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Alternative nuclear futures

The global nuclear order is changing, but where is it headed? Will the expected expansion of nuclear power in many regions around the world lead to increased dangers of nuclear terrorism and increased risks of nuclear weapons proliferation? As we noted in our introduction in volume 1,¹ the common answer provided by the diverse international group of contributors to this two-volume special issue of *Dædalus* is that it depends: it depends on how quickly and how widely nuclear power spreads to new countries; it depends on the domestic political and governance characteristics of the new nuclear power states; it depends on whether terrorists' plans to attack nuclear sites or steal nuclear materials succeed or fail; and, crucially, it depends on the steps taken by the international community to improve the safety mechanisms, physical protection standards, and nonproliferation safeguards that make up the tapestry of agreements that we call the nonproliferation regime.

Our colleagues have laid out a rich menu of steps that could strengthen the nonproliferation regime. We hope that governments around the world

will listen to the ideas offered by these scholars, industry leaders, and former officials about how best to gain the benefits of nuclear energy while minimizing the security risks that are inherent in the spread of nuclear power. But we know from studying the history of nuclear power and proliferation that not all good ideas are adopted over time, and that wise policies and potential constructive compromises among conflicting interests do not always triumph.

Our crystal ball is not clear enough to predict with confidence whether the global nuclear future will be characterized by peace and prosperity or by conflict and destruction. But we do believe that the choices made in the coming few years will be crucial in determining whether the world can have more nuclear power without more nuclear weapons dangers in the future. Here we first briefly outline five major security challenges posed by the potential expansion and spread of nuclear power. Second, we discuss the major players whose decisions and interactions will determine which policies are adopted and which are rejected as the international community seeks solutions to these five security challenges. Finally, we sketch a number of alternative nuclear futures to demonstrate the truly

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momentous nature of the political and technical decisions that will soon be made by critical national and international actors.

What specific challenges to international security are created by the anticipated expansion and spread of civilian nuclear power? Five serious, interrelated problems appear on the horizon: safety, sabotage, terrorist theft or purchase of a weapon or nuclear materials, nuclear weapons proliferation, and destruction of nuclear facilities in a conventional war. Each of these challenges must be addressed if the global expansion of nuclear power is to evolve in desirable directions.

First, will it be possible to ensure that high levels of *safety* are created and maintained in each new power plant as nuclear power spreads? Even the most established and experienced nuclear power states – including the United States, Japan, and Russia – have had accidents in their nuclear facilities. As Richard Meserve notes in his essay in volume 1, these incidents led to the creation of both safer reactor technology and national and international institutions, such as the Institute of Nuclear Power Operators (INPO) and the World Association of Nuclear Operators (WANO), to encourage organizational learning and best safety practices.² The stakes here are high, for unless the nuclear power newcomers do even better in maintaining safety than did previous new nuclear power states, we can expect periodic minor accidents and rare but occasional serious incidents. Rapid construction of power plants, weak national regulatory systems, and shortages of trained personnel may exacerbate concerns about safety in the future. Constant vigilance and a high degree of cooperation among

all governments and operators will be necessary, as a major accident anywhere would have global repercussions.

Second, will adequate standards for the protection of nuclear facilities against *sabotage* be adopted and implemented as nuclear power spreads? Sabotage can be a gray area since it could be initiated by a disgruntled worker striking out against his or her employer but not meaning to harm coworkers; by an anti-nuclear environmentalist seeking to shut down a power plant; or by a terrorist organization seeking to create a release of radiation and spread fear and panic. All three of these scenarios have occurred in the past, and we see no reason to expect that future sabotage attempts can be eliminated entirely. Fortunately, some measures, such as strong containment vessels and effective personal reliability programs, protect against both accidents and sabotage. The protection of nuclear installations has always been a concern, but the revelation that the 9/11 al Qaeda aircraft hijackers initially considered crashing a jumbo jet into a nuclear power plant heightened the alarm. Continued terrorist interests in targeting nuclear power plants – to create panic, economic damage, and civilian casualties – was demonstrated in the “Toronto 18” case in 2006, in which an Islamic fundamentalist group apparently planned a truck bomb attack against a nuclear power plant in Ontario.³

Third, will there be adequate standards of physical protection against a *terrorist theft or purchase* of a nuclear weapon or the materials necessary to make a nuclear bomb or radiological device? Former International Atomic Energy Agency (IAEA) Director General Mohamed ElBaradei has highlighted this danger: “The gravest threat the world faces today, in my opinion, is that extremists could get hold of nuclear or

radioactive materials.”⁴ The urgency of the physical security problem is well established, as al Qaeda leaders, including Osama Bin Laden, have announced their desire to get nuclear weapons and al Qaeda operatives, such as the British terrorist Dhiren Borat, have been apprehended with plans on how to make and use radiological “dirty bomb” devices.⁵ Yet as Matthew Bunn points out in his essay, there is currently no international agreement about what physical protection standards are considered adequate and how much spending is justified in the name of physical security.⁶ For some nuclear utilities, security activities too often are seen as a trade off against profit, even though in the long term strong security can prevent successful terrorist incidents that would be incredibly harmful to both company profits and national security. Even in the United States, with more than six decades of nuclear experience, there is still intense and unsettled debate about whether existing standards of physical security are sufficient given the threats that are now thought to exist. As nuclear facilities are built in more states, especially in countries that may have high degrees of corruption and poor regulatory competence, it will be crucial to promote better international standards and implementation of strong physical security measures. New international institutions, such as the World Institute for Nuclear Security (WINS), will need to play an absolutely critical role in promoting best physical security practices between the existing nuclear power states and new states that construct nuclear power plants.

Fourth, will the spread of nuclear power lead to further *nuclear weapons proliferation*? The link between nuclear power and nuclear weapons has been a serious worry throughout the nuclear age. The

expansion of nuclear power can lead to the dissemination of expertise and technology that is useful in the weapons context. This will be true particularly if nuclear newcomers acquire the full panoply of technology associated with nuclear power, including fuel cycle technologies that have direct weapons applications. This risk can be limited if the acquisition of uranium enrichment or plutonium reprocessing technologies is discouraged or prohibited. These technologies are, however, also indispensable for the production of fuel for nuclear reactors. Hence, states have to be persuaded that reliable external sources of supply exist before they will agree to forsake the option of national fuel cycle capabilities. States that doubt whether they can trust international suppliers of reactor fuel (whether commercial or multinational) are more likely to think it necessary to acquire their own fuel cycle infrastructure – which means that they will possess a latent nuclear weapons capability. The more states that acquire their own national enrichment or reprocessing capability, the more worrisome the nuclear future will be.

Fifth, there is legitimate concern that a nuclear power plant could be attacked during a *conventional war*, potentially leading to an environmental catastrophe, if, for example, the containment vessel was breached or the spent fuel was attacked and dispersed. Fortunately, some states are acutely aware of this danger and have attempted to mitigate it: India and Pakistan, for example, have agreed not to target each other’s nuclear facilities in the event of armed conflict and, as a confidence-building measure, routinely exchange information about their commercial nuclear facilities. Other states, in contrast, have engaged in dangerous attacks during conflicts: during the 1991 Gulf War, for example, Iraq launched a

SCUD missile attack against the Dimona nuclear reactor in Israel, but fortunately lacked the accuracy to hit the intended target. Future “no-targeting” agreements, like the confidence-building measures that India and Pakistan have signed, between new states that have both nuclear power plants and an enduring military rivalry, may be useful.

These five challenges are not the only consequential questions associated with the growth of nuclear power. Questions of finance, of nuclear waste, and of human capital are also important and will have great bearing on decisions about whether states pursue or expand nuclear power, by how much and how quickly. But from a global security perspective, the degree to which the future nuclear order promotes safe, secure, proliferation-resistant, and effectively monitored and governed nuclear power is of paramount importance.

Given these concerns, there are some experts (including some in this special issue⁷) who oppose the further spread of nuclear power on security grounds. There are other experts (again including some in this special issue⁸) who are skeptical about the wisdom of expanding nuclear power worldwide, on grounds that other renewable energy resources will be more effective in combating global climate change. Here we are agnostic on the question of whether there *should be* an expansion and spread of nuclear power in the future. Instead, we simply assume that there *will be* some degree of growth in the use of nuclear energy, including some new states acquiring nuclear power plants. Who will determine which states acquire nuclear technology and how the resulting security concerns are addressed? The fact is that the Nuclear Non-Proliferation Treaty (NPT) regime is, first and foremost, a system of

states. Within the governments of those states, however, there are often diverse bureaucratic and political interests affecting nuclear issues. And within those states, the innovators, the providers, the owners, the operators, the sellers, and the exporters of nuclear technology are often found in the private sector.

Accordingly, it is in central governments and corporations around the world where the fundamental decisions are being made that will play the largest role in shaping the future global nuclear order. To be sure, these decisions are not wholly independent of one another. The relevant actors are often influenced by the nuclear policies and programs of others. They are often at least indirectly connected and constrained by varying levels of engagement with the international nuclear marketplace. They are typically participants in the international institutions created to provide some structured governance of the world’s nuclear affairs – whether the IAEA and the Nuclear Suppliers Group (NSG) for states or WANO for corporations. They all operate in the context of existing treaty obligations, legal constraints, regulatory requirements, export control guidelines, and normative expectations, however imperfectly the rules-based regime may operate at times. And in a substantially integrated and highly mobile globalized world, the intellectual infrastructure for thinking about nuclear power and nuclear weapons can spread worldwide and produce many common or overlapping frameworks for addressing nuclear issues. Rarely will nuclear decisions be made in complete isolation from these wider realities.

Within this web of potential constraints and influences, however, governments and companies will decide and act on the basis of their own self-defined perceptions, preferences, pol-

icies, and calculations of self-interest. They will make their own judgments about the desirability or unattractiveness of nuclear power as a component of their overall approach to energy. Their choices will determine how fast and how widely nuclear power expands and spreads. As part of its long-term energy strategy, China, for example, has chosen to pursue a policy that will more than double its nuclear power capacity within a decade and that aims to increase that capacity by fivefold or sixfold by 2050. (China currently has 17 nuclear power reactors under construction.) Countries such as Egypt, Jordan, and the United Arab Emirates have already decided to acquire nuclear power plants and other regional powers may follow suit, with the result that the Middle East will become a much more nuclear region.⁹ Similar decisions by other states (so-called nuclear aspirant states) will gradually but eventually change the strategic geography of nuclear power on a global scale.

States and firms will also determine, within the constraints of the politicized international nuclear marketplace, which technology paths to follow in developing their nuclear programs. A crucial question for the future is whether the spread of nuclear power reactors will be accompanied by the spread of sensitive fuel cycle technologies that can produce bomb material as well as reactor fuel. There may be international norms and pressures against the acquisition of such worrisome technologies, but ultimately states will choose for themselves. For example, proponents of the nonproliferation regime have long argued that countries like Iran or Brazil do not need, and should not seek, independent uranium enrichment capabilities; however, both of those governments, at least thus far, have decided otherwise. Similarly,

the feasibility of proposed international or multinational nuclear fuel cycle arrangements intended to discourage the spread of sensitive weapons-usable technologies will depend on whether states embrace or reject such schemes. Washington, for example, may believe that it is a good idea for Iran to have its nuclear fuel produced in Russia or Western Europe, but Tehran has yet to find the proposal acceptable.

In short, national governments play the central role in shaping the governance of global nuclear affairs. They decide which rules to accept and which to reject, which to respect and which to violate, which are enforced and which are ignored. Whatever constraints or restrictions for strengthening the NPT regime may seem obvious or desirable to the international community of nonproliferation experts, they have no hope of acceptance unless they are found agreeable by the overwhelming majority of states. Similarly, the IAEA is an international organization comprised of member states that provide its funding, oversee its policies, and determine its powers. If the IAEA is to be given additional resources and greater investigative powers, it will be because states have agreed that this should happen.

Within those states, however, different actors often hold different views about which nuclear policies their governments should adopt at home and support abroad. The evolving nonproliferation regime will therefore be strongly influenced by whether supporters of international cooperation and compromise or supporters of national fuel cycle facilities win the debate at home. Fortunately, in many states the central government and industry leaders are committed to the cause of nonproliferation and will act in support of a stronger NPT regime.

Six conclusions follow from this analysis. First, as nuclear power spreads, a growing number of states will become active players in the NPT system. Their investment in nuclear power will mean that they can be directly affected by the functioning of the regime. Moreover, they will be different states. Once, nuclear power was, with a few exceptions, found in the wealthy industrial nations: the United States, Japan, France, and Britain, among others. In the future, many developing countries – Egypt, Iran, Malaysia, Indonesia, and many others – will be in the nuclear power club and will have interests to be defended in the NPT regime. Their views will no doubt sometimes be different from those of the established nuclear power states. The mix of states active in NPT diplomacy will be different than in the past, and these states' decisions will help determine the future global nuclear order.

Second, in an NPT system of 189 states that relies on voluntary commitments by members and that operates generally on a consensus principle, inclusive diplomacy is an imperative if progress is to be made. States need to be persuaded that new rules or reinterpreted norms are desirable and in their interests. The perceptions and preferences of nuclear newcomers need to be understood and taken into account; outreach is essential. States need to believe that they have a stake and a voice in the system or they are unlikely to invest much effort in preserving and strengthening it. This need for broad participation and cooperation is why occasions such as the periodic NPT Review Conferences are so important, despite all their well-known difficulties and problems. They represent the sort of inclusive diplomacy that is necessary if the NPT regime is to be strengthened and if states are to

be convinced to choose nuclear policies that are compatible with the needs of the NPT system.

Third, any deviations from the principle of consensus within the NPT regime must be perceived by the majority of states as being legitimate if they are to be effective. This is true regarding both new interpretations of NPT rules and any future efforts to enforce them. As Jayantha Dhanapala's essay in this volume suggests, it is possible that future NPT Review Conferences may adopt a resolution to strengthen the NPT regime, overriding the votes of one or more member states; this could be highly disruptive unless there are widespread perceptions that any such resolutions are fair and legitimate.¹⁰ In his April 2009 speech in Prague, President Obama also emphasized the importance of enforcing nonproliferation commitments:

Rules must be binding. Violations must be punished. Words must mean something. The world must stand together to prevent the spread of these weapons.¹¹

Enforcement decisions, in the UN or in other international institutions are, almost by definition, not consensus decisions, since those states being punished will dissent. The degree to which the vast majority of states, however, views any resulting sanctions or military actions as legitimate and fair enforcement of commitments (as opposed to being raw coercion) will help determine whether the act strengthens or weakens the overall NPT regime in the long term.

Fourth, the points discussed so far highlight the importance of the IAEA and other international organizations. Will the IAEA be able to cope effectively with a world in which there is more nuclear technology spread across more countries? In the design of the nonpro-

liferation regime, the IAEA is intended to play a crucial role in reassuring the international community that civilian nuclear programs are not contributing to weapons acquisition. Through a scheme of inspections and safeguards, the IAEA is meant to bring transparency to the world's peaceful nuclear activities and thus to serve as a buffer between peaceful nuclear programs and possible development of nuclear weapons. Across time, the IAEA increasingly has been expected to fulfill the additional role of investigating concerns about the possible existence of clandestine nuclear weapons programs, an issue of obvious importance in judging compliance with the NPT. The IAEA attempts to perform these pivotal roles with limited (many would say inadequate) resources and many political and legal constraints on its ability to act. In his remarkably candid farewell address, IAEA Director General ElBaradei stated, "Our ability to detect possible clandestine nuclear material and activities depends on the extent to which we are given the necessary legal authority, technology, and resources. *Regrettably, we face continuing major shortcomings in all three areas, which, if not addressed, could put the entire nonproliferation regime at risk.*"¹² As nuclear power spreads, the IAEA's challenge will become even more demanding and the shortfalls could become even more acute. A crucial question for the future of the nuclear order is whether the member states that fund the IAEA and determine its legal mandate will be prepared to strengthen the Agency so it is adequate to its responsibilities in a more nuclear world. If not, one of the principal barriers between energy production and weapons programs will be seriously weakened.

Fifth, an important determinant of future proliferation will be the degree to

which the spread of the nuclear power industry produces civilian nuclear power bureaucracies in different states that want to maintain peaceful programs and oppose turning civilian energy programs into nuclear weapons programs. Indeed, how best to ensure that civilian nuclear power bureaucracies maintain a strong interest in opposing nuclear weapons proliferation may be the \$64,000 question for estimating the effect of the global spread of nuclear power on the likelihood of nuclear weapons proliferation. This is ironic, for although some nonproliferation specialists may not want more countries to start nuclear power programs, once those states do so, it will be important for nonproliferation that their nuclear power programs are successful. The leaders and bureaucratic organizations that run successful nuclear power enterprises will want to maintain strong ties to the global nuclear power industry, to international capital and technology markets, and to global regulatory agencies – and hence will be more likely to cooperate with the nuclear nonproliferation regime. Leaders of less successful or struggling nuclear power enterprises, in contrast, might be more likely to support clandestine or breakout nuclear weapons development programs as tools to justify their existence, prestige, and high budgets within their state. Research on Japan and South Korea, for example, has shown that the liberalizing governments supported maintaining their close relationship to global markets and institutions and that this decision influenced the capability and willingness of nuclear bureaucracies to push for weapons programs. In the case of India, by contrast, the power and autonomy of the state's "strategic enclave," coupled with the record of failure in producing nuclear energy, strongly encouraged the leaders

of India's nuclear bureaucracies to lobby Indira Gandhi to test a weapon in 1974, to encourage the Bharatiya Janata Party (BJP) to test another set of weapons in 1998, and to oppose constraints on their ability to test new nuclear weapons today.¹³

Sixth, and finally, a critical factor shaping our nuclear future will be whether leaders in the non-nuclear-weapons states (NNWS) see the NPT merely as an effort to get the nuclear-weapons states (NWS) to disarm, or whether they conceive of the NPT as a solution to a collective action problem. This clearly was part of how leaders conceived of the NPT when they signed and ratified it in the late 1960s and subsequently. The Treaty and the IAEA inspection regime it created were valued because they provided a sense of confidence that other states in the region were not developing nuclear weapons and that, therefore, the state in question could renounce nuclear weapons as well. But over time, that vision was lost, and many NNWS began to see the NPT as merely an unfair constraint on them and as a largely unsuccessful goad to encourage nuclear disarmament in the NWS. The possibility of international control of the nuclear fuel cycle, and the accompanying constraint on national nuclear fuel production programs, will be more likely if all nuclear power states see a danger in their neighbors operating sensitive nuclear fuel facilities. This perceived fear may make states more willing to accept international control of the nuclear fuel cycle, and the constraints on their national programs that come along with it, in exchange for constraints on their neighbors' programs.

Many possible outcomes could arise from the complicated, unpredictable, decentralized process of nuclear deci-

sion-making. Expectations have often been confounded and predictions have often been wrong. The notion of nuclear electricity "too cheap to meter," for example, has long ago faded into history. Forecasts that there would be dozens of nuclear-armed states have fortunately proven wrong (so far). Previous predictions that there would be a rapid expansion of nuclear power around the globe turned out to be wildly off the mark. Though we can see today features of the nuclear landscape that will materialize well into the future, it is not easy to predict what the global nuclear order will be. A long legacy of incorrect predictions should keep us humble and remind us that we, too, can be wrong. It is possible, however, to envision how things might turn out if things go well or badly.

The most optimistic vision of the future sees the substantial expansion and spread of nuclear energy use around the globe, but with effective constraints placed on the potential adverse security consequences. There would be many more nuclear reactors on a global scale, contributing to the mitigation of climate change and to energy security, but fuel cycle capabilities would not have spread. Nuclear newcomers would rely on international arrangements for the fuel to run their reactors and would use international or regional repositories to store spent fuel, rather than hold it or reprocess it at home. In this way, the link between nuclear power and nuclear weapons could be limited. Ideally, further reassurance about the purely peaceful applications of the world's additional investments in nuclear power would be provided by a larger, stronger, better funded IAEA, presiding over a regime that institutionalized high levels of transparency and empowered the IAEA with sufficient investigative powers to produce confidence that cheaters will not undermine

the regime. If the international governance of the world's nuclear affairs can evolve and strengthen, then it may be possible to establish and promote compliance with high common standards for safety and physical security – for example, through the refinement and enforcement of UN Security Council Resolution 1540, which already calls on states to ensure “appropriate and effective” levels of security at their nuclear facilities (but without ever defining what steps meet that standard). It will never be possible to eliminate all risk, of course; but the world would be a safer place if all states possessing nuclear technology were not only obliged to accept desirable standards, but made more genuine and monitored efforts to meet those standards. A system that possessed this set of attributes would be a robust nonproliferation regime that would allow the wide exploitation of nuclear power while circumscribing the potential risks and problems associated with nuclear power.

The likelihood of reaching this nuclear future would be increased if steps were taken to delegitimize and marginalize nuclear weapons and if the NWS were judged to be making sincere efforts to move toward nuclear disarmament in fulfillment of their obligations under Article VI of the NPT.¹⁴ It is difficult to dampen the appetite for nuclear weapons when existing NWS enshrine those weapons at the center of their security policies, tout the unique and indispensable security contributions of these weapons, and proclaim their intention to retain nuclear weapons for the indefinite future. It is also difficult to credibly call for a strictly enforced rules-based nonproliferation system when the NWS are seen to be flouting their own obligations under the nonproliferation regime. It is too soon to tell where the arms con-

trol initiatives launched by President Obama, notably in his nuclear disarmament speech in Prague in April 2009, may lead, but even the first small steps seem to have had a positive impact on the climate of opinion in nuclear affairs. If there is progress toward deeper cuts in nuclear forces, if the NWS begin to reduce their reliance on nuclear weapons, and if there is success in putting into place other measures such as the Comprehensive Test Ban Treaty and the Fissile Material Cutoff Treaty, then nuclear weapons would seem less valuable and the incentive for new states to acquire them would diminish. This shift would be a useful buttress to a more extensive and effective nuclear nonproliferation regime.

A much more negative vision of the future finds that the global expansion of nuclear power has produced an array of undesirable consequences. If nuclear newcomers lack confidence in the international market for nuclear fuel, however it is configured, some will surely seek to master the nuclear fuel cycle themselves (as Iran has done) in order to ensure a reliable supply of reactor fuel for their nuclear programs and, perhaps, to maintain a weapons option for the future. Neighboring states will be nervous, great powers will be alarmed, and friction is likely to ensue – as evidenced in the past decade in the cases of Iraq, Iran, Libya, and North Korea. Coping with this problem will be even worse if the standing of the IAEA were to erode and its ability to provide transparency and reassurance were undermined. It is certainly possible that in the future the IAEA, hobbled by inadequate resources, handicapped by its limited legal mandate, partially blinded by the lack of its own intelligence capabilities, tainted by the political maneuverings of member states, harmed by past failures, and crip-

pled by the defiance of troublesome states, would be judged insufficient, incapable of addressing the challenges of a more nuclear world. The IAEA has its critics even today, but its problems could easily be compounded in the future. If the IAEA were no longer regarded as an effective tool in the nonproliferation regime, this would weaken another barrier that stands between nuclear power and nuclear weapons. In the event that the nonproliferation system seems to be breaking down, institutionalized efforts to provide global governance in the nuclear realm are also likely to decay or fail. In a world in which states are aggressively pursuing their own nuclear interests and the institutions and mechanisms of nonproliferation are weakening, rules are less likely to be accepted, respected, or enforced. The evolution toward universal high standards for safety and physical security would be stifled and the result could be very uneven safety and security efforts in national nuclear programs – meaning higher risk of accident or incident.

The most disturbing variant of this negative vision for the nuclear future would be one in which the norm against acquisition of nuclear weapons is fractured and new NWS emerge. States that determined for their own self-interested reasons to acquire nuclear weapons could defy or ignore the NPT/IAEA system or simply withdraw from the NPT (as North Korea did). In conflict-prone regions in which fuel cycle capabilities exist in multiple states, there arises the possibility of the competitive pursuit of nuclear weapons (as occurred in South Asia between India and Pakistan). If enrichment and reprocessing are more widely distributed across states, acquisition of nuclear weapons by one power could more easily trigger nuclear acqui-

sition by others. In the past, rapid cascades of proliferation – though sometimes predicted – have not occurred and are not certain to occur in the future.¹⁵ But the dynamic could well be different if the nonproliferation regime is thought to be eroding and more NNWS possess the latent capability to manufacture nuclear weapons. The reassuring record of a past era marked by few NWS, a sturdy norm against acquisition, a reasonably sound nonproliferation regime, very infrequent spread of nuclear weapons to new states, and possession of fuel cycle capabilities by only a few states may not be a reliable guide to the future if trends slide in a negative direction. Decades ago, Henry Rowen and Albert Wohlstetter famously worried about the dangers of “life in a nuclear-armed crowd.”¹⁶ Decades hence, we could find ourselves living in that world if unwise choices and unfortunate preferences lead us down an undesirable nuclear path.

Momentum toward a proliferated world would be reinforced if the current NWS fail to move away from reliance on nuclear weapons. The notable cooling in U.S.-Russia relations could plausibly lead to a restoration of their nuclear rivalry and to a resurrection of nuclear deterrence as the centerpiece of the strategic relationship between the world’s two largest nuclear powers. Indeed, both powers retained substantial nuclear arsenals postured at least in part to “hedge” against the possibility that hostility would resume in their bilateral relationship. The nuclear obsession that marked the Cold War could return. But even if that does not happen, both the United States and Russia have continued to embrace nuclear weapons and to adopt doctrines and defense policies that accord a prominent role to nuclear weapons. If the arms con-

trol process sputters and breaks down, if multilateral agreements founder and fail to enter into force because of strenuous opposition within NWS, if the articulated commitments to nuclear disarmament come to be regarded as false promises, then relations between nuclear haves and have-nots are likely to be difficult and the international atmosphere will be more conducive to the spread of nuclear weapons.

A third vision of the nuclear future would involve a collapse of the expected nuclear renaissance and a possible contraction of the role of nuclear power. It would not be the first time that an expected nuclear renaissance did not happen. This could come about in two ways, one benign and the other dystopian. It is possible that the economic costs and security challenges will in the end outweigh the incentives to expand nuclear power. Perhaps alternative energy sources will develop more rapidly than expected or some technological innovation will make nuclear power seem less necessary or less competitive. Perhaps it will be possible to address the world's energy and climate change challenges without additional exposure to the risks and challenges associated with nuclear power. This would be the benign route to a more circumscribed future for nuclear power.

The darker scenario involves failure to contain successfully the risks of nuclear power. The anticipated expansion and spread of nuclear technology could be derailed if something horrible happens. The catastrophic reactor accident at Chernobyl set back the nuclear sector by decades in some countries; another large accident would likely have similar effects. A breach of physical security at a nuclear installation that resulted in a serious sabotage incident or terrorist possession of nuclear materials or weap-

ons undoubtedly would dampen the enthusiasm for nuclear power expansion and cause some recalculation of the cost-benefit equation. And then there is the most horrible scenario of all: the use of nuclear weapons. A nuclear detonation in a city or against any other target would clearly alter the global nuclear debate and produce a more constrained nuclear power future.

The global nuclear future is highly uncertain, and there is no reason to assume that a desirable nuclear order will arise automatically or spontaneously. Men make their own history, but they do not make it entirely as they please, Karl Marx famously noted. Governments, the nuclear industry, and international institutions will make our nuclear future, but their complex interactions may not produce the nuclear world that each of them seeks. This is why it is so important to think hard now about where we may be headed, what desirable outcomes we should seek, and what steps should be taken now to increase the likelihood of a safer and more secure nuclear order in the years ahead.

ENDNOTES

- ¹ See Steven E. Miller and Scott D. Sagan, "Nuclear Power Without Nuclear Proliferation?" *Dædalus* 138 (4) (Fall 2009): 7–18.
- ² Richard A. Meserve, "The Global Nuclear Safety Regime," *Dædalus* 138 (4) (Fall 2009): 100–111.
- ³ See Colin Perkel, "Terror Cell Co-leader Pleads Guilty," *The Canadian Press*, October 8, 2009, http://ca.news.yahoo.com/s/capress/terror_guilty_plea; and Melissa Leong, "Fertilizer, Remote Detonators Figure in Terror Plot," *Canwest News Service*, May 30, 2008.
- ⁴ Mohamed ElBaradei, "Statement to the Sixty-Fourth Regular Session of the United Nations General Assembly," November 2, 2009.
- ⁵ See U.S. Regulatory Commission, "Backgrounder on Dirty Bombs," July 30, 2009, <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/dirty-bombs-bg.html>.
- ⁶ Matthew Bunn, "Reducing the Greatest Risks of Nuclear Theft & Terrorism," *Dædalus* 138 (4) (Fall 2009): 112–123.
- ⁷ Robert H. Socolow & Alexander Glaser, "Balancing Risks: Nuclear Energy & Climate Change," *Dædalus* 138 (4) (Fall 2009): 31–44.
- ⁸ Harold A. Feiveson, "A Skeptic's View of Nuclear Energy," *Dædalus* 138 (4) (Fall 2009): 60–70; and José Goldemberg, "Nuclear Energy in Developing Countries," *Dædalus* 138 (4) (Fall 2009): 71–80.
- ⁹ See *Nuclear Programmes in the Middle East: In the Shadow of Iran* (London: International Institute for Strategic Studies, 2008).
- ¹⁰ See Jayantha Dhanapala, "The Management of NPT Diplomacy," in this volume. See also, Cecilia Albin, *Justice and Fairness in International Negotiation* (Cambridge: Cambridge University Press, 2001).
- ¹¹ U.S. President Barack Obama speaking in Prague, April 5, 2009.
- ¹² ElBaradei, "Statement to the Sixty-Fourth Regular Session of the United Nations General Assembly," emphasis added.
- ¹³ See Etel Solingen, *Nuclear Logics: Contrasting Paths in East Asia and the Middle East* (Princeton, N.J.: Princeton University Press, 2007); and Itty Abraham, *The Making of the Indian Atomic Bomb: Science, Secrecy and the Postcolonial State* (London: Zed Books, 1998). See also George Perkovich's essay, "Global Implications of the U.S.-India Deal," in this volume.
- ¹⁴ See Scott D. Sagan, "The Case for No First Use," *Survival* 51 (3) (2009): 163–182.
- ¹⁵ See William C. Potter's essay, "The NPT & the Sources of Nuclear Restraint," in this volume.
- ¹⁶ See Albert Wohlstetter, Thomas A. Brown, Gregory Jones, David McGarvey, Henry Rowen, Vincent Taylor, and Roberta Wohlstetter, "Moving Toward Life in a Nuclear Armed Crowd?" Report for the Arms Control and Disarmament Agency, April 22, 1976, <http://www.npec-web.org/Frameset.asp?PageType=Single&PDFFile=19751204-AW-EtAl-MovingTowardsLifeNuclearArmedCrowd&PDFFolder=Essays>.