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Citizen Scientist: Frank Von Hippel's Adventures in Nuclear Arms Control

PART 3. Working with Gorbachev's Advisors to End the Nuclear Arms Race

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ABSTRACT
Von Hippel describes his collaboration with a group advising Soviet leader, Mikhail Gorbachev, as they devised strategies, including "glasnost" (openness and transparency) to end the nuclear arms race with the United States as part of a larger effort to reform the Soviet Union and integrate it into the global economy.

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Velikhov Revealed as a Gorbachev Advisor

***Tomoko Kurokawa (TK)*:** General Secretary of the Communist Party and leader of the Soviet Union, Yuri Andropov, died in February 1984. He was succeeded by Konstantin Chernenko who died a year later in March 1985. Chernenko was succeeded by Mikhail Gorbachev.

***Frank von Hippel (FvH)*:** And then we learned that Velikhov and Sagdeev were advising Gorbachev.

***TK*:** Until then you didn't know that?

***FvH*:** We did not. We weren't into Kremlinology and we had never heard of Gorbachev. We were brainstorming with a group of senior Soviet scientists about nuclear arms control and disarmament; we hoped they were influential but we didn't know.

After Gorbachev took over, however, things started getting exciting.

I believe the US nuclear-weapons freeze movement had an impact on Gorbachev. The Soviets had an image of the US as being run by the military-industrial complex. In the area of nuclear policy, that is, in fact, true to a considerable degree.

But Gorbachev and his advisors saw in the nuclear-weapons freeze movement the rise of an opposing force. They thought that this might create an opening for some kind of negotiations. They were right.

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Monitoring Gorbachev's Unilateral Nuclear Test Moratorium

Gorbachev's first initiative to end the nuclear arms race was a unilateral moratorium on Soviet nuclear-weapon tests starting on August 6 (Hiroshima Day), 1985. He said that, if the US did not reciprocate, the moratorium would last only until the end of 1985.

This initiative may have been inspired in part by Nikita Khrushchev's 1958 nuclear testing moratorium. The Eisenhower Administration joined five months later, beginning negotiations that ultimately yielded the 1963 US-USSR-UK Partial Test Ban Treaty, ending those three countries' nuclear testing in all environments except underground.[1]

But this time, the Reagan Administration, unlike the Eisenhower Administration, did not reciprocate. Thinking that the US should continue to develop new types of nuclear weapons, the Reagan Administration was opposed to a nuclear test ban and therefore tried to reduce the political impact of Gorbachev's moratorium. Specifically, administration officials suggested that the Soviets had just completed a series of tests, and therefore had no near-term need to test. They suggested furthermore that perhaps the Soviets were cheating with small tests at their main test site in Kazakhstan. (The second Soviet test site on the Arctic island Novaya Zemlya was being monitored by seismic arrays in nearby Norway, leaving little room for cheating there.)

In October 1985, two months after the Soviet moratorium began, I met Velikhov in Copenhagen at the centennial celebration of Niels Bohr's birth to which we and others had been invited because of Bohr's interest in nuclear arms control.

Velikov knew of the Reagan administration's suggestions that the Soviets were cheating. He suggested that perhaps a credible third party could be invited in to verify that the Soviet Union was not testing.

Even a suggestion that the historically secretive Soviet Union might unilaterally invite in-country verification was a remarkable development. I started looking for people who might be interested in seismic monitoring of the Soviet moratorium and found three: Aaron Tovish of the Parliamentarians for Global Action (PGA), a non-governmental organization with members from most of the world's democracies;[2] Jack Evernden, a senior seismologist with the US Geological Survey; and Tom Cochran of the Natural Resources Defense Council (NRDC).

At Tovish's suggestion, in April 1986, two of the leaders of the PGA, Olafur Grimsson[3] from Iceland and Relus ter Beek[4] of the Netherlands, took me along to Moscow as their technical advisor for a meeting with Eduard Shevardnadze, Gorbachev's Foreign Minister. Their purpose was to encourage the USSR to continue with the moratorium.

After the meeting with Shevardnadze, I found Velikhov at his office in the Academy of Sciences. The first thing he asked me as I entered was, "Got any ideas?"

I told him I had found some people who were interested in monitoring the Soviet test site. Velikhov responded, "Let's invite them to Moscow!"

[1] France conducted its last atmospheric test in 1977 and China in 1980. Since then, there have been no nuclear tests in the atmosphere.

[2] Parliamentarians for Global Action was founded in 1977. It has about 1400 members from 140 Parliaments, https://www.pgaction.org.

[3] Grimsson later served for an unprecedented five terms (20 years) as the President of Iceland (1996–2016).

[4] Ter Beek later served as Minister of Defense of the Netherlands for five years (1989–94).

The next month, representatives of the three candidate organizations and I traveled to Moscow and we had a meeting at the headquarters of the Soviet Academy of Sciences in Moscow to discuss how to move forward.

It turned out that the Parliamentarians were politically constrained: they could not monitor a moratorium unless the US joined. Evernden also was out because the Reagan Administration would not allow his organization, the US Geological Survey, to participate. That left Tom Cochran and the NRDC.

Cochran was well prepared. He had brought along NRDC staff attorney, Jacob Scherr, and Christopher Paine, who was working as a Congressional staffer with Representative Edward Markey to advance a Comprehensive Test Ban. Most importantly, however, Cochran also had brought along the chairman of the NRDC's board, Adrian DeWind.

Tovish also made a crucial contribution. He had found a seismologist, Charles Archambeau, of the University of Colorado, Boulder, who was willing and able to recruit a group of academic seismologists to actually carry out the monitoring project.

After the Moscow meeting, the NRDC group was quickly able to raise $1 million for the project from US foundations (Cochran 1987, 5).

In the meantime, to dramatize to the Soviet political leadership that the world was paying attention to the Soviet moratorium, Velikhov decided to organize an international scientists' conference in Moscow in July 1986, including a session with Gorbachev.

By the time the scientists' meeting took place, the US seismologists were already in Kazakhstan with portable seismometers monitoring the test site. They brought their first seismograms, showing earthquakes but no tests, to the Moscow meeting. They also shared copies with test ban supporters in Congress, including then Representative (now Senator) Ed Markey (Figure 1).

The seismologists deployed so rapidly that they got ahead of the Soviet leadership. Velikhov later told me that Gorbachev decided that he should check the acceptability of the project with the Politburo, the highest decision-making body in the Soviet Union. At the meeting, the hardliners were strongly opposed to unilaterally letting foreigners in to monitor Soviet nuclear activities. After the meeting, Gorbachev and Velikhov were alone and Gorbachev suggested that they not proceed. Velikhov told me he responded, "Sorry, boss, they're already there."

***TK*:** What was the political impact of the project in the US?

***FvH*:** It had a huge impact on the US Congress. Negotiations to ban testing underground had failed in 1962 because President Kennedy, under pressure from his Joint Chiefs of Staff, insisted on at least five or six on-site inspections of suspicious seismic events in the Soviet Union each year while Khrushchev, under pressure from *his* hard-liners, insisted on no more than two or three. Now, Gorbachev was *unilaterally* allowing the installation of foreign seismic stations around the main Soviet test site. Test-ban advocates in Congress started pressing the Reagan Administration to join the moratorium and launch negotiations on a Comprehensive Test Ban Treaty with the Soviet Union.

The Reagan and George H.W. Bush administrations were unresponsive. Gorbachev sustained his unilateral moratorium until February 1987 but then allowed a resumption of Soviet testing.

Figure 1. Top, University of California San Diego seismologists with their portable seismometers on a granite outcrop about 200 kilometers from the Soviet test site in Kazakhstan (NRDC); bottom left, Cochran and Velikov visiting monitoring project (RIA, Novosti); bottom right (Representative Ed Markey holding up the first seismogram in the chamber of the US House of Representatives. (NRDC-CSPAN?).

But the Congressional pressure for a US moratorium kept getting stronger. Finally, in October 1992, just before the presidential election, three senior senators, Republican Mark Hatfield and Democrats James Exon and majority-leader George Mitchell, added an amendment to the Fiscal Year 1993 Energy and Water Development Appropriations Act that forced the phaseout of US testing as long as other countries did not test. If there were any safety or reliability concerns about specific US warheads, their amendment would allow up to 15 more tests before 30 September 1996 to check fixes to those problems. After that, however, if other countries had stopped testing, the US would have to as well. (In Part 4, I discuss how the Clinton Administration decided that the 15 tests were not necessary.)

***TK*:** So you had the chance to meet Gorbachev?

***FvH*:** I spoke to Gorbachev on three occasions. The first two times, I was asked to report the conclusions of scientists' meetings to Gorbachev.

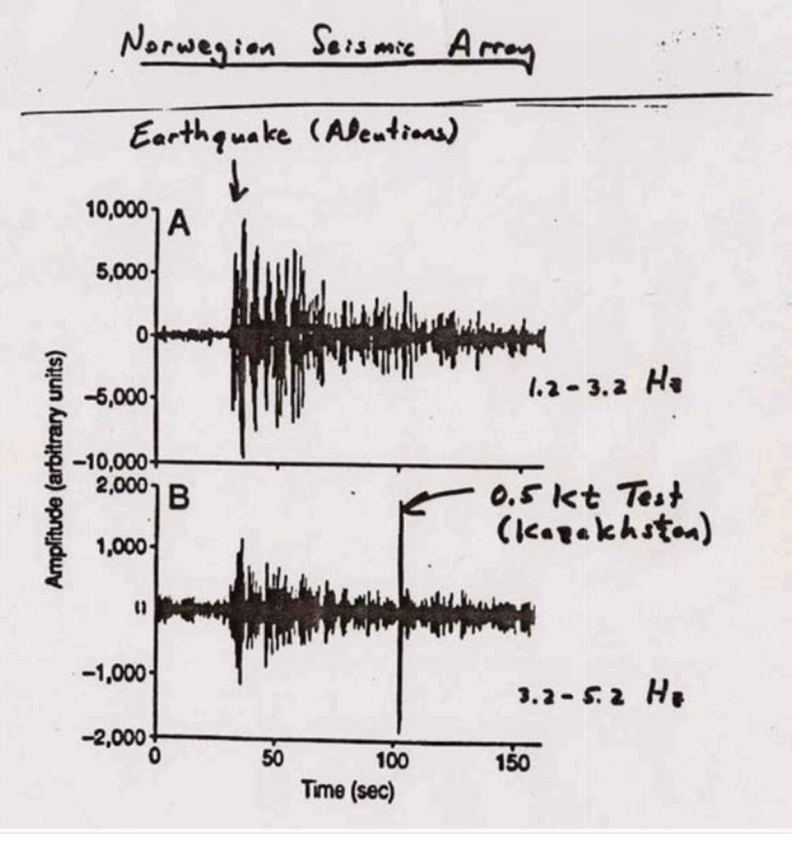

Figure 2. Earthquake in Aleutians masks the seismic signal from a small Soviet nuclear test in Kazakhstan at low frequencies but the earthquake's signal falls away at higher frequencies to reveal the test (Von Hippel 2013).

I have wondered why I was chosen for this role. My best guess is that the Soviet scientists liked my title, Chairman of the Federation of American Scientists (FAS). It made me sound very important – the chairman of all American scientists. In reality, the FAS is a small NGO. At that time we had a few thousand dues-paying members.

At the end of the July 1986 scientists' meeting on a Comprehensive Test Ban Treaty, Velikov asked me to make a presentation to Gorbachev. That was before Powerpoint and I used transparencies on an overhead projector annotated with a felt-tipped pen. One of my transparencies was of a seismogram made in Norway of an earthquake in the Aleutians (Figure 2).

One of the scenarios US test-ban opponents had put forward for Soviet cheating was that the Soviets would wait until there was an earthquake and then set off a test whose signal would be lost in that background.

But seismology had advanced. My transparency showed that, in an ordinary seismogram, the signal of the Soviet test was indeed buried in the larger signal from the earthquake. But the signal from the earthquake was mainly at lower frequencies and, if you filtered out the lower frequencies, there emerged a seismic signal from a small nuclear test in Kazakhstan, with an estimated explosive power of a few percent of that of the Hiroshima bomb.


ПРАВДА

ган Центрального Комитета КПСС

24818] Вторник, 15 июля 1986 года Цена 4 коп.

Встреча М. С. Горбачева

с представителями международного форума ученых за прекращение ядерных испытаний

Во время встречи.

Figure 3. Gorbachev's meeting with an international group of scientists to discuss a Comprehensive Test Ban. On near side of table, FvH is second and Velikhov third from the left.

So I was lecturing Gorbachev about verification of a Comprehensive Nuclear Test Ban.

***TK*:** What was his reaction?

***FvH*:** He was reserved. The story was on the front page of *Pravda* the next day, however (Figure 3). So I guess Velikhov's purpose had been achieved.

When I returned from Moscow, a reporter for our local newspaper, the *Trenton Times*, interviewed me about the meeting and then asked, "Would you meet with President Reagan?" I responded, "Of course!" So the headline for the story was, "von Hippel willing to meet with Reagan." *[Laughs.]*

Sakharov Returns to Moscow

***TK*:** And the second meeting with Gorbachev?

***FvH*:** The second time Velikhov asked me to speak to Gorbachev on behalf of an international gathering of scientists was a half year later, in February 1987.

A year earlier, in January 1986, Gorbachev had sent President Reagan a letter containing a step-by-step plan to eliminate nuclear weapons by the year 2000.[5] Velikhov decided to convene an international scientists' forum to discuss that proposal. His idea then morphed into eight simultaneous forums. In addition to a scientists' forum, there would be a medical

[5]Nuclear Security Archive, "Gorbachev's Nuclear Initiative of January 1986 and the Road to Reykjavik," https://nsarchive.gwu.edu/briefing-book/nuclear-vault-russia-programs/2016-10-12/gorbachevs-nuclear-initiative-january-1986.

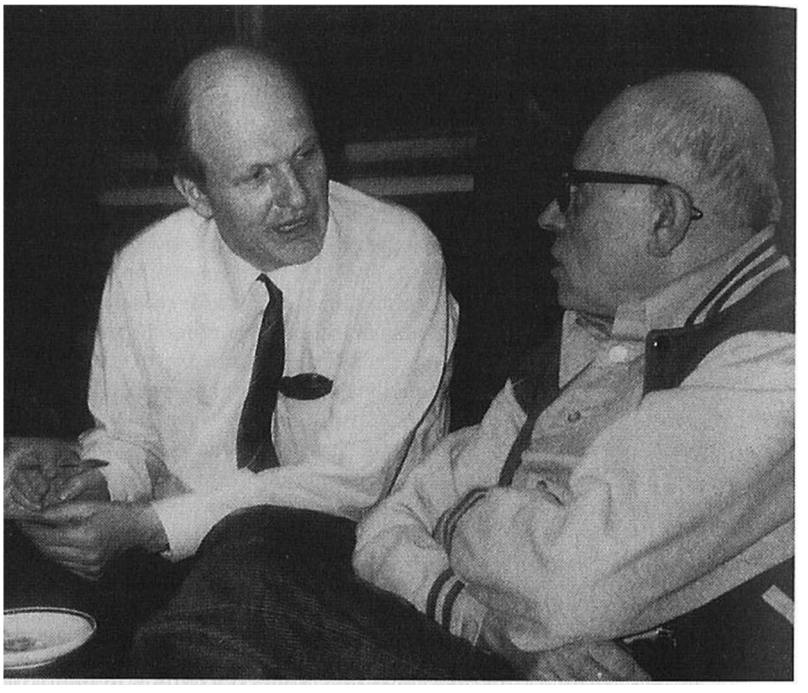

Figure 4. First meeting with Andrei Sakharov at his apartment, 11 February 1987 (photo by Jeremy Stone).

doctors' forum, a businessmens' forum, a forum that included writers and actors, a political scientists' forum and others I have forgotten. I helped Velikhov organize the scientists' forum.

Aeroflot sent an airplane for the Americans. The famous movie actor, Gregory Peck, was on board as was John Lennon's widow, Yoko Ono, Dan Ellsberg, my wife Pat, me, and many others.

For me, the most significant presentations at the scientists' meeting were by Andrei Sakharov[6] and by a panel of West European advocates of nonoffensive defense.[7]

The Politburo had been persuaded to allow Sakharov to return from exile in Gorky in time for the scientists' meeting. Sakharov therefore was able to speak publicly on nuclear arms control for first time since 1979. Jeremy Stone and I and our wives met with Sakharov and his wife, Yelena Bonner, in their apartment the night before to discuss what he would say (Von Hippel 2017), (Figure 4).

After the collapse of the Soviet Union, Gorbachev's files were thrown open to scholars. As a result, I received a transcript of Jeremy's and my meeting with Sakharov from Matthew Evangelista, a historian at Cornell.[8] Pavel Podvig, a colleague in our Program, translated it for me.

[6]Sakharov, a physicist who made critical contributions to the development of the Soviet Union's thermonuclear weapons, became a human rights and democracy activist after the 1968 Soviet suppression of a democratization movement in Czechoslovakia. In 1978, he received the Nobel Peace Prize for being "the spokesman for the conscience of mankind." In 1979, he was exiled to Gorky (now Nizhny Novgorod), a city closed to foreigners, for his denunciation of the Soviet invasion of Afghanistan.

[7]Jeremy Stone gave his own contemporary account of his and our meetings in Moscow in Stone (1987).

[8]There is a copy of the transcript in Stanford's Hoover Library, TsKhSD, Fond 89, Opis 18, document 114.

The transcript was made by the KGB, the Soviet intelligence agency, which had Sakharov's apartment wired with hearing devices. There was a cover letter to Gorbachev from Viktor Chebrikov, the head of the KGB, saying,

> "I am sending you the transcript of parts of a conversation of Academician Sakharov A. D. with American scientists Jeremy Stone and Frank von Hippel, obtained through our operations."

Some passages were underlined, presumably by Gorbachev. They were mostly factual statements about the balance of forces. Perhaps Gorbachev was using the transcript in part to educate himself on the basic facts and obtain ammunition for the Politburo's internal debate over nuclear arms control.

In the most important part of our discussion, Sakharov asked what we thought about the Reagan Administration's Strategic Defense Initiative (SDI). A few months earlier, the Gorbachev-Reagan summit on nuclear disarmament in Reykjavik, Iceland had failed over Reagan's refusal to limit the US ballistic missile defense (BMD) program.

Stone told Sakharov that, in his view, the Soviets should ignore SDI and seize the opportunity for deep bilateral nuclear reductions. Sakharov said that was, in fact, the position that he was planning to put forward at the Scientists' Forum three days later. They also agreed that, if the US did in the future deploy a hugely costly ballistic missile defense (BMD) system, the Soviet Union could build up offensive systems to overcome the defenses at a much lower cost. Sakharov came back at the issue several times because he wanted to be prepared for debate with defenders of the then-Soviet position of linking deep cuts to restraints on the US BMD program.

In my part of the discussion with Sakharov, I talked about an article that I had recently co-authored with Hal Feiveson and Richard Ullman in which we proposed deep cuts to about 2,000 deployed warheads on each side (Feiveson, Ullman, and von Hippel 1985). That would correspond approximately to ten-fold cuts. Included in our proposal were reductions to one warhead each on land-based intercontinental ballistic missiles (ICBMs) and the elimination of "tactical," i.e. short-range weapons systems.

Sakharov began to ask technical questions such as how the US had estimated the yields of Soviet nuclear warheads.[9] He then began to discuss the complexities of determining analytically how much would be enough to deter the other country if you took into account counterforce attacks, ballistic missile defense, the psychologies of the leaderships, malfunctions of some of the missiles, the vulnerability of command and control, etc. He concluded that

> "this kind of analysis would require a large organization with thousands of staff, with computers, etc. It's just impossible to do it on the back of an envelope."

In fact, the US and Russia have by now reduced to approximately the levels that we advocated in 1985 plus about 2,000 stored warheads on each side. The US also has reduced the number of warheads on its ICBMs to one each, although Russia has not.

In his public speech at the Scientists' Forum three days later, Sakharov urged the Soviet leadership to forget about Star Wars. He predicted it would collapse due to

[9] I said from the seismic signals from Soviet underground tests and from deducing the weight of Soviet warheads from flight tests. Sakharov commented that underground tests can be done at partial yield.

infeasibility and cost. (It did.) If Reagan was willing to agree to a bilateral reduction of offensive strategic weapons, then the Soviet Union should agree.

Others had been providing the same advice in private and, a few months later, in December 1987, Gorbachev signed the Intermediate Nuclear Forces Treaty with Reagan in Washington and, in July 1991, Gorbachev and President G.W. Bush signed the START Treaty reducing strategic warheads by about half.

These two treaties fulfilled the first of the three steps to nuclear disarmament proposed in Gorbachev's January 1986 letter to Reagan. Later, in fall of 1991, a few months before the collapse of the Soviet Union, Gorbachev and President Bush eliminated most Soviet and US tactical nuclear weapons.

Nonoffensive Defense

The other significant presentations at the Scientists' Forum were by three leading West European advocates of "nonoffensive defense:" Anders Boserup from Denmark; Robert Neild from Cambridge University, UK; and Albrecht von Mueller from Germany.

They had been trying to devise a way to deal with the confrontation of offensive tank forces along the interGerman border. They argued for a shift to weapons that can stop tanks but cannot be used to invade the other side. I invited them to present their arguments at the forum.

Two days after the scientists' forum, the participants of all the forums assembled in the Kremlin's great meeting hall where their conclusions were presented to Gorbachev. Once again, Velikov asked me to present for the scientists.

Bernard Lown, the American co-president of the Nobel-Peace-Prize-winning International Physicians for the Prevention of Nuclear War, spoke for the doctors and Graham Greene for the creative artists.

Speaking for the scientists, I talked about the futility of ballistic missile defense and the possibility of 90-percent cuts in the Soviet and US nuclear stockpiles, and proposed the elimination of multiple-warhead ballistic missiles and battlefield nuclear weapons. I also talked about the importance of the ideas of the nonoffensive-defense advocates (Von Hippel 1987). Kokoshin and I had shared a car to the Kremlin meeting. He urged me to include more about nonoffensive defense, and we drafted a couple of sentences together.

Eight months later, in October 1987, I joined the three West European advocates of non-offensive defense in writing a letter to Gorbachev urging a specific simple approach:

> "from the Atlantic to the Urals, reduce the numbers of strike aircraft, tanks, armed helicopters and long-range artillery on each side to equal levels well below the current levels of the lower side; and ban ballistic missiles in Europe with ranges greater than approximately 50 km. Although the reductions required to reach equality will be unequal, tbe security of both sides will be increased."

A month later, Gorbachev responded, "[t]his is very close to our understanding of the problem."[10]

There were a number of Soviet analysts already advocating nonoffensive defense. Andrei Kokoshin was one.

[10]"Analysts address Gorbachev" and "Gorbachev's Reply," *F.A.S. Public Interest Report*, February 1988, pp. 14, 15, https://fas.org/faspir/archive/1982-1989/February1988.pdf.

In December 1988, Gorbachev broke the impasse by announcing unilateral cuts of 5,000 Soviet tanks and other equipment in Eastern Europe. This laid the basis for much deeper Soviet cuts in the 1990 Treaty on Conventional Forces in Europe (CFE). The CFE was structured almost exactly along the lines our letter to Gorbachev had proposed.

***TK*:** So, Kokoshin asked you to write the letter, and also include some ideas in your letter to the Gorbachev?

***FvH*:** Kokoshin was not at the meeting where we drafted the letter but he may have planted the seed. Writing a letter to Gorbachev was not an idea that would have occurred naturally to me but it may have occurred to one of my West European colleagues. Unfortunately, I don't remember who suggested the letter.

***TK*:** So, what happened between the February 1987 meeting and the October letter?

***FvH*:** Three things for me.

The first was that, after the February 1987 conference, Boserup, Nield, von Mueller and I visited Lev Mendelevich, Director of the Foreign Ministry's Evaluations and Planning Directorate and a former Soviet ambassador to Denmark. Mendelevich was an advocate of nonoffensive defense.

Then, in May 1987, I went to Moscow again for a workshop on conventional arms control in a group organized by Randall Forsberg, the intellectual leader of the US Nuclear Weapons Freeze movement. There had been discussions between NATO and the Warsaw Pact on Mutual and Balanced Force Reductions for more than a decade, since 1973. But the talks had not made much progress. We suggested that, to break the impasse in the negotiations over conventional forces in Europe, the Soviets could unilaterally withdraw one thousand tanks.

Then, in September 1987, I went to another Pugwash meeting, this time in Gmunden, Austria, where I met again with Boserup, Nield and von Mueller in a working group on conventional arms control. That is where we drafted our letter.

***TK*:** Tell me a little bit more about Dr. Kokoshin.

***FvH*:** He is a decade younger than Velikhov. He was trained as an engineer but became a specialist in military history and policy. His father and grandfather were career military. I think his father was in military intelligence (the GRU). He was the only one in the Velikhov group I was initially wary of. I suspected that he was providing reports to the intelligence people on what Velikhov was doing.

But then, as he told me, he became convinced that Velikhov was a great man. He was especially impressed by Velikhov's willingness to take political risks and get out ahead of Gorbachev, as he did with the test-site monitoring.

At the time, Kokoshin was the deputy director of the Institute for US and Canadian Studies. That institute had been founded in 1967 by Georgy Arbatov to advise the Kremlin's leadership on how to deal with the United States. Kokoshin really cared about non-offensive defense and tried to promote it to the military. Later on, under Yeltsin, he became Deputy Minister of Defense.

***TK*:** So, who wrote the draft letter? You?

***FvH*:** Certainly not the first draft, because I was not an expert on this subject. I might have edited a later draft.

The other three, Boserup, Nield and von Mueller had been thinking about these things for a long time. Their diagnosis of the problem was correct. As our letter said,

> "Current fears of war in Europe are due primarily to the offense-capable structure of the military forces on both sides. These structures give forces the capability for surprise attack and a conquest. They feed the fears whlch are used to justify very high Ievels of military spending and a continued technological arms race after more than 40 years of peace in Europe. These same fears are also used to justify reliance on nuclear weapons as a deterrent to nonnuclear aggression."

The letter acknowledged that we were proposing unequal reductions because the Warsaw Pact had so much more offensive hardware in Europe than NATO. This would have made the proposal unacceptable to any leader other than Gorbachev. He accepted equal levels between NATO and the Warsaw Pact, which became unequal when most of the East European nations plus the Baltic States of the Soviet Union split away from the Warsaw Pact and joined NATO.

In addition, the NATO forces had technological superiority because of their precision-guided munitions. This resulted in Russia feeling very insecure after the disintegration of the Warsaw Pact and Soviet Union. In 1993, Russia renounced the Soviet Union's no-first -use policy for nuclear weapons.[11]

***TK*:** So then, one month later, you had a letter back from Gorbachev. Was it expected or unexpected?

***FvH*:** I did not expect a response.

***TK*:** How did you get it?

***FvH*:** My copy came to the FAS because I gave it as my affiliation.

***TK*:** And what was your impression when you received and read this letter?

***FvH*:** I was happy but did not think it was necessarily a big deal. I thought that most likely somebody wrote it for Gorbachev.

***TK*:** But Gorbachev was personally committed to communicating. He enjoyed his exchanges with liberal scientists and NGOs in the West.

***FvH*:** Yes, public diplomacy was a very important part of the strategy of the group around Gorbachev. They saw the peace movements in West Europe and the United States as allies in their effort to end the Cold War.

***TK*:** But, for the West Europeans, the INF issue was big and also the superiority of Soviet conventional power in Europe – the tanks, especially. So this initiative was really important.

***FvH*:** Yes, after World War II, the US drastically reduced the size of its army but the Soviet Union much less. That became the justification for the US deploying more than

[11]See Schmemann (1993). The Soviet no-first-use policy had been dismissed as propaganda by the US.

5,000 nuclear weapons in Western Europe from the early 1960s into the mid-1980s, including nuclear shells for the artillery.

In March 1988, Hal Feiveson and I took a group of Princeton undergraduate students to Europe to study the conventional arms control problem. We went by train from Brussels (NATO headquarters) to Berlin (at that time isolated deep within East Germany) and then to Warsaw. On the way, we visited a US nuclear artillery unit at the famous Fulda Gap on the East-West German border where, if war broke out, the Soviet tank armies were expected to pour through and, in the absence of a US nuclear response, to overrun West Europe. A war in Europe therefore would have very quickly gone nuclear.

Late in the Cold War, however, I don't think that the Soviet quantitative advantage was as important anymore. It was probably more than offset by NATO's precision-guided anti-tank munitions. The Warsaw Pact's numerical advantage in conventional weapons was becoming more of a talking point than a real threat.

***TK*:** In any case, Gorbachev's decision to reduce the Soviet tank forces was a big step in ending the Cold War.

***FvH*:** It really was. The Russians may not honor him because his economic reforms were insufficient and he allowed Russia's empire to disintegrate. But, to those of us concerned about the dangers from nuclear weapons, he is a hero.

The International Foundation

***TK*:** Okay, what about your third meeting with Gorbachev?

***FvH*:** It was immediately after the big February 1987 meeting on nuclear disarmament. It was in a meeting with Gorbachev of the Board of Velikhov's newly created International Foundation for the Survival and Development of Humanity.

Velikov had been impressed at how fast the NRDC had been able to raise money for its seismic-monitoring project from US foundations. So he proposed that we create our own foundation, to be funded by US foundations and headquartered in Moscow.

Velikhov invited Sakharov to be on the board, which gave me an opportunity to get to know Sakharov better. Sakharov insisted on the International Foundation's long name; there should be no doubt about its purpose. The active American members of the board were Jerome Wiesner, former President of MIT and science advisor to President Kennedy who was co-chair with Velikhov; Robert MacNamara, former Secretary of Defense for Presidents Kennedy and Johnson; Susan Eisenhower, granddaughter of President Eisenhower (she later married Sagdeev); and me. Wiesner added the president of Fudan University in Shanghai China, Xie Xide, who had received her PhD in physics from MIT in 1951.

Velikhov decided to launch the foundation with a meeting with Gorbachev. We all sat around a big round table in Gorbachev's office and each of us had an opportunity to say something to him. I only remember two of the exchanges. In the first, Wiesner asked Gorbachev, "How many nuclear weapons would it take to deter you?" by which he meant deter from ordering a Soviet attack on the West. Gorbachev answered, "one."

The other exchange was with Sakharov.

I had sat next to Sakharov on the bus to the Kremlin and asked him to tell me how the message had come to him that he had permission to come back to Moscow. He said he and his wife, Elena Bonner, were not allowed a phone in their apartment in Gorky. One day, however, their KGB minders arrived with a phone and installed it. Not long thereafter it rang. Sakharov picked it up and it was Gorbachev calling to tell him that he could come back to Moscow.

Sakharov responded by telling Gorbachev that he had to release *all* political prisoners.

So, when it was Sakharov's turn, he said, "Mikhail Sergeyevich, to pick up the conversation where we left it off when you called me in Gorky, I have brought along a list of political prisoners I want you to free."

Gorbachev responded, "Andrei Dmitrievich, we can't go too fast. You know what happened with the Red Guards in China." But finally he signaled to someone to accept Sakharov's list. According to the last volume of Sakharov's memoir, "it may have expedited the release of several prisoners of conscience in 1988" (Sakharov 1992, 45).

***TK*:** Did you feel that Gorbachev and his team were serious about nuclear disarmament?

***FvH*:** Gorbachev's actions left no room for doubt. He agreed with Reagan to eliminate all intermediate-range nuclear missiles, and he later agreed with President George H.W. Bush to eliminate all land-based shorter-range nuclear weapons and to put into storage the nuclear weapons deployed on surface ships and air-defense missiles.

The International Foundation ended up being a disappointment, however; a couple of years later, the US members of the board, including Wiesner and me, pulled out. Velikhov had brought on as a deputy to the Swedish Executive Director, a Russian who the Director and we believed was corrupt. We became more and more uncomfortable with the way he was operating but Velikhov was unwilling to get rid of him. Finally, we saw no alternative to terminating our involvement.

Brainstorming in the Foreign Ministry

During that time and into the early Yeltsin period, I would brainstorm with Sergei Kortunov in the Foreign Ministry. The Soviet Foreign Ministry was and now the Russian Foreign Ministry is located in one of the seven massive, approximately 30- story-high "wedding cake" Moscow buildings commissioned by Stalin after World War II. Kortunov was what the group around Gorbachev called a "new thinker." I believe this was a reference to the statement in the 1955 (Bertrand) Russell-Einstein Manifesto,

> We have to learn to think in a new way. We have to learn to ask ourselves, not what steps can be taken to give military victory to whatever group we prefer, for there no longer are such steps; the question we have to ask ourselves is: what steps can be taken to prevent a military contest of which the issue must be disastrous to all parties? (Butcher 2005, Appendix A)

During the Reagan Administration, I brought Kortunov and others in the Foreign Ministry copies of the Reagan Defense Department's annual, *Soviet Military Power*. It included illustrations based on satellite images of Soviet nuclear-weapon and other installations. One of the Foreign Ministry people exclaimed, "The Ministry of Defense doesn't let us have this kind of information!"

Fusion physics and physics Internationalism

***TK*:** Why do you think Velikhov and Gorbachev wanted to invite foreign scientists in for these meetings?

***FvH*:** Before my time, there were Pugwash meetings in which senior scientists from both the US and Soviet Union discussed possible initiatives to reduce the danger of nuclear war (Evangelista 1999). The Pugwash Conferences on Science and World Affairs were founded in 1957 at a meeting in Pugwash Village, Nova Scotia in response to the Russell-Einstein Manifesto. Two of the Soviet participants in Pugwash were senior Soviet physicists, Lev Artsimovich and Mikhail Millionshchikov. Artsimovich was the head of Soviet fusion program and a senior official in the Soviet Academy of Sciences. Millionshchikov was deputy director of the Kurchatov Institute of Atomic Energy. Both became important advocates for the 1972 Soviet-US Antiballistic Missile Treaty (ABM treaty) which limited the two countries' ballistic missile defenses. Velikhov was heir to their positions and to their interest in nuclear arms control.

The internationalism of the physicists went back to the prewar physics community, in which Niels Bohr was the leading figure. That community recognized no national boundaries for brainstorming with colleagues. With the Cold War, the connection with the Soviet physicists was broken. After Stalin's death and President Eisenhower's Atoms for Peace speech at the UN (both in 1953), however, internationalism was restored in fusion-energy research. Perhaps this was because fusion as a practical source of energy was seen as still too far in the future for it to be an object of international competition. Long before I met him, Velikov had been a frequent visitor to Princeton's Plasma Physics Laboratory, the largest fusion-research laboratory in the US. Indeed, the first time I met him in November 1983 in Moscow, he was wearing a Princeton tie!

Roald Sagdeev, Velikhov's deputy and successor as chairman of the Committee of Soviet Scientists, started as a fusion theorist. He too was very comfortable with Americans and spoke excellent English.

Therefore, even though fusion has not produced commercial energy, the money spent on it has not been wasted. Soviet fusion physicists helped end the Cold War.

***TK*:** During the years and the chances to meet Gorbachev, did you feel a change of atmosphere, strategic or military?

***FvH*:** Very much so! We started with the Reagan administration launching a nuclear buildup with the goal of forcing the Soviet Union into an economic collapse if it tried to keep up. The response was the Nuclear Weapons Freeze in the United States and the anti-Euromissile movement in Western Europe. Reagan was affected by that. He dropped the proposed nuclear buildup and decided to focus instead on ballistic missile defense (BMD). The Soviets thought BMD too could result in a first-strike advantage, but I don't think that was the way Reagan thought about it.

And then Reagan finally came to nuclear disarmament.

Only a few people in the Reagan Administration, including Secretary of State George Schultz and INF Treaty negotiator Paul Nitze, followed Reagan in these transitions. For

example, when Gorbachev said "yes" to the Reagan Administration's proposal of zero intermediate-range land-based missiles, the nuclear policy makers in the Reagan Administration were furious. They had never expected the Soviets to accept zero. They wanted to deploy nuclear-armed cruise missiles and intermediate-range ballistic missiles in Western Europe. I recall debating John Deutch[12] about the INF Treaty at an annual meeting of the American Association for the Advancement of Science. Although he was not in the Reagan Administration, he did not like the INF Treaty. His opening sentence was, "The problem is, how do we cover those targets now?"

***TK*:** But personally, did you hear something new, something different?

***FvH*:** There is a small book, *Getting to Yes*, by Harvard Law School professor, Roger Fisher (Fisher 1991). He said you should think about a negotiation as if you and the person you are negotiating with are on one side of a table and the problem you are trying to solve is on the other side. You are trying to solve a problem together. After the first day of meetings of the 1983 FAS trip to the Soviet Union, when we were worried about being used for propaganda, I became convinced that Velikhov and we were on the same side of the table, working together to reduce the danger from nuclear weapons.

Velikov had the sense that you have to have dramatic events to get people to pay attention to policy opportunities. He was much more sophisticated about that than I was. I tend to have the weakness of most academics that, after you publish an article, you think you have done your job. Cochran was a much better match for Velikhov in that regard, as they showed in their partnership on the nuclear test site monitoring project and the later "glasnost" ("openness") tours (see below).

I don't know where Velikhov got his instinct for public relations. But I imagine he saw Gorbachev's problems in persuading the Politburo and the military to go along with him, and wanted to reinforce Gorbachev with favorable publicity.

***TK*:** They were fighting against military people.

***FvH*:** Gorbachev did have some supporters in the military, notably, Chief of the General Staff Marshal Sergey Akhromeyev. Eventually, however, they parted ways and Akhromeyev supported the August 1991 coup by the military and intelligence forces against Gorbachev. Akhromeyev committed suicide after the coup failed. As the coup showed, there was considerable opposition to the direction that Gorbachev was taking the Soviet Union. In fact, his initiatives did unintentionally accelerate the disintegration of the Soviet empire and then the Soviet Union itself.

Science & Global Security

***TK*:** In 1989, Feiveson and you, in collaboration with Sagdeev, started the journal, *Science & Global Security*.[13] This was before the end of the Cold War.

[12]MIT Professor of Physical Chemistry and, in the Clinton Administration, Deputy Secretary of Defense (1994–5) and Director of the CIA (1995–6).
[13]https://www.tandfonline.com/loi/gsgs20.

***FvH*:** That story also has to do with how I met my wife, Patricia (Pat) Bardi von Hippel. She was working for a small publishing company, Gordon and Breach, Science Publishers, Inc., that had launched a program of translating Soviet scientific books, and commissioning review articles of the Soviet literature in scientific fields of interest to Western scientists. The president, Martin Gordon, and Pat first went to Moscow in 1980, three years before my first trip. Roald Sagdeev was recommended to them. Sagdeev introduced them to other leading Soviet scientists, who became editors of the new review journals.

A few years later, Sagdeev suggested that Gordon and Breach publish a journal on arms control. He said, however, that US participation would give the journal more credibility in the West and suggested specifically contacting Sidney Drell, Wolfgang Panofsky and William Perry at Stanford.

Gordon and Pat went to Stanford and talked to all three. They supported the idea but said that Gordon and Breach should be talking to someone in the next generation and mentioned me.

I met Gordon and Pat the first time in September 1984 when a group of us from Princeton were at Kennedy Airport waiting to board a flight for my second trip to Moscow. We discussed the idea and then, in Moscow, we discussed it with Sagdeev. The arrangements were very complicated, however, and it took five years before the first issue of *Science & Global Security* was published in 1989.

In the meantime Pat and I were married in 1987. The Soviet scientists, because they had brought us together, urged us to marry in Moscow.

At the time, it was a delicate matter for Soviet scientists to publish anything on arms control. They had to deal with censorship. Also, they didn't want to be pressured to publish Soviet propaganda. They proposed that the US editors should have a veto on any article that they submitted. They did not want to have a veto for themselves, however. Their concerns diminished after Gorbachev came into power and his policy of "glasnost" ("openness") began to take hold.

Hal Feiveson, became the editor of *Science & Global Security* and continued for more than 20 years.

Sakharov died in December 1989 just as the first issue of *Science & Global Security* came out. As our tribute to him, we reprinted in the second issue an article Sakharov had published in 1958, when he was trying to persuade General Secretary Khrushchev that a scheduled series of huge Soviet nuclear tests in the atmosphere were not all necessary or could be carried out at reduced yield. Sakharov was concerned about the genetic damage to subsequent generations that would be caused by the enormous quantity of radioactive carbon-14 that the tests would produce by neutron absorption in atmospheric nitrogen. Carbon-14 has a halflife of 5600 years. In the West, people focused more on the shorter term radiation doses from fission products such as 30-year halflife strontium-90.

At the same time, in the US, Linus Pauling had been mounting a much more public campaign against atmospheric testing, including a petition that, by the beginning of 1958, had been signed by 9,000 scientists. In 1962, when President Kennedy invited all living US Nobel Prize winners to dinner at the White House, Pauling marched up and down in front of the White House with a protest sign, "Mr. Kennedy, Mr. MacMillan [the UK Prime Minister], we have no right to test." Then he went into the dinner.

On the Soviet side, it was Sakharov alone arguing against atmospheric testing and it was an inside debate, except for this one article in the Soviet journal, *Atomic Energy*. At the time, the article went without public notice in the West because Sakharov was not yet a public figure.

In his article, Sakharov estimated that 10,000 people would suffer cancers and other genetic disorders as a result of each 1 megaton of nuclear yield released in the atmosphere.

Khrushchev refused to reduce the number of high-yield tests, however, and, as Sakharov recounts in his memoirs, disparagingly rejected Sakharov's appeal. Khrushchev said he needed to demonstrate to the US in the most dramatic fashion the power of Soviet nuclear weapons. Three years later, in 1961, the Soviet Union carried out the largest nuclear test in history, with a yield of over 50 megatons. Following the scare of the 1962 Cuban Missile Crisis, however, the Soviet Union, US and UK agreed in the 1963 Partial Test Ban Treaty to limit nuclear testing to the underground.[14] France conducted its last atmospheric test in 1974 and China in 1980. Since then, all nuclear testing has been underground.

In an appendix to *Science & Global Security's* reprint of Sakharov's article, I published an update to Sakharov's thirty-year-old calculation and found that his number was not that far off from my update. On the one hand, he assumed a future human population of 30 billion whereas I assumed 10 billion. On the other hand, the cancer-causing effects of radiation had been found to be higher than Sakharov had assumed.

It was a great article, and we thought people should know about it (Sakharov 1990).

Science & Global Security has provided a place where technical analyses relevant to policy can be published. Over the past three decades, I have myself published more than 20 articles there on reactor safety, nonproliferation and arms-control issues.[15]

Space-reactor Arms Control

***TK*:** The very first issue of *Science & Global Security* (1989) has a set of articles on space-reactor arms control and the second issue (1990) has a set on the detection of nuclear warheads. Can you tell us the story behind these two sets of articles?

***FvH*:** They came out of two joint projects of the Federation of American Scientists and the Committee of Soviet Scientists (CSS).

With regard to the article on space-reactor arms control, while the US has to date put only one reactor into orbit, as of 1988, the Soviet Union had put into orbit 37 nuclear-powered radar ocean reconnaisance satellites (RORSATS) to track US Navy ships. They flew in a low orbit[16] and, after one to three months, when their propellant for offsetting the effects of the modest air resistance at that altitude was exhausted – the reactors were

[14]The UK had used the US nuclear test site since 1958.

[15]An archive of articles published in *Science & Global Security*, except for those published within the most recent year, is available on line at http://scienceandglobalsecurity.org/archive/. The most recent year of articles is behind the publisher's paywall.

[16]Because the low-power radar signal originates from the satellite and then is reflected back from the object of interest, the strength of the reflected signal declines as R^{-4} where R is the distance between the satellite and the object. Hence the incentive to fly at low orbital altitude.

boosted up to a higher orbit where the air resistance would not bring them down for hundreds of years.

In 1978, one of the reactors did not boost and crashed in a remote region of Canada, resulting in a big cleanup operation and bad press for the Soviet Union. The reactors were redesigned so that the fuel would burn up in the atmosphere if they reentered and, in 1983, a Soviet reactor did reenter and burned up over the South Atlantic.

In April 1988, Sagdeev came to us at the Federation of American Scientists (FAS) with the news that the Soviets were having trouble getting another reactor to boost into storage orbit, and the Soviet government was worried that they would have another nuclear incident. The world was still traumatized by the Chernobyl accident two years earlier.

Five months later, the beginning of reentry triggered an automatic backup system and the boost system finally did its job.

In the meantime, however, Sagdeev proposed a joint FAS study with the Committee of Soviet Scientists to establish rules for space reactors.

The result was six articles providing background on space reactors and alternative power sources for various missions and discussing various possible bans ranging from bans in low-earth orbit to total bans. No space reactors have been launched into space since 1988 but there is continuing governmental and commercial interest.

The second series of articles, on warhead detection, spawned the Black Sea Experiment (see below), which is famous in the nuclear-weapons community.

The Warhead Detection Project

***TK*:** Please tell us the arms-control context.

***FvH*:** During the spring of 1988, the US Senate Foreign Relations Committee held 26 days of ratification hearings on the Intermediate-range Nuclear Forces (INF) Treaty.[17] I happened to attend the second day of hearings and heard Senator Jesse Helms, the ranking Republican member and future chairman of the committee, complain that the warheads were not to be destroyed with the missiles. This did not make sense to him because "the warhead is the thing that goes 'boom,' and kills you."[18]

The response from the Reagan Administration's witness was, "there is no way to verify [the elimination of a warhead], other than to open up bomb design, and we are not going to let them see our bomb design."[19] I felt, however, that nuclear disarmament would require the verified elimination of warheads and that it ought to be possible to devise a way to do that without sharing the bomb designs.

On his side, Sagdeev was interested because of a mistake that Velikhov had made with regard to warhead detectability.

[17] *Hearings Before the Committee on Foreign Relations, United States Senate on the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Elimination of Their Intermediate-Range and Shorter-Range Missiles*, 25 January 2026, 27, 28; February 1, 2, 3, 4, 5, 16, 18, 19, 22, 23, 24; 3 March 2014, 16, 17, 22, 23, 24, 28, 29, 30; and 16 May 1988.
[18] *Hearings*, 26 January 1988, p. 120.
[19] *Hearings*, 26 January 1988, p. 123.

At the time, the Soviet Union wanted the Strategic Arms Reduction Treaty (START), which was being negotiated, to cover nuclear-armed sea-launched cruise missiles (SLCMs) as well as long-range ballistic missiles and bombers. The US argued that this would not be verifiable because it is impossible to tell the difference between nuclear-armed and conventional SLCMs.

Valeri Barsukov, director of the Soviet Academy's Institute of Geochemistry and Analytical Chemistry, came to Velikhov claiming that he had a way to detect warheads from kilometers away. As I recall, the idea was that the radiation from a warhead would result in a long-lived excitation of air molecules that could be detected downwind.

Unfortunately, Velikhov did not check the idea before he told Gorbachev, and Gorbachev immediately seized on it and announced that the Soviet scientists had come up with a solution to the problem of long-distance nuclear-warhead detection.

Sagdeev believed that Barsukov's idea was nonsense, and he proposed a joint FAS-CSS study to determine what could and could not be done with regard to warhead detection.

Sagdeev and I therefore agreed on a joint FAS-CSS study on warhead verification. Sagdeev did not get personally involved but he assigned two physicists on the staff of his Space Research Institute, Oleg Prilutsky and Stanislav Rodionov, to work with us. These were the same two physicists who later translated the journal, *Science & Global Security*, into Russian. The project resulted in articles in *Science & Global Security* in 1989 and 1990 that were also published in a book, *Reversing the Arms Race* (Von Hippel and Sagdeev 1990).

The Black Sea Experiment

***TK*:** Tell us about the famous "Black Sea Experiment".

***FvH*:** When Tom Cochran of the Natural Resources Defense Council (NRDC) learned about the joint FAS-CSS project on warhead verification, he proposed to Velikhov a joint demonstration of warhead detection. Velikhov went to Gorbachev and obtained permission for demonstration using a Soviet nuclear-armed sea-launched cruise missile on a cruiser that rendezvoused with the experimental teams in the Black Sea off Yalta (Cochran 2011) (Figure 5).

The "Black Sea Experiment" happened in the summer of 1989 as the last stop of a glasnost tour arranged by Velikhov. We stopped first at the closed plutonium-production city, Chelyabinsk-40 (now Ozersk); second at the Soviet ballistic-missile test site at Shary-Shagan, Kazakhstan; and last at Yalta. The NRDC brought along three members of the US House of Representatives.[20] Sergei Kortunov from the Foreign Ministry was there and told me when we arrived that the Soviet scientists had been rehearsing their experiments for some days.

[20] John M. Spratt, Jr. (D-South Carolina), Robert Carr (D-Michigan) and Jim Olin (D-Virginia). Spratt rose to be the chairman of the House Budget Committee and second-ranking member of the House Armed Services Committee. We became friends as a result of the days we spent together on this trip, and I met with him several times thereafter to discuss arms control but we never really accomplished anything together before he lost his seat to John Michael ("Mick") Mulvaney in the Republican sweep of 2010. This is the same Mulvaney who later became President Trump's chief of staff, Director of the Office of Management and Budget and acting head of the Consumer Protection, which was created by Elizabeth Warren and which the Republicans wanted to neuter.

Figure 5. Approaching the Soviet cruiser *Slava* (*Glory*) in the Black Sea off Yalta in the Crimea. Note its ranks of cruise-missile storage/launch tubes on the front deck (left). For the detection experiment, a nuclear-armed cruise missile was left in one of these tubes. This picture was taken as we approached the cruiser on a boat from our temporary residence on a hospital ship moored in the port. The head with the bald spot in the foreground is that of Representative John Spratt. (NRDC).

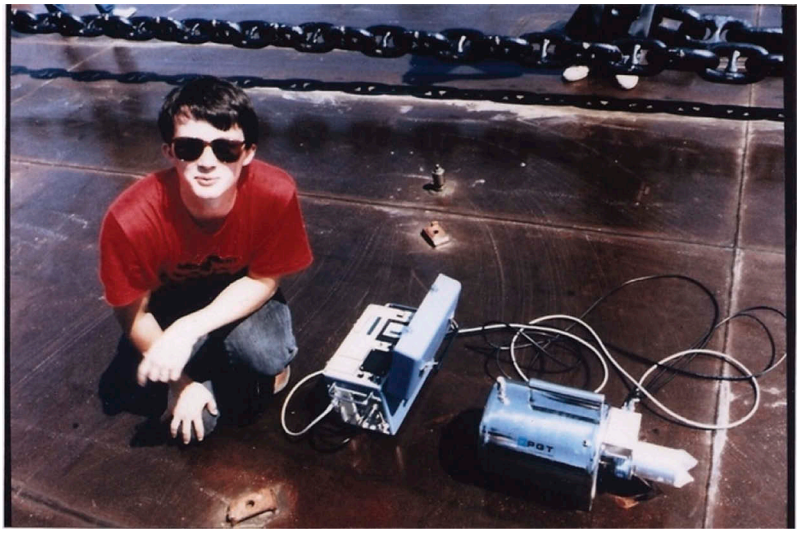

Figure 6. Steve Fetter, the technical lead on the FAS-NRDC team, with the NRDC gamma detector, a crystal of germanium that was kept cool with liquid nitrogen and attached by cable to a multichannel analyzer that plotted the spectrum of the energies deposited in the crystal (NRDC).

Figure 7. Soviet helicopter with a neutron detector attached to its side, flying past the *Slava*. The hatch of the launch tube containing the nuclear-armed cruise missile is on the right. (NRDC).

Two types of radiation emitted by warheads were detected in the Black Sea Experiment: 1) gamma rays emitted by the decays of different uranium and plutonium isotopes and by their decay products, and 2) neutrons emitted mostly by spontaneous fissions of the plutonium isotope, Pu-240. The NRDC group and a counterpart Soviet group detected the gamma rays with detectors positioned on the launch tube immediately above the warhead (Fetter et al. 1990) (Figure 6). The neutrons were detected by detectors on helicopters that flew by the *Slava* at distances of 30 and 70 meters (Belyaev et al. 2009) (Figure 7).

At one point, the Soviets had to show us that there really was a nuclear missile in the tube. So they opened the hatch on the front of the tube so we could see the pointed tip of the missile.

***TK*:** What became of Sergei Kortunov?

***FvH*:** He died young in about 2010. It was a total surprise; a ruptured aneurism I believe. His younger brother, Andrey, also enormously impressive, is currently president of the New Eurasia Foundation and general director of the Russian Council on International Affairs.

There were stories on our trip every day in the *New York Times* and the *Washington Post*, because they each had a reporter accompanying us for the whole trip.[21] The trip therefore had a big impact.

***TK*:** That was the beginning of the end of the Cold War.

[21] Bill Keller, Moscow bureau chief and later editor of the *New York Times,* and Jeffrey Smith of *The Washington Post*, now managing editor for national security at the Center for Public Integrity, a nonprofit, investigative newsroom in Washington, D.C.

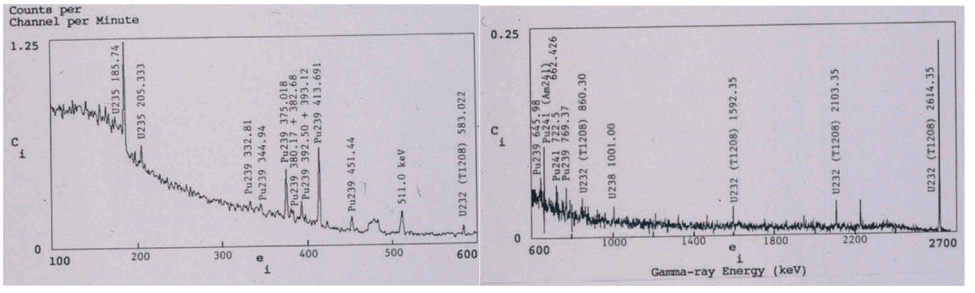

Figure 8. Gamma-ray energy spectrum obtained from the Soviet warhead. The large peaks include gamma rays from decays of the main chain-reacting isotopes in nuclear weapons, U-235 and Pu-239. Thallium-208 is a decay product of U-232, a reactor-produced uranium isotope with a half-life of 70 years. The presence of U-232 indicates that the uranium in the weapon was enriched after it was used to fuel a plutonium-production reactor (S&GS).

***FvH*:** Gorbachev was still in charge. However, the Black Sea Experiment was our last big nuclear "glasnost" event with Velikhov.

The experiment is quite famous in the nuclear-warhead community because it produced the only gamma spectrum of a nuclear warhead that has ever been published (Figure 8).

***TK*:** So the Black Sea experiments were successful.

***FvH*:** Yes and no. In order to measure the gamma rays, the NRDC group had to sit on top of the launch tube for tens of minutes. And the measurement of the gamma-ray spectrum was quite intrusive. What the Kurchatov Institute physicists did was potentially more practical. They showed they could detect the warhead from a helicopter flying by the ship at a distance of up to 70 meters. Later on, I met with the physicists at the Kurchatov Institute and they told me their detector had been flown over US nuclear-armed ships and that they could even estimate from the strength of the neutron signal approximately how many warheads the ships were carrying in their launchers. When I said, "Oh, the US Navy certainly would not let you fly so close!" they showed me pictures of US sailors waving at them.

***TK*:** Wow!

***FvH*:** Plutonium-240 puts out neutrons because it fissions spontaneously at a very slow rate. Neutrons are much more penetrating than gamma rays. Neutron detectors are therefore also a good way to detect someone trying to smuggle plutonium through a border or a nuclear warhead hidden in a city – if it contained plutonium, as virtually all modern warheads do.

***TK*:** So, the purpose of this experiment was to demonstrate that you could detect nuclear-armed cruise missiles on ships?

***FvH*:** The experiments supported the Soviet position in the START Treaty negotiations that you could verify whether a ship was carrying nuclear-armed cruise missiles – at least in launchers on the deck. But the Soviets did not get the US to agree to include nuclear-armed sea-launched cruise missiles in the START Treaty. They only got an agreement

that each side would limit its deployed nuclear-armed sea-launched cruise missiles to 880 or less and that there would an annual exchange of information on the actual number.

***TK*:** But sea-launched cruise missiles are theater, not strategic weapons.

***FvH*:** The Soviet Union considered U.S. nuclear-armed sea-launched cruise missiles to be strategic weapons. Reportedly, they had a range of 2500 kilometers. With that range, they could reach Moscow from ships located in the Baltic, the Black Sea, the northeast portion of the Mediterranean, and from the Atlantic off the coasts of Norway and the United Kingdom.

***TK*:** According to your background memo, Gorbachev approved the 1989 Black Sea experiment over the objections of Yulii Khariton, the Director of VNIIEF, the Soviet Union's first nuclear-weapon-design laboratory, the equivalent of the US Los Alamos National Laboratory. And you wrote that Khariton told you that story two years later in 1991, when you picked him up at the Kennedy Airport and drove him to New York City. Was he just sightseeing?

***FvH*:** I got a mysterious telegram from Khariton to the effect, "Please meet me at (New York City's) John F. Kennedy Airport where I will arrive on such-and-such an Aeroflot flight from Moscow. " I had never met him before but, of course, I knew who he was.

***TK*:** You didn't invite him?

***FvH*:** No. I was mystified by this message from the Soviet Union's most senior nuclear scientist who I had never met. I thought, "This must be important! What kind of message could he be carrying?" I drove from Princeton to the airport and met him in the baggage area.

After apologizing that his English was rusty because it had hardly been used since he had gotten his PhD in Rutherford's group in Cambridge sixty-four years earlier, Khariton explained, "I have an eye problem and there's a specialist in New York City who may be able to help me. But I was worried that a taxi driver might rob me." He continued, "I therefore asked Vitalii Goldanski [a senior physical chemist in Moscow whom we both knew] and he told me, 'You can trust Frank von Hippel'."

So, I was a certified trustworthy taxi driver. *[Laughs]*

As I drove him into New York City, I brought up the Black Sea Experiment, and he told me that he had protested against allowing the NRDC to measure the warhead's gamma-ray spectrum. He was afraid that the US weapons labs would be able to figure out the design.

In fact, he was right. Nuclear-weapon designers at the Lawrence Livermore National Laboratory calculated the gamma spectra from all the designs they could think of and found one that matched the NRDC spectrum pretty well. I doubt, however, that Soviet security suffered as a result.

***TK*:** Okay, then, you took him to the hospital?

***FvH*:** Like a good taxi driver, I just dropped him off. I can't remember whether it was at the hospital or his hotel. A week or two later, I met him again. A Russian émigré physicist

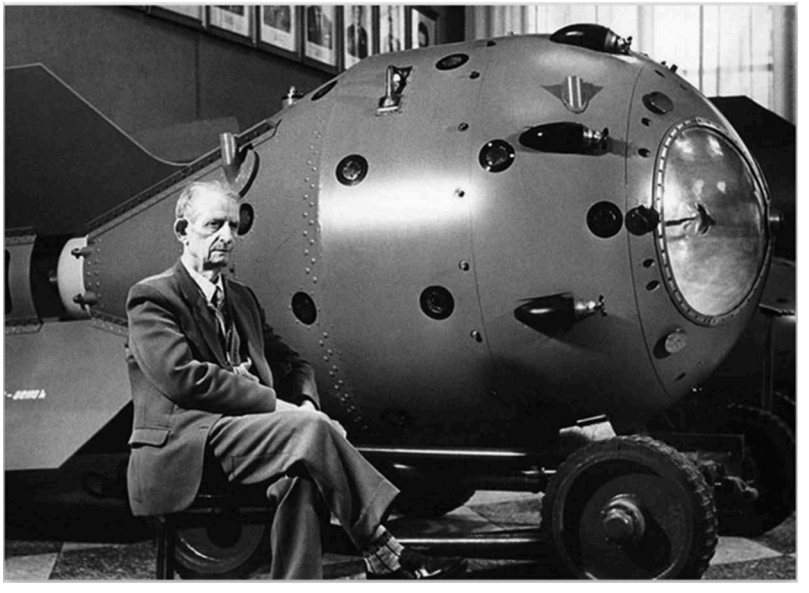

Figure 9. Yulii Khariton with a replica of the casing of the device used in the first Soviet nuclear test in 1949. It was a copy of the US Nagasaki bomb, a design that the Soviet physicists had obtained in detail from Soviet spies in the United States and that they knew worked. This was a significant consideration because they expected to be executed if the test did not succeed.[22]

on Princeton's faculty had a reception for Khariton and invited me. Khariton greeted me but we did not have another discussion. And I never learned whether the eye doctors in New York were able to help him or not.

***TK*:** I doubt many American scientists met both Sakharov and Khariton.

***FvH*:** Yes, it was amazing to meet this historic figure. Yulii Khariton was the Soviet counterpart of J. Robert Oppenheimer who directed the Los Alamos National Laboratory during World War II and died in Princeton in 1967 before I arrived. Khariton was the founding director of what is now the All-Russian Scientific Research Institute of Experimental Physics (VNIIEF) which designed the first Soviet nuclear bombs (Figure 9). Unlike Oppenheimer, who quit Los Alamos at the end of World War II, however, Khariton continued on as the director of VNIIEF for more than 40 years. Soviet institute directors – especially founding directors – were revered and often stayed in office until they died. He was about 85 years old at the time of the Black Sea Experiment in 1989. He retired in 1992 and died in 1996.

***TK*:** So, what was your impression of Dr. Khariton?

***FvH*:** He seemed a well-educated nice elderly gentleman. Apparently, that impression was not deceptive. Sakharov worked for Khariton while he was in VNIIEF. Sakharov did not say good things in his memoirs about many of the managers he had dealt with in the Soviet nuclear program but he did about Khariton.

[22] https://alchetron.com/Yulii-Borisovich-Khariton#-

Later, I went twice to visit Sarov, the town built around VNIIEF. The first time was in July 1998 at the invitation of the Russian Pugwash group. Robert McNamara came along on that trip and the Russian weapon scientists listened with great interest to his very forceful declarations on the unusability of nuclear weapons.

In September 2000, I visited Sarov again, this time with my wife, Pat. We were invited by the Analytical Center for Nonproliferation, which I had helped Ken Luongo's Russian-America Nuclear Security Advisory Council (RANSAC) establish with MacArthur Foundation funding. Luongo had founded RANSAC, an NGO, to promote the kind of cooperative security efforts he and I had promoted while we were working in the Clinton Administration (see Part 5).

Pat and I stayed at the laboratory's guesthouse. I believe we were the only guests on those nights. The security people had a man sitting all night at the end of the corridor watching our door to make sure that we didn't go out and spy. When I wanted to go jogging, his daytime counterpart made clear by his expressions that he did not relish the idea of jogging with me. So I decided to skip it. *[Laughter]*

After Putin took over from President Yeltsin at the end of 1999, such visits to the Soviet nuclear-weapon institutes virtually ended because of the concern among his intelligence people that the visitors were after nuclear secrets.

End of the Cold War

***TK*:** When the Cold War ended in 1989 with the fall of the Berlin wall, what were your feelings?

***FvH*:** When the Berlin wall came down in November 1989, I happened to be in Moscow at a meeting of the Board of the International Foundation. So I didn't see it on television as did everyone else in my generation outside the Soviet Union.

I also was in Moscow in January 1991 when Soviet troops put down an uprising in Lithuania with 14 deaths. That was the beginning of the Soviet Union coming apart. We had a meeting with Gorbachev. I have forgotten the details but my recollection is one of feeling distressed by the violence and sympathy for Gorbachev with his world falling apart around him.

Fortunately, that was the only violence during the disintegration of the Soviet empire. The military was very upset that Gorbachev let the Soviet empire slip away. And you know Putin's statement that the disintegration of the Soviet Union was "the greatest geopolitical tragedy of the 20th century." For me, one of the greatest geopolitical tragedies of the 21st century is that Putin took away the freedom Gorbachev had given the Russian people.

***TK*:** Did the fall of Berlin Wall affect your view of Gorbachev?

***FvH*:** I think he is a great man to have managed both a peaceful end to the Cold War and the freeing of the captive peoples of Eastern Europe and the Soviet Union.

***TK*:** In December 1988, at the UN, he announced the unilateral withdrawal of 5,000 tanks and other weapons from Europe and that the remaining Soviet forces there would be reorganized to "become unambiguously defensive."

***FvH*:** That speech is truly remarkable.[23] He also gave a progress report on democratization in the Soviet Union and declared "freedom of choice" as a "right of peoples." In retrospect, I think that this statement prefigured his decision not to deny that freedom to the subject nations of eastern Europe and ultimately the non-Russian republics of the Soviet Union.

***TK*:** So, step by step, Gorbachev tried to change that situation.

***FvH*:** I don't think he saw clearly where things were headed but, when he was confronted by the crisis, he did the right thing.

***TK*:** Was there any communication with your Soviet colleagues about the falling of the Berlin Wall and the collapse of the Soviet Union?

***FvH*:** I don't recall any. At that point, I was just an outside observer of these extraordinary events.

Proposal for Deeper Cuts and De-alerting

***TK*:** In your prepared chronology, you say that you and your Princeton colleagues argued for much deeper US-Russian cuts than were achieved by the INF and START Treaties and by the deep cuts in the so-called "tactical" nuclear weapons by Presidents Bush and Gorbachev.

***FvH*:** For the readers' information, in late September and early October 1991, after the August coup attempt against Gorbachev that Yeltsin thwarted, and before the disintegration of the Soviet Union in December 1991, Presidents G.W.H. Bush and Gorbachev undertook very dramatic "unilateral, reciprocal initiatives" to reduce the danger of "loose nukes" in the soon-to-be former Soviet Union. With all the nuclear-armed Army and Navy units around the Soviet Union, we could have ended up with many more nuclear-armed successor republics.

After the collapse of the Soviet Union, there were four nuclear-armed former Soviet Republics: Belarus, Kazakhstan, Russia and Ukraine. Those were the four republics within which Soviet strategic missiles and bombers had been deployed. One of the main tasks of the Clinton Administration was to work with the Yeltsin Administration in Russia to persuade Belarus, Kazakhstan and Ukraine to turn their nuclear weapons over to Russia in exchange for compensation and security guarantees. The agreements by those three countries to surrender their nuclear weapons became part of the START Treaty.

But it also was during the Clinton Administration that the US Nuclear Weapons Freeze movement demobilized and the US nuclear-weapons establishment was able to regain control over the agenda.

For example, in the Clinton Administration's 1994 Nuclear Posture Review, it was decided as a "hedge" to keep extra nuclear-missile and bomber carrying capacity so that, if Russia should revert to hostility, the US would be able to quickly increase the number of its deployed strategic warheads to twice the agreed START level. Russia

[23] Address by Mikhail Gorbachev at the UN General Assembly Session 7 December 1988 (Excerpts) https://digitalarchive.wilsoncenter.org/document/%20116224%20.pdf.

did not have such a hedge because, at the time, it could not even afford to maintain enough missiles to accommodate the warheads allowed by START.

So the US "upload hedge" induced paranoia in Russia's nuclear-weapon establishment that, was further inflamed in 2002 when President George W. Bush took the US out of the ABM Treaty.

NATO's expansion during the Clinton, G.W. Bush and Obama Administrations to absorb Russia's former satellite countries in Eastern Europe and even the former Soviet Baltic states of Estonia, Latvia and Lithuania was even more paranoia inducing. Today, the struggle between Putin's Russia and the NATO countries is over the futures of the former Soviet Republics of Ukraine and Georgia.

The upload hedge may have reflected the political reality in US nuclear-weapons policy. When you have a Democrat administration proposing a nuclear arms control agreement for Senate ratification, Senate Republicans get very suspicious that they are being asked to approve dangerous reductions. The hedge was one way to reassure them.

The Clinton Administration also agreed that it would be a good idea to negotiate a Fissile Material Cutoff Treaty (FMCT). But neither the Clinton Administration nor the Obama Administration were able to get negotiations going. (The George W. Bush Administration's no-verification proposal for the FMCT is discussed in Part 6.)

***TK*:** You were disappointed that more was not accomplished during the Clinton Administration?

***FvH*:** Yes, the momentum toward nuclear disarmament was lost. We were euphoric about the end of the Cold War. The anti-nuclear-weapons movement therefore demobilized.

I confess that I shared the euphoria over the end of the Cold War. At one point, I thought, "What will I do after we have gotten rid of nuclear weapons?" *[Laughter]* But, although it has been downsized, we are still stuck with the nuclear-weapons problem.

In 1999, concerned that the reductions process had slowed almost to a halt, a group of us wrote the book, *The Nuclear Turning Point* (Feiveson 1999). We proposed further cuts that would have reduced the US, Russian, Chinese and West European nuclear arsenals to about 200 warheads each – another factor of ten reduction.

Bruce Blair, then with the Brookings Institution in Washington, DC, was one of the authors. His overriding concern for thirty years has been about the danger of accidental nuclear war.[24] So we included proposals for taking US and Russian nuclear missiles off launch-on-warning alert. In 2013, Blair joined our Program on Science and Global Security in Princeton.

***TK*:** When did you first meet Blair?

***FvH*:** I became aware of him in the late 1980s and I have been strongly influenced by the depth of his understanding and concern about the danger of accidental nuclear war.

[24]Bruce Blair started his career as an launch-control officer for the US Minuteman intercontinental ballistic missiles and as support officer for their airborne command posts. He has written three deep books about the dangers of accidental nuclear war – all published by the Brookings Institution: *Strategic Command and Control* (1985); *The Logic of Accidental Nuclear War* (1993); and *Global Zero Alert for Nuclear Forces* (1995). In 2008, he co-founded the international NGO, Global Zero.

While the Soviet Union and United States nuclear weapon establishments were worrying that the other might detect a vulnerability and launch a first strike, Blair was worrying that the resulting launch-on-warning postures of both sides' intercontinental ballistic missiles was a recipe for accidental nuclear war.

In 1997, Feiveson and I joined Blair in writing a *Scientific American* article, "Taking Nuclear Weapons off Hair-Trigger Alert" (Blair, Feiveson and von Hippel 1997). It drew significant attention and the three of us were invited by General Habiger, then the Commander in Chief of the US Strategic Command, for a couple of days of discussion at his headquarters in Omaha, Nebraska.

General Habiger tried to convince us that there was no danger of accidental nuclear war. I think his confidence was in good part because he was in charge. Later, after he retired, he became more concerned and, for a time, joined former Senator Nunn's NGO, the Nuclear Threat Inititiative. Senator Nunn's thinking about the danger of accidental nuclear war also was heavily influenced by his discussions with Bruce Blair.

***TK*:** But, in *The Nuclear Turning Point*, you suggest decreasing the number of nuclear warheads to hundreds, not to zero.

***FvH*:** That's right. Physicists talk about two-body problems and multi-body problems. Two-body problems, like the nuclear confrontation between the US and Russia, are much simpler to solve than a many-body problem involving eight or (today) nine nuclear-armed states.

So we thought that, when the US and Russia get down to the levels where the nuclear arsenals possessed by other countries can no longer be ignored, nuclear reductions will become much more complicated. We thought at first that we should go down to 1,000 and call on other countries to get involved, but then we decided to propose that the US and Russia go all the way down to the same level as the others, so that the other countries would have no excuse not to become involved.

We proposed that the US, Russia, Europe (i.e. the combined nuclear forces of France and the UK) and China all to reduce or limit themselves to 200 warheads each with the warheads de-mated from their missiles and bombers. Our ultimate goal was zero but 200 warheads each – still a capacity to destroy civilization – was as far as we felt we could see confidently at the time. We did not devote much energy to thinking about how to engage India, Israel and Pakistan in the process. That shows how complicated the many-body problem already is at this level.

***TK*:** Going back to the senior Bush Administration, President Bush did an important thing by eliminating so many tactical nuclear weapons, but the size of the reduction of long-range strategic weapons in the START Treaty was modest.

***FvH*:** Yes, approximately 50 percent, from about 10,000 to about 5,000 strategic warheads each. It was basically what Gorbachev had proposed as a first step.

***TK*:** But, after the end of the Cold War, they could have gone further.

***FvH*:** Yes, and, in fact, there were further reductions in G.W. Bush's SORT Treaty[25] and Obama's New START Treaty.[26] New START reduced both sides to 1550 counted, deployed strategic warheads each – about 1800 if you count the actual number of bombs and cruise missiles deployed with the long-range bombers instead of counting them as carrying one warhead each. New START does not cover reserve strategic nuclear warheads or tactical nuclear weapons. Including them would double the totals to about 4,000 operational warheads each for Russia and the US plus perhaps two thousand more warheads still in each of their dismantlement queues. The other nine weapon states combined have about 1,000.

***TK*:** And, in the book, you wanted 200 each.

***FvH*:** Yes, we have come a long way down to a global total of about ten thousand nuclear warheads today today from about sixty thousand nuclear warheads at the end of the Cold War. But those ten thousand remaining nuclear warheads are still sufficient to destroy civilization one hundred times over. We still have a long way to go before we are free of this legacy of our Cold War madness.

The HEU Deal

***TK*:** The last question in this Part is about Tom Neff's proposal of the HEU Deal with Russia. Can you tell me about that?

***FvH*:** Tom Neff's initiative is probably the most consequential nuclear initiative you can credit to a single individual. Way back, Neff was one of the Stanford physics graduate students who took a class with me during my three years at Stanford – along with John Holdren and Ernie Moniz, President Obama's future science advisor and Secretary of Energy and at least two others.[27] I don't take credit for any of their subsequent careers. But it is remarkable that so many of us got involved in policy. My theory is that it was because of the concerns the Vietnam War protests at Stanford raised in our minds about US policymaking at the time. We thought we could not do worse.

After getting his PhD in 1972, Neff joined the theoretical physics group at MIT but left in 1974 to help staff the Ford Foundation's study on Nuclear Power Issues and Choices that helped confirm President Carter's belief that the US plutonium program was unnecessary as well as dangerously proliferative. Neff then went to work on nonproliferation in the Carter Administration's State Department.

Returning to MIT after the Carter Administration, Neff headed MIT's International Energy Studies Program and, among other things, became an expert on the uranium market.

[25]The 2002 Strategic Offensive Reductions Treaty (SORT) committed the US and Russia to reduce to between 1700 and 2200 deployed strategic warheads each (counting nuclear bombers as carrying only one warhead each). The range reflected the fact that the Bush Administration was unwilling to go below 2200 and the Putin Administration did not expect to be able to afford a force with more than 1700 warheads. The SORT reductions were verified using the arrangements in the START treaty, which did not expire until 2010.

[26]The 2010 New START Treaty committed the US and Russia to reduce to 1550 deployed strategic warheads each – again counting nuclear bombers as carrying one warhead each. Unless Presidents Putin and Trump agree to extend it for another five years, it will expire in February 2021.

[27]Richard Meserve, chairman of the Nuclear Regulatory Commission (1999–2003); and James Timbie, senior arms control advisor to the State Department (1983–2016).

When the Soviet Union collapsed in December 1991, there was tremendous concern about "loose nukes" in Russia. Secretary of State James Baker warned that the Soviet Union could become a "Yugoslavia with nukes" (Bradsher 1991).

Neff had foreseen the problem several months earlier and had come up with the idea that perhaps the US could buy the highly-enriched uranium (HEU) from excess Soviet weapons after it had been diluted down to low-enriched uranium so that it could be used to fuel US power reactors. That struck him as a win-win deal. It could keep the HEU out of the black market and could generate the funds to support Russia's nuclear-weapons complex at a time when, due to the low price of oil and gas and the chaotic state of an economy in transition from government to private ownership, the Russian government could not meet its financial obligations. Providing an income for Russia's nuclear-weapons workers would reduce the danger of a "brain drain" to countries such as Iran and North Korea.

Coincidentally, Tom Cochran and Christopher Paine at the NRDC had organized a workshop in Washington, DC in October 1991 with Soviet nuclear experts and officials. I was invited because the FAS was co-sponsoring the meeting.

The most important invitee was Soviet Minister of Atomic Energy, Victor Mikhailov. Neff told me about his idea; so I invited him to the meeting and Neff pitched his idea to Mikhailov.

Mikhailov was interested and, according to Neff, asked how much weapon-grade uranium he could sell. Tom suggested 500 tons, enough for about 20,000 warheads. A few days after the meeting, Neff published his idea in a *New York Times* oped (Neff 1991). Mikhailov then proposed the deal to the US government.

This was only the beginning of the saga, however. There were complications, for example, a ban on the import of Russian uranium into the US because of the concerns of US uranium mining companies. But Neff contributed important ideas for how to deal with each of these problems and found an ally in Pete Domenici, a powerful Republican Senator who was able to solve some of them legislatively.

Neff also had to deal with the US Enrichment Corporation (USEC), the privatized US enrichment complex to which the Clinton Administration assigned management of the US side of the deal. USEC had profit motives that set up a zero-sum dynamic with the profit motives of Russia's Ministry of Atomic Energy. It took huge efforts by Neff over the next two decades to keep the deal from collapsing a number of times. Somehow, however, by the end of 2013, all the 500 tons had been blended down and sold to US nuclear utilities and Russia had received an estimated $17 billion in exchange. Neff is writing his own memoir about the HEU Deal.

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No potential conflict of interest was reported by the authors.

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