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Citizen Scientist: Frank Von Hippel's Adventures in Nuclear Arms Control PART 5. Working in the White House Office of Science and Technology Policy

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ABSTRACT

Von Hippel describes his introduction to the ways of the government bureaucracy as an assistant director in the White House Office of Science and Technology (OSTP). He describes providing White House support to the lab-to-lab program through which the US helped Russia strengthen the security of its nuclear materials and his visits to the Kurchatov Institute and Russia's first plutonium city to discuss such upgrades, and also the false starts that delayed the replacement of the heat and electricity generated by Russia's last three operating plutonium-production reactors so that they could be shut down. He also describes some the other efforts in which he became consequentially involved: ending HEU use in research-reactor fuel, opening up the issue of converting US naval reactors to low-enriched uranium, shutting down Experimental Breeder Reactor II, raising safety issues with NASA's plutonium-heat-powered Cassini mission to Saturn, and a failed attempt to intervene in the UK's decision to launch its new THORP reprocessing plant into operation. Finally, he explains why he left OSTP eight months before his originally planned return to Princeton. He also discusses his failed nongovernmental initiative to promote an end to the production of fissile materials for weapons in South Asia and the Clinton Administration's half-hearted efforts to negotiate warhead arms control with Russia. Finally, he discusses highlights of his life in Washington, DC and the lessons he learned about working in the government.

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***Tomoko Kurakawa* (*TK*)**: Who invited you to join the White House?

Frank von Hippel (FvH): Jane Wales. She had been working on security issues at the Rockefeller Brothers Foundation and was part of the White House transition team for the Clinton Administration. She became the Associate Director for International Affairs and National Security in the White House Office of Science and Technology Policy (OSTP). She knew about me and invited me to become her deputy for National Security. The Director of OSTP was Jack Gibbons who had previously been the Director of Congress's Office of Technology Assessment, which was abolished after the Republicans took control of Congress in the 1994 election.

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For some reason, they asked me, "What would you like your title to be?" I responded, "How about Assistant Director for Global Security?" The response was, "National Security."

I should also be clear that, although I sat in at meetings in the White House Situation Room a few times, my office was in the Old Executive Office Building (OEOB), next door to the White House (Figure 1). The OEOB is a wonderful French Second Empire Style structure built in the 1870s and 1880s to house the Departments of State, Navy and War bureaucracies. After the tremendous expansion of the government during World War II and the Cold War, it was insufficient even to hold the White House staff. Therefore, in the 1960s, the ten-story New Executive Office Building was built a block away to house mostly the staff of the Office of Management and Budget.

TK: But you didn't join the OSTP from the beginning of the Clinton administration.

FvH: President Clinton took office in January 1993 and it takes a while to fill the positions. Background investigations are required for everyone, and also Senate confirmation for the top two levels of political appointees. The appointment process usually starts at the top to give the top appointees a voice in selecting the people who will work for them. I joined in September 1993.

TK: You didn't need any confirmation by the Senate?

FvH: My level was the highest one that does not require confirmation. But not everybody in the White House was happy about me being appointed. For a time, Jane tried to conceal from the National Security Council the fact that I was there.

She told me that, when she told Vice President Gore's national security advisor, he exclaimed, "von Hippel in the White House! But he has an agenda!" His concern was that I would try to make policy rather than implement the policy decisions made at higher levels.

He was right to a degree. I was supportive of most of the administration's policy in my domain, but I had some additional ideas I wanted to put on the agenda.

Figure 1. Old Executive Office Building with Pennsylvania Avenue in the front and 17th street to the right. The west wing of the White House is visible on the left. My first office was up on the top floor with a view of the lawn behind the White House where the President's helicopter lands.

In fact, Jane later became exasperated with me. She said, "Frank, don't you understand? Your most important job is to make me look good!"

I did not pay attention to that priority and, as a result, I was downwardly mobile among the White House staff. I started with seven assistants and a suite overlooking the White House, and ended up sharing a desk with my dedicated deputy, mentor, and bureaucratic samurai, Army Lieutenant Colonel Fred Tarantino[1].

TK: What was your main task in the White House?

FvH: I was eager to work on ballistic-missile defense and nuclear-test-ban issues but quickly learned that the National Security Council (NSC) didn't want me near anything related to arms control. This was probably the influence of Bob Bell, the Senior Director for Defense Policy and Arms Control who had previously worked on the Senate Armed Services Committee for Senator Nunn. While working for Nunn, Bell had organized a hearing to discredit my argument for reciprocal openness by the US in exchange for the openness we were demanding at Russian nuclear sites to verify that Nunn-Lugar assistance was being used as intended (see Part 4).

When the NSC had interagency meetings on arms control, they would "forget" to send me meeting notices. When Ken Luongo, the senior arms control person in the Department of Energy, started forwarding me copies of NSC meeting notices, he was threatened with an FBI investigation.

Later on, the NSC did find something they were willing to have me take White House responsibility for: the disposal of excess US weapon plutonium.

The NSC also was not interested in the Department of Energy's efforts to launch a program to upgrade the security of nuclear materials in the Soviet Union. I therefore decided to provide White House support for that effort.

TK: The Nunn-Lugar program?

FvH: It was not supported by the Nunn-Lugar program, which authorized the Department of Defense (DOD) to provide Russia with equipment and funds to destroy Russian nuclear weapons systems that were in excess to START Treaty limits. That program was named after Senators Sam Nunn and Richard Lugar, who were responsible for the amendment to the Defense Authorization Act that first authorized the program. Senator Nunn once exclaimed, "Imagine, how much money we would have been willing to spend on weapons systems to destroy all those Russian weapons of mass destruction!"

The Department of Energy wanted funding for the its nuclear labs to work with their Russian counterparts to upgrade security of highly-enriched uranium and plutonium at Russia's nuclear facilities. But the DOD refused to transfer any of the Nunn-Lugar money to the Department of Energy (DOE). As a result, for a time, we struggled to figure out how to fund this work. Ultimately, Senator Domenici provided money directly to DOE for the effort. So, the DOE lab-to-lab program was a different program from the DOD's Nunn-Lugar

[1]Frederick A. Tarantino later left the Army and joined Bechtel. He ran the Nevada Test Site (renamed the Nevada National Security Site after testing ended) for DOE from 2001 to 2004. He then became associate director for nuclear weapons at Los Alamos National Laboratory and finally, president of the Universities Space Research Association from 2006 till 2014 when he died from brain cancer. It was a great and untimely loss. I think of Fred often.

program. Ken Luongo was the key person in DOE overseeing the lab-to-lab program. Prior to working for Secretary of Energy Hazel O'Leary, he had worked as a staffer in Congress.

In a similar way, the State Department got its own funding to set up, in cooperation with US allies, an International Science and Technology Center to put Soviet weapons scientists to work on non-weapon projects so that they would not look for work in other countries. At the time, Russia's economy had collapsed. Its GDP was about 400 billion USD and still declining. It bottomed out in 1999 at about 200 billion USD, which was at the time less than half of the GDP of the Netherlands, a country with one tenth of Russia's population. Vladimir Putin took over at the end of 1999, and, by 2013, Russia's GDP had grown back to USD 2,300 billion (World Bank 2019). No wonder Putin is popular in Russia! Putin was lucky, however. The recovery was powered in good part by the fact that the price of oil increased from a low of 20 USD a barrel at the beginning of 1999 to about 100 USD per barrel in 2013 (Macrotrends 2019).

There was also the hope that we could convert the Russian nuclear-weapons scientists to non-weapons work. In the end, however, there wasn't much conversion. After 2000, when the price of oil and natural gas increased, Putin put them back to work on nuclear weapons.

TK: Was there any analysis of net results of these program?

FvH: Sharon Weiner wrote a book evaluating the long-term impact of these programs and found that the amount of lasting conversion from weapons to civilian work was small (Weiner 2011). But the programs did help hold the nuclear cities together through the economic crisis years of the 1990s.

"Turf"

One thing I learned when I was in the government was that bureaucracies defend their "turf." In the dictionary, "turf "is an area of grass. In an organization, "owning turf" is being able to say, "That's my turf. You stay off!" That is what I was faced with at the National Security Council. I also witnessed it happening to others.

For example, the Department of Energy launched a Nuclear Cities Initiative that, unlike the State Department's International Science and Technology Center, was focused on the nuclear cities rather than on individual scientists. The head of the Nuclear Cities Initiative wanted to go to Russia but, for a government employee to go to another country requires "clearance" by the State Department. The person who was responsible within the State Department for the International Science and Technology Center blocked the clearance. I intervened and got him clearance and later – perhaps in appreciation – he took me with him on his trip to the third of the Soviet Union's three plutonium-production cities, Zheleznogorsk (see Part 4).

Replacing the Energy from Russia's Last Three Plutonium-production Reactors

I got involved in another US-Russian initiative because of Velikhov. He knew that the US was interested in converting excess military industrial capacity in Russia to civilian purposes and, early in my time in the White House, he came to visit me with an idea related to conversion.

General Electric, which produces jet engines for aircraft, had adapted them to burn natural gas and drive ground-based electric-power generators. Velikhov proposed that the U.S. fund the conversion of a Russian jet engine factory to produce power turbines. He said he would buy a few of them himself to power the Kurchatov Institute which he directed.

What gave the idea traction in the White House was Velikhov's second idea: that gas turbines could be used to replace the heat and electrical power that was being produced by the three dual-purpose plutonium-production reactors that were remained in operation in two of Russia's plutonium cities: two at Tomsk-7 (now Seversk) and one in Krasnoyarsk-26 (now Zheleznogorsk) (Figure 2). The reactors were still operating because the heat and electrical power they had been producing as a byproduct of plutonium production was needed by the cities. Now, the weapon-grade plutonium was an unwanted byproduct.

Velikhov believed that Russia's natural gas monopoly, Gazprom, would build pipelines to supply Seversk and Zheleznogorsk with gas for the power turbines. The waste heat from the gas turbines would replace the heat from the nuclear power plants that heated water that flowed through large pipes into the cities to heat their apartment buildings in the winter.

I thought this was a brilliant idea.

At the time, Vice-President Gore and Russian Prime Minister Viktor Chernomyrdin were meeting every six months to discuss the progress of the ongoing US-Russian cooperative initiatives and ideas for new ones.

Figure 2. Satellite image of the ADE 4 and 5 dual-purpose reactors at Seversk, the Soviet Union's second plutonium city, 28 August 2004. The long building in the center is the turbine building. Below it the taller building (relative height can be determined by the relative lengths of shadows) houses the two reactors. The vapor coming from the cooling towers at the right indicates that the reactor on the right was operating. At the top center, the hot water pipes cross the security boundary and then head left toward the city (Google Earth, 56.646°N, 84.913 °E).

I put Velikhov's idea on the agenda for the next Gore-Chernomyrdin Commission meeting. It received support and the US and Russia agreed that, in exchange for US funding for replacement power, all the plutonium produced by the Russian production reactors after 30 September 1994 would be placed under joint monitoring to ensure that it would not be used for weapons. That part of the agreement is still in force.

The gas-turbine idea was not, however, embraced by the nuclear cities. They did not want to be at the mercy of Gazprom. They wanted coal-burning power plants. Gazprom could turn off their gas supply at any time, but the nuclear cities could buy and pile up enough coal to carry them through the Siberian winter.

It took years before the US agreed to supply the coal plants. The Department of Defense (DOD), which was funding the project, favored a proposal put forward by the Pacific Northwest National Laboratory (PNNL) to convert the reactors to weapon-grade uranium fuel. The idea was that weapon-grade uranium contains only a little U-238. Therefore, only a little plutonium would be made by neutron absorption on the U-238.

It was an insane idea, however, because every year four tons of weapon-grade uranium, containing more than 90 percent U-235 – enough for 160 bombs – would have to be fabricated into fuel and shipped thousands of miles across Russia, exposing it to theft. Perhaps the Pentagon saw this as a way to get rid of additional Russian weapon-grade uranium but I saw the risk of diversion as unacceptable.

I went to the Department of Energy with my concern, and they commissioned a study at Argonne National Lab of the feasibility of using uranium enriched to 19.75%, just below the 20-percent boundary above which uranium is defined by international agreement to be highly-enriched uranium (HEU) and weapon-usable. The Argonne group found that low-enriched uranium (LEU) would work as well as HEU. But DOD and PNNL plowed on heedlessly with their plan.

Then, in February 1998, in a meeting in Moscow, Anatoli Diakov, who had established an arms control center at the Moscow Physics and Technology Institute, brought Alexander Dmitriev to meet me. Dmitriev was the Deputy head of GAN, Russia's nuclear-safety regulatory agency. He had actually operated some of the plutonium-production reactors at Seversk and was very worried about the safety of PNNL's design which involved alternating in the fuel channels slugs of HEU with rods of neutron absorber. The neutron absorbers were required to soak up the extra neutrons that previously had been used to make plutonium. Dmitriev was concerned that the HEU slugs would create hot spots in the fuel channels.

This was after the Chernobyl accident and the dual-purpose reactors in the two nuclear cities were the progenerators of the Chernobyl reactor. I took Dmitriev's concerns to Vice President Gore's national security advisor (Von Hippel 1998).

Finally, a year later, in 1999, the US accepted the nuclear cities' original proposal to use coal-fired plants to provide the replacement heat (Von Hippel and Bunn 2000). The last of the three reactors was shut down in 2010.

TK: So the Russian economy recovered. That's why the assistance from the United States became less valuable.

FvH: My interest in helping the nuclear cities continued until 2000. We had a big meeting in Princeton in June 2000 that was attended by Lev Ryabev, the former head and, at that time, deputy head of Russia's Ministry of Atomic Energy (Bukharin et al. 2000; Bukharin, von Hippel, and Weiner 2000).

That same year, however, Vladimir Putin and his coterie of KGB veterans took over. They were paranoid about US spying, so they ended US access to the nuclear cities. Also, because of the coincidental rise in the price of oil and gas starting in early 1999, they no longer needed our financial help.

Nuclear-material Security Upgrades in Russia

TK: Tell me more about your work on these programs.

FvH: Even before Putin, the Russian security services were suspicious about the US interest in upgrading the security of their nuclear materials and they misunderstood what we wanted. Because of a lucky break, I was able to reduce their misunderstanding.

Discussions between the US and Russia on the subject had been ongoing but had been stalemated. The Russian negotiators were suggesting that the US work first on upgrading the security of a facility fabricating low-enriched uranium fuel, while the US negotiators wanted to focus on the security of weapon-usable materials.

On the US side, the discussions were led by Ambassador James Goodby, a senior official with deep expertise on nuclear issues[2]. One day, he had to be out of town and asked me to preside in his place. The meeting was in a conference room in the L'Enfant Plaza Hotel.

On my side of the table were lined up representatives from the Energy, State and other departments and there was a corresponding group of Russian officials on the other side.

Our discussion went around in the same circles that Goodby and his Russian counterpart had been stuck in. At the end, I invited my Russian counterpart to lunch and tried to figure out what the problem was.

What I learned was that the Russians had been misunderstanding our desire to increase the security of their weapons-usable material as a desire to access the facilities where they were producing their nuclear weapons. I was able to explain that we would be satisfied to focus initially on highly-enriched uranium and plutonium in civilian use. That proved to be a breakthrough.

A second breakthrough was that Velikhov offered the Kurchatov Institute as a demonstration site. The institute designed HEU-fueled submarine reactors for the Russian Navy and had some HEU-fueled critical facilities for testing the configurations of the cores. It also had a space-reactor prototype fueled with about 20 kilograms of HEU.

When the upgrades at the Kurchatov Institute were complete, I accompanied a group of national laboratory safeguards and security experts to Moscow to inspect them.

[2]After two years in the Air Force during the Korean War, James Goodby began his engagement with nuclear issues in 1954 as a foreign affairs specialist with the US Atomic Energy Commission. In 1960, he moved to the State Department where he participated in the negotiations of the Helsinki Accords and the START Treaty. In 1993, he was appointed Chief U.S. Negotiator for the Safe and Secure Dismantlement of Nuclear Weapons. After his retirement from government, he continued to work on nuclear disarmament, including with Sidney Drell at Stanford University.

Security had been increased by barring the windows of the building containing the critical assemblies and pruning the trees and placing fencing around the building. Inside, coded locks were installed on the doors to the rooms containing HEU and intrusion sensors were installed inside.

There was still a cultural problem, however. I remember especially the room with the space-reactor critical assembly. The fuel was kept in a locker similar to a US high-school student's locker, not a safe. The nuclear engineers opened up the locker, took out a tube and dumped a pile of washer-shaped discs into a dish so I could feel them. They were made of 96-percent-enriched weapon-grade uranium.

Before the entrance to that part of the building, a cage had been installed with sensors that could determine whether you were carrying plutonium or uranium. But, when I was about to go into the cage, someone said, "Oh, that's not necessary for you!" and they waved me and my backpack by. So, if I had managed to pocket some of their weapon-grade uranium disks, the theft would never have been detected.

The demonstration effect worked, however. Representatives of Russia's nuclear navy inspected the improvements and talked with the Kurchatov people about their experience with the Americans. Then, the navy decided to invite the US labs to strengthen the security of their nuclear fuel storage facilities.

These upgrades were desperately needed. In November 1993, some fuel had been stolen from a naval storage facility in the Arctic coast shipyard of Sevmorput near Murmansk. Oleg Bukharin, who had just joined our group as a post-doc, picked up the story in the Russian press and wrote an article for the *Bulletin of the Atomic Scientists* with Bill Potter of the Monterey Institute. The title they chose for their article was taken from a summary statement by the investigator, "Potatoes Were Guarded Better!" (Bukharin, 1995)

Later, the lab-to-lab program was even extended to upgrading the security of Russia's nuclear-warhead storage facilities. So, the Kurchatov Institute demonstration project was very important.

Russia's Central Plutonium Stores

FvH: My second visit to Russia in connection with the lab-to-lab program was in October 1994, toward the end of my time in the White House. It was to Ozersk, the plutonium-production city that a group of us had visited with Velikhov in 1989 (see Part 4). This time, I went with a group of national laboratory experts to look into possible security upgrades for the plutonium there.

That's when I visited the warehouse full of the approximately 24 tons of reactor-grade civilian plutonium that the Soviet Union had separated out as of that time.

The plutonium was in the form of oxide powder and stored in double metal cans the size of coffee pots, each containing about two kilograms of plutonium, so about 10,000 cans in all.

The cans were stored in an old warehouse that had not been designed for this purpose. Concrete-lined trenches had been made in the floor and the cans were lined up in the trenches (Figure 3). Perhaps that was in part to reduce the amount of radiation for the workers. Reactor-grade plutonium contains a significant amount of plutonium-241,

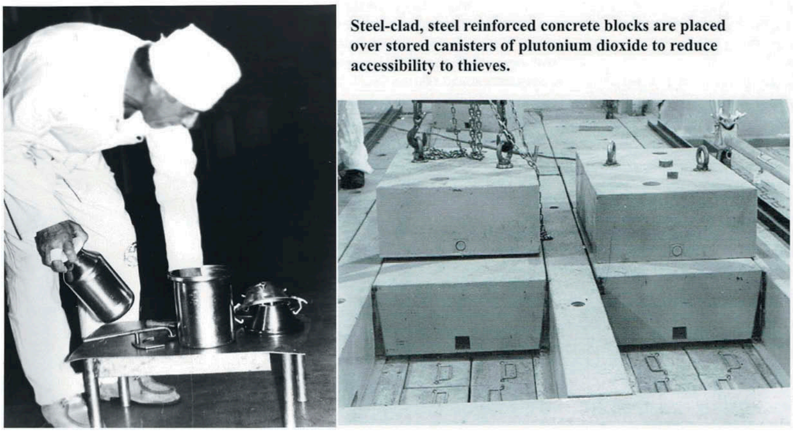

Figure 3. Left: Mayak plutonium worker placing an inner container holding about two kilograms of plutonium oxide into an outer container during our visit to Ozersk in October 1994 (Mayak Production Association). Right: After the upgrade, the containers were stored in metal boxes at the bottom of concrete trenches in the floor of the warehouse. Each folded-down handle is on the top of a box that contains one container. The US security upgrade included the placement of heavy, steel-clad, reinforced concrete blocks over the boxes. The blocks were then locked together with pipes threaded through the holes in their bottoms (DOE).

which decays with a 14-year half-life to americium-241, which puts out gamma rays. So it would not be healthy to stay in that room too long.

The trenches also protect the containers from being shoved together accidentally to create a crtical mass and a chain reaction.

Not all of the security upgrades provided by the US within the building were high-tech. Heavy reinforced concrete blocks were laid on top of the concrete trenches and locked together. Sensors and alarms were installed in the building, as were bars to prevent access to the room via its large air-conditioning ducts. (Twenty-four tons of reactor-grade plutonium would generate about 250 kilowatts of radioactive decay heat.)

On our way into Ozersk, our van passed a site outside the town where the DOD's Nunn-Lugar program was starting construction on what became a USD 400 million fortress to hold Russia's excess weapons plutonium (Figure 4). The structure was designed to protect the plutonium from bombs. The contrast between that facility for the storage of the weapons plutonium, and the facility for the storage of comparable quantities of civilian but weapon-usable plutonium was dramatic.

TK: DoD paid for the construction?

FvH: Yes, the Nunn-Lugar program.

TK: And Russia used that storage facility?

FvH: Yes, for about 24 tons of the 34 tons of weapons plutonium they declared excess in parallel with the US in the Plutonium Management and Disposal Agreement of 2000. These 24 tons were extracted from the plutonium pits of perhaps as many as 8,000 excess warheads. The remaining ten tons of excess Russian weapon-grade plutonium were never

Figure 4. US-built USD 400-million storage facility for about 24 tons of excess Russian weapons plutonium outside Ozersk. Note the outer and inner security perimeters, which each have two fences with a microwave-beam monitored strip between. The storage building in the center is designed to withstand bombs and the cans of plutonium are stored in vertical tubes in a concrete monolith (Google Earth, 16 July 2019, 55.713° N, 60.848° E).

in warheads and are stored in the former underground plutonium production complex in Zheleznogorsk. In the meantime, as of the end of 2018, according to its annual declaration to the IAEA, Russia's stock of separated civilian plutonium at the Mayak reprocessing facility had increased to about 57 tons.

TK: Do you believe that all of that canned civilian plutonium is secure in that building?

FvH: It is now a quarter century later and Russia's stock of civilian plutonium at Mayak has more than doubled. It is possible that they have built a new storage facility, but I still worry about theft by an insider.

There is a fence around the city of Ozersk, but people in the city smuggle things in and out, and these cans of plutonium are quite small.

In any case, plutonium separation is a completely unnecessary activity. Russia's current stock of civilian and excess weapons plutonium would be enough to start up ten large breeder prototypes and they have just put off building a second plutonium-fueled breeder prototype until at least the 2030 s because their current prototypes are not economically competitive with their light-water reactors. They should stop reprocessing. Unfortunately, instead of doing that, they have started operating a second pilot reprocessing plant at Zheleznogorsk.

TK: What else did you discuss after you got back from visiting this plutonium warehouse?

FvH: We discussed "design-basis threats." What kind of threats should they plan against? I can't remember the specifics anymore but it is not unimaginable that terrorist groups could in the future acquire the kind of capabilities used in the US raids that killed Osama Bin Laden, the leader of Al Qaeda, in 2011 and Abu Bakr al-Baghdadi, the leader of ISIS, in 2019. The isolation of Ozersk in the middle of Russia makes such threats less plausible there today but plutonium has a long halflife and who knows what the political future holds? Why create unnecessary risks (Von Hippel, Kang, and Takubo 2019)?

In another meeting in Moscow, we met with the director of the institute that designed and supplied the equipment to help secure Russia's nuclear facilities: sensors, fences, and so on. I learned how the double fence around sensitive facilities has microwave beams in the space between so that, if somebody steps through the beam, an alarm is set off. The DOE security-assistance program bought Russian equipment when possible – both to support the supplier and so that the facilities would be able to maintain and replace the equipment after US assistance ended.

Brain Drain

TK: Was there brain drain?

FvH: Some. In 1992, a plane full of Russian missile designers was stopped before it could take off for North Korea. Some may have ultimately gotten there. There also was at least one Soviet weapons-design expert who went to Iran. He was a Ukrainian who had implosion expertise. The Iranians claimed they were interested in using implosions to make diamond dust for abrasives.

TK: So international initiatives to avoid the brain drain were relatively successful?

FvH: They helped, but, when I talked to the Russian nuclear experts, it was clear that most were real patriots who understood their responsibilities and wanted to make sure that their nuclear materials and technology did not go astray. That helped a great deal – probably more than the US assistance.

TK: I see, they are principled.

FvH: Yes. We tend to assume that money is everything; that if you are poor and someone waves a hundred-dollar bill at you, you will do what is asked. I don't think that was true for the vast majority of these nuclear scientists and technicians.

TK: So, on the missile side, the US didn't pay as much attention to the leakage of Soviet missile technology?

FvH: Too little; missile experts have looked carefully at pictures the North Koreans have published of Kim Jong Un visiting missile test sites and they see Cyrillic writing on the missile engines. It appears that the North Koreans were buying surplus missile engines from Russia and/or Ukraine.

US intelligence may have known this two decades ago. In 1998, the Republican-led Congress set up a commission to assess the missile threat from Iran, Iraq and North Korea. The purpose was to pressure the Clinton Administration into breaking out of the ABM Treaty limits on ballistic-missile defenses against long-range missiles. The Republicans appointed Donald Rumsfeld to be the chair of the commission. Two years later, he became President G.W. Bush's first Secretary of Defense. The Democrats appointed Richard Garwin among others, which gives the commission's report some credibility for me.

The commission concluded that, if they received foreign assistance, Iran and North Korea could get intercontinental ballistic missiles within five years. It was not specified where the assistance might come from but the obvious source at the time was the former Soviet Union.

TK: So, at the end of the Cold War, we could have done better to stop the proliferation of ballistic missiles?

FvH: I searched the website of the International Science and Technology Center, the organization that was set up to give non-weapons work to weapon scientists. I searched the project descriptions for the term "nuclear weapons" and got 374 hits. When I searched for "ballistic missiles," I got 14.

TK: In retrospect, what were your main accomplishments in your sixteen months in the White House?

FvH: I spent much of my time on two efforts: strengthening the security of Russian fissile materials and plutonium disposal. I feel good about the first effort. The second one turned out to be a waste of time.

There were three other important issues to which I contributed, however:

(1) Ending the use of highly-enriched uranium in reactor fuel.
(2) Shutting down US breeder reactor research and development.
(3) Space nuclear power safety.

Ending the Use of Highly-enriched Uranium (HEU) in Reactor Fuel

TK: OK, please tell me about your work on HEU issues.

FvH: HEU is uranium containing 20% or more of the chain-reacting isotope U-235. In practice, the HEU used in research, naval-reactor and space-reactor fuel has mostly been "weapon-grade," containing more than 90% U-235. It is treated specially because it is very easy to make a nuclear weapon from HEU. Virtually all power reactors are fueled with low-enriched uranium containing three to five percent U-235, which is not weapon usable (Figure 5).

Research reactors

After India's 1974 nuclear test with civilian plutonium, in addition to ending its policy on promoting the separation of plutonium for civilian use, the US started a Reduced Enrichment for Research and Test Reactors (RERTR) program at the Argonne National Laboratory to work on reducing the use of HEU fuel in civilian reactors.

At the time, most US research reactors were fueled with HEU. As a result of the Atoms for Peace Program launched by President Eisenhower in 1954, the US was exporting

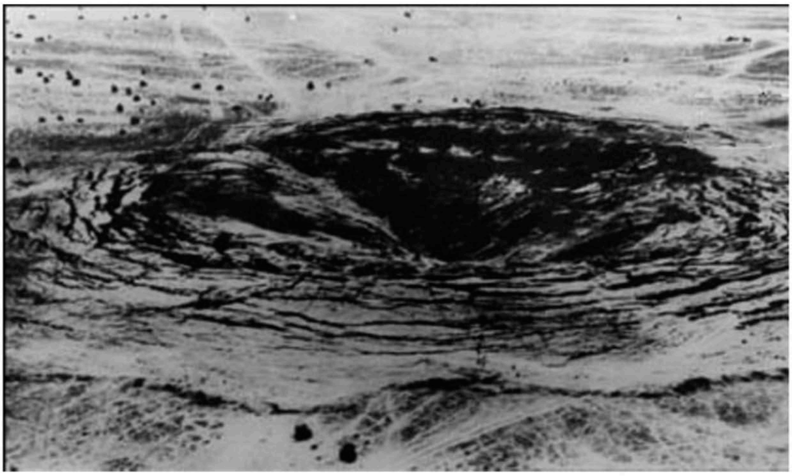

Figure 5. Subsidence crater from India's first nuclear test on 18 May 1974. The explosion deep underground created a large spherical cavity. The collapse of that cavity created a crater above that was more than 200 meters in diameter. India's use of plutonium separated for peaceful use with US assistance, triggered a multitude of nonproliferation initiatives, including a change of US policy away from regarding plutonium as the nuclear fuel of the future and efforts to reduce the use of weapon-grade uranium as a nuclear fuel (Atomic Heritage Foundation).

annually on average about one ton of HEU – enough for 40 implosion-type nuclear bombs – to fuel the research reactors it had provided to about 30 countries. The Soviet Union was doing the same. During the Reagan and G.W.H. Bush administrations, the RERTR program budget was held down to a few million dollars a year, and Argonne was forbidden to work on the development of new LEU fuel to convert the US government's own research reactors.

In 1994, the leadership of the RERTR program came to brief me on the program's status, and I became their White House advocate, including accompanying them to Moscow to negotiate a US-funded joint program to convert Soviet-exported research reactors. As of the end of 2018, 34 of the 56 countries that formerly had HEU-fueled research reactors had been cleaned out down to a level of less than one kilogram of HEU (Figure 6).

Russia worked with the US converting reactors in countries to which the Soviet Union had supplied HEU-fueled reactors, but did not give conversion a high priority at home where it still had, as of the end of 2019, twenty-eight HEU-fueled reactors. In the US, there has been a focus on converting research reactors and the number of HEU-fueled research reactors is down to ten, with most of those awaiting the development of higher-density LEU fuel that would have about the same U-235 density as the HEU fuel that it replaces.

During my time in OSTP, I became involved in a major battle over the proposed new Advanced Neutron Source (ANS), a multi-billion-dollar high-powered research reactor, at Oak Ridge National Laboratory. To maximize its performance, Oak Ridge had designed it to be fueled with weapon-grade highly-enriched uranium (HEU).

I urged, through coomunications from the President's Science Advisor Jack Gibbons to Secretary of Energy Hazel O'Leary, that the RERTR program at the Argonne National Laboratory be funded to do an independent analysis of whether the ANS design could tweaked so that it would operate nearly as well with LEU fuel (Von Hippel 1994a).

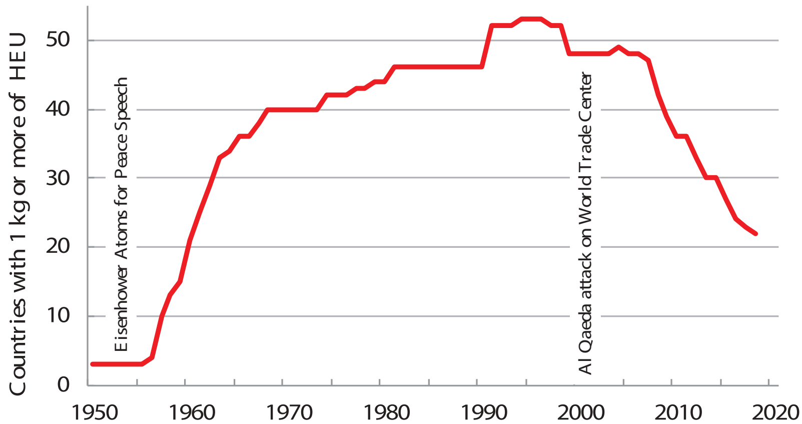

Figure 6. After President Eisenhower's 1953 Atoms for Peace speech at the United Nations, the US and Soviet Union exported research reactors fueled with weapon-grade uranium to about 50 nations. In 1978, the US launched a program to convert research reactors to low-enriched fuel and, in 1994, recruited Russia to work on converting research reactors exported by the Soviet Union. These efforts only received high-level backing in Congress, however, after the 2001 terrorist attacks in the United States (Von Hippel, Kang, and Takubo 2019).

Oak Ridge funded Argonne to do only two person-weeks of work and refused to provide design information on the ANS until it was too late, I was able to get the study deadline extended, however, so that Argonne could participate in a more meaningful way.

In the meantime, the cost of the project kept increasing and it was a subject of increasing criticism in Congress for both cost and nonproliferation reasons. As a result, the Office of Management and Budget took it out of the budget for fiscal year 1995.

Ultimately, Oak Ridge got another type of neutron source, a "spallation source" in which neutrons are created by crashing high-energy protons into a tank of liquid mercury. The neutrons are created in pulses because the protons hit the target in pulses. That is advantageous for many types of experiments because it makes it possible to determine the kinetic energies of the neutrons, based on the time it takes them to make it from the mercury target to the experiment. So the Oak Ridge scientists are happy and the US did not undermine its own campaign for converting research reactors to LEU fuel.

At the time, however, the leadership of Oak Ridge was extremely unhappy with me for holding up the ANS. They went to Vice President Gore, who had been a senator from Tennessee where Oak Ridge is located, and tried to get me fired. Gore did not act on their request. He had an aversion to nuclear-energy issues and his office often asked me to draft responses to letters he received about them.

Naval reactors

In the spring of 1994, I received a call from the office of Representative Peter Stark of California. The caller asked whether the White House would object to an amendment to the Fiscal Year 1995 National Defense Authorization Act requiring "a report on the costs, advantages, and disadvantages of using low-enriched uranium (LEU) to fuel naval reactors." I was unaware of any procedure for processing such enquiries, so I just said that I did not object. Apparently, that was good enough for Representative Stark.

The result was the first report to Congress by the Office of Naval Reactors on the feasibility of fueling future naval reactors with low-enriched uranium.

At the end of 1994, just before I left the White House, I visited the manager of the Naval Nuclear Propulsion Program (NNPP) to discuss the issue. I recall that I had to deal with a freezing rain between the metro stop and his office.

During our meeting, to dramatize how robust the navy's metal fuel was, he took a piece and threw in on the concrete floor. Later, I learned that Admiral Rickover, the "father" of the US nuclear navy required that every new nuclear-powered submarine and ship be subjected to the explosion of a nearby depth charge to make sure that all the welds in its nuclear system could take the shock.

NNPP's report to Congress was pretty negative about LEU fuel. The density of chain-reacting U-235 in the fuel would be lower because of its dilution by four times as much U-238. An LEU-fueled reactor would therefore require a larger core or more frequent refueling, either of which would raise costs.

The report did not take seriously the possibility that there could be a nonproliferation benefit if the US joined China and France in using LEU fuel so that non-weapon states such as Brazil – which was and still is developing nuclear-powered attack submarines – would have less of an excuse to claim that it too needed HEU to fuel its submarines.

Appeals to set a good example are too speculative to carry much weight with defense establishments. In fact, NNPP's report argued that the Navy was doing a nonproliferation service by consuming HEU from excess Cold War nuclear weapons. Today, however, the nuclear navy is backing studies on how to reestablish a US HEU-production capacity because the US stock of HEU will be depleted sometime around 2060.

To date, Brazil has focused on fueling its nuclear submarines with LEU. Iran has stated that it will need to produce HEU to fuel its future ship-propulsion reactors, but this may just have been a talking point in Iran's assertion of its rights to a pursue uranium enrichment to the limits of what is allowed to non-nuclear-weapon parties to the Nonproliferation Treaty (NPT). The right of non-weapon states to take enriched uranium out from IAEA safeguards for non-explosive military purposes is sometimes described as a "loophole" in the NPT.

In 2012, almost two decades after my 1994 interaction with the US nuclear navy, I suggested that the House Armed Services Committee ask for an update of NNPP's views on the issue of designing future naval reactors to use LEU fuel. The request was put into the Defense Authorization Act for Fiscal Year 2013.

The report that came back in 2014 was less negative than the 1995 report and a small group of Congresspeople and staffers has taken the issue on (Phillippe and Von Hippel 2016).

My work in engaging Congress on this issue has been in partnership with Alan Kuperman of the University of Texas, Austin. As a staffer to then Representative (now Senate Minority Leader) Charles Schumer, Kuperman wrote the "Schumer Amendment" to the Energy Policy Act of 1992. That amendment required that foreign research reactor operators receiving HEU research reactor fuel from the United States commit to converting to LEU as soon as suitable LEU fuel became available.

My own campaign to end the use of HEU has broadened to encompass banning its production (Von Hippel 2016).

Today, the U.S. has no government-owned enrichment plant. With the end of the Cold War, the Clinton Administration privatized the operation of the government's enrichment complex with the understanding that the resulting U.S. Enrichment Corporation (USEC) would build a modern replacement enrichment plant. But USEC went bankrupt in 2014. Today, the only enrichment plant in the US was built, starting in 2006, by URENCO, a multinational controlled jointly by the governments of Germany, the Netherlands and the UK.

The US Government argues that it must have a national enrichment plant because its agreement with URENCO will not allow it to buy enriched uranium for military purposes from URENCO. URENCO has a different interpretation that might limit the ban on US use of URENCO-enriched uranium to use in nuclear explosives.

In any case, the National Nuclear Security Administration (NNSA) within the Department of Energy proposes to build a new government-financed enrichment complex to produce low-enriched uranium fuel for the reactors that produce tritium for US nuclear weapons starting around 2040, and weapon-grade uranium fuel for US naval reactors starting around 2060, when the supply of HEU from excess Cold War nuclear weapons is projected to run out. The future of uranium enrichment in the United States has therefore become part of the battle over ending the use of HEU as a reactor fuel (Von Hippel and Weiner 2019).

Space reactors

The US has only launched one reactor into space. It was fueled with weapon-grade uranium. The logic was that the U-238 in low-enriched uranium is dead weight. Why carry it into space? While I was at OSTP, I asked DOE to commision a study on minimizing the weight penalty but the report arrived after I left. There is increasing interest in space reactors today, and I have become involved with the issue again, also in partnership with Alan Kuperman. Senator Ed Markey of Massachusetts, a long-time nuclear arms control and nonproliferation activist, and Representative Bill Foster of Illinois, currently the only physicist in Congress, have taken on the issue with us.

Shutting down US Breeder-reactor Research and Development

TK: What about the US breeder-reactor program?

FvH: Congress halted funding the construction of the Clinch River demonstration breeder reactor in 1983 but, when I joined the White House a decade later, I found that the Department of Energy's breeder research and development program was continuing.

Specifically, the program still had two operating sodium-cooled reactors. One was the Fast Flux Test Facility (FFTF) at Hanford. The Department of Energy decided to shut down the FFTF in December 1993 because of lack of need.

Figure 7. Sunset at the Experimental Breeder Reactor II (EBR II), which went into operation in 1969 at what is now the Idaho National Laboratory (INL). I was involved in shutting down EBR II in 1994. INL has remained committed to its breeder reactor dream, however, and is now seeking funding for a Versatile Test Reactor based on the EBR II design (Argonne National Laboratory).

The DOE's other operating sodium-cooled reactor was the Experimental Breeder Reactor II (EBR II) at the Idaho National Laboratory (Figure 7). INL had been established in 1949 as Argonne National Laboratory's reactor test site because it was safely away from major population centers like Chicago, outside of which Argonne was based.

In 1993 – and still today – the leadership at INL persisted in the hope that the US would come to its senses and return to breeder reactors. In their minds, the design features of EBR II were and are the key to a breeder future.

In the meantime, they claimed to have an answer to the proliferation problem with breeder reactors raised by India's diversion of civilian plutonium to weapons. They would integrate the reactor with a small reprocessing and fuel fabrication plant so that separated plutonium would never leave the facility. They wanted to use the EBR II to demonstrate this concept of an Integrated Fast-neutron Reactor. As Jungmin Kang and I – and, later, government assessments – pointed out, however, it would be much easier for a country to separate plutonium from the recycled mix than from spent power reactor fuel. (Kang and von Hippel 2005).

There was still no economic case for breeder reactors, but breeder advocates pointed to another problem they could solve: the difficulty of siting a radioactive waste repository. They argued that fissioning the long-lived plutonium and other "transuranic" (heavier than uranium) elements in spent power-reactor fuel would eliminate the long-term hazard. Fast-neutron reactors would be required to fission some isotopes of plutonium and other transuranic isotopes in reactor fuel. That argument does not stand up to review either. Other radioisotopes dominate the hazard from deeply-buried spent fuel and the hazard is in any case comparable to to that from a uranium deposit (Von Hippel, Kang, and Takubo 2019).

While I was in the White House, I attempted to straighten out this debate. A group of Argonne breeder advocates therefore came to persuade me that shutting down EBR II would be more costly than operating it. They explained that it would only be possible to remove a certain number of fuel assemblies per year, and it would take more than three years to unload the core and the "blanket" assemblies around the core. I added up the annual removals and found that, in three years, they would have removed more fuel assemblies than the reactor contained. They then confessed that their plan included replacing the old assemblies with fresh ones.

The EBR II was shut down in September 1994. When I returned to Princeton, I included my exchange with the Argonne breeder advocates in my undergraduate course on Science, Technology and Public Policy as an example of why it can be valuable to policy analysts to be able to add.

TK: Who actually made the decision to shut down the EBR II?

FvH: Secretary of Energy Hazel O'Leary. I helped educate her on the issue through her meetings with the President's Science Advisor, Jack Gibbons (Von Hippel 1993b). Unlike relationships in academia, relationships inside government are hierarchical. As a Princeton professor, I have had opportunities to communicate directly with the Secretary of Energy. Now that I was inside the government and two levels below her, I had to communicate through the President's Science Advisor, who was at her level in the hierarchy.

Today a quarter century later, fast-neutron reactor advocates are still promoting liquid-sodium-cooled reactors as "advanced" reactors because they were never commercialized, and other groups are promoting other 50-year-old concepts, such as molten-salt reactors whose development was abandoned even earlier. These reactors are sometimes described as "fourth-generation" reactors, the implication being that they will naturally succeed today's third-generation light-water reactors. Advocates of failed reactor types have become adept at such deceptive language. Russia completed a prototype breeder reactor in 2015. India has for several years been on the verge of commissioning a prototype, and China has begun building one. None is claimed to be economically competitive with light-water reactors, but advocates claim to their increasingly skeptical governments that follow-on simplified designs will be.

In the United States, the breeder advocates are hanging on as well. The Idaho National Laboratory has succeeded in convincing a few gullible pro-nuclear members of Congress that the US is falling behind in fast-neutron reactor technology and have obtained funding to design a "Versatile Test Reactor" based on the EBR II design. Bill Gates, the billionaire co-founder of Microsoft, is funding research and development of a fuel for sodium-cooled reactors that would be so long-lived in the reactor that much of the uranium efficiency benefit of a breeder reactor could be realized without reprocessing. Today, however, the capital costs of liquid-sodium-cooled reactors are their economic challenge. Capital costs already dominate the cost of nuclear power. The cost of the uranium that sodium-cooled reactors and reprocessing would save accounts for only a few percent of the cost of nuclear power from conventional light-water reactors. Their capital costs have been increasing because of added safety features and more stringent quality control inspired by the Three Mile Island (1979), Chernobyl (1986) and

Fukushima (2011) accidents. In the meantime, the costs of renewable energy and natural gas have fallen dramatically (Von Hippel 2010).

Ed Lyman of the Union of Concerned Scientists and I have begun an effort to educate a new generation of Congresspeople on the issues relating to the Idaho National Laboratory's proposed Versatile Test Reactor. There is a saying that, in Washington, bad ideas never die.

Space Nuclear-power Safety

Since the Carter Administration, the President's Science Advisor has had the responsibility for reviewing the safety of launches into space carrying significant amounts of radioactivity. During my time in the White House, this responsibility was delegated to me.

While I was in the White House, the space nuclear safety issue was NASA's Cassini mission to study Saturn and its moons (see Figure 8). The spacecraft would be powered by 33 kilograms of plutonium-238. Pu-238 is attractive for power generation because it generates 560 watts of decay heat per kilogram, and it emits a relatively small amount of penetrating radiation. It is an intense source of short-range but high energy "alpha-particle" radiation, however, which makes it enormously carcinogenic if inhaled.

In 1964, a US satellite containing one kilogram of Pu-238 burned up in the atmosphere. After that, US Pu-238 heat sources were packaged to survive reentry at a speed of 11 kilometers per second.

The safety problem for the Cassini mission was that, after launch the speed of the spacecraft was to be boosted by two flybys of Venus and then of Earth. In effect, an infinitesimal part of the kinetic energies of Venus and the Earth circling the sun would be imparted to Cassini to enable it to climb out of the gravitational well around the sun to reach Saturn's orbit. During the Earth flyby, Cassini's speed would be 19 kilometers per second with three times more kinetic energy to dissipate than that the Pu-238

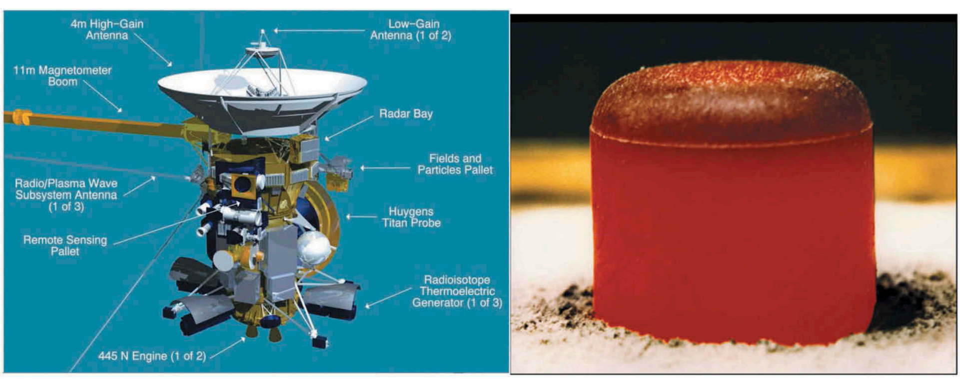

Figure 8. Left: The 6-ton Cassini spacecraft was launched in 1997 and began orbiting Saturn in 2004. On top is the large antenna that sent images and other data back to earth. Below are numerous sensors. On the bottom are the maneuvering engines and three Pu-238 thermionic generators that provided a total of about 0.8 kilowatts of electric power to the craft. Right: A pellet of Pu-238 oxide heated red-hot by decays of the 88-year half-life radioisotope (NASA).

packages had been designed to survive. If the package reentered and burned up in the atmosphere, the result was an estimated extra 15,000–65,000 cancer deaths worldwide.

Of course, the probability that any individual would get cancer as a result of inhaling atoms of Pu-238 would be low – only one chance in 200,000 or so – and the victims would not know and therefore could not credibly complain that that their cancers were due to Pu-238 and not some other cause. This situation illustrates the cynical adage, "The solution to pollution is dilution."

I wanted the package redesigned to survive reentry at flyby speed. That would have been relatively simple: make the heat shields around the Pu-238 heat sources thicker (Von Hippel 1994b). NASA insisted that it was too late to make *any* changes and meet its launch window three years hence. Also, NASA insisted that the probability of reentry was acceptably low.

As with Oak Ridge, NASA's preferred solution to the problem was to try to get me fired. They did not succeed but I left at the end of the year and they proceeded to a successful mission. I was told later, however, that the packaging around the Pu-238 had been redesigned to be more robust for any future mission involving an Earth flyby. I hope that is true.

Trying to Influence Plutonium Policy in Other Countries

I was, of course, interested in convincing other countries to follow the US example of abandoning its civilian plutonium program.

In 1992 and 1993, before I joined the Clinton Administration, I had participated in or co-organized workshops on plutonium policy in Chelyabinsk, Russia (a big meeting in opposition to the continuation of reprocessing in Ozersk, the plutonium city Velikhov had taken us to in 1989); Bonn, Germany; London; Moscow; and Tokyo.

One of the arguments from breeder proponents that we had to deal with in Europe and Japan was that reactor-grade plutonium was not weapon useable. So I invited Carson Mark along to our meetings in Europe. Carson was the retired head of the nuclear-weapon design group in Los Alamos. Later, he wrote an article deriving very cleverly the probabilities of different yields for reactor-grade plutonium, from estimates of the corresponding probabilities for the weapon-grade plutonium in the Nagasaki bomb in a declassified memo from J.R. Oppenheimer, the first director of Los Alamos, to General Groves, the overall leader of the World War II nuclear-weapons project (Mark 1993). Carson sent his draft to me without telling me that it was still in the clearance process so we published it *Science & Global Security* and thereby inadvertently preempted the quibbles that could have tied it up indefinitely. Carson was so eminent and the issues so marginal that the classifiers decided not to pursue their quibbles.

Since 1993, it has become public that the use of tritium in modern weapons design to "boost" their fission yields has made those yields insensitive to the isotopic makeup of the plutonium used. There are other reasons why weapon designers prefer weapon-grade plutonium with its low radioactivity, but explosive yield is not one of them.

In the Clinton Administration, whenever the European Union or Japan or Switzerland had to ask for U.S. permission to reprocess spent fuel that had been enriched in the U.S. or had been irradiated in one of their General Electric or Westinghouse-designed reactors, I attended the inter-agency meetings on their requests.

When I was working in the White House, the UK Government was expected to give the go-ahead for starting up British Nuclear Fuel Limited's (BNFL's) Thermal Oxide Reprocessing Plant (THORP). By that time, however, the UK breeder-reactor program was dead and, as a result of its reprocessing of the natural-uranium-metal fuel used in its first generation Magnox reactors in an older reprocessing plant, the UK already had 50 tons of separated plutonium that it did not know what to do with.

BNFL's idea was to make money by reprocessing spent fuel from light-water power reactors in countries that did not have their own reprocessing plants but were still seeking plutonium for their breeder programs: Japan, Germany and other European countries partnering with France in its breeder program. The plant would also reprocess the uranium oxide spent fuel from the UK's second-generation Advanced Gas Reactors, although that would just add to the UK's stockpile of plutonium with no usage plan.

Here I thought I had a great idea. I wrote a draft memo to the UK government saying that, instead of operating the THORP plant, the UK could use its reprocessing contracts with the foreign utilities to get rid of its now unneeded civilian plutonium and the radioactive reprocessing waste that the UK had accumulated as a result of its previous reprocessing. In exchange, the UK could take the foreign utilities' money and keep their spent fuel, which would be easier to manage than the UK's separated plutonium and reprocessing waste. I called this "virtual reprocessing." Much later, I learned that this idea had already been proposed by some independent analysts in the UK and had been rejected (Forwood, MacKerron, and Walker 2019, 16).

TK: That would have been a good deal for the UK.

FvH: Yes, they also wouldn't have to clean up the THORP plant when they decommissioned it, which will cost billions of pounds.

TK: You wrote that idea in a draft memo?

FvH: Yes, and then, OSTP circulated it to the Defense, Energy, and State Departments and to the National Security Council for their comments (Von Hippel 1993a).

I recall that Bob Einhorn, who was a Deputy Assistant Secretary of State at the time, called me up and said, "Frank, OSTP doesn't talk to other countries. That's the State Department's job – and this would just make the UK government more angry at the US anti-reprocessing policy. So there is no point."

He was right but I was convinced that we should share my great idea with the UK. So, Jack Gibbons, the President's Science Advisor called up his UK counterpart, William Waldegrave, Minister of Public Service and Science, and read the memo to him over the phone.

The UK went ahead anyway and started up THORP, which did indeed turn into an economic disaster and bankrupted BNFL. Ten years later, the UK set up a taxpayer-funded Nuclear Decommissioning Authority that is currently spending 4 billion USD a year cleaning up the reprocessing site in an effort that is projected to take another century. Most of the mess, however, is from earlier reprocessing plants.

TK: One last question then about your time in government: How about the indefinite extension of the Nonproliferation Treaty in the spring of 1995 and the Fissile Cut-off Treaty on which negotiations were supposed to begin? Those were not within your scope?

FvH: Those issues were primarily the responsibility of the Arms Control and Disarmament Agency (ACDA). Ambassador Tom Graham of the ACDA led the negotiations on the extension of the NPT.

Unfortunately, later, Jesse Helms, the Republican chairman of the Senate Arms Services Committee insisted that ACDA be abolished as an independent agency as his price for bringing the Chemical Weapons Convention to the Senate for ratification in 1997.

The problem of Republican disdain for arms control and disarmament did not begin with the Trump Administration.

Promoting a Fissile Material Cutoff Treaty in South Asia

FvH: Before I went into the Clinton Administration, Gorbachev and Yeltsin had both stated that Moscow was interested in an FMCT and, relatively early in his Administration, Clinton, said that the US was as well. But, until 1996, the focus in the Geneva-based Conference on Disarmament (CD) was on the Comprehensive Test Ban Treaty. So, there was not much to do on the FMCT until the negotiations started. Remarkably, they never did start: initially because Russia and China wanted to prioritize the prevention of an arms race in outer space while the US did not want to be constrained there, and later because Pakistan wanted to delay the process so that it could build up its stocks of plutonium to equal those of India.

The problem that has neutered the CD as a disarmament negotiating body since 1996 is that a consensus is required to proceed. Any one of the 65 countries that are members can block progress. And it has been impossible to achieve a consensus.

TK: But didn't you promote the Fissile Cutoff Treaty in trips to Pakistan and India?

FvH: Yes, starting in 1993, just before I went into the White House.

I was invited to come to Pakistan to lecture in an arms-control course for interested young Pakistanis. That was where I met Zia Mian who, subsequently, along with Alex Glaser, succeeded me in co-chairing Princeton's Program on Science & Global Security and the International Panel on Fissile Materials.

TK: Who organized the arms control course?

FvH: I recently learned that the initiative came from Pervez Hoodbhoy, at that time a professor of physics at Quaid-i-Azam University in Islamabad. The funding came from the W. Alton Jones Foundation whose international security program was run by George Perkovich, a South Asia expert.

The meeting was in the Murree Hills, a mountain resort where the British, when they controlled South Asia, went to get away from the summer heat in the lowlands. This was my first trip to South Asia, and, by getting sick, I learned how dangerous it was to drink the water – even bottled water.

The vans we were driven around in were original pieces of art. The drivers had covered them with mosaics of colored cut glass. But the drivers also would cut corners speeding around the blind curves of the mountain roads. If another vehicle had been coming around the curve in the other direction, we all would have been killed.

After the meeting, I went to Islamabad and bought a book about A.Q. Khan written with his cooperation. It was written like a promotional brochure and included cutaway diagrams of the interiors of the gas centrifuges whose designs Khan had stolen from the Netherlands to enrich uranium for Pakistan's nuclear-weapon program.

That was a decade before it became publicly known that A.Q. Khan was selling centrifuge designs and components to Iraq, Iran, Libya and North Korea. I should have realized that something was going on.

In any case, I did talk about the proposed Fissile Cutoff Treaty in Islamabad and then went to New Delhi and talked about it there as well. They listened politely. In New Delhi, I suggested, "instead of having a nuclear arms race with Pakistan, why don't you people talk to each other about how you could prevent it?" And the Indians said, "We don't care about Pakistan's nuclear program. It's China's we worry about. So, if you want us to talk to somebody, get us together to talk to the Chinese."

So I talked with our former post doc, Shen Dingli, who had gone back to be a professor at Fudan University in Shanghai. He was willing to host a Chinese-Indian-Pakistani meeting on "Possible Interlinked South Asian and Worldwide Arms Control and Disarmament Initiatives." Therefore, in February 1994, while I was in the White House, I took a week off to go to Shanghai with Jeremy Stone, President of the Federation of American Scientists, with whom I had partnered with in our non-governmental initiatives with Soviet Union (see Part 2).

We learned that the receptivity to outside non-governmental initiatives in Gorbachev's Moscow was the exception, not the rule.

The Pakistanis were happy to be part of the meeting but the Chinese officials said, in effect, "Why don't you Indians and Pakistanis use this opportunity to talk with each other?" And the Indians responded, "Why don't we all talk about how hypocritical the United States is being when it tries to persuade other countries not to acquire nuclear weapons?"

In 1995, just after I left the OSTP, we had a second meeting as a part of this initiative in Goa, India and, in 1997, a third meeting in Islamabad. But we did not accomplish much.

Verifying Warhead Dismantlement

TK: So, while you were in the White House, there were no official preparation for Fissile Material Cutoff Treaty negotiations?

FvH: Not much. We did have studies on verifying warhead elimination, which we were interested in negotiating with Russia.

One of the issues I introduced into that debate was whether the average amount of plutonium and highly enriched uranium (HEU) in US warheads could be declassified. If we could declassify those numbers, it would be possible to monitor mixed batches of warheads going into the dismantlement process, and verify the associated quantities of plutonium and HEU oxide coming out the other end and being placed into an IAEA safeguarded disposal process. Of course, it would be more complicated than that because you would need to use what the IAEA calls "containment and surveillance" to assure that no fissile material was diverted from the process. Also, between dismantlement campaigns, you would have to check that no fissile material remained inside the dismantlement facilities.

Al Narath, then director of the Sandia National Laboratories, led a "Fundamental Classification Review that concluded these the average numbers could be declassified. But they weren't.

TK: The weapons labs didn't want to disclose the information?

FvH: They made a silly argument that, if terrorists stole some plutonium, they might realize that they had enough to make two bombs instead of one. My counter was, that in such a case, it would be good if they tried, since bombs made with a smaller amount of plutonium would be more likely to fail.

In fact, I had already estimated these numbers by dividing my estimates of the US stockpiles of weapons HEU and plutonium by the number of US nuclear warheads at the end of the Cold War. I published those estimates in August 1993, just before I joined the White House (Von Hippel et al. 1993).

Later – probably 2000 – while I was serving as an external reviewer of the work of Los Alamos National Laboratory's Nonproliferation and International Security Division, I had an interview with the Los Alamos security people when my clearance came up for review. They raised two issues. One was the fact that I had published the average amount of plutonium in a US warhead. I was able to respond that that was before I had had a clearance.

I had been quite reluctant to take a clearance because I was afraid that it would mean that my publications would have to be reviewed forever after. In fact, I was exposed to relatively little classified information while I was in the White House, and I have not felt significantly constrained about what I can say since.

Life in Washington

TK: So, how was life in Washington.?

FvH: I had just been awarded a MacArthur Fellowship, which gave us enough money to pay off the mortgage on our home. My wife, Pat decided to quit her job and go to college. She stayed in our house in Princeton Junction for a last year commuting to New York, London and Moscow as a publisher. As a result, during my first year in Washington, we were together in Princeton most weekends. I left to Washington via train early Monday mornings and returned Friday nights. A former student, Michael O'Hanlon[3], rented me his extra bedroom for the four nights a week I stayed in Washington. I often worked late those nights but occasionally I met with friends.

Daniel Ellsberg

One was Dan Ellsberg[4], who was living in Washington and part of the non-governmental arms control community at the time.

[3]Currently, a senior fellow at the Brookings Institution in Washington, specializing in defense and foreign policy issues. He began his career as a defense budget analyst at the Congressional Budget Office.

[4]Ellsberg was a defense analyst who worked at the Air Force think tank, RAND, from 1958 until 1970 with three years leave to work for the US government. He is famous for releasing the "Pentagon Papers," a classified history of the Vietnam War commissioned by Defense Secretary MacNamara. Ellsberg was arrested and charged under the 1917

When I started at OSTP, I had half a dozen people working for me. One was on assignment from the CIA. One night, he and I were working late around 6:00 PM when he came to me and said, “Frank, there’s someone on the phone. He says his name is Dan Ellsberg. And I’m the Queen of Sheba!”

TK: What did he mean?

FvH: He thought that this could not be Ellsberg because Ellsberg was a historical – even mythical – figure, like the Queen of Sheba.

I went out to dinner with Ellsberg, and he asked me what I was working on and I told him. His response was, “Frank, you should be more discreet!” I broke down in laughter at hearing *him* say that. So he explained that he meant that you should be very discreet until you learn something so big and bad that you have to blow the whistle.

TK: That is what he did.

FvH: Yes, and he wishes more people would do the same.

Tom Cochran also worked nearby at the Natural Resources Defense Council. One evening, I had to give a public talk in Arlington on our progress in developing a plan for plutonium disposal. Tom came and made some critical comments. Afterwards, he gave me a ride to the Metro and told me, “Frank, you know what I just discovered? I enjoy attacking my friends as much as my enemies!”

Lessons Learned

TK: So what were the most important things you learned from your 16-month experience in the government?

FvH: One was that the information I got from the NGOs was almost always more useful than from the CIA.

In fact, I have some funny stories about that. The funniest was when I asked my assistant from the CIA, “What does the intelligence community know about plutonium in Russia?” He checked and, when he came back, he said, “I have a report from a source of unknown reliability.” The CIA had removed the identification of the source to conceal how they had gotten the report. It turned out to be a report I had written on an international seminar that Diakov had organized on reprocessing in Moscow in 1992.

I also learned that there are some real experts in the government – like Fred McGoldrick[5].

Espionage Act but the charges were dismissed by the judge as a result of the revelation that the Nixon Administration’s “Plumbers,” who were caught breaking into the Democratic Party’s headquarters in the Watergate complex, had previously broken into the files of Ellsberg’s psychiatrist in the hope of finding compromising information on him. Indeed, the group was named “plumbers” because they were originally established to stop Ellsberg’s “leaks.” Ellsberg has written two remarkable books about his experiences in the government, *Secrets: A Memoir of Vietnam and the Pentagon Papers* (Viking 2002) and *The Doomsday Machine: Confessions of a Nuclear War Planner* (Bloomsbury 2017).

[5]Now a consultant in nonproliferation and international nuclear cooperation, McGoldrick served for 30 years in the U.S. government in a variety of positions, including director of the Office of Nonproliferation and Export Policy in the Department of State.

I learned too that meetings are held on too short notice to prepare for – and there are too many meetings. You don't have time for thoughtful preparation. You are just reacting.

TK: What do you mean by short notice?

FvH: Typically, a meeting would be called for the next day – not for two weeks in the future.

There is a hierarchy of meetings. I was equivalent to an assistant secretary. I therefore could convene an interagency meeting of people at that level to discuss an issue.

People would try to settle things at that level because, at the next level up, the deputy secretary level, people didn't know as much detail. But, if something was really important – like, how to react to the Chinese test of 1993, for example – that would rise to the level of the Secretaries of Defense, Energy and State and the president would even become involved.

TK: Have you ever been tempted to go back to the government since?

FvH: As I will describe in Part 7, in December 2008, after Obama asked John Holdren to be his science advisor, John asked me whether I would be willing to be his associate director for national security and international affairs. I told him that I would think seriously about it. But he didn't come back. My guess is that he was told that the Senate would not confirm me. It later failed to confirm Phil Coyle for the position, because a number of Senators held it against Coyle that he was skeptical about the effectiveness of the ballistic missile defense system that the G.W. Bush Administration had started to deploy. The Senate did not bring Coyle's nomination up for a vote even though he had spent 32 years working on nuclear weapons at the Livermore National Laboratory and seven in the Pentagon as Director for Operational Test and Evaluation.

In the end, despite Obama's stirring Prague speech about the importance of working toward the goal of abolishing nuclear weapons, his administration was blocked by the Pentagon and the Republicans in Congress from accomplishing much on that agenda.

When Obama came in, he wanted to take US intercontinental ballistic missiles off hair-trigger alert. Later, he wanted to reduce the number of US strategic warheads to 1,000 and institute a US no-first-use policy for nuclear weapons. He wanted to get the Senate to ratify the Comprehensive Test Ban Treaty. All he got were modest cuts in the ten-year New START treaty whose ratification he had to buy with a commitment to a new generation of US intercontinental ballistic missiles, ballistic missile submarines, strategic bombers and long-range air-launched, nuclear-armed cruise missiles. President Trump is now balking at extending the New START Treaty beyond 2021.

I don't blame this failure on Obama or the people he staffed his administration with. In my view, it shows you the limits of what you can do to move nuclear-weapon policy when the public and Congress are no longer interested because they assume that the danger of nuclear war had gone away with the end of the Cold War. Indeed, as a result of public pressure during the Cold War, President Reagan's Administration, which came in determined to ramp up the nuclear arms race and drive the Soviet Union into bankruptcy, agreed to much deeper fractional cuts. So did the G.H.W. Bush

Administration that followed the Reagan Administration and preceded the Obama Administration.

TK: What about the question of the demarcation line between theater and strategic ballistic missile defense?

FvH: The National Security Council people kept me completely out of any discussions of ballistic missile defense.

TK: How come? You were in charge of scientific issues relating to national security.

FvH: They managed to not inform me about the meetings. They probably guessed that I was skeptical of the effectiveness of the ballistic missile defenses being proposed, and that I felt that they would be counterproductive in that they would stimulate offensive countermeasures and potentially even an offensive buildup by Russia and China.

Which is what has happened.

In retrospect, I realize that the focus of the NSC staff was on how to deal with the political pressure from the Republicans in Congress for a US commitment to a national ballistic missile defense that would violate the 1972 Soviet/Russian-US ABM treaty.

They managed to hold off that commitment until President G.W. Bush took over.

TK: How about the indefinite extension of the Nonproliferation Treaty (NPT)?

FvH: The one thing that I did do, as I have recounted in Part 4, was argue very strongly that, even if the Chinese and the French continued to test, the US should not restart because, if we did, the Russians would, and that would sour the atmosphere for a vote to indefinitely extend the Nonproliferation Treaty, which otherwise would have expired in 1995.

TK: Before the 1995 NPT Extension Conference, the idea was to promote the CTBT and the Cut-off treaty. And in Geneva, there were tough negotiations over CTBT for more than a year after the Extension Conference.

Leaving OSTP

TK: Why did you resign from the White House?

FvH: Princeton had given me two years leave so I originally expected to stay on in OSTP through August 1995.

But, after about a year, I concluded that those of my ideas that people in the administration were willing to listen to had been accepted and my other ideas would never be accepted.

Also, I didn't have time to think of new ideas. As Kissinger had said, you spend your intellectual capital when you're in the government. So I started thinking about leaving early and I talked about it with Fred McGoldrick, a wise career bureaucrat in the State Department with whom I worked on foreign reprocessing. Fred had negotiated virtually all the US agreements with other countries for peaceful nuclear cooperation. More importantly, I liked his sense of humor.

One day, I said to Fred, "I think I'm about ready to go and rejoin the outside world." His reaction was, "Frank, that's crazy! You can have much more impact on the inside! Those people outside are like gnats!" (Gnats are tiny flies.)

This observation made me realize that even people inside the government as smart as Fred didn't understand the role of the policy activists on the outside. Outsiders may not know about or be able to insert themselves into government meetings where the decisions are made but the people on the outside set the agenda. The big policy ideas come from the outside.

So, I left OSTP at the end of 1994. To my surprise, OSTP gave me a big farewell party at which they told stories about how I had operated inside the government. I learned that they had both admired and been amused by my independent initiatives.

Of course, it was easier for me than the career people to tune out the negative feedback I had been receiving, I had nothing to lose.

I spent my final six months in Washington starting a new project at the Federation of American Scientists. I also wrote an article in the FAS *Public Interest Report* on what I had done while inside the government. (Von Hippel 1995a) and a perspective for *Physics Today* (Von Hippel 1995b).

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References

Bukharin, O., F. N. von Hippel, and S. K. Weiner. 27-29 June 2000. "An Update Based on a Workshop Held in Obninsk." Program for Nuclear Policy Alternatives. Russia: Princeton University.

Bukharin, O., H. A. Feiveson, F. N. von Hippel, S. K. Weiner, M. Bunn, W. Hoehn, and K. Luongo. 14-15 March 2000. "Helping Russia Downsize Its Nuclear Complex: A Focus on the Closed Nuclear Cities: Report on an International Conference Held at Princeton University." Program for Nuclear Policy Alternatives. Princeton University.
Bukharin, O., and W. Potter. May/June 1995. "Potatoes Were Guarded Better." *Bulletin of the Atomic Scientists*: 46.
Clements, T., E. Lyman, and F. von Hippel. July/August, 2013. "The Future of Plutonium Disposition." *Arms Control Today*. https://sgs.princeton.edu/pdf/clements-lyman-vonhippel-2013.pdf
Forwood, M., G. MacKerron, and W. Walker. 2019. *Endless Trouble: Britain's Thermal Oxide Reprocessing Plant (THORP)*. Princeton: International Panel on Fissile Materials. http://fissilematerials.org/library/rr19.pdf
Kang, J., and F. N. von Hippel. 2005. "Limited Proliferation-Resistance Benefits from Recycling Unseparated Transuranics and Lanthanides from Light-Water Reactor Spent Fuel." *Science & Global Security* 13: 169–181. doi:10.1080/08929880500357682.
Macrotrends. 2019. "Crude Oil Prices – 70 Year Historical Chart." Accessed 7 November. https://www.macrotrends.net/1369/crude-oil-price-history-chart
Mark, J. C. 1993. "Explosive Properties of Reactor-Grade Plutonium." *Science & Global Security* 4: 111–128. doi:10.1080/08929889308426394.
Philippe, S., and F. N. von Hippel. November, 2016. "The Feasibility of Ending HEU Fuel Use in the U.S. Navy." *Arms Control Today*: 15–22. https://sgs.princeton.edu/sites/default/files/2019-11/philippe-vonhippel-2016.pdf
Von Hippel, F. N. 1993a. "Draft Letter from Dr. Gibbons to William Waldegrave, U.K. Chancellor of the Duchy of Lancaster Re a Possible Alternative to Putting the Thermal Oxide Reprocessing Plant (THORP) into Operation." Accessed 8 November 1993. https://sgs.princeton.edu/pdf/gibbons-to-waldegrave-1993.pdf
Von Hippel, F. N. 1993b. "Memorandum to Jack Gibbons, "Shutting down the Liquid-Metal-cooled Reactor (LMR) Program, (Talking Points for Gibbons-O'Leary Lunch)." Accessed 13 November 1993. https://sgs.princeton.edu/pdf/gibbons-to-oleary-1993.pdf
Von Hippel, F. N. 1994a. "Memorandum to Jack Gibbons, Advanced Neutron Source MEU/LEU Study." Accessed 28 January 1994. http://sgs.princeton.edu/pdf/vonhippel-to-gibbons-1994.pdf
Von Hippel, F. N. 1994b. "Memorandum to Jack Gibbons, "The Possibility of Redesigning the Pu-238 General-Purpose Heat Sources to Be Used in the Cassini Mission to Increase Confidence of Survival of Reentry from an Earth Flyby." Accessed 22 September 1994. http://sgs.princeton.edu/pdf/vonhippel-to-gibbons-1994b.pdf
Von Hippel, F. N. March/April, 1995a. "Working in the White House on Nuclear Nonproliferation and Arms Control: A Personal Report." *F.A.S. Public Interest Report* 1: 3–8. http://sgs.princeton.edu/pdf/vonhippel-1995b.pdf
Von Hippel, F. N. June, 1995b. "Big Government and Little Analysts." *Physics Today*. 48: 51–52. http://sgs.princeton.edu/pdf/vonhippel-1995.pdf
Von Hippel, F. N. 1998. "Memo to Leon Fuerth, Vice President Gore's National Security Advisor, "Conversion of Russia's Plutonium-production Reactors: Nuclear Terrorism and Safety Issues." 20 October. http://sgs.princeton.edu/pdf/vonhippel-to-fuerth-1998.pdf
Von Hippel, F. N., ed. 2010. *The Uncertain Future of Nuclear Power*. Princeton: International Panel on Fissile Material. http://fissilematerials.org/library/rr09.pdf
Von Hippel, F. N. 2016. *Banning the Production of Highly Enriched Uranium*. Princeton: International Panel on Fissile Materials. http://fissilematerials.org/library/rr15.pdf
Von Hippel, F. N., J. Kang, and M. Takubo. 2019. *Plutonium: How Nuclear Power's Dream Fuel Became a Nightmare*. New York City, NY: Springer.
Von Hippel, F. N., and M. Bunn. November/December, 2000. "Saga of the Siberian Plutonium Production Reactors." *F.A.S. Public Interest Report*: 1–9. http://sgs.princeton.edu/pdf/vonhippel-bunn-2000.pdf

Von Hippel, F. N., M. Miller, H. Feiveson, A. Diakov, and F. Berkhout. August, 1993. "Eliminating Nuclear Warheads." *Scientific American*. 269: 44–49. https://sgs.princeton.edu/sites/default/files/2019-11/vonhippel-1993b.pdf
Von Hippel, F. N., and S. K. Weiner. July/August, 2019. "No Rush to Enrich: Alternatives for Providing Uranium for U.S. National Security Needs." *Arms Control Today*. 10–15. https://sgs.princeton.edu/pdf/vonhippel-weiner-2019.pdf
Weiner, S. K. 2011. *Our Own Worst Enemy? Institutional Interests and the Proliferation of Nuclear Weapons Expertise*. Cambridge, MA: MIT Press.
World Bank. 7 November 2019. "GDP (Current US$)." https://data.worldbank.org/indicator/NY.GDP.MKTP.CD