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Editors' Note

The three articles in this issue explore different aspects and consequences of survivability and stability and demonstrate how technical analysis can offer real-world policy insights.

In "One Hundred Nuclear Wars: Stable Deterrence between the United States and Russia at Reduced Nuclear Force Levels Off Alert in the Presence of Limited Missile Defenses," a team of distinguished technical and military analysts from the United States and Russia explore the implications of what many see as the next set of challenges for nuclear arms control: deep reductions in the respective nuclear forces, taking nuclear weapons off alert, and the deployment of limited missile defenses. Bruce Blair, Victor Esin, Matthew McKinzie, Valery Yarynich, and Pavel Zolotarev present the results of a large number of simulated nuclear first-strikes by the United States and Russia on each other, where the two countries have reduced their arsenals to a total of 1000, 500, or 100 warheads each, with the weapons dealerted so as to be hours away from launch readiness, and with deployment of U.S. missile defenses and Russian countermeasures. They show that even in such a situation, the attacker will confront an adversary with surviving nuclear forces sufficient to inflict devastating retaliation. This analysis provides an important reference point for analysts and policy makers concerned about deeper reductions in U.S.-Russian nuclear arsenals.

The survivability of China's nuclear forces against a possible U.S. attack with current and next-generation precision-guided conventional forces is addressed in the article by Tong Zhao, from Georgia Institute of Technology's Sam Nunn School of International Affairs. In "Conventional Counterforce Strike: An Option for Damage Limitation in Conflicts with Nuclear-Armed Adversaries?" Zhao shows how China's strategy of building underground facilities for its nuclear forces may help protect these weapons (especially China's ballistic missiles) from U.S. preemptive strikes with conventional weapons. This is the third recent article in *Science and Global Security* by Chinese analysts on the perceived threats to China's nuclear forces from U.S. military capabilities. (The previous articles were: Li Bin, "Tracking Chinese Strategic Mobile Missiles," volume 15, 2007, and Wu Riqiang, "Survivability of China's Sea-based Nuclear Forces," *Science and Global Security,* volume 19, 2011.) Taken together, these articles suggest that instead of an ever more challenging contest in which the United States seeks to make China's nuclear weapons more vulnerable to attack and China develops additional

possible countermeasures, the two countries would be better served by a policy that advances mutual reassurance and strategic stability.

The third article in this issue uses the lens of survivability and stability to look backwards rather than forward. In a potentially important contribution to the new field of "nuclear archaeology"—a set of approaches to reconstruct past fissile material production activities—Alex Gasner and Alexander Glaser of Princeton University propose that, as with graphite-moderated reactors, evidence for the amount of plutonium produced in heavy-water reactors may survive in long-lived isotopic anomalies induced in reactor core support structures and other components. Their article "Nuclear Archaeology for Heavy-Water-Moderated Plutonium Production Reactors" uses computer modeling of the core of Canada's NRX reactor (which was the basis for the design of plutonium production reactors both in India and Pakistan) to look at changes in the isotope ratios of boron, lithium, chlorine, calcium, titanium, chromium, iron, nickel, zirconium, and lead in the support structure's aluminum alloys and how these correlate with the plutonium production in the reactor to present a possible technical basis for verifying the amount of weapon plutonium produced by reactors in Israel, India, and Pakistan. Experiments to validate this approach would be a significant step towards development of the verification capabilities that will be needed as part of a nuclear disarmament regime.