Standing Committee and CMC pursue a significant expansion of the PLA's nuclear weapon inventory?

## Threat Perception

Senior leaders develop requirements based on threat perception, calculated deterrence, and operational doctrine. China's nuclear operations doctrine calls for force equipped with the minimal number of warheads required to deter a potential adversary from launching a nuclear attack against Chinese territory. Minimal deterrence entails a credible ability to reconstitute after a nuclear attack and then an assured abil-

2. Among various sources addressing the possibility or unlikelihood of a "sprint to parity" breakout scenario, see Brad Roberts, "On Order, Stability, and Nuclear Abolition," in eds. George Perkovich and James M. Acton, *Abolishing Nuclear Weapons: A Debate,* Washington, DC: Carnegie Endowment for International Peace, 2009, pp. 163-166; Michael O. Wheeler, *Nuclear Parity with China?,* Alexandria, VA: Institute for Defense Analysis, 2012; Jeffrey Lewis, "The Ambiguous Arsenal," *Bulletin of Atomic Scientists* Vol 61, No. 3, May/June 2005, pp. 52-59, available at web.archive.org/web/20050525064447/http://www.thebulletin.org/article.php?art_ofn=mj05lewis; Gregory Kulacki, *China's Nuclear Arsenal: Status and Evolution*, Cambridge, MA: Union of Concerned Scientists, October 2011, available at www.ucsusa.org/nuclear_weapons_and_global_security/solutions/us-china-cooperation/chinas-nuclear-arsenal.html; and Caroline S. Reilly, "Assessing the Prospect of China's Potential 'Sprint to Parity'," in *Nuclear Scholars Initiative: A Collection of Papers from the 2011 Nuclear Scholars Initiative,* Washington, DC: Project on Nuclear Issues, Center for Strategic and International Studies, December 2011, pp. 156–173.

ity to retaliate in kind.

Such a doctrine requires detailed and accurate calculations of how much pain the U.S. and other potential nuclear powers could endure. Deterrence and psychological operations enjoy a symbiotic relationship. The GPD, which manages the PLA's political work system, oversees a powerful organization responsible for strategic psychological operations and attenuating or amplifying the political effects of existing or latent nuclear weapons. Regular assignments of career Second Artillery officers to senior GPD positions reflect the intimate linkage between military operations and desired political effects.

Determination of required number of warheads may be based on estimated attrition of payloads expected to reach their targets due to losses on the ground or inception in flight. Planning for use of nuclear weapons to support warfighting could increase requirements significantly. However, increasingly accurate and lethal conventional payloads able to achieve the desired effects may decrease incentives for fielding a large arsenal of tactical nuclear weapons.

Force planners and political analysts may perceive a shift in the threat environment that could reduce PLA confidence in its assured retaliatory capability and the adequacy of its nuclear weapon inventory. Nuclear states of potential concern include the United States, Russia, and India, among others. A number of scenarios could trigger a significant expansion of China's inventory of nuclear weapons. For example, a loss of confidence in U.S. extended deterrence could reverse Japan's traditional aversion to nuclear weapons and trigger an independent nuclear capability. A second scenario could be Russian withdrawal from the Intermediate Range Nuclear Forces (INF) Treaty and subsequent deployment of nuclear-capable missiles that had been previously restricted under terms of the treaty.

### Expansion of Comprehensive National Power

Drivers shaping future force structure may not be limited to rational considerations, such as threat perception and calculations of deterrence, coercion, and counter-coercion. Insecurities and values that are unique to China's political system may influence how leaders perceive the utility of nuclear weapons. As an important source of legitimacy, nuclear weapons are not only instruments of mass destruction, but are also powerful symbols of a state's standing in the world. Analysts have evaluated China's relative position in terms of comprehensive national power and assessed steps needed to elevate its relative standing. As the United States and Russia pare their strategic nuclear arsenals down to a level that the PLA could reasonably match, the political advantages of establishing parity with the two largest nuclear powers may outweigh perceived costs.

### Decentralization

The PLA and other defense establishments around the world are characterized by competition among military services for prestige and share of resources. Since initiating its nuclear program in the 1950s, Chinese political leaders have granted nuclear warheads special political significance. Bureaucratic rivalries within the PLA that result in decentralization of custodianship also could drive an expansion of the PLA's nuclear warhead inventory. In the domestic Chinese context, nuclear weapons carry significant value as symbols of power and authority. One of the most quoted principles of CCP Chairman Mao Zedong is "political power grows out of the barrel of a gun."[3] There is no gun more powerful than a nuclear weapon.

3. Mao Tse Tung, "Problems of War and Strategy," November 6, 1938, in *Selected Works, Vol. II*, p. 224, available at www.

China's nuclear force was born during an era of tremendous political chaos. The Cultural Revolution, which began in 1966 and ended by 1976, produced enduring fears of political instability and concerns over warhead security after a move by a rival faction to seize China's nuclear arsenal in its early stage of development. Presumably, the side that asserted control over the PLA's most tangible symbols of military power likely would dominate the political agenda as well. Since then, security appears to have been a central factor in how the CMC assigns custodianship and ensures strict political control over its nuclear warheads.

Since the end of the Cultural Revolution, the Politburo Standing Committee and CMC Chairman appear to have entrusted Second Artillery as sole custodians of China's limited nuclear weapon stockpile. During peacetime, the CMC chairman exercises political control through the Second Artillery Party Committee and politically reliable officers at Base 22 deep in the Qinling Mountains.
However, the introduction of a viable submarine-launched ballistic missile force and an increasingly powerful PLA Navy could result in decentralization of warhead custodianship. Whether or not the Navy has or will manage an independent inventory of nuclear warheads cannot be determined at the current time based on available information. A specialized unit under the Second Artillery's Base 22 could manage warheads on behalf of Navy submarine force during peacetime. Upon CMC orders, Base 22 could deliver warheads for integration with submarine launched ballistic missiles for training purposes or in a crisis situation. Alternatively, the PLA Navy may seek independent peacetime custodianship. Specialized nuclear warhead transport units subordinate to the two PLA Navy submarine bases have been noted. Navy peacetime custodianship could create pressures for the PLA Air Force for similar responsibilities, and perhaps for missile bases within the Second Artillery who advocate for greater peacetime custodian responsibilities.

*Conclusion: A Notional Pathway to an Expanded Force*

A notional PLA pathway to nuclear parity would be marked by administrative issues associated with acquisition management, adjustments in China's civilian engineering R&D and production, and adjustments to operational infrastructure. Decentralization of nuclear warhead custodianship may be accompanied by new organizational responsibilities for requirements development and acquisition management.

Without a dedicated staff familiar with nuclear strategy and operations, the CMC likely delegates PLA-wide nuclear force planning and acquisition management to Second Artillery.[4] The intellectual center of Second Artillery's long-term nuclear force planning resides within its Equipment Department. The Second Artillery Equipment Department also is responsible for managing individual programs. Strategic weapon systems are developed and acquired in three phases: 1) concept development and program validation; 2) system engineering R&D; and 3) and design finalization and low rate initial production.

The Second Artillery works closely with the GAD in leveraging national-level technology development programs and ensuring the production of safe and reliable warheads and components. The GAD develops, coordinates, and oversees broad defense acquisition and technology policies for the CMC.[5] GAD supports

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marxists.org/reference/archive/mao/works/red-book/ch05.htm.

4. In 1993, Second Artillery published guidelines outlining coordination procedures for nuclear warhead R&D. The Second Artillery guidelines (GJB-1568-1992), Nuclear Warhead R&D Coordination Procedures and Requirements (核弹头研制协调程序及要求), are classified and unavailable.

5. GAD was created in a reorganization in 1998 intended to address shortcomings in oversight of defense technology development. Its predecessor, the Commission for Science, Technology, and Industry for National Defense (COSTIND), was split into military and civilian functions, with the General Armaments Department absorbing defense acquisition functions of COSTIND

Second Artillery program managers in the detailed design, engineering development, and manufacturing of nuclear warheads. GAD manages allocation of resources directed toward basic and applied defense technologies, including potential future nuclear-related technologies.

GAD and the civilian authorities responsible for defense industrial enterprises jointly oversee the CAEP. CAEP is responsible for nuclear warhead design, engineering R&D, and manufacturing. Research institutes under CAEP manage a complex supply chain that includes power supplies, firing/safing switches, high explosives, deuterium, tritium, neutron sources, environmental sensing devices, detonators, pits, etc.

CAEP's existing engineering R&D and manufacturing infrastructure likely could support expanded production with minimal adjustment. With support from CMC and State Council, fissile material probably would not be a limiting factor. Assessments of China's existing nuclear warhead inventory have in large part been based upon estimates of plutonium production and reserves. In 2009 testimony, the DIA assessed that "China likely has produced enough weapon-grade fissile material to meet its needs for the immediate future."[6] The International Panel on Fissile Materials estimates that China's two production facilities at Jiuquan and Guangyuan have produced about 20 tons of highly enriched uranium and two tons of weapon-grade plutonium.[7]

The Second Artillery's basic operational infrastructure likely would require minimal adjustment should political authorities decide to expand China's nuclear force posture. A conventional missile brigade currently consists of six battalions, each equipped with six launchers, for a total of 36 launchers. Nuclear-capable brigades equipped with medium, intermediate, and intercontinental range missiles also consist of six battalions, each with at least one launcher or silo. Presumably, at least one missile and one warhead are programmed and available per launch platform. An expansion of China's nuclear force, or rush to parity with U.S. and Russian nuclear forces, could be achieved by adjusting existing nuclear brigade-level force structures along similar lines as conventional missile brigades (eg., 36 launchers per brigade vice current six-12 launchers). Multiple missile reloads and warheads presumably would be available for each launch platform.

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and GSD Equipment Bureau. For background, see Harlan W. Jencks, "COSTIND Is Dead, Long Live COSTIND!: Restructuring China's Defense Scientific, Technical, And Industrial Sector," in eds. James C. Mulvenon and Richard H. Yang, *The People's Liberation Army in the Information Age,* Santa Monica, CA: RAND Corporation, 2004, pp. 59-77; Evan S. Medeiros, Roger Cliff, Keith Crane, and James C. Mulvenon, *A New Direction for China's Defense Industry,* Santa Monica, CA: RAND Corporation, 2005, available at www.rand.org/pubs/monographs/2005/RAND_MG334.pdf. The GAD Comprehensive Planning Department (综合计划部) probably is responsible for overall acquisition planning and policy. Bureaus within the GAD Service probably function as coordinating bodies. For a good GAD overview, see Harlan Jencks, "The General Armament Department," in eds. James Mulvenon and Andrew N.D. Yang, *The PLA As Organization,* Arlington, VA: RAND Corporation, 2002, pp. 273-308, available at www.rand.org/content/dam/rand/pubs/conf_proceedings/2008/CF182part1.pdf.

6. Michael D. Maples, Director of the Defense Intelligence Agency, "Annual Threat Assessment," statement at "Current and Future Worldwide Threats," Hearing before the Committee on Armed Services, U.S. Senate, 111th Cong., March 10, 2009, available at fas.org/irp/congress/2009_hr/031009maples.pdf.

7. *Global Fissile Material Report 2010,* Princeton, NJ: International Panel on Fissile Materials, December 2010, p. 98, available at fissilematerials.org/library/gfmr10.pdf.

# Chapter 3

## Alternative North Korean Nuclear Futures

*Shane Smith*[1]

On February 12, 2013, North Korea's state media announced that it had conducted a third nuclear test "of a smaller and light A-bomb unlike the previous ones, yet with great explosive power…demonstrating the good performance of the DPRK's nuclear deterrence that has become diversified."[2] Since then, there has been renewed debate and speculation over the nature and direction of North Korea's nuclear program. Can it develop weapons using both plutonium and uranium? How far away is it from having a deliverable warhead and how capable are its delivery systems? How many and what kind of weapons is it looking to build? These are not easy questions to answer. North Korea remains one of the most notoriously secret nations, and details about its nuclear program are undoubtedly some of its most valued secrets. Yet, the answers to these questions have far reaching implications for U.S. and regional security.

This paper takes stock of what we know about North Korea's nuclear motivations, capabilities, and ambitions to explore where it's been and where it might be headed over the next 20 years. Drawing on available evidence, it maps one path it may take and explores what that path might mean for the shape, size, and character of North Korea's future arsenal. Making long-term national security predictions is of course fraught with challenges and prone to failure.[3] Making predictions about North Korea's nuclear future should be done with even more humility considering so many questions about the current state of its program remain unanswered. But, there is a growing amount of evidence to suggest that North Korea's leaders have high ambitions for its nuclear program and the investments in place to sooner or later realize at least some of those goals.

The first section maps out the different motivations that animate North Korea's nuclear program and related decisions. The next section assesses what is known about North Korea's current capabilities. The paper then sets out alternative nuclear paths and what the evidence suggests about the direction North Korea might be heading over the next generation. The paper concludes with a discussion about what that path could mean for the size, shape, and character of North Korea's future nuclear arsenal.

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1. This paper represents the author's personal views and does not reflect the views of the National Defense University, the Department of Defense, or any part of the U.S. government.

2. "KCNA Report on Successful 3rd Underground Nuclear Test," *Korea Central New Agency (KCNA)*, February 12, 2013, available at www.kcna.co.jp/item/2013/201302/news12/20130212-18ee.html.

3. For a discussion of the challenges of national security predictions and how to plan for the unexpected, see Richard Danzig, *Driving in the Dark: Ten Propositions about Prediction and National Security,* Washington, DC: Center for a New American Security, 2011.

*North Korea's Multiple Motivations*

North Korea has built its nuclear weapons program over decades despite significant costs in terms of international sanctions, diplomatic isolation, and heightened military tensions with neighbors and the United States. Not to mention, it has likely spent billions of dollars on the program even while at times struggling to feed its own people. The decision to continue its nuclear program with such a high price tag suggests that its leaders place significant value in it. In fact, some argue that the Kim regime increasingly depends on the nuclear program for survival.[4]

With roots dating back to the 1950s, North Korea's nuclear program is driven by a number of factors that tend to fall into three broad categories: military, politics, and diplomacy.[5] These motivations have evolved overtime to become so intertwined and entrenched that, as one expert puts it, "the nation itself and nuclear weapons have been combined in a condensed symbol of intention."[6] It is worth discussing them separately, however, because they frame North Korea's nuclear decision-making and strategic goals.

Military

North Korean leaders have consistently justified developing nuclear weapons as a deterrent primarily against U.S. aggression.[7] There is evidence, however, that they have also considered them for more offensive purposes.[8] North Korea's military strategy has long favored offense over defense to provide for a rapid, short-notice invasion and forceful reunification of the peninsula before the United States can

4. Ibid. James Clapper, the U.S. Director of National Intelligence, told the Senate Armed Services Committee that Kim Jong Un appears to feel "more intensely than his father" that nuclear weapons are "key to their [the regime's] survival." Tony Capaccio and Sangwon Yoon, "Kim Won't Talk on N. Korea's Nuclear Arms, DIA Chief Says," *Bloomberg*, April 18, 2013, available at www.bloomberg.com/news/2013-04-18/north-korea-demands-u-s-remove-nuclear-arms-before-any-dialogue.html. For a study on how authoritarian regimes leverage nuclear programs for political survival as well as the impact of domestic and international factors on related decisions, see Etel Solingen, ed., *Sanctions, Statecraft, and Nuclear Proliferation,* New York: Cambridge University Press, 2012.

5. This is similar to Siegfried S. Hecker, "Lessons from North Korea's Nuclear Crises," *Daedalus* Vol. 139, No. 1,Winter 2010, pp. 44-56; and, it largely follows the framework of Scott D. Sagan, "Why do States Build Nuclear Weapons?: Three Models in Search of the Bomb," *International Security* Vol. 21, No. 3, Winter 1996-1997, pp. 54-86.

6. Peter Hayes, "The DPRK's Nuclear Constitution," *NAPSNet Policy Forum*, Nautilus Institute for Science and Sustainability, June 13, 2012, available at nautilus.org/napsnet/napsnet-policy-forum/the-dprks-nuclear-constitution/#axzz2jhUXzEj8.

7. "Rodong Sinmun on DPRK's legitimate right to self-defence," *KCNA*, December 20, 2002, available at www.kcna.co.jp/item/2002/200212/news12/21.htm; "DPRK FM on Its Stand to Suspend Its Participation in Six-party Talks for Indefinite Period," *KCNA*, February 10, 2005, available at www.kcna.co.jp/item/2005/200502/news02/11.htm; "DPRK Foreign Ministry Clarifies Stand on New Measure to Bolster War Deterrent," *KCNA*, October 3, 2006, available at www.kcna.co.jp/item/2006/200610/news10/04.htm; and "Meeting Marks Anniversary of KPA Supreme Commander," *KCNA*, December 23, 2010, available at www.kcna.co.jp/item/2010/201012/news21/20101221-14ee.html. Some argue that the target of its nuclear doctrine has in fact shifted since 2009 from the United States to a multi-directional and flexible strategy that has South Korea as its main focus. Peter Hayes and Scott Bruce, "North Korean Nuclear Nationalism and the Threat of Nuclear War in Korea," *Pacific Focus* Vol. XXVI, No. 1, April 2011, pp. 65-89.

8. In interviews with North Korean officials before 2000, for instance, Joseph Bermudez found that for its leaders "deterring the United States also creates the opportunity to reunify Korea by force and under their terms." Joseph S. Bermudez, Jr., "The Democratic People's Republic of Korea and Unconventional Weapons," in eds. Peter R. Lavoy, Scott D. Sagan, and James J. Wirtz, *Planning the Unthinkable: How New Powers will use Nuclear, Biological, and Chemical Weapons,* Ithaca: Cornell University Press, 2000, p. 183.

flow reinforcements.[9] Its leaders might simply be incorporating nuclear weapons into this strategy. If so, they may believe that they can launch an attack at some favorable time, perhaps for limited objectives, and present the United States with a fait accompli that is protected by the threat of nuclear retaliation or nuclear use to deny U.S. access to the peninsula.[10] In the past, of course, North Korea often emphasized that it would "never use nuclear weapons first" but recent statements and preemptive nuclear threats raise doubts about that pledge.[11]

## Politics

Juche and Songun are twin concepts that have shaped North Korean domestic politics, strategic culture, and arguably, its nuclear decisions.[12] Juche emphasizes national self-determination and unquestioned loyalty to the supreme leader. Songun is a "military first" policy that prioritizes military might in state and social affairs and is arguably aimed at achieving two goals.[13] One is the professed North Korean desire to strengthen its military in the face of an increasingly precarious international environment. The other has been to consolidate domestic power through the military under the heirs to the regime after the death of Kim Il Sung. These may be ideological tools that provide political legitimacy but they are also organizing principles for the North Korean state and society.[14]

Nuclear weapons, in part, seem to be an outgrowth of these concepts. They allow North Korea to present itself as the true protector of an independent Korean people while portraying the South as being under the yoke of U.S. colonialism.[15] International crises over its nuclear program similarly feed Pyongyang's narrative of being the sole defender against U.S. imperialism, while simultaneously rallying domestic support around the leadership. Nuclear weapons also offer North Korea perhaps the last remaining area where it holds superiority over South Korea in order to divert attention away from other clear deficiencies in military, economic, and technological matters. Lastly, nuclear weapons traditionally serve narrow bureaucratic interests, such as a state's scientific and engineering communities and elements within the military. This should be no different in North Korea's case; the nuclear program could be manipulated to shape and re-

9. Mark Fitzpatrick, ed., *North Korean Security Challenges: A Net Assessment,* London: International Institute for Strategic Studies, 2011, p. 49.

10. Some see the 2010 sinking of the Cheonan and shelling of Yeonpyeong-do as evidence that North Korean leaders are emboldened to take offensive actions because of goring confidence that the specter of nuclear war deters U.S. and ROK escalation.

11. "DPRK Foreign Ministry Spokesman Totally Refutes UNSC 'Resolution'," *KCNA*, October 17, 2006, available at www.kcna.co.jp/item/2006/200610/news10/18.htm#1; and "Second Korean War Is Unavoidable: DPRK FM Spokesman," *KCNA*, March 7, 2013, available at www.kcna.co.jp/item/2013/201303/news07/20130307-17ee.html.

12. Joseph S. Bermudez, Jr., "North Korea and the Political Uses of Strategic Culture," in eds. Jeannine L. Johnson, Kerry M. Kartchner, and Jeffrey A. Larsen, *Strategic Culture and Weapons of Mass Destruction: Culturally Based Insights Into Comparative National Security Policymaking,* New York: Palgrave, 2009, pp. 189-200; Victor Cha, *The Impossible State: North Korea, Past and Future,* New York: HarperCollins, 2012; and Alexandre Y. Mansourov, "The Origins, Evolution, and Current Politics of the North Korean Nuclear Program," *Nonproliferation Review* Vol 2, No. 3, Spring-Summer 1995, pp. 25-38.

13. Suk Hi Kim, "North Korea: Yesterday, Today, and Tomorrow," in eds. Suk Hi Kim, Terrence Roehrig and Bernhard Seliger, *The Survival of North Korea: Essays on Strategy, Economics, and International Relations,* Jefferson, NC: McFarland & Company, 2011, pp. 18-19.

14. Ibid.

15. Brian Reynolds Myers, *The Cleanest Race: How North Koreans See Themselves—and Why it Matters,* Brooklyn, NY: Melville House, 2010, pp. 151-162.

shape a ruling coalition in ways that maximize the regime's control over the state and minimize potential rivals for power.

Diplomacy

North Korea has long exploited its nuclear program for international influence, prestige, and revenue. Its leaders have never hidden their belief that nuclear weapons can provide North Korea with international privilege on par with major powers.[16] Since the 1994 Agreed Framework, of course, they have also used their nuclear program as a bargaining chip to garner political and economic concessions from the international community. More recently, however, North Korean leaders have emphatically claimed that their nuclear program is not a bargaining chip. Rather, it is "the nation's life [and a national treasure] which can never be abandoned."[17]

Summary

Below is a table highlighting these motivations. There is sufficient evidence to suggest that North Korea sees its nuclear program serving all of these interests, which have varied and evolved with differing levels of importance over time. This helps explain why North Korea marches forward despite a heavy price and why de-nuclearization is an uphill diplomatic goal for the international community—there is no "silver bullet." Individually, however, they help explain different assessments about North Korea's nuclear related decision-making discussed further in the following sections.

**TABLE 1. NORTH KOREA'S MULTIPLE NUCLEAR MOTIVATIONS**

| MILITARY | POLITICAL | DIPLOMATIC |
|---|---|---|
| Deter primarily U.S. and secondarily ROK aggression | Symbol of self-reliance (Juche and Songun) | Bargaining Chip |
| Part of offensive military strategy to unify Korea by force | Technological triumph over U.S.-dependent ROK | Prestige of nuclear weapons |
| Supplement declining conventional balance | Bureaucratic interests | Revenue |

16. International Crisis Group, "North Korea's Nuclear and Missile Programs," *Asia Report*, No.168, June 18, 2009, p. 3.

17. "Report on Plenary Meeting of WPK Central Committee," *KCNA*, March 31, 2013, available at www.kcna.co.jp/item/2013/201303/news31/20130331-24ee.html.

*North Korean Nuclear Capabilities*

North Korea's nuclear capabilities and investments ought to reflect its motivations and also tell us something about its ambitions. Of course, here too we need to be cautious about overstating the evidence. The available information is rarely straightforward and can lead reasonable people to different conclusions. Assessments of North Korea's nuclear capabilities can be broken down into three areas: size, design, and delivery systems.

Size

Estimates about the size of North Korea's nuclear arsenal—past, present or future—turn on different calculations about the weapons grade material that North Korea has or can produce. That calculation is then typically divided by the amount of material the IAEA says is a "Significant Quantity" (IAEA SQ) for atomic bombs (8kg for Pu and 25kg for HEU) but some estimates include different assumptions about the amount of material that is required for North Korea's weapons.[18] For instance, North Korea claimed that its 2006 test used only 2kg of plutonium. Some use 2kg of plutonium-per weapon to help bound the range of weapons North Korea could have in its stockpile, even though they may be skeptical about North Korean claims.[19]

By most assessments, Pyongyang now has two routes for attaining bomb-making material. It has enough separated plutonium for around half a dozen or so weapons and it has a long-suspected uranium enrichment program that it acknowledged in 2009. Indeed, the North Korean statement that opens this paper claiming to have a diversified arsenal suggests to some that it has now tested both plutonium and uranium devices.

Plutonium Production

North Korea is reported to have everything it needs to produce Pu239.[20] However, there is a great deal of uncertainty over exactly how much plutonium it has produced and stockpiled to date. Estimates range between 24 and 50kg depending on how one answers technical questions about early covert production, the efficiency of the separation and conversion processes, and the amounts required for North Korea's first two tests—it is uncertain whether the third test was a plutonium or uranium device.[21] As a result, estimates of its current plutonium based arsenal range from 4-7 weapons at the low end and 12-23 weapons at the high end, again also depending on how much plutonium North Korea might need per-weapon.[22]

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18. Mary Beth Nikitin, *North Korea's Nuclear Weapons: Technical Issues*, RL34256, Washington, DC: Congressional Research Service, April 3, 2013; For IAEA definitions, see, IAEA Safeguards Glossary, 2001 Edition, Vienna: IAEA, June 2002, 23, available at www-pub.iaea.org/MTCD/publications/PDF/nvs-3-cd/PDF/NVS3_prn.pdf.

19. David Albright and Christina Warlond, "North Korea's Estimated Stocks of Plutonium and Weapons Grade Uranium," *Institute for Science and International Security*, August 16, 2012, p. 9.

20. It has industrial-scale mining and plants for milling, refining, and converting uranium as well as a fuel fabrication plant, reactor, and reprocessing facility. Niktin, p. 3.

21. For a catalog of the different estimates, see *North Korean Security Challenges*, p. 112.

22. Albright and Walrond, p. 2.

From 2007-2012, North Korea froze and largely disabled its plutonium production program but it reportedly restarted its 5 MWe reactor in 2013 for the purpose of growing its weapons stockpile.[23] Siegfried Hecker projects that it could operate the reactor for two years with 8,000 fuel rods and extract roughly 10 to 12 kilograms of plutonium within three years. Thereafter, it could produce enough plutonium for about one weapon per year.[24] Moreover, some believe that an experimental light water reactor (25-30 MWe) that was under construction in 2010 may be nearing completion. While its state purpose is to produce electricity, some experts assess that it also be used to produce 10-15kg of weapons grade plutonium per year.[25] Even more troubling, Hecker argues, is the potential for North Korea to build a copy of the 50 MWe graphite moderated heavy water reactor similar to one that was near completion in 1994. While it would need to be rebuilt from scratch, it could produce enough plutonium for up to ten weapons per year. The reactor might take five years to build, if Pyongyang decides to significantly increase its plutonium production capability.

Uranium Production

For years, many believed North Korea operated a clandestine uranium enrichment program. While asserting its right to enrich uranium, however, North Korea denied that the program existed until 2009, when it stated that it would begin developing enrichment technologies to provide fuel for a new light water civilian reactor. In 2010, an unofficial U.S. delegation led by Hecker was invited to what North Korea claimed to be a gas centrifuge enrichment plant operating at Yongbyon. Hecker later reported that the plant likely had 2,000 Pakistani P-2 design centrifuges in six cascades, with a capacity of 8,000kg SWU/year.[26] As such, he calculated that the plant could be configured to produce up to about 40kg of 90% highly enriched uranium (HEU) per year. In 2013, satellite images showed that the facility had been expanded to accommodate roughly double the number of potential centrifuges. If it fills out those centrifuges, one assessment suggests that North Korea could soon produce anywhere from 16 to 68kg or roughly two weapons worth of HEU annually from the new facility.[27]

Estimating production rates for HEU is fraught with more uncertainty than estimating plutonium production due in part to uncertainty regarding the configuration, efficiency, and consistency of the enrichment process. More importantly, however, there are doubts that the Yongbyon plant is the only one of its kind. The speed of construction, size, and apparent sophistication of its disclosed centrifuge facility suggest to some that North Korea likely has at least a pilot-scale plant elsewhere. In fact, the U.S. Special Envoy for North Korea told the IAEA in 2010 that the United States believes North Korea has other clandestine ura-

23. Nick Hansen, "More Evidence that North Korea has Restarted Its 5 MWe Reactor," *38 North*, October 2, 2013, available at 38north.org/2013/10/yongbyon100213/.

24. Siegfried S. Hecker, "North Korea reactor restart sets back denuclearization," *Bulletin of the Atomic Scientists*, October 17, 2013, available at thebulletin.org/north-korea-reactor-restart-sets-back-denuclearization.

25. "North Korea Makes Significant Progress in Building New Experimental Light Water Reactor (ELWR)," *38 North*, November 14, 2011, available at 38north.org/2011/11/elwr111411/.

26. Siegfried S. Hecker, "A Return Trip to North Korea's Yongbyon Nuclear Complex," *Center for International Security and Cooperation*, Stanford University, November 20, 2010, cisac.fsi.stanford.edu/sites/default/files/HeckerYongbyon.pdf.

27. David Albright and Robert Avagyan, "Recent Doubling of Floor Space at North Korean Gas Centrifuge Plant : Is North Korea doubling its enrichment capacity at Yongbyon?," *Institute for Science and International Security*, August 7, 2013, available at isis-online.org/isis-reports/detail/recent-doubling-of-floor-space-at-north-korean-gas-centrifuge-plant/10#2.

nium enrichment facilities outside of Yongbyon.[28] Some also argue that North Korea may have gathered materials over ten years to build up to 10,000 centrifuges, and that related illicit procurements continue to pass through China.[29] Complicating the picture even further are reports that North Korea could now be building its own centrifuges using indigenous rather than imported technologies, which would make it nearly impossible to get an accurate estimate of its HEU production capabilities.[30]

The Institute for Science and International Security released a study in 2012 that ran calculations on five different enrichment scenarios to estimate the range of HEU North Korea could produce. As a baseline, the analysis starts with only the 2,000-centrifuge production plant in Yonbyon that Hecker saw in 2010 and assumes that only LEU for energy was being produced there. The worst-case scenario posits that two 2,000-centrifuge production plants outside of Yongbyon were started sequentially, one in 2005 and another in 2008, based on cited reports. In this scenario, centrifuges from the first plant were relocated to the Yongbyon facility in 2009 to produce LEU. The second facility could then act as a finishing plant, producing HEU from LEU feedstock enriched at Yongbyon. Based on the different scenarios, they calculate that North Korea could have had anywhere between 0-16 weapons worth of the HEU through 2011.[31]

In short, we could see North Korea's nuclear arsenal grow in a frightening way over the next 20 years. Table 2 shows that it could have enough material for an arsenal of around 65 weapons with minimal additional investment by that time. Of course, there are a number of assumptions built into this estimate that have not been confirmed. One, it assumes IAEA SQ for North Korean weapon designs. It also includes a baseline of 4-7 weapons in North Korea's current stockpile plus a rough estimate of a one-weapon-per-year plutonium production capability at the 5 MWe reactor and an estimate of two-weapons-per-year production of HEU at the known centrifuge enrichment facility at Yongbyon, assuming that the facility is operating 4,000 centrifuges.

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28. Amb. Glyn Davies, "U.S. Statement to the IAEA: DPRK," IAEA Board of Governors Meeting, Vienna, Austria, December 2-3, 2010, available at vienna.usmission.gov/101202dprk.html.

29. Albright and Warlond, p. 14.

30. Choe Sang-Hun, North Korea Learning to Make Crucial Nuclear Parts, Study Finds," *The New York Times*, September 23, 2013, available at http://www.nytimes.com/2013/09/24/world/asia/north-korea-learning-to-make-crucial-nuclear-parts-study-finds.html?_r=0. David Albright and Olli Heinonen dispute these findings, see, "In Response to Recent Questionable Claims about North Korea's Indigenous Production of Centrifuges," October 18, 2013, available at isis-online.org/isis-reports/detail/in-response-to-recent-questionable-claims-about-north-koreas-indigenous-pro/10.

31. Albright and Warlond, p. 2.

**TABLE 2. POSSIBLE SIZE OF NORTH KOREA'S ARSENAL IN 20 YEARS: A ROUGH LOW END ESTIMATE**

| Source Material | Current Stockpile | Future Weapons | Total in 20 years |
|---|---|---|---|
| Plutonium | 4-7 weapons (assumes IAEA SQ) | ~1 per year operating only the 5MWe reactor | 24-27 weapons |
| HEU | 0-16 weapons (assumes IAEA SQ) | ~2 per year operating only the 4,000-centrifuge facility at Yongbyon | 40-56 weapons |
| Total | | | 64-83 weapons |

If North Korea's weapons require less material than IAEA SQ, as some suggest could be the case, then the number of weapons in its arsenal in 20 years could increase to well over 100. Similarly, should North Korea use its 25-30MWe experimental light water reactor to produce weapons grade plutonium and rebuild a 50 MWe graphite moderated heavy water reactor, its stockpile could increase exponentially. The same could be said if North Korea in fact has a larger uranium enrichment program than the 4,000-centrifuge facility at Yongbyon or decides to expand over the coming years.

| TABLE 3. POSSIBLE SIZE OF NORTH KOREA'S ARSENAL IN 20 YEARS: ADDITIONS TO LOW END ESTIMATE | | | |
|---|---|---|---|
| Low end Est. in 20 years | If less material than IAEA SQ is needed per weapon | If DPRK increases fissile material production (using IAEA SQ per weapon) | If less material than IAEA SQ is needed per weapon and DPRK increases material production |
| Pu weapons 24-27 | 48-54 weapons<br>(assumes 4kg per weapon) | ~1.5 weapons per year operating 25-30 MWe reactor (30 total additional weapons)<br>~10 weapons per year operating a 50 MWe graphite reactor (takes 5 years to build with 150 total additional weapons) | ~384-387 (assumes 4kg per weapon) |
| HEU weapons 40-56 | 66-93 weapons<br>(assumes 15kg per weapon) | ~2 weapons per year operating an additional 4,000-centrifuge facility beyond currently known facility at Yongbyon (40 total additional weapons) | ~132-186 (assumes 15kg per weapon) |
| Total in 20 yrs ~64-83 | 114-147 | ~289-308 | ~516-573 |

Table 3 shows how decreases in the amount of fissile material North Korea needs to build each weapon and/or increases in fissile material production could dramatically impact the size of its arsenal. If North Korea was able to produce weapons using only 4kg of Pu and 15kg of HEU, as Albright and Warlond suggest could be the case, it could have between 114-147 weapons in 20 years.[32] Expanding its Pu and HEU production capabilities as discussed above in the worst-case scenario, North Korea could have an arsenal of 289-308 weapons. If it is able to expand its production and build weapons using less-than-IAEA SQ,

32. Albright and Warlond provide an expanded range weapons based on the amount of required fissile material needed per weapon in "North Korea's Estimated Stocks of Plutonium and Weapons Grade Uranium."

North Korea could produce an astounding 516-573 weapons. Clearly, the 50MWe graphite reactor that Hecker worries about North Korea reconstructing would be the single greatest contributor to an expanded arsenal. Fortunately, there is no current evidence that North Korea is planning to move in that direction. It is also worth noting that these worst-case calculations of course do not take into account technological, economic or political constraints nor does it consider whether North Korea would desire such a large arsenal. Indeed, it is hard to believe North Korea would ever deem that large of an arsenal is necessary or viable.

The point here is that North Korea may face significant challenges if it decides to build a nuclear arsenal but producing enough fissile material is likely to be low on that list over the next generation. Even the more modest estimates of North Korea's possible arsenal size of 64-83 weapons in 20 years would approach at least one nuclear stockpile estimate for India (110) and Pakistan (120).[33]

## Weapon Design

North Korea has tested three nuclear devices—in 2006, 2009, and 2013. The first test is widely considered a partial failure for a number of reasons. One is that North Korea reportedly informed China beforehand that it expected a yield of about four kilotons but the test produced less than one.[34] The second and third tests are commonly thought to have been more successful with progressively higher estimated yields of "a few" to upwards of ten kilotons, respectively. Other than that, there is little substantively known about North Korean weapon designs, but there are a few core principles that allow us to consider the limited available information.

First, there are two types of basic weapons that are commonly discussed.[35] A "gun-barrel design" uses high-explosives to blow one subcritical piece of fissionable material from one end into another subcritical piece held in the other end to create a supercritical mass. An "implosion" design uses a solid spherical core of subcritical fissile material that is compressed with high explosives into a critical mass. A chain reaction is then set in motion with the introduction of neutrons. It is widely thought that plutonium cannot be used in a gun-barrel device because it emits so much stray radiation that a chain reaction would likely start before a supercritical mass is reached, resulting in a fizzle rather than a large explosion.[36] Since radioactive debris collected from its first test was consistent with a plutonium core, North Korea is thought to have tested an implosion device. That would also be consistent with reports on North Korea's weapon design efforts dating back three decades.[37]

Greg Jones notes in his paper that conventional wisdom suggests that a country's first nuclear weapon will be a simple or crude design—as a proof of concept or demonstration—before developing smaller and lighter designs. When North Korea tested its first weapon, many thought that it was following a similar

33. Hans M. Kristensen and Robert S. Norris, "Global nuclear weapons inventories, 1945−2013," *Bulletin of the Atomic Scientists,* Vol 69, No. 5, September/October 2013, pp. 75-81.

34. Mark Mazzetti, "Preliminary Samples Hint at North Korean Nuclear Test," *The New York Times*, October 14, 2006, available at www.nytimes.com/2006/10/14/world/asia/14nuke.html?_r=0.

35. This section is based on Samuel Gladstone and Philip J. Dolan, *The Effects of Nuclear Weapons,* Washington, DC: U.S. Department of Defense, 1977, pp. 13-18.

36. Also see, Stephen M. Younger, *The Bomb: A New History,* New York: HarperCollins, 2009, p. 23.

37. *North Korean Security Challenges: A Net Assessment*, p. 115.

path and concluded from the low yield that it was a fizzle. Even the successively more powerful second and third tests produced low yields relative to the first tests of all previous nuclear powers (starting at 12kt). As a result, many believe North Korea is still trying to master a "simple fission" device and is far from an effective weapons capability.[38] Others, however, suggest that the tests might not have been for a simple design at all.[39] Rather, they argue, North Korea could have tested a smaller and lighter design toward a warhead that can fit on a missile—consistent with its claims. Still others have speculated that North Korea may have tested early designs toward a boosted fission device or the trigger for a thermonuclear weapon.[40] While most experts believe this is currently out of North Korea's reach for a number of technical reasons, likely requiring further tests and a reliable source of tritium, such capability might not be too far of a stretch over the next 20 years.[41]

For Hecker, North Korea's HEU program seems inconsistent with the presumed priority of developing a weapon that can be delivered on the U.S. homeland because it is generally thought to be easier to miniaturize a weapon for missile delivery using plutonium. He argues that HEU weapons require more fissile material and more high explosives than plutonium based weapons. However, he speculates that if Pakistani nuclear scientist A. Q. Khan shared his country's HEU implosion design and test data, the North Koreans may have seen a quicker and more assured path to miniaturization as well as the added bonus of having an HEU program that is easier than plutonium production to hide.[42]

## Delivery Systems

North Korea has long had an ambitious program to build missiles with various ranges and payloads.[43] It is thought to be developing two inter-continental range missile (ICBM) systems. The first is a multi-stage Taep'o-dong-2 (TD2) rocket that North Korea successfully launched in December 2012 to put a satellite into orbit. While the TD2 is ostensibly for peaceful space-related purposes, U.S. analysts fear that it could be configured to deliver a nuclear warhead on the United States.[44] The second is a road-mobile ICBM (KN-08) that North Korea displayed during a military parade in 2012 but it is not yet clear how far along

38. Choi He-Suk, "Estimates Differ on Size of N.K. Blast," *Korea Herald*, February 14, 2013, available at www.koreaherald.com/view.php?ud=20130214000765.

39. Jeffrey Lewis, "North Korea's Big Bang," *Foreign Policy*, February 13, 2013, available at foreignpolicy.com/2013/02/13/north-koreas-big-bang/; Albright and Warlond, pp. 24-25; and David Albright and Andrea Stricker, "ISIS Statement on North Korean Nuclear Test," February 12, 2013, available at isis-online.org/isis-reports/detail/isis-statement-on-north-korean-nuclear-test/.

40. John Pike, "'Primitive' but Dangerous Skills," *New York Times Room for Debate* (blog), April 7, 2009, available at roomfordebate.blogs.nytimes.com/2009/04/07/how-hard-is-it-to-fire-a-rocket/?_r=0.

41. Jeffrey Lewis, "Can North Korea Build the H-bomb?," *38 North*, June 11, 2010, available at 38north.org/2010/06/can-north-korea-build-the-h-bomb/.

42. Hecker, "North Korea reactor restart sets back denuclearization."

43. Joseph S. Bermudez, Jr., "A History of Ballistic Missile Development in the DPRK," *Occasional Paper,* No. 2, Monterey, CA: Center for Nonproliferation Studies, Monterey Institute for International Studies, 1999.

44. Department of Defense, *Military and Security Developments Involving the Democratic People's Republic of Korea: A Report to Congress Pursuant to the National Defense Authorization Act of 2012,* Washington, DC: Office of the Secretary of Defense, February 15, 2013, p. 9, available at www.defense.gov/pubs/report_to_congress_on_military_and_security_developments_involving_the_dprk.pdf.

the missile is in the development-to-deployment process.[45]

North Korea has tested medium-range Nodong missiles on three separate occasions, dating back to 1993, and there are now two reported variants of the Nodong.[46] Some have long suspected that North Korea likely has the ability to deliver a nuclear warhead on the earlier design up to 1,300km, which could reach all of South Korea and Western Japan. The newer, untested variant was displayed during a 2010 parade—it is thus called the Nodong-2010. Experts note that the new version shows improvements that suggest it could deliver up to 800kg about 1,600km.[47] That would give North Korea the ability to strike all of Japan, including U.S. assets in Okinawa. Both versions of the Nodong are thought to be liquid-fueled, low-accuracy, counter-value weapons with little utility against point or military targets. A recent DOD report suggests that North Korea likely has fewer than 50 Nodong missiles.[48]

Also on display during the 2010 parade was a lengthened version of the R-27—a Soviet designed submarine-launched ballistic missile—referred to as the Musudan. The untested missile is thought to be undergoing modifications for mobile land launches.[49] Estimates suggest that it could have a range of up to 2,400km carrying a payload of about 650kg. It is reported to use a liquid propellant with a circular probable error of 2km. Similar to the Nodong, then, it is more for threatening cities than hardened military or point targets. If the range and accuracy estimates are correct, the only new targets this system really offers North Korea with any confidence are cities in non-U.S. and non-allied countries in Asia, like China and Russia, with a low potential for targeting U.S. military assets in Guam. This suggests one of a number of potential motivations: the North Koreans either want a redundant capability for the Nodong-2010, they want to expand the range of country targets for a more multi-azimuth strategy, or there are internal bureaucratic/technological motivations outside of its strategic value.

Most North Korea watchers believe that the country faces significant technical hurdles before it can deliver a nuclear weapon using an ICBM. One such hurdle is the need to develop a re-entry vehicle and warhead components that can withstand the heat and tumult of atmospheric travel. That hurdle is lowered for short and regional missiles, although the warhead would still need to be rugged enough to survive the rigors of flight. While there is no available evidence to suggest North Korea has tested such a capability, one report speculates that North Korea may have received data related to warhead flight from Pakistan, which conducted such tests of its own missiles that are derived from the Nodong.[50] This would have provided Pyongyang with a valuable head start toward an operational medium-range nuclear capability.

In order to deliver a nuclear weapon with any confidence using its air force, North Korea would likely

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45. Some believe that the mockups illustrate an aspirational capability that is still under development. See Jeffrey Lewis and John Shilling, "Real Fake Missiles: North Korea's ICBM Mockups are Getting Scary Good", *38 North*, November 4, 2013, available at 38north.org/2013/11/lewis-schilling110513/. U.S. Vice Chairman of the Joint Chiefs, Admiral James Winnefeld recently stated: "we believe the KN-08 probably does have the range to reach the United States and the — our assessment of — of where it exists in its lifetime is something that would remain classified." See, Department of Defense, "DOD News Briefing on Missile Defense from the Pentagon," March 15, 2013, available at www.defense.gov/transcripts/transcript.aspx?transcriptid=5205.

46. *North Korean Security Challenges: A Net Assessment*, pp. 133-135.

47. Ibid.

48. *Military and Security Developments Involving the Democratic People's Republic.*

49. See *North Korean Security Challenges: A Net Assessment*, pp. 140-143.

50. Ibid., pp. 133-135.

need to modernize its Soviet-era bombers and overcome formidable and growing U.S.-ROK air defenses. This does not seem to be a viable or reliable method of delivery in the short to medium term. However, it does have alternative delivery methods besides missiles. It might look to deliver a weapon by ship, exploiting its submarine capabilities, or it could infiltrate South Korea using special operations forces (SOF) to deliver weapons behind the DMZ. It might also build large, simple weapons that it could transport by truck to fixed locations during conflict. Lastly, it could attempt to deliver nuclear or at least radiological munitions by artillery. These are largely speculative although there is some evidence that North Korea is at least thinking about such tactical uses for nuclear weapons.[51]

North Korea is similarly investing in ways that could increase the survivability of its missiles against pre-emptive attacks. For instance, North Korea has long showed interest in transporter-erect launchers for mobile missiles that make tracking and targeting difficult—the KN08, Nodong, Musudan, and some shorter-range missiles are thought to be mobile. Additionally, South Korean sources recently announced that North Korea has been constructing missile silos since the mid-2000s and some are located near the border with China.[52] While there is no readily available evidence to corroborate this claim in the literature or online sources, silos would be considered "hard targets" because the missile would be underground, requiring greater accuracy and/or higher yield ordinance to ensure their destruction.

**TABLE 4. DELIVERY SYSTEMS**

| | Potential Targets | Current Status |
|---|---|---|
| Taep'o-dong-2/Unha | United States | Not operational |
| KN08 | United States | Not operational |
| Musudan | China, Russia, possibly Guam, Japan | Not operational |
| Nodong-2010 | Japan, South Korea | Operational (<50) |
| Nodong | South Korea, Western Japan | Operational (<50) |
| Short range (Scud) missiles | South Korea | Operational (<100) |
| Boat/Submarines | South Korea | NA |
| Truck | Defensive | NA |
| "Landmines" | Defensive | NA |
| SOF | South Korea | NA |

51. For one exploration of possible delivery methods, see Peter Hayes and Scott Bruce, "Translating North Korea's Nuclear Threats into Constrained Operational Reality", in Gregory J. Moore, ed., *North Korean Nuclear Operationality,* Baltimore: Johns Hopkins University Press, 2014, pp. 15-31.

52. "North digs silos for missiles in Mt. Paektu area: Government sources say nearness to China is strategic advantage ," *Korea Joongang Daily*, October, 10 2012, available at koreajoongangdaily.joins.com/news/article/article.aspx?aid=2978649.

*Alternative Nuclear Futures*

This section maps out the different nuclear strategies or postures that North Korea could adopt over the next generation. They include a political or diplomatic strategy aimed at extracting international concessions; a catalytic strategy intended to internationalize a conflict on the peninsula; assured strategic retaliation; and, asymmetric escalation or nuclear war-fighting strategy.[53] These different strategies take into consideration the primary strategic goal that would presumably guide nuclear decisions and investments; the relative transparency of nuclear capabilities that would likely be needed; the relative arsenal size and diversity of weapon systems; when and under what conditions they might be used against which targets; the command and control procedures for carrying out related decisions; and, the primary challenge each strategy would inevitably confront. Table 5 below highlights these characteristics.

Political/Diplomatic

It is generally assumed that a state's nuclear strategy or posture is aimed at security or deterrence related goals. But, this might not always be the case. North Korea has used its nuclear program at times to garner international economic and energy assistance, gain international and domestic prestige, shape domestic politics, and increase diplomatic leverage. These goals share one important characteristic: operational, militarily viable nuclear capabilities are not necessary. To achieve these goals, North Korea only needs to invest what is minimally necessary to satisfy different constituencies or to maximize leverage/profit.

A nuclear posture that is oriented primarily toward political or diplomatic goals requires very little transparency. This type of posture is not overly concerned with deterring an adversary, so it does not necessarily require the demonstration of a nuclear weapons capability. Rather, the demonstration of the technical means for a nuclear weapons program would likely suffice for symbolic or bargaining purposes to extract international concessions. Since there is no requirement for a functioning arsenal, this strategy has few demands in terms of operational complexity or command and control. The major problem such a strategy faces, however, is that it likely offers a diminishing margin of return—as a source of prestige, international bargaining or bureaucratic leverage—on investments. Even a nuclear posture that is aimed at maximizing monetary profit through trade faces a limited and narrow market that can likely sustain investments only so far.

53. This is an extension of Vipin Narang's excellent work in "Posturing for Peace? Pakistan's Nuclear Postures and South Asian Stability," *International Security,* Vol 34, No. 3, Winter 2009/2010, pp. 38-78.

| TABLE 5. ALTERNATIVE NUCLEAR FUTURES AT A GLANCE: MINIMUM REQUIREMENTS FOR FOUR MODELS | | | | | |
|---|---|---|---|---|---|
| **Nuclear Model** | **Primary Goal** | **Relative Transparency** | **Relative Arsenal Size/ Diversity** | **Operational Complexity** | **Problems** |
| Political/Diplomatic | Bargaining/ Revenue /Prestige / Bureaucratic and domestic politics | Lowest | None | None | Diminishing margin of return on investments |
| Catalytic | "Catalyze" third party assistance or intervention | Low | Small<br>-Hand full of Counter-value weapons | Low<br>-Central authority<br>-Weapons may/ may not be assembled | Relies on third party intentions and adversary calculations |
| Assured Strategic Retaliation— Limited Deterrence | Deter strategic/ nuclear attacks and coercion | Medium<br>-Demonstrate survivable second strike | Medium<br>-Enough counter-value weapons to threaten unacceptable retaliatory costs | Medium<br>-Central or delegated authority<br>-Weapons may or may not be assembled | Credibility gap against conventional threats |
| Asymmetric Escalation— Full spectrum Deterrence | Deter broad range of threats, including lower-level conventional attacks | High<br>-Demonstrate survivable second strike and first strike capabilities/ will | High<br>-Large, diverse arsenal (counter force and counter value) for first use in a range of scenarios with reserve of second strike forces | High<br>-Pre-delegation and rapid deployment during crises<br>-Planning integrated into military doctrine<br>-Alert status is high | Expensive and significant pressure on C2 that could lead to inadvertent escalation |

Catalytic

This posture's primary goal is to internationalize the conflict and prompt third party—typically superpower—assistance or intervention to restrain one's adversary. The two examples often used to illustrate this model are Israel's "nuclear signal" during the Yom Kippur War and South Africa's nuclear program

during the 1980s.[54] In both cases, some argue, the primary goal was to encourage U.S. involvement in regional conflicts rather than to directly deter adversaries. That is, the specter of regional nuclear war would frighten the United States into intervening and restraining adversaries.

A catalytic posture requires a higher level of transparency than a nuclear posture that is primarily aimed at political or diplomatic goals because nuclear war must be credible. However, the minimum transparency is still low because the goal is not necessarily to convince an adversary that it faces the threat of nuclear retaliation. Rather, the goal is to raise the potential costs of conflict more generally where third party interests would be at risk. Thus, the minimum requirement would be demonstration of the technical means for a nuclear weapons capability not just a nuclear weapons program. Perhaps, this would consist of conveying the ability to use a hand-full of counter-value weapons under highly centralized command and control. Requiring a low level of operational sophistication, the weapons do not necessarily even need to be assembled but could be stored on stand-by to create the mere impression that war could escalate. The problem for this posture is that it is essentially a gamble on third party intentions as well as the adversary's calculation that the third party will intervene and that the resulting intervention would outweigh the benefits of conflict.

Assured Strategic Retaliation or Minimum Deterrence

This posture is aimed at deterring strategic attacks and coercion that threaten state or regime survival. Assured strategic retaliation depends foremost on developing survivable second-strike nuclear forces that can render an adversary's strategic assets vulnerable and pose unacceptable costs. China is often thought to have relied on this type of posture for at least three decades.[55] Meanwhile, North Korean investments in mobile and hardened nuclear-tipped missiles suggest it may be moving in this direction—a survivable assured retaliation against the United States and its allies.

A medium level of transparency is necessary for this posture because the aim is to convince an adversary that you can endure and retaliate against a first strike, even during heightened crises. It requires demonstrating and disclosure of technical capabilities so that one's adversary has little doubt about the ability to retaliate following a first strike. However, other aspects associated with operations and command and control can remain hidden. For instance, China has long demonstrated its technical capabilities but it has kept hidden details regarding its command and control, the size of its arsenal, deployment patterns, etc. It presumably wants adversaries to know that it can strike high value targets, but it employs a shroud of opacity to enhance survivability of a relatively limited arsenal.

More generally, this posture calls for a larger arsenal than what is minimally necessary in the two discussed above because some redundancy is needed to ensure enough weapons survive a first strike to threaten an adversary with unacceptable costs. However, the arsenal can be comprised solely of counter-value weapons since it does not need to hold at risk a range of different targets or need to engage in nuclear warfighting. It also requires a higher level of operational sophistication. Procedures for delegated or alternate launch authority would likely be put in place to protect against first or decapitating strikes. However, the weapons do not necessarily need to be pre-assembled —assured retaliation does not need to be immediate.

54. Avner Cohen and Terence McNamee, *Why Do States Want Nuclear Weapons? The Cases of Israel and South Africa,* Oslo: Norwegian Institute for Defence Studies, 2005.

55. M. Taylor Fravel and Evan S. Medeiros, "China's Search for Assured Retaliation: The Evolution of Chinese Nuclear Strategy and Force Structure," *International Security,* Vol 35, No. 2, Fall 2010, pp. 48-87.

Thus, the command and control structure can still be highly centralized, at least during peacetime. The main problem with this posture is a credibility gap for deterring lower levels of conflict, when facing a nuclear-armed and conventionally superior adversary that is able to respond in kind.

Asymmetric Escalation or Full-Spectrum Deterrence

This model is intended to deter strategic attacks as well as conventional ones by threatening rapid first use of nuclear weapons in the event of conflict. This is what some might call a nuclear war-fighting posture. It requires survivable second-strike capabilities like the assured retaliation posture to deter strategic attacks and an ability to disperse and deploy nuclear weapons quickly to be released for battlefield use. North Korean statements that assert its intentions to grow and diversify its arsenal in order to better deter aggression—not just nuclear and strategic attacks—suggests that it might have this type of posture in mind as a long term goal.

A high level of transparency is needed to make this posture credible for deterrence purposes. To adopt this model, North Korea would need to demonstrate multiple technical capabilities, highly complex deployment patterns, and command and control to emphasize a high-alert status with pre-delegated launch authority, at least during crises. In order to address varying conventional conflict scenarios, the size of the arsenal would have to be much larger and more diverse, including counter-force capabilities. The major drawback for this posture is that maintaining a diverse, large arsenal with a complex operating system can be exponentially expensive and it also presents significant pressures that can lead to unintended escalation or loss of command and control.[56]

North Korea's Nuclear Direction

North Korea's nuclear posture continues to evolve and its direction remains uncertain. But one reading of the evidence suggests an ambitious and dangerous trajectory (see Table 6). In the past, North Korea may have valued political and diplomatic goals above others. Andrei Lankov argues in fact that "on balance, this goal [diplomatic blackmail] seems to be even more important than using the nukes as a strategic deterrent."[57] The practice of nuclear diplomacy began in the 1960-70s in an effort to manipulate China and the Soviet Union but the target of blackmail shifted to the United States and its allies in the 1990s. Between 1994 and 2007, for instance, it froze or disabled elements of its program in exchange for energy assistance, food aid, diplomatic talks, security assurances, sanctions relief, and economic concessions. Some of those trades constrained North Korea's ability to produce nuclear weapons. But, international and U.S. concessions dried up around 2008, when the Obama administration articulated its policy of "strategic patience" saying that it "will not buy this horse for a third time." In other words, there was a declining margin of return on investments for North Korea's brand of nuclear diplomacy.

In accord with a political-diplomatic posture, North Korea's nuclear capabilities remained unproven and

56. Scott D. Sagan, *The Limits of Safety: Organizations, Accidents, and Nuclear Weapons,* Princeton, NJ: Princeton University Press, 1993.

57. Andrei Lankov, T*he Real North Korea: Life and Politics in the Failed Stalinist Utopia,* New York: Oxford University Press, 2013, p. 149. In a recent conversation, however, he clarified that the primary motive for North Korea has shifted over time from military to diplomatic and back to military.

far from transparent throughout the 1990s and most of the early 2000s.[58] Without much of an arsenal, operations of the nuclear program were likely controlled and under centralized authority. The Nuclear-Chemical Defense Bureau, an organ of the Ministry of People's Armed Forces with direct report to the supreme leader, was thought by some to have been responsible for managing the nuclear inventory.[59] Even later, in 2009, the International Crisis Group assessed that the weapons had not been transferred to the KPA. Rather, the supreme leader through an independent yet still unidentified institution closely guarded them.[60]

North Korea's nuclear posture may have shifted toward a catalytic model shortly after its first nuclear test in 2006. The specter of nuclear war has become a routine feature during crises on the Peninsula in an apparent attempt to galvanize outside intervention. By threatening to escalate conflict to nuclear war, for instance, North Korea has stimulated Chinese, U.S., and even Russian actions to restrain South Korea following provocations, such as after the brazen attacks in 2010. The major powers, especially the United States and China, have a lot at stake in stability. The prospect of a wider, nuclear war in Korea could draw them in on opposing sides. The resulting costs for both would be extremely high, while neither faces particularly high costs for returning to the status quo and stability. North Korea may realize this and exploit our mutual interests and fears by utilizing its nuclear weapons to "rock the boat." But, recent experience suggests this strategy might not be reliable over time. Chinese patience shows signs of having limits when it comes to North Korea's nuclear saber rattling. Moreover, the United States and South Korea are developing a deterrence and defense strategy aimed specifically at neutralizing the North's nuclear threat. It would be a gamble for Pyongyang to rely on outsiders to restrain South Korea in the future.

In line with a catalytic posture, North Korea's nuclear program has become more transparent through tests, military parades, media releases, and public statements since 2006. It has demonstrated a growing although still ambiguous capability, with only a few weapons in its arsenal. Many began to assess that North Korea could deliver a nuclear warhead on a short to medium range missile, even if with only low levels of accuracy and confidence.[61] Its nuclear threats have become less subtle and have even threatened the United States, although few believe it actually has the capability to do so. Leaders in Pyongyang have also signaled their intent to bolster nuclear operations and command and control but with continued emphasis on centralized authority. In March 2012, for instance, North Korea upgraded the Missile Guidance Bureau in charge of short and long-range missile developments to the status of Strategic Rocket Forces Command, which is somewhat autonomous from the KPA with a direct report to Kim Jong Un and the KPA General Staff. Its commander was also elected to the Worker's Party Central Military Committee, chaired by the supreme leader. Some believe this could be the new home for North Korea's nuclear forces.[62] The point here is that North Korea's posture has started to change since 2006 and, since then, has taken on a more "catalytic" quality than in the past.

To be sure, leaders in Pyongyang might have even higher ambitions for its nuclear program. Investments in a survivable and more robust nuclear arsenal suggest that it may be striving for an assured retaliation ca-

58. It announced that it had a nuclear arsenal in 2003 and there were outside reports that it may have had a couple of weapons before then.

59. Andrew Scowbell and John M. Sanford, *North Korea's Military Threat: Pyongyang's Conventional Forces, Weapons of Mass Destruction, and Ballistic Missiles,* Carlisle, PA: Strategic Studies Institute, 2012.

60. International Crisis Group, p. 12.

61. Albright and Warlond, p. 10.

62. *East Asia Strategic Review,* Tokyo: National Institute for Defense Studies, 2013, p. 146.

pability in the near-to-midterm with a longer-term goal of adopting an asymmetric or nuclear war-fighting posture. As highlighted above, North Korea has the infrastructure to significantly increase the quantity and quality of its arsenal over the coming years. It rhetorically targets strategic centers in the U.S., ROK, and Japan and an increasingly capable missile program will sooner or later put those targets within reach unless there is a dramatic change in course. It is also trying to improve the survivability of those delivery systems by emphasizing mobility, deception, and hardening.

A larger and more survivable counter-value arsenal would be consistent with an assured retaliation posture. Aspirations for such capabilities are reflected in North Korea's policy adopted by the Supreme People's Assembly (SPA) in 2013:

> "[Nuclear weapons] serve the purpose of deterring and repelling the aggression and attack of the enemy against the DPRK and dealing deadly retaliatory blows at the strongholds of aggression…." [63]

Given current doubts about North Korea's nuclear capabilities, it may feel the need to conduct more tests to prove and demonstrate an assured retaliation capability to make sure the United States and South Korea get the message. As for operational planning, the SPA Law also makes clear that launch authority remains highly centralized for the time being; "nuclear weapons of the DPRK can be used only by a final order of the Supreme Commander of the Korean People's Army…"[64]

While North Korea's investments and recent policy statements suggest it may be building an assured retaliation posture, there are signs that it also has an asymmetric or nuclear war-fighting goal for the future. The SPA "Law on Consolidating Position of Nuclear Weapons State" expands the role of its nuclear weapons beyond deterring high-end attacks to also deter and repel lower levels of aggression using its nuclear weapons:

> "The DPRK shall take practical steps to bolster up the nuclear deterrence and nuclear retaliatory strike power both in quality and quantity to cope with the gravity of the escalating danger of the hostile forces' aggression and attack."[65]

As already discussed, it has the current infrastructure and investments in place not only to grow its arsenal in terms of quantity and quality but also in terms of diversity, if it is indeed producing HEU. It could look to field a range of weapons for counter-value and counter-force targets in order to address different conventional conflict scenarios while retaining a strategic deterrent. Of course, this would require a much more sophisticated command and control system that would likely entail a high alert status, some predelegated authority, and integration of nuclear forces into its broader military doctrine. Indeed, the Central Committee of the Workers' Party of Korea released a report one day before the SPA Law directing the military to begin such planning:

> The People's Army should perfect the war method and operation in the direction of raising the pivotal role of the nuclear armed forces in all aspects concerning the war deterrence and the war strategy, and the nuclear armed forces should always round off the combat

63. "Law on Consolidating Position of Nuclear Weapons State Adopted," *KCNA*, April 1, 2013, available at www.kcna.co.jp/item/2013/201304/news01/20130401-25ee.html, emphasis added.

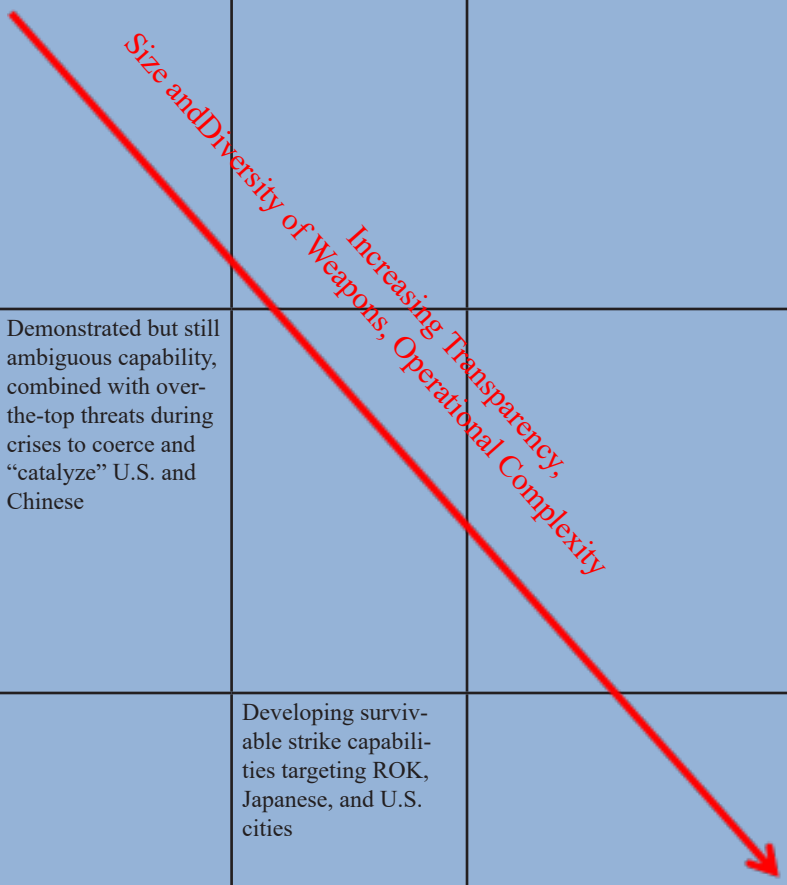
64. Ibid.

65. Ibid.

posture.[66]

TABLE 6. NORTH KOREA'S NUCLEAR DIRECTION

| Nuclear Model | Past | Present | Emerging (5-10 years) | Over the Horizon Ambitions (10-20 years) |
|---|---|---|---|---|
| Political/Diplomatic | Trade elements of unproven program for concessions<br>-1994 Agreed Framework<br>-Six Party Talks<br>-Fuel and Food Aid (Yongbyon) | | | |
| Catalytic | | Demonstrated but still ambiguous capability, combined with over-the-top threats during crises to coerce and "catalyze" U.S. and Chinese | | |
| Assured Strategic Retaliation— Limited Deterrence | | | Developing survivable strike capabilities targeting ROK, Japanese, and U.S. cities | |
| Asymmetric Escalation—Full spectrum Deterrence | | | | Parallel Development Policy of Economy and Nuclear<br>Weapons and the April 1 Nuclear Law on Consolidating Nuclear Weapon State |




To summarize, Table 6 above illustrates North Korea's nuclear trajectory. The primary goal for its nuclear program may have been political or diplomatic, in the past, as it was willing to trade elements of its program during the 1990s and early 2000s. Those days appear to be over. North Korea has demonstrated a growing, although still ambiguous capability since 2006. With only a hand full of weapons estimated to be in its arsenal, it has threatened nuclear war during crises ostensibly aimed at encouraging Chinese and

66. "Report on Plenary Meeting of WPK Central Committee."

U.S. involvement. But it aspires for a more robust posture. It is making investments and has articulated intentions to build a larger and more survivable counter-value arsenal that would be consistent with an assured retaliation posture. Meanwhile, recent policy statements indicate that it may have ambitions for an asymmetric escalation posture.

*What's Next? North Korea's Nuclear Program in 20 Years*

What does North Korea's nuclear direction mean for the size, shape, and character of its future arsenal? It is worth recalling that North Korea could have the infrastructure to produce at least 64 but as many as 83 weapons with relatively little additional investment over the next 20 years. That number could easily exceed 100, if North Korea can design weapons using less fissile material than the IAEA SQ, as some have suggested; and it could grow to 200-500, if it increases its fissile material production capabilities as some fear that it might. As such, North Korea's nuclear posture will not likely be limited by its size. An arsenal of 60-80 weapons may be sufficient for North Korea to implement an asymmetric escalation strategy.

In the near term, North Korea would likely focus on efforts to bolster its strategic deterrent against the United States if is in fact pursuing an assured retaliation posture. Some believe it can already or might soon be able to deliver a nuclear warhead on short-medium range missiles to strike cities in South Korea and Japan.[67] That may have some deterrent effect on U.S. decision-making but North Korea's leaders would likely want a more robust deterrent but threating its main adversary with unambiguous and unacceptable retaliatory costs. To do this, North Korea may believe that a couple dozen nuclear tipped missiles that can strike the United States would be sufficient. After all, China's ICBM force is thought to have numbered only in the twenties well into the 1990s.[68] However, growing U.S. missile defenses could lead North Korea to a higher number and/or pursue penetration aids—which, in turn, would very likely spur additional U.S. national missile defenses.

To adopt an assured retaliation posture, North Korea would likely continue to improve its missile delivery systems, survivability, and command and control. Its first priority would logically be to develop proven and tested ICBM technologies, so that few doubt its missiles can reach proximate targets in the United States. We may see continued progress on its Taep'o-dong missiles to include modifications for warhead delivery. But since these are fixed location, liquid fueled missile systems, they could be vulnerable to a first strike. Underground silos could make the systems less vulnerable or at least increase the scale of a potential disarming attack for the United States. More likely, North Korea will push forward its KN08 enterprise because these systems can be routinely dispersed to increase survivability. The TELs can similarly exploit underground tunnels, caves, and North Korea's rough mountainous terrain for deception, evasion, and sheltering. Testing the propulsion and guidance systems for a mobile TEL base as well as fixed location ICBM forces would be important.

Additionally, it might also believe that it is necessary to improve, test, and communicate that it can miniaturize a device for a warhead. Restarting its plutonium production could be critical for this, since many experts believe plutonium is better suited than uranium for missile delivery by providing better yield-to-

67. Press reports claim that the U.S. intelligence community assess that "North Korea has not…fully developed, tested, or demonstrated the full range of capabilities necessary for a nuclear-armed missile." See Ernesto Londoño, "Pentagon: North Korea Likely Has Nuclear Warhead for Its Ballistic Missiles", *Washington Post*, April 11, 2013, available at www.washingtonpost.com/world/national-security/pentagon-north-korea-could-have-nuclear-missile/2013/04/11/72230dea-a2eb-11e2-82bc-511538ae90a4_story.html.

68. Fravel and Medeiros.

weight ratios. Even though Hecker and others speculate that A. Q. Khan may have shared his country's HEU implosion design and test data with North Korea, offering a quicker and more assured path to miniaturization, it is worth recalling that Pakistan never gave up the plutonium pathway.[69] Pakistan's plutonium production may yet be central to its warhead modernization program.[70] North Korea might similarly see plutonium as its surest path to delivering an atomic weapon over 6,000 miles away.

Like countries before it, North Korea might try to offset the inaccuracy of its ICBMs through higher yield and more efficient warheads. At any rate, it would likely seek higher yields in order to demonstrate that it can pose unacceptable costs with even a few weapons on target to account for U.S. defenses or system errors. North Korea is unlikely to have the wherewithal to develop thermonuclear weapons in the near-to-mid-term but some speculate that it might be able to develop boosted-fission designs in the not-too-distant future. Jeffrey Lewis suggests that this would require additional testing but not much.[71] He argues that China successfully tested a boosted fission weapon with only its third test, and Pakistanis claim to have included a boosted fission weapon in its first round of tests. While North Korea may want to move in this direction, such weapons require tritium, lithium-6, deuteride or other fusion fuels.[72] An exhaustive search in the literature and online sources does not provide evidence that would suggest North Korea has a domestic or international source for such fuels.

As mentioned above, North Korea recently upgraded the Missile Guidance Bureau in charge of short and long-range missile developments to the status of Strategic Rocket Forces Command. It remains a direct report to Kim Jung Un, which follows the SPA Law directing that nuclear weapons can be used only by a final order from the Supreme Commander. This suggests that centralized authority over the arsenals is still closely held. While an assured retaliation posture does not require pre-delegated authority during peacetime, it does require an arsenal that can survive first disarming as well as decapitating strikes to then retaliate. So, North Korea's forces would need to disperse and/or take shelter to wait out an attack but then emerge, communicate, and launch with or without orders. This means that some delegated authority must be provided at least during crises in the event that leadership is taken out. Such command and control operational concepts can be complex. They often require clear guidance and exercises that are made public in order to send a deterrence message. They should also require robust communication capabilities beyond radio-frequency equipment, which can be disabled during conflict. Leaders would not want commanders to mistake failed communications for decapitation and unnecessarily launch their missiles. Moreover, leaders would want to maintain positive control and coordination over launches during conflict. Robust and survivable communications would be important to fully implement an assured retaliation posture. North Korea could make these types of investments over the coming years.

In 20 years, North Korea might adopt a more ambitious asymmetrical escalation posture to compensate for its inferior conventional military amid much stronger neighbors and adversaries. Its prospects for winning a conventional war against South Korea and/or the United States, particularly if it is prolonged, are increasingly slim. As such, leaders in Pyongyang show signs that they may rely more and more on nuclear weapons to deter conventional conflict by threatening first strikes. To do so, they would presumably want counter-force weapons to blunt enemy advances and quick strategic options that could sway the conven-

69. Hecker, "North Korea Reactor Restart Sets Back Denuclearization."

70. Narang.

71. Jeffery Lewis, "Can North Korea Build the H-bomb?,"; and, "Setting Expectations for a DPRK Test," *Arms Control Wonk* (blog), January 29, 2013, available at lewis.armscontrolwonk.com/archive/6200/setting-expectations-for-a-dprk-test.

72. Gladstone and Dolan, pp. 20-25.

tional fight on the peninsula, while holding survivable retaliatory strike options in reserve to deter nuclear attack from the United States or others.

As highlighted earlier, HEU could at some point provide North Korea with a range of options using relatively simple weapons. It could set "atomic landmines" or use trucks loaded with rudimentary devices to deliver weapons to block corridors into North Korea. Additionally, it might exploit its arsenal of short range missiles or SOF to target approaching forces, reserves, or supply lines. It would not necessarily take many of these weapons to cover the main passageways, slow advances, or complicate operations for an advancing army. These weapons would also not necessarily need to be particularly high yield weapons and there might not be any requirement for testing a simple Gun Barrel type of weapon. Recall that the United States did not test the very first weapon of this design before it was used on Hiroshima. North Korea might nonetheless find testing useful as a deterrence signal.

Meanwhile, the Nodong and Musudan missiles are already thought by many to be capable or near-capable of delivering nuclear warheads on strategic centers in the region, such as Busan, Okinawa, and Guam. North Korea might think that striking such targets could slow the flow of U.S. forces to the peninsula, but without increased accuracy or higher yield weapons, confidence in achieving the desired militarily effective would be low. Or it could seek other delivery means. For instance, using simple design options, North Korea might attempt to deliver a weapon to key ports by ship or by exploiting its submarine fleet.

To be sure, North Korea would still need to have a reserve of second strike retaliatory forces to implement an asymmetrical escalation posture. It would want to be confident that it could deter the full retaliatory response from the United States by threatening it with unacceptable costs if the United States launches a strategic strike. Should North Korea cross the nuclear threshold, however, the stakes would likely be significantly higher for the United States and it might be willing to take on additional risks. So, the couple dozen boosted weapons that could be sufficient for an assured retaliation posture might not be adequate for asymmetric escalation. To be confident in strategic deterrence even during a conflict in which it uses nuclear weapons, North Korea may be pursuing thermonuclear designs. In fact, North Koreans have said as much. Those statements have largely been dismissed because such designs seem out of its technological reach but it may not be out of the question for very long and, particularly, in twenty years' time.[73] North Korea would likely require a number of tests for its own design as well as deterrence purposes, but that would likely be another constraining factor given its limited territory and close, watchful neighbors.

73. Lewis, "Setting Expectations for a DPRK Test."

# Chapter 4

## How South Korea Could Acquire and Deploy Nuclear Weapons

*Charles D. Ferguson*

*Introduction: Why Studying Options for Nuclear Weapons is Necessary to Prevent Futher Proliferation*

Political leaders and defense planners in the Republic of Korea (ROK), or South Korea, are cognizant that worsening security in Northeast Asia could lead to additional states, including the ROK, to consider and even develop nuclear weapons. In particular, South Korean President Park Geun-hye warned in May 2014 that another nuclear bomb test by North Korea (Democratic People's Republic of Korea or DPRK) would be "crossing a Rubicon" and would make it "difficult for us to prevent a nuclear domino from occurring in this area."[1] She mentioned that there are some leaders in minority political parties in the ROK discussing options for South Korea's acquisition of nuclear weapons. But the preference is still strongly for the ROK to rely on extended nuclear deterrence from the United States and for the ROK Armed Forces to improve their conventional military capabilities in cooperation with the United States. Nonetheless, if the Japanese government decides that it must acquire nuclear weapons, which would also be far from Japan's preference, the ROK would feel pressure to follow Japan. Thus, while South Korea would not be first to acquire these weapons, it would not want to feel vulnerable to a nuclear-armed Japan.

Often nonproliferation analysts avert their gaze and do not want to contemplate too deeply how trusted allies such as South Korea or Japan could plausibly develop nuclear arms. However, to prevent an awful event, it is useful to study how the external geopolitical and internal domestic political circumstances could transpire to lead to this event and then to examine the consequences if such an action were to occur. This technique of "negative visualization" has a long and distinguished history, having been practiced by Stoics such as the Roman Emperor Marcus Aurelius, in identifying what the practitioners can do and control in order to reduce the likelihood that tragic "Rubicon"-crossing events would happen. President Park herself proposed in an op-ed for the Wall Street Journal, a "Northeast Asian Peace and Cooperation Initiative" for China, the ROK, and Japan to work together to resolve the region's "many quandaries."[2] Moreover, the ROK needs to continue to work closely with alliance partners to strengthen non-nuclear defense options, and the United States needs to continue to provide nuclear deterrence commitments to the ROK.

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1. Gerard Baker and Alastair Gale, "South Korea President Warns on Nuclear Domino Effect: Potential Bomb Test by North Korea Would Have 'Huge Impact' on Regional Security," *Wall Street Journal*, May 29, 2014, available at http://www.wsj.com/articles/south-korea-president-park-geun-hye-warns-on-nuclear-domino-effect-1401377403.

2. Park Geun-hye, "A Plan for Peace in North Asia: Cooperation among Korea, China, and Japan Needs a Correct Understanding of History," *Wall Street Journal*, November 12, 2012, available at http://www.wsj.com/articles/SB10001424127887323894704578114310294100492.

*Rationales for South Korea to Consider Acquiring Nuclear Weapons*

Faced with growing threats of nuclear weapons and missile capabilities from North Korea, South Korea clearly needs reliable means to deter the North's nuclear weapons and effective responses if deterrence fails. Would South Korea develop nuclear weapons to provide deterrence and response capabilities? Different political factions in South Korea have at times doubted U.S. nuclear deterrence assurances or have wanted their own nuclear capabilities to provide for credible deterrence. Other factions have in contrast argued for reconciliation with North Korea and pushed for creating a peninsula free of nuclear weapons.[3]

Reasons against South Korea acquiring its own nuclear weapons can look compelling, but a different viewpoint on these reasons can argue for South Korea crossing that threshold. Let's examine a few prominent reasons for and against.

First, South Korea has become one of the most globalized nations in the world with one of the largest economies, supplying coveted goods (such as electronic products made by Samsung and LG Corporation) to markets around the world, especially to the United States. This argues against South Korea acquiring nuclear weapons because it would jeopardize its economy due to the resulting international sanctions. On the other hand, South Korea would most likely weather the storm of sanctions considering the precedent of India. In May 1998, India conducted nuclear explosive tests and was then sanctioned. But the sanctions did not last much longer than a year. While India was not producing many coveted goods at that time, its huge population offered an enticing market and, as a democracy, was seen by the United States as an important counter to communist China's rising military strength. In the case of South Korea, it has a tiny population compared to India, but most of its people are relatively wealthy and take part in a vibrant democracy, and as mentioned, many South Korean companies create goods that Americans want to consume. Thus, the sanctions would likely be pro forma and be removed after a period of a few to several months.

Second, South Korea has positioned itself as one of the stalwart defenders of the nuclear nonproliferation regime. South Korea, for example, has applied the Additional Protocol to its Comprehensive Safeguards Agreement and thus opened up its civilian nuclear program to intensive inspections by the International Atomic Energy Agency (IAEA). Also, Seoul hosted the 2012 Nuclear Security Summit and demonstrated leadership in securing nuclear and other radioactive materials. Moreover, South Korea would not want to risk sanctions on its ability to export nuclear technologies because it has pledged to garner 20 percent or more of the future nuclear export market, estimated to be worth more than $100 billion in the coming decades. The flipside, however, states that the nonproliferation regime is only good as long as it serves South Korea's national interests. If the Republic of Korea's government determines that its national security requires developing nuclear weapons, it can cite Article X of the Non-Proliferation Treaty (NPT) to exercise its right to leave the treaty in 90 days, similar to what North Korea did in 2003. As to sanctions on nuclear exports, South Korea has smartly embedded its nuclear industry with the United States, France, and Japan, to name a few prominent partners. If these countries want to continue to benefit from partnership with South Korea in the United Arab Emirates or other countries where South Korea has negotiated deals, they would not press too much or hardly at all for sanctions that would also hurt themselves.

Another argument against South Korea's obtaining nuclear weapons is that the ROK would rupture its defense agreement with the United States as well as spark a potential nuclear arms race with Japan or perhaps China. This may be the most powerful argument impeding South Korea's acquisition of nuclear weapons, but there are plausible ways in which it could still happen. Despite the U.S.-stated strategic pivot to the Asia-Pacific region, the fiscal reality is that the United States is increasingly hard pressed to meet the

3. Jongryn Mo, "What Does South Korea Want?" *Policy Review,* No. 142, April & May 2007.

levels of defense spending required to shore up the security of Japan and South Korea. Also, some current and former leaders in those two countries have perceived the Barack Obama administration as downplaying the utility of nuclear weapons, and President Obama's call for a world free of nuclear weapons has alarmed some defense analysts in Japan and South Korea. If the United States were perceived to not be able to reliably and credibly counter the threats posed by China and North Korea, prudent military planners in Japan and South Korea would want to take steps to have their own nuclear capabilities. Moreover, some ROK officials might rationalize that acquiring nuclear weapons would wake up the United States to the need to work more seriously with the ROK on security matters, namely the denuclearization of North Korea.

Finally, if Japan crosses the threshold to nuclear weapon acquisition, South Korea would feel compelled to follow suit. South Korean leaders would then not want to be vulnerable to both nuclear-armed North Korea and Japan. Imperial Japan subjugated the Korean people to colonial rule from 1910 to 1945, and many South Koreans still feel bitter animosity toward Japan and want to prevent Japanese incursion onto Korean territory or into Korea's national interests.

### *Scenarios for South Korean Acquisition of Nuclear Arms*

Let's consider three scenarios that would lend South Korea the means to deter, counter, and respond to nuclear threats. The first scenario will be called "enhanced status quo" because it will show that the current status quo has already resulted in South Korea having delivery systems such as missiles and aircraft for nuclear weapons and having a relatively large civilian nuclear infrastructure that would only need to be enhanced a bit to provide the means to extract fissile material for weapons and deploy the first nuclear weapons on available delivery systems. This scenario posits that South Korea would first stockpile separated reactor-grade, but still weapons-usable, plutonium (Pu) and proceed with enhancing its means to produce larger quantities of weapons-grade or near-weapons-grade plutonium for a potential major breakout if necessary. In parallel to the initial amassing of separated plutonium, the ROK would continue to improve its ballistic and cruise missile systems and perform development and testing to ensure that these systems are nuclear capable. Once South Korea has at least a few bombs' worth of plutonium and has confidence in its missile systems, it could go for a quick breakout that would most likely be used to signal North Korea, China, Japan, and the United States. One plausible purpose of this signaling of these initial "diplomatic" bombs would be to prod Washington as well as Beijing to engage seriously on the denuclearization of North Korea.

If the United States and China failed to act, if Japan acted to breakout or build up its nuclear arsenal if it had already broken out, or if North Korea took steps to increase its nuclear arms, South Korea could leverage its base of a handful of nuclear bombs to keep ratcheting up and implement its potential to make dozens of nuclear warheads annually from near-weapons-grade plutonium produced from its four pressurized heavy water reactors (PHWRs). The initial steps could take place conceivably within a five-year period, and the latter ramp up might require more than five years from the initial start. South Korea would try to do as many preparatory steps in parallel. It would need to be prepared for relatively rapid buildup because of the uncertainty concerning how the other states might respond.

In the second scenario, "encirclement," which would build on the first scenario, South Korea would need to ratchet up its nuclear capability to deal with nuclear threats from Japan and China as well as North Korea. In particular, the assumption is that Japan has obtained nuclear weapons and is threatening both North and South Korea. Also, although Seoul and Beijing have good political and economic relations,

South Korea wants to prevent China from occupying the North in the event of a regime collapse or some catastrophe that would give the People's Liberation Army (PLA) a rationale to cross the Yalu River. Seoul would perceive nuclear weapons as a way to deter Chinese incursion into the Korean Peninsula. Beijing's top priority in the region is stability in the Korean Peninsula because of its concern about a mass exodus of millions of North Korean refugees into Chinese Manchuria. In this encirclement scenario, South Korea would likely perceive the need for longer-range strategic nuclear weapon systems and battlefield-capable tactical systems.

In the third scenario, the wild card will be that Japan and South Korea actually join forces and cooperate against common foes. This scenario could be called "the enemy of my enemy is my friend." Working together, Japan and South Korea could climb the ladder to advanced nuclear weapons faster than their separate efforts. They would aim to counter China and North Korea. The United States might actually welcome such a nuclear alliance because this could reduce the U.S. defense burden, but on the other hand, Washington would worry that this scenario could lead to more aggressive conventional and nuclear arms races in Northeast Asia and a more militarily capable China. Without a doubt, this scenario would result in a major strategic realignment.

*Scenario One: Enhanced Status Quo*

In this scenario, South Korean conservatives gain the political ascendancy and argue successfully that engagement policies toward North Korea are bankrupt. They win the debate that it is time to stop wishing for North Korea to denuclearize because South Korea offers food aid and other means of assistance or because Seoul keeps admonishing Pyongyang to participate in peace summits. Indeed, South Korean conservatives have in recent years become the dominant political force, and some have argued in public for South Korea to consider seriously acquiring nuclear weapons. For example, Chung Mong-jun, former chairman of the ruling Saenuri Party, and Won Yoo-chul, former chairman of the National Assembly's Defense Committee, have been two of the most vocal advocates. Chung Mong-jun raised concern among the Washington nonproliferation establishment at the Carnegie Nuclear Policy Conference in April 2013 when he called for tactical nuclear weapons from the United States to return to South Korea and also insinuated that if U.S. deterrence is not strengthened then South Korea should take matters into its own hands.[4] In February 2013, a Korea Gallup poll showed that 64 percent of 1,006 respondents replied, "yes" to the question: "Should South Korea have nuclear weapons?"[5]

Many South Korean conservatives believe that North Korea will not negotiate away its nuclear weapons given the recent statements by Kim Jong-un and the Korean Central News Agency, the media voice of the North Korean regime, that North Korea is a nuclear weapon state and has joined this elite club. Moreover, South Korea needs to face the reality that the Kim regime cannot give up its nuclear weapons because then it would not maintain its rule over North Koreans. For decades, starting with the reign of Eternal President Kim Il Sung and even 21 years after his death, North Korean leaders have based their legitimacy on the Songun, or military-first, policy. To justify the sacrifices of the North Korean people, their leaders have

4. Chung Mong-jun, "Keynote: M.J. Chung, Member, National Assembly of the Republic of Korea," Speech at the Carnegie International Nuclear Policy Conference, Washington, DC, April 9, 2013, available at *carnegieendowment.org/2013/04/09/keynote-m.j.-chung-member-national-assembly-of-republic-of-korea/fv9t.*

5. Martin Fackler and Choe Sang-hun, "South Korea Flirts with Nuclear Ideas as North Blusters," *The New York Times*, March 10, 2013, available at http://www.nytimes.com/2013/03/11/world/asia/as-north-korea-blusters-south-breaks-taboo-on-nuclear-talk.html.

to constantly point to the "hostile policy" of the United States and the "American lackeys" in the South.[6]

DPRK rhetoric notwithstanding, North Korea has been building up its nuclear and missile capabilities and has been alarming South Korean military planners.[7] In January 2015, the South Korean Minister of Defense stated that the ministry's assessment is that North Korea has made "significant" advances toward making a warhead small enough to fit onto a long-range missile capable of reaching the West Coast of the United States but that North Korea had yet to conduct a test to demonstrate this capability.[8] The more North Korea builds up these capabilities, the more South Korean military planners would want to counter them.

To make its first nuclear weapons, South Korea would need (1) fissile material, (2) capable warhead designs, and (3) reliable delivery systems for the warheads. South Korea can plausibly and relatively easily acquire all these ingredients. More advanced thermonuclear warheads would require access to heavy hydrogen isotopes of deuterium and tritium. South Korea has these readily available as well.

## Obtaining Fissile Material

Acquiring fissile material would require South Korea to have facilities for either uranium enrichment or reprocessing of spent nuclear fuel. The former could produce highly enriched uranium (HEU) that could initially power a relatively easy-to-make gun-type nuclear explosive such as the one first made during the Manhattan Project for the Hiroshima bomb. HEU could also power more advanced implosion-type nuclear explosives. South Korea does not have enrichment facilities. Although the Korean nuclear industry has expressed interest in developing enrichment capabilities, the financial incentives for South Korea venturing into enrichment are not apparent for the foreseeable future given the relative glut of cheap enriched uranium on the world market. In addition, South Korea would likely not get U.S. permission to build an enrichment facility. A clandestine facility could not be ruled out, but reprocessing seems to be a more promising immediate pathway as argued herein.

Reprocessing would separate plutonium from spent fuel; the plutonium could power first-generation implosion-type bombs or second-generation pure fission weapons that make use of levitated plutonium pits surrounded by neutron reflectors made of beryllium. Later, South Korea could use its plutonium in more advanced boosted fission and thermonuclear bombs. Notably, these more advanced weapons could use HEU in combination with plutonium or by itself. By the time the ROK went down the thermonuclear pathway, it would be many years into an open breakout scenario and would then be overt about building an enrichment facility.

Plutonium is more desirable to South Korea for a few other reasons. Because plutonium is more efficient in terms of the amount of material needed to achieve a certain explosive yield as compared to HEU, South Korean weapon designers would most likely prefer this fissile material for their first nuclear bombs. Such

6. B. R. Myers, *The Cleanest Race: How North Koreans See Themselves and Why It Matters,* Brooklyn, NY: Melville House, 2011.

7. Choe Sang-hun, "U.S. and South Korea Agree to Delay Shift in Wartime Command," *The New York Times*, October 24, 2014, available at http://www.nytimes.com/2014/10/25/international-home/us-and-south-korea-agree-to-delay-shift-in-wartime-command.html.

8. Choe Sang-hun, "North Korea has made 'Significant' Advances in Nuclear Arms Program, South Says," *The New York Times*, January 6, 2015, available at http://www.nytimes.com/2015/01/07/world/north-korea-has-made-significant-advances-in-nuclear-arms-program-south-says.html.

material is more amenable for use in compact or miniaturized warheads. Moreover, the ROK would likely choose the plutonium pathway because it has many tons of plutonium already resident in spent nuclear fuel, and it has been acquiring expertise in reprocessing. Thus, the enhanced status quo scenario focuses on plutonium.

Spent fuel could be acquired from either South Korea's pressurized water reactors (PWRs) or PHWRs. While South Korea presently has much more PWRs with 19 operable and several more under construction or planned, the four PHWRs are much more useful for acquiring weapons-usable plutonium. Due to the design of a PHWR, it does not burn up as much nuclear fuel as a PWR. A lower burnup means that the isotopic composition of the plutonium in the spent fuel is better suited for nuclear explosives. That is, the higher the fraction of the fissile isotope plutonium-239, the better the material will be for weapons purposes. Fissile Pu-241 is also useful for weapons purposes but is less desirable than Pu-239 because it is more reactive and emits more radiation, which is a consideration during the handling and fashioning into an explosive. In particular, a PHWR with a typical burnup of 7,500 megawatt-day/ton results in a plutonium mix of 66.6% Pu-239, 26.6% Pu-240, and 5.3% Pu-241 for a total fissile content of 71.9%. A PWR with a typical burnup of 53,000 megawatt-day/ton results in a plutonium mix of 50.4% Pu-239, 24.1% Pu-240, and 15.2% Pu-241 for a total fissile content of 65.6%.[9] Thus, in terms of the portion of Pu-239 and total fissile content, PHWR spent fuel is more weapons-usable than PWR spent fuel.

These "reactor-grade" plutonium mixtures are weapons-usable, as officially stated by the U.S. Department of Energy.[10] According to former nuclear weapon designer Dr. Richard Garwin, it is wrong to rule out the use of a plutonium mixture that has less than 85% fissile content. His calculations show that even a fissile content of about 66% is weapon-usable and has a "bare" critical mass of about 13 kilograms as compared to about 10 kilograms bare critical mass for weapons-grade plutonium (Bare means a sphere of this material by itself in a vacuum without being surrounded by a neutron reflector that would reduce the critical mass). He outlines in a 1998 article the relatively simple engineering steps that would be needed to be able to use reactor-grade plutonium of 66% or greater fissile content. He also points out that Pu-240 would add to the fissile yield because high-energy neutrons, produced during the fission of Pu-239 and Pu-241, can fission Pu-240. Thus, he argues that the explosive yield of a reactor-grade plutonium bomb would be comparable to a weapons-grade plutonium bomb because of approximately the same number of fissions in each bomb, assuming similar number of critical masses.[11]

Moreover, there should be no doubt because the United States demonstrated via a nuclear test during the Cold War that reactor-grade plutonium is usable in nuclear explosives and will produce powerful nuclear yields.[12] Also, it is believed that India demonstrated during its May 1998 tests that it used reactor-grade

9. World Nuclear Association, "Plutonium," Information Paper, updated September 2014, available at www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Fuel-Recycling/Plutonium/, accessed on January 30, 2015.

10. U.S. Department of Energy, "Final Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Excess Plutonium Disposition Alternatives," DOE/NN-0007, Washington, DC: U.S. Department of Energy, January 13, 1997, pp. 66-68.

11. Richard L. Garwin, *Reactor-grade Plutonium Can Be Used to Make Powerful and Reliable Nuclear Weapons: Separated Plutonium in the Fuel Cycle Must Be Protected as If It Were Nuclear Weapons,* New York: Council on Foreign Relations, August 26, 1998, available at www.fas.org/rlg/980826-pu.htm.

12. U.S. Department of Energy, Office of the Press Secretary, "Additional Information Concerning Underground Nuclear Weapon Test of Reactor-Grade Plutonium," available at www.osti.gov/opennet/forms.jsp?formurl=document/press/pc29.html.

plutonium. The Indian PHWRs were the likely source of that fissile material for at least one of the tests.[13] The Indian PHWRs and the Korean PHWRs are both derived from Canadian-designed PHWRs known as CANDUs. The currently stockpiled spent fuel at the dry cask storage facility at Wolsong could provide about 26,000 kilograms of reactor-grade, but still weapons-usable, plutonium for South Korea.[14] Assuming a conservative estimate of about six kilograms plutonium for a first-generation fission device, the ROK has up to 4,330 bombs' worth of plutonium at this site. South Korea could also use its PHWRs without too much effort to make near-weapons-grade, often called fuel-grade, plutonium with a content of about 10 to 11 percent Pu-240 and at least 85 percent fissile isotopic content in the overall plutonium mixture.

The CANDU design is proliferation-prone from the standpoints of nuclear material diversion and relative ease in making near-weapons-grade or fuel-grade plutonium. The CANDU can be fueled with natural uranium, low enriched uranium, or even mixtures of various fissionable and fissile materials. South Korea has fueled its CANDUs or PHWRs with natural uranium fuel. The CANDU is designed so that it is refueled while operating. Thus, the plant does not have to shut down to refuel, and there is no outward signal that the plant is refueling. In contrast, a PWR would have to shut down to refuel, and an inspector could witness this activity by noting that there would be no steam plume leaving the cooling tower. Consequently, if South Korea decided to make nuclear weapons and wanted fissile material, it could keep its PHWRs operating while removing and then diverting the spent fuel. Secondly, a CANDU uses heavy water as a moderator and coolant. The heavy water does not absorb as many neutrons as light water, so there would be more neutrons available to convert the uranium-238 atoms in the natural uranium fuel to plutonium-239. Natural uranium has more than 99 percent of its atoms as uranium-238, providing for numerous targets for the neutrons to hit and result in conversion to plutonium. To optimize for near-weapons-grade plutonium production with a very large percentage of plutonium-239, the operator of the PHWR would want to remove irradiated fuel on the order of about once a month.

According to the calculations of Thomas Cochran and Matthew McKinzie, every year until the decommissioning of the PHWRs, South Korea could make about 2,500 kg or 416 bombs' worth of near-weapons-grade plutonium (with a Pu-240 content of about 10 percent) from the four PHWRs at the Wolsong Nuclear Power Plant assuming 6 kilograms of weapons-grade plutonium per bomb and assuming an operational mode of 1,500 to 2,000 MW-day/ton burnup.[15] For more sophisticated weapon designs, the ROK might have available upwards of 830 bombs' worth of plutonium in this operational mode.[16] But as Cochran and McKinzie point out, this scale of operations would require four to five times the domestic natural uranium fuel production capacity that the ROK presently has and would need a reprocessing capacity that is two to three times that of the relatively large-scale commercial plant at Rokkasho in Japan. Therefore, they argue that the ROK would reasonably reduce the scale to fit within its current fuel production capacity. That would still result in approximately 500 kilograms of plutonium, enough for several dozen to somewhat more than 100 bombs' worth of material. Even a more modest production rate of 150 kilograms of pluto-

13. The third test Shakti III is believed to have used reactor-grade plutonium. See the "Nuclear Weapons Archive," updated March 30, 2001, available at www.nuclearweaponarchive.org/India/IndiaShakti.html.

14. This assumes about 6,500 tons irradiated fuel at Wolsong as of end of 2014 and a burnup of about 7,500 MWd/ton with approximately 0.4% plutonium per ton. See the calculations and estimates in the chapter by Thomas B. Cochran and Matthew G. McKinzie, "Mapping Out Alternative Nuclear Weapons Futures for East Asia: What Impact Do Civil Nuclear Programs Have on Breakout and Ramp-Up Activities?" Unpublished Manuscript, October 2014, pp. 27-29.

15. Ibid.

16. Thomas B. Cochran and Christopher E. Paine, *The Amount of Plutonium and Highly Enriched Uranium Needed for Pure Fission Nuclear Weapons,* Washington, DC: Natural Resources Defense Council, revised April 13, 1995.

nium annually, which is well within the capabilities of the four PHWRs, would generate 25 to 50 bombs' worth of material depending on the level of sophistication of the weapons' designs.

Cochran and McKinzie notably highlight that the ROK imports all its natural uranium for producing fuel for these reactors because the ROK has had very limited supplies of natural uranium. Consequently, the ROK would have to make sure that it had available sufficient supplies of this material before embarking on a nuclear weapons program. Typically, fuel manufacturing states do purchase the raw material in advance and because uranium is a dense material, hundreds to thousands of tons can be stockpiled without taking up much space. South Korea, however, would have to be careful not to appear to purchase too much natural uranium in a limited time period so as to provide a telltale sign. Because of this concern, the ROK would likely keep its initial weapons' material production program at a lower level within the capabilities of existing stockpiles of natural uranium.

To ensure continuing supplies of natural uranium after the onset of the weapons program, the ROK would mine newly discovered uranium deposits on land and accelerate deployment of seawater extraction methods. Regarding the former source, Stonehenge Metals Limited presently owns 100 percent of the rights to four uranium projects in South Korea. The lead project, known as the Daejon Project, has inferred uranium resources of about 30 million kilograms (30,000 tons) of U3O8 with an average grade of 320 ppm in the ore bodies.[17] Seoul would likely move to nationalize the uranium resources in the event of a breakout to a nuclear weapons program. South Korea has also invested significant research and development (R&D) into seawater extraction of uranium.[18] The world's oceans contain at least several hundreds of years of uranium based on current demand, but the concentration of uranium is very diffuse. Recently, an international team of researchers led by U.S.-based Oak Ridge National Laboratory announced a potential major breakthrough that the group claims "can extract five to seven times more uranium at uptake rates seven times faster than the world's best absorbents."[19]

Shifting the PHWRs to low burnup operations is an essential step, but the ROK would also need a reprocessing facility to separate the plutonium from the spent fuel. While South Korea in early 2015 does not have a reprocessing facility, it has made significant strides in developing a prototype pyroprocessing facility at the Korea Atomic Energy Research Institute (KAERI) in Daejon. The stated rationale for pyroprocessing is to remove the fissionable materials from spent fuel and thus reduce the radioactivity and volume of the high level waste that would have to be stored underground. The Korean government anticipates fierce public opposition to a permanent high level waste facility and wants to present a technological method that would show to the public that the amount of waste to be stored would be minimized.

Pyroprocessing would under normal operations not separate out pure plutonium from other fissionable materials in spent nuclear fuel. But it would remove the plutonium and other fissionable materials from the protective barrier of highly radioactive fission products inside spent fuel. The plutonium would be mixed in with transuranic materials such as americium, curium, and neptunium. While this mixture would not be desirable for a militarily useful weapon, it could be susceptible to theft or diversion if adequate physical protection measures are not in place because the mixture would not be highly radioactive and could

17. Stonehenge Metals Ltd, "Stonehenge Metals Ltd Announces 87% Increase in Uranium Resources to 65 Mlbs eU3O8," *ASX/Media Release*, February 22, 2011, available at www.stonehengemetals.com.au/asx/2011/20110222_upgrade.pdf.

18. See, for example, Seong-ho Choi et al., "Absorption of Uranium Ions by Resins with Amidoxime and Amidoxime/carboxyl Group Prepared by Radiation-Induced Polymerization," *Radiation Physics and Chemistry,* Vol 67, Issues 3-4, June 2003, pp. 387-390.

19. "Moving Closer to Extracting Uranium from Seawater," *Science Daily*, August 21, 2012.

be handled. The main concern from the proliferation standpoint is that South Korea could divert enough material into a Plutonium Uranium Redox EXtraction (PUREX) type reprocessing facility or could misuse the pyroprocessing facility in order to extract plutonium from the mixture. This plutonium could then be used for making nuclear weapons.

Safeguarding pyroprocessing is challenging due to the nature of the process, it is extremely hard to measure and track the amounts of plutonium. While the International Atomic Energy Agency is working on a safeguards method for pyroprocessing, the most often discussed scenario is to couple the pyroprocessing facility with fast neutron reactors. These reactors make use of high-energy, or fast moving, neutrons to cause fission of plutonium and other transuranic fissionable materials. Uranium enriched to 20 percent or more in the fissile isotope uranium-235 could also be used to fuel these reactors. If the fast reactors were just used to burn up transuranic materials, they could help reduce the amount of these materials that would have to be stored or that could be diverted into weapons programs. But these reactors can also be run in a breeder mode to produce more plutonium, especially plutonium that can be weapons-grade. Consequently, safeguarding fast reactors adds to the challenge of ensuring that the combined system of pyroprocessing plus fast reactors is not furthering a nuclear weapons program.

At KAERI in Daejon, a small-scale research facility could provide a relatively small amount of initial plutonium for breakout into a nuclear weapons program. This is the HANARO research and isotope production reactor and an associated hot cell facility. HANARO is rated at 30 MWth, but the Korean regulatory authority has downgraded the operational power to at most 26MWth. The reactor uses heavy water, but instead of natural uranium fuel, it is fuelled with 19.75 percent U-235. If the reactor were fuelled with natural uranium, it could make upwards of 8 kilograms plutonium annually assuming the power limitation of 26 MWth and 300 days of full power operation. However, due to the far fewer number of target U-238 atoms in the 19.75 percent U-235 core versus a 0.7 percent U-235 natural uranium core, this reactor would not be able to make more than 0.55 kg of plutonium annually.[20] While placing natural or depleted uranium target material in the irradiation channels and around the core could produce some more plutonium, it is likely that this would not be much more than a few more kilograms of plutonium annually. Although the HANARO reactor might provide some starter plutonium for a weapons program, the annual amount would not be enough for the first bomb, but it might supply enough after another year or two of operations assuming that natural or depleted uranium target material were inserted in the reactor. Notably, the hot cells have been used to extract radioisotopes for medical, industrial, and research purposes. These hot cells could also provide a means to extract some plutonium. Of course, this assumes that South Korea would break out of its safeguards commitments, but given the basis of this scenario in which South Korea feels under serious threat to its supreme national interests, safeguards commitments are the least of its worries. The important finding from this analysis of the HANARO facility is that the four PHWRs at Wolsong would be the preferred production route for near-weapons-grade plutonium.

While KAERI has not yet used its PyRoprocessing Integrated DEmonstration (PRIDE) facility with irradiated materials, its experience to date with surrogate materials and its R&D work alongside U.S. researchers at Idaho National Laboratory give KAERI's researchers the essential knowledge and some work with this technique. The ROK has also requested to the United States that packages of pyroprocessed material be made in advance of operating the ROK's experimental fast reactor, which the ROK wants to bring online by 2028. Making packaged pyroprocssed fuel would give Korean technicians even further useful experience. The PRIDE facility could handle about 10 tons of material per year. This capacity would not

20. For an applicable calculation, see Ali Ahmad, Frank von Hippel, Alexander Glaser, and Zia Mian, "A Win-Win Solution for Iran's Arak Reactor," *Arms Control Today,* Vol 44, No. 3, April 2014. Also, the author appreciates the e-mail communications from Prof. Frank von Hippel, May 13 and 14, 2015.

allow for extensive production of plutonium annually from the PHWRs given the several hundred tons of irradiated material from these reactors, but it could provide a smaller scale means to extract the first few bombs' worth of fissile material while KAERI is building a bigger reprocessing facility.

To ensure much greater production capacity, the ROK would likely want to build a dedicated reprocessing facility for the PHWRs that could use the well-proven aqueous PUREX method. As Cochran and McKinzie point out, the ROK could first make a "Simple, Quick Processing Plant," which could only require four to six months to build.[21] Considering that the PHWRs have much lower burnup than PWRs and thus roughly an order of magnitude greater amount of spent fuel to be reprocessed, this simple plant would likely generate on the order of about one kilogram of plutonium per week or about 50 kilograms per year. In parallel, the ROK could build a facility on the scale of the Rokkasho Reprocessing Plant, which can reprocess up to 800 tons of irradiated fuel annually, but such a plant would take considerably longer than six months to build. (Also, given the technical struggles that Japan has had with operating the complex Rokkasho plant, the ROK might not want to go down this road. But Japan had successfully operated a pilot scale reprocessing plant at Tokai that could process about 200 tons per year—plenty for the ROK's needs.) Nonetheless, the simple facility would still provide the ROK with more than enough plutonium to make its first few handfuls of nuclear bombs.

### *Acquiring Materials for Advanced Nuclear Weapons*

South Korea already has the essential elements for making advanced nuclear weapons. Such weapons would include boosted fission warheads and thermonuclear warheads. Two essential ingredients for these warheads are deuterium and tritium, the two isotopes of heavy hydrogen. Deuterium is a stable isotope found in water. South Korea has a large plant that can produce about 400 tons per year of heavy water run by Korea Electric Power Corporation (KEPCO) Nuclear Fuel Limited in Daejon.[22] Korea's HANARO research reactor and four PHWRs at Wolsong routinely make tritium when the heavy water in these reactors absorbs neutrons. South Korea has to remove the tritium from the water in order to prevent too much worker and public exposure to this radioactive substance. The Wolsong Tritium Removal Facility can process 100 kg per hour of tritiated heavy water feed to produce 99% pure tritium. The recovered tritium is then made available for various commercial applications.[23] However, this large amount of tritium would provide South Korea with what would be needed to power boosted fission warheads and even more advanced thermonuclear warheads.

For thermonuclear warheads, South Korea would need to also acquire or manufacture the chemical lithium-6 deuteride. As mentioned, South Korea already has lots of deuterium. Lithium-6 occurs at the portion of 7.6 percent of natural lithium. Column exchange separation processing can be used to separate this isotope.[24] In 2012 South Korea made a major deal with Bolivia to acquire abundant supplies of lithium

21. D. E. Ferguson to F. L. Culler, "Subject: Simple, Quick Processing Plant," Intra-Laboratory Correspondence, Oak Ridge National Laboratory, August 30, 1977.

22. WISE Uranium Project, "Heavy Water Reactor Fuel Fabrication Facilities," updated November 3, 2014, available at www.wise-uranium.org/efac.html#FUELFABHW.

23. S.H. Son, S.K. Lee, and K.S. Kim, "Tritium Production Recovery and Application in Korea," *Applied Radiation and Isotopes,* Vol 67, Issues 7-8, Jul-Aug 2009, 1336-1340.

24. Federation of American Scientists, "Lithium Production," updated July 9, 2000, available from www.fas.org/nuke/intro/nuke/lithium.htm.

for production of lithium-ion batteries.[25] South Korea could conceivably divert some of this lithium into an isotope separation plant in order to obtain the needed lithium-6 for thermonuclear weapons.

## Designing Nuclear Warheads

Essential components for any successful nuclear warhead design include high-speed electronic triggers to signal the detonations of high-energy conventional explosives, the ability to shape the high-energy explosives, and of course, the capacity to manufacture reliable high-energy explosives. Advanced computers would also be helpful but not necessary given the fact that the earliest nuclear warheads did not require such computers; nonetheless, South Korea has very advanced computers. The other components are truly necessary, and South Korea has them available and could most likely readily adapt their non-nuclear applications to nuclear weapons use.

High-speed electronic triggers such as krytrons or sprytrons can operate in voltage ranges of two to 20 kilovolts and "can draw currents ranging from 10 to 100 kilo-amps. Pulse neutron tubes, used to precisely control the initiation of fission chain reactions, require voltages of 100 to 200 kilovolts, and currents in the ampere range. These currents must be turned on rapidly and precisely, timing accuracies of tens to hundreds of nanoseconds are required."[26]

Subject to export controls, krytrons were illegally acquired by Iraq, Pakistan, and North Korea for their nuclear weapons programs. David Albright, for example, cites a statement from A.Q. Khan, who headed Pakistan's nuclear black market, acknowledging that Pakistan received technical assistance from North Korea in acquiring and developing these electronic triggers.[27] Krytrons have non-nuclear defense and civilian applications. For example, in 1976, the Agency for Defense Development (ADD) in the Republic of Korea purchased krytrons for the stated purpose of developing laser-range finders and identifiers for the South Korean Air Force. The ADD said that there were no other intended applications. The ADD, however, at that time had also been ordered by President Park Chung-hee to work on creating a nuclear weapons program. More recently, in 1994, South Korea hosted an international conference in Daejon, South Korea where a group of Japanese researchers presented a paper describing the use of a krytron for X-ray photography, which requires very high-speed switches. Thus, there is evidence that South Korea has had access to krytrons. However, the extent of South Korea's capability to manufacture these particular devices is not clear from open literature. More advanced types of this technology might be developed and manufactured in South Korea.

Electronic technology does not stand still especially in South Korea. In 1976, the Korean government founded and began funding the Korea Electrotechnology Research Institute (KERI), which is involved in numerous R&D projects, including advanced electrical grids, medical devices, high voltage direct current energy technologies, and nano-technologies. This government-supported research institute has hundreds of Ph.D. and master's level researchers with access to high quality manufacturing and testing facilities.[28]

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25. "South Korea Firm Partners with Bolivia on Lithium Processing Plant," *Fox News Latino*, March 29, 2012, available at latino.foxnews.com/latino/news/2012/03/29/south-korea-firm-partners-with-bolivia-on-lithium-battery-components/.

26. John Pasley, "Pulse Power Switching Devices—An Overview," *Nuclear Weapons Archive*, May 8, 1996, available at nuclearweaponarchive.org/Library/Pasley1.html.

27. David Albright, "North Korean Miniaturization," *38 North*, February 13, 2013, available at http://38north.org/2013/02/albright021313/.

28. Korea Electrotechnology Research Institute (KERI), "General Information," available at www.keri.re.kr/html/en/sub01/

Conceivably, under the scenario being considered, the Korean government could task a small portion of these researchers with developing high-speed, high-voltage, high-current switches for nuclear weapons.

Another essential component of nuclear weapons is high-energy conventional explosives that can be shaped into forms that result in implosion shock waves. These shock waves would squeeze plutonium or HEU into super-critical dense shapes necessary for detonating a fission chain reaction. South Korea has world leading manufacturing capability for these types of explosives. In particular, Hanwha Corporation, which is headquartered in Seoul, can make the nuclear-weapon-usable high-energy conventional explosives HMX and RDX, which have been used to trigger nuclear explosions by rapidly compressing fissile material, as well as other high-energy conventional explosives.[29] While Hanwha presently manufacturers these types of explosives for non-nuclear military applications, it would not take much effort to retool for nuclear weapon applications. Hanwha was founded in 1952 and was then called the Korea Explosives Company. In 1974, the government designated it as "a national defense firm."[30] This was during the time of the Park Chung-hee administration. Hanwha also manufactures explosives and related technologies for commercial applications as well as for the defense sector. This company is recognized as a global leader in its field and can reliably manufacture high quality explosives.

Combining the essential components together, the South Korean government could assign a highly trained group of Korean engineers (of which Korea has many) to design reliable nuclear warhead designs. They would likely first simulate their designs on advanced computers. Then once they have promising designs, they could potentially use explosive test facilities at Hanwha's testing facilities for conventional explosives to test how surrogate nuclear material such as depleted uranium would behave in the designs. A successful run of non-fissile material tests would give further confidence that the designs work.

Then the government would be faced with a decision to conduct one or more nuclear tests. For fission weapons or even boosted fission weapons such tests might not be needed, especially with the confidence that would result from a set of successful non-nuclear tests. It would be next to impossible to hide the seismic signals from nuclear tests given the extensive detection network operated by the Comprehensive Test Ban Treaty Organization. At this point in the development, the government could decide to be content with doing a series of subcritical tests or to declare its nuclear capability with nuclear yield tests. Plausibly, South Korea would want to signal to North Korea and possibly other states that it had this capability, and Seoul would likely announce that it had left the Non-Proliferation Treaty citing supreme national interests.

## Leveraging Strategies and Deployments for the First Nuclear Bombs

The first few nuclear bombs could be considered "diplomatic" bombs that would be directed toward announcing South Korea's arrival in the nuclear-armed club.[31] A major motivation could be to signal the United States that Washington needs to seriously engage in denuclearizing North Korea. If this is one of the South's major motivations for pursuing nuclear weapons, it will then have to be willing to bargain

sub01_010201.html.

29. Hanwha Corporation, "Energetic Materials and Pyrotechnics," available at english.hanwhacorp.co.kr/BusinessArea/Explosives/Defense/Pyrotechnics/Pyrotechnics.jsp. The exact names for HMX and RDX are subject to speculation and originated in secret military programs during World War Two. HMX has sometimes been written as High Melting Explosive, and RDX as Research Department Explosive.

30. Hanwha Corporation, "History," available at english.hanwhacorp.co.kr/Company/History/History.jsp.

31. Personal communication with Henry Sokolski, who created this term, February 2014.

away its new nuclear arsenal in exchange for denuclearizing the North. In this sense, these weapons would be diplomatic nuclear bombs. Another motivation would be to signal to Japan and China that South Korea is nuclear-armed or at least nuclear-capable with essentially a bomb-in-the-basement if it pursues trading away its newly acquired nuclear arms.

Assuming that the diplomatic ploy vis-à-vis North Korea does not pan out, then the South would most likely move to build up its nuclear arsenal with the types of capabilities that would deter the North and would provide battlefield capabilities against the North. This action would help fuel a nuclear arms race in East Asia that the ROK would then further respond to, spiraling to more nuclear arms to the other states. North Korea, in particular, would feel compelled to respond with further buildup putting pressure on Japan and South Korea and potentially leading to China to ramp up, then pressuring India and Russia. More Russian and Chinese nuclear arms could push the United States to consider more arms depending on the amount of buildup and types of arms deployed, or at least to halt additional nuclear arms reductions.

What would the ROK's nuclear weapon systems consist of? Seoul might consider a back-to-the-future strategy in which it could reproduce or emulate the types of nuclear weapons the United States had deployed in and around the Korean Peninsula during the Cold War. In recent years, some South Korea political leaders have called for the redeployment of U.S. tactical nuclear weapons, for example.[32]

In 1957 Secretary of State John Foster Dulles convinced President Dwight Eisenhower to approve stationing of U.S. nuclear weapons in South Korea. The United States first deployed in January 1958 280-mm nuclear cannons and Honest John nuclear-tipped missiles. In 1959, the United States positioned a squadron of nuclear-armed Matador cruise missiles with up to a 1,000-kilometer range in South Korea. "By the mid-1960s Korean defense strategy was pinned on routine plans to use nuclear weapons very early in any new war. As a 1967 Pentagon war game script put it, 'The twelve ROKA and two U.S. divisions in South Korea had … keyed their defense plans almost entirely to the early use of nuclear weapons.'"

By the 1980s, the United States had a multi-pronged nuclear use plan for U.S. forces in Korea. According to scholar of modern Korea, Bruce Cumings, based on a briefing by a former commander of U.S. Forces in Korea:

> The United States planned to use tactical nuclear weapons in the very early stages of the outbreak of war, if large masses of North Korean troops were attacking south of the DMZ. This he contrasted with the established strategy in Europe, which was to delay an invasion with conventional weapons and then use nuclear weapons only if necessary to stop the assault… The 'Air-Land Battle' strategy developed in the mid-1970s called for early, quick deep strikes into enemy territory, again with the likely use of nuclear weapons, especially against hardened underground facilities … Neutron bombs—or 'enhanced radiation' weapons—might well be used if North Korean forces occupied Seoul, in order to kill the enemy but save the buildings.[33]

However, today and for the foreseeable future, an early-use tactic could result in the North's use of nuclear weapons. In the Cold War, the North was not nuclear-armed. Nonetheless, the South would likely consider or even decide to deploy nuclear weapon systems that can provide multiple roles such as air defense against swarms of North Korean aircraft, ground defense against massive tank formations, mining of harbors, mining parts of the DMZ, and striking the North's missile bases and aircraft bases. The neutron

32. Bruce Cumings, *Korea's Place in the Sun: A Modern History,* New York: W.W. Norton & Company, 1997, pp. 479-480.

33. Ibid, pp. 481-482.

bomb option could be appealing especially in a situation in which Seoul or other densely populated South Korean cities are evacuated and the South then wants to kill off occupying North Korean forces. Therefore, strategic deterrence alone in which the South could hold at risk the North's leadership would arguably not be sufficient in a scenario in which the North continues to build up its nuclear arms and the South perceives the need to have its own nuclear arms because it cannot rely exclusively on the United States.

### Mating Warheads to Delivery Vehicles

South Korea already has several types of weapon systems that could be modified without too much effort to deliver nuclear warheads. Since the late 1970s, the ROK has been moving forward with acquiring and developing ballistic and cruise missiles as a counter to North Korea as well as obtaining modern fighter-bomber aircraft with aircraft types that can be nuclear-capable. While the United States for many years was opposed to the ROK having long-range missiles and kept the range and payload limited to 300 kilometers and 500 kilograms, South Korea has been able to argue that it needs longer-range missiles for its own defense. In October 2012, Seoul received U.S. agreement to allow the ROK to make ballistic missiles with ranges and payloads that would exceed the Missile Technology Control Regime guidelines of 300 km range and 500 kg payload. The new range and payload limits are 800 kilometers and 500 kilograms and shorter-range missiles can carry up to 2,500 kilograms payload. The agreement also allows the ROK to possess drones that can carry up to 2,500 kilograms of weapons and reconnaissance equipment.[34] The new range limitation was expressly intended to give the South the capability to hit all potential targets in the North but not pose a significant threat to China or Japan.

In the late 1970s, South Korea reverse engineered the U.S. Nike-Hercules surface-to-air missile. The Nike-Hercules was originally designed and intended for air defense roles. This missile was equipped with either a high explosive conventional fragmentation warhead or a nuclear warhead. The first nuclear warhead was the W7 with two yields in the X1 and X2 models: 2 kilotons or 40 kT. This was soon replaced by the boosted fission warhead designated W31 with variable yields of 2 kT, 20 kT, and 40 kT.[35]

While mostly for a surface-to-air role, the Nike-Hercules could also be employed in a surface-to-surface mode, delivering either conventional or nuclear warheads against enemy targets on the ground. For example, a nuclear-armed Nike-Hercules could be directed against enemy tank formations. North Korea has been investing in more advanced T-72 Soviet-based tanks to replace its aging tanks. A nuclear-armed South Korea would consider potential use of tactical nuclear arms to stop North Korean tanks from crossing the DMZ. For air-based targets, the nuclear-armed Nike-Hercules was intended to strike against swarms of aircraft such as Russian bombers launched from Cuba against the Southern United States. For South Korea, this air defense weapon could help defend against swarms of North Korea fighter-bomber aircraft.

The ROK's decades long experience with mastering missile technology via reverse engineering as well as indigenous technologies has resulted in Hyunmoo ballistic and cruise missiles. The Hyunmoo-1 and 2 ballistic missiles and the Hyunmoo-3 cruise missiles could carry upwards of 500 kg warheads. The Hyunmoo-1 has a range of only 180 km while the Hyunmoo-2 has a longer range of 500 km with the 2B variant. It is a two-stage rocket with the first stage based on the Nike-Hercules. The missile uses an inertial guid-

34. Choe Sang-hun, "U.S. Agrees to Let South Korea Extend Range of Ballistic Missiles," *The New York Times*, October 7, 2012, available at http://www.nytimes.com/2012/10/08/world/asia/us-agrees-to-let-south-korea-extend-missile-range.html.

35. Nuclear Weapon Archive, "Complete List of All U.S. Nuclear Weapons," updated October 14, 2006, available at nuclearweaponarchive.org/Usa/Weapons/Allbombs.html.

ance system. With the new extended range missile agreement, the ROK will further boost the capabilities of these delivery systems to 800 km.

The Hyunmoo-3 cruise missile is patterned after the U.S. Tomahawk cruise missile. The Hyunmoo-3C variant has a reported extended range of 1,500 km. With a global positioning system (GPS) guidance system, the ROK could have precision strike capabilities to target the North's command and control with either conventional explosives or low-yield nuclear weapons. High-precision strike thus allows the ROK to try to limit the collateral damage by permitting lower yields to achieve the intended mission. Indeed, the ROK Air Force has recently admitted that the Hyunmoo-3C has GPS guidance and "can fly through a window to hit a target."[36]

For a first-generation or somewhat more advanced plutonium implosion weapon, the ROK could use gravity bombs coupled to nuclear-capable F-15 and F-16 aircraft. In particular, the ROK has received from the United States 61 F-15K Slam Eagles and 180 F-16s. Both types of aircraft have the range and payload to strike targets throughout North Korea. But in recent years, the ROK Air Force has expressed concern that the upgraded version of the F-15 built by Boeing would not have adequate stealth capabilities to penetrate North Korean airspace. Consequently, South Korea decided not to purchase these newer planes but also turned down Lockheed Martin's highly stealthy F-35 due to the high cost.[37] Instead, South Korea has been trying to develop its own advanced stealth fighter-bomber designated the KF-X. This plane's development, however, has experienced significant technical difficulties, and it is unclear whether the ROK can successfully develop the KF-X without substantial foreign assistance. Since 2009, the ROK has been upgrading the capabilities of its KF-16s, which are the Korean variant of the F-16.[38]

*Scenario Two: Encirclement*

In this scenario, South Korea has to contend with not just nuclear threats from North Korea but has to deter Chinese and Japanese nuclear forces. In effect, South Korea would be encircled by nuclear-armed states. The ROK would have more perceived need for a secure second-strike nuclear force to deal with threats from more than one nuclear-armed state.

Some South Korean defense analysts have expressed deep concern about how to deter China from encroaching onto the Korean Peninsula in the event of a collapse of the North Korean regime.[39] This is not farfetched because the PLA did cross the Yalu River into North Korea to save the Kim Il Sung regime during the Korean War. One of Beijing's greatest fears is that millions of North Korean refugees would flood into Manchuria. Thus, China highly values stability on the Korean Peninsula to such an extent that it has not pushed Pyongyang very hard on denuclearizing. Ironically, this stance might spark the very development China would not want: South Korea with nuclear arms.

Because South Korea has a relatively small land area (about the size of Virginia), it would likely move toward deployment of nuclear weapons at sea on submarines. The submarines would not necessarily have

36. Bradley Perrett, "South Korea Works on New Missile Technology," *Aviation Week*, June 1, 2012, available at aviationweek.com/awin/south-korea-works-new-missile-technology.

37. Brendan McGarry, "Boeing Loses South Korean Fighter Contest," *DODbuzz*, September 24, 2013, available at www.dodbuzz.com/2013/09/24/boeing-loses-south-korean-fighter-contest/.

38. "South Korea Launches KF-16 Fighter Fleet Upgrades," *defenseindustrydaily.com*, November 13, 2014, available at www.defenseindustrydaily.com/south-korea-looking-to-upgrade-its-kf-16s-05404/.

39. Personal communication in January 2005 when the author was in Seoul.

to be nuclear-powered. There would have to be at least one submarine continuously at sea. Because submarines require major overhauls every decade or so and periodic maintenance every year, the ROK would want more than one nuclear-armed submarine. Also, due to concerns about anti-submarine warfare, the ROK would want more than one submarine at sea. Perhaps the ROK's submarine requirements could be set at a minimum of four or five advanced ships and could eventually climb even higher depending on arms race scenarios and military assessments. The point is that once the ROK ventures down the nuclear-armed submarine path, it could find itself feeling naval service pressure for more and more such ships. However, reliable and stealthy submarines would help buttress the ROK's second-strike capability.

The ROK Navy (ROKN) has made significant investments and advancements in its submarine capabilities in the past ten years. It has upgraded its submarine fleet to acquire more advanced 1,800-ton displacement air independent propulsion ships that can stay submerged for two weeks in an ultra-quiet mode to prevent detection. These Type 214 class submarines, also known as the Won-il class, have the ISUS 90 combat battle management system, which can track up to 300 targets. These submarines carry cruise missiles for ship-to-land precision strike capability and have a deep diving depth of 400 meters with speeds upwards of 20 knots. The submarine can reportedly travel from Korea to Hawaii roundtrip without refueling. The launch in August 2013 of the Kim Jwa-jin submarine in this class was accompanied by patriotic fanfare and a pointed message by President Park Geun-hye, who said, "I will not tolerate any kind of attempts at damaging our national interests and maritime sovereignty." This ship was specifically named for a Korean independence fighter. The previous ship in this class was also named after another independence fighter. The naming and rhetoric seem directed at Japan and appear to show that the ROK will never again be humiliated by colonial subjugation.[40]

The ROKN has plans for even more advanced submarines that might have vertical launch capability to allow ballistic missiles to be carried and fired. This 3,000-ton displacement ship will have even more capability to stay submerged longer than two weeks. It is reported that this submarine will have an even longer operational range than the Type 214 class. According to a report published by the Nuclear Threat Initiative, this submarine will have effects on Korea's strategic environment because the projected capabilities seem well suited to targeting China and Japan.[41] The first of this class is planned for 2018, but the schedule might slip.

While South Korea has in the past few years been working on extending the range of its ballistic and cruise missiles, the current extended ranges would likely not be sufficient to strike targets in China and Japan. The distance between Seoul and Beijing is 955 kilometers and between Seoul and Tokyo is 1,155 kilometers. South Korea might want even longer-range missiles to threaten Chinese targets beyond Beijing, which is relatively close to South Korea. As mentioned earlier, the Hyunmoo-3C cruise missile has a range of 1,500 kilometers and thus could hold at risk Tokyo, but the Hyunmoo-2 ballistic missiles are yet to go beyond 500 kilometers. To make longer range ballistic missiles, South Korea could try to leverage its emerging space launch capabilities that have been recently demonstrated in a successful satellite launch.[42]

As mentioned in the first scenario, the ROK Air Force has nuclear capable fighter planes, but to ensure that

40. Zachary Keck, "South Korea Goes 'All In' on Submarines," *The Diplomat*, August 17, 2013, available at *h*ttp://thediplomat.com/2013/08/south-korea-goes-all-in-on-submarines/.

41. Nuclear Threat Initiative, "South Korea Submarine Capabilities," July 13, 2013, available at www.nti.org/analysis/articles/south-korea-submarine-capabilities/.

42. Miriam Kramer, "South Korea Launches Rocket in 1st Space Success," *Space.com*, January 30, 2013, available at www.space.com/19553-south-korea-launches-naro-rocket-satellite.html.

the F-15s and F-16s could hit targets outside the Korean Peninsula, the ROK will need air refueling tanker planes as well as early warning aircraft to give advanced warning of enemy fighter interceptors. The ROK has already been moving in this direction with the acquisition of four aerial tankers from 2017-2019. The goal is to have the endurance of the KF-16 increased by 70 minutes and the F-15K by 90 minutes.[43] For early warning capabilities, in 2011 and 2012, the ROK Air Force obtained four Peace Eye aircraft from Boeing based on the Boeing 737 AEW&C aircraft. The ROK is also planning on placing more reconnaissance satellites in orbit that could help with surveillance, targeting, and early warning.

*Scenario Three: The Enemy of My Enemy is My Friend*

In this scenario, Japan and South Korea decide to cooperate in a mutual defense pact to acquire nuclear weapons. For similar reasons, they both feel growing nuclear and missile threats from North Korea. For different reasons, they fear nuclear-armed China with increasingly advanced conventional and asymmetric warfare capabilities. Admittedly, this scenario might strike many defense analysts as farfetched given the historical and present day animosity between Japan and the ROK. But if both feel abandoned by the United States or at least feel that the U.S. defense posture is weakening, then mutual vulnerability might conceivably drive Seoul and Tokyo to help each other develop a nuclear deterrent. Leaders in both countries would, nonetheless, have to worry that they would not be double-crossed and that one of them would take a significant lead in nuclear weapons development that could create a coercive vulnerability against the relatively weaker state. Thus, this scenario envisions that the two nations would have a pact that would stipulate enough sharing and cooperation to ensure near nuclear parity. Each state would have its own separate nuclear command and control.

One of main advantages of such a nuclear development partnership is that each country can benefit from existing capabilities that the other does not have. In particular, Japan could offer use of PUREX reprocessing facilities as well as the Monju breeder reactor. Korea could bring to the table its advanced cruise and ballistic missiles as well as its source of tritium for advanced nuclear weapons. However, each nation would not want to solely rely on the other long-term for such critical capabilities. For instance, while Japan's lending reprocessing assistance to South Korea would kick start the Korean nuclear weapons program, the ROK would also want to have its own reprocessing facility as a backup in case of being cut off by Japan.

Depending on how the security environment unfolds in Northeast Asia, the United States might, behind closed doors, welcome Japan and South Korea developing nuclear weapons. While this would be a huge blow to the nonproliferation regime, Washington might have little choice in its Northeast Asian allies taking such a drastic action if North Korea further advances its nuclear capabilities and if Seoul and Tokyo have governments that cannot tolerate increasing vulnerability. Also, if China makes substantial nuclear advancements and if the United States cannot afford adequate power projection and extended deterrence capabilities in the region, this scenario might offer a plausible worst-case means for Japan and South Korea to deter nuclear attacks. But, of course, the major concern is that this would stimulate nuclear arms races throughout the region and even globally considering the likely reactions by India, Pakistan, and Russia.

43. Jung Sung-Ki, "S. Korea to Extend Range of Jets with Aerial Tankers," *Defense News*, October 18, 2013, available at archive.defensenews.com/article/20130812/DEFREG03/308120008/S-Korea-Extend-Range-Jets-Aerial-Tankers.

*Conclusion*

It is not the intention of these scenario exercises to argue for South Korea's acquisition of nuclear weapons. On the contrary, by examining plausible potential developments in the foreseeable future, the intention is to urge political leaders and defense officials in South Korea, Japan, China, and the United States to work together to resolve the region's "many quandaries" in the words of President Park Geun-hye. And in the case of North Korea, which has been modernizing its nuclear forces, the solution is not for the ROK and Japan to further worsen the security environment by developing their own nuclear arms. Nuclear acquisition by these states would likely stimulate nuclear arms races and would increase the likelihood of these weapons in war. While denuclearizing North Korea is an extremely tough problem and all concerned countries need to redouble their efforts on this front, for the time being the option that provides the best practical assurances to the ROK and Japan is for the United States to continue to demonstrate its resolve to provide conventional and nuclear extended deterrence.

# Chapter 5



# HOW DARK MIGHT EAST ASIA'S NUCLEAR FUTURE BE?

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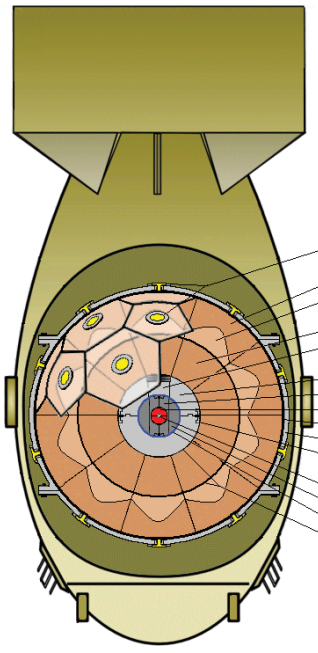
Executive Director, Nonproliferation Policy Education Center
http://www.npolicy.org/

Presented at the RAND Corporation
Santa Monica, California
June 14, 2016

# 1. North Korean Nuclear Worries



## Earlier N. Korean Tests Were Plutonium Implosion Weapons



Cross-section drawing of the Y-1561 implosion sphere showing component placement. Numbers in ( ) indicate quantity of identical components. Drawing is shown to scale. (Author)

A) 1773 EBW detonators inserted into brass chimney sleves (32)
B) Comp B component of outer lens (32)
C) Cone-shaped Baratol component of outer lens (32)
D) Comp B inner charge (32)
E) Removable aluminum pusher trap-door plug screwed into upper pusher hemisphere
F) Aluminum pusher hemispheres (2)
G) Tuballoy (U-238) two-piece tamper plug
H) Pu-239 hemispheres (2)
I) Cork lining
J) 7-piece Duralumin sphere
K) Aluminum cups holding pusher hemispheres together (4)
L) Polonium-Beryllium initiator
M) Tuballoy (U-238) tamper sphere
N) Boron plastic shell
O) Felt padding layer under lenses and inner charges

"Atom Bombs: The Top Secret Inside Story of Little Boy and Fat Man," 2003, p 140. John Coster-Mullen drawing used with permission.

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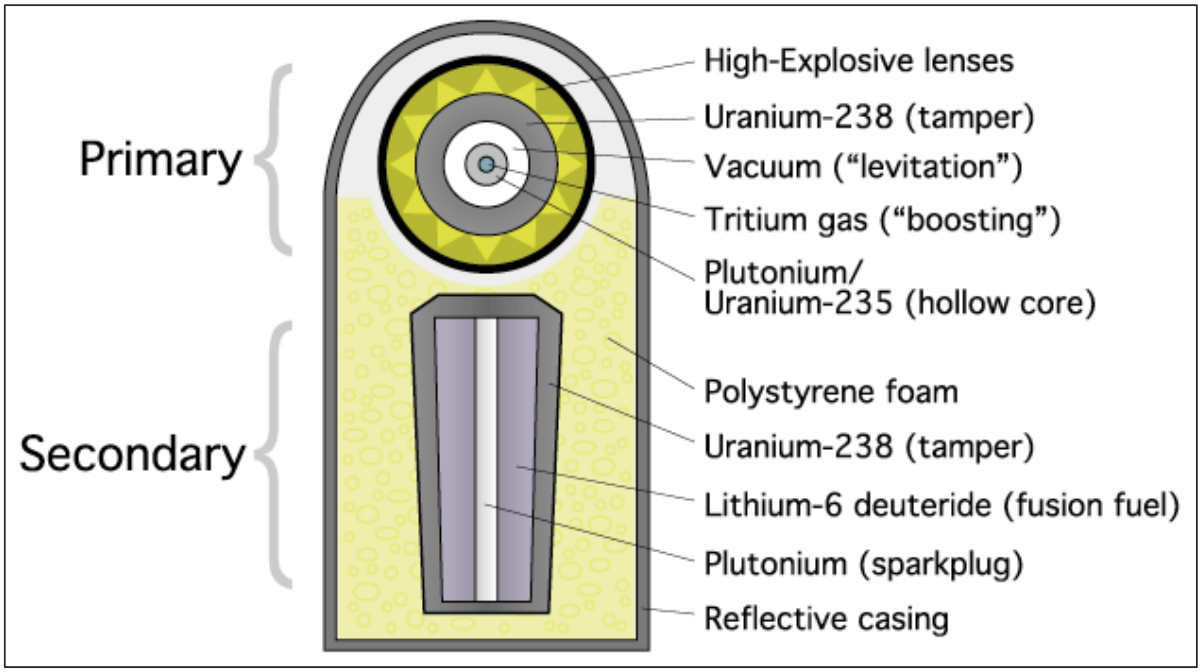
# Latest North Korean Claim: A Two-Stage Hydrogen Bomb?

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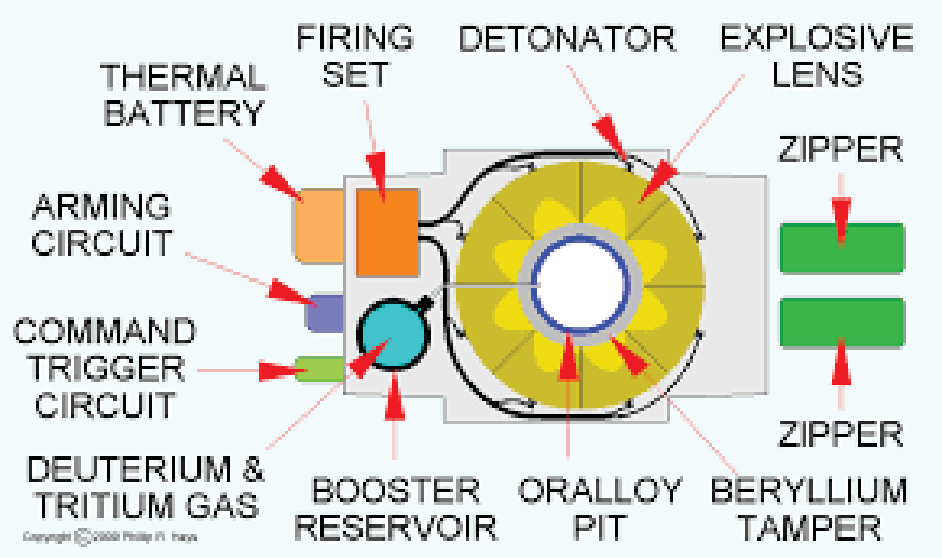
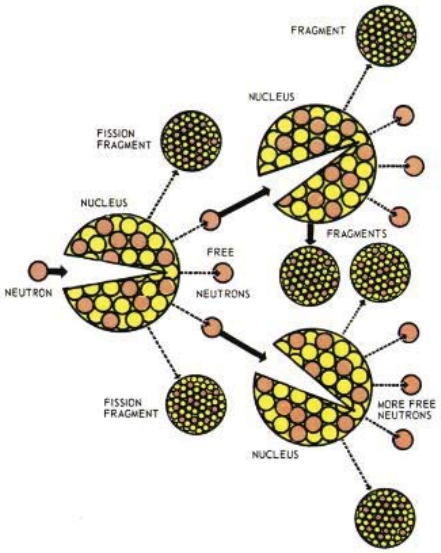
# What's More Certain: Miniature Warhead Mockup vs. Trinity Shot

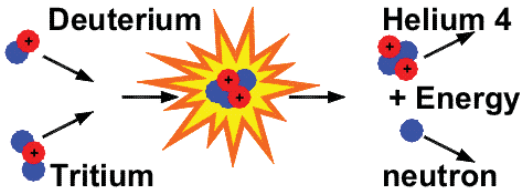
# Boosted Fission Weapon Design






# Fission-Fusion Chain Reactions in Boosted Weapons



# Evidence of DPRK Tritium Extraction Plant

# 1st Security Implication: Reactor-Grade Pu Can Make Very Effective Nuclear Weapons

**By making use various combinations of advanced technologies - improved implosion techniques such as … boosting with deuterium and tritium…it is possible to offset the problems created by the high rate of spontaneous fission of PU-240.** Thomas B. Cochran, "Technological Issues Related to the Proliferation of Nuclear Weapons," Aug. 23, 1998.

**When about 1% of the fission reaction has taken place, the thermonuclear fuel—deuterium and tritium (doubly and triply heavy hydrogen)—reacts and floods the remaining nuclear explosive with neutrons. Thus,…*With a boosted weapon there is no concern about stray neutrons starting the fission chain reaction too early and having the bomb blow apart before attaining full yield... it permits a fission bomb to use any type of plutonium, including so-called reactor-grade, without degradation in performance.*** Gilinsky, Sokolski, "The Other Dangers from That N. Korean Nuke Test," WSJ, Jan. 18, 2016.

## Additional Security Implications for DPRK's Nuclear Weapons Capabilities

- Higher yield to weight ratio warheads– missile delivered warheads
- Potential to make more warheads from a given amount of fissile material
- Potential arsenal size measured in hundreds before 2030



# 2. SOUTH KOREAN NUCLEAR WEAPONS WORRIES

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## RoK Politicians React to DPRK's 4th Test

- "We cannot borrow an umbrella from a neighbor every time it rains. We need to have a raincoat and wear it ourselves," *Won Yoo-cheol, ruling Saenuri Party's floor leader*
- "In preparation against Pyongyang's possession of nuclear arms, (South Korea) should at least have capabilities sufficient enough to build nukes at any time," *Rep. Kim Jung-hoon, chief policy maker for the ruling Saenuri Party*
- "South Korea needs to consider temporarily withdrawing from the Nuclear Nonproliferation Treaty in line with the provisions in the treaty citing national emergency." *Chung Moong-joon, former chairman of the ruling Saenuri Party*

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## *Chosin Ilbo* -- RoK Could Go Nuclear in 18 Months

During the course of their operation, nuclear power plants produce spent nuclear fuel rods that contain small amounts of plutonium. In particular, the four Wolsong power plants (#1-4), which are heavy water reactors, produce spent fuel that is of higher plutonium content than that produced by light water reactors. On average, the spent fuel from the Wolsong plants consists of 1% plutonium. ***At the end of 2014, the Wolsong plants stored 7,414 metric tons of spent fuel rods. If this reprocessed, it is possible, in theory, to obtain 74 metric tons of plutonium.*** *Chosin Ilbo, February 19, 2016. (Note Well: This article exaggerates how much plutonium Wolsong reactors have made: The right figure is more like ~30 metric tons, not 74 since .38%, not 1%, is the correct figure for how much plutonium is produced in a typical heavy water reactor. Still, that's enough for more than 4,500 weapons)*

# Wolsong Heavy Water Reactors

From the four CANDU-6 reactor cores and spent fuel at Wolsong, the RoK could recover 150 kg of lower-burnup fuel-grade plutonium (discharged during the first cycle after start-up—100 to 400 full- power days after start-up) and about 220 kg of higher burnup fuel-grade plutonium that could be used to fabricate more than 50 nuclear warheads with yields exceeding 20 kilotons based on pure fission solid core, levitated core or hollow core designs.



# More: Pyroprocessing

- South Korea also has advanced reprocessing technology. One professor of nuclear engineering said that "our capabilities when it comes to pyroprocessing, which involves reprocessing by using electolysis, are world-class." He noted that "if spent fuel is first reprocessed using pyroprocessing and then dissolved using nitric acid-which is the typical method-then it is possible to obtain more fissile material in a shorter amount of time." ***Experts estimated that it would take a total of 6 months to build a reprocessing facility and then obtain the necessary fissile material for a nuclear bomb***

# Planned RoK Pyro Plant

# RoK Has Produced and Stockpiled Enough Tritium (4 kgs.) to Boost 1,000 Weapons

Wosong Tritium Removal Facility

# 3. JAPANESE NUCLEAR WEAPONS WORRIES



## South Korea's Other Nuclear Threat: Japan

- Hardliners in North Korea have formed a hostile mutual dependence with rightwing groups in Japan, who have pitched the North Korean menace in order to pave the way for Japan's own nuclear armament…Unless South Korea gains a full understanding of the security structure in Northeast Asia and take stern measures, it will once again end up ***sandwiched between two terrifying threats, this time one nuclear-armed country in the North and another in the East***.—*Chosin Ilbo*, June 29, 2012

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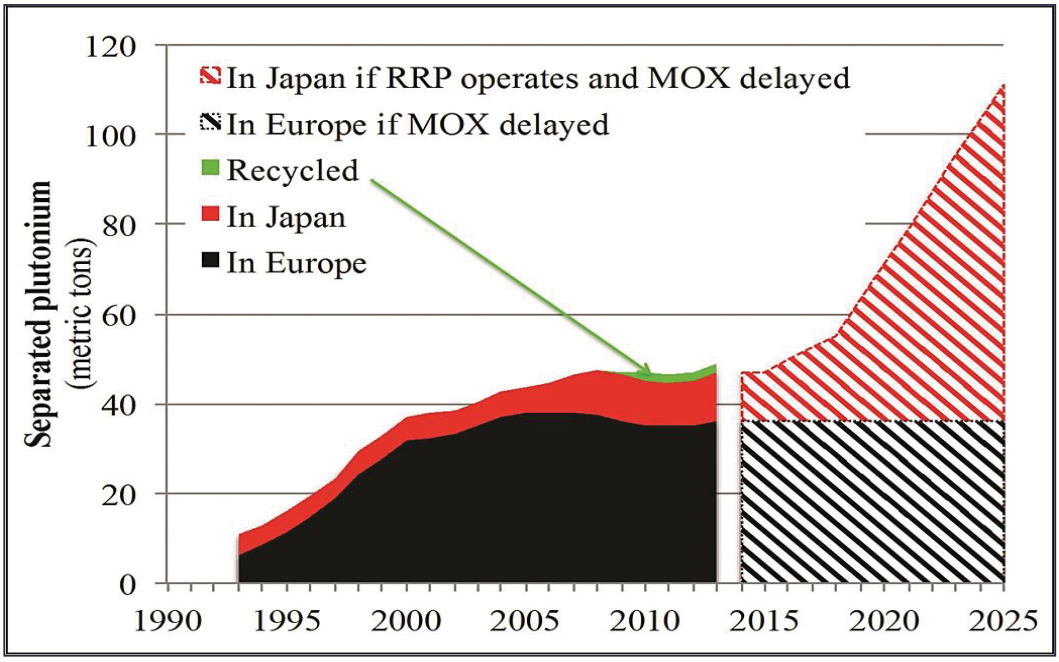
# Too Much Planned Plutonium

**Rokkasho now may open Fall 2018**

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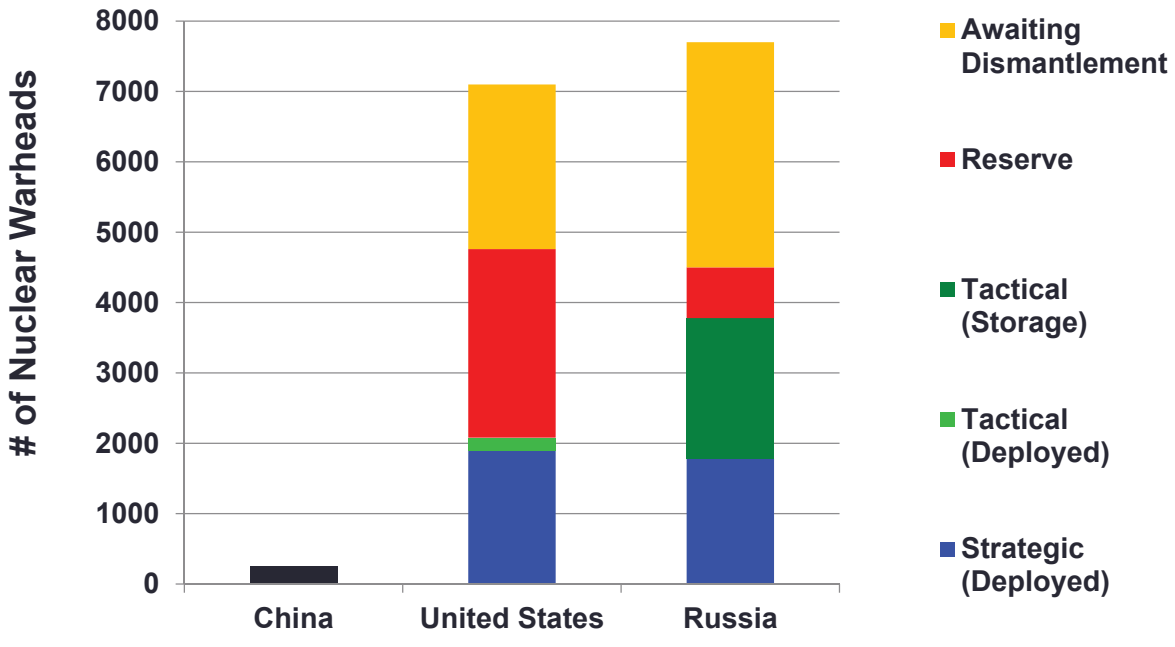
# Japan Can Master Boosting and Beyond

- The National Institute for Fusion Science (NIFS) in Toki
- Japan Atomic Energy Agency's (JAEA) Naka Fusion Institute, Ibaraki Prefecture
- As its contribution to the International Thermonuclear Experimental Reactor (ITER) under construction in France, Japan will provide much of the high-tech components and will host an €1 billion materials testing facility – the International Fusion Materials Irradiation Facility (IFMIF).
- Naka Fusion Institute, which includes the Tritium Processing Laboratory
- National Institute of Fusion Research

# 4. CHINESE NUCLEAR WEAPONS WORRIES



## Total Warhead Inventories: PRC, US, Russia




Source: http://bos.sagepub.com/content/71/2/107.full.pdf+html and http://bos.sagepub.com/content/71/3/84.full.pdf+html

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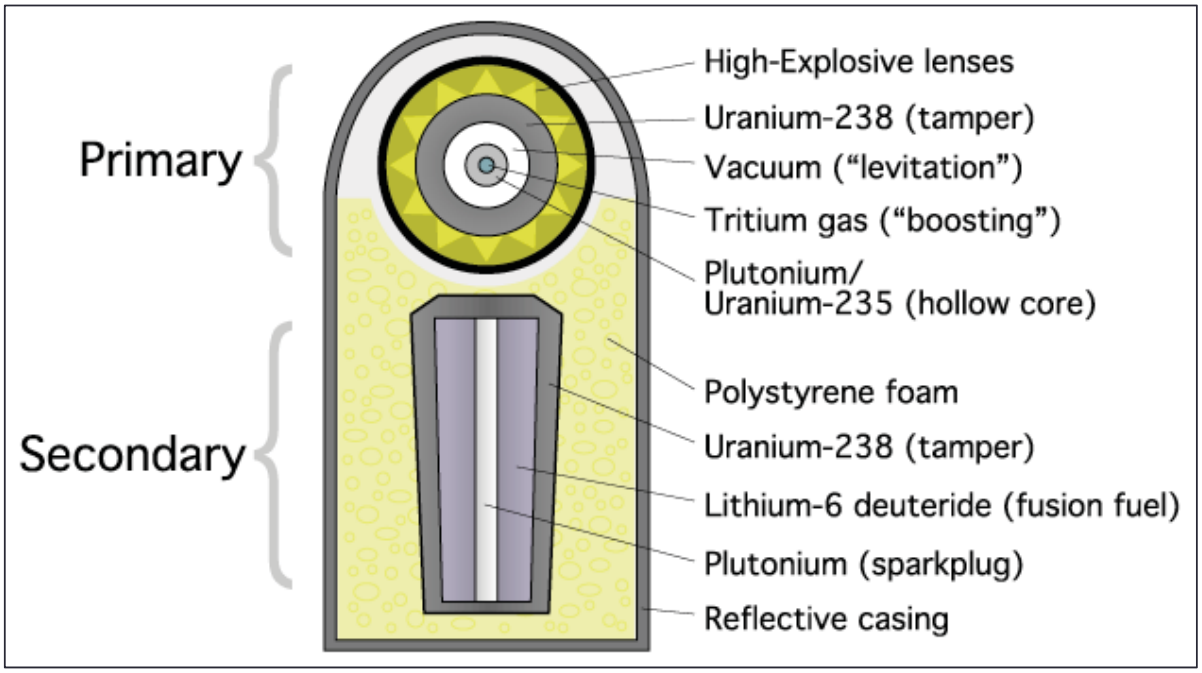
# Two-Stage Fusion Weapon: Teller-Ulam Design: What's Needed

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# What if China Develops Many MIRVs?

- "The most obvious concern from the perspective of potential adversaries is the potential for China to significantly increase the number of nuclear warheads deployed on its MIRV-capable missiles. According to the Belfer Center's Hui Zhang, **China's limited fissile material stockpile means that the country does not have the ability to build significantly more warheads without restarting fissile material production.**" *BAS March 24, 2015, Tong and Logan*

- "The second coming of MIRVs in Asia – in addition to new ballistic and cruise missiles – places a greater obligation on national leaders to exercise strategic restraint… **The key to strategic restraint with the second coming of MIRVs is to avoid the pursuit of counterforce capabilities**." *Arms Control Wonk May 12, 2016, Krepon*

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# What About Chinese Tactical Nuclear Weapons?

- China developed and tested a neutron bomb in 1988 as a "technological reserve" - Liu Huaqiu, Senior Chinese Nuclear Scientist
- What future mission– Countering the U.S., its allies, or Russia?

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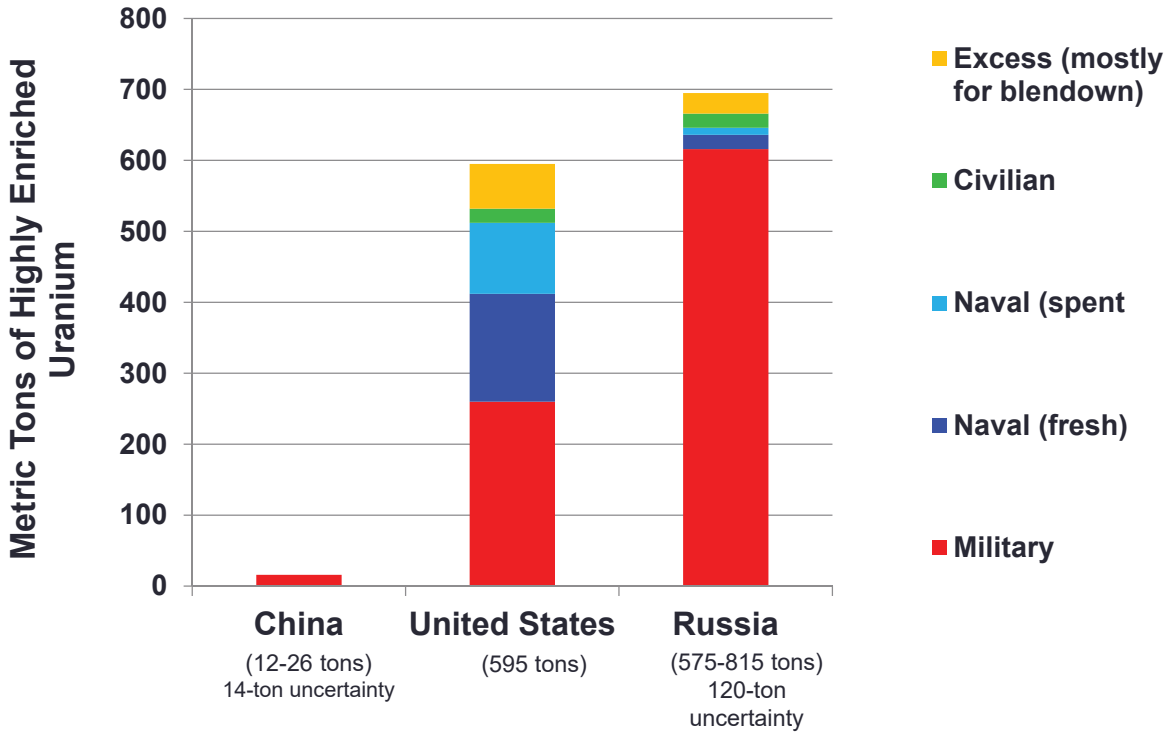
# Stocks of Highly Enriched Uranium




Source: http://fissilematerials.org/library/gfmr13.pdf and http://fissilematerials.org/library/gfmr10.pdf

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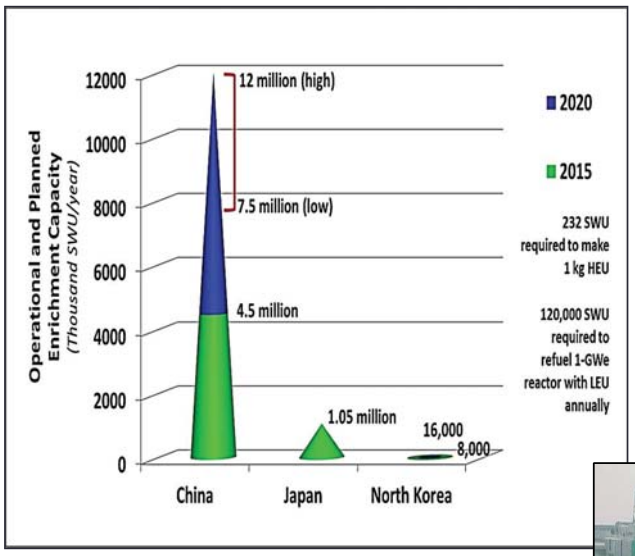
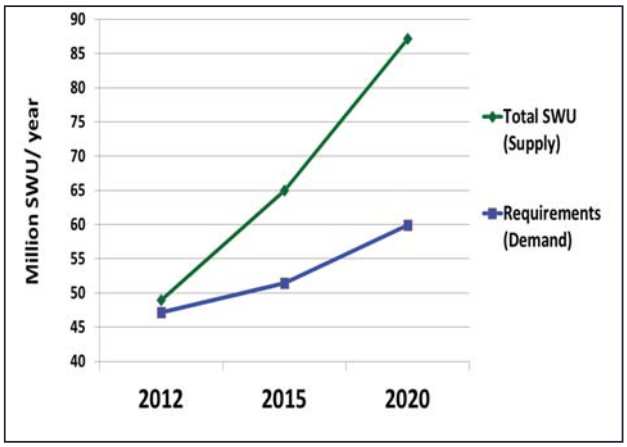
# Uranium Enrichment for Peace?




**~232 SWU required to make 1 kg HEU**
In 2020, the PRC is projected to have at least a 3 million SWU surplus enrichment capacity – enough to make ~1,000 bombs/yr.

**120,000 SWU required to refuel 1-GWe reactor with LEU annually**
(66 GWe PRC, 12.5 GWe Japan in 2020)

**Rokkasho Uranium Enrichment Plant**

**Hanzhong and Lanzhow**

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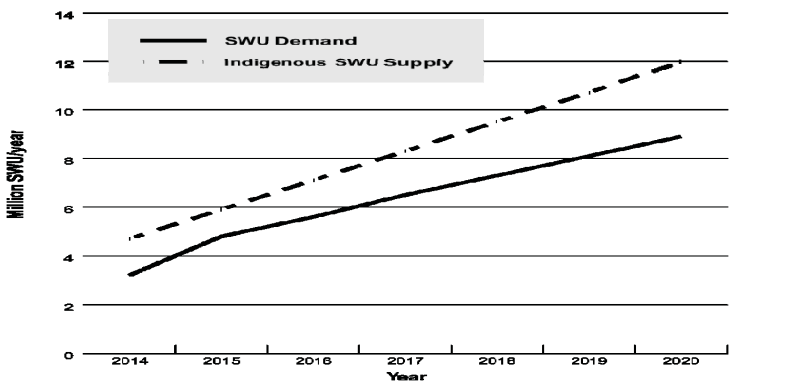
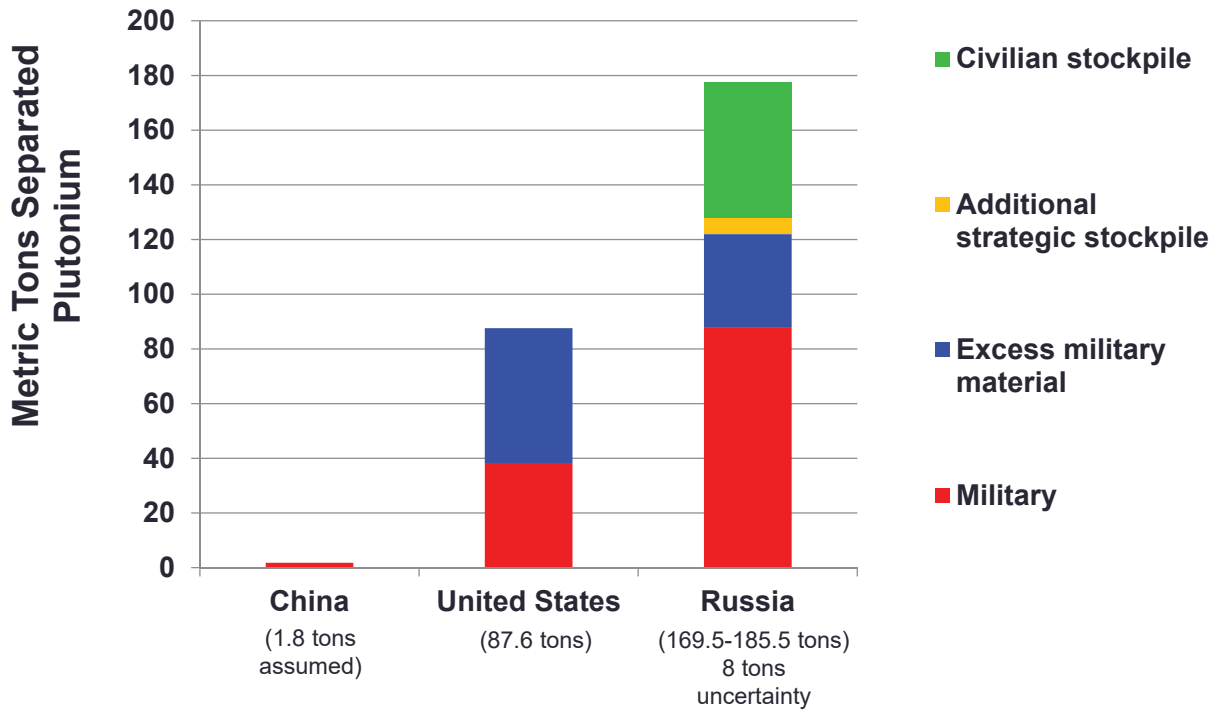
# Projected PRC Supply vs. Demand – 3 million SWU surplus beyond any projected domestic civil requirement or ~ 1,000 bombs' worth /year

**Figure 11: Projection of China's SWU Supply and Demand (2014–2020)**



# Tons of Separated Plutonium




Source: http://fissilematerials.org/library/gfmr13.pdf and http://fissilematerials.org/library/gfmr10.pdf



# PRC's Limited Plutonium Production Capacity Is the Bottleneck to Many More Weapons

- PRC has only 2 plutonium production reactors
- One is being dismantled
- One hasn't operated since the early 1990s
- If restarted, the single reactor could produce roughly 300kg of plutonium a year, only enough to make roughly 75 plutonium triggers or bombs.

Jiuquan plutonium production reactor

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# PRC's Most Immediate Alternative Plutonium Production Option: Its Heavy Water Reactors

- Two Candu-6 reactors (600 MWe each) at Qinshan
- Capable of producing ~650 kilograms of plutonium a year
- Sufficient for roughly >100 bombs a year

Source: https://en.wikipedia.org/wiki/CANDU_reactor

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# 1987: Reagan Administration Proposed Using WPSS LWR to Make Weapons Plutonium

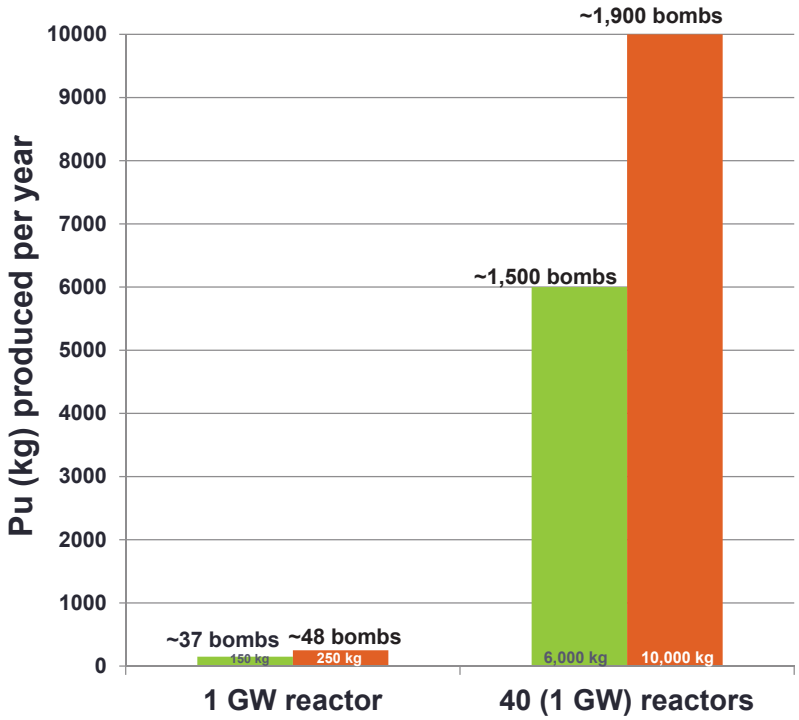
Source: http://www.historylink.org/index.cfm?DisplayPage=output.cfm&File_Id=5482

# So a Standard Power Reactor Produces Lots of Plutonium That Can Be Used For Bombs

- A standard 1 GWe light water reactor (LWR)—the main type used world-wide and in East Asia—provides roughly 200 kilograms of nuclear explosive plutonium at each refueling. This is enough for 50 bombs.
- **At each subsequent refueling, 1/3rd of the core can be removed with about 100 kgs of near-weapons grade plutonium in it**—enough for roughly 20 bombs
- The LWR can also be operated to **make as much as 150 kgs of weapons-grade plutonium—enough for roughly 30 bombs—every 10 months**
- **More details can be found in a report** by the Lawrence Livermore Laboratory, "Verifying the Agreed Framework," April 2001



# How Much Plutonium Could a 1 GWe LWR Generate/Year?




- 4 kg weapons-grade Pu assumed per bomb based on DOE estimate.
- 5.2 kg reactor-grade Pu assumed per bomb based on estimate by Richard L. Garwin (see http://fas.org/rlg/980826-pu.htm)
- 150 kg weapons-grade Pu conservatively assumed per reactor year (see page 64, http://fsi.stanford.edu/sites/default/files/VAF-June.pdf)
- 250 kg reactor-grade Pu conservatively assumed per reactor year.

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# PRC's Other Plutonium Production Bottleneck: Lack of Large, Reliable Reprocessing Plant

Images of 50tHM/year Chinese Reprocessing plant at the Jiuquan Atomic Energy Complex

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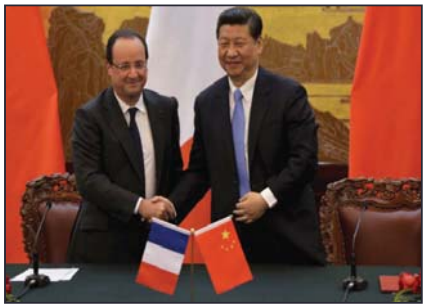
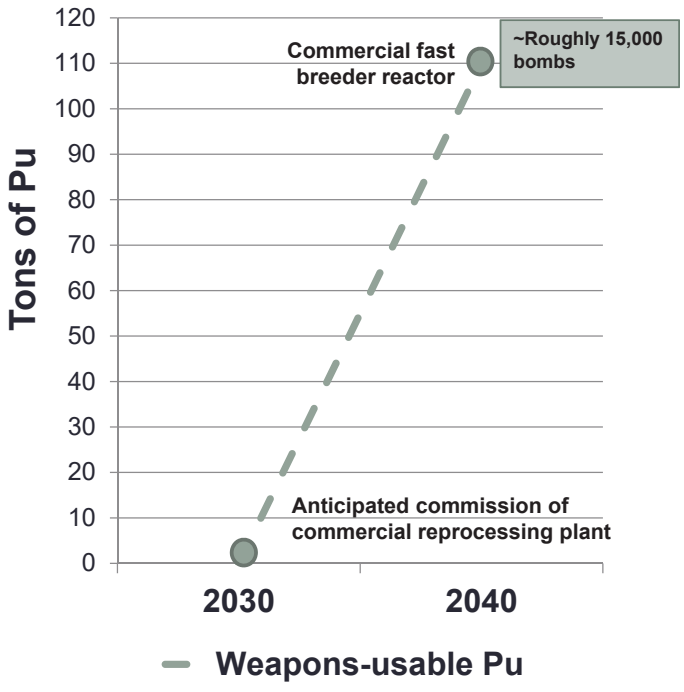
# Solution: By French

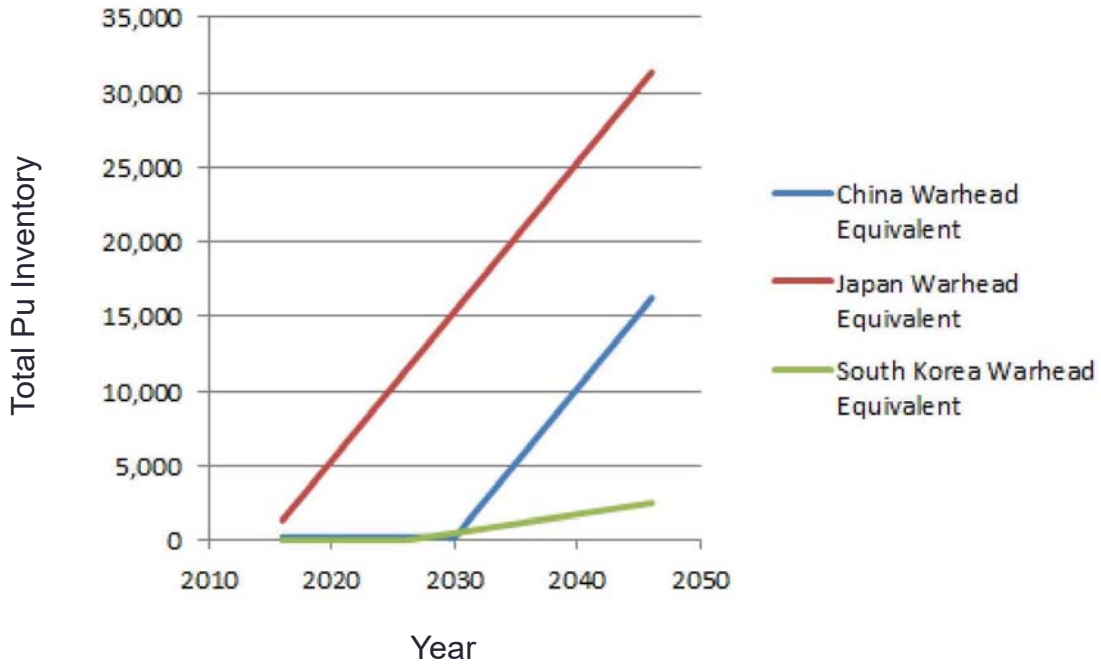


**Presidents Francois Hollande and Xi Jinping**
France agrees to build PRC a large commercial reprocessing plant at Jianyuguan

**China Experimental Fast Reactor (CEFR)**



## Projected Plutonium Stockpiling in East Asia: The Next Three Decades






## What Might Be Done?

- Current policy of trying to "balance" Japan's production and consumption of commercial plutonium is failing. Japan now has stockpiled 47 tons of Plutonium
- If Rokkasho operates, PRC and RoK likely will respond with fissile production hedges of their own
- French sale to China of a large reprocessing plant, however, is likely to lock in Rokkasho's opening in 2018
- This argues for promoting an East Asian plutonium pause

## About the Contributors

**Ian Easton** is a Research Fellow at the Project 2049 Institute, where he studies emerging security issues in Asia. Previously, he spent two years at the Center for Naval Analyses (CNA Corporation) as a China analyst. Before that Ian lived and worked in Taiwan (the Republic of China) and the People's Republic of China for five years. Ian holds an M.A. in China studies from National Chengchi University in Taipei, a B.A. in international studies from the University of Illinois at Urbana-Champaign, and a certification in advanced Mandarin Chinese. He received his formal language training in Taipei and Shanghai.

**Charles D. Ferguson** is the president of the Federation of American Scientists. At the Council on Foreign Relations, he most recently served as the project director of the Independent Task Force on U.S. Nuclear Weapons Policy, chaired by William J. Perry and Brent Scowcroft. In addition to his work at CFR where he specialized in arms control, climate change, energy policy, and nuclear and radiological terrorism, Dr. Ferguson also is an adjunct professor in the security studies program at Georgetown University. He has done scientific research at the Los Alamos National Laboratory, the Space Telescope Science Institute, the Harvard-Smithsonian Center for Astrophysics, and the University of Maryland. After graduating with distinction from the United States Naval Academy, he **s**erved as a nuclear engineering officer on a ballistic-missile submarine. He holds a Ph.D. in physics from Boston University.

**Shane Smith** is a Senior Research Fellow at the National Defense University's Center for the Study of Weapons of Mass Destruction. His current research focuses on strategic stability and the role of nuclear weapons in Asia-Pacific affairs, extended deterrence, and North Korea's nuclear program. He is also a Special Advisor at the Defense Threat Reduction Agency, where he helps shape and support a strategic engagement and applied research program aimed at reducing WMD dangers. In 2007, Dr. Smith helped launch the WMD Center's Program for Emerging Leaders and was the Program's Director from 2008 to 2012. He has taught national security and nuclear policy related courses at the University of Colorado at Boulder, the National Defense University, and at Johns Hopkins University. Before joining the WMD Center, Dr. Smith worked for former Secretary of Defense William Perry and the current Secretary of Defense, Ashton Carter, at the Harvard-Stanford Preventive Defense Project. He was also a Research Associate for National Security Studies at the Council on Foreign Relations, where he coordinated two nuclear policy task forces, and a Research Assistant at the Russian-American Nuclear Security Advisory Council. He holds a Ph.D. in Political Science from the University of Colorado at Boulder.

**Henry D. Sokolski** is the Executive Director of the Nonproliferation Policy Education Center (NPEC). He previously served as Deputy for Nonproliferation Policy in the Department of Defense, and has worked in the Office of the Secretary of Defense's Office of Net Assessment, as a consultant to the National Intelligence Council, and as a member of the Central Intelligence Agency's Senior Advisory Group. In the U.S. Senate, Mr. Sokolski served as a special assistant on nuclear energy matters to Senator Gordon Humphrey (R-NH) and as a legislative military aide to Dan Quayle (R-IN). He was appointed by Congress to serve on both the Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism in 2008 and the Deutch WMD Proliferation Commission in 1999. Mr. Sokolski has authored and edited a number of works on proliferation, including *Underestimated: Our Not So Peaceful Nuclear Future* (Strategic Studies Institute, 2016) and *Best of Intentions: America's Campaign Against Strategic Weapons Proliferation* (Praeger, 2001).

**Mark Stokes** is the Executive Director of the Project 2049 Institute. Previously, he was the founder and president of Quantum Pacific Enterprises, an international consulting firm, and vice president and Taiwan country manager for Raytheon International. He has served as executive vice president of Laifu Trading Company, a subsidiary of the Rehfeldt Group; a senior associate at the Center for Strategic and International Studies; and member of the Board of Governors of the American Chamber of Commerce in Taiwan. A 20-year U.S. Air Force veteran, Stokes also served as team chief and senior country director for the People's Republic of China, Taiwan and Mongolia in the Office of the Assistant Secretary of Defense for International Security Affairs. He holds a B.A. from Texas A&M University, and graduate degrees in International Relations and Asian Studies from Boston University and the Naval Postgraduate School. He has working proficiency in Chinese.

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