Environmental Defense Institute
P.O. Box 220 Troy, Idaho 83871-0220
www.environmental-defense-institute.org

October 12 2019

Vic Pearson
U.S. Department of Energy, Idaho Operations Office
1955 Fremont Ave.
Idaho Falls, Idaho 83415-1170
Sent via Email to: nsrrea@id.doe.gov

Comments on Department of Energy's Draft Environmental Assessment for Expanding Capabilities at the National Security Test Range (NSTR) and the Radiological Response Training Range at Idaho National Laboratory (INL) (DOEIEA-2063). [1] [2]

DOE must not be allowed under the National Policy Act (NEPA) to get away with the short cut environmental assessment and be required to conduct a complete environmental impact statement due to the cumulative impact of the new NSTR combined with existing soil and water contamination.

DOE's NSTR claims: "Due to continued growth and need, DOE proposes to increase the testing capabilities at each range allowing for the use of unmanned aerial systems, additional explosive materials and additional radioisotopes for testing and training purposes. DOE proposes to expand the capabilities of each range allowing for the installation of permanent structures and utilities, an increase in the frequency of range activities, and an increase in testing capabilities."

DOE need not release more radiation ("Total annual release for all glass containing radionuclides will not exceed 12 Ci per year and dispersed only within enclosed structures having removable spill containment") [3] to an already heavily contaminated site – they only need to adequately study what has already been released and conduct adequate study of existing and former workers. CDC and NIOSH did conduct crude and inadequate INL dose-reconstruction that failed to include all the releases and workers. [4]

The Environmental Defense Institute (EDI) has been reviewing INL environmental, health and safety issues for over 30 years. Attachment A below shows an excerpt of EDI's Citizens Guide to INL on the sites history of accidents. [5] Of the 52 reactors operated at INL the site has had forty two reactor meltdowns in its history of operations. Sixteen of these meltdowns were accidents. The remaining twenty six were experimental/intentional meltdowns to test reactor design parameters, fuel design, and radiation

---

[1] DOE/EA-2063: Draft Environmental Assessment

[2] Final *Idaho National Laboratory Radiological Response Training Range Environmental Assessment and FONSI* (DOE-ID, 2010) discusses construction and use of temporary containment structures.

[3] DOE/EA-2063, Pg. 19.

[4] Chuck Broscious**,** Comments on Centers for Disease Control and Prevention INEEL Dose Reconstruction Health Study Sanford Cohen and Associates Aerosol Releases from the Idaho Chemical Processing Plant 1957-1959 and A Critical Review of Source Terms for Select Initial Engine Testes Associated with the Aircraft Nuclear Propulsion Program January 5, 2004 submitted on behalf of Environmental Defense Institute. June 23, 2004. http://www.environmental-defense-institute.org/publications/aerosol.releases.com.Final.2.htm

[5] http://www.environmental-defense-institute.org/publications/GUIDE.963.pdf

releases. These nuclear experiments were conducted with little regard to the radiation exposure to workers and surrounding residents. Attachment A below shows a partial listing of the more notable meltdowns and criticality releases and for a listing of acknowledged melt-downs, accidents, and experimental radioactive releases. The term accidental, used by DOE, is perhaps not an appropriate term any more than when the term is applied to a hot-rodder who "accidentally" crashes his car while speeding at 100 miles per hour down a road designed for 30 mph. Hot-rodding a nuclear reactor just to see what it will take is no accident and no less irresponsible.

DOE has the perfect place to conduct studies on the impact of radiation on workers without releasing more radionuclides as planned. There simply is no need to release more. Tami Thatcher has written extensively about the inadequacy of the National Institute for Occupational Health (NIOSH). [6]

DOE states: "Due to continued growth and need, DOE proposes to increase the testing capabilities at each range allowing for the use of unmanned aerial systems, additional explosive materials and additional radioisotopes for testing and training purposes." DOE's new NSTR program promises to use As-Low-As-Possible (ALAR) [7] as the parameter for release of radionuclides. This is an affront to any sensible person given DOE's 60 year history of turning INL into one of the largest and most radioactively contaminated areas in America.

Currently, neither DOE nor Idaho Department of Environmental Quality does adequate monitoring of INL emissions to the atmosphere or groundwater. [8] [9] [10] Even the huge INL wild fire of the summer of 2019 got any published results despite press conference commitments.

DOE's complete disregard for workers and downwind populations are clearly shown when they state: "Control fugitive dust by applying water, covering soils, replanting disturbed areas, or other methods; Monitor wind speeds prior to each dispersal; Limit explosive dispersals to wind speeds less than **25 mph**; Evaluate all new isotopes in irradiated materials for potential offsite dose prior to initial distribution." [11] At 25 MPH the radionuclides could be in Mountview in 15 min. or

---

[6] Tami Thatcher, NIOSH Dose Reconstruction Concerning Radiation Dose Reconstruction for Energy Employee Occupational Illness Compensation, http://environmental-defense-institute.org/publications/EmailNIOSH.pdf

[7] "Multiple dispersals in accordance with releases listed in Table 4. Additional radionuclides evaluated using the environmental ALARA process." Table 6 Pg. 36.

[8] Tami Thatcher, PETITION FOR REVIEWOF HWMA/RCRA HAZARDOUS WASTE TREATMENT AND STORAGE PERMIT RENEWAL FOR THE AMWTP, http://www.environmental-defense-institute.org/publications/IDEQpetition.pdf

[9] Tami Thatcher , Tritium at 800 pCi/L in the Snake River Plain Aquifer in the Magic Valley at Kimama: Why This Matters Environmental Defense Institute Special Report By Tami Thatcher December 31, 2016 (updated January 2017) http://www.environmental-defense-institute.org/publications/kimamareport.pdf

[10] Tami Thatcher, **The Hidden Truth About INL Drinking Water - Environmental**
environmental-defense-institute.org › publications › INLdrinkwater
contaminant levels (MCLs) at some INL *drinking water* wells. ... In one of the few USGS reports to discuss INL *drinking water* contamination, only one INL.
Tami Thatcher, **What's Up With The Radionuclides in Drinking Water Around INL**
www.environmental-defense-institute.org › publications › News.18.Feb.pdf
The public *drinking water* monitoring conducted by the State of Idaho is available on its ... Environmental Working Group at www.ewg.org and see their *tap water*.

[11] DOE/EA-2063, Pg. 22

Idaho Falls in 2 hours. So claims of short-half lived radionuclides are preposterous and ridiculous.

Respectfully submitted on behalf of the Environmental Defense Institute by
Chuck Broscious
EDI Board

Attachment A

EDI Comments Attachment A
INL Radiological Accidents

Citizens Guide to INL Section I.B. INL Accident History [12]

INL has had forty two reactor meltdowns in its history of operations. Sixteen of these meltdowns were accidents. The remaining twenty six were experimental/intentional meltdowns to test reactor design parameters, fuel design, and radiation releases. These nuclear experiments were conducted with little regard to the radiation exposure to workers and surrounding residents. Below is a partial listing of the more notable meltdowns and criticality releases. See IX Appendix (A) for a listing of acknowledged melt-downs, accidents, and experimental radioactive releases. The term accidental, used by DOE, is perhaps not an appropriate term any more than when the term is applied to a hot-rodder who "accidentally" crashes his car while speeding at 100 miles per hour down a road designed for 30 mph. Hot-rodding a nuclear reactor just to see what it will take is no accident and no less irresponsible.

According to Boyd Norton, manager of the SPERT tests in the early 1960s notes, "These reactors are, essentially, stripped-down hot-rodders; they had no radiation shielding and no elaborate safety systems. Sitting as they were, in the middle of more than nine hundred square miles of desert, there wasn't much concern over such things. Not back then." [Norton]

An ICPP criticality accident on October 16, 1959 required evacuation of the facility. "Outside the building and for 130 yards west to the area entrance the radiation field was 5 R/hr or greater." [IDO-10035 @ 4] Thankfully, it was a night shift and less than 10% of the normal work-force was on the site. Twenty-one workers were considered at immediate risk from exposure. Film badge dosimetry and calculations on internal radiation exposure found the highest skin exposure was 50 rem and the highest penetrating exposure was 8 rem. Highest internal dose was 29 mrem. [IDO-10035 @ 5 & 38] This accident followed a Rala run the previous day. Over the course of the accident 337,717 Ci of long-lived fission product was released to the atmosphere. [DOE/ID-12119@A-99]

"The accident at the Stationary Low-Power Reactor Number One (SL-1) occurred on January 3, 1961. Located in the Auxiliary Reactor Area, SL-1 was a small compact Army nuclear power plant designed to generate electricity at remote military locations such as the Arctic or Antarctic. The reactor served both as an experimental prototype and as a training facility for military personnel. On the bitterly cold afternoon of January 3rd, three Army technicians arrived at the facility for the four to midnight shift. The SL-1 reactor had been shut down for routine maintenance, and the task of the three men that evening

---

[12] http://www.environmental-defense-institute.org/publications/GUIDE.963.pdf

was to complete certain preparations for nuclear startup. Apparently, in the process of attaching control rods to drive motors, one of the men raised the central control rod too far and too fast. Evidence indicates that the rod might have stuck momentarily. In the past, there had been sticking problems with that rod. When it came unstuck, it moved upward much higher than anticipated and triggered a supercritical power excursion in the reactor core. In a fraction of a second the power reached a magnitude of an estimated several billion watts, melting and perhaps even vaporizing a large part of the core. The water in the core region was vaporized, creating a devastating steam explosion. The remaining water in the reactor vessel was hurled upward at high velocity, striking the underside of the reactor's pressure lid and lifting the whole nine-ton vessel upward, shearing cooling pipes in the process. The three men, who had been standing atop the reactor vessel, were crushed against the ceiling of the building before the huge vessel dropped back into place. One of the men remained impaled on the ceiling by a piece of control rod rammed through his groin. It all happened in a second or so." [Norton]

"It [SL-1]was a terrible accident, made even more grisly because the intensely radioactive fission products scattered inside the building by the accident hampered the work of recovering the bodies. Staying in the building for mere seconds resulted in a year's allowable dose of radiation for rescue workers. And it took six days to remove the body that was impaled on the ceiling by use of a remotely operated crane and a closed circuit television. The bodies were so badly contaminated, the heads and hands of the victims had to be severed and buried with other radioactive wastes at the Radioactive Waste Management Complex." [Norton] The Oil Chemical and Atomic Workers Union protested vigorously that the government refused to provide a proper Christian burial for the workers.

The SL-1 reactor explosion not only resulted in three deaths but also serious exposure of 0.1-0.5 roentgens [rem] to nearly 100 personnel. Over 12 workers received exposure greater than 10 roentgens [rem]. [IDO-19301@138] The maximum acknowledged personnel exposure was 1,000 R/hr. (Rad per hour). [ERDA-1536,p.II-243] The exposed reactor was still emitting 22,000 R/hr. five months after the accident. Readings above the reactor one month after the accident were 410 R/hr. [IDO-19301,p.109] 1,128 Ci including 80 Curies of radioactive Iodine were also released during the SL-1 accident. [ERDA-1536,p.II-243] [DOE/ID-12119@A-53] A temperature inversion kept the radiation plume close to the ground and at 25 miles the radioactive iodine levels were 10 times above background. At 100 miles the radiation levels were above background.

The author interviewed the widow of James Dennis who was a member of the SL-1 **in**voluntary Army demolition crew brought in to dismantle the reactor after the accident. Dennis died of a rare blood cancer called Waldenstrom's micro globulin anemia, which his medical documents confirm, was caused by exposure to 50 rem/hr. for nine hours and ten minutes at the SL-1 site. [Dennis ,p.10] Dennis' documents further challenge the government's acknowledged exposure of whole body - 2135 mrem, and skin - 3845 mrem [Dennis citing AEC/SL-1,CAB] as grossly understated. Dr. Charles Miller M.C., hematologist / oncologist, chief of Medical Services at Letterman Army Medical Center and Dennis' internal physician, supports the allegation that Dennis' cancer was caused by exposure to radiation. [Dennis, p.17] The government refused to grant Dennis any compensation for his radiation exposure injuries that caused his early death. John Horan, an INL health physics technician, was an expert witness brought in by the Atomic Energy Commission to refute Dennis' claims to radiation induced injuries. Dennis is only one of thousands of individuals who are victims of the health effects of radiation exposure caused by radioactive releases from DOE facilities.

Another ICPP criticality accident on January 25, 1961 released 5,200 Ci [ERDA-1536 @ C-5] and required full evacuation of the plant. Two hundred fifty one workers were on-site at the time. The highest exposure as determined from film badge readings did not exceed 55 mrem of penetrating radiation. The maximum thermal neutron exposure detected in the 65 badges analyzed was less than 10 mrem. Excessive cesium-138 was detected at the Central Facilities Area three miles south of the ICPP after the accident. [IDO-10036@5&6] "Highest personnel exposure received for the four-week period of January 20 through February 16, 1961 by any Phillips' employee in the ICPP at the time of the incident was 240 mrem gamma, 310 mrem beta." [Ibid.@37] Considerable uncertainty exists in relying on the badge reading due to variability in isotope exposure, and the distance the badge is from the worker's hands. More often than not, the badges are considerable understatements of exposure.

For more detailed information see Tami Thatcher's SL-1 report at: http://environmental-defense-institute.org/publications/SL-1Article%20Rev5.pdf

INL Managers Deny Any Responsibility for ZPPR Accident (By Tami Thatcher)

"A recent article in the Boise Weekly about the 2011 Zero Power Physics Reactor (ZPPR) accident at the Idaho National Laboratory's Materials and Fuels Complex (MFC) included interviews of INL managers.[13]

"The ZPPR accident contaminated workers with plutonium when damaged fuel plates were exposed. The DOE accident investigation report[14] concluded that the accident was preventable and that the safety chairman for MFC had twice given written information about his concerns about the continued use of the hood and the higher likelihood of finding damaged ZPPR plates.

"The Department of Energy accident investigation report stated that "Battelle Energy Alliance (BEA) continued operation of the ZPPR Facility with known safety basis deficiencies and without adequately analyzing the hazard to the worker."

"Interviewed for the Boise Weekly, Phil Breidenbach recalls the meeting with the safety oversight chair as cordial and soft-spoken. "This letter, when it's looked at outside the context of what goes on here every day, creates the image that someone ran in here and said, 'No, stop, danger, danger, danger.'" John Grossenbacher said. "That's not the case."

"DOE and its contractors should take note: all safety issues of *actual* importance require the person describing it to say "Stop" and then say "danger, danger, danger" at least three times.

"Breidenbach said one simple action could have prevented the exposure: Ralph Stanton and others could have stopped the work once they found the plastic-wrapped plate. "I'm not a rocket scientist or a Ph.D.," Grossenbacher added, "but if I'm a rad-con tech and I think, 'Well, what happens to this stuff after 30 years of being wrapped in plastic, anybody know?' And if the answer is no, I would say, 'You know what, let's stop.'"

"These two INL managers have forgotten the DOE accident investigation report that describes Stanton and others who questioned several times whether to proceed and it describes the operations personnel including the facility manager – who confidently directed that the work proceed. They have also forgotten the finding that BEA management failed to report the Safety Chair's findings as an Unreviewed Safety Question." [15] [16]

---

[13] Article by Jessica Murri, "Half-Life: How an Accident at the Idaho National Laboratory Changed a Family," *Boise Weekly*, April 2014. http://www.boiseweekly.com/boise/half-life-how-an-accident-at-the-idaho-national-laboratory-changed-a-family/Content?oid=3094301&showFullText=true

[14] Department of Energy, Office of Health, Safety and Security (HSS), Accident Investigation Report, "Plutonium Contamination in Zero Power Physics Reactor Facility (ZPPR) at the Idaho National Laboratory" accident 11/8/11 at the Materials and Fuels Complex (MFC). http://energy.gov/hss/downloads/investigation-november-8-2011-plutonium-contamination-zero-power-physics-reactor.

[15] DOE Occurrence Report NE-ID-BEA-ZPPR-2011-0001 https://orpspublic.hss.doe.gov/orps/reports/displayReport2.asp?crypt=%87%C3%95%9Ba%8Etjz%5D%91

"Breidenbach said, "the stars aligned in such a way that too much equipment was out of service." But, BEA had problems far beyond the work room's ventilation and inadequate alpha alarm placement.

"For INL managers who had been briefed on the safety problem but never acted on it, never bothered to find out if operations people understood the increased risk, never questioned whether the controls were adequate – for them to state that it was the fault of the rad-con techs reflects an uncorrectable mentality.

"Grossenbacher also said that when it comes to the health effects of plutonium inhalation: "We know what kind of radiation exposures will result in physical impacts on a person's health, and none of these exposures came anywhere near that."

"The problem is that estimated doses have are large uncertainties and questionable cancer risk prediction adequacy.[17]

"I would also like to remind Grossenbacher that the Energy worker compensation act (EEOICPA) points out that "studies indicate than 98 percent of radiation-induced cancers within the nuclear weapons complex have occurred at dose levels below existing maximum safe thresholds." [18]

Experimental Reactors and Atmospheric Releases

The original name for INL was the National Reactor Testing Station (NRTS). The name more accurately characterizes the activities undertaken at the site. Idaho was the proving ground for military and commercial reactor designs. Reactors were deliberately run to high power levels (excursioned [sic] or melted down) to establish operating limit parameters and component durability under accident scenarios. The power stability of different types of fuel and their configuration inside the core were also the subject of many tests. During INL's six decade history, experimental nuclear projects contributed significantly to the site's radioactive emissions to the environment. Detailed information about these projects is still largely classified as secret and unavailable to the public. Therefore, the complete history of INL may await an executive order from the President. To his credit, President Clinton is releasing more information than the previous two Presidents; however, the Defense Department (DOD) remains intransigent. Because most of the reactor and fuel reprocessing programs at INL were military related, DOD has claimed jurisdiction over DOE in the declassification decisions. The Air Force has claimed jurisdiction over some of the intentional radioactive releases from the ICPP during operation Bluenose.

Aircraft Nuclear Propulsion Program

The US Air Force's Aircraft Nuclear Propulsion (ANP) program in the 1950's designed built, and flight tested a nuclear jet powered bomber which employed more than 10,000 workers. The plane was a modified B-36 (called NB-36) built by Convair and flight tested at Carswell Air Force Base in Fort Worth, Texas. Between 1955 and 1957, the NB-36 made 47 test flights. In 21 of these flights, the nuclear jets were operating. This particular prototype was powered by six conventional propeller engines and two nuclear jets powered by a reactor in the fuselage of the bomber. Considerable radiation was

---

[16] See the October 2013 EDI newsletter article about ZPPR: http://www.environmental-defense-institute.org/publications/News.13.Oct.-Final.2.pdf

[17] December 2013 EDI Newsletter article, "How Believable are Estimated Radiological Doses Following Plutonium Inhalation?" by Tami Thatcher. http://www.environmental-defense-institute.org/publications/News.13.Dec.Final..pdf

[18] 42 USC 7384, The Act--Energy Employees Occupational Illness Compensation Program Act of 2000 (EEOICPA), as Amended.

released by the unshielded reactor and by the exhaust resulting from the reactor driven jet engine nozzles, which meant the plane was radioactive after each flight. To protect the flight crew from radiation from the reactor, up to 2.5 inches of lead and 17 inches of special rubber were used to line the crew compartment. WFAA-TV's American Portrait program on the "History of the Nuclear Jet Engine" offers original Air Force footage of the NB-36 and related ANP programs.

The Air Force was intent on building a bigger long-range nuclear powered bomber that could stay aloft indefinitely over the North Pole and deliver a nuclear attack on the Soviet Union. Pratt and Whitney, General Electric, and Lockheed were competing for contracts on reactor designs on this next generation of nuclear powered bombers. GE won the contract and proceeded to build and ground test the 44,000 horsepower nuclear jet engines at INL where a 20,000 foot runway was also slated to be built for the plane. The 8-foot concrete shielded hanger for the plane was built at INL's Test Area North where the runway was also to be built. This test program was called the Initial Engine Tests (IET), and it lasted from 1955 through 1961 when it was canceled by President Kennedy. By 1961, the ANP program consumed $4.6 billion. [American Portrait, 1993] Another analysis in 1995 included all related ANP activities and found the price tag to be over $6 billion. [Wald(b)] Other space related reactor testing programs at INL, however, continued with the SPERT, SNAPTRAN, and NASA's Light-bulb reactor tests.

"The power plant design concept selected for development by the General Electric Company was the direct air cycle turbojet. Air is the only working fluid in this type of system. The reactor receives air from the jet engine compressor, heats it directly, and delivers it to the turbine. The high-temperature air then generates the forward thrust as it exhausts through the engine nozzle." [Wilks]

One Initial Engine Test (IET) series at INL released from April to June of 1956 over 1.9 million curies of activity including significant amounts (453,350 Ci) of Iodides. [DOE-ID-12119@A-114] Between 1956 and 1970, fifty-nine ANP tests released an estimated 4,635,724 curies of radiation. [DOE/ID-12119 @A55] By comparison, the Three Mile Island reactor accident, generally considered this nation's worst nuclear incident, released 15 curies (Ci) of radioactive iodine to the environment.

"The ANP Reactors were direct, open cycled air cooled. This means that air was driven into the jet engine, compressed, passed through the reactor fuel element where heat energy was extracted, and then discharged through the turbine and jet engine nozzle." ... "Any radioactivity leaking from the fuel elements was also discharged to the air stream." [ERDA-1536@II-239]

Many deliberate fuel element failure tests by blocking reactor coolant were conducted to test a full scale aircraft reactor accident. One of these tests went awry resulting in significant portions of reactor core to melt and considerable additional radiation to be released to the environment. [Ibid.] DOE publicly denies that any ANP reactors were buried at INL yet the literature specifically acknowledges that jet engines are buried at the Radioactive Waste Management Complex (RWMC) Subsurface Disposal Area (SDA). [PR-W-79-001 @ 4-1] The SDA does not meet the Environmental Protection Agency's Subtitle D garbage landfill standards let alone Nuclear Regulatory Commission greater than class C radioactive waste disposal standards. The IET series involved three reactor assemblies that were constructed at INL for the ANP program. "These three assemblies were designated HTRE No. 1, HTRE No. 2, and HTRE No. 3." [DOE/ID-12119@A-87] Though two ANP nuclear jet engine shells are on display at the Experimental Breeder Reactor-I, the disposition of the other engines and reactor cores for these engines was to the RWMC. The HTRE experiments included the following:

> "HTRE-1. The HTRE-1 reactor operated a modified J47 turbojet engine exclusively on nuclear power in January 1956. It accumulated a total of 150.8 hours of operation at high nuclear power

> levels."
> "HTRE-2. The HTRE-2 reactor was a modification of HTRE-1. Testing began in July 1957. The reactor accumulated 1,299 hours of high-power nuclear operation."
> "HTRE-3. The HTRE-3 reactor was built in a full-scale aircraft reactor configuration. Two modified J47 turbo jets engines were operated by this reactor. Full nuclear power was achieved in 1959 and the system operated for a total of 126 hours." [RE-P-82-053 p.2]

Knowing full well how hazardous the emissions from these reactors would be, the IET managers built a remote test site called the IET Core Test Facility some distance north of TAN's Technical Support Facility. The two sites were connected by a 4-rail track on which the reactors were moved on rail dollies between test series. The Technical Support Facility Hot Shop assembled and disassembled the reactors. The Core Test Facility (CTF) is where the reactors actually operated. CTF consisted of an underground bunker control building where personnel ran the reactors, and a 214 foot-exhaust duct connected to a 150-foot exhaust stack. The reactors were rolled up to the exhaust duct using a shielded locomotive. When the reactors were operating, a plume rose from the exhaust stack to a height of over 1,200 feet. Jackrabbit thyroids sampled downwind from the IET in March 1958 showed radioactivity at 293,700 disintegrations per minute per gram (d/m/g). [IDO-12082(58)@74]

The HTRE-2 and 3 were disassembled in the IET Hot Shop where the highly radioactive plug shield and core assembly were removed and shipped intact to the RWMC. Radiation levels (300 R/h) were too high to allow further disassembly of the reactor vessel and its shielding. Then the reactor vessels were moved back out to the IET test pad where the 200 ton HTRE-2 (with dollies) and the 90 ton HTRE-3 (w/o dollies) were jacked up off the rail tracks and a special 350-ton transporter was moved under for shipment to the RWMC burial grounds at INL. Bridges between TAN and the RWMC had to be blocked up to take the heavy transporter, and special ramps made into the trench where they were buried. [PR-W-79-001 @4-3] The 106,000 pounds of radioactive mercury used in a tank for shielding around the HTRE-3 and considerable volumes of related radioactive parts were dumped at the RWMC. [See Section IV(C)] These dumping practices are another reason why the RWMC is a Superfund cleanup site today.

The Strategic Defense Initiative Organization (SDIO) revived the nuclear jet engine project for use in the space program. This new Black Budget program's (code name Timberwind) purpose is to develop the technology and demonstrate the feasibility of a high-temperature particle bed reactor propulsion system to be used to power an advanced nuclear rocket engine. The Strategic Defense Initiative involves orbiting space platforms that theoretically will have the capacity to shoot down missiles launched at the USA. To build these platforms, heavy payloads would have to be launched - requiring powerful rockets. SDIO believes that the nuclear rocket offers a greater thrust to weight ratio than conventional rocket designs. SDIO generated a secret Environmental Impact Statement (EIS) on Timberwind in 1990. When the existence of this EIS was discovered by the Federation of American Scientists, they demanded that it be released. A declassified Environmental Impact Statement (EIS) was released in 1991, however most substantive (classified) sections have been blacked out. This violates the intent of the National Environmental Policy Act which requires full disclosure of the environmental impacts of proposed federal activities. The Timberwind program was later officially transferred to the Air Force and a new EIS was released in 1992. The 103rd Congress, however, eliminated funding for nuclear rocket program in the FY-1994 budget after spending $464 million. Black Budget projects rarely survive the light of day. The 104th Congress revived the SDI program so Timberwind may also be revived. Since INL was originally selected as the Timberwind ground test site, it is possible that Idahoans will again be subjected to massive radioactive emissions if the nuclear propulsion part of SDIO's program is built and tested. For a more detailed assessment of Timberwind, the Environmental Defense Institute's written comments upon the EIS are available on request.

In other nuclear aircraft related tests, General Electric conducted two open air burning tests on March 20, 1957 of reactor fuel rods to see how much radiation would be released in a nuclear powered plane crash. These tests, called Operation Wiener Roast because of the live animals used to test radiation exposure, also released over 78.3 curies of radiation to the air. [DOE/ID-12119 p. A-55]

The US Air Force conducted the Fission Products Field Release Tests (FPFRT) between July and September 1958. "The tests were performed to obtain information for evaluating the release of radioactivity from potential accidents involving nuclear powered aircraft using metallic reactor fuel." [DOE-ID-12119 @A-176] These open air, furnace induced hot burns of reactor fuel rods released 502.7 curies of radiation to the atmosphere.[Ibid. p. A-54] "The experiments at Idaho using 'fresh' fuel elements were cooled from 21 days before meltdown, thus losing essentially all of the short lived isotopes of iodine." [Dunning(b)] The Atomic Energy Commission put a limit on the ANP individual releases of iodine at 1500 rads. [Dunning (b)] See ANP Test Table.

The Special Power Excursion Reactor Test (SPERT) reactor test series were "planned integral core destructive tests to investigate the consequences of reactor accidents." [DOE/ID-12119@79] "The accident scenarios tested included reactors suddenly being made greatly supercritical and undergoing a severe power excursion or transient. In just hundredths of a second the power, or fission rate, could leap from zero to billions of watts, with the potential for severe core damage." [Norton] Each of the four SPERT reactors was different. "SPERT-I, built in 1954 was the simplest of the four, with a large open tank containing the core and moderator. Before it [SPERT-I] was shut down in 1967, seven different cores had been used in it and more than two thousand power excursions conducted."... "In 1962, it was decided to conduct the ultimate test on SPERT-I. Blow it up, deliberately. It would be an answer to ... how far could you push a highly enriched core in a power excursion?" [Norton] The November 15, 1962 SPERT-I experimental reactor "destruct" test resulted in a release of 240,000 Curies including Iodine. [DOE/ID-12119@79] The reactor was placed in an open tank 16 feet deep and 5 feet in diameter. Coolant water was spewed 100 feet in the air in less than one hundredth of a second after the 2 and a half billion watt power surge. Gross reactor damage occurred. Wind direction and the arrival of a monitoring airplane were factors in the timing of the meltdown. [Norton] SPERT-I site would later be used for the Power Burst Facility. SPERT-II was a scale prototype of a modern nuclear power plant except that it used low pressure and heavy water as a moderator. SPERT-II first went critical in 1959, performed tests for five years, and was retired in 1964. The reactor was remotely controlled from a control center one half mile away. The SPERT-II reactor "destruct test" experiment on November 10, 1963 produced 24,000,000 curies; 530 curies were released including iodine. This was a pressurized heavy water reactor.

SPERT-III was a high temperature, pressurized (2,500 psi) light water reactor built in the late 1950's, went critical in 1958, and was placed on standby in 1968. The April 14, 1964, SPERT-III test released 1900 Ci. to the atmosphere producing a radioactive cloud that was tracked for 2.5 miles. The reactor surged in one hundredth of a second from zero to thirty billion watts. [Norton] Using different cores the reactor continued to run until an accidental melt-down in 1968. [Norton] The SPERT-III site was later to be used for the WERF incinerator. SPERT-IV, constructed in 1960, and was called a swimming pool reactor; was immersed in a 30 foot diameter tank and was placed on standby in 1970. These tests demonstrated reactor instability and power oscillations. SPERT project manager Boyd Norton acknowledges "...that it got pretty scary in the control room when the power began oscillating out of control and threatened to blow the thing apart. Being at the reactor console was ... a total exercise in sphincter control. SPERT-IV was later converted to the Capsule Drive Core, forerunner of the Power Burst Facility, which was built a few years later." [Norton] What was left of the SPERT reactors and components were buried at the RWMC. [ERDA-1536,p.II-244-246]

The Space Nuclear Auxiliary Power Transient (SNAPTRAN) destructive reactor tests were part of the space nuclear power program. The tests were conducted at Test Area North's IET site. These reactors lacked shielding because of the added weight limitations. The tests were "designed to provide information on the radiological consequences of accidental immersion of a SNAP 2/10A reactor in water or wet earth such as could occur during assembly, transport, or a launch abort." [ERDA-1536,@II-247] The SNAPTRAN involved the following tests:

- "A series of tests aimed at providing information about beryllium-replicated reactor performance under atmospheric conditions and assessing hazards during reactor assembly and launch."
- "Nuclear excursions resulting from immersion of the reactor in water or wet earth."
- "Non-destructive tests including static tests and those kinetic tests in which minor damage to the reactor occurred, and"
- "Destructive tests in which the reactor was destroyed". [RE-P-82-053,p.3]

The first April 1, 1964 SNAPTRAN destructive reactor test released 24,000 curies plus 9,500 gallons of highly contaminated water that blew out of the test tank when the operators intentionally allowed the reactor to blowup. The radioactive cloud was followed by an airplane for 21 miles before it dissipated. Estimated dose at INL boundary was 10 mRem. Reactor debris was buried at RWMC. [ERDA-1536,.@II-248] The SNAPTRAN second open air destructive tests in January 1966 exploded spreading reactor fuel 700 feet around the site and released 600,000 curies (Ci) including 0.1 Ci I-131 and created widespread heavy contamination of beryllium on the surrounding ground. The radioactive cloud was followed by aircraft for 19 miles before it was no longer visible. Estimated radiation dose at INL boundary was 10 mRem. Again, reactor debris and 300 cubic yards of contaminated soil were buried at RWMC. [Ibid@II-249]

Aircraft Nuclear Propulsion Program INL Tests 1956 to 1970

IET Test Number	**Test Date**	**Release Quantity (Curies)**	**Source**
IET # 3 HTRE-1	2/11 – 2/24/56	132,000.00	D @ ES-11
IET # 4			
# 4-A-1	5/1 – 5/23/56	7,264.00	D @ ES-13
# 4-B-2	5-24 – 6/29/56	205,772.00	D @ ES-13
# 4-C-3	6/29/56	689,886.00	D @ ES-13
IET # 6	12/18/56	9,000.00	B @ A-202
IET # 8 HTRE-2	7/31 – 8/28/57	1,700.00	B @ A-121
IET # 10-A			
# 10-B	12/20/57 – 2/25/58	2,220,000.00	D @ ES-16
# 10-C	3/1 - 3/6/58	2,740,000.00	D @ ES-16
IET # 11	3/20/58 to 4/14/58	4,635.00	B @ A-128
IET # 12 "Boot"	4/21/58 to 5/7/58	29,070.00	B @ A-132
FPFRT-1	7/25/58	9.80	B @ A-201

FPFRT-2	8/4/58	9.30	B @ A-201
FPFRT-3	8/6/58	9.90	B @ A-200
FPFRT-4	8/14/58	9.60	B @ A-200
FPFRT-5	8/27/58	140.00	B @ A-200
FPFRT-6	9/4/58	115.28	B @ A-200
FPFRT-7	9/17/58	90.79	B @ A-200
FPFRT-8	9/18/58	102.48	B @ A-200
FPFRT-9	9/26/58	10.08	B @ A-200
IET # 13	10/8/58 to 11/18/58	9,730.00	B @ A-137
IET # 14	4/24/59 to 5/19/59	13,456.00	B @ A-139
IET # 15	5/27/59 to 6/24/59	3,178.34	B @ A-199
IET # 16	7/28/59 to 10/28/59	294.42	B @ A-199
IET # 17	11/2/59 to 12/12/59	6,202.00	B @ A-147
IET # 18 "HTRE-3"	12/23/59 to 2/8/60	14,157.30	B @ A-153
IET # 19	2/9/60 to 4/30/60	11,381.00	B @ A-153
IET # 20	5/1/60 to 6/13/60	10,249.00	B @ A-155
IET # 21 "Feet # 1"	6/20/60 to 8/8/60	3,752.00	B @ A-158
IET # 22	8/12/60 to 8/25/60	10,526.80	B @ A-160
IET # 23 "Feet #2"	9/1/60 to 10/14/60	2,890.00	B @ A-163
IET # 24 "Lime"	10/17/60 to 10/26/60	7,725.90	B @ A-165
IET # 25	11/15/60 to 12/16/60	10,171.26	B @ A-197
IET # 26	12/22/61 to 3/31/61	12,110.00	B @A-173
SPERT-1	11/5/62	240,000.00	B @ A-79

SPERT-2	11/10/63	530.00	A @ II-246
SNAPTRAN-3	4/1/64	24,000.00	A @ II-248
SPERT-3	4/14/64	1,900.00	A @ II-244
SNAPTRAN-2	1/11/66	600,000.00	A @ II-249
7 Module # 1168 to # 1183	1967 to 1968	?	C @ 29 to 116
3 Module # 1185 to # 1192	1969	?	C @ 165 to 179
Total # Tests > 59		Total Curies* 7,021,878.25	
Total Uranium Released		1,635.82 grams	

Acronyms: IET = Initial Engine Test; FPFRT = Fission Product Field Release Test; SPERT- Special Power Excursion Reactor Test; SNAPTRAN = Special Nuclear Auxiliary Power Transient; Modular - NASA's Modular Cavity or "Light Bulb" Reactor.

* Only hot run tests are listed in the table above, therefore, missing test numbers indicate cold runs. Curie content of uranium released is not included in the total curies released. Releases for the 7 &3 Module are not yet fully analyzed. Between 1956 and 1966 the ANP reactors operated in excess of 3,064.24 hours. During this time the reactors were operated at high power for 1,575.8 hours.[DOE/ID-12119] [PG-WM-85-008 @2-3] Table sources: [A - ERDA-1536]; [B - DOE/ID-12219]; [C - IN-1376]; [D - Critical Review of Source Terms for Select Initial Engine Tests Associated with the Aircraft Nuclear Propulsion Program at INEL, CDC, 7/03.

Other nuclear jet engine projects that impacted INL were ground tested in Nevada. [Times News10/15/90] The nation's first nuclear-powered rocket engine, Kiwi-A, first fired for five minutes in July 1959 at the Nuclear Rocket Development Station about 100 miles northwest of Los Vegas. Several Kiwi-A's were test fired throwing smoke and dust hundreds of feet into the air. "The remains of the reactors from the development project collectively called the ROVER project are among the highly radioactive wastes stored at the INL's ICPP." [Ibid.] ICPP also has a ROVER fuel reprocessing building that has been identified in DOE's Highly Enriched Uranium vulnerability report as having criticality problems.

In 1972, after the ROVER program had shut down, 26,000 fuel elements were shipped from Jackass Flats, Nevada to INL. About 18,000 rods of ROVER program fuel were eventually processed at the ICPP between April 1983 and June 1984 removing about 3,200 kilograms of highly enriched uranium.[Times News10/15/90] The reprocessing of ROVER fuel was discontinued because burning the graphite off the fuel plugged up the off-gas systems and dissolved fuel raffinate plugged up process lines. These plugged lines remain as they were left at the end of the program. "For the contractor slated to deactivate the ROVER Facility...criticality risks are of paramount concern. The ROVER Facility which was shut down in 1984, houses a substantial amount of uranium in its processing lines, vessels, and related equipment." [EM Progress, Winter 1996] Workers attempting to decontaminate the fuel burn cells in 1984 received significant exposures because the graphite plugged face masks and seeped into protective suits.

Management refused to provide workers with pressurized air lines and suits so the workers refused to reenter the ROVER cells. After a dozen years and a belated commitment of over $23 million, DOE is finally willing to address this lingering criticality hazard.

The NERVA (Nuclear Engine for Rocket Vehicle Application) - engine, later developed by Aerojet-General and Westinghouse Electric, was designed to propel a rocket or space vehicle once it escapes the earth's atmosphere. The heart of the engine is a little reactor that uses small ceramic-coated fuel pellets imbedded in graphite. The reactor heated liquid hydrogen, causing it to expand and turn to gas. The rapid expansion provided the propelling force of the engine. [Times News10/15/90]

Budget disputes in 1991 over the Strategic Defense Initiative revealed a secret program called Centaurus at INL. Bill Thielbahr, director of DOE Idaho's energy technology division, acknowledged the difficulties of gaining continued Congressional funding for the $3 million annual requirements of the project. Thielbahr described the Centaurus as a "nuclear-pumped laser" testing program. The work could include studying methods to recover safely some space debris and new systems to produce electrical power. This INL research team consisted of about 20 workers. The $4 million total proposed for INL research is uncertain, since both chambers of Congress have voted to cut the 1991 SDI budget by at least $1 billion. [AP(k)] The basic SDI concept is a space-based network of nuclear powered lasers that could shoot down missiles launched at the United States. This secret program has never had any publicly available environmental monitoring data, which is a repetition of decades of non-accountability fostered by classified Black Budget projects.

Atmospheric Release Experiments

OMRE Solvent Burning Experiment on November 16, 1960 was conducted to "determine the feasibility of open-air burning of contaminated solvents accumulated at the Organic Moderated Reactor Experiment (OMRE) facility. 400 gallons of radioactive solvents were placed in an open vessel and ignited." [DOE/ID-12119 @A-173]

Other "human guinea pig" experiments were carried out just to see how Iodine-131 is absorbed in humans and disperses in the surrounding ground. Twenty-nine Controlled Environmental Radio iodine Test (CERT) between May 1963 and December 1977 released over 32.72 Ci including 26 Curies of Iodine-131 to the environment. [ERDA-1536@II-250]&[DOE/ID-12119] "On three of these CERT releases, human subjects were deliberately exposed. The general design was that radioactive iodine was released in gaseous form, and prevailing winds took the iodine over an area designated the 'hot pasture.' Monitoring devices in the pasture determined the radioactivity deposited. A herd of cows was than led to the pasture to graze for several days. The cows were milked and the milk monitored for Radio iodine. Humans were exposed either by drinking the milk or by direct exposure to the released iodine gas. During CERT-1, conducted in May 1963, one curie of radioactive iodine was released into the hot pasture. Six cows were placed in the contaminated pasture. Cows were milked twice a day and the milk from one cow saved for human ingestion. Seven human subjects each drank 0.5 liter of radioactive milk over a period of 18 days. Radioactive iodine uptake was determined by counting the radioactivity absorbed in the thyroid of each subject." [IDO-12053]

CERT-2 was conducted in September 1964. Approximately one curie of radioactive iodine was again released over the hot pasture. Milk samples were again tested, but were not consumed by humans. Instead, three human subjects were placed on the pasture during iodine release, and the radiation accumulated in their thyroids was counted after exposure. This was not a food chain experiment, but was designed to measure the direct iodine dose from inhalation. During CERT-6 conducted in the summer of 1965, several vials of Radio iodine were broken and the contents (2-6 curies) released to the environment. [IDO-12053, 8/66 @2] "Several individuals were inadvertently exposed to airborne Radio iodine from the leaking and broken containers, and efforts were made to obtain data on the retention of this form of iodine in humans." [Ibid. @2] These exposures occurred over a four-day period, and a few people received multiple exposures; radiation accumulation in the thyroids of these individuals was counted. CERT-7 was conducted in November 1965; 1 curie of I-131 in the gaseous molecular form was released over the pasture at the INL Experimental Dairy Farm. Six cows grazed, and milk samples were counted. In addition, seven human 'volunteers' were placed seated on the pasture area. Uptake of radioactive material was determined by counting the subject's thyroids. "DOE reported to the Subcommittee that no medical follow up of the experimental subjects in the CERT tests was performed." Through the course of the CERT tests, twenty one individuals were exposed. [Congressional Research Service, 5-156 @ 22- 24]

"From 1963 to 1965, at the Atomic Energy Commission National Reactor Testing Station in Idaho, [now called Idaho National Laboratory] radioactive iodine was purposely released on seven separate occasions. In one of these experiments, seven human subjects drank milk from cows which had grazed on iodine-contaminated land. This experiment was designed to measure
the passage of iodine through the food chain into the thyroids of human subjects. In a second experiment, three human subjects were placed on the pasture during iodine release, and seven subjects were placed on the pasture in a third experiment. In addition, "several" individuals were contaminated during yet another experiment when vials of radioactive iodine accidentally broke.
Cows grazed on contaminated land and their milk was counted in four of the experiments; in the remaining three, radiation measurements were made only in the pasture."

http://www2.gwu.edu/~nsarchiv/radiation/dir/mstreet/commeet/meet1/brief1/br1n.txt

"Between 1965 and 1972, 8 individuals were involved in 13 different human experiments. All eight were employees of the Idaho Division of the Atomic Energy Commission. In four experiments, subjects inhaled Argon-41; in nine experiments, subjects swallowed capsules containing micro curie amounts of radioactivity. These experiments were funded and carried out by the Atomic Energy Commission. The objective of this experiment was to calibrate instruments that measure radioactive substances inside the human body; such instruments are usually used to examine workers accidentally exposed or hospital patients receiving radioactive material for diagnostic purposes. A second objective of the experiments was to examine the metabolism of radionuclides ingested or inhaled by humans. In the first set of experiments, one subject was fed one micro curie of Manganese-54; another subject was fed an unspecified amount of Iodine-131. In a second set of experiments, individual subjects were fed 3.5 micro curie of Cesium-132, 1.9 micro curie of Potassium-42, or 1.1 micro curie of Manganese-54. In addition, 4 subjects inhaled Argon-41 in amounts of 1.3 to 2.2 micro curie. In a third experiment, one subject was fed 1.5 micro curie of Cobalt-60 and Cesium-137. The Department of Energy reported there was no medical follow up of any of these experimental subjects." [Congressional Research Service, 5-156 @ 35-36]

Intentional releases of Iodine-129 into the environment referred to as the Iodine-129 Technology Studies took place in August 1964. The studies were a collaborative effort of the US Weather Bureau Research Station at the INL and the Nuclear Science and Engineering Corporation of Pittsburgh, PA. The Iodine-129 Technology Studies were conducted to examine the atmospheric mixing and dilution of gases and particles containing small amounts of Iodine-129. There were a total of five tests: two with particles, one with gases, and two more with particles and gases combined. The first three tests were sampled to distances of about 10 miles over a densely instrumented grid located in the center of the INL site. The last two tests were sampled at distances of 25 to 35 miles in off-site areas to the north-east of the point of release. One mill curie of iodine-129 was released during the experiment. [DOE News, 7/31/95] The 17-million year half-life of Iodine-129 plus its ability to enter the food chain and subsequently concentrate in the thyroid makes this isotope especially toxic.

The Atomic Energy Commission (AEC) also collected human body parts that were used in radiation experiments from hospitals in the Idaho Falls area. Between 1954 and 1955, five samples of human bone obtained at surgery or autopsy from local hospitals were analytically compared with measurements of radioactivity in animals located at the INL. According to the US General Accounting Office report titled "Information on DOE's Human Tissue Analysis Work", the human bone samples appear to have been analyzed for two radioactive elements, strontium and yttrium. In other studies between 1968 and 1970 skin from amputated limbs or other surgical procedures was obtained from various hospitals in the Idaho Falls area. The study's ultimate objectives were to apply radioactive iodine to the human skin to evaluate the hazards caused by iodine permeation. The principal goals of the program were to establish procedures for making accurate predictions of the thyroid dose that would result from an accidental iodine exposure. Other goals were to help in selecting iodine impermeable materials for protective clothing and to develop improved decontamination procedures. In both of these studies informed consent was **not** obtained from the patients and/or family by the researchers. [GAO/RCED-95-109FS@39]

Three Long Distance Diffusion Tests (LDDT) between March 1971 and August 1972 were conducted by the National Oceanic and Atmospheric Administration and the Health Services Lab at INL. These tests released 1000 Ci of Krypton-85 and 12.3 Ci of Iodine-131 into the atmosphere. The stated purpose of these tests was to see how these radionuclides disperse in the atmosphere. [DOE/ID-12119@A-59] The Three Mile Island nuclear accident released more than 15 curies of Iodine-131.

Nine Experimental Cloud Exposure Study tests, appropriately named EXCES, released between May 1968 and April 1970, 987 Ci of Xenon-133 and Sodium-24.[DOE/ID-12119.@A-61] Another air dispersion testing series called Relative Diffusion Tests (RDT) released 10.4 Ci of Iodine-131 between November 1967 to October 1969. [Ibid]

The U.S. Army built support structures and reactors at the Auxiliary Reactor Area (ARA) between 1957 and 1965 when the program was phased out. ARA was divided into four areas (I through IV). ARA-I acted as support facility for the other ARA sites. ARA-III originally housed the Army Gas Cooled Reactor Experiment (AGCRE), water moderated, nitrogen-cooled reactor that generated heat but no electricity and was finally placed on standby on April 6, 1961. After the Army vacated ARA, the buildings were used for various INL projects such as sensor fabrication, experimental instrumentation, and a metallurgical laboratory for nuclear reactor experiments. In 1965, the U.S. Army built the ARVF in the center of INL. "The facility consisted of a test pit, an underground bunker, and a system of pulleys and cables. The steel-lined, open-top test pit was filled with water into which nuclear fuel elements were placed." [DOE/EH/OEV-22-P @2-39] Presumably, the tests were done to create an accident scenario of a nuclear plane or satellite crash and the resulting radioactive releases to the crash site. In 1974, "four drums of radioactively contaminated NaK from ERB-1 were placed in the bunker, where they remain today. In 1980, a protective shed and crane were built above the pit, and in 1980-81 a series of explosive tests were conducted in the pit." [DOE/EH/OEV-22-P @2-39]

INL has a long history of intentional reactor melt-downs that were conducted to test the operating parameters of military and civilian reactor designs. The Loss-of Fluid Tests (LOFT) were conducted at INL's Test Area North (TAN) beginning in late 1977 and ending in 1985 costing over $350 million.[Norton]

As the name suggests, the purpose of LOFT was to test the effects of loss of coolant to a reactor, damage to fuel, and related reactor systems. DOE acknowledges eight LOFT test series over this period. [DOE-ID-12119@A-57] The main components of the LOFT facility were the Mobile Test Assembly that was a large four rail dolly capable of moving the reactor between the Technical Support Facility (TSF) Hot Cell and the test pad containment vessel. The Hot Cell assembled the reactor on the rail dolly, which then transported it to the test pad.

The LOFT test pad containment structure is 70 feet wide and 129 feet high with huge doors to allow the reactor and rail dolly to move in and out. As with the ANP, the tests were conducted at a site removed from the main TAN support area because of the known hazards. After the test run, the rail dolly was moved by a shielded locomotive back to the TSF Hot Cell for disassembly and inspection. After the reactor components were inspected, they were transported to INL's RWMC burial ground for shallow disposal. [ERDA-1536 @II-123]

A "blow-down emission suppression system" in the LOFT containment structure was intended to catch steam and water ejected during the intentional melt-downs resulting from loss of coolant. A 150-foot stack was used to exhaust the effluent into the atmosphere. ERDA’s "conservatively estimated airborne radioactivity releases from LOFT experiments" were 941,912 Ci per year which includes stack emissions and containment structure leakage. [ERDA-1536 @II-118] Annual solid radioactive waste generated by LOFT contained 27,000 Ci. [Ibid @ II-124] The last LOFT experiment (LP-FP-2) on July 9, 1985 released 8,800 Ci plus 0.09 Ci of Iodine. [DOE/ID-12119 @A-52]

These releases were done with full knowledge of the implicit hazards of radioactive emissions. "In 1950 the 'destructive force of the atom' and the 'harmful effects of radiation' were basically understood." [DOE-ID-12119@A-50] Yet, no public announcements or warnings were ever given to the public so that they could take some measure of precaution.

Indeed, INL operations were shrouded in absolute secrecy. Only recently have public interest groups had some limited success in gaining access to historical records through the Freedom of Information Act. Today, the vast majority of the most revealing documentation is still classified, technically unavailable in contractor files, or intentionally destroyed. DOE and Department of Defense's (DOD) claims of national security concerning the declassification of fifty-year old radiation release documents is not justified. DOE and DOD have yet to offer guarantees to agencies of the US Health and Human Services conducting health studies at INL that all operating history documents will be declassified. Moreover, DOE delayed for two years granting security clearances to public health agency researchers.

Bluenose Releases

In the late 1940s and 1950s a U. S. Atomic Energy Commission (AEC) and U.S. Air Force secret program code named Operation Bluenose attempted to determine Soviet plutonium production levels by analysis of fission product gases released during the reprocessing of reactor fuel. To test the instruments in their U-2 spy planes, the Air Force requested that large amounts of radiation be released from the Hanford, Washington and Oak Ridge, Tennessee process facilities. The Hanford Education Action League (HEAL) received a DOE document through the Freedom of Information Act (FOIA) describing the releases. “The April 1949 report obtained by HEAL recommends that another test be conducted at Hanford that would release more radiation and also suggests that the plant filters be disconnected. This was done for the Green Run experiment.” [HEAL(d)] The Hanford Environmental Dose Reconstruction

Health Study determined that the Green Runs released 740,000 curies of Iodine-131. The Richland Washington Tri-City Herald offered the following interpretation:

"In the 1940s Walt Singlevich headed a classified program known as Operation Bluenose whose object was to determine soviet plutonium production by analysis of fission product gases given off during the reprocessing of reactor fuel."... "The 340,000 curies intentionally released [from Hanford] in 1949 were part of this test program. This release was achieved by hauling 'green' irradiated fuel from the 100 area over to the 200-B Plant were it was dissolved in nitric acid and 'some purple iodine was vented up the stack'. It was later found that I-131 was not an accurate indicator of plutonium processing throughput ..." The noble gas Krypton-85 was found to be the only isotope which could not be removed from the off-gases and that is what Francis Gary Powers was sampling in 1960 when he was downed by the Soviets. His U-2 spy plane had a Cold Finger sampler in-take on its wingtip to sample air at 100,000 feet over the USSR for its Kr-85 content." [Tri-City Herald]

Michael D' Antonio's book *Atomic Harvest* notes a series of articles in the Portland Oregonian newspaper that interviewed Carl Gamertsfelder, a retired Hanford radiation control manager who was at the site during the infamous "Green Runs." Gamertsfelder seems to corroborate the above *Tri-City Harold* article. According to D' Antonio, Gamertsfelder's characterization of the "Green Runs" in the following way.

"It had related to the intrigue and espionage of the Cold War. The United States had been trying to spy on Soviet weapons factories from the stratospheric perspective of exotic surveillance aircraft. The aircraft, and monitoring stations at sites bordering the Soviet Union, could be equipped with devices that would measure the pollution coming out of Russian plutonium plants. But in order to know how the emissions related to the volume of uranium being processed, the Americans needed to simulate Soviet manufacturing methods. To do this, they ran the [Hanford] T-Plant Soviet style, shortening the cooling period and allowing higher levels of pollution. They then measured off-site radiation and worked out a formula that would turn readings from monitoring devices into estimates of the enemy's bomb-production rate. Since the Soviets processed green uranium, in order to stay competitive in the arms race, Hanford had to conduct a Green Run too. Of course, without documentation, no one could be sure that this explanation was accurate. Years later, HEAL would continue to suggest that there was more to the story. Jim Thomas theorized that the US scientists have to perform the Green Run in the way they did because their instruments were not sensitive enough to detect the small emissions." [D' Antonio@125]

Secret document titles obtained during the Hanford Environmental Dose Reconstruction suggest that the INL's ICPP was involved in this Bluenose program in the 1950s. The focus on Kr-85 is confirmed in a United States Government Office Memorandum titled Bluenose and Other Matters that was the transmittal document conveying the attached "Critique of Possible Methods of Computing the Amount of American Kr-85 in the Atmosphere." [HAN-40477] The INL Research Bureau (IRB) submitted a Freedom of Information Act (FOIA) request to both Hanford and INL for release of these documents. Though Hanford did send copies of some of the formerly secret documents, INL refuses to declassify these forty year old documents because of "national security." In a formerly secret memorandum from Paul G. Holsted, Chief of Planning and Reports Branch, Hanford Operations Division, titled "Review of Bluenose Program" dated May 26, 1955, Holsted notes the following:

"General Electric Company has been requested by the [AEC] Division of Research to make release calculations to cover operations of the ICPP at Arco. This work has not yet started although many Kgs of U-235 have been recovered. GE had indicated that it would be willing to do the calculations but that further information would be necessary before it could start. This program was discussed briefly and GE is now ready to start the work." [HAN-59174@4]

The Bluenose program precisely irradiated U-235 slugs under highly controlled reactor conditions by AEC prime contractor General Electric Hanford Atomic Products Operation. [HAN-58767] The slugs were shipped from Hanford to other sites where the slugs were dissolved in nitric acid and the gases allowed to escape. These other sites identified are Savannah River, Oak Ridge, Argonne National Laboratory, Knolls Atomic Power Laboratory, Brookhaven National Laboratory, and National Reactor Testing Station (now INL). [HAN-59174@][HAN-401931 Hanford has the INL release data related to the Bluenose program but refuses to release the documents, referring the Environmental Defense Institute (EDI) to INL who also refuses to release the documents. Dr. Charles Miller, Centers for Disease Control, Environmental Health Physicist, has a Q-security clearance and was shown a secret Bluenose document at INL. Dr. Miller's security cleared characterization of the document is that it had nothing to do with releases but was related to shipping of nuclear materials between sites. Verbatim transcript of the CDC May 25, 1994 meeting note:

"Mr. Miller: Let me tell you what I can tell you legally, I'm reading my notes very carefully because they have been approved. Bluenose was a measurement program, measurement of analytical samples. It did involve the shipment of what are called limited quantities. Now that is not a judgment [sic] on the part of anybody, that's a legal definition as defined by the U.S. Department of Transportation, a limited quantity of radioactive material. And it did involve the shipment of these limited quantities between DOE sites. There were no releases associated with the project. It was not a release project. INEL has been involved since 1970 and everything else was classified.

"Mr. Broscious: Was it the Air Force that was involved in it?

"Mr. Miller: I can't answer that."

"Mr. Broscious: so are they going to declassify that information?

"Mr. Miller: I would say absolutely no way.

"Mr. Broscious: No way?

"Mr. Miller: No way." [CDC(d)@175]

Dr. Miller concluded that the Bluenose program was not a relevant issue to the INL Dose Reconstruction Study because he was convinced no releases occurred. It is entirely possible that the Bluenose document Dr. Miller was shown only dealt with transporting the Hanford irradiated U-235 slugs to INL. However other declassified documents released under FOIA to EDI clearly show the Bluenose program objectives for releases at numerous chemical processing sites around the country including INL. For instance a document titled "Reporting Bluenose Releases" from S. G. English, Chief, Chemistry Branch, Division of Research, and Washington to G. Victor Board, Director, Health and Safety Division, Idaho Operations Office, Idaho Falls states: "Enclosed for your information are the November reports on the dissolving at the ICPP." [HAN-64357] Another declassified March 18, 1955 memo between AEC Washington, D.C. and Hanford titled Preparation of ICPP Release Data states: "Your wire of January 27, 1955, requested a review of the feasibility of having General Electric perform calculations on krypton releases from the ICPP plant at Arco." [HA-58488]

Jim Thomas, now with a law firm involved in a Hanford Downwinder class action suit against DOE still believes that the U.S. efforts to determine Soviet plutonium production rates first tried iodine releases and switched to Krypton-85 because it was more reliable. They used atmospheric inventories of Kr-85 through known U.S. and Allied releases and subtracted that sum from the global total to determine the Soviet production levels.

It appears that through ineptitude or conspiracy, CDC has allowed DOE to hide relevant information needed to establish radioactive releases from INL. These Bluenose revelations strike at the very core of public confidence in CDC's political will to conduct good science. Before a scientific finding can have any credibility in the real world the methodology and supporting data must be reviewed and the method replicated by other independent scientists. As long as information remains classified, independent researchers cannot review the source information that CDC relied on to do the INL Dose Reconstruction health study, and therefore cannot replicate the science. The public will remain justifiably skeptical as long as fundamental scientific method is not followed.

The INL Research Bureau (IRB), a coalition sponsored by the Environmental Defense Institute, filed a Freedom of Information Act (FOIA) request to DOE Richland Operations Office in September for copies of documents identified during the Hanford Dose Reconstruction. The Department's October 24th response was: "We have conducted a thorough search of the Department of Energy's Richland Operations Office (RL) and contractor offices and the following documents were not located." "Therefore, this portion of your request must be denied." Twenty seven documents were listed as lost.

The IRB's appeal to DOE's Office of Hearings and Appeals in Washington, DC notes that "if indeed the requested documents are no longer in existence, the more serious implications of document destruction raises issues of Department non-compliance with United States Code, Title 44 Chapter 31 "Records Management by Federal Agencies"; Chapter 33, "Disposal of Records"; Code of Federal Regulations, 36 CFR, Chapter XII, Subchapter B, "Records Management"; 41 CFR Chapter 201, "Agency Programs"; DOE Order 200.1; and Secretary of Energy memorandums dated March 26, 1990, and January 13, 1994 mandating the retention of epidemiological and other related health study records. The IRB requested that DOE stipulate the fate of these 'not located' records."

The reason these INL documents were at Hanford is both sites were involved in Operation Bluenose. In the 1950's, the Air Force 's U-2 spy plane would fly over the Soviet nuclear production sites, take pictures and take air monitoring samples. In order for the air samples to be useful, the instruments had to be calibrated. As previously noted, intentionally large amounts of fission products including Iodine-131 and later Krypton-85 were released from Hanford, INL and other US production sites and over flown by the U-2 planes. Since The US throughput (production rate) was known, the air sample instruments could be calibrated.

Hanford, being the older AEC sibling, was also involved in INL's start up. INL's original name was the National Reactor Testing Station which more accurately characterizes its five decade mission. No other site has had a more diverse range of operations. Because of this diversity, documents needed for a dose reconstruction study are spread out over the country at different sites and archives. Preservation of these records is essential until after the dose reconstruction studies are completed and all challenges resolved.

Missing documents are not the only problem researchers face. DOE's response to a June INL Research Bureau Freedom of Information Act request was to black out the important parts of the report.

These documents quantified the amount of krypton-85 that was released from INL in support of the 1956 Bluenose project. DOE justified deleting the amount of krypton that was released by stating that:

"The Atomic Energy Act of 1954 prohibits the disclosure of information concerning atomic energy defense programs that is classified as Restricted Data pursuant to the Atomic Energy Act. The portions deleted from the subject documents pursuant to exemption 3 contain information about nuclear weapons design that has been classified as Restricted Data. Disclosure of the exempt data could jeopardize the common defense and the security of the nation." [DOE-9/23/97]

The only credible aspect of national security in jeopardy is the American public's confidence in its government to tell the truth. It is ludicrous to suggest that a person could figure out how to make a bomb from knowing how much iodine and krypton INL released over forty years ago. People living downwind or downstream have a right to know the truth about how these government activities affected their lives.

Summary of INL Radioactive Releases to Atmosphere

Facility	**Date**	**Curies Released**	**Source**
Naval Reactor Facility*	6/18/55	305	A @ A-203
ERB-1	11/29/55	single excursion	LA-13638
ICPP*	10/58	1,200	B @ C-3
ICPP*	10/16/59	367,717	A @ A-99
ICPP*	1/25/61	5,200	B @ C-5
SL-1*	1/3/61	1,128	A @ A-196
BORAX-1*	7/22/54	714	A @ A-203
Aircraft Nuclear Propulsion*	1956-66	4,635,724	see ANP table

Other INL			
Operational Release	1952-89	13,552,880	A @ A-189
Total Air Release	1952-98	18,564,868	

Sources: (A) DOE/ID-12119; (B) ERDA-1536; LA-13638 Los Alamos

* Significant episodic releases not included in general INL operational releases to the atmosphere. Curie releases less than 0.1 were not added in this summary and are considered understated due to lack of information.

A Review of Criticality Accidents 2000 Revision

Resource: Los Alamos National Laboratory Report, LA-13638

Idaho Chemical Processing Plant, 16 October 195913 pg. 18

Uranyl nitrate solution, U(91), in a waste receiving tank; multiple excursions; two significant exposures.

During evacuation of the building, airborne fission products (within the building) resulted in combined beta and gamma doses of 50 rem (one person), 32 rem (one person), and smaller amounts to 17 persons. While the evacuation proceeded relatively rapidly, the general evacuation alarm was never activated; it was a manually activated system.

Idaho Chemical Processing Plant, 25 January 196114,15,16,17 pg. 18

Uranyl nitrate solution, U(90), in a vapor disengagement vessel; multiple excursions; insignificant exposures.

Radiation alarms sounded throughout the process areas, apparently from the prompt gamma–rays associated with the fission spike. All employees evacuated promptly, and there were only minimal doses (<60 mrem) caused by airborne fission products after personnel left the building. A team of operating and health physics personnel reentered the building 20 minutes after the excursion and shut down all process equipment. As radiation levels had quickly returned to normal and there was no indication of any contamination within the manned areas, management authorized the workers to return to the plant at 14:45.

Idaho Chemical Processing Plant, 17 October 197828,29,101 pg. 45

Uranyl nitrate solution, U(82), in a lower disengagement section of a scrubbing column; excursion history
unknown; insignificant exposures.

The shift supervisor and the health physicist went outside the building and detected radiation levels up to 100 mrem/h. At 21:03, the shift supervisor ordered the building evacuated, and by 21:06 an orderly evacuation had been completed. Road blocks were established and management was notified.

SPERT

National Reactor Testing Station, 22 July 195469,70,71,72

BORAX reactor, aluminum-uranium alloy, water moderated; single excursion; insignificant exposures.

National Reactor Testing Station, 3 January 196174,75

SL–1 reactor; aluminum-uranium alloy; water moderated; single excursion; three fatalities

National Reactor Testing Station, 5 November 196276 pg.98

Assembly of Spert fuel elements; single non-nuclear excursion; insignificant exposures.

National Reactor Testing Station, 29 November 195582,83
EBR-1; enriched uranium fast breeder reactor; single excursion; insignificant exposures.

National Reactor Testing Station, 18 November 195884 pg. 105
HTRE Reactor; instrumentation failure; single excursion; insignificant exposures.

Idaho Chemical Processing Plant, 16 October 195913 pg.18
Uranyl nitrate solution, U(91), in a waste receiving tank; multiple excursions; two significant exposures.

This accident occurred in a chemical processing plant that accepted, among other items, spent fuel elements from various reactors. The fissile material involved in the accident (34 kg of enriched uranium, U(91), in the form of uranyl nitrate concentrated to about 170 g U/ l) was stored in a bank of cylindrical vessels with favorable geometry. The initiation of a siphoning action, inadvertently caused by an air sparging operation, resulted in the transfer of about 200 l of the solution to a 15,400 l tank containing about 600 l of water. Before the accident, a campaign was underway to process stainless steel clad fuels by sulfuric acid dissolution followed by impurity extraction in three pulse columns. Intermediate between the first and second cycle extraction, the solution was stored in two banks of 125 mm diameter by 3050 mm long pipe sections, often referred to as pencil tanks. There was a line leading from the interconnected banks of pencil tanks to the 5000 gallon (18900 l) waste receiving tank, but it was purposefully looped 600 mm above the top of the tanks to avoid any possibility of gravity drain from the pencil tanks to the waste tank. Only deliberate operator actions were thought capable of effecting transfers to the waste tank. On the day of the accident the operators, following routine written procedures, initiated sparging operations to obtain uniform samples for analysis. While the pressure gauge that indicated the sparge air flow was showing expected pressures from one of the banks, the gauge associated with the other bank was not functioning. There was not another gauge on this bank and the operator proceeded to open the air (sparge) valve until circumstantial evidence indicated that the sparge was operating. However, the air sparge was apparently turned on so forcefully that it caused the liquid to rise about 1,200 mm, from the initial liquid height in the pencil tanks to the top of the loop leading to the waste tank, which initiated a siphoning action. Although the siphoning rate was 13 liters per minute, it is difficult to relate this directly to the reactivity insertion rate since it also depended on the degree of mixing. The reactivity insertion rate could have been as high as 25 ¢/s. Because the 2.73 m diameter by 2.63 m long waste receiving tank was lying on its side, the solution configuration approximated a near infinite slab. Waves in the solution could have caused large fluctuations in the system reactivity. After the accident, much of the uranyl nitrate was found crystallized on the inner walls of the tank, and most of the water had evaporated. The resulting excursions generated 4 □□1019 fissions, sufficient to boil away nearly half of the 800 l solution volume that eventually terminated the excursions.

The excursion history is a matter of conjecture. There were only strip chart recordings from continuous air monitors at various distances from the tank. Some of these apparently stopped recording upon being driven to a very high level while those in lower radiation fields (generally farther away) may have been influenced by fission product gases. It is not unreasonable to assume that an initial spike of at least 1017 fissions was followed by multiple excursions and, finally, by boiling for 15 to 20 minutes. The very large yield is a result of the large volume of the system and the relatively long duration, rather than of the violence of the excursion tank. Because of thick shielding, none of the personnel received significant prompt gamma or neutron doses. **During evacuation of the building, airborne fission products (within the building) resulted in combined beta and gamma doses of 50 rem (one person), 32 rem (one person), and smaller amounts to 17 persons. While the evacuation proceeded relatively rapidly, the general evacuation alarm was never activated; it was a manually activated system**. The reason offered was that the accident occurred during the graveyard shift, and the small workforce left their work areas promptly and were all accounted for at the guard station. Afterwards it was acknowledged that local radiation alarms sounded relatively frequently and had somewhat conditioned operators to not evacuate until the second or third separate alarm had sounded. It was also noted that the normal building egress was used by all personnel; none used the prescribed and clearly marked evacuation route. This led to a bottleneck at the exit point, which could have been severe during the day shift with ten times as many workers present. Thus exposures could probably have been reduced somewhat if immediate evacuation by the proper route had occurred. Equipment involved in the excursion was not damaged. Several factors were identified by investigating committees as contributing to the accident:

- the operators were not familiar with seldom used equipment, the banks of pencil tanks, and their controlling valves.
- there was no anti-siphon device on the line through which the siphoning occurred. It was noted that such devices were installed on routinely used tanks.
- operating procedures were not current nor did they adequately describe required operator actions such as the need for careful adjustment of the air sparge

****

8. Idaho Chemical Processing Plant, 25 January 196114,15,16,17

Uranyl nitrate solution, U(90), in a vapor disengagement vessel; multiple excursions; insignificant exposures.

This accident occurred in the main process building, CPP 601, in H–cell, where fission products were chemically separated from dissolved spent fuel. The uranium was then concentrated via evaporation. Operations were conducted 24 hours per day on three 8–hour shifts. The accident happened at 09:50 after a routine shift change at 08:00. This was only the fifth day of operation following a shutdown that had lasted nearly a year. The accident took place in the upper disengagement head of the H–110 product evaporator. This was a vertical cylindrical vessel of about 600 mm diameter and more than a meter tall, which was above a 130 mm diameter favorable geometry section. In spite of an overflow line located just below the disengagement head to preclude significant amounts of solution from reaching it, concentrated uranyl nitrate solution, about 200 g U(90)/ l , was apparently rapidly ejected up into this unfavorable geometry section. There were several conjectured causes of the solution entering the disengagement head, which were discussed in the accident investigating committee's reports.14,15 The most probable cause was thought to have been a bubble of high pressure air (residuum from an earlier line unplugging operation) inadvertently forcing a large fraction of the available 40 l of uranyl nitrate solution in the 130 mm pipe section up into the vapor disengagement cylinder. Neither the exact fissile volume (and thus uranium mass) nor the geometry at the time of the spike is known; they can only be conjectured and bounded. It was certain that the excursion occurred in the head and was reported to be of short duration, a few minutes or less. The total number of fissions was estimated to be 6 x10□1017 with an uncertainty of 25%. There was no instrument readout to give a direct indication of the excursion history. Recordings from remote detectors such as continuous air monitors were all that were available from which to infer the time evolution of the excursion. Inspection of these strip chart recordings along with knowledge of their locations led to inconclusive, and, in the case of one strip chart, unexplainable findings. A subsequent American Nuclear Society (ANS) paper15 on a method for estimating the energy yield of criticality excursions shows an initial spike of 6 □□1016 and a total yield of 6 □□1017. The source of these values could not be determined. Experimental data from the CRAC5 series of prompt critical excursions coupled with the knowledge of the bounds on the volume of liquid involved in this accident support the values in the ANS paper. One final source of guidance as to the likely first spike yield is a private communication from Dr. D. L. Hetrick in which he concludes that a value of 6 □□1016 seems the most reasonable. 17

Radiation alarms sounded throughout the process areas, apparently from the prompt gamma–rays associated with the fission spike. **All employees evacuated promptly, and there were only minimal doses (<60 mrem) caused by airborne fission products after personnel left the building. A team of operating and health physics personnel reentered the building 20 minutes after the excursion and shut down all process equipment. As radiation levels had quickly returned to normal and there was no indication of any contamination within the manned areas, management authorized the workers to return to the plant at 14:45.**

No equipment was damaged. Several items were noted in the reports of the accident investigation committees as contributing causes. These included (1) poor communications, particularly oral messages between operators as to the positions of valves; (2) unfamiliarity of personnel with the equipment after such a long shutdown; and (3) relatively poor operating condition of the equipment.

19. Idaho Chemical Processing Plant, 17 October 197828,29,101

Uranyl nitrate solution, U(82), in a lower disengagement section of a scrubbing column; excursion history unknown; insignificant exposures.

The accident occurred in a shielded operation of a fuel reprocessing plant in which solutions from the dissolution of irradiated reactor fuel were processed by solvent extraction to remove fission products and recover the enriched uranium.

In the solvent extraction process, immiscible aqueous and organic streams counter–flow through columns while in intimate contact and, through control of chemistry, material is transferred from one stream to the other. A string of perforated plates along the axes of the columns was driven up and down forming a “pulsed column” that increased the effectiveness of contact between the two streams. The large diameter regions at the top and bottom of the columns were disengagement sections where the aqueous and organic streams separated.

In this particular system (Figure 27), less dense organic (a mixture of tributyl phosphate and kerosene) was fed into the bottom of the G–111 column while an aqueous stream containing the uranium and fission products was fed into the top. As the streams passed through the pulsed column, uranium was extracted from the aqueous stream by the organic with fission products remaining in the aqueous stream. The aqueous stream containing fission products was sampled from the bottom of the G–111 column to verify compliance with uranium discard limits before being sent to waste storage tanks. The organic product stream (containing about 1 g U/ l) from the top of the G–111 was fed into a second column, H–100; at the bottom of its lower is engagement section.

In H–100, the organic product was contacted by a clean aqueous stream (fed into the top) to scrub out residual fission products. The aqueous stream was buffered with aluminum nitrate to a concentration of 0.75 molar to prevent significant transfer of uranium from the organic stream to the aqueous stream. In normal operation, a small amount of uranium (about 0.15 g/ l) would be taken up by the aqueous stream, which was, therefore, fed back and blended with the aqueous recovery feed going into G–111. The organic stream from H–100, normally about 0.9 g U/ l , went on to a third column, where the uranium was stripped from the organic by 0.005 molar nitric acid. The output of the stripping column then went to mixer settlers where additional purification took place. Still further downstream, the uranium solution went to an evaporator where it was concentrated to permit efficient recovery of the uranium.

Several factors contributed to this accident. The water valve on the aluminum nitrate make–up tank (PM–106) used for the preparation of the aqueous feed for the scrubbing column, H–100, had been leaking for about a month prior to the accident. Over time, this leak caused a dilution of the feed solution from 0.75 M to 0.08 M. The 13,400 l make–up tank was equipped with a density alarm that would have indicated the discrepancy, but the alarm was inoperable. A density alarm was scheduled to be installed on the 3,000 l process feed tank (PM–107) that was filled, as necessary, from the make–up tank, but this had not been done. The make–up tank was instrumented with

a strip–chart recorder showing the solution level in the tank. However, the leak into the tank was so slow that the change in level would have not have been discernible
unless several days' worth of the chart was analyzed.

To complicate matters, the chart recorder had run out of paper on 29 September and it was not replaced until after the accident. Furthermore, procedures that required the taking of samples from the feed tank, PM–107, to confirm the density, were not being followed.

Figure 27. First cycle extraction line equipment. The accident occurred in the lower is engagement section of the H-100 column. Scrubbing column caused it to operate as a stripper
rather than as a scrubber. Some of the enriched uranium was removed from the H–100 column organic and recycled into the input of G–111. This partially closed loop resulted in a steady increase in the uranium inventory in the two columns. Each time diluted solution was added to the feed tank from the make–up tank, the aluminum nitrate concentration in the feed was further reduced and stripping became more effective until the excursion occurred.

Analyses of the aqueous feed for column H–100 (feed tank PM–107) showed the proper concentration of 0.7 M aluminum nitrate on 15 September 1978.

Samples taken on 27 September and 18 October (the day after the accident) had on concentrations of 0.47 M and 0.084 M, respectively. Concentrations of aluminum nitrate less than 0.5 M would allow some stripping of uranium from the organic, and the final aluminum nitrate concentration would result in almost all of the uranium being stripped from the organic.

The feed tank (PM–107) was filled with aluminum nitrate solution from the make–up tank (PM–106) at about 18:30, on 17 October. At approximately 20:00, the process operator was having difficulty in controlling the H–100 column. During his efforts to maintain proper operation, he reduced the system pressure causing an increased aqueous flow from H–100 back to G–111. At approximately 20:40, a plant stack radiation monitor alarmed, probably because of fission products in the plant stack gases. Shortly after this alarm, several other alarms activated and the plant stack monitor gave a full–scale reading. **The shift supervisor and the health physicist went outside the building and detected radiation levels up to 100 mrem/h. At 21:03, the shift supervisor ordered the building evacuated, and by 21:06 an orderly evacuation had been completed. Road blocks were established and management was notified.**

It is probable that as the uranium inventory in the bottom of H–100 increased the system achieved the delayed critical state, then became slightly supercritical. As the power increased, the temperature rose compensating for the reactivity introduced by the additional uranium. This process would continue as long as the uranium addition was slow and until the reduced pressure on the column permitted more rapid addition of uranium and a sharp increase in reactivity.

The system is thought to have approached prompt criticality, at which time the rate of power increase would have been determined by the neutron lifetime (on the order of milliseconds).
Prior to evacuating, the process operator shut off all feed to the first cycle extraction process, but did not stop the pulsation of the columns. The continuation of the pulse action after the feed was turned off probably led to better mixing of the solution in the bottom section of H–100 and terminated the excursion. Later analysis showed that the excursion had occurred in the lower disengagement section of the H–100 column.

Records indicate the reaction rate increased very slowly until late in the sequence, when a sharp rise in power occurred. The uranium inventory in Column H–100 was estimated to have been about 10 kg, compared with slightly less than 1 kg during normal operation.

The total number of fissions during the excursion was estimated to be 2.7 □□1018. Several factors contributed to this accident.

- The water valve on the aluminum nitrate make-up tank (PM-106) used for preparation of the aqueous had been leaking for about a month prior to the accident.
- Significantly more solution had been transferred from the make–tank to the feed tank than should have been available (because of the leak). This was not noticed by any of the plant staff.

- The chart recorder for the make–up tank that would have shown the solution level had run out of paper weeks earlier. The paper was not replaced until after the accident.
- The density recorder and alarm on the aluminum nitrate feed tank, PM–107, had not been installed even though it appeared on the controlled drawings of the plant.
- The operating procedure that required sampling before transfer between the aluminum nitrate make–up and feed tanks was not followed. Furthermore the procedure actually used on the process floor was an older out–of–date version that did not contain this requirement.
- In the two years preceding the accident, the experience level of the operators had decreased dramatically.
- The safety analysis prepared in 1974 identified the criticality risk if the aluminum nitrate scrub feed were to become dilute, but in correctly assumed that stoppage of the scrub feed was also necessary. The evaluation process had been excessively focused on the physics of sub criticality and not on risk assessment. There were no significant personnel exposures and no damage to process equipment. As a direct result of this event, the plant suffered an extended and expensive shutdown. Operating procedures were reviewed in detail and revised as appropriate. Increased emphasis was given to plant maintenance and operator training.

An extensive and highly instrumented plant protection system involving redundant sensors and redundant automatic safety controls was installed. The importance of maintenance of safety related equipment and the need for adherence to well-developed operating procedures were reemphasized by this accident.

SPERT

SPERT-1 reactor cores (heterogeneous, moderated, and reflected by water)99 were of two general types. The first had fuel in the form of MTR type aluminum– uranium plates and cores designed to include the range from under moderation to the more hazardous region of over moderation. The second was composed of canned UO2 rods about 10 mm in diameter. The uranium enrichment in these rods was 4%.

Transients of the plate type reactors have been extensively studied since 1957 in an effort to solve core design problems and to find the limitations of such reactors. In particular, the period and energy release that can cause damage have been carefully determined. The shutdown of a power transient in the SPERT systems is more complicated than in simpler reactors. The model developed includes heating and density change of the water; heating of the core structure, including its own geometry changes and moderator expulsion from such changes; and finally, the boiling of water next to the plates and loss of moderator when water is expelled from the core. When the plate type core was destroyed, the reactivity, period, peak power, and fission energy release were essentially as predicted. The destructive steam pressure pulse starting some 15 milliseconds after completion of the nuclear phase was not foreseen and is thought to have been caused by very rapid transfer of energy from the near molten aluminum plates to the thin layer of water between the plates. The transfer, occurring before any significant volume change took place, and the resulting high pressure destroyed the core. This effect seems to have been involved in the destruction of BORAX, SPERT, and SL-1.

The second type of SPERT-1 core89 (4% enriched UO2 rods in water) was tested during 1963 and 1964. Transient experiments with this core demonstrated the effectiveness of the Doppler mode of self-shutdown and provide a basis for analysis of accidents in similar power reactor systems. Two attempts to destroy the core by placing the reactor on very short periods (2.2 and 1.55 milliseconds) failed. In each case, the Doppler effect was operative and additional quenching developed because one or two fuel pins (out of several hundred) cracked and caused local boiling. The pins were thought to have been saturated with water before the test.

5. National Reactor Testing Station (now called INL), 22 July 1954 69,70,71,72

BORAX reactor, aluminum-uranium alloy, water moderated; single excursion; insignificant exposures.

The National Reactor Testing Station was located near Idaho Falls, Idaho in the United States. This excursion was an accident only in the sense that it was larger than expected. The BORAX-I reactor had been built as a temporary affair; steady state and transient studies were regarded as complete; and it was decided that the reactor should be forced onto a short period transient to obtain the maximum amount of experimental information before it was dismantled. The excess reactivity was chosen to produce a fission yield such that about 4% of the fuel plates would melt.

The BORAX-I reactor consisted of 28 MTR-type fuel elements moderated by light water. Each element contained 18 fuel plates 2.845 inches □ 0.060 inches □□24.6 inches consisting of aluminum–uranium alloy clad with about 0.020 in. of aluminum.

The total uranium inventory was 4.16 kg, and the whole core was in a semi–buried tank 4 feet in diameter and 13 feet high.

It had been estimated from earlier controlled prompt excursions that about 4% excess *k* would put the reactor on a period between 2.0 and 2.5 milliseconds and that the resulting excursion would release about 80 mega joules of fission energy. To perform this experiment a larger than usual fuel loading and a more effective central control rod were required.

The excursion and associated steam explosion following rapid ejection of the control rod completely disassembled the reactor core and ruptured the reactor tank (Figure 59). Very extensive melting of the fuel plates occurred; some elements remained in the tank and small pieces were found up to 200 feet away.

An example of the force of the explosion was the carrying away of the control rod mechanism. This mechanism, which weighed 2,200 pounds, sat on a base plate, about 8 feet above the top of the reactor tank. Except for the base plate, about 4 feet square, the top of the 10 foot shield tank was essentially unobstructed.

The force of the explosion plus the impingement of water and debris on the base plate tore the plate loose from its coverage and, as revealed by high speed movies, tossed the mechanism about 30 feet into the air. 71

The total energy release was 135 mega joules instead of the predicted 80 mega joules or, assuming 180 MeV deposited per fission, 4.68 □□1018 fissions. This energy is equivalent to that contained in about 70 pounds of high explosive, but it has been estimated that between 6 and 17 pounds of high explosives would produce comparable damage. The minimum period was 2.6 milliseconds, and the maximum power was about 1.9 □□1010 watts. It is apparent that the nuclear excursion was completed before the steam explosion destroyed the system.

In this excursion, the reactor was destroyed but, because of the remote site, physical damage was limited to the reactor. No personnel were exposed to radiation.

8. National Reactor Testing Station, 3 January 196174,75

SL–1 reactor; aluminum-uranium alloy; water moderated; single excursion; three fatalities

The SL-1 reactor (originally known as the Argonne Low Power reactor) was a direct–cycle, boiling water reactor of 3 megawatts gross thermal power using enriched uranium fuel plates clad in aluminum, moderated, and cooled by water. Because the reactor was designed to operate for 3 years with little attention, the core was loaded with excess 235U. To counterbalance the excess of 235U, a burnable poison (10B) was added to some core elements as aluminum–10B– nickel alloy. Because the boron plates had a tendency to bow (and, apparently, to corrode, increasing reactivity), some of them were replaced in November 1960 with cadmium strips welded between thin aluminum plates. At that time the shutdown margin was estimated to be 3% (about 4 $) compared to the initial value of 3.5% to 4%. The cruciform control rods, which tended to stick, were large cadmium sheets sandwiched between aluminum plates.

The nuclear accident was probably independent of the poor condition of the core. After having been in operation for about 2 years, the SL-1 was shut down 23 December 1960 for routine maintenance; on 4 January 1961, it was again to be brought to power. The three man crew on duty the night of 3 January was assigned the task of reassembling the control rod drives and preparing the reactor for startup.

Apparently, they were engaged in this task when the excursion occurred. The best available evidence (circumstantial, but convincing) suggests that the central rod was manually pulled out as rapidly as the operator was able to do so.

This rapid increase of reactivity placed the reactor on about a 4 millisecond period; the power continued to rise until thermal expansion and steam void formation.

9. National Reactor Testing Station, 5 November 196276

Assembly of Spert fuel elements; single non-nuclear excursion; insignificant exposures.

The accident occurred with a small test assembly designed to investigate the transient behavior of water moderated and cooled plate type reactors. The Spert fuel consisted of plates of highly enriched uranium alloyed with aluminum and clad with the same material. Previous test programs had produced data for transients whose initial period exceeded 8 millisecond.

These experiments were nondestructive, having resulted in only minor fuel plate distortion. However, some data of a destructive nature was obtained for a 2.6 millisecond period in the 1954 BORAX-I test that resulted in an explosion that destroyed the reactor.

These experiments were therefore designed to investigate the transition from essentially non–damaging to destructive excursions.

After completion of a long experimental program, two tests were conducted resulting in periods of 5.0 and 4.6 milliseconds. These resulted in some plate distortion and some limited fuel melting. The transient behavior was regarded as a reasonable extrapolation of data from earlier experiments having longer periods.

There was no indication that further extrapolation was not valid. In the final test with a 3.2 milliseconds period (energy release 30.7 MJ) all 270 plates showed melting to some degree, with the average molten fraction about.

9. National Reactor Testing Station, 5 November 196276

Assembly of Spert fuel elements; single non-nuclear excursion; insignificant exposures.

The accident occurred with a small test assembly designed to investigate the transient behavior of water moderated and cooled plate type reactors. The Spert fuel consisted of plates of highly enriched uranium alloyed with aluminum and clad with the same material. Previous test programs had produced data for transients whose initial period exceeded 8 millisecond.

These experiments were nondestructive, having resulted in only minor fuel plate distortion. However, some data of a destructive nature was obtained for a 2.6 millisecond period in the 1954 BORAX-I test that resulted in an explosion that destroyed the reactor.

These experiments were therefore designed to investigate the transition from essentially non–damaging to destructive excursions.

After completion of a long experimental program, two tests were conducted resulting in periods of 5.0 and 4.6 milliseconds. These resulted in some plate distortion and some limited fuel melting. The transient behavior was regarded as a reasonable extrapolation of data from earlier experiments having longer periods. There was no indication that further extrapolation was not valid.

In the final test with a 3.2 milliseconds period (energy release 30.7 MJ) all 270 plates showed melting to some degree, with the average molten fraction about 35%. The performance of this test, from the nuclear point of view, was very close to predicted. Evidently the nuclear characteristics of the shutdown were essentially identical to the earlier transients and involved fuel and moderator thermal expansion and boiling of water. However, about 15 milliseconds after the nuclear transient was terminated, a violent pressure surge resulted in total destruction of the core. This is attributed to a steam explosion caused by rapid energy transfer from the molten fuel to the water moderator.

Fuel, water, and core structure were violently ejected from the vessel in which the experiment took place.

This experiment was instrumented to measure the activity of any fission products that might be released, even though no violent excursion was expected. The measurements showed that about 7% of the noble gases produced during the transient escaped to the atmosphere. The roof and some of the siding of the reactor building had been removed prior to the test, so the building provided only limited confinement.

Neither solid fission products nor any radioiodines were found in the atmosphere. Based on the detection sensitivity of the instrumentation and the lack of any indicated presence of iodine, it was established that less than 0.01% of the radioiodines produced had escaped to the atmosphere.

2. National Reactor Testing Station, 29 November 195582,83

EBR-1; enriched uranium fast breeder reactor; single excursion; insignificant exposures.

Design of the EBR-1 fast neutron reactor was started in 1948 with the objectives of establishing possible breeding values and demonstrating the feasibility of cooling a metal fueled reactor with liquid metals. These objectives were met, and in early 1952, the plant furnished more than enough electrical power for the reactor and the reactor building; excess steam was blown to the condenser.

The reactor core consisted of cylindrical, highly enriched uranium rods slightly less than 1/2 inch in diameter canned in stainless steel with a bonding of NaK between the rod and can. The total core mass of about 52 kg of uranium was bathed in a stream of NaK, which served as a coolant.

The final experiment was designed to investigate coefficients of reactivity and, in particular, to study a prompt positive power coefficient without coolant flow.

To do this, the system was placed on a period of 60 seconds at a power of 50 watts. About 3 seconds later the power was 1 megawatt, the period had decreased to 0.9 seconds, and core temperatures were rising significantly.

The signal to scram the system was given, but by error the slow moving motor driven control rods were actuated instead of the fast acting scram—dropping part of the natural uranium blanket under gravity—as had been done to conclude similar experiments. This change in reactivity caused a momentary drop in power, but was inadequate to overcome the natural processes (very slight bowing inward of the fuel elements) adding reactivity to the system. After a delay of not more than 2 seconds, the fast scram was actuated, both manually and by instruments, and the experiment completed.

It was not immediately evident that the core had been damaged. Later examination disclosed that nearly one-half the core had melted and vaporized NaK had forced some of the molten alloy into the reflector.

Theoretical analysis showed that the excursion was stopped by the falling reflector, after the power reached a maximum of 9 to 10 megawatt. The total energy release was close to 4.6 □□1017 fissions. The theoretical analysis was carried further in an attempt to determine if the core would have shut itself off in a non–catastrophic manner. The conclusion was that the energy release could have been nearly 2.5 times the observed yield but would not have resulted in violent disassembly of the core.

During this accident no one received more than trivial radiation from airborne fission products, and direct exposure was essentially zero.

*R. Feynman pointed out the similarity of the procedures used in these experiments to tickling the tail of a dragon.

4. National Reactor Testing Station, 18 November 195884

HTRE Reactor; instrumentation failure; single excursion; insignificant exposures.

The High Temperature Reactor Experiment (HTRE No. 3) power plant assembly was a large reactor (core diameter 51 in., length 43.5 in.) with nickel–chromium-UO2 fuel elements, hydrided zirconium moderator, and beryllium reflector. The experimental objective was to raise the power to about 120 kilowatts, about twice that attained earlier in the day. This was done by manual control until about 10% of desired power was reached. At that point, control shifted to a servomechanism programmed to take the reactor power to 120 kilowatts on a 20 second period. When about 80% of full power was attained, the flux, as shown on the power level recorder, began to fall off rapidly and the servosystem further withdrew the control rods. The power indication, however, did not increase but continued to drop. This situation existed for about 20 seconds when the reactor scrammed automatically; within 3 seconds the operator took The critical assembly consisted of a large cylindrical enriched uranium–graphite core on a lift device and a stationary platform holding a reflector of graphite and beryllium into which the core was raised.

Most of the 235U was placed in the graphite in the form of thin foils, therefore the excursion characteristics should be similar to those of the honeycomb assembly. The experiment was concerned with measurements of the axial fission distribution, which was perturbed from its normal value by an end reflector of layers of graphite and polyethylene. For this reason, some fresh 235U foils had been placed in the assembly to obtain a reasonably precise value of the fission energy release.

4. National Reactor Testing Station, 18 November 195884

HTRE Reactor; instrumentation failure; single excursion; insignificant exposures.

The High Temperature Reactor Experiment (HTRE No. 3) power plant assembly was a large reactor (core diameter 51 in., length 43.5 in.) with nickel–chromium-UO2 fuel elements, hydrided zirconium moderator, and beryllium reflector. The experimental objective was to raise the power to about 120 kilowatts, about twice that attained earlier in the day. This was done by manual control until about 10% of desired power was reached. At that point, control shifted to a servomechanism programmed to take the reactor power to 120 kilowatts on a 20 second period. When about 80% of full power was attained, the flux, as shown on the power level recorder, began to fall off rapidly and the servosystem further withdrew the control rods. The power indication, however, did not increase but continued to drop. This situation existed for about 20 seconds when the reactor scrammed automatically; within 3 seconds the operator took action that also activated the scram circuit. It is thought that the automatic scram was triggered by melting thermocouple wires. The primary cause of the accident was a drop in the ion collecting voltage across the detection chamber of the servosystem with increasing neutron flux. This behavior was, in turn, caused by the addition to the wiring of a filter circuit designed to reduce electronic noise from the high voltage supply or its connecting cable. Thus, this accident appears to be unique, as it was due solely to instrumentation.

In the nonviolent power excursion of about 2.5 x□1019 fissions, all core fuel elements experienced some melting; only a few of the zirconium hydride moderator pieces were ruined. The melting of fuel elements allowed a minor redistribution of fuel, decreasing the reactivity by about 2%. Some fission product activity was released downwind, but personnel radiation doses apparently were negligible.

Reference: Los Alamos A Review of Criticality Accidents 2000 Revision LA-13638