

THE URANIUM TRAIL FADES

We are eliminating programs that are no longer needed, such as nuclear power research and development. (Applause.)

—President Bill Clinton, State of the Union Address, 1993—

The technicians loaded EBR-II with the new IFR fuel pins. Made of plutonium, uranium, and zirconium, the fuel pins conducted heat well, a virtue that helped to keep the temperature of the fuel low. Furthermore, the first test assemblies had achieved a nineteen to twenty percent burnup rate, which was far better than what Charles Till considered necessary for commercial feasibility. Commercial water-moderated reactors were still averaging only three to four percent burnup. If the rest of the IFR tests went as well as the fuel burnup demonstration, the IFR might change the world of nuclear energy rather dramatically.¹

This April day in 1986 was the moment to prove that a nuclear reactor could be safe because of the natural laws of physics, not because of complex, highly engineered emergency systems and consistent human performance. The reactor sat in EBR-II's tank of liquid sodium coolant, ready for the test. For over twenty

years, this solid little sodium-cooled reactor had run safely and reliably, contributing electricity steadily to the Site. The coolant, which had a poor reputation among some engineers because it reacts with water and air, in fact conducted heat (very well) and operated at atmospheric pressure. The piping was never subjected to the stresses introduced to a system when water circulated under high pressure. In practical experience, the sodium coolant had proved to be a non-problem. Sodium

had the additional benefit of not causing corrosion or the crud that went with it.²

The designers of the IFR fuel felt that its safety reliability rested on the fact that hot metal expands. If the pencil-thin fuel pins overheated, the metal would swell and the plutonium and uranium atoms would move farther apart from one another and lose reactivity. If the coolant failed to circulate for some reason, the chain reaction should shut down before the fuel could melt, all without any help from scram buttons or control rods.

At least, that was the principle to be proved. As in the exciting days of the 1950s, Argonne invited distinguished visitors from all over the world—utility executives, scientists, and representatives of governments—to witness what they hoped would be a historic day. The plan was to simulate a complete electrical blackout occurring

while the reactor operated at full power. They would initiate two types of accidents that day. In the first, the pumps would “fail” to move the coolant, pre-



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Visitors at EBR-II during the first test on April 3, 1986, watch gauges that show the coolant temperature rise—and fall—after the coolant pump “failed.”



Space was available at the Irradiated Fuel Storage Facility for additional fuel from Ft. St. Vrain reactor. Distances and dividers were arranged to prevent accidental criticalities.

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saging the accident at Chernobyl later that month; and in the second, the heat exchange between the reactor core and the electrical generator would cease, as had happened at TMI.

As the experiment began the reactor was at full power. The pumps then shut down. Till and the others eyed the gauges. The temperature in the reactor shot straight up, “not a pretty sight to anyone who’s had anything to do with a reactor,” observed Till later. But the temperature spiked quickly, and within a few minutes the reactor’s power dropped to zero. The temperature returned to normal. The IFR operators, meanwhile, stood back, their hands in the air, so to speak, disengaged from the controls. Neither they nor an emergency core cooling system had been necessary for the reactor to recover safely all by itself.³

“It worked on the blackboard, it worked in computer simulations, and the engineers were willing to bet their lives that it would work in practice,” wrote an admiring reporter of the demonstration. The implications for a commercial reactor were good: an IFR would need less reliance on emergency power and core cooling accessories, reducing the capital cost of the plant. A few environmental organizations took notice of the IFR. A spokeswoman for the Audubon Society said that she supported the development of solar energy as the best way to save the planet from fossil fuel heat contamination, but she also favored testing “these so-called idiot-proof reactors.”⁴

The Argonne team now could move on to prove the next principle: that the IFR could solve the nuclear waste problem.

Like all other reactor fuels, the IFR fuel generated fission and activation products, the latter of which included plutonium, americium, and the other long-lived TRU elements. These elements required isolation from the environment for centuries, and these were the ones to be recycled as IFR fuel. By contrast, the most dangerously energetic fission products would decay to harmless levels within a few hundred years.

Recycling was to be done within the same doughnut-shaped argon-atmosphere cell next door to EBR-II where Argonne had re-cast uranium metal fuel in the 1960s. The recipe began with chopping up the fuel and dissolving it in a solution of cadmium and molten salt. Upon applying an electric current through the material, the plutonium and uranium (and other TRU elements and some fission products) accumulated on collector electrodes. The rest of the fission products

remained in the cadmium and salt. Thus separated, the uranium and plutonium could be recast into new fuel pins and sent back to the reactor to generate more electricity. The rest was waste,



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Above. Using a glovebox, a technician performs a quality assurance check on a new IFR fuel pin. Below. The exterior shape of the Fuel Cycle Facility reflects the circular architecture of the argon-atmosphere laboratory.



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but it lacked the great volumes of contaminated water and long-half-life chemicals typical of Chem Plant recovery processes.

The recycling of plutonium promised to assuage fears about terrorist diversion. Because the plutonium was mixed up with other TRU elements and fission products, it was dirty, impure, and highly radioactive, not the kind of “weapons grade” material required for making bombs. If someone managed to steal it, the would-be bomb-maker would have to refine it in a facility similar to the Chem Plant. Terrorists or rogue states would have a hard time hiding one of those.

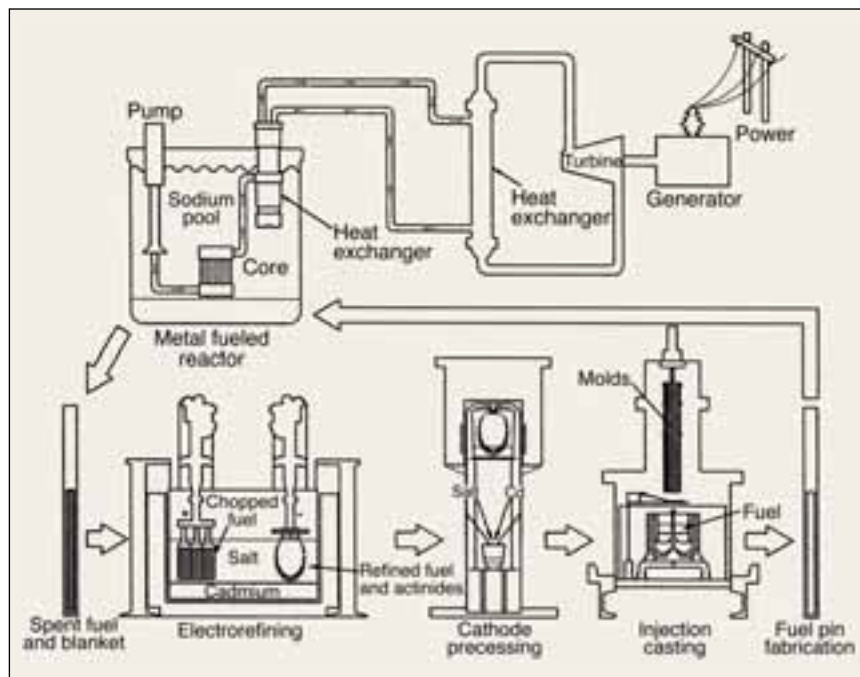
Argonne proceeded. Additional preparations and safety studies were required before launching the final experiments. When all was ready, EBR-II would need to burn IFR fuel in the reactor for two years or so, recycle the spent fuel into new fuel pins, and then burn the new fuel for another two years. This would “close the loop” and demonstrate the continued reliability of the reactor operating on its new recycled fuel while producing electricity at the same time.

Three weeks after the IFR fuel had passed its test so well, an accident occurred at the Chernobyl reactor in the USSR, overshadowing the good news. Far worse than the TMI accident, steam and fuel vapor explosions blew the top off the reactor and released into the atmosphere great quantities of radioactivity, more than that released in the bombing of Hiroshima. Opponents of nuclear power felt confirmed in their objections to any and all nuclear reactors, even the IFR. To the shelves of nuclear literature were added books with titles such as *Final Warning: The Legacy of Chernobyl*.⁵

Initially, the stark contrast between the safe and harmless shutdown of EBR-II and the dramatic events at Chernobyl—each initiated by the same turning off of the coolant pumps—worked to the advantage of the IFR, but as the decade ended, the political environment in Washington, D.C., became more hostile to the IFR. Many of the nuclear opponents from the Carter years still wielded influence at policy-making levels. Consumer advocates like Ralph Nader called for the government to give up nuclear research altogether and concentrate on renewable energy alternatives. By the time Bill Clinton won election

as president in 1992, the weight of political sentiment continued to be unfavorable for nuclear power. In fact, in his first State of the Union address, he told Congress that he felt nuclear power research was no longer needed.⁶

To nuclear opponents, the IFR looked like any other dangerous plutonium-breeding reactor. The program was canceled in 1994, despite the best efforts of the Idaho congressional delegation to keep the project funded. Argonne shut down EBR-II for the last time on September 30, 1994. It had not had its chance to demonstrate the full fuel cycle. After a technically sensational thirty-year run, the reactor was grounded



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The Integral Fast Reactor concept. Fuel makes electricity and when spent, goes next door to be recycled as new fuel pins.

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for political reasons before it could prove its most important principle.⁷

Like a spool that had tumbled to the ground and unwound its thread, INEL research on new reactor concepts rolled to a stop. Many INEL scientists had invested their careers and their patriotism on the proposition that the United States should become and remain the world leader in nuclear technology. It appeared to them that such leadership was now likely to pass to Japan or some other nation. It was a moment of profound and, for some, bitter regret.

The Cold War, one of the igniters of patriotism, was a spool that had come to the end of its thread as well. Perestroika and Glasnost changed the USSR. Lithuania declared itself independent of the Soviet “union.” The USSR collapsed. The Berlin Wall came down. In November 1990 President George Bush said the Cold War was over. American defense spending declined, and the U.S. Navy scaled back its nuclear fleet. With this, the Navy’s training needs diminished and the Navy started to close some of its training facilities.⁸

At the INEL, the Navy shut down its reactors and the research and training programs associated with them. It had shut down the S1W prototype on October 17, 1989, before the Cold War had ended, citing the prototype’s age and the high cost of its continued operation. Its last core had operated for twenty-two years, the longest of any nuclear reactor core in the world at that time. The A1W prototype ran until January 1994, and S5G until May 1995. The regular arrival and departure of trainees

ended. Only the Expanded Core Facility remained. Despite a diminished fleet complement, the Navy planned to continue shipping reactor cores to Idaho.⁹

Thus the number of reactors actually operating at the INEL went down to three. The ATR and the ATRC (its low-power auxiliary) remained operating as an essential part of the Navy’s fuel examination and materials testing program. Indeed, the Navy was the ATR’s biggest customer, although the reactor continued to manufacture isotopes of interest to medical and industrial markets. At Argonne-West, the low-power NRAD reactor operated from time to time as a tool for neutron radiography, a method of taking pictures of radioactive materials by directing a stream of neutrons at the subject. NRAD had taken the pictures of the TMI fuel-failure simulations. The TREAT reactor was in standby at Argonne, but without an assignment. The uranium trail was

carrying the merest trickle of fresh reactor fuel into Idaho.¹⁰

However, DOE still needed to ship Rocky Flats TRU waste and spent reactor fuel to INEL for storage. The Idaho governor, on the other hand, did not support these missions. In stark contrast to its tolerance of INEL’s earlier nuclear missions, the governor’s office now wrestled with DOE to keep these forms of uranium and plutonium from entering the state. Although the IDO played a role in the struggles, the decisions about INEL missions in the scheme of things came primarily from DOE in Washington, D.C.

The wrestling match had begun not long after Cecil D. Andrus became Idaho governor for his third term in

Admiral Bruce DeMars (left) and Governor Cecil Andrus discuss naval nuclear propulsion in the S5G prototype.



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1986. He had returned to the state after serving the Carter administration and took office after John Evans completed his second term. Andrus knew that the decade of the 1970s had passed without DOE removing any buried waste from the INEL. But he could also see that during the 1980s, DOE had prepared a deep underground salt cavern near Carlsbad, New Mexico, to isolate and store the waste. In 1988 the Waste Isolation Pilot Plant (WIPP) seemed nearly ready to open.¹¹

In September 1988 Andrus and Don Ofte, who had followed Troy Wade as IDO manager in 1987, went to New Mexico for a first-hand look at the WIPP. While there, Andrus was unable to extract from DOE officials an opening date for the plant. New Mexico opponents were promoting delay, and Andrus feared that the decade of the 1980s also would pass without any waste leaving Idaho. Meanwhile, Rocky Flats continued sending waste to the INEL. For Andrus, the predicament with the INEL had not changed. As he had observed more than once, the INEL was of enormous importance to the Idaho economy. It seemed that the only way to ensure public confidence in the INEL was to protect its environmental integrity and restore the Site's credibility with the public. That meant removing any reasonable possibility that the aquifer could become contaminated because of buried radioactive waste.¹²

Andrus contemplated what strategies a small state like Idaho might use to muscle the federal government into opening WIPP and proceeding with the removal of waste from Idaho. One idea was to shine a very bright light on the problem



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and make it pertinent to the national government and other states as well. As he wrote later, he had learned from his experience as a cabinet secretary that “the government in our nation’s capitol reacts only to crises.” He set out to create one.¹³

On October 20, 1988, after DOE officially postponed the opening of WIPP, Andrus ordered the Idaho State Police to stop at the border any railcars bringing shipments from Rocky Flats to INEL. The order stranded a boxcar that had come as far as Blackfoot but had not completed its journey to the INEL. DOE honored the closure and turned away a shipment from Illinois before it had a chance to reach a roadblock at the Idaho border. CBS television invited the governor to appear on its morning news program. On October 23, a Sunday, the *New York Times* published a photograph of an Idaho state trooper, his arms folded across his chest and eyes shaded by the visor of his hat, standing in front of his patrol car guarding the boxcar. Andrus had his bright light. “They have

Shoshone-Bannock tribal police block train shipment of Naval spent fuel.

broken their word too many times,” Andrus said of DOE’s failure to open WIPP. “They cannot give us a date.” DOE turned the Blackfoot car around and sent it back to Rocky Flats.¹⁴

The governor’s actions did not open WIPP, but it shut off the flow of Rocky Flats waste to the INEL. It might also have shut off shipments of TMI fuel to Idaho, but Ofte persuaded Andrus not to:

Not long after Rocky Flats shut down, I discussed with [Andrus] and his staff all of the materials coming to the INEL. The TMI fuel was controversial, and Andrus wanted to stop that, too. I explained how we had been tasked to analyze the TMI accident because we were the uniquely qualified facility in the country with the capability to do it. We had cooperative agreements with the Germans and the Japanese, and this was

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a nationally and internationally important project. He agreed to let it enter the state, and we shook hands. He told me later, he regretted it, but he said he wouldn't go back on his word.¹⁵

As it happened, DOE shut down production at Rocky Flats temporarily in December 1989 to deal with safety and management problems at the site, interrupting the production of waste that otherwise would have gone to Idaho. In 1991, after reassessing military requirements in the post-Cold War world, DOE decided that its arsenals no longer needed fresh nuclear warheads, and DOE stopped making plutonium weapons parts at the plant.¹⁶

The concept of “waste dump” took on a new meaning when Andrus learned in 1990 that INEL planned to accept for storage at the Chem Plant spent graphite fuel from the Public Service Company of Colorado, which was decommissioning its Fort St. Vrain reactor in Platteville. The fuel belonged to DOE, which had a contract with the utility company to store the fuel after it had been used up. DOE had built the Irradiated Fuel Storage Facility at the Chem Plant in 1975. It already stored fuel from Fort St. Vrain that had been shipped many years previously. These next shipments would send the balance of the fuel and fill hundreds of remaining vacant storage cells.

Andrus saw this move as new evidence of DOE's intention to convert INEL's “superb laboratory” into a “*de facto* waste dump.” He once again threatened to mobilize the state police to stop shipments at the Idaho border. The Shoshone-Bannock Tribe supported him,



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attempting to forbid shipments on the stretch of interstate highway crossing its reservation on the way to INEL.¹⁷

Much of the subsequent struggle took place in the courts. A long series of legal filings ensued and kept the IDO legal staff and the governor's attorneys busy for the next several years. With the help of temporary injunctions, Idaho managed to prevent the fuel from entering the state until September of 1991, when the 9th Circuit Court of Appeals in San Francisco sided with Colorado and DOE. Andrus's roadblock was ruled unconstitutional.

Idaho responded with another wave of litigation. During a short interlude in the fall of 1991 in which no judicial injunction prohibited fuel shipments, at least two Colorado shipments made it into the Chem Plant. Another injunction soon followed, and those shipments proved to be the last. The Colorado utility decided not to await the final outcome of the

Barrels of Rocky Flats waste stand in a certification staging area ready to go to the Waste Isolation Pilot Plant in 1989.

legal battles, which it feared could take years. It wanted to remodel Fort St. Vrain as a gas-fired power plant and proceeded to erect a spent-fuel storage building next door to the reactor.¹⁸

In April 1992 DOE announced that it would no longer reprocess any spent nuclear fuel at the Chem Plant. The country's need for enriched uranium was much reduced, it said. Since July 1988 the Chem Plant had processed no fuel while its underground pipes had been upgraded (placed in double conduit as extra protection against leaks), and now the shutdown was to be permanent. The Chem Plant would store spent Navy fuel instead of reprocessing it. The question of how long the fuel would be stored was unclear. At the direction of Congress, DOE was con-

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sidering a site at Yucca Mountain, Nevada, as a potential place to store spent reactor fuel. But the technical and ultimate political viability of this idea was far from certain.¹⁹

This turn of events brought Navy fuel into the continuing swarm of litigation, court orders, and political spotlights. Previously, Andrus had not sought to interfere with Navy fuel shipments into Idaho, partly because he considered the Navy's business a matter of national security and partly because the fuel had traditionally been reprocessed at the Chem Plant. However, he saw storage without reprocessing as an entirely new kind of mission. He soon concluded that the Navy saw Idaho as a weak state, a remote place where it could "dump" its spent nuclear fuel. He wanted such activity placed under the scrutiny of the nation's environmental laws.²⁰

Meanwhile, the IDO had embarked on the preparation of an Environmental Impact Statement (EIS) on waste management at the INEL, a study that would include waste burial practices and environmental restoration at the Site. (DOE Headquarters was to do a parallel study on its national waste management program.) Upon a finding by the U.S. District judge that DOE'S national program for the disposition of its spent fuel also should be subject to an EIS, DOE decided to add this item, national in scope, to the EIS already underway. Later, the study also embraced the Navy's spent fuel.²¹

The expensive project placed the burden of effort on the IDO staff in Idaho Falls to prepare and coordinate a document affecting Navy and DOE spent



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nuclear fuel operations across the entire national DOE complex—as well as a very large percentage of the work done at the INEL. It was a huge undertaking. The forces in conflict—the state of Idaho, the U.S. Navy, and DOE—now relied on an EIS to fulfill their conflicting hopes. The Navy wanted to send its fuel to Idaho. Idaho wanted a scientific document to demonstrate that storing TRU waste and spent fuel above the aquifer was environmentally unacceptable. DOE wanted to manage its national responsibilities and use its resources at the INEL in the most optimal way, hopefully welcomed by its host state.

The Fluorinel and Storage Facility at the Chem Plant in 1985. Fuel stored at the Chem Plant's 1950s-built storage basin was to move into this new facility.

The nation's environmental laws, which had been conferring on the states new powers of participation, intervention, and comment on federal activities ever since the beginning of the environmental movement, had given Idaho standing to discuss and influence the Site's internal affairs. In the old debate between the Site and Idaho about states' rights, the environmental movement had swung the pendulum decidedly in favor of Idaho.²²

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The court had told the Navy that while the EIS was being prepared, it could not ship its fuel into the Site. The Navy needed to defuel its ships, wished to send the fuel to Idaho, and didn't want to wait for the years it might take before a final EIS was published. The Navy decided to negotiate with Governor Andrus, hoping to ease the court's injunction before the EIS was completed. Soon the Secretary of the Navy himself, John H. Dalton, was trading letters with Andrus about what they might agree upon.

Andrus had a list of items to place on the negotiation table. The Snake River Alliance had recently brought to Andrus's attention a technical study that had questioned the reliability of the Chem Plant's 1950s-built storage basin (Building CPP-603) in an earthquake. Therefore, Andrus insisted that spent fuel being stored in this building be moved to safer quarters. In general, spent fuel should be stored above-ground and dry, not below ground in pools of water. Also, DOE should speed up the calcining of sodium-bearing liquid waste sitting in the aging storage tanks at the Chem Plant. Aside from the freedom to ship reactor cores to Idaho, the Navy wanted Andrus to help persuade the environmental community to accept whatever agreement they made. "Let's all be heroes," wrote Dalton.²³

When the discussions were over, the Navy was allowed to ship nineteen (of sixty-four) containers of fuel to Idaho, plus any others certified to be needed for national security. DOE agreed to accelerate the items on Idaho's work list and to make grants supporting the diversification of the economy in eastern Idaho. The IDO staff, already embarked on its massive EIS, was given milestone dates and had to complete the study on an aggressively accelerated schedule. The Navy and DOE agreed not to appeal the judge's injunction on further shipments or his decision requiring DOE to examine the agency's spent nuclear fuel program in an EIS. With Idaho's assent, the judge amended the order and allowed the nineteen shipments.²⁴

When DOE published for public review and comment the Draft EIS in June 1994, the governor's office was not happy with the document. It was not comprehensive, said Idaho, and it failed to evaluate the cumulative impacts of

waste storage or to consider alternatives; its proposed action program was vague. In November, the Navy asked if Idaho would allow eight more containers. Andrus refused.²⁵

But Andrus was about to leave the Idaho Statehouse, and the Navy's request fell into the lap of Phil Batt, the new governor. Batt allowed the additional containers. He told protesting Idaho citizens he was convinced that a court or Congress would decide that the Navy shipments were a matter of national security.²⁶

The Final EIS was published in April 1995 and its subsequent Record of Decision in June. The Record of Decision identified which of the alternatives developed in the EIS that DOE intended to implement. It indicated that the INEL could receive nearly 2,000 shipments of (Navy and other) spent nuclear fuel and additional shipments of TRU waste, but mentioned no requirement that the material ever leave Idaho. Batt decided to try to fulfill Idaho's long-



INEEL 99-237-1-27

At 7:00 a.m. on April 27, 1999, the first truckload of transuranic waste leaves the Radioactive Waste Management Complex for WIPP. Buildings in background store waste above ground.

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Former governors Cecil Andrus and Phil Batt stand behind Governor Dirk Kempthorne during ceremonies celebrating the first shipment of Rocky Flats waste to leave the Site.

time mission: to obtain from DOE a written schedule for removing waste—and now spent fuel—from the state. The citizens of Idaho had to be assured that INEL would not threaten the Snake River Plain Aquifer by transforming the Site into a “dump” for nuclear waste.²⁷

The new governor and his staff still felt that eventually the court would force Idaho to allow Navy fuel into the INEL. The question was whether Idaho might obtain any concessions from DOE or the Navy. The Navy was running out of options to hold nuclear fuel at its shipyards, threatening its ability to defuel ships and support the fleet, and the conflict was inhibiting DOE from carrying out its missions at the INEL. All parties chose to negotiate.²⁸

DOE representatives began making trips to neutral ground, cities like Chicago or Minneapolis, to meet their Navy and Idaho counterparts. They met in a law office or hotel rooms; sometimes the principals holed up together,

sending their aides and lawyers outside to await developments. After one such session lasting several hours, one of them stepped outside and said, “We have a deal.” The terms were refined throughout September, and an agreement was signed on October 16, 1995.²⁹

The Idaho Settlement Agreement was a detailed import/export list itemizing what could enter the state and what must leave and by when. With many interim milestones—including shipments of Rocky Flats waste to WIPP—the fulfillment of the Settlement was set for 2035. The stored fuel and TRU waste would all be gone. Penalties for DOE failure would cost it \$60,000 a day after 2035. At last, Idaho had it “in writing.”³⁰

After Batt signed the Agreement, those who opposed it attempted but failed to recall him from office. Opponents then gathered enough signatures to place on the ballot an initiative, Proposition Three, to nullify the Agreement and require voter approval for the receipt of

radioactive waste. After a spirited campaign in which “Stop the Shipments” battled “Get the Waste Out,” Idaho voters soundly rejected the proposition and supported Batt’s action by a margin of nearly two to one.³¹

Throughout the Idaho campaign to open WIPP and to fend off the entry of additional waste and spent nuclear fuel for long-term storage in Idaho, the role of science, technical analysis, and risk assessment had been relatively minor. The heart of the problem had been one of public perception. Settling it—and restoring the credibility of the INEL as an environmentally sound neighbor—had required political risk and eventually a careful collaboration—a partnership—between the IDO managers and the governor’s office. As of 1999, it seemed as if they may have succeeded. The DOE (and the Navy) were meeting their Settlement Agreement milestones. WIPP opened in 1999, and the first barrels of TRU waste left Idaho.

But a major question about the Site remained: With the United States no longer testing reactor concepts on the desert and the storage of spent fuel a mission with no long-term future, what exactly was the mission of the Site into the 21st century?