I.D. INTEC Reactor Fuel Processing

Idaho Nuclear Technology and Engineering Center

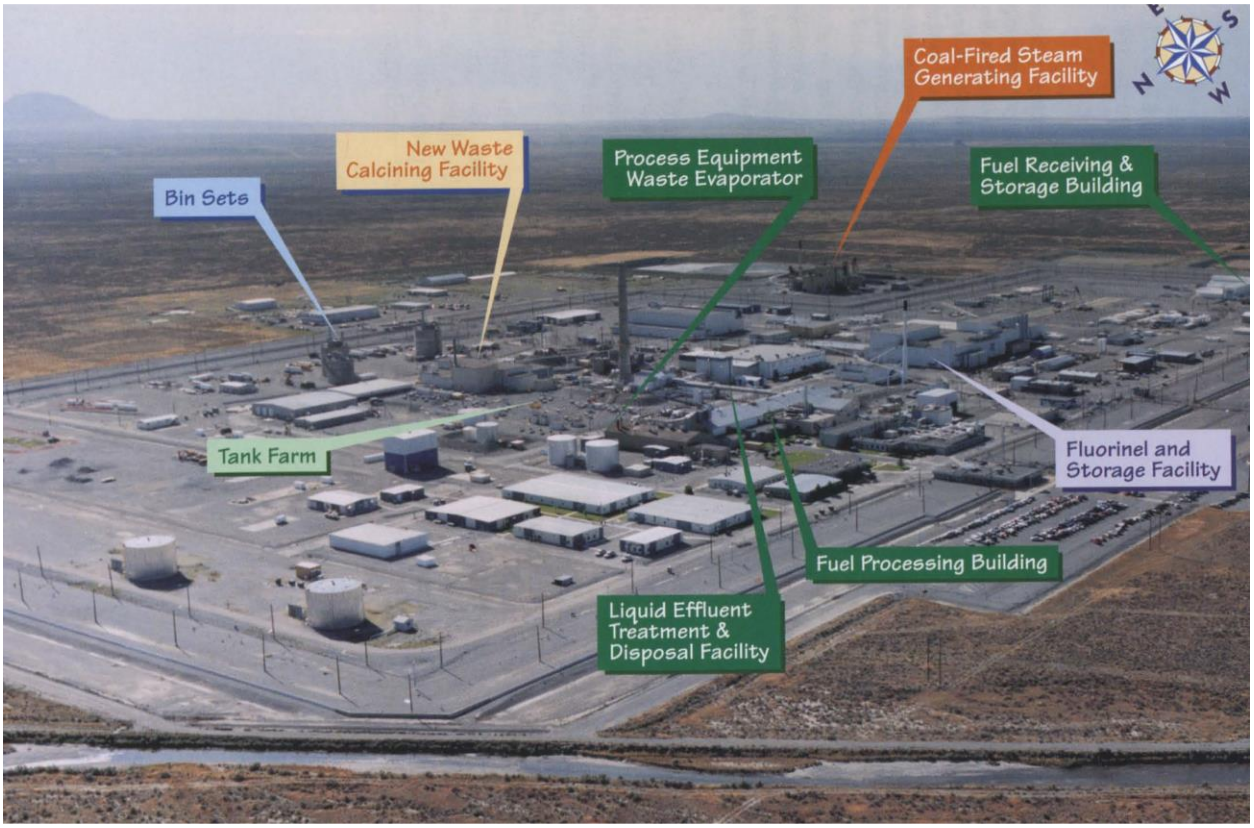
The Idaho Chemical Processing Plant (ICPP) (now called Idaho Nuclear Technology and Environmental Center [INTEC]) opened in 1953 served (until 1993 when reprocessing was temporarily stopped) as the principal facility for storage and reprocessing of spent nuclear fuel (SNF). Man-made elements created by fission uranium in a nuclear reactor are isolated by reprocessing of the irradiated or "spent" reactor fuel. Because this is known as the most hazardous industrial operation in the world, these reprocessing plants were located in remote areas. Fuel cladding (metal covering around the uranium fuel) types reprocessed at ICPP included zirconium, aluminum, stainless steel, graphite and specialty cladding.

The INTEC (ICPP) is a large complex made up of numerous individual buildings. Current major process buildings at the INTEC include the following:

Fluorinel and Storage Facility (FAST) (CPP-666) built in 1978 and is divided into two sections - Fluorinel Dissolution Process (FDP) and fuel storage facility. The FDP is the first step in zirconium clad spent fuel reprocessing primarily from the Navy reactors. The fuel is dissolved in a solution of hydrofluoric acid and other chemicals. The FDP hot cell contains three dissolves designed for remote operation. The last campaign (reprocess run) at FDP was in 1988, however the plant remains on standby status. **The Custom Dissolution Process Facility (CPP-627)** customized small scale SNF reprocessing systems operated in the Hot Chemistry Laboratory located in CPP-627 to process nuclear materials that could not be handled in existing ICPP dissolution facilities. Only small quantities of material were processed in each campaign. The facility comprises the Multi Curie Cell, and anteroom and a radio chemistry laboratory.

The Head-end Processes (CPP-640) houses the Hot Pilot Plant which is a five level structure with each level containing one or more shielded dissolution process areas. Five process areas were used for the Rover Dissolution Process and one for the Electrolytic Dissolution Process. The Rover reprocessing facility recovered uranium from graphite-based SNF from a nuclear powered rocket project conducted in the 1960's.

The facility consists of the Mechanical Handling Cave and four shielded cells. Cell 5 of the Hot Pilot Plant contains the electrolytic dissolver used to dissolve stainless-steel clad SNF.



Separations Facilities (CPP-601) contains a series of 29 cells used to extract uranium from dissolved fuel. Most cells are about 20 feet square and 28 feet deep and are lined with stainless steel. Most of the equipment is stainless steel except for some pieces made of more exotic alloys for resistance to sulfuric or hydrofluoric acids or to electrolytic currents. With the exception of four special cells provided with viewing windows and manipulators, the in-cell equipment was controlled from an operating corridor. The corridor runs the length of the building between two rows of cells and contains equipment for regulating the flow of liquids through the process.

The Denitrator (CPP-602) is where liquid uranium solutions from chemical extraction processes were converted to a solid in a heated, fluidized bed. The granular product was packaged and stored in an adjacent vault pending shipment to the Un-irradiated Storage Facility. CPP-602's last campaign was in 1994.

The Rare Gas Plant (CPP-604) has three off-gas cells on the west side that cryogenically recovered radioactive krypton and xenon from dissolver off gas streams for commercial use. The three cells range in size from 20 to 24 feet wide and nine to 24 feet long, and 35 feet high. All have thick concrete walls and ceilings and contain equipment used in the off-gas recovery process. The Fuel Processing Restoration Facility (CPP-691) is a new plant that was under construction when reprocessing was discontinued in 1992. It was intended to replace CPP-601 and 602.

The Waste Calcining Facility (WCF) was the world's first plant-scale facility for solidifying liquid high-level waste from reprocessing. WCF converted high-level radioactive liquid wastes into granular solids, which are less corrosive, more stable and have less volume. From 1963 to 1982, WCF calcined over four million gallons of liquid waste before it was replaced by the New Waste Calcine

Facility (NWCF), which incinerated another 4 million gallons of high-level waste. Critics of the calcining process characterize it as a giant radioactive aerosol. In April of 2000, the Environmental Defense Institute, Keep Yellowstone Nuclear Free, and David McCoy filed a Notice of Intent to Sue DOE, EPA, and the state of Idaho for operating the NWCF for eighteen years without a RCRA permit. DOE immediately shut down the Calciner and implemented a closure plan.

I.D. 1 RaLa Process Runs

"The term "RaLa" is an abbreviation for **Ra**dioactive **La**nthanum-140 which is a decay product of barium-140. The term RaLa as used here refers to all phases of Barium-140 production from development to actual production facility operation." [IDO-14344 @10] CDC's analysis of the RaLa releases between 1957 and 1961 shows 3,269.818 curies of Iodine-131 and 17,233.610 curies of I-132 were released. [1] By contrast, the Three Mile Island reactor accident, considered to be America's worst nuclear accident, released 15 curies (Ci) of Iodine-131. [Benson, p.2]

Yet, RaLa fuel process runs at INL's Idaho Chemical Processing Plant (ICPP) produced "Radio iodine which can also be released under certain conditions amounts to 50,000 to 100,000 curies." [IDO-14532@13] The highest radioactive release period - over half of the total - occurred between 1956 and 1966 and amounted to 15,256,015 curies to the atmosphere. [ERDA-1536, p. III-7] [DOE/ID-12119 @A 55]

The Idaho Chemical Processing Plant (ICPP) conducted 11 process runs in 1953 for the capture of Krypton-85 and 113 process runs between May 1954 and February 1963 to recover Barium-140, Uranium-235, and Lanthanum-140 for the radiological/chemical weapons program. These isotopes were produced for Atomic Energy Commission (DOE's predecessor) Los Alamos National Laboratory. RaLa was used to produce material which Los Alamos used as a "substitute" for plutonium in certain types of radiological weapons tests. Barium-140 shared many of the physical properties of plutonium and could be used to disperse deadly fission products without destroying infrastructure. With a shorter half-life of twelve days it did not permanently contaminate the environs the way plutonium would with a half-live of 24,000 years. So, it was a people killer weapon (dirty bomb), not a building leveler that the nuclear priesthood was developing and testing on the residents of New Mexico.

"The government moved the RaLa project to Idaho from Oak Ridge, Tenn. because of concerns over the iodine releases connected with the processing "green fuel." The Oak Ridge plant was within five miles of the nearest site boundary, said [John] Horan who worked at the Tennessee facility during the early 1950s." [Times News(f)] In fact, a RaLa run blew up at ORNL when operators tried to produce a 100,000 curie batch of Barium-140 which resulted in a three day plant evacuation.

Recent disclosures by the General Accounting Office about radiation warfare experiments conducted at Oak Ridge on American citizens where hundreds of thousands of curies of Lanthanum were released suggests the Barium-140 came from either from Oak Ridge or the ICPP depending on the date of the experiment. According to the extremely limited documentation EDI has on the Ba-140/La-140 shipments from ICPP to Los Alamos, over 502,000 curies were sent and used in open air tests to evaluate the killing power of this radiological weapon.

"Radioactive Lanthanum-140, daughter of Barium-140 has been used as an intense radiation source for a number of years. Historically, a need has developed for increasing batches of the Barium-140 sources material with additional emphasis on increasing specific activity of the barium. The increasing demand resulted in inadequacy of facilities of the original barium producer, the Oak Ridge National Laboratories (ORNL). The more recent availability of high specific activity fuel from the [INL] Materials Test Reactor indicates the desirability of locating production facilities in conjunction with that reactor. In fact, a RaLa production cell was provided for in the ICPP original design of the Chemical Processing Plant [ICPP] by ORNL.

"The popular term 'RaLa' is a misnomer since the research, development, and production is

[1] CDC INEL Dose Reconstruction, Reported releases from the ICPP during RaLa Operations, From Hayden, R.E. 1957-1963. Activity Discharged to Atmosphere. INEEL Task Order Database MC Number 60111.

centered on the isotope barium-140." "At this time [1951], ORNL commenced the development of a process [at ICPP], based on irradiated MTR elements as feed material, capable of consistently yielding batches of at least 30,000 curies." [IDO-14445 @ 14]

RaLa runs were conducted at ICPP during the nine year period of 1954-1963. During some periods in 1954-55 while the process was being developed, un-irradiated fuel was used. Between 1953 and 1963 the ICPP released 6,092,985 Ci to the atmosphere. [ERDA-1536@III-7] Discussions in this section focus primarily on pre-1957 Rala runs because DOE has not acknowledged them in their 1992 INL Historical Dose Evaluation report as Rala runs.

Acknowledged ICPP Iodine-131quantities released between 1957 and 1963 were 2,800 Ci, with the highest year being 1958 releasing 1,028 Ci of I-131. [ERDA-1536.@II-242] Internal DOE documents suggest the quantity of I-131 that may have been released in a single run was more than what DOE acknowledged for an entire year.

This RaLa program is the INL equivalent of the infamous Hanford "Green-Runs" which also processed "green" reactor fuel. When reactor fuel is processed "green", that is, prior to a cooling period that allows short-lived radioactivity to "safely" decay, a significant amount of radioactivity is released to the environment when the fuel is processed. The ICPP emission control system during that period was very primitive.

The veil of secrecy also allowed the nuclear alchemists to proceed without public notification or accountability. This secrecy persists today. DOE's 1991 INL Historical Dose-Assessment Report does not include nor acknowledge many RaLa runs or the 1956 Bluenose releases from ICPP. Some of the first process runs were conducted with non-irradiated simulated fuel. Full access to ICPP operations documentation is needed to accurately assess the RaLa program. It should be noted that it took nearly five years of public pressure on DOE to allow Q-clearance access to the daily fuel processing documentation at Hanford, however, all the documents are yet to be declassified. The same is true for INL. The Department of the Navy is a claiming jurisdiction over some of DOE's secret documents because they pertain to Navy fuel processing and they refuse to declassify the information.

"The RaLa process involves the dissolution and processing of a 2-day cooled MTR [Materials Test Reactor] fuel assembly for recovery of radioactive barium-140. The operation is performed over a 24 to 36 hour period several times each year and involves about 1,200,000 curies of short-lived fission products. While 1.2 million curies is not a great amount compared to the normal processing plant operations [ICPP], the quantities of such elements as xenon, iodine and lanthanum are tremendous compared to those normally encountered; furthermore, the 1.2 million curies is contained in a solution volume of only a few liters. Xenon and krypton, which go to the off-gas, amount to about 100,000 curies and special measures must be taken to prevent unauthorized release. Radio iodine, which can also be released under certain conditions, amounts to 50,000 to 100,000 curies." [IDO-14532,p.13]

Phillips Petroleum, then operator of the ICPP, reported in the second quarter of 1957, that; "The liquid waste system operated satisfactorily except for failure to remove iodine resulting from RaLa processing". [IDO-14419,p.7] RaLa Run 002-RH originally scheduled for process on November 26, 1956, was delayed until November 30 "due to weather conditions being too adverse to permit gas release to the stack." [IDO-14414 @ 156] During run 002-RH, "Area AEC radiation surveys indicated that activity in the dissolver off-gas discharging from the stack persisted for about five minutes. During this period, the AEC sky scanner radiation instruments read maximum and then dropped to zero." [Ibid. @ 158] During this run, the Process Makeup Area was contaminated by a burst of airborne activity into the work area when the shipping pot was removed from the process cell. [[IDO-14414 @ 45]

"The Barium-140 recovery (RaLa) at ICPP produces a separate off-gas stream, treated with extreme care because it normally contains kilocurie quantities of radio xenon and Radio iodine. The xenon is released under controlled conditions. If the weather permits, it goes directly to the plant stack. If the weather does not allow immediate release, it is held in a 10,000 cubic foot shielded gas holder until a more opportune time, or until the xenon has decayed to a low level." [IDO-14532,p.26]

This holding tank was, however, not built and fully functional until 1958, two years after hot RaLa processing began. [IDO-14414 @ 170] Another problem, even after the off-gas holding tank was built, was

that it could only hold 10 hours of operational emissions. [IDO-14414 @29&42] Since significant amounts of radionuclides continued to be released over days and weeks after the process run, the holding tank was of limited value even after it was installed.

RaLa Materials Test Reactor (MTR) fuel runs No.3 (12/56), and No.5 (2/57) contained 6,580 and 166,000 Ci of Iodine respectively. "Runs No. 3 & 5 weather conditions permitted venting all gases to the stack." [PTR-185 @6&7] Run No. 3 had significant equipment malfunctions that resulted in extensive contamination of the L Cell. "Four hundred man-hours were expended in reducing the general background radiation in L cell from an estimated 1000 R/hr. to 0.3-1 R/hr." [Ibid. @45] Exposure to the decontamination workers under those conditions would be expected to be considerable.

"Scrubbers were later installed as part of the off-gas emission control system. "There are indications that considerable iodine activity passed through the scrubber. Smears indicated the presence of iodine in the stack. AEC site surveys indicated that local rabbits showed significant increases in thyroid radiation count immediately following Runs 3, 4, and 5. Since gases from the runs were not collected and sampled it is not known how much activity was discharged from the stack. The stack monitor, which was put into service just prior to Run No. 4, indicated that significant iodine activity continued to be released for several days after each of the last two runs was completed. This would indicate that iodine has a tendency to plate out or deposit in lines and vessels only to be released gradually." [PTR-185 @19&20] The biological significance of the release of radioactive iodine is that the human body readily assimilates it into the thyroid gland.

Rala Run No. 001-RP (Feb.1, 1957) which processed 38,800 curies of barium and 70,000 curies of Iodine was delayed 17 hours until the wind changed directions away from populated areas. [PTR-185,p.6] February 20, 1957 run No. 002-RP contained 166,000 curies of Iodine. [Ibid.] The reason both Runs No.001-RP and 002-RP had such high Iodine content was because the cooling time for the fuel was two and less than one day respectively. Barium-140 runs in the third quarter of 1962 totaled 61,252 curies. [IDO-14599,P.1]

"RaLa off-gas involves a two-fold problem; namely, activity hazard due to contained active iodine and xenon, and explosion hazard due to contained hydrogen. The off-gas activity is too great to permit indiscriminate venting to the atmosphere and the hydrogen concentration is in the explosive region making mechanical compression and storage hazardous." [IDO-14414 @ 170] "Consequently operation was necessarily limited to periods when the weather was favorable for stack disposal." [Ibid]

In other words, the ICPP operators were reluctant to put much off-gas into the holding tank because of the hydrogen explosion potential and therefore it was expedient to release it to the atmosphere. So processing was delayed until the radiation would be blown north away from the more populated areas to the southeast.

"The [ICPP] fission product noble gases are present in the dissolver off-gases, and any not recovered go to the atmosphere. Krypton-85 in amounts up to 2,000 curies per-day could be released from power fuel processing. Comparable quantities of Krypton-85 have been released during previous operations without hazard to personnel on or off the site. This will be diluted by stack gas to 0.3 micro curie per liter [3 x 10^5 pCi/L] at the top of the stack, about 100 times maximum permissible [at the time] level for air." [IDO-14532 @46]

These documented statements by Atomic Energy Commission (AEC), predecessor to DOE, demonstrate the cavalier attitude about releasing large quantities of radiation to the environment. Moreover, no warnings were ever offered so that the public could take appropriate measures to protect themselves and their families.

"Total Iodine present in an [one] irradiated MTR fuel assembly after two days cooling approaches 76,000 curies with Iodine-131 accounting for 28,000 curies of the total. Approximately 80 % of this iodine was expected to reach the off-gas scrubber which was estimated to be 95% efficient in removing iodine. Thus about 3,000 curies of total iodine activity was expected to pass through the scrubber within a one hour period." [IDO-14414 @ 170]

Even weeks after the fuel dissolution process is completed, iodine continues to escape. "It has been found that during quiescent conditions in the cell the iodine release will be from five to ten curies a

day. Solution transfer or vessel decontamination will raise this to 20 to 50 curies per day. [IDO-14419, p.61]

Considerable uncertainty exists between the design efficiency of scrubbers and the actual efficiency. [See Stack Emission Section I(G) below] Uncontrolled iodine releases were also "escaping from centrifuges to cell off-gas which does not pass through the scrubber." [IDO-14419, p.61] +[14494, p.19] The combined releases from these multiple sources were significant.

A postulated example of iodine releases applied to run number 002-RP would yield the following scenario. Run 002-RP had 166,000 ci of I-131. Using the extremely optimistic design standard of 95% efficiency of the scrubbers, and 80% release to the scrubber, and subtracting 80% from 166,000 Ci in the fuel, leaves 132,800 Ci released to the scrubber which theoretically had 95% efficiency. That leaves 6,640 curies of iodine going out the stack over a two-day period. This figure would not include any DOE acknowledged releases escaping the centrifuges and cell off-gas system.

The above assumption scenario (non-conservative) is supported by DOE internal documents. "Approximately 80% of the I-129 is released as an airborne effluent and 20% is in the liquid effluent." [DOE/ID-12119@A-18]

A 1978 DOE engineering study by Allied Chemical Idaho Operations for INL proposed an I-129, C-14, Ru-106 and Kr-85 filtration system for ICPP fuel reprocessing to reduce the emission of these radionuclides. "More than 99% of these volatile isotopes were assumed to be released during dissolution of the fuel rods." [ICP-1126@iv]

The design was to include a matrix of filters to trap these volatilized isotopes. Should these filters fail or become plugged the system would just go back temporally to normal non-filtered operation. During RaLa Run 003-RH, "Approximately 7 percent of charged iodine was found in the scrubber solution after the run was completed." [IDO-14414 @ 158]

This suggests iodine release fractions in the range of 93%. "Since the current practice of releasing all airborne iodine species is acceptable, short-term releases in future reprocessing plant would be considered an inconsequential accident." [IDO-14414.@18]

The above discussion is supported by the 1977 INL Environmental Impact Statement (EIS) which stated that "the efficiency of this scrubber was low for iodine." [ERDA-1536 @ 242] The iodine content was so high in the RaLa reprocessing that the liquid waste evaporator would experience “Iodine-131 boil over during several batches when RaLa operations were in progress.” [IDO-14430 @ 11] “Recent [1957] operational practices in the concentration of process equipment waste provided essentially no reliable decontamination of the condensate from iodine-131 in the feed. Many different schemes have been tried to retain iodine ...” ... “These schemes were not successful in improving the iodine decontamination of the stream.” [IDO-14430 @ 18]

RaLa Iodine releases varied widely depending on the fuel processed and the cooling time before processing. The extremely optimistically low figures for part of the Rala period (1957-63) offered in the ERDA EIS were 2,800 Ci. of Iodine-131 released to the atmosphere. Based on the crude emission system in use, these figures can only be considered as extremely understated. A thorough analysis of the entire process and the efficiency of the emission systems are needed to assess the probable radioactive releases.

Considerable variation existed in scrubber efficiency in removing Iodine-131 from 7% to 70% due to filter problems. [IDO-14287] These runs produced Barium-140 solutions averaging 5,400,000 R/hr [IDO-14306 @ 7] , and containing a minimum of 30,000 curies. [IDO-14445 @14]

The RaLa process MTR throughput fuel had extremely high burnup rates of 24% which generated 55,600 curies of Ba-140 as opposed to undesirable 17% burnup fuel that only produced 38,800 curies of Ba-140 for every 168 grams processed. [IDO-14445 @21]

The known hazard with reprocessing high burnup fuel with less than a two-day cooling time was the release of volatilized iodine, ruthenium and krypton. “Ruthenium accounted for about 10% of the volatile activity other than krypton, with about nineteen times as much ruthenium coming off during the acid dissolution as during the caustic dissolution.” [IDO-14445 @31]

Efforts by ICPP operators to reduce iodine releases included dilution of the post process waste and neutralization of the caustic “supernate.” “In the case of the caustic solution diluted thirty-fold, the maximum amount of iodine trapped from the off-gas was 0.93 percent. Material balances were good.

With the caustic solution diluted only fifteen-fold, the amount of iodine trapped averaged about 1 percent."[IDO-14445 @80]

Another 1958 Phillips Petroleum report discussed attempts to improve the Process Equipment Waste (PEW) iodine scrub efficiency by adding neutralizing solutions. "With no neutralization of the evaporator feed, there was essentially no decontamination from Iodine-131 in the [PEW] condensate." But even this effort "yielded a condensate which contained about 0.5 percent of the iodine from the feed." [IDO-14443 @ 16][IDO-14430 @18]

This documentation suggests extremely poor performance of emission control systems to filter/ scrub out iodine prior to release to the atmosphere. "Since the curies of activity associated with these elements [iodides] is of similar magnitude to that of the barium being produced [30,000 to 60,000 curies] provisions to conduct dissolution under meteorological control may be necessary or an accumulator vessel to retain the gases for several weeks; decay prior to venting may be required, in order to avoid possibilities of area contamination or personnel exposure if dispersion of the plant stack gas is inadequate." [IDO-14308 @8]

Even at very low PEW efficiency rates for iodine the condensate was still extremely radioactive because of very high curie content of the fuel being dissolved as feed. "Because the feed to this [PEW] evaporator is usually fairly high in activity, the condensate represents a significant source of activity discharge to ground from the plant." [IDO-14362 @ 8] This is a reference to waste discharged to the injection well. 1959 Phillips Petroleum reports continue to acknowledge that low iodine scrubber efficiencies of 17.9% of the calculated iodine were found in the caustic and less than 1% in the acid solution. [IDO-14445 @94]

Recent revelations about Hanford releases from fuel reprocessing exposed by the Hanford Environmental Dose Reconstruction (HEDR) Project are germane to INL. [TSP News letter, 12/92] The original estimates or 530,000 curies of I-131 released from Hanford were based on unreliable stack monitoring data. The public and independent researchers knew this was not true. After nearly five years of public pressure, DOE finally allowed access to classified daily fuel reprocessing data that allowed scientists to do a physical reconstruction of the Green Runs. The results showed an increase of 70% over previously DOE acknowledged releases of 530,000 curies Iodine-131. [Benson @2] The key elements of the data needed for a physical reconstruction were:

1.) Cooling time of the fuel processed. Short cooling periods of hours or days rather than months means that short-lived isotope inventories such as I-131 will be much higher in the fuel.
2.) Release fractions. This figure is based on how much of the iodine present in the fuel is released to the environment. For Iodine-131, HEDR calculated the release fraction to be 90.5%.
3.) Reactor power levels of fuel used. A direct relationship exists between the reactor power level and the isotopes created in the fuel. The higher the power level, the more Iodine-131 is generated. [TSP News letter, 12/92]
4.) Fuel type and percentage U-235/Pu-239 enrichment.

HEDR now estimates Iodine-131 releases between 1944 to 1972 at about 740,000 curies which produced a 870 rad exposure to an infant born in Ringold, WA in 1943 or 1944. [Connections(a)] While working on the Hanford Downwinders class-action lawsuit, Owen Hoffman, President of the SENES Oak Ridge Center for Risk analysis, determined that approximately 900,000 curies of Iodine-131 were released by the AEC's Hanford plants between 1944 and 1957, a period known as the Hanford "Green Runs." This amount is 150,000 curies more than the "official" estimates from the Centers for Disease Control. [Hoffman]

The Hanford Health Information Network reports independent downwinder consultant research showing Plutonium-239 releases between 1945 and 1969 as high as 1600 curies. These plutonium release estimates are based on Hanford's George Brabb's 1961 internal memo assessing fuel reprocessing (Z Plant) "and found the filtering system was not adequate to capture the vaporized plutonium oxide which was essentially in a gaseous form when released by burning. This was revealed by the fact that a significant

amount of plutonium was found in the ducts of the vacuum system...even though it was protected by filters. This convinced me that fine plutonium was being released into the atmosphere from Z Plant." [Connections(b)] The reason for citing the Hanford problems is not to compare the release numbers but to compare the emission control system problems because the technology in any given era was the same whether at Z Plant or the ICPP.

CDC refused, in its INL Dose Reconstruction, to do a physical reconstruction of the INL RaLa Runs as part of the INL Dose Reconstruction Health Study. CDC is opting for the use of discredited DOE stack monitoring data. This is another deliberate attempt by CDC to understate the radiation release estimates in the hope that the government's liability exposure will be minimized. There are extremely important "lessons learned" from the Hanford studies that the public justifiably wants applied to the INL studies.

Plutonium was also extracted from the high burnup power reactor fuels processed at the ICPP. F and V cells generated plutonium batches up to 500 grams. [IDO-14306] Plutonium emissions must be included in any analysis. The solvent burner is noted in numerous reports as a problem area. The solvent burner is used to incinerate the waste solutions used to dissolve the fuel rods containing plutonium. "Plutonium is the most bothersome contaminate" in this Solvent Burner and its "Combustion gases go directly to the main plant stack without filtering." [IDO-14287] "The solvent burner is probably the largest source of Transuranic discharged to the stack and the largest unfiltered radionuclide discharge at ICPP." [ENICO-1086 @1]

Acknowledged Chem Plant (ICPP) airborne radioactive releases during the Rala runs (1953 through 1963) totaled 6,092,985 curies of gross beta and gamma isotopes. RaLa runs in 1959 released the highest airborne radioactivity at 1,334,902 curies of gross beta and gamma isotopes. [DOE/ID-12119@A-41][Also see Guide Appendix listing by year]

These figures do not include other INL facilities that were also releasing considerable quantities of radiation. For instance, the Test Reactor Area's Materials Test Reactor that provided the RaLa Run fuel rods released excessive amounts of Strontium 90 both to the air and to effluent water used to cool the reactor. [IDO-16375, p.8-9] Between 1952 and 1968 alone, the Test Reactor Area released 5,035,572 curies of radioactivity to the atmosphere. [Ibid @ A-30]

Iodine-131 (around ICPP) activity in jack rabbit thyroids for the 1958 sampling period peaked in March 1958 at 709,000 d/m/g. At sixteen and twenty miles distance from the ICPP the I-131 activity dropped respectively from to 140,000 d/m/g to 93,000 d/m/g. "The highest thyroid I-131 activity ever observed at the NRTS [up to 12/58] jack rabbits was observed in two animals collected on September 10 [1958]. Their mean I-131 activity was 7.7×10^6 [7,700,000]." [IDO-12082(58)@78-87]

DOE's INL Historical Dose Assessment Report acknowledges only 78 Rala Runs. This DOE report list begins with what they call Rala Run 001 in February 1-3, 1957. [DOE/ID-12119 @ A-33] Yet, Phillips Petroleum, ICPP contractor at the time, documents that, "Hot runs were begun on November 24, 1956." [PTR-185 @ 5] Although fifteen runs are acknowledged, details are given for only eight runs up to June 1957. [IDO-14414 @ 131]

It must be emphasized that the Environmental Defense Institute's analysis is limited due to DOE's unwillingness to declassify all INL operating history documents. Therefore, the information contained here is not by any means conclusive. DOE has yet to declassify documents requested by CDC for both the Hanford and the INL dose reconstruction health studies. This is discouraging since the Hanford requests are seven years old and the INL requests are three years old.

Partial Listing of EARLY RaLa Run Fuel Iodine Content

Run Date	Run Number	I-131 Curies	Cooling Days	Ba-140 Curies
11/24/56	001-RH	?	3	?
11/30/56	002-RH	1,260	4	3,033
12/6/56	003-RH	6,580	1	18,000
2/1/57	001-RP	70,000	2	39,000
2/20/57	002-RP	166,000	4	55,000
4/5/57	003-RP	13,560	2	28,000
5/19/57	004-RP	14,500	?	29,150
6/24/57	005-RP	16,180	6	32,000

[IDO-14414][PTR-181 & 185] [IDO-14430][IDO-14419]

Incomplete Listing of RaLa Run Barium-140 Produced

Run Date	Run Number	Ba-140 Curies
?	006 -RP	?
10/57	007-RP	22,800
12/57	008-RP	37,000
4/58	?	30,000
6/58	?	30,000
4/59	022-RP*	23,400
?	023-RP	10,200
?	024-RP	24,800
?	025-RP	23,160
?	026-RP	19,270
?	027-RP	23,900
6/59	028-RP	26,200
10/59	034-RP*	19,695 #
?	035-RP	21,620
?	036-RP	14,075
12/59	037-RP	26,137
7/62	?	21,085
9/62	?	40,067
6/13 to 9/13/63	071RP to 079RP *	200,000
Last Run 4/63	?	?
Incomplete total	83 Runs	501,920 curies Ba-140

[IDO-14430][PTR-185][PTR-181][IDO-14419][IDO14414][IDO-14410][IDO-14344]

Notes for above table:

* break in run number sequence [PTR-749][IDO-14599][IDO-14494][IDO-14512][IDO-14453]

 # ICPP Criticality Accident (16 October 1959) "During the [accident] 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." A Review of Criticality Accidents, 2000 Revision, Los Alamos National Laboratory; pg.18; LA-12638.

Atmospheric RaLa Releases of Iodides and Beta Activity

Year	Run Numbers	Curies Released
1957	006 through 008	6,399.00
1958 *	009 " 021*	5,334.87
1959	022 " 037	1,605.60
1960	038 " 049	246.44
1961	050 " 066	352.27
1962	067 " 075	253.26
1963	076 " 079	116.55
Totals	79	14,307.99

[DOE/ID-12119 @ A-33] [* IDO-12082(58) lists 13 RaLa runs between 1/6/58 & 10/23/58]

CDC INL Dose Reconstruction Review of RaLa I-131 and I-132

Compiled by Risk Assessments Corp. Task Order Database MC Number 60111

1,000 mCi = 1 Ci

Reported releases from the ICPP during RaLa Operations

From Hayden, R.E. 1957-1963. Activity Discharged to Atmosphere. INEEL Task Order Database MC Number 0111.

		Beta emitters (mCi)	I-131 (mCi)	I-132 (mCi)
	Feb-57	403	472000	
	Mar-57	35	50,400	
	Apr-57	1	68,800	
	May-57	6	50,400	
	Jun-57	43	132,800	
	Jul-57	3	32,860	
	Aug-57	0	140	
	Sep-57	5	33,750	
	Oct-57	16,348	277,745	
	Nov-57	19,265	225,841	
	Dec-57	14,727	2512	
1957 Total			**1347248**	
		Beta emitters	**I-131**	**I-132**
	Jan-58	**(mCi)**	**(mCi)**	**(mCi)**
	Feb-58	23,284	75,327	
	Mar-58	19,763	129,710	
	Apr-58	14,146	686,000	
	May-58	49,623	275,645	1,540,300
	Jun-58	24,465	212,173	128,100
	Jul-58	25,129	1,495	2,276
	Aug-58	52,260	78,524	21,100
	Sep-58	44,318	24,492	7,600
	Oct-58	86,040	109,680	804,000

	Nov-58	46,420	35,030	117,400
	Dec-58	34,965	2,846	7,308
1958 total			**1,630,922**	**2,628,084**
	Jan-59	9,600	240	1,296
	Feb-59	319,600	111,860	187,925
	Mar-59	120,000	47,160	62,520
	Apr-59	148,600	7,727	124,378
	May-59	82,400	3,131	43,590
	Jun-59	100,800	2,419	65,117
	Jul-59	287,200	8,903	238,877
	Aug-59	80,900	4,045	63,102
	Sep-59	69,600	7,934	55,262
	Oct-59	10,011,000	15,016	9,963,948
	Nov-59	137,130	13,302	114,092
	Dec-59	37,470	1,836	27,990
1959 total			**223,333**	**10,948,097**
	Jan-60	30,030	1,120	21,321
	Feb-60	37,400	9,200	21,804
	Mar-60	12,520	1,865	7,299
	Apr-60	34,170	4,578	27,712
	May-60	3,150	400	1,899
	Jun-60	33,840	2,132	27,985
	Jul-60	33,840	2,132	28,020
	Aug-60	25,560	2,056	22,493
	Sep-60	11,540	1,235	9,601
	Oct-60	37,620	3,762	32,353
	Nov-60	1,970	969	601
	Dec-60	220	40	180
1960 total			**28,369**	**201,268**
	Jan-61	144,350	17,466	121,831
	Feb-61	22,280	3,632	16,599
	Mar-61	19,890	2,347	15,395
	Apr-61	2,210	1,050	100
	May-61	33,050	2,479	29,216
	Jun-61	5,300	1,458	1,601
	Jul-61	9,890	2,660	2,799
	Aug-61	4,890	2,342	1,198
	Sep-61	25,500	1,836	20,575
	Oct-61	10,730	2,886	7,103
	Nov-61	10,780	919	8,001
	Dec-61	37,710	871	1,901
1961 total			**39,946**	**3,456,161**
1957 to 1961 total			**3,269,818**	**17,233,610**

Source: CDC INEL Dose Reconstruction, Reported releases from the ICPP during RaLa Operations, From Hayden, R.E. 1957-1963. Activity Discharged to Atmosphere. INEEL Task Order Database MC Number 60111.

RaLa Accidents at ICPP

A criticality (uncontrolled nuclear chain reaction) accident at the ICPP on October 16, 1959, one day after a RaLa run on the 15th increased the atmospheric releases. An AEC accident report noted twenty-one workers were exposed and offered the following description of the RaLa run.

"A RaLa run had been completed on the afternoon of October 15. This process involves the separation of radio-barium from short-cooled MTR fuel elements. Dissolution of these short-cooled elements and even later disturbance of solutions in post-run cleanup usually cause some release of fission product iodine to the process vent system. On some occasions iodine has escaped to the access corridor and PEW control room in sufficient quantity to set off the sensitive air monitor alarms in those areas. Consequently, it was natural initially to suspect that the release of apparently short-lived air-borne activity

was in some way related to the RaLa equipment. This assumption seemed to have been further substantiated by the fact that : the RaLa process instruments indicated that a pressure surge had occurred, no other instruments that were observed in the hurried re-entry [after ICPP accident evacuation] showed evidence of more than minor disturbance, and high level (greater than 25 R/hr) contamination was discovered around the RaLa slug chute. High level contamination noted in the PEW control room was a reasonable consequence of the pressure surge initiated in the RaLa system." [IDO-10035 @ 16]

Another ICPP criticality accident on January 25, 1961 during the RaLa period also released radioactivity to the atmosphere. This incident (requiring full evacuation) occurred during the work week when 251 employees were at the ICPP. The radioactive cloud traveled southwest toward Big South Butte where it stagnated for several hours before moving on south. Radiation readings at Big South Butte ranged over 200 counts per second. Readings at Central Facilities Area, 2 miles south ranged over 30 mrem. [IDO-10036@35]

AEC accident report notes the following: "Two processes in the plant handle gaseous and volatile fission products, viz., a radio-barium separation system (RaLa process) and the dissolver off-gas handling system. A RaLa processing run had been completed two days earlier and no operations were being performed in that equipment. However, post-run activities in the past had resulted in some release of Iodine-131. Chemical changes in the process and essentially eliminated this problem, but the associated high concentrations of short-lived fission products cause this system to be suspect in any unidentified radiation incident." [IDO-10036@35]

I.D.2 Post RaLa ICPP Releases

This section discusses the post RaLa Idaho Chemical Processing Plant (ICPP) from 1964 to present. Within part of this period, (1964 to 1981) ICPP released 1,417,210 Ci of radioactivity to the atmosphere and 22,200 Ci to the aquifer via injection well and 6,523 Ci discharged to the percolation ponds. [ERDA-1536@II-89&III-7][INL-95/0056@2-13][IDO-10054(79)(81)@14]

In 1974 the ICPP alone released over 259,955 curies (6,055 were not noble gases) of radiation into the air. These figures do not include what went into the soil and aquifer below INL via injection wells. [ERDA-1536, p. II-18] Airborne releases between 1980-81 included 416 curies of barium, 42 curies of cesium, 153,589 curies of krypton, 10,053 of xenon. [ID-10054-80&81, p.3-4] Between January and November of 1982 28,943 curies of radioactivity were released at INL (28,020 curies of that were airborne) 2,592 billion liters (683 billion gallons) of radioactive waste were dumped in the ground, 1,552 billion liters (409 billion gallons) of which were injected into the aquifer. [Williams, 1/31/83, 4-4]

ROVER Spent Fuel Processing

The space vehicle nuclear rocket ROVER program used graphite reactor fuel that was reprocessed at the ICPP now INTEC. The graphite around the fuel was first burned off in an auxiliary building not part of the head end fuel processing system, which at least has some emission scrubbers. After the graphite was burned off, the residual containing 80 to 90% enriched uranium was then put through the normal ICPP chemical extraction process. A full investigation is needed to determine how much ROVER fuel was burned, what emission systems (if any) were in use, and how much radiation was released. Workers sent in to decontaminate the ROVER burn cells were severely contaminated due to inappropriate protective clothing. Later attempts to decontaminate the burn cell caused additional personnel contamination due to the fine graphite powder plugging respirators and leaking through protective garments. Management refused to allow worker requests for pressurized air lines. Workers claim exposures of 800 to 2,000 rem per person per entry into a ROVER cell. [Allan] Also see Section I.C. 6. ROVER Reactor Tests for more discussion.

Decontamination operations were canceled and the ROVER process lines remain plugged with high activity material. In 1997, ROVER process decontamination was again attempted.

After a criticality accident in one interim storage tank under the ICPP Head End fuel dissolution building, a worker was sent in to inspect for damage. The criticality occurred because enough uranium and plutonium remained in the raffinate to cause a spontaneous reaction. Barium acting as a poison was dumped

into the tank and the mix was pumped out to underground storage tanks. Instruments indicated that the tank was empty, but when the worker was lowered into the tank, he ended up in shin deep high-level raffinate before he was pulled out. Later after the tank was pumped out workers were sent in to move a robotic vacuum between the piping that laced the entire bottom of the tank. The radiation exposures these workers received during this and other decontamination projects must be fully included in CDC's worker dose reconstruction health study. Also see Section

Contaminate Migration from ICPP/INTEC Operations

Congress's Office of Technology Assessment states that INL, "contaminates have migrated into surrounding soil; floods have enhanced migration." ... "Plutonium has been detected in a clay layer about 110 feet beneath the site." ... "Hazardous contaminates have been measured in the groundwater that is about 600 feet beneath the site." [OTA @ 34]

For decades public interest groups have tried to convince DOE that continued operation of the ICPP not only exacerbated waste generation but also diversion of precious resources needed for environmental restoration. A principal tenet to responsible waste management is source reduction or minimizing waste. The largest single liquid waste generator at INL is the Idaho Chemical Processing Plant (ICPP). The mission of the ICPP has been the recovery of highly enriched uranium for the four Savannah River reactors. These reactors have been shut down since 1988 because of safety violations and only one (K-Reactor) is likely to restart. According to DOE, K-Reactor will only restart for a short period of testing - not for a full production schedule. Therefore, the ICPP mission has radically changed. DOE's recent decision to shut down the ICPP should be permanent not temporary. Jim Werner, former senior environmental engineer for the Natural Resources Defense Council, offered (at a 1/24/91 PEIS hearing in Boise) the following comments:

"The Chem Plant produces hundreds of millions of gallons of hazardous and radioactive wastes annually. From 1953 to 1974, DOE discharged nearly 7 billion gallons of radioactive wastes to an underground injection well at an average rate of more than 300 million gallons annually -- nearly a million gallons a day. In addition, 10,000 to 35,000 gallons of radioactive chemical wastes such as nitric acid raffinate, and 19,000 cubic feet of radioactive solid wastes were generated each year at the Chem Plant. Because of significant modifications to increase the capacity of the Chem Plant, the volume of wastes currently generated by the Chem Plant has approximately doubled and have more recently been estimated to be as much as two million gallons of radioactive liquid waste daily."
[Werner, NRDC, PEIS Testimony, Boise, 1/24/91]

"For FY 1991, the operating cost of the Chem Plant is budgeted at more than $150 million. In addition, more than $120 million is budget in FY 1991 for additional construction and capital equipment costs. Hence, for FY 1991 alone, DOE will likely spend nearly a quarter billion dollars on the Chem Plant. However, these costs do not account for the future waste treatment and disposal costs for the hazardous and radioactive wastes generated and in long-term storage at the Chem Plant. Moreover, the costs of this "temporary" long-term storage of calcined waste at the Chem Plant have increased substantially from 1981 when DOE estimated the costs of the sixth set of storage bins at approximately $14 million to a 1989 estimate for the eighth set of storage bins of more than $30 million."
[Werner, NRDC, PEIS Testimony, Boise, 1/24/91]

"In light of the significant quantities of hazardous and radioactive waste resulting from reprocessing, and the hundreds of millions of dollars that may be spent to renovate the Chem Plant, storage alternatives should be considered for naval reactor and other fuel now scheduled for reprocessing at the Chem Plant. A full and fair analysis of these and other alternatives may very well show that the construction of additional spent fuel pools or a dry cask facility would be far cheaper than renovating and operating the ICPP. Any funds saved could be spent on critical environmental restoration activities at INL and elsewhere. Since there does not appear to be any clear environmental advantage to reprocessing naval fuels compared to direct disposal, DOE should discontinue any Chem Plant operations that cannot be justified for national security purposes." [Werner, NRDC, Testimony, Boise, 1/24/91]

DOE will spend an additional $409 million through 1994 on upgrades to the ICPP just for standby capacity. [DOE 1993 Budget Request] As previously discussed, the $467.7 million ICPP Spent Fuel Program presented to former Idaho Governor Andrus is slated for converting the ICPP into DOE's

complex wide incinerator of high-level waste. Since there is actually an increase in waste volume when reactor fuel is processed, the question is raised as to why DOE is proceeding with such a program. One logical scenario is that the ICPP waste program is only a guise for continued nuclear weapon materials production and other military nuclear material needs. A January 17, 1996 State Permit granted to DOE to construct air pollution emitting source describes:

"... the ICPP is a multipurpose, spent fuel recovery facility with the following assigned objectives: The safe and economical receipt, storage and recovery of highly enriched uranium from fuel elements discharged from Naval Nuclear Propulsion Reactors, Research and Test Reactors (foreign and domestic) as well as from other unique fuels that cannot be processed elsewhere. The safe storage and management of the resulting high-level radioactive waste". [DEQ]

At a time when Congressional appropriations are being cut on cleanup programs, DOE has developed creative accounting approaches to shifting production projects over to so called "environmental" categories. Another waste issue involves the exhumed waste that will need to be dug up at the old burial sites. These quantities will be considerable. DOE waste management resources must be fully applied to isolating these wastes from the environment. It is not acceptable that environmental restoration activities must be made to compete with newly generated waste from nuclear materials production.

CDC INL Annual Release Estimates for INTEC/ICPP 1953 to 1960 (Curies)

Nuclide	Half-life	1953	1954	1955	1956	1957	1958	1959	1960
H-3	**12.35 y**	7.75E+02	1.93E+03	2.71E+03	2.81E+03	5.51E+03	7.81E+03	6.41E+03	6.05E+00
C-14	**5730 y**								
Mn-54	**303 d**								
Mn-56	**2.6 hr**								
Co-57									
Co-60	**5.27 y**								
As-76	**26.5 hr**								
Br-82	**35.3 hr**								
Kr-85	**10.7 y**	1.41E+04	3.52E+04	4.95E+04	5.40E+04		1.42E+05	1.17E+05	1.15E+02
Kr-85m	**4.48 hr**				5.52E-15	7.29E+00	21.9	2.12E+01	1.12E+01
Kr-87	**1.27 hr**					4.61E-08	1.38E-07	1.32E-07	6.91E-08
Kr-88	**2.86 hr**					2.71E-01	0.814	7.81E-01	4.08E-01
Kr-89	**3.2 m**								
Kr-90	**33s**								
Rb-90	**2.91 min**								
Sr-89	**52 d**	4.92E+00	1.23E+01	1.73E+01	2.07E+01	1.92E+01	1.48E+01	7.56E+00	9.38E-01
Sr-90	**27.7 y**	4.92E+00	1.23E+01	1.73E+01	1.99E+01	3.50E+01	4.98E+01	4.09E+01	4.31E-01
Sr-91	**9.7 h**				4.71E-09	9.19E-01	1.02	4.31E-01	3.85E-02
Y-91	**58.8 d**	1.06E+01	2.65E+01	3.72E+01	4.36E+01	2.11E+01	1.61E+01	8.29E+00	1.02E+00
Y-91m	**50.3 d**								
Zr-95	**65.5 d**	1.55E+01	3.87E+01	5.45E+01	6.36E+01	2.13E+01	1.64E+02	8.47E+00	1.03E+00
Nb-95	**35 d**	3.31E+01	8.27E+01	1.16E+02	1.34E+02	5.72E+00	4.29E+00	2.35E+00	2.60E-01

Nuclide	Half-life	1953	1954	1955	1956	1957	1958	1959	1960
Tc-99m	**6.01 h**								
Ru-103	**39.4 d**	9.61E-01	2.40E+00	3.38E+00	4.46E+00	1.53E+01	1.18E+01	6.05E+00	7.49E-01
Ru-106	**1 y**	5.03E+00	1.26E+01	1.77E+01	2.03E+01	5.87E+00	8.18E+00	6.65E+00	8.11E-02
Sb-125	**2.7 y**								
Te-132	**3.26 d**				1.50E-01	3.41E+01	3.06E+01	1.51E+01	1.77E+00
I-129 (Total)	**1.57E+07**	2.69E-17	6.72E-17	9.45E-17	3.42E-08	1.29E-06	8.35E-07	1.84E-07	2.71E-08
I-131	**8.04 d**				1.11E+01	1.40E+03	1.03E+03	2.24E+02	3.20E+01
I-132	**2.28 h**				9.83E+00	4.03E+03	3.38E+03	1.55E+03	1.76E+02
I-133	**20.9 h**				6.73E-03	4.41E+02	4.84E+02	9.98E+01	1.14E+01

I-134	**52.5 min**								
I-135	**6.61 h**				2.08E-11	6.65E+00	7.67E+00	1.51E+00	1.35E-01
Xe-131m	**12 d**				3.22E+02	1.65E+03	2.41E+03	3.17E+03	2.34E+03
Xe-133	**5.25 d**				2.54E+04	4.62E+04	8.43E+05	1.09E+06	7.92E+05
Xe-133m	**2.26 d**				1.16E+02	9.16E+03	2.02E+04	2.49E+04	1.74E+04
Xe-135	**9.1 h**				2.76E-04	1.24E+04	3.73E+04	3.81E+04	2.17E+04
Xe-135m	**15.6 min**				2.17E-10	6.97E+00	1.89E+01	1.71E+01	8.84E+00
Xe-138	**17.5 min**								
Xe-139	**43 s**								
Cs-134	**2.06 y**	1.97E-01	4.93E-01	6.93E-01	7.97E-01	5.38E-01	7.62E-01	6.24E-01	6.81E-03
Cs-136	**13 d**				3.69E-02	3.17E+00	2.23	4.97E-01	7.06E-02
Cs-137	**30.1 y**	4.99E+00	1.25E+01	1.76E+01	2.02E+01	3.57E+01	5.07E+01	4.17E+01	4.39E-01
Cs-138	**32.2 min**								
Cs-139	**9.5 min**								
Cs-140	**66 s**								
Ba-139	**83 m**								
Ba-140	**12.8 d**	6.55E-06	1.64E-05	2.31E-05	1.31E+00	5.85E+01	4.67E+01	2.37E+01	2.91E+00
La-140		7.55E-06	1.89E-05	2.65E-05	1.50E+00	6.31E+01	4.96E+01	2.53E+01	3.13E+00
Ce-141	**32.5 d**	5.40E-01	1.36E+00	1.91E+00	3.37E+00	3.32E+01	2.57E+01	1.31E+01	1.63E+00
Ce-144	**284 d**	6.86E+01	1.72E+02	2.41E+02	2.77E+02	5.40E+01	7.39E+01	5.97E+01	8.21E-01
Pr-143	**13.6 d**	2.06E-05	5.14E-05	7.23E-05	1.40E+00	5.79E+01	4.56E+01	2.32E+01	2.87E+00
Pm-147	**2.62 y**	1.65E+01	4.14E+01	5.82E+01	6.69E+01	1.40E+02	2.00E+02	1.64E+02	1.72E+00
Eu-152									
Eu-154	**16 y**	1.19E-02			4.81E-02	7.05E-02	1.00E-01	8.21E-02	8.70E-04
Eu-155	**1.8 y**								
Eu-156			8.31E-07	1.17E-06					
Ta-182	**115 d**								
Ir-192	**74 d**								
Hg-203	**47 d**								
Tl-208									
Ac-228									
Pa-231									
Th-232	**1.41E10 y**								
Np-237	**2.14E6 y**								
U-238	**4.5E9 y**								
Pu-238	**86.4 y**	1.10E-02	2.75E-02	3.87E-02	4.44E-02	7.78E-02	1.12E-01	9.07E-02	0.0312
Pu-239	**24390 y**	1.62E-03	4.04E-03	5.69E-03	6.53E-03	1.15E-02	1.64E-02	1.33E-02	4.55E-03
Pu-240	**6580 y**								
Pu239,240		1.62E-03	4.04E-03	5.69E-03	6.53E-03	1.15E-02	1.64E-02	1.33E-02	4.55E-03

Source: CDC INEL Dose Reconstruction, Facility Reported Annual Air Releases from the ICPP in curies.