

# U.S.-ROK COOPERATION FOR GLOBAL NUCLEAR GOVERNANCE



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## **SESSION I. GLOBAL NUCLEAR GOVERNANCE AND U.S.-ROK COOPERATION PAPERS AND PRESENTATIONS**

- *Global Nuclear Governance: South Korean Perspective* by Chaesung Chun, EAI & Seoul National University
- *U.S.-ROK Alliance and Non-proliferation Cooperation* by Seongho Sheen, Seoul National University
- *Possible Bilateral and Regional Nuclear Energy Cooperation Measures in East Asia* by Chaim Braun, Center for International Security and Cooperation, Stanford University

## Global Nuclear Governance of Non-Proliferation: South Korean Perspective

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### 1. Current Status of the NPT and Asian Security Environments

The current NPT first made in 1968 is the significant global regime which should perpetuate, but also needs reform. There have been critics and challenges from different perspectives. What is important is to build and reinforce the basis of legitimacy of the NPT as the most important means for non-proliferation.

The Nuclear Nonproliferation Treaty (NPT) is the core component of the global nonproliferation regime, and establishes a comprehensive, legally binding framework based on three principles: (1) states without nuclear weapons as of 1967—a year before the treaty opened for signature—agree not to acquire them; (2) the five states known to have tested nuclear weapons as of 1967—the nuclear weapon states (NWS)—agree to not assist other states in acquiring them and to move toward eventual disarmament; and (3) the nonnuclear weapon states (NNWS) are guaranteed access to civilian nuclear technology and energy development.

Non-proliferation is the end-result of complex efforts which should evolve with the change of situations, political, economic, technological. Therefore, measures for non-proliferation should evolve with the change of motivations of proliferators, including bilateral, regional and global.

Existing multilateral institutions have failed to prevent states such as India, Pakistan, and North Korea from "going nuclear," and seem equally ill-equipped to check Iran as well as potential threats from nonstate, terrorist groups. The current framework must be updated and reinforced if it is to effectively address today's proliferation threats. International instruments for combating nuclear proliferation were largely successful before 1991, but most cases since the early 1990s—Pakistan, Iraq, Iran, North Korea, Libya, or Syria— were not deterred or reversed by the multilateral institutions created for this purpose.

Recent case such as Libya's abandoning its nuclear program in 2003 and the accession of all of the Soviet successor states except Russia to the Nuclear Nonproliferation Treaty (NPT) as nonnuclear weapon states, have been the result of direct bilateral government-to-government negotiations. Also ad hoc forums of interested parties, such as the Six Party Talks on North Korea, the P5+1 grouping on Iran have been formed to deal with difficult cases.

Aside from NPT's functional incompetency, there have been critics against NWS for its "unfair" treatment of the NNWS. To cite one case: "major critic is that US non-proliferation policy and the future of the NPT are inextricably linked. The hypothesis is that an underlying acceptance of proliferation optimism has led to the shift in US policy away from non-proliferation and towards a policy of condoning selective nuclear proliferation among friendly states; centered on US-led 'coalitions of the willing' rather than the NPT...that the US indefinite retention of nuclear weapons despite Article VI of the NPT and its continuing reliance on the doctrine of deterrence undermine the core bargain of the NPT and threaten the treaty's survival....that the Bush administration's greater reliance on counter-proliferation (the threat of use of military force) against 'rogue' or 'irresponsible' states is a bad policy that threatens the NPT and could lead to the emergence of a 'nuclear armed crowd'".<sup>1</sup>

<sup>1</sup> Mario E. Carranza, "Can the NPT Survive? The Theory and Practice of US Nuclear Non-proliferation Policy after September 11," *Contemporary Security Policy*, Vol.27, No.3 (December 2006), pp. 489–525

Recently, the NWS have recommitted themselves to reductions in nuclear arms, particularly in the New START Treaty and the outcome document of the 2010 NPT Review Conference. The Obama administration is reportedly considering deep cuts to the U.S. nuclear arsenal. In April 2009 President Obama reinforced global nonproliferation efforts in Prague speech. Subsequently, in September of the same year, the UN Security Council (UNSC) unanimously passed Resolution 1887, which called for accelerated efforts toward total nuclear disarmament. In February 2012, the number of states who have ratified the Comprehensive Test Ban Treaty increased to 157, heightening appeals to countries such as the United States, Israel, and Iran to follow suit.

Also security guarantee of the United States are crucial in the matter of non-proliferation of US allies. There are four categories of states: (1) the current nuclear powers; (2) determined proliferators; (3) nations relying on U.S. security assurances; and (4) other non-nuclear weapon states. For (3) nations relying on U.S. security assurances, the U.S. nuclear deterrent assurance provides an important reason for non-proliferation. Due to US assurances, Japan has not pursued its own nuclear weapons capability, even while its stockpile of plutonium provides it with a hedge. Also true with South Korea. By the same logic, lessening of the U.S. nuclear umbrella could very well trigger a proliferation in East Asia and the Middle East.<sup>2</sup>

For now the potential 'renaissance' of nuclear energy also presents major proliferation challenges. There have been claims from NNWS with the matter of compliance (or non-compliance) of NNWS with NPT obligations. Advocates of forbidding the spread of fissile material production capabilities recognize that recipient states have a right under the NPT to enjoy the benefits of nuclear power. However, the "inalienable right" to peaceful nuclear technology, they argue, does not necessarily imply assured access to the entire nuclear fuel cycle.

Moreover, it is possible to utilize nuclear power without pursuing enrichment or reprocessing; this requires simply that nuclear fuel be purchased on the international market rather than being produced domestically. However the NAM states "reject, in principle, any attempts aimed at discouraging certain peaceful nuclear activities on the grounds of their alleged 'sensitivity'; and emphasize that any ideas or proposals pertaining to the nonproliferation of any peaceful technology, which are used as a pretext to prevent the transfer of such technology, are inconsistent with the objectives of the NPT."

Steven E. Miller, for instance, proposes interest-based approach, arguing that "it will probably be more effective to concede rights and argue on the basis of interests. Enrichment, for example, is so costly and so unnecessary (given the existence of a robust nuclear fuels market) that in anything like current market conditions, it makes little sense for any state whose motives are purely peaceful. Fuel assurances or reserve stockpiles can offer insurance against market disruptions. If there is a winning argument, it is not that states have no right to enrich but that it is not rational or profitable to enrich. It is not clear that this approach will be successful in every case (some states may not have entirely peaceful motives, for example), but it is clear that tussles over rights should be avoided."<sup>3</sup>

Another issue is the possibility of proliferation by non-state actors. By design, the NPT does not address proliferation by non-state actors. After the September 11 attacks, the UN Security Council (UNSC) adopted Resolution 1540, a legally binding instrument requiring all UN member states to enact and enforce measures to prevent non-state actors from acquiring WMD. Many states in the UN General Assembly, however, have argued that the UNSC did not have the authority to impose a binding resolution in this area.

The United State is especially concerned about this issue, and the April 2010 Nuclear Posture Review identifies nuclear terrorism and nuclear proliferation as urgent threats, necessitating a U.S.

<sup>2</sup> Christopher F. Chyba, "Time for a Systematic Analysis: U.S. Nuclear Weapons and Nuclear Proliferation," *Arms Control Today*, December 2008.

<sup>3</sup> Steven E. Miller, "Nuclear Collisions: Discord, Reform & the Nuclear Nonproliferation Regime," in Steven E. Miller, *Nuclear Collisions: Discord, Reform & the Nuclear Nonproliferation Regime*, with responses from Wael Al-Assad, Jayantha Dhanapala, C. Raja Mohan, and Ta Minh Tuan (Cambridge, Mass.: American Academy of Arts and Sciences, 2012)

nuclear policy focused on rebuilding the nuclear nonproliferation regime through international efforts.

For the Asian strategic environment, there is a shift in nuclear numerology. According to the Federation of American Scientists as of May 2010 the US had approximately 2,468 operational nuclear warheads, of which 1,968 were deployed strategic warheads, while Russia had approximately 4,650 operational nuclear warheads, of which some 2,600 were deployed strategic warheads (FAS 2010). In contrast the three other major Asian nuclear powers have much smaller arsenals with China estimated to have between 180 and 400 strategic warheads, Pakistan between 70 and 90, and India between 60 and 80. The extent of North Korea's nuclear arsenal, however, remains uncertain with most estimates suggesting between 0 and 10, although there is no publicly available evidence that Pyongyang has operationalized its nuclear weapons capability (FAS 2010).

## 2. The US efforts: the present and the future

To sustain the global leadership, the United States now has the responsibility and burden to maintain the global nuclear governance, dealing with many issues such as how to accomplish the task of non-proliferation; how to keep nuclear programs out of the so-called rogue states' hands; how to prevent the connection between terrorists and nuclear programs; how to enhance the international safety system of nuclear maintenance. Also there are related tasks; how to accomplish nuclear arms reduction as promised in the NPT; how to convince non-nuclear powers away from nuclear weapons by guaranteeing their security; how to harmonize the states' right for peaceful use of nuclear energy and non-proliferation; who to legitimize the US move to favor some states in dealing with nuclear matters as shown in the US-India civil nuclear energy cooperation, and so on.

We have witnessed President Obama's achievements in nuclear security and nuclear arms reduction with Russia, but there are still more to do with global nuclear governance, esp. in the area of non-proliferation. After 2010 review conference, NPT still has problems; universality gap, implementation gap, and the absence of effective measures towards general and complete nuclear disarmament.

Now the challenges for the NPT members and the United States are how to harmonize three pillars of NPT; peaceful use of nuclear energy (Preamble, paragraphs 4–7, and Articles IV–V); nuclear disarmament (Preamble, paragraphs 8–12, and Article VI); and non-proliferation of nuclear weapons (Preamble, paragraphs 1–3, and Articles I–III).

For these matters, U.S. policymakers take the following steps to lessen nuclear threats and promote cooperation on disarmament:

- state clearly that it is a U.S. goal to prevent nuclear weapons from ever being used, by either a state or a nonstate actor, and that the sole purpose of U.S. nuclear weapons is providing deterrence for itself and its allies;
- reaffirm security assurances to allies;
- continue to reduce reliance on nuclear weapons and do so in a transparent manner, and take the international lead in reducing the salience of nuclear weapons in security policy;
- seek further reductions in nuclear forces, beginning with a bilateral strategic arms control agreement with Russia;
- seek to ratify the Comprehensive Test Ban Treaty (CTBT), taking as many steps as possible toward this end before the Nonproliferation Treaty Review (NPT) Conference in May 2010;
- call for a moratorium on the production of fissile material for weapons purposes;
- strengthen the International Atomic Energy Agency's vital role of containing proliferation, including seeking universal adoption of the Additional Protocol and providing adequate and sustainable funding to the Agency;
- work cooperatively to ensure that every state with nuclear weapons or weapons-usable materials -- even those that remain outside the Nonproliferation Treaty like India and Pakistan --

implements best nuclear security practices.<sup>4</sup>

Here one important point is that The United States cannot form a more effective nuclear security system alone. It must work cooperatively with global partners. All states share the responsibility to ensure that nuclear weapons are never used again, to prevent the acquisition of additional nuclear weapons by other states, and to redouble efforts to secure and reduce existing nuclear weapons and weapons-usable materials. Then the questions follow:

- How can the United States maintain the leadership in the global nuclear governance which will be crucial to the efforts of non-proliferation, US security from terrorists, and economic interests of the US?
- How can the United States deal with claims and complaints of other followers in the issues of slow achievements in nuclear arms reduction of nuclear states, of preventing peaceful use of atomic energy of non-nuclear states, and of giving particular favor to some states using double standards?
- As some states criticize the lack of US leadership in creating regional peace with the excuse of developing nuclear programs (such as Iran and North Korea), how can the United States revive its general role of security guarantor in several regions? In this sense, how will the United States maintain and deepen alliance relationship with current allies?
- With the rising economic and technological powers of rising states in the domain of nuclear energy production and export, how can the United States with declining commercial capability maintain its economic interests and force the unalienable standard of non-proliferation?
- Who will be the best partners for the revitalization of the US leadership in the area of global nuclear governance with common values and high-level of competence?

### 3. South Korea as a middle power and Strengthening the NPT for South Korean interests

South Korea with its developed economy and democratization is moving from the paradigm of weak state's foreign policy to that of "middlepowermanship." There is growing consensus that South Korea can best achieve its national interests by contributing to enhancing universal values, regional and global. By being a champion or at least facilitator of universal interests, South Korea can establish itself as a middle power. In the area of nuclear energy and non-proliferation, South Korea needs to realign and consolidate the system of non-proliferation which has been underdeveloped for many reasons.

Cooper (1993, 17-19) categorized four approaches in defining a middle power: (1) a positional approach locating a middle power at the middle point in a range of bigness to smallness in terms of population, economic strength and complexity, and military capability, (2) a geographic approach physically or ideologically locating a middle power between the system's great powers, (3) a normative approach viewing a middle power as potentially wiser, more virtuous, and more trustworthy with its recourse to diplomatic influence rather than to force, and less selfish when taking responsibility for the creation and maintenance of the global order, (4) a behavioral approach defining a middle power by its behavioral tendency to engage in middlepowermanship, such as pursuing multilateral solutions to international problems, embracing compromise positions in international disputes, or adopting the notions of "good international citizenship" to guide its diplomacy.

Cooper et al. (1993, 25-26) divides middle power behavior into three patterns of catalysts, facilitators, and managers. Catalysts provide the intellectual and political energy to trigger an initiative and take the lead in gathering followers around it. Facilitators focus on agenda-setting and engage in some form of associational, collaborative, and coalitional activities. Managers emphasize institution-building, creating formal organizations or regimes, and developing conventions and norms.<sup>5</sup>

<sup>4</sup> William J. Perry, U.S. Nuclear Weapons Policy (CRF)

<sup>5</sup> Sook-Jong Lee. 2012. *South Korea as New Middle Power Seeking Complex Diplomacy*, EAI Asia Security

Then, "Middle Power" is a category of states defined by the amount of national power and relative status in the international system, but also a category for a specific value orientation for its foreign strategy and policies. The interests of middle powers' foreign policy is more than just survival and prosperity, but to provide policy inputs on regional architectural, or structural issues, thereby striving for long-term return of benefits. However, as the policy means and measures are limited vis-à-vis great powers, new ways of maneuvering and finding policy sources are required.

Then, normative bases of middle power strategy will be the mixture of realism and cosmopolitanism. In other words, middle powers cannot but adopt realist strategy in critical issues being sensitive to balance of power. However, they also pursue universal values beyond just selfish national interests. How to mix these two different concepts will differ according to issue areas and international environments.

Middle powers try to balance against "great power politics" itself rather than any specific great power for specific their national interests. Middle powers try to balance against great power politics not to replace the role of great powers, but to transform the logic of power politics with better logic of multilateral cooperation. Middle powers try to advance a new picture of regional governance with more universal value orientation benefiting regional citizens regardless of power distribution.

Possible common strategic purposes of middle powers are to limit military rivalry and the use of military means of great powers; to enhance the mechanism of peacefully managing power transition among great powers; to bring about multilateralist ways of solving sensitive issues, thereby to lessen security dilemma; to transform the logic of balance of power in the region.

Several main points for achieving these purposes are to improve common understandings among regional middle powers; to establish strong mechanism of cooperation among middle powers to evade collective action problems; to strengthen civil to civil cooperation among democratic middle powers; to import well-established norms of global governance to solve difficult regional problems.

With North Korean nuclear crisis and hosting Nuclear Security Summit, South Korea felt the need to reinforce the domestic platform for non-proliferation. South Korea actually became the victim for weak NPT regime because North Korea took advantage of the loopholes of the NPT regime. Also South Korea had the learning effect of enhancing its national interests by contributing to global regime, especially with strategic cooperation with the United States.

It is doubtful whether the NPT regime can prevent further proliferation under current situation. Countries like Iran and North Korea endeavored to become de facto nuclear weapon states and this may repeat. Coping with these cases with more elaborate technical measures for non-proliferation is important. However, the motivation of developing nuclear programs and of proliferation is more than anything else political. For the example of North Korea, motivation for nuclear program and proliferation is related to its survival strategy in Northeast Asian international relations after the end of the Cold War. Without giving due attentions to international political and domestic situation, efforts for non-proliferation are hard to succeed.

In dealing with North Korean case, for example, South Korean and US joint efforts of engagement needs to be combined with the efforts for non-proliferation. In that sense, how to reinforce the NPT regime by connecting it with other bilateral and regional efforts for different cases will be important. Then, maintaining coordinated efforts of the United States with alliance partners or friends will be critical.

For South Korea, extended deterrence provided by the United States is critical. Then, South Korea agrees to the idea of maintaining a certain level of nuclear preparedness of American to provide right level of deterrence to states in need. This is related to the debates concerning article VI of the NPT regime, which defines the responsibility of NWS. For the peaceful use of nuclear energy, NWS tend to emphasize regional/multinational cooperation. On the other hand, NNWS and NAM states

stress their rights for peaceful use of nuclear energy. However with the limited performance of IAEA, and loopholes of the NPT regime as in the case of North Korea, still there are many things to be done to guarantee the future roads of peaceful use. South Korea and the United States can cooperate to find out due ways to develop proliferation-resistant nuclear energy production.

#### 4. North Korean problems and Non-proliferation

For South Korea, North Korean nuclear problems have been major obstacle to find proper role in non-proliferation regime. Almost twenty years have passed since the outbreak of the first North Korean nuclear crisis. Geneva system based on the Agreed Framework for eight years(1994. 10-2002. 10) has failed to manage the problems of nuclear proliferation, and "normalization" of North Korea.

To worsen the situation, North Korea has repeated the same pattern of nuclear diplomacy: raising the level of military tensions such as launching a long-range rocket and performing nuclear test, and searching for more favorable position when the negotiation is resumed. The vicious circle composed of North Korea's brinkmanship and other countries' multilateral sanctions will also repeat without the prospect of solving North Korean nuclear problem in the near future. As the nuclear program is the last resort to guarantee the survival of North Korean regime, system, and state altogether, sticks and carrots focusing on the specific issues of nuclear negotiation will be far short of solving the problems of "North Korea" as a whole.

. "North Korean" problem is older than North Korean "nuclear" problem. The latter is the necessary outcome of the former. "North Korean" problems concern the followings: how North Korea will survive in post-Cold War period when most socialist countries have transformed into non-socialist countries; what kind of regime and system North Korea will have under these environments; and how North Korea will compete with South Korea resisting the absorption by the South. North Korea adopted the development of nuclear programs, and militaristic diplomacy as the most plausible shortcut to solve the "North Korean" problem.

Diplomacy on North Korean nuclear crisis has failed to solve North Korean nuclear problems as well as North Korean problem. North Korea desperately tries to strengthen its negotiating position vis-a-vis Obama administration by launching a long-range rocket and then, testing their nuclear weapons for the second time, reversing the achievement of the disablement stage, and rejecting the Six-Party Talks. North Korea desires a comprehensive deal with Obama administration by bilateral talks, and long for a variety of political, economic, and diplomatic rewards such as peace treaty, diplomatic normalization, economic assistance, lifting international economic sanctions, and possibly light-water reactors.

A proper strategic option should include a vision for the future of North Korea which is desirable not just for North Koreans, but also most Northeast Asian countries. Long-term strategy aiming for the next decade should at least visualize North Korea which is post-Kim Jong-Il, with a new leadership, nuclear but economically poorer, or non-nuclear with more international assistance. With this "shadow of the future" in which North Korea coexists with other powers in an appropriate way, Northeast Asian countries will begin to coordinate North Korean policy. To do this, we need to be clear about the nature of North Korean regime and system.

From these observation about the essence of North Korean political situation, come North Korea's dilemmas. North Korea faces almost insoluble three dilemma in planning its own future: 1) dilemma between nuclear program and economic and political survival; 2) one between economic reform and political totalitarianism; 3) one between peace process on the Korean Peninsula and political legitimacy.

By broadening the scope of approaching North Korean nuclear problem, South Korea will be able to deal with the issue for the future of the non-proliferation regime as well as inter-Korean peace and stability.

## **ROK-US Nuclear Partnership, Alliance and North Korean nuclear problems**

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### **I. The current state of Korea-U.S. relations**

It is true that the current state of the Korea-U.S. relationship is in large part due to the personal friendship that has been formed between the incumbent leaders: President Lee and President Obama. However, it also has much to do with the qualitative expansion of the two countries' relations, which has become ever more evident during the 2000s. This denouement has resulted from Korea's increasingly rising status and role in regard to Washington's foreign policy.

The foremost factor in this regard has been the steady upgrade of Korea's global status. For example, Korea's impressive economic development has enabled it to become the world's 10th largest economic power. Moreover, its successful hosting of the Seoul Nuclear Security Summit in 2012 that included the participation of the leaders of about 50 countries, came on the heels of its role as host of the G20 Seoul Summit in November 2010, which has served to vault Korea onto the center stage of global diplomacy. In addition, Korea's democratization process has been recognized as the most positive model for the democratic struggles now playing out in the Middle East and around the world. Korea went from being one of the poorest countries in the world, in the aftermath of the Korean War, to becoming an ODA donor. It has also evolved from being the one of the largest recipients of U.S. foreign aid to becoming the first developing country to join the OECD's Development Assistance Committee. As such, Korea can be regarded as an ideal example of the developmental diplomacy that the Obama administration has sought to promote among developing countries.

A second factor has been the expansion of Korea's military capability and role. During his final visit to Europe before announcing his retirement, Secretary of Defense Robert Gates expressed his concern that with only five of the 28 members of NATO (the U.S., U.K., France, Greece, and Albania) spending at least 2% of their GDP on national defense, this placed too much of an onus on the United States, in regard to military-related matters. From the position of the United States, which intends to cut back on government spending, and in particular defense-related expenditures, the ongoing economic crisis and fiscal deficit situation has helped to make Korea an obvious military ally and cooperation partner. The Korean military, which now boasts a force of some 600,000 active troops, has expanded its capability not only in terms of numbers, but also from a qualitative standpoint. It has also become the best suited and prepared military for combined operations with U.S. forces. And for this reason, the United States endorses the concept of a Korea-U.S. strategic alliance that can



extend beyond the Korean Peninsula and contribute to the security of the entire Asian region and to world peace.

The third factor has been the renewed geopolitical importance of the Korean Peninsula in light of the steady rise of China. Along with it being widely said that the 21st century would be the Asia-Pacific era, this perspective has been regularly emphasized by the Obama administration, which has clearly identified Asia as the primary economic and political center of the 21st century. It has also consistently stressed the fact that the future of the United States will be dependent upon Asia, and that the United States is a country which straddles both the Atlantic and Pacific Oceans.<sup>i</sup>

The ascent of China has been the key determinant of the growing geopolitical significance of the Korean Peninsula. The political, military, and economic relations between the United States and China have become the most important focal point for U.S. diplomacy in the 21st century. Under these circumstances, the Korean Peninsula has emerged as one of the most important matters in U.S.-China relations, from both a geopolitical and a diplomatic standpoint. For the United States, the strategic value of the Korean Peninsula has become ever more important. During the Cold War period, the military strategy of the United States was focused on Europe, and in particular East and West Germany, as it sought to mitigate the threat of the then Soviet Union. The 21st century is likely to see a strategic competition play out between the United States and China in Asia. In this regard, the United States' interest in the strategic value of the Korean Peninsula, which constitutes the most critical bridgehead in terms of access to the Chinese mainland, can only increase.

Fourth, after long serving as the most important ally of the United States in Asia, Japan has seen a dramatic reduction of its previous importance. Japan is still the most important ally of the United States in Asia thanks to its advanced country status and economic capability. Nevertheless, Japan has shown signs of a decline in its social dynamism amidst a long-term economic slowdown, along with the advance of its rapidly aging society, and the devastating tsunami and ensuing nuclear disaster in 2011. Moreover, there has been a tendency for political issues to be buried under domestic concerns. While the leadership of both countries continues to emphasize the importance of the U.S.-Japan alliance, it has become increasingly difficult to envision Japan's future role as an active partner of the United States on the international stage, especially from a military perspective. This decline in Japan's prestige has led to a rapid surge in the relative status of Korea, which has demonstrated a greater level of dynamism and extent of motivation

## **II. U.S.-ROK ATOMIC COOPERATION AND NORTH KOREA**

### ***Allies with Different Agendas***

South Korea's interest in revising the agreement is mainly driven by its growing energy demand and business interests. The Korean government emphasizes that its interest in a more comprehensive fuel cycle capacity is for the peaceful use of nuclear energy. At the same time, South Korea feels it has a legitimate right for advanced nuclear technology considering its commitment to non-proliferation efforts and its growing nuclear power generation capacity. Meanwhile, nuclear proliferation has become a major concern for the U.S. government with the spread of weapons of mass destruction and terrorism. The Obama administration, in particular, undertook non-proliferation as one of its main foreign policy agendas with its focus on nuclear terrorism and its "nuclear free world" initiative. South Korea's demand for advanced fuel cycle capacity would put the United States in a dilemma between managing its alliance partnership and its global efforts for nuclear security.

At the same time, South Korea has worked closely with the US in nuclear nonproliferation initiative. During the Bush Administration, Seoul joined the GNEP initiative and PSI. And in 2012 Seoul hosted the 2<sup>nd</sup> Nuclear Security Summit and emerged as an active partner for President Obama's nuclear free world initiative. South Korea global role was accompanied with its own domestic initiative. Starting from 2011, Seoul established a Nuclear Safety Law. Under the law, the Korean government is imposing new regulations on nuclear safeguards, nuclear security, and nuclear export controls. For this the government established Nuclear Security Committee which will publish and review Comprehensive Plan on Nuclear Security every five years.

### ***Challenges from North Korean Nuclear Programs***

Meanwhile, South Korea's claim for reprocessing is complicated by its own existing pledges. One would argue that South Korea's pursuit of reprocessing and enrichment right violates its own pledges in accordance with the 1992 Joint Declaration on Denuclearization of the Korean Peninsula. Against the backdrop of the end of the Cold War in Europe, the Roh Tae-woo administration (1988-1993) of South Korea pursued reconciliation with former enemies like North Korea. After announcing the unilateral withdrawal of U.S. tactical nuclear weapons, the Roh government issued a joint declaration with North Korea in February 1992 that the two countries would not pursue any kind of nuclear weapons program. In addition, they also pledged not to carry out nuclear reprocessing and uranium enrichment.<sup>ii</sup> Accordingly, South Korea was expected to abide by its own promise. A U.S. official pointed out that "the existence of a reprocessing plant in South Korea would be inconsistent" with the Joint Declaration of 1992.<sup>iii</sup>

Yet, the most serious challenge for both Washington and Seoul comes from a third party: North Korea and its nuclear program. Allowing South Korea reprocessing would make it more difficult in dealing with North Korea's claims of peaceful use for its nuclear program. North Korea may demand the same reprocessing rights, even if it finally decides to give up its nuclear weapons

program. In past negotiations, North Korea has insisted its right to possess a full nuclear capability for peaceful purposes. The 1994 *Agreed Framework* between Washington and Pyongyang included building two light water reactors (LWRs) for North Korea as a key element of the settlement. Later, on September 19, 2005, the *Joint Statement of the Fourth Round of the Six-Party Talks* also acknowledges North Korea's right to the peaceful use of nuclear energy, which may include reprocessing in conjunction with possible provision of LWRs to North Korea. Indeed, North Korea reportedly demands the provision of LWRs as a key component of a nuclear deal. After a series of defiant nuclear provocations by Pyongyang, including two nuclear tests) the United States thinks it is undesirable to allow North Korea any form of nuclear capability, whether or not it is for civilian or military purposes. Yet, Pyongyang may demand the same rights if the United States agrees to South Korea's reprocessing. In 2004, the North Korean authorities defended their nuclear program citing the reported case of South Korea's secret test of uranium enrichment. In 2009 when the United States and the international community condemned North Korea for its long-range missile launch, North Korea claimed it was a satellite and noted that South Korea's satellite launch in the same year was regarded as legitimate by the international community.

South Korea would argue that its case is different from that of North Korea. While North Korea is a case of denuclearization of a weapons program, South Korea is a case of bilateral atomic energy cooperation for peaceful use. South Korean nuclear scientists are currently working on peaceful nuclear energy that is more proliferation-resistant as well as environmentally friendly. As for the 1992 Denuclearization pledge, one could argue that South Korea, as a sovereign state, has a right to forfeit its own commitment should it be deemed necessary. Indeed, North Korea has already violated the joint declaration by developing nuclear weapons since then. North Korea's nuclear weapons program and two nuclear tests clearly nullify the joint declaration. Furthermore, the September 2005 Joint Statement leaves the possibility open that North Korea could have a full nuclear fuel cycle by acknowledging its peaceful use of nuclear energy.<sup>iv</sup> However, at the same time the Joint Statement also reaffirms that "the 1992 Joint Declaration of the Denuclearization of the Korean Peninsula should be observed and implemented." No matter what the arguments put forward by both Seoul and Pyongyang, Washington will be extremely concerned about the possible complications that would result from allowing Seoul any kind of reprocessing rights, while still trying to persuade Pyongyang to and its nuclear ambitions. Sharon Squassoni, an expert at the Center for Strategic and International Studies in Washington, said, "It is hard to imagine a member of Congress who would support facilitating spent fuel recycling by South Korea if it is seen to make negotiations with North Korea more difficult."<sup>v</sup>

### ***Testing the U.S.-ROK Alliance***

The most important challenge for Washington and Seoul is to prevent the issue from becoming a test-case for the alliance. During their summit meeting in June 2009, President Obama and President Lee promised close cooperation regarding the peaceful use of nuclear energy, among others.<sup>vi</sup> Yet, any hint of U.S. objections to South Korea's demand for "peaceful" nuclear sovereignty could send the current amicable alliance relationship into turmoil, as shown during the fierce anti-American rallies in Seoul over the U.S. beef import issue in 2008. Many South Koreans often compare the U.S.-ROK revision of the atomic agreement with the U.S.-Japan revision in the 1980s. In its renegotiation in the late 1980s of its nuclear agreement with the United States, Japan acquired an advanced agreement on full-scale spent fuel reprocessing and uranium enrichment. Japan has become the only non-nuclear weapons state with a full reprocessing capability.<sup>vii</sup> Washington believed that Japan posed no proliferation risk given its excellent nonproliferation credentials; however, many in South Korea think that they deserve the same right. Washington seems to have difficulty in giving the same benefit of doubt to South Korea when it comes to sensitive nuclear technology. They may say South Korea is different from Japan, which already had reprocessing and enrichment plants under the existing agreement that was agreed to before North Korea's nuclear program was revealed.

Yet, it will be difficult for the United States to simply ignore South Korea's demand and its growing nuclear capacity because South Korea, along with Japan, is one of the most important U.S. allies in Asia. It will be a challenge for the United States to balance its bilateral alliance management with Seoul and its commitment to global nonproliferation efforts. An editorial in the *Chosun Ilbo* (a prominent Korean newspaper) warned the U.S.-ROK alliance could, "come under strain if Washington stubbornly insists on blocking South Korea from reprocessing."<sup>viii</sup> For many Koreans the negotiation could be another test case for the U.S. commitment to the alliance after the very controversial KORUS FTA negotiations. The U.S. attitude could be regarded as another referendum on America's sincerity and respect for South Korea's status as a key ally. The comparison with Japan would provide a compelling case for both critics and supporters of the alliance in Korea. In addition, the 2008 Bush administration's decision to award another long-term consent to India for reprocessing nuclear waste will make it more difficult for U.S. negotiators to persuade Seoul to forgo the same right.<sup>ix</sup> How minor they might be, some strong nationalists may even argue for the need for South Korea to have its own nuclear weapons program. Recently, Kim Dae-Joong, a prominent Korean conservative journalist called for a South Korean nuclear weapons program.<sup>x</sup> In addition, some members of the National Assembly argued for having a "conditional" nuclear option until the complete resolution of North Korea's nuclear issue.<sup>xi</sup>

The Korean government stated that the revision should contribute to mutual economic interests as well as the strengthening the ROK-U.S. alliance.<sup>xii</sup> At the same time, the United States needs to acknowledge South Korea's growing technology capacity as well as the demand for advanced atomic usage.

- <sup>i</sup> Hillary Clinton. "America's Pacific Century" (Honolulu Hawaii, East-West Center, November 10, 2011)
- <sup>ii</sup> Section 3 of "ROK-DPRK Joint Declaration of the Denuclearization of the Korean Peninsula," January 20, 1992.
- <sup>iii</sup> Horner, Daniel. "S. Korean Pyroprocessing Awaits U.S. Decision," Arms Control Association, [http://www.armscontrol.org/act/2009\\_07-08/SouthKorea](http://www.armscontrol.org/act/2009_07-08/SouthKorea).
- <sup>iv</sup> Full text of the September 19, 2005 Joint Statement of the Beijing Six-Party Talks, [http://www.chinadaily.com.cn/english/doc/2005-09/19/content\\_479150\\_2.htm](http://www.chinadaily.com.cn/english/doc/2005-09/19/content_479150_2.htm). The last paragraph of article 1 said, "The DPRK stated that it has the right to peaceful use of nuclear energy. The other parties expressed their respect and agreed to discuss, at an appropriate time, the subject of the provision of a light water reactor to the DPRK."
- <sup>v</sup> Sharon Squassoni, "U.S.-ROK Nuclear Energy Cooperation: A U.S. View," *The Center for US-Korea Policy*, <http://asiafoundation.org/resources/pdfs/SquassoniUSROKNukeEnergy100120.pdf>.
- <sup>vi</sup> The White House, "Joint Vision for the Alliance of the United States of America and the Republic of Korea," June 16, 2009, <http://www.whitehouse.gov/the-press-office/joint-vision-alliance-united-states-america-and-republic-korea>.
- <sup>vii</sup> Japan now runs both reprocessing and enrichment facilities at Rokkasho-mura. Emma Chanlett-Avery and Mary Beth Nikitin, "Japan's Nuclear Future: Policy Debate, Prospects, and U.S. Interests," *CRS Report RL34487* (February 19, 2009).
- <sup>viii</sup> "S. Korea Must be Allowed to Reprocess Spent Nuclear Fuel," *Chosun Ilbo*, February 16, 2010.
- <sup>ix</sup> George Perkovich, "Global implications of the U.S.-India Deal," *Daedalus*, Winter 2010.
- <sup>x</sup> Kim Dae-Joong, "Time for South Korea to Develop its Own Nuclear Arms," *Chosun Ilbo*, January 11, 2011.
- <sup>xi</sup> Some suggested developing South Korea's own nuclear capability. while others argued for reintroducing U.S. tactical nuclear weapons withdrawn after the 1992 North-South Denuclearization Statement. Yoon, Jung-ho, "National Assembly men argue for a nuclear option," *Chosun Ilbo*, February 26, 2011.
- <sup>xii</sup> Ministry of Foreign Affairs and Trade, *E-Newsletter*, no. 331 <http://news.mofat.go.kr/enewspaper/articleview.php?master=&aid=3350&ssid=24&mvid=1003>.

# **U.S. – ROK Prospective Nuclear Energy Cooperation Measures**

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## **1. Introduction**

In this paper I discuss near-term prospective nuclear energy cooperation measures that could be undertaken by the U.S. and the Republic of Korea (ROK) as a part of a more comprehensive program of enhanced long-range nuclear cooperation between the two countries. The suggestions made here represent one American perspective on what steps the ROK Government could undertake in the near-term to enhance the quality of its nuclear cooperation with the U.S. Clearly, Korean experts might have their own parallel set of suggestions, and we hope that an exchange of opinions might eventually lead to mutually acceptable practical steps that could be undertaken. The important factor to consider here is that none of the proposed cooperative steps discussed below prejudice the results of the currently ongoing negotiations regarding the extension of the Agreement for Nuclear Cooperation between the U.S. and the ROK (the 123 Agreement) (1). In fact, the measures proposed here could be undertaken independently of the 123 Agreement discussions, and they might even enhance the prospects for successful conclusion of these negotiations.

Most of the measures discussed below represent possible bilateral steps that could be undertaken by the U.S. and the ROK Governments and their respective nuclear agencies and industries. In this paper, I also review two multilateral regional proposals involving the ROK and other regional countries, though these represent longer-term options that will require significant negotiations effort before they could be implemented. Despite the forward-leaning nature of these proposals, their significance in terms of regional and global governance of the nuclear fuel cycle justifies their public review and discussion.

## **2. ROK Participation in U.S. Uranium Enrichment Program**

As a part of the 123 Agreement renewal negotiations, the ROK Government expressed an interest in producing low-enriched uranium (LEU), which is required for the operation of its nuclear power plants (NPPs). Korea Nuclear and Hydro Power Corporation (KHNP) now operates 23 reactors with a total capacity of 20.7 GWe, which provide one third of the ROK's total electricity generation. Given the lack of indigenous energy fuels, nuclear energy remains a strategic priority for the ROK, and this capacity is planned to increase to 27.3 GWe by 2020, and then to 43 GWe by 2030. The ROK Government aims to provide 59% of total electricity generation from 40 nuclear reactors by 2030 (2). Considering the important role that nuclear energy occupies

in Korean electricity supply, it is reasonable that the ROK would try to secure the provision of nuclear fuel to its operating nuclear power plants (NPPs). The ROK lacks domestic uranium resources and must purchase uranium on the world markets. KHNP has instituted a large program of diversification of uranium purchases from various suppliers to provide adequate and assured supplies of this resource. Korean industry has mastered the art of nuclear fuel fabrication and operates a very modern fuel fabrication plant in Daejeon (3). What is missing for the mastery of the complete front-end of the nuclear fuel cycle is uranium enrichment.

In general, energy economists consider the construction of a domestic dedicated uranium enrichment plant justified when a country's nuclear capacity exceeds 20 GWe. (4). An enrichment plant serving this size nuclear capacity could produce enriched uranium at prices equal to or lower than world market prices. By this economic standard it is understandable why the ROK may wish to obtain domestic uranium enrichment capacity. On the other hand, the U.S. Government views enrichment as a sensitive fuel-cycle step that could be used (or abused) for nuclear weapons proliferation purposes. The examples of Pakistan and Iran are cases in point. The enrichment and reprocessing steps of the nuclear fuel cycle (lumped together as ENR) are considered sensitive nuclear technologies and the U.S. Government discourages the spread of these technologies anywhere in the world, as a matter of long-term policy enunciated in the 1978 Nuclear Nonproliferation Act (1978 NNPA) (5). The current U.S. - ROK 123 Agreement (in force till 2014) prohibits the development and construction of ENR facilities in the ROK. The U.S. Government further points to the current glut of world enrichment supplies as further proof that no new enrichment plant is required in the ROK and that KHNP could well rely on the competitive world enrichment markets for the supplies of all intermediate-term ROK enrichment requirements.

The ROK Government, on the other hand, stresses the need to control its nuclear fuel supplies given its growing nuclear capacity and the important role that nuclear energy occupies in the national electricity generation system. Thus the ROK Government is interested in removing the restriction on uranium enrichment from the terms of the revised 123 Agreement with the U.S. How then to reconcile between the global nonproliferation concerns of the U.S. Government and the energy security and commercial interests of the ROK Government?

As an alternative to a domestic enrichment plant, I propose that the ROK Government should purchase, in consultation with the U.S. Government, commercially-significant (10 – 30 percent) ownership stake in the American Centrifuge Plant (ACP) of the U.S. Enrichment Corporation (USEC), or in USEC itself, or in the other enrichment plants operating or planned in the U.S. (The URENCO enrichment plant now operating in New Mexico, or the Areva enrichment plant planned for Eagle Creek, Idaho) (6). Partnering with USEC in the development and commercialization of the ACP in Portsmouth, Ohio would best satisfy Korea's desire for assurance of uranium supply for energy security and commercial nuclear export.. USEC and the ACP represent U.S. technology, and the continuation of the long-term U.S. national uranium enrichment program, started in Oak Ridge, Tennessee, in 1944. For reasons of sovereignty, national pride, control of technology and maintaining a role in the global nonproliferation debate, the U.S. Government is unlikely to allow USEC to fail commercially. Yet, USEC is now burdened with an old and expensive gaseous diffusion enrichment plant, it must contribute towards the environmental cleanup of the old U.S. uranium enrichment complex which it inherited from the U.S. Government, while at the same time it must develop and prove the (almost revolutionary) ACP centrifuge enrichment technology, and build the new ACP facility. It is thus not surprising that USEC is now in financial difficulties. These financial difficulties present a challenge for the potential role of the ROK; but they are also an opportunity to help the United States and assure long-term access to enrichment services for the ROK nuclear industry, both domestically and for export.

The ROK could now, with the concurrence of the U.S. Government, provide significant capital injection into the ACP or the parent USEC in exchange for management role in the commercial aspects of USEC's operation. Such role will not include access to the ACP technology, but will guarantee enriched uranium supplies to KHNP once the ACP begins commercial operation. This will acquaint the ROK with the commercial aspects of operating a global uranium enrichment venture. In this way the two-tier black-box model of a junior partner participation in a major enrichment plant could be maintained. KHNP will participate in USEC commercial management discussions and become a regular partner in the world market for uranium enrichment, while not being exposed to the ACP confidential technology, and not having to construct a domestic enrichment plant within the ROK boundaries.

There are several precedents to such an approach. The French enrichment Corporation Eurodiff (now a part of Areva) has several minor commercial partners (Spain, Belgium, and Italy – altogether 40 percent ownership stake). A proposed additional enrichment venture, Sofidiff, was conceived as a partnership between France and (pre-revolutionary) Iran. In both cases the junior partners participated in commercial discussions but had no access to the French enrichment technology (7). The General Electric Corporation Global Laser Enrichment (GLE) venture includes commercial (but no technology access) participation by Hitachi (Japan – 25%) and Cameco (Canada – 24%) (8). KHNP Corporation itself has taken a 2.5 percent ownership stake in the new French centrifuge enrichment plant Georges Besse II, in order to guarantee its enrichment supplies from Areva (9). The proposal made here thus represents an effective way in which the ROK can participate in the enrichment enterprise that could ease some of the ROK's concerns associated with energy security and commercialization of the fuel cycle. I suggest that KHNP, in partnership with the US Government and USEC, consider a significant ownership stake given the ROK's long-term enrichment interests and fuel requirements for its maintenance and expansion of nuclear power.

### **3. ROK Demonstration Program for Centralized Dry-Cask Spent Fuel Storage**

Currently all spent fuel elements from operating ROK NPPs are stored at the plant sites, mostly in the spent fuel water pools attached to each reactor. It is now expected that the spent fuel storage pools in most NPPs will be filled up within the next decade. The ROK may be able to arrange for several additional years of pool storage by shuttling spent fuel in some older NPPs whose pools are filled up to the new reactors recently commissioned on-site whose spent fuel pools are yet relatively empty. In about fifteen years, even this temporary relief measure will run its course and the basic problem of what to do with the spent fuel will again become acute.

One possibility for handling spent fuel is to build dry cask storage facility on-site in each NPP station and remove the spent fuel from the 'wet' storage pools to the dry-cask facility. However, not all NPP stations have adequate land reserve on which such a dry-cask storage facility could be constructed. A more comprehensive alternative would be to construct a centralized away-from-reactors dry-cask storage facility somewhere in the southern part of the ROK and transport spent fuel from the NPP sites to the centralized storage facility. Such interim centralized storage facility is referred to generically as Independent Spent Fuel Storage Installation (ISFSI). Given that all ROK NPPs are located on sea-side sites, the spent fuel could be transported from plant sites by specially designed ship to the prospective centralized storage facility, assuming that that facility will be located not far from the shore. The problem with the construction of a large national ISFSI facility is the potential public opposition from nearby communities that might view the facility not as a temporary measure but as the permanent disposal site of ROK spent fuel if no permanent repository program is concurrently initiated by the government. While a centralized low level waste storage facility was finally approved by the



local community and constructed at Kyongju /Gyeonju on the east coast 370 km from Seoul (10), no parallel site for a spent fuel or high level waste has been approved.

The other alternative method for disposing of spent fuel is to reprocess it, recycle the useful energy contents back to the operating NPPs and sent the remaining high-level waste to a waste repository. This alternative is currently unavailable to the ROK since the reprocessing of spent fuel (as well as enrichment of fresh fuel) is not allowed under the terms of the current U.S. – ROK 123 Agreement. The ROK Government is trying to remove this restriction from the revised 123 Agreement based on two arguments. The ROK Government claims that it needs to reprocess its spent fuel for two purposes: Firstly, to reduce the volume of waste which will ultimately be sent to the final repository, and avoid the need to construct a difficult-to-site centralized ISFSI facility, and; Secondly, to recover the fissile content of the spent fuel and recycle it ultimately in fast breeder reactors, thereby ensuring the long-term viability of nuclear energy generation in the ROK for the future generations. In order to buttress these claims, the ROK Government is now engaged in the development of a new pyroprocessing fuel separations process, which is technically different from the ‘conventional’ wet chemistry PUREX reprocessing technology. Indeed the ROK and U.S. Governments have started a new ten years long technology review program of pyroprocessing to determine its technical and commercial feasibility (11).

In my opinion, the current ROK approach of basing its spent fuel disposal program on the hopes of commercializing the pyroprocessing technology is fraught with uncertainties: Firstly, it is not clear that pyroprocessing will live up to its expectations from the technical and economic perspective. Secondly, even if proved suitable, it will take at least ten additional years to further develop, demonstrate design and construct commercial scale pyroprocessing plants. We thus have here a prospective twenty years solution to a real ten years spent fuel accumulation problem. Thirdly, even if proven feasible, it is not clear that the U.S. would be willing to modify the terms of the revised 123 Agreement to accommodate pyroprocessing, especially given opposition in the U.S. Congress. As a U.S. Department of State (DOS) expert has stated publicly a year ago “Pyroprocessing IS reprocessing” (12) and the U.S. Government is generally opposed to approve new reprocessing plants (or any new ENR facilities) anywhere. How then to resolve this impending dilemma?

I posit that some form of centralized spent fuel storage will be ultimately required in the ROK, regardless of the fortunes of the pyroprocessing technology, based on spent-fuel logistics considerations. Some NPPs will run out of spent fuel storage space before a pyroprocessing plant is commercialized, assuming all objections to this technology are resolved. Thus it will be prudent of the ROK Government to prepare for the eventuality of the need for a temporary, limited, centralized spent fuel storage program. I propose that in order to prepare for near-term needs and without committing itself to one alternative or the other (ISFSI or pyroprocessing plant) the ROK Government could initiate a small, independent spent-fuel storage facility demonstration program. Such demonstration program will only expand the field of alternative spent fuel disposal alternatives available to the ROK, without committing the ROK Government to one course of action or another. In fact, I view such demonstration program as enhancing the ROK Government’s options flexibility, so that a more informed disposal choice could be made in the future.

The spent fuel storage demonstration program I propose would be limited to a relatively small-sized concrete pad on which about ten dry cask concrete storage silos will be constructed and well-packaged spent fuel elements will be emplaced in those concrete casks. The entire facility will be thoroughly instrumented and monitored in order to analyze its performance over time. The small dimensions of such facility will facilitate its location in any remote, uninhabited suitable area in the southern part of the ROK. The proposed

demonstration facility could be developed and constructed with U.S. support since the U.S. has now accumulated significant experience in the design, licensing, construction and operation of such spent fuel storage facilities albeit only at NPP sites. Furthermore, the U.S. Nuclear Regulatory Commission (NRC) is currently very interested in the entire issue of dry-cask spent fuel storage on its own merit and as one of the lessons learned from the Fukushima Accident (13). Thus, at this point, the U.S. can significantly contribute to such an ROK near-term spent fuel dry-cask storage demonstration program, and such a joint program will be of value to both countries, without jeopardizing the ROK Government's long-term interest in pyroprocessing.

#### **4. ROK Participation in U.S. Generation III+ / Generation IV Development and Commercialization Programs**

There exists a long history of U.S. and ROK corporations' joint programs for NPPs construction in Korea. Westinghouse and Bechtel Corporations supported Korea Electric Power Corporations (KEPCO) in the construction of the early ROK NPPs, followed by similar support provided KEPCO by Combustion Engineering (CE) and Sargent and Lundy (S&L). In later years Westinghouse (now owned by Toshiba) purchased CE and reestablished its position in the Korean NPP market. This cooperation has extended to two-way support in international NPP projects: Westinghouse was a member of the KEPCO team which won the contract to supply four Korean APR1400 reactors to the United Arab Emirates (UAE). In turn, the ROK Corporation – Doosan Heavy Industries and Construction has supplied nuclear steam supply system (NSSS) equipment to the first AP1000 reactors of each of the two reactor stations built by Westinghouse in Haiang and in Sanmen. Furthermore, Doosan Heavy Industries and Construction also supplies NSSS equipment to four Westinghouse AP1000 reactors now under construction in the U.S. in Plant Vogtle in Georgia and in the V.C. Summer plant in South Carolina (14). Two-way cooperation on new NPPs construction between U.S. and ROK corporations is thus already well established.

The ROK has show interest in further enhancing its commercial NPPs cooperation with U.S. corporations. Such future cooperation is in part a matter of direct commercial contacts between the interested corporations that does not involve direct governmental intervention. However the changing pattern of global NPP bids requires additional governmental support. The current trend is to offer a joint package of 'cradle-to-grave' reactor supply and operating plant services. These could include nuclear fuel supply (uranium, enrichment & fabrication), plant operations support (provided by experienced utility personnel), regulatory & licensing support, and where feasible, support on spent fuel disposal issues. Each bid will be different, but will include several of the above mentioned services, in addition to the reactor(s) supply. Such services could be provided under several separate contracts as is the case in the UAE reactors sale, or they could be provided under one master contract of the build, operate, transfer (BOT) type, as the case is in Russia's proposed sale of four VVER1200 reactors to Turkey for the Akkuyu site (15). It is in these types of 'cradle-to-grave' bids that a scope for enhanced cooperation between the U.S. and the ROK exists.

Joint U.S. ROK NPP bids for Generation III type reactors could include uranium enrichment provided by U.S. corporations such as USEC. This would be particularly true if KEPCO will take an ownership stake in USEC as suggested in Section 2. U.S. electric utilities (affiliated with Westinghouse) could provide operations support and assistance in plant licensing and construction of dry cask spent fuel storage facilities, as mentioned above. U.S. vendors could supply some equipment to ROK designed plants, including primary pumps and fine motion control rod drive mechanisms (CRDMs). Both the U.S. and the Korean Export-Import Banks could

provide loans for the scope of equipment and services provided by vendors of each respective country, thus increasing the overall level of foreign financing available for each international joint bid. Thus, positive U.S. and ROK governmental support could enhance the scope of project bids offered by joint teams of American and Korean corporations. It will also benefit the United States because it would allow it to participate in the international nuclear power market, something that is difficult for it to do by itself because it has lost the full supply chain capabilities. U.S. participation in the international nuclear power markets is crucial if it is to continue to provide international leadership for nuclear safety, security, and the global nonproliferation regime.<sup>1</sup>

Another level of joint cooperation on nuclear reactor development might involve advanced reactors of the Generation IV type, particularly in the Liquid Metal (LMR) or Fast Breeder (FBRs) reactor technology. The ROK nuclear research institute KAERI is now developing a FBR reactor design called KALIMER of 600 MWe capacity (16), to be fueled by fissile material provided by the pyroprocessing system discussed above. Other versions of the pyroprocessing system will be used to recycle FBR fuel out and into the reactor. The development of the reactor design and fuel cycle facilities in the ROK is a relatively new phenomenon extending (in a limited way) over about twenty years. In contrast, the U.S. has extensive experience in FBR plants design, construction, and fuel supply extending over sixty years. In particular, there now are two main lines of FBR design developments in the U.S. in which ROK scientists have expressed interest in enhanced cooperation. These are the Super Prism FBR developed over the last twenty five years by General Electric Corporation and the newer Travelling Wave Reactor (TWR) developed by Terra Power Corporation over the last seven years (17).

The Super Prism reactor is an advanced FBR design of 300 MWe, now considered by the U.K. Government for an excess plutonium elimination mission. It employs an external fuel cycle system including fuel reprocessing and re-fabrication plants. The plant design has been extensively developed by GE Corporation over the last two decades. The newer TWR design is supported by venture capitalists affiliated with alumni of the Microsoft Corporation, headed by Bill Gates. The Terra Power Corporation which they funded using private funds has employed the best modern nuclear design tools available and has made great strides in its nuclear reactor modeling over the last seven years. The TWR design (of 500 – 1100 MWe sizes) does not require an external fuel cycle and can operate for many years on the original fissile fuel charge only. It also can use, in some versions, cleaned-up spent LWRs fuel as a fertile material in its breeding zone, thus supporting the elimination of both spent fuel and unwanted separated fissile material (18). The TWR design, however, required special high strength steels for fuel cladding material and will likely require testing of a lead test fuel assembly (LTA) before full confidence in the design can be established. The ROK Government and scientists are interested in both FBR design options and with the support of the U.S. Department of Energy (DOE) could establish joint research and development (R&D) programs involving these two FBR design options. Thus there exists a scope for joint U.S. - ROK collaborations on FBR designs should both governments agree to proceed. Clearly, enhanced cooperation in these areas requires extensive contacts between representatives of U.S. and ROK Governments and their respective industrial concerns.

## **5. ROK Participation in U.S. Small and Medium Power Reactors (SMRs) Design and Development Programs**

<sup>1</sup> As pointed out by P.V. Domenici and W.F. Miller, Jr., in “Maintaining U.S. Leadership in Global Nuclear Energy Markets,” Report of the Bipartisan Policy Center, September 2012.

<http://bipartisanpolicy.org/library/report/maintaining-us-leadership-global-nuclear-energy-markets>

Over the last four years the U.S. has assumed global leadership role in the design and development of small and medium power reactors (SMRs). These programs are strongly supported by the Obama Administration, which views the SMRs program as a vehicle to re-establish the U.S. lead role in the field of reactor design development and sales. Success in this area will support both the U.S. economy and the Administration's overall nonproliferation policies. Advanced SMR designs are considered especially suitable for small (isolated) electric utilities, small-sized utilities in industrializing countries which cannot absorb 1,000 MWe sized Generation III large reactors, and utilities with under-developed electric transmission grids that cannot install large reactors far away from the load centers and transmit the generated electricity to where it is to be consumed. Furthermore, due to their enhanced passive safety designs, and in some cases placement of the reactors in underground silos, SMRs could be considered safe enough for siting near urban load centers to avoid the need for long transmission lines. Another advantage of the SMR program for the U.S. is the presumed ability to manufacture all necessary reactor equipment in U.S. factories based on the accumulated U.S. experience in the design and construction of naval reactors.

The two most promising U.S. SMR designs are the mPower design of B&W Corporation (4 x 125 MWe) and the Westinghouse Corporation design of 200 MWe (19). Several other designs are also pursued by other corporations, though at lower levels of development. The U.S. DOE has issued a Request for Proposals (RFP) for SMR designs that will enjoy Government and industry matching support and allow significant new progress in SMR design and readiness for licensing for the winning teams (20). In parallel the ROK Government has supported through KEPCO the design of a small reactor – SMART – of 100 MWe capacity optimized for both electricity generation and water desalination (21). An industrial consortium headed by KEPCO was formed in 2011 to support the commercialization of the SMART design, though no commercial sales have been made to date.

Given the strong leadership role of the U.S. in the SMR development area, and considering the prospects for this technology, The ROK might wish to get more involved in U.S. SMR activities, based on the concurrence of the U.S. DOE. I suggest that there are several separate steps that the ROK Government and industrial concerns might take in this regards to enhance U.S. – ROK SMR cooperation:

1. The ROK Government might contribute significant funds to the DOE SMR RFP and assume partial leadership role in the management of this program together with the DOE. This will give the ROK a top view of U.S. SMR activities and position it to take further cooperative steps as appropriate.
2. ROK corporations might seek to invest directly into U.S. SMR developing corporations and assume equity stake in specific SMR programs. This might also entail direct participation in SMR components manufacturing by ROK industrial corporations.
3. ROK corporations might wish to join specific SMR teams as partial equipment suppliers based on their manufacturing experience and likely lower production costs.
4. ROK corporations might join U.S. SMR teams in international SMR bids in the future, taking project scope and risks as appropriate for each bidding situation and supporting 'cradle-to-grave' type bidding packages.
5. The ROK SMART concern, headed by KEPCO, might seek U.S. industrial partners for both reactor design and development and for partnering on future power plant bids.

Any or a combination of some of the steps outlined above, as well as possibly others, could be pursued by the ROK Government as a part of a coherent program coordinated with the U.S. Government, particularly with the DOE and the State Department.

## **6. U.S. – ROK Participation in Joint Regional Longer-Term Nuclear Energy Cooperative Programs**

The discussion thus far centered on bilateral steps that could be undertaken by the U.S. and ROK Government and industrial concerns only. There are other nuclear cooperative ventures that might be of interest to the two countries that are of a regional nature. Such ventures will be multilateral, involve several governments and corporations, and be of longer-term duration by their very nature. Nevertheless, the importance of such ventures might make them worth pursuing even if the prospects for immediate implementation might not be very promising. I do believe that discussing the underlying issues involved is of value and that by raising concerns regarding these issues some satisfactory resolution will be found in time, even if not identical to the suggestions I make here. Two of these regional issues and my proposed solutions are discussed below. These include the future safe operation of the North Korean Experimental Light Water Reactor (LWR), and the institution of an adequate safety regime for nuclear power plants located on the shores of the East (Japan) Sea.

### **6.1 Potential ROK Support for Safe Operation of the Yongbyon LWR**

The Democratic People's Republic of Korea (DPRK) has started a new LWRs construction program and the first experimental LWR of 100 MWth or about 25 MWe capacity, is now in advanced stage of construction at the Yongbyon site. It is expected to become operational around 2014 (22). No information is available outside the DPRK regarding the reactor design, the quality of the manufactured equipment, operators training and safety approach and the general DPRK licensing and safety regulation regime. Due to their international isolation, the DPRK LWR design team has operated without any direct contact with the global nuclear industry; presumably relying on publicly available written materials without access to experienced nuclear personnel abroad. The quality of manufacturing processes in the DPRK is unknown. While it might be able to manufacture heavy reactor components, it is not clear that its nuclear welding capabilities are up to global standards, nor is it clear that it is capable of manufacturing more delicate equipment items such as leak-proof reactor vessel head (with multiple penetrations), or control-rod drive mechanisms. It is not clear how the DPRK designers will resolve the issues of reactor instrumentation and control, control room design and man-machine interface in a way that will ensure safe reactor operation.

Furthermore, the DPRK is not a member of the IAEA now and has no access to IAEA safety assistance or safety review teams. The DPRK is not a member of the World Association of Nuclear Operators (WANO) and does not participate in the WANO plant inspection activities, peer reviews or transfer of best practices. The DPRK has a regulatory agency, revealed during the days of the Korea Energy Development Organization (KEDO) during the late 1990's. However, its functions, scope, level of expertise, and degree of independence from the government are unknown. Likewise, nothing is known regarding the training of reactor operators in the DPRK and their plant operating safety approach. Thus, the international community has significant concerns regarding the construction, commission, and operation of the Yongbyon experimental LWR. We should remember that an accident in the Yongbyon reactor might have cross-border consequences and might impact the safety of the neighboring countries, let alone the fortunes of the regional and global nuclear industry. What then could be done to assure the safety of the Yongbyon reactor given the ongoing isolation of the DPRK regime, the UN Security Council resolutions prohibiting any nuclear activities because of the DPRK's nuclear weapons program, and the frozen diplomatic process of the Six Parties talks?

I fully recognize that any nuclear cooperation with the DPRK must be part of a renewed diplomatic process designed to resolve the nuclear crisis on the Korean Peninsula. It is very likely that the DPRK will insist on its right to produce commercial nuclear electricity, which it claims is the objective of the experimental LWR. I

assess this reactor not to be a serious proliferation concern as long as it is not accompanied by domestic enrichment and reprocessing. Hence, my suggestion offers a path that would allow the DPRK to pursue civilian nuclear power while limiting those activities sensitive from a proliferation perspective. The Six Party process could insist on the elimination of enrichment and reprocessing, but allow the pursuit of nuclear electricity. My suggestion is to offer the DPRK help to make sure that the experimental LWR is constructed and operated according to the best modern safety practices.

I propose to institute a peer review or a joint inspections process for the Yongbyon experimental LWR with an NPP in a country bordering the DPRK. In the ROK, the plant nearest the Yongbyon site is the Ulchin station. In China, some nuclear plants are planned for the Liaoning and Jilin provinces bordering the DPRK, while several NPPs are now under construction in the neighboring Shandong province. It might be possible to institute an NPP to NPP peer review process with any of these plants acceptable to the DPRK. In such a process, the Yongbyon LWR could be matched with a specific LWR station in either the ROK or China. Staff members from each LWR could visit the other LWR, conduct safety inspections and transfer best practices data as available. The inspections will be conducted at the technical level only and the results will be kept confidential save for a summary public statement at the end of each inspection. Confidentiality will be essential to encourage openness and to prevent retribution against plant personnel should embarrassing details be made public. This level of confidential NPP to NPP inspections will be the nearest equivalent to bringing the experimental Yongbyon LWR under the WANO umbrella and into greater conformity with the global nuclear safety standards. At a minimum, this will provide the global community some, though limited, outside review of the DPRK LWRs program and might enhance confidence in the safety of that program. A precedent to this approach exists in the Argentina-Brazil Agency for Accounting and Control of Nuclear Materials (ABACC) (23). The ABACC organization performs similar mutual inspections of power plants in two formerly antagonistic countries – Argentina and Brazil. ABACC activities are more related to safeguards than to safety, but the principle of cross inspections of NPPs at the power plant level only is applicable to the Northeast Asia situation. The ABACC model also involves top-tier IAEA inspections both as audits of the cross-national inspections and as another independent safeguards inspections venue. A similar measure could be eventually incorporated into the plant-to-plant safety peer review process proposed here if and when the DPRK normalizes its relationship with the IAEA.

## **6.2. ROK Participation in Safety Regime for NPPs Located around the East (Japan) Sea**

The East Sea (or Sea of Japan) is an almost totally enclosed sea with the largest concentration of NPPs located on its shores on a world-wide basis. On the Japan side lies the Kashiwazaki-Kariwa plant – the largest capacity NPP in the world at about 8,700 MWe, located in Niigata province and operated by the Tokyo Electric Power Corporation (TEPCO). Further south along the coastline are the Mihama Takahama and Ohi stations of Kansai Electric Power Corporation (KEPCO) as well as the Tsuruga Station of Japan Atomic power Corporation (JAPCO) and the 250 MWe FBR plant Monju. Other NPPs are located further southwest. On the Korean shoreline we find two of the largest nuclear generation complexes in the country – the Kori – Shin Kori NPPs complex and the Ulchin – Shin Ulchin NPPs complex –each with an aggregate capacity of about 8,000 MWe once construction is completed, as well as the Wolsung – Shin Wolsung NPPs complex with an aggregate capacity of about 5,000 MWe. As mentioned above, there are plans for additional NPPs in areas not far from the East Sea, in the DPRK, in Shandong, Liaoning and Jilin provinces in China and in the Primorsk region of Far-Eastern Russia. It thus might make sense to establish a special-purpose safety regime for the NPPs located in this area given the large number of nuclear units involved and the large total nuclear plants capacity (24).

Concern with the safety situation of the above-mentioned plants might well be justified. On the Japanese side the Kashiwazaki-Kariwa station was damaged during the 2007 Niigata earthquake and the entire station might not have returned to commercial operation by the time of the Fukushima accident. Even before that accident there were allegations regarding falsification of operating records in TEPCO as well as other Japanese utilities (25). The Japanese utilities are formally members of WANO but did not actively participate in WANO's programs, claiming that the special safety procedures instituted in Japan suffice to maintain an adequate safety regime. Following the Fukushima accident the Japanese utilities have started a peer review process, however this review is conducted in public and all results are published. There is a concern that such public reviews could deteriorate to a mutual self-congratulatory exercise. The mutual support attitude and maintenance of a common façade of evident safety and full control of the situation are ingrained habits of decades of operation, if not longer, and are difficult to eradicate. The Japanese utilities are now attempting to establish a Japanese INPO, patterned after the very successful U.S. Institute of Nuclear Plant Operators, which has contributed significantly to the improvement of safety levels and operating records of all U.S. NPPs. It is not clear that this attempt, even if and when fully implemented, will significantly change the patterns of the Japanese nuclear safety culture.

On the Korean side some recent safety issues have cropped up in the Kori station (a small-scale station blackout event in Kori-1 as well as sub-standard equipment purchase practices). In addition, a control rod problem was discovered in one of the reactors in the Yeongwang station (26). We have discussed the issue of the DPRK experimental LWR above. In China, while adequate safety levels seem to be well maintained, the large number of new NPPs now under construction or planned leave some concern regarding the ability of the National Nuclear Safety Agency (NNSA) – the Chinese nuclear regulatory agency – to effectively regulate the construction and operation of all the NPPs now under consideration, as well as the Chinese fuel-cycle facilities. Furthermore, even though an Asian branch of WANO exists, it is not clear how its various safety and operation recommendations are implemented in the various countries and utilities mentioned above.

I propose, given all the above, a special safety regime in East Asia as a sub-region of WANO, aimed at strengthening the safety culture of the regional NPPs located around the East Sea, and patterned more on the U.S. INPO model than on the international (and weaker) WANO model. In this area, the ROK Government with a very dynamic and transparent nuclear energy program, and with the most to lose should its nuclear program falter due to safety concerns and public opposition, might consider taking the lead in promoting such an arrangement (eventually an institution). What I propose here is an extension of the DPRK cross inspections regime mentioned above, to be applied to the various NPPs located on the shores of the East Sea. The ROK might consider advocating a multi-NPP peer review process concentrating on closed-doors, no-holds-barred reviews similar to the INPO process and transfer of best practices similar to the WANO process. This cross inspections regime could be administered similarly to the ABACC model mentioned above and operated as a sub-region of WANO. This regime will concentrate on safety (rather than safeguards) inspections and might include additional IAEA top-tier inspections since most of the countries involved here are members in good standing of the IAEA. Confidentiality over the sensitive reviews should be maintained and only top level summary inspection results and performance indices for the NPPs involved should be published. Since so much hangs on maintaining good safety regime in all the East Sea NPPs in terms of the success of their respective national nuclear programs, the ROK Government could consider taking a leadership role in promoting such an arrangement.

## **7. Conclusions**

I have proposed in this paper various options for enhancing the (already strong) cooperation in nuclear energy matters between the U.S. and the ROK. Most of the suggestions made here concern bilateral arrangements between the U.S. and ROK Governments as well as cooperative ventures between their respective R&D and industrial organizations. I have proposed here cooperative arrangements related both to fuel cycle and new reactor developments and commercialization. Implementation of even some of the proposals mentioned here will significantly enhance the nuclear cooperation level between the U.S. and the ROK, while none of the above proposals conflicts with the desires of either country with regards to the revision of the 123 Agreement now under review.

On the regional level, I have made two suggestions here with regard to the DPRK experimental LWR and with regard to an enhanced safety regime for NPPs located around the East Sea. By their nature, these proposals relate to longer-term arrangements as they require significant negotiations among several countries. I have made these proposals to highlight the acute safety issues underlying each proposal, rather than to propose a unique solution. As long as the basic safety issues are well understood and addressed, and so long as the countries involved understand the potential consequences of inaction in these matters, then an appropriate solution will be found. These proposed solutions will hopefully contribute to this discussion.

## 8. References

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U.S. Department of Energy (DOE) Text, Washington DC, July 30, 1965  
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(2) – For a detailed discussion of the Republic of Korea (ROK) nuclear energy program see:  
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(3) – For a discussion of the Korean fuel fabrication plant in Daejeon, Korea, see the web site of the KEPCO Nuclear Fuel Corporation (KNFC), in: [http://www.knfc.co.kr/main/?en\\_skin=index.html](http://www.knfc.co.kr/main/?en_skin=index.html)  
This plant provides fuel fabrication services for all Korean Light Water (LWRs) and Heavy Water reactors (CANDUs), using two separate and automated fabrication lines. Further discussion on all Korean fuel cycle facilities is available in (2).



- (4) – Given the curve of enrichment unit costs a function of enrichment plant capacity it is seen that at plant capacity sufficient for twenty large LWR annual reloads (About four millions Separative Work Units (SWUs) per year) a lower asymptotic value is reached. An enrichment plant of this capacity or slightly larger will produce enrichment services for as low a price as any other global enrichment plant. Once this point on the production cost curve is reached a domestic enrichment plant will be as economic as any other global enrichment facility. See:

G. Rothwell, C. Braun

“Costs and Market Structure of the International Nuclear Fuel Cycle”

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- (5) – U.S. Nuclear regulatory Commission

“U.S. Nuclear Nonproliferation Act of 1978 (PL 95-242)”

P. 1029 of NRC’s “Nuclear Regulatory Legislation, 111 Congress, 2<sup>nd</sup> Session”

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- (6) – For general information on U.S. Uranium enrichment plants see:

World Information Service on Energy (WISE)

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Available electronically as: <http://www.wise-uranium.org/indexe.html>

See also

World Nuclear Association (WNA)

“U.S. Nuclear Fuel Cycle”

Information Paper, London, U.K., Updated October 2012

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Pomper of the Monterey Center for Nonproliferation Studies (CNS). See “How to Unsnag U.S. Korea Nuclear Negotiations”, Bulletin of the Atomic Scientists, September 25, 2012, Available at:

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