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RECONCILING THE NUCLEAR RENAISSANCE WITH DISARMAMENT

Alex Bollfrass and Kelsey Hartigan

Fridtjof Nansens plass 8, N-0160 Oslo - Tel: 22 40 36 00 - Fax: 22 40 36 10 - E-mail: post@atlanterhavskomiteen.no

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Alex Bollfrass is a Research Associate for the International Security and Nuclear Weapons program and is the co-editor with Barry Blechman of two recent books on nuclear disarmament, Elements of a Nuclear Disarmament Treaty and National Perspectives on Nuclear Disarmament. Prior to joining the Stimson Center, Alex held a Herbert Scoville, Jr. Peace Fellowship at the Arms Control Association. He worked on chemical weapons, the U.S.-India nuclear agreement, and Comprehensive Test Ban Treaty verification issues and reported for Arms Control Today magazine. He is a graduate of the University of California, Berkeley.

Kelsey Hartigan is the Nonproliferation and Defense Policy Researcher for the National Security Network. Prior to joining NSN, Kelsey worked at the International Security and Nuclear Weapons program at the Henry L. Stimson Center. Kelsey has also interned with the State Department and the U.S. Delegation to the Conference on Disarmament in Geneva, Switzerland. She has spent time studying at Leiden University in the Netherlands as well as at Tec de Monterrey in Queretaro, Mexico. Kelsey is a graduate of Purdue University.

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In 2007, a new disarmament movement sprouted among US national security leaders and revived a goal as old as the Bomb itself: a world without nuclear weapons. It has since seen the election to the American presidency of one of its most vocal supporters, and has won converts among leaders in other nuclear-weapon states. Simultaneously, governments the world over are considering major investments in nuclear energy as a carbon-free and independent source of energy. These two nuclear trends have, in recent years, become the subject of academic and political debate, but few practical suggestions have been developed to address the reconciliation of the technical and political tensions inherent in both. Pursuing one path without regard for the other will halt disarmament efforts and harm the expansion of nuclear energy if it continues to be seen as the foundation of a nuclear weapons program. With foresight, planning, and creativity, however, they can be mutually reinforcing processes. The multi-lateralization of reactor fuel services and an interlinking of progressive phases between the two processes during the transition are the key elements of such a reconciliation.

As a renewable resource that emits no carbon dioxide, nuclear power offers distinct advantages. Rising oil prices, a growing distaste for reliance on foreign oil, and heightened concerns over global climate change have led policymakers the world over to revisit the benefits of nuclear energy and its prospects for mitigating such concerns. Based largely on an overestimation of the role nuclear energy can play in reducing dependency on foreign oil and reversing the effects of climate change, this "nuclear renaissance" will likely occur, despite the perennial challenges and inherently high costs associated with nuclear energy. While it will likely be less expansive than its supporters predict, an increasing number of states will continue to consider developing civilian nuclear programs, a trend which will have serious consequences, both generally and in a disarming world, if not carefully managed.

Coinciding with the renewed interest in nuclear power are international efforts to work toward the global elimination of nuclear

weapons. U.S. President Barack Obama, along with a cohort of world leaders and prominent national security voices, has strengthened the call for a world without nuclear weapons.[1] While arsenals shrink and civilian nuclear programs spread, sensitive dual-use elements of the nuclear fuel cycle must be safeguarded to ensure peaceful use. Otherwise, it would become easier for additional nations to build nuclear weapons based on the pursuit of nuclear energy– a highly combustible scenario, particularly in a disarming world.

Nuclear Power and the Current Non-Proliferation Regime

Nuclear power plants currently generate roughly 14 percent of the world's electricity. It is often argued by nuclear energy advocates that if this number were to increase, countries with domestic nuclear power plants could reduce their dependency on foreign oil. In countries such as the United States, however, 40 percent of the energy that is consumed comes from oil, while oil only produces 1.6 percent of consumed electricity. Thus, as one professional has explained, "nuclear energy—because it currently only produces electricity—is inherently limited in its ability to reduce this dependence."[2]

Nonetheless, nuclear energy is perceived as an effective solution to lowering carbon emissions and enhancing a state's energy security. Whereas wind and solar sources typically fluctuate, nuclear energy offers a continuous flow of power, further increasing its appeal. In addition to such factors, some states are likely to pursue nuclear power as a political answer to dependency on foreign oil or as a means to gain the prestige associated with nuclear capabilities. In 2009, U.S. Senator Lamar Alexander pushed for investing in nuclear power, saying, 'the United States should build 100 new nuclear power plants during the next 20 years' to put America on the path to clean energy independence."[3]

Recent studies have found that nuclear power cannot quickly and effectively reverse the effects of climate change, nor can it bring about true energy independence. Mining and milling uranium is not always possible domestically and will likely require outside assistance and imports. As one report warns, "new entrants into the nuclear energy field might be pursuing energy independence, but they will wind up

with energy interdependence."[4] The economic viability of nuclear power also remains to be seen as initial costs are very high. Historically, reservations surrounding nuclear energy have focused on proliferation risks as well as safety concerns, waste disposal issues, and the high costs associated with building nuclear reactors. This unease still exist today, though the overall calculations may have shifted as high oil and natural gas prices, coupled with a need to reduce carbon emissions, have altered the perceived trade-offs.

Because of these sensitive components, civilian nuclear programs--regardless of their intended use--pose serious concerns for a disarming world. This does not mean, however, that nuclear energy is incompatible with nuclear disarmament. In fact, should the nuclear power industry expand significantly, the safeguards and verification measures that would be required in a disarming world would also be necessary to ensure that it expands safely. In this transition, safeguarding the nuclear fuel cycle would be a top priority.

Nuclear Trends

There are currently 31 countries housing operating nuclear power reactors, reaching a total of 438 reactors worldwide.[5] Presently, there are no nuclear power reactors operating in the Middle East. Some analysts are predicting a dramatic build-up of nuclear power plants in what has been labeled a "nuclear renaissance." The U.S. State Department has identified 12 new countries (including Egypt and Turkey) that have either planned or given serious consideration to developing nuclear power plants within the next ten years.[6] An additional 20 states, 10 of which are located in the Middle East, were identified by the State Department as having long-term plans. The IAEA has said it is currently discussing nuclear energy with 60 states.

States with existing plants are also expected to construct additional reactors, most notably China and India, where plans have already been developed to build scores of new reactors over the next two decades. Japan and South Korea are also planning to continue to increase their nuclear capacity. Italy, Sweden, and perhaps Germany are also considering utilizing nuclear power to combat global climate change.[7] The U.S. has not constructed a single nuclear reactor since

the Three Mile Island incident three decades ago. That may change. This February, US President Obama announced loan guarantees for two new nuclear power plants to be built in Georgia. This investment sends a message to the international community: The resumption of American construction may signal to other states that they should press ahead, as well. Some have already proceeded with projects without the American example, but if the richest nation decides to pursue nuclear energy, more may feel compelled to follow the lead.

Governance

Tasked with monitoring the peaceful use of nuclear technology by the Non-Proliferation Treaty (NPT), the International Atomic Energy Agency (IAEA) has expressed serious doubts about its ability to detect clandestine nuclear weapons development programs. Former director Mohamed ElBaradei, balked at the disparity between the expectations of the IAEA and its crippling lack of authority: "In many cases, we are a sleepy watchdog because we don't have the authority."[8]

Under the current governance structure, the Agency can only inspect a state's declared facilities. Should inspectors suspect additional activity at an undeclared site, they cannot conduct on-site inspections without first notifying the state and asking for permission to inspect the site at a later date. In response to Iraq's exploitation of this gap in the 1980s, the IAEA now has a voluntary Additional Protocol that allows for unannounced inspections throughout the state. The Additional Protocol has been ratified by 94 countries as of March 2010. However, the existing regime can only inspect declared facilities through announced inspections in those countries that have refused to agree to it. As a result, the IAEA is essentially relegated to knocking on doors and asking for permission to inspect national facilities.

With ageing laboratories and insufficient access to developed satellite monitoring areas, verification mechanisms like environmental sampling and satellite monitoring are also typically supplied by outside parties, further stifling the Agency's authority and independence. "I'm at the mercy of the suppliers," ElBaradei has said. Such shortfalls severely hinder the Agency's ability to detect clandestine facilities, which considerably weakens the nonproliferation regime.

Chronic underfunding has also limited the IAEA's ability to fully safeguard all relevant facilities. If additional states acquire sensitive fuel cycle capabilities under the current nonproliferation regime, proliferation risks will almost certainly increase with the expansion of the nuclear power industry as the IAEA is demonstrably ill-equipped and underfunded to halt the spread of nuclear weapons.

Threats and Risks

The Non-Proliferation Treaty (NPT) is comprised of three main pillars: Disarmament, nonproliferation, and the right to peacefully develop and use nuclear technology. Under any safeguards system it is difficult to ensure that the knowledge, materials, and technologies that support civilian nuclear programs are not diverted for weapons purposes. The current system, considering the governance and verification restrictions described above, is especially handicapped.

National uranium enrichment facilities and plutonium reprocessing plants are the dual-use technologies that are the most vulnerable to diversion, as these facilities provide states with the capability to produce the fissile materials required for a weapons program. While national fuel facilities are not needed to operate a fleet of reactors, states considering nuclear power will also likely contemplate building their own enrichment or reprocessing plants to achieve independence from foreign suppliers or assume that they will construct a fleet of reactors sufficiently large to make it economical. Under the current system, the potential benefits or perceived independence that such plants might bring outweigh the financial incentives to forgo national enrichment or reprocessing capabilities and threatens to bring about a wave of latent proliferation, in which scientists and engineers are trained, research facilities and nuclear reactors are constructed, and nuclear materials and technologies are all acquired in the name of peaceful use. This would present serious challenges, especially for regions that have never before managed nuclear security.

This growing interest in nuclear energy will also place even greater demand on the nonproliferation regime, which is already strained internally by its inherent contradictions. The most worrying symptom is a severely damaged NPT review process. The 2005 conference

collapsed and, despite initially promising preparatory meetings with an improved diplomatic atmosphere, a looming confrontation over the issues of Israel's nuclear weapons, progress on disarmament, and peaceful-use rights threatens the May 2010 conference. Similarly, Pakistan's obstructionism has halted the nearly-restarted Fissile Material Cut-off Treaty negotiations because it claims the need to further expand its nuclear arsenal. The supporting elements of the anti-proliferation network have been fraying, as well. The Nuclear Suppliers Group, which restricts transfers of sensitive nuclear materials and knowledge to non-NPT signatories, undermined its own purpose in August 2008. An India-specific exemption was pushed through by the United States, which had led the group's creation in the 1970s as a response to India's use of foreign-supplied materials to begin a weapons program. Foreign suppliers are now racing to conclude nuclear cooperation agreements with India in a bid to supply it with nuclear energy materials.

Among the NPT-approved weapon-states, every government's policy appears to be the management of each symptom of the sickening nonproliferation order with the fatalistic attitude that the tide of proliferation can be slowed, but not stopped. This capitulatory approach to the problem is not the only option, however. Another, more comprehensive solution to release that pressure has been gaining support from policymakers across the globe: The phased, verified, and multilateral elimination of all nuclear arsenals.

The Rebirth of a Disarmament Moment

A world free of nuclear weapons would make it impossible for a nation to claim a particular need for such weapons on the grounds of its unique security situation. It would also raise the costs of nuclear weapons to include universally denounced belligerence. An end to a system of haves and have-nots would distribute every nation's stake in the system equally. It would also transform necessary nonproliferation and nuclear security measures from bargaining chips against the weapons states to measures that must be taken seriously by all states to maintain the disarmed order.

The disarmament option has emerged as a serious policy position in

the United States and is spreading to other countries. The new disarmament movement started with an op-ed written by four senior American statesmen in the Wall Street Journal in January 2007. In "A World Free of Nuclear Weapons," George Shultz, William Perry, Henry Kissinger and Sam Nunn endorsed "setting the goal of a world free of nuclear weapons and working energetically on the actions required to achieve that goal." Other influential thinkers and policymakers in international security soon echoed this call to action by these dyed-in-the-wool Cold Warriors.

The new disarmament movement is organized loosely. The two most prominent initiatives are led by the original four statesmen, who focus on an elite American constituency and Global Zero, which recruits internationally and aims to reach the public at large. In addition, Global Zero has convened a commission of international experts and released an "Action Plan" that sketches a path for the elimination of all nuclear weapons within 20 years. The efforts surrounding the four statesmen eschew the establishment of such a target date, but have been actively urging governments to initiate prompt action.

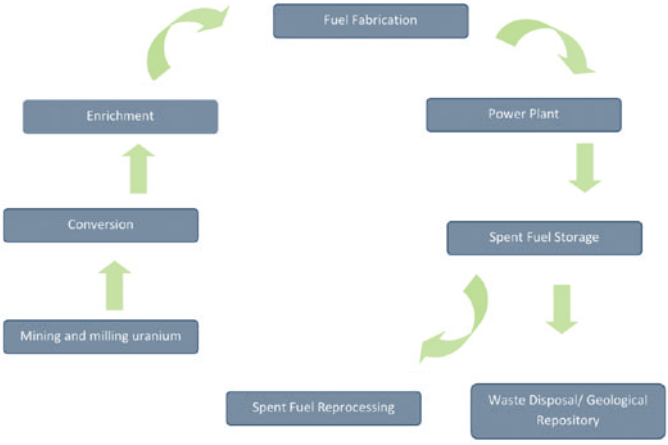
These efforts have yielded results. The United States elected a president who had publically announced his plan to pursue the elimination of nuclear weapons, a goal his rival, John McCain, also supported. In office, President Barack Obama made it official US policy to "seek the security of a world without nuclear weapons." He chaired a special session of the UN Security Council on this subject, which produced UNSC 1887 expressing the agreement among the five nuclear-armed permanent members and other heads of state and government present that they would "seek a safer world for all and to create the conditions for a world without nuclear weapons."

Other world leaders have expressed agreement with the nuclear zero agenda. President Obama and Russian Federation President Dmitry Medvedev jointly announced that both the US and Russia, which together account for 95 percent of the world's nuclear weapons, will pursue deep cuts in their arsenals with the overall objective of complete global disarmament.[9] British Prime Minister Gordon Brown has also presented an initiative on disarmament.[10]

After decades as a fringe pursuit, nuclear disarmament has become a mainstream, bipartisan, and multinational cause. Increasing numbers of world leaders recognize that the risks of retaining nuclear weapons now exceed the benefits that these arsenals may have once provided. This has not generated automatic agreement on implementing the vision, with most disagreements being driven by arguments over who would need to move first.

This disagreement is not limited to sequencing and proportionality of arsenal reductions, which at least share a common currency of nuclear warheads. More subjective is the establishment of equivalent steps taken by weapon-states and non-weapon states. To ensure that the pursuit of nuclear power does not deter states from reducing and eventually eliminating their arsenals, disarmament will require tighter controls on the nuclear fuel cycle (which the non-weapons states interpret as concessions). Under current arrangements, the sensitive, dual-use components of civilian nuclear programs--regardless of their intended use—make proliferation more likely. Therefore, should the nuclear power industry expand significantly, the safeguards and verification measures that would be required in a disarming world would also be necessary to ensure that the expansion occurs safely. However, as described in the following section, some elements of the nuclear fuel cycle are too dangerous to remain under single-nation control.

Nuclear Fuel Cycle



The nuclear fuel cycle is divided into two stages: the front-end where reactor fuel is produced, and the back-end where the spent fuel is either sent to a geological repository or recycled for future use. Uranium enrichment plants produce reactor fuel as part of the front end of the fuel cycle, whereas plutonium reprocessing is a back-end approach that extracts plutonium from the spent reactor fuel. The two main routes for acquiring weapons-useable fissile material—uranium enrichment and plutonium reprocessing—present the most direct challenges for the nonproliferation regime. Both types of facilities have applications as part of a civilian nuclear power program, which could also be used to produce weapons-useable material.

Nuclear power reactors that generate electricity require low-enriched uranium (LEU), whereas nuclear weapons necessitate highly-enriched uranium (HEU). Enrichment plants, especially those that use gas centrifuge technology, can be reconfigured relatively quickly to produce either LEU or HEU, making misuse more difficult to detect. The separation, stockpiling, transport, and use of recycled plutonium presents opportunities for military diversion or theft as the exact quantity of extracted plutonium cannot be verified with 100 percent accuracy, as discussed below. Domestic ownership also makes it easier for the plant operators to organize a diversion.

Light water reactors (LWR) dominate the nuclear energy market. These reactors are cooled and moderated by light (regular) water and use low-enriched uranium for fuel. Other reactor types, like the CANDU reactor, use heavy water (water with a higher degree of deuterium atoms) and operate on natural uranium. Thorium-based reactors, high-temperature gas-cooled reactors, and fast neutron reactors are also being developed and considered for future operation.

Plutonium Reprocessing

Two LWR back-end fuel cycle configurations are currently in use; the once-through fuel cycle and the partially-closed fuel cycle utilize different approaches for handling spent fuel. States that use the once-through approach temporarily store the spent reactor fuel before sending it to a geological repository, whereas states that utilize the partially-closed fuel cycle reprocess the spent fuel and separate the

plutonium so that it can be recycled into fresh mixed-oxide (MOX) fuel for the reactors. According to one report, "Six countries reprocess their commercial spent fuel today. France, India, Japan, and Russia are deeply committed to reprocessing; China operates a pilot reprocessing plant and is contemplating commercial reprocessing today; and the United Kingdom is on the verge of abandoning reprocessing. The United States does not reprocess civilian spent fuel nor does it introduce plutonium into its power plants, policies established under Presidents Ford and Carter."[11]

The IAEA cannot collect a measurement of non-diversion that is 100 percent accurate. Even with a margin of error that is less than one percent, this level of uncertainty can still pose major proliferation concerns, given the amount of weapons-usable materials involved. A recent study puts this in perspective: "Assuming that 20 large-scale reprocessing plants existed in this world, the uncertainty would be equivalent to 500 kg of plutonium every year for every plant—enough for 60 bombs per year from each of these plants."[12]

Economic audits indicate that "the once-through fuel cycle is the most economical option today and, even if nuclear power use grew significantly, will likely remain so for a century or more." Nonetheless, some states will likely consider a partially-closed approach as long as it remains an option. Because plutonium separation cannot be accurately accounted for, and because the partially-closed approach significantly decreases the time it would take a country to build nuclear weapons, plutonium reprocessing remains one of the most dangerous and perhaps unnecessary proliferation risks.[13]

Uranium Enrichment

Natural uranium contains three different isotopes, uranium-238 (99.3 percent), uranium-235 (0.7 percent), and a very small amount of uranium-234.[14] A uranium-based bomb requires a large ratio of uranium-235, so the raw uranium must be highly enriched to significantly increase the level of the necessary isotope. Uranium is also used as fuel for nuclear power reactors, though this process only requires low-enriched uranium, which typically contains about three to five percent uranium-235, whereas weapons grade uranium requires

about 80 to 90 percent U-235. Enrichment facilities present proliferation risks as it is relatively easy to reconfigure the gas centrifuge technology that produces low-enriched uranium (LEU) so that it produces highly-enriched uranium (HEU). When such a switchover occurs, it can be difficult to detect.

There are currently 14 operational enrichment plants spread across 10 countries, not including the military enrichment plants in Pakistan and India.[15] Plans for expansion are already underway at several of these existing facilities, which could facilitate a 30 to 40 percent increase in the global enrichment capacity. Thus, even if the demand for nuclear energy were to increase sharply, the current plans and projects that are already in progress eliminate the need for additional facilities. Plans to safeguard the nuclear fuel cycle by building jointly owned and operated multinational plants will not alter the current system now, or over the next ten to twenty years. Nonetheless, countries like Canada, South Africa, and South Korea are considering building indigenous uranium enrichment and/or plutonium reprocessing plants.[16] Under the current regime, there is little to prevent states from acquiring such facilities, despite the fact that there is no actual demand. The promise of prestige and independence derived from national ownership overpowers any other rationale for forgoing domestic investments. It can be safely assumed that the future will bring an increase in reactors, as well as reprocessing and enrichment facilities, whether or not that future includes nuclear arsenals.

An Ideal Model: Flattening the Nuclear Energy Playing Field

In a disarmed world with an active nuclear energy industry, the most proliferation-resistant nuclear fuel cycle would keep uranium enrichment and plutonium separation out of the hands of national governments while all nuclear materials would remain under the strict supervision of an international organization. At the same time, if nuclear energy does become a significant portion of the world's energy portfolio, it must be organized to deliver energy reliably and efficiently to those countries that have invested in it. Commercial competition within a sound regulatory framework is, as in any other energy market, the best precondition for achieving these objectives. The profit-maximizing incentive would generally override political

biases that might otherwise disrupt services. Given the high security stakes and the importance of an uninterrupted supply of electricity for the economy and of everyday life, the competition must take place within the boundaries set by regulation, much like a stock market. It is important, however, that all nations would be treated equally in their ability to participate in multilateral nuclear fuel consortia and to receive the fuel they purchase as long as they are in good standing with their safeguard obligations.

A disarmament regime would need to establish an effective international governance structure for verification, enforcement, and maintenance.[17] This would include some measures without direct precedent: Veto-free and partially automatic enforcement of treaty compliance; greatly enhanced safeguards for nuclear materials and technologies; and removing uranium enrichment and reprocessing from the sole control of national governments. This has already been a long-standing arrangement in Europe; the German-Dutch-British URENCO and the five-nation Eurodif provide fuel services for reactors built by multinational companies. The world's largest suppliers of nuclear reactors are multinational enterprises, which has not inhibited their commercial success or operational efficiency.

This model could be globalized. A series of competing regional multinational fuel banks would lease their fuel to private or public utilities operating reactors. They would take back the spent fuel as soon as it cooled enough for transport. Additionally, nations would receive other nuclear materials for peaceful purposes, such as medical isotopes or small quantities for scientific research, from the fuel banks. At all times, whether in the possession of the fuel bank or the national reactor, the nuclear material would be monitored by the international inspection agency deputized by the disarmament treaty to ensure that no materials can be diverted.

[1] The governing and implementation procedures for nuclear disarmament would not necessarily need to be codified in a single treaty, but could be constructed from a network of parallel agreements on each issue. For simplicity of discussion, however, this article presumes that these arrangements would be determined with an international treaty that had been signed by all nuclear-armed countries and those with advanced nuclear capacity.

These monitors could be part of the IAEA or a new inspection agency. Given the IAEA's past difficulty reconciling its dual mission of promoting nuclear energy and applying safeguards, it would be useful to separate the agency's safeguards division and integrate it into a new organization charged with the full-spectrum verification of the disarmament treaty's implementation. This new agency would oversee the destruction of warheads, coordinate the disarmament schedule, receive and investigate information about noncompliance, and monitor the use of nuclear materials and technologies from the fuel banks to the end user.

With or without disarmament, a growing nuclear industry will produce growing stocks of spent nuclear fuel. Countries hoping to host fuel banks and repositories would face the political obstacle of convincing their citizens to store nuclear waste from other countries. This difficulty would need to be reflected in the cost of leasing the fuel, and presumably, the countries supplying fuel and using nuclear energy to diversify their energy portfolios would see public support for these activities.

The basic principle behind this model has existed nearly as long as nuclear weapons. In 1946, the US Government-commissioned Acheson-Lilienthal Report advocated the "assignment of the intrinsically dangerous phases of the development of atomic energy to an international organization."[18] The report's recommendations were modified and converted into a concrete proposal by Bernard Baruch in a speech to the United Nations Atomic Energy Commission that same year. However, the early Cold War environment did not prove hospitable for such measures, even though the terms for the spread of nuclear technology still could be set by the United States. This has not been the case for a long time, but the United States can still influence the direction of the international regime. Today, what has been missing is the political will and -- especially since the two issues were formally linked in the NPT -- progress on nuclear disarmament.

False lessons from Iran

The escalating conflict with Iran over its nuclear ambitions is typically interpreted as an illustration of the tension between the NPT's right to peaceful use and the reality of the blurred line between civilian

and military applications of the nuclear fuel cycle. Iran has gained much from framing the conflict this way; it has earned support from states that are dissatisfied with the inequality of the NPT grand bargain's implementation. The Western proclivity to punish Iran's clandestine work and myriad safeguards evasions by restricting its access to fuel cycle technologies certainly abridges the country's NPT Article IV rights.

However, with violations mounting over time, it has become evident that Iran has not been innocently pursuing nuclear energy with a cavalier attitude toward procedural safeguards nuances. Evidence of its acquisition of warhead designs and its construction of separate, secret facilities for uranium enrichment points to the pursuit of a nuclear weapons program. The efforts to restrict its technological development, then, are not a discriminating revocation of Iran's rights, but a legally sound response to attempts of using Article IV as a cover for contravening the very purpose of the treaty. Indeed, the case of Iran underscores the worsening frailty of the NPT regime.

The ideal model of fuel supply should not be constructed around this highly irregular case. Instead, the concerns of advanced nuclear nations such as Brazil and Germany, which have forsworn nuclear weapons and have not been implicated in safeguards violations recently, should be the guiding principles in designing a non-discriminatory model of nuclear disarmament. The Iranian case is best understood as a worst-case scenario. The lessons learned from attempts to contain Iran's ambitions must include criteria that a future regime would react more robustly to attempts at using civilian nuclear technology as a cover for a weapons program. The international community has learned from nonproliferation failures before. After Iraq's undetected nuclear weapons program surprised the world after the first Gulf War, the Model Additional Protocol to nations' safeguards agreements was developed for adoption on a voluntary basis. The Iranian case demonstrates why voluntarism is not sufficient.

The Fuel Cycle in a Transition to Zero

Some opponents of nuclear disarmament accept the value of a world without nuclear weapons, but see the transition to such a world as

rife with instability and perhaps impossible to complete because as arsenal numbers decrease, the relative value of nuclear weapons rises. Countries, they believe, would find the temptation to catch up with the great powers and gain nuclear parity irresistible.

In the transition, these advocates of the nuclear status quo fear that gaps in a new or refurbished nuclear nonproliferation regime could be easily exploited by ambitious states like North Korea or Iran, leaving the disarming powers at a perilous disadvantage.[19] This concern is fully justified, but it can be addressed. Mandating the implementation of the previously discussed multinational fuel cycle governing structure as a precondition for serious arms reductions, however, has no chance of gaining the necessary support from key non-weapons countries. Instead, the active participation of these non-weapons states in the design of a multilateral disarmament process would make gradual concessions on their part more likely.

The non-weapons states have long advocated for disarmament, but view it chiefly as the weapons states' responsibility to implement. Seeing little substantive progress on disarmament, they have been growing understandably more reluctant to address the concerns of the weapons states that nuclear energy materials could be used for weapons programs. A recent survey of non-weapons state diplomats' views on this issue found that "nuclear-weapon states are in arrears and have a significant debt to pay before key non-nuclear-weapon states will consider additional nonproliferation commitments."[20] This is not merely a hypothetical obstacle to nuclear disarmament, but an ongoing division that has hindered the application of more robust safeguards. One diplomat in the report cautioned that "more progress on disarmament is necessary for creating an atmosphere for non-nuclear-weapon states to consider other nonproliferation steps; however, disarmament progress is a necessary, but not sufficient step."[21] Their frustration over disarmament foot-dragging has kept countries like Brazil from adopting the IAEA's Model Additional Protocol into its safeguards agreement, arguing that self-limitation is not justifiable in the face of a world with several nuclear powers.

Over the past decade, this mutual disappointment has produced a

deep division charged with combative rhetoric. Yet, the choice between living with nuclear weapons and not having a secure nuclear fuel supply is a false one and can be resolved with the proper set of incentives that will bring benefits to all affected countries. Once the weapons states place their arsenals on the negotiating table, it will be easier to foster productive discussions.

These negotiations would not be without friction. At the heart of the argument over the management of the nuclear fuel cycle in disarmament will be the classic political problem of who will bear which burden at what time and who will expose themselves to risk by acting first. Further compounding the difficulty of prospective negotiations is that the weapons states have some of the most advanced nuclear energy programs and tend to be the primary fuel providers. Proposals for the creation of fuel banks have generally come from these states and have been greeted with understandable suspicion by non-weapons states, which would see themselves at the mercy of a fuel supply oligopoly – on top of having their peaceful use rights abridged in principle.

Interlinking disarmament and multi-lateralization

The disarming states will not take the final steps toward eliminating their arsenals if they do not have confidence that another state will not seek the advantage of a monopoly on nuclear force. On the other hand, the non-weapons states will not agree to stricter nonproliferation rules in exchange for the promise that disarmament will be underway as soon as they do; this arrangement too closely parallels that of the NPT. Additionally, any disarmament process is unlikely to unfold in one quick step, but would rather be a series of choreographed reductions by each side, with potential suspensions as disputes were resolved or political hurdles overcome -- or not, as may prove to be the case.

The solution to the procedural problems above is in the establishment of the interlinked sequencing of steps taken on the multi-lateralization of the fuel cycle and on disarmament. Each step would be implemented upon the conclusion of parallel steps of the dismantlement of nuclear arsenals. A series of stages could be negotiated

along the following categories.

I. Agreeing to a desirable disarmament end state and the plan for achieving it, including the following steps regarding the fuel cycle;
II. A moratorium on new national enrichment and reprocessing plants;
III. A commitment to conclude new fuel supply agreements exclusively with multinational fuel banks;
IV. The application of toughened safeguards to the full fuel cycle from uranium mining to spent fuel storage;
V. The conversion of existing national fuel production and storage facilities to multinational control.

Each of these phases would be triggered by a corresponding step on the schedule for the dismantlement of nuclear arsenals. To take an illustrative example of such a schedule, the Global Zero Action Plan (GZAP), produced by a US-Russian-led commission of senior nuclear policy experts, is divided into four phases:[22]

Phase 1 (2010 to 2013): US-Russian agreement to reduce their arsenals to a total of 1,000 warheads each by 2018.

Phase 2 (2014 to 2018): A multilateral pact has the US and Russia agree to halve their warheads to 500 each by 2021. The other nuclear-armed states pledge to refrain from increasing their arsenal and, after 2018, join in proportional reductions to be completed in 2021. These reductions would be monitored with a new verification and enforcement system. Here, the GZAP also suggests the strengthening of safeguards for civilian nuclear applications.

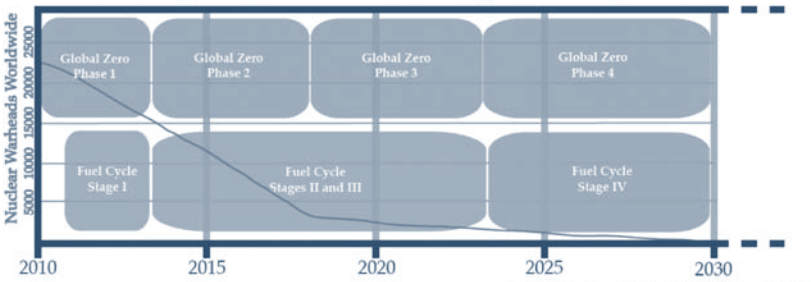
Phase 3 (2019 to 2023): Countries negotiate the final agreement for phased and proportionate disarmament by 2030.

Phase 4 (2024 to 2030): Full implementation of the agreement.

One can imagine fuel cycle stage I being initiated following the

agreement of the GZAP's first phase, which, once completed, would make the second fuel cycle stage possible. The beginning of phase 2 of the disarmament plan would trigger stages III and IV. The conclusion of the final disarmament agreement would bring with it the implementation of the last fuel cycle stage, the establishment of a fully multinational nuclear fuel supply system.

Model for Interlinking Global Zero Action Plan with Progressive Fuel Cycle Multilateralization



Adapted by authors from Global Zero Action Plan

Other models for arsenal reductions have been proposed that would interact differently with fuel cycle denationalization.[23] As the details for both sequences would necessarily arise from negotiations among governments, the precise linkage between the fuel cycle multi-lateralization stages and the disarmament phases need not be described with excessive precision.

A *quid pro quo* model has the advantage of establishing a long-term goal to guide near-term decisions. It would therefore encourage current positive projects and discourage those that are less helpful for achieving a safe, multilateral fuel cycle and the destruction of the world's nuclear arsenals.

The economic prism

Non-weapons states will vary in their reception to a phased multi-lateralization proposal, based on their particular nuclear economics. Countries that are only beginning to explore their nuclear energy options may respond more readily, because "multilateral projects in principle have important advantages, especially for countries with medium or small nuclear power projects and for countries that lack abundant sources of capital and technology."[24] Similarly, countries that already participate in multilateral projects, such as the Netherlands and Germany (which

is debating whether to proceed with its phase out of nuclear energy), would see little change to the way they procure their fuel.
Even though the weapons states are the chief advocates of multilateral approaches, they may not react well to the demand that all countries enjoy equal opportunity to participate in international ventures. While they have been the leading purveyors of proposals for multinational fuel banks, this is because several of them are among the world's main operators of single-nation fuel services. Russia, France, and the United States are chief among them. Their enrichment and reprocessing facilities, furthermore, have not been subjected to serious safeguards or inspections, which have been deemed unnecessary given their nuclear status.

Their formal multi-lateralization proposals stop short of meeting the important criteria of equal nuclear rights among nations, but they are nonetheless beneficial to pursue as intermediate steps. These proposals center on the mechanisms with which reactor operators could lease fuels that would remain under the supplier's control. The furthest along is a Russian-led project for a joint uranium enrichment project with Kazakhstan and Armenia, the Global Nuclear Infrastructure Initiative at its Angarsk facility.

Austria, Germany, Japan, the United Kingdom, and the United States have also created fuel supply plans, as have several groups of supplier countries and private initiatives. These proposals have been summarized and analyzed by several writers.[25] Even those proposals that promote fuel supply guarantees instead of the physical control of dangerous materials by a multinational body are useful as bridging solutions for stages II through IV described above. The Austrian government's proposal is alone in its ambitiousness, in that it envisions the transformation of "all enrichment and reprocessing facilities from national to essentially multilateral operations under the auspices of the IAEA."[26] Unfortunately, many of these proposals have not addressed questions of cost, reliability, and technical assistance to potential non-weapons state fuel purchasers' satisfaction.

Furthermore, these are political solutions to a technical and economic issue. Even with the most optimistic assumptions of the expansion

of the use of nuclear energy, there will be little need for new enrichment facilities to meet global demand over the next two decades.[27] This means that existing national facilities would need to undergo gradual multi-lateralization, a more difficult political proposition than the establishment of new projects. However, under the interlinked approach, new multilateral projects initiated at that point would not be far behind the final stages of disarmament.

Conclusions

In spite of its high cost, negative safety record, public unwillingness to accommodate facilities, limited ability to counteract climate change and inherent proliferation dangers, nations are poised to increase their use of nuclear energy. If the current wave of support for nuclear disarmament is to be successful, the anticipated spread of nuclear materials and knowledge cannot make the acquisition of these weapons easier. The solution – the removal of uranium enrichment and plutonium reprocessing from the sole control of individual countries – has been recognized since the dawn of the nuclear age. The legacy of historical inequity and countries' security concerns about being first adopters can be overcome with an interlinked schedule between the two. Such a schedule would establish the phases for the dismantlement of nuclear arsenals and for the gradual adoption of a multilateral fuel cycle with stronger safeguards. The fulfillment of each phase on one track would trigger the commencement of the other track's next phase. The earlier inter-governmental discussions, which also should include the private nuclear industry, commence, the higher the odds of success in keeping the door open for nuclear disarmament in a world that seeks to grow more reliant on nuclear energy.

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N-0160 Oslo
Tel: +47 22 40 36 00
Fax: +47 22 40 36 10

post@dnak.org
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