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In Memoriam
Allan S. Krass (1935–2013)

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As a scientist, mentor, writer, negotiator, and diplomat, Allan Krass commanded a range of skills that few in his profession could match. He dedicated those skills to making the world a safer place.

Like others in his generation, Krass was liberated by the political ferment of the 1960s and 1970s to question conventional wisdom and to try to make a difference. He was very successful in both. His first step off the beaten path was in 1974 when, after being an Assistant Professor of Physics at the University of California Santa Barbara and at Princeton, he became a Professor of Physics and Science Policy at Hampshire College, a small, unconventional college in Western Massachusetts.

As the title that he chose for his position suggested, Krass had decided to start using his analytical abilities to tackle policy issues. An obvious policy problem for an elementary particle theoretical physicist to tackle in those days was nuclear weapons proliferation, which had come to the fore again after India's 1974 nuclear test.

In the fall of 1976, Krass took a one-semester sabbatical at Princeton to spend time with a like-minded group of physicists who were in the process of establishing what is now known as Princeton's Program on Science and Global Security. India had taken the plutonium route to nuclear weapons but Allan

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was concerned that an easier and less detectable route might open up via laser isotope separation of uranium-235 to produce highly enriched uranium (HEU).

The product of the sabbatical semester was "Laser Enrichment of Uranium: The Proliferation Connection," published in *Science* magazine in May 1977. This article put on public display for the first time the lucidity of Krass's writing about an arcane technical subject and also his willingness to question conventional political assumptions. This may account for the fact that the editors of *Science*, the world's leading vehicle for the communication of developments in science to the educated public, gave Allan more than ten pages to present his perspective.

The purpose of the article was not to sound the alarm, which had already happened, but rather to offer a realistic risk assessment. In retrospect, Krass's emphasis on the great technological challenges facing laser enrichment appears to have been justified. It was not until 2012 that Global Laser Enrichment, a joint subsidiary of General Electric and Hitachi, received a license from the U.S. Nuclear Regulatory Commission (NRC) to build a commercial laser enrichment facility—if it decides that the process will be economically competitive with gas centrifuge enrichment.

One obvious question not addressed in the *Science* article was how to compare laser enrichment as a proliferation risk with other enrichment technologies—especially gas centrifuge enrichment. In 1980–81, Krass had an opportunity to explore this question during a sabbatical at the Stockholm International Peace Research Institute (SIPRI). The result was a book, *Uranium Enrichment and Nuclear Weapon Proliferation*, co-authored with Peter Boskma, Boelie Elzen, and Wim A. Smit, who were pursuing the same questions at the Centre for Studies on Problems of Science and Society at Twente University of Technology in the Netherlands. This book spotlighted gas-centrifuge enrichment, which had been commercialized in Europe and had already spread to Pakistan, where it made possible a nuclear-weapon program based on HEU.

The first policy recommendation of the book was that the "enrichment industry should be internationalized"—a long-forgotten recommendation of the 1946 Acheson-Lilienthal Report. It also recommended that the international agency use gaseous-diffusion and chemical enrichment technologies, which, unlike centrifuge and laser enrichment, require thousands of stages of enrichment to produce weapon-grade uranium and are therefore more proliferation resistant. *Uranium Enrichment and Nuclear Weapon Proliferation* became a primer for a generation of physicists interested in learning about nonproliferation issues.

In the early 1980s, however, the world's focus shifted back from proliferation to the Soviet-U.S. nuclear arms race. With the election of Ronald Reagan to the U.S. presidency in 1980, a group of Cold War hawks moved into the Executive Branch. Some of them talked freely about the possibility of

being able to fight and win a nuclear war with the Soviet Union. The response was widespread alarm including massive public demonstrations in the United States and Europe calling for a halt to the arms race. Ultimately, starting in 1987, President Reagan began to partner with Mikhail Gorbachev in his effort to end the Cold War. The hawks, however, were sure that the Soviet Union would cheat.

The verification issue was the subject of Krass's next project, launched during a second sabbatical at SIPRI (1983–84), which resulted in the book, *Verification: How Much Is Enough?* (1985). In the conclusion, he argued that "a legalistic 'contract' approach to arms control cannot survive the political tensions it helps to exacerbate" and proposed instead a requirement that verification arrangements be sufficient "to detect militarily significant violations in time to make an appropriate response." He also argued for "a concerted effort at public information and education to regain a public consensus in the United States on the possibility of adequately verifying future arms control treaties." A few within the Reagan Administration—especially Paul Nitze—also made this argument. Furthermore, Gorbachev went to extraordinary lengths in allowing on-site inspections. The Intermediate Nuclear Forces Treaty was signed in 1987 and the Cold War came to an end in 1989.

In 1994–95, Krass took another sabbatical—this time at Stanford's Center for International Security and Arms Control (now the Center for International Security and Cooperation). The result was his third book, *The United States and Arms Control: The Challenge of Leadership* (1997), dedicated to his wife Dorothy and daughter Caroline. The book argued that modern arms control had had a revolutionary impact on the international security system but had not yet been fully accepted by the U.S. national security establishment as a valid tool for reducing the excesses and dangers of arms races. He also worried—as he had in his previous writings—that the slow progress of nuclear disarmament was undermining the legitimacy of the Nonproliferation Treaty. He argued, however, that the institutions created to contain the Cold War confrontation and nuclear proliferation were helping to stabilize the post-Cold War world and that the U.S. should provide leadership in sustaining and strengthening these institutions.

In 1995, after two decades of self-education, research and writing, Krass took a leave of absence from Hampshire to see what life would be like as a Foster Fellow inside the U.S. Arms Control and Disarmament Agency. He stayed on for a decade as a Physical Science Officer until he retired in 2005.

During that decade, the prevention of nuclear terrorism became a major U.S. concern—especially after 9/11—and Krass became the State Department's lead official in negotiating agreements with other governments to convert their research reactors from weapon-usable HEU to low-enriched uranium (LEU) fuel and to return both unused and spent HEU fuel to the U.S. and Russia.

In this position he had to parry objections to conversion from reactor operators, funding institutions, and government managers. His efforts within the U.S. interagency teams also were critical to maintaining a fair and consistent collaborative approach and the development of solutions for each specific facility. His reports on those meetings reveal an uncanny understanding of the political sensitivities that had to be dealt with before technical solutions could even be discussed.

In addition to his representation of the State Department in these negotiations, Krass became an unofficial mentor to the Department of Energy staff engaged in the implementation of this initiative. Charles Messick recalls

> I came into the Foreign Research Reactor Spent Nuclear Fuel Acceptance program at the formal start of the program, May 1996. I came from an operations background and knew very little about nuclear nonproliferation. . . . We traveled to the Philippines, Taiwan, Thailand, and Indonesia. I was very green and trying to do a good job, but clearly having trouble keeping everything straight preparing the trip report to document these agreements during the visit. Allan spoke during the meetings, of course, to clarify and represent State, but later he jumped in to help write the report and prepare it for signature by the foreign reactor operator before we left the reactor facility. I can still remember us joking about the cost of having a Department of State representative doing work for us. A year later, we made shipments of HEU out of all of these countries.

Krass was famous among his colleagues for flashing the warmest of grins whenever an ironic nuance or potentially unconventional solution occurred to him—a trait that could break down barriers among a whole room of disparate interlocutors.

Krass emphasized the importance of the U.S. domestic program for the conversion of research reactor fuel. He stressed specifically that *we must lead by example and cannot ask others to do what we ourselves are not willing to do*. Galvanized in part by Krass's urgings, by the end of 2009, all U.S. HEU-fueled research reactors that could be converted to LEU fuel had been. Higher density fuel is under development for the rest.

Krass retired in 2005 but returned to work part-time from 2009–11 as a consultant on the Global Threat Reduction Initiative, based within the Department of Energy in the National Nuclear Security Administration. He provided support and guidance to the growing number of staff within an extraordinarily successful effort that, by the end of 2013, had resulted in HEU being cleaned out of 24 of the 44 non-weapon states to which it had been exported following President Eisenhower's 1953 "Atoms for Peace Speech."

Allan Krass passed away on 3 January 2013.