

= Radioactive contamination from the Rocky Flats Plant =

The Rocky Flats Plant , a former U.S. nuclear weapons production facility located about 15 miles northwest of Denver , caused radioactive (primarily plutonium , americium , and uranium) contamination within and outside its boundaries . The contamination primarily resulted from two major plutonium fires in 1957 and 1969 (plutonium is pyrophoric and shavings can spontaneously combust) and from wind @-@ blown plutonium that leaked from barrels of radioactive waste . Much lower concentrations of radioactive isotopes were released throughout the operational life of the plant from 1952 to 1992 , from smaller accidents and from normal operational releases of plutonium particles too small to be filtered . Prevailing winds from the plant swept airborne contamination south and east , into populated areas northwest of Denver .

The contamination of the Denver area by plutonium from the fires and other sources was not publicly reported until the 1970s . According to a 1972 study coauthored by Edward Martell , " In the more densely populated areas of Denver , the Pu contamination level in surface soils is several times fallout " , and the plutonium contamination " just east of the Rocky Flats plant ranges up to hundreds of times that from nuclear tests . " As noted by Carl Johnson in Ambio , " Exposures of a large population in the Denver area to plutonium and other radionuclides in the exhaust plumes from the plant date back to 1953 . "

Weapons production at the plant was halted after a combined FBI and EPA raid in 1989 and years of protests . The plant has since been shut down , with its buildings demolished and completely removed from the site . The Rocky Flats Plant was declared a Superfund site in 1989 and began its transformation to a cleanup site in February 1992 . Removal of the plant and surface contamination was largely completed in the late 1990s and early 2000s . Nearly all underground contamination was left in place , and measurable radioactive environmental contamination in and around Rocky Flats will probably persist for thousands of years . The land formerly occupied by the plant is now the Rocky Flats National Wildlife Refuge . Plans to make this refuge accessible for recreation have been repeatedly delayed due to lack of funding and protested by citizen organizations . The Department of Energy continues to fund monitoring of the site , but private groups and researchers remain concerned about the extent and long @-@ term public health consequences of the contamination . Estimates of the public health risk caused by the contamination vary significantly , with accusations that the United States government is being too secretive and that citizen activists are being alarmist .

= = Background = =

The Rocky Flats Plant was located south of Boulder , Colorado and northwest of Denver . Originally under management of the Dow Chemical Company , management was transferred to Rockwell in 1975 . Initially having an area of 4 sq mi (10 km²) , the site was expanded with a 4 @, @ 600 acres (19 km²) buffer zone in 1972 .

Construction of the first buildings was started on the site on July 10 , 1951 . Production of parts for nuclear weapons began in 1953 . At the time , the precise nature of the work at Rocky Flats was a closely guarded secret . The plant produced fission cores for nuclear weapons , used to " ignite " fusion and fissionable fuel in all modern nuclear weapons . Fission cores resemble miniaturized versions of the Fat Man nuclear bomb detonated above Nagasaki . They are often referred to as " triggers " in official and news documents to obfuscate their function . For much of its operational lifetime , Rocky Flats was the sole mass @-@ producer of plutonium components for America 's nuclear stockpile .

Management of the site passed to EG & G in 1990 , which did not reapply for the contract in 1994 . Management of the site then passed to the Kaiser @-@ Hill Company as of July 1 , 1995 . The Department of Energy now manages the central portion of the plant where production buildings were once located , while the Fish and Wildlife Service has taken over management of the peripheral outer unit .

=== 1957 fire ===

On the evening of September 11, 1957, plutonium shavings in a glove box located in building 771 (the Plutonium Recovery and Fabrication Facility) spontaneously ignited . The fire spread to the flammable glove box materials , including plexiglas windows and rubber gloves . The fire rapidly spread through the interconnected glove boxes and ignited the large bank of High efficiency particulate air (HEPA) filters located in a plenum downstream . Within minutes the first filters had burned out , allowing plutonium particles to escape from the building exhaust stacks . The building exhaust fans stopped operating due to fire damage at 10 : 40 PM , which ended the majority of the plutonium release . Fire fighters initially used carbon dioxide fire extinguishers because water can act as a moderator and cause plutonium to go critical . They resorted to water hoses when the dry fire extinguishers proved ineffective .

The 1957 fire released 11 Ci (160 ? 510 grams or 0.35 ? 1.12 pounds) of plutonium , much of which contaminated off site areas as microscopic particles entrained in smoke from the fire . Isopleth diagrams from studies show portions of the city of Denver included in the area where surface sampling detected plutonium . The fact that the fire had resulted in significant plutonium contamination of surrounding populated areas remained secret . News reports at the time reported , per the Atomic Energy Commission 's briefing , that there was slight risk of light contamination and that no fire fighters had been contaminated . No abnormal radioactivity was reported by the Colorado Public Health Service .

=== Pad 903 leakage ===

Plutonium milling operations produced large quantities of toxic cutting fluid contaminated with particles of plutonium and uranium . Thousands of 55 gallon drums of the waste were stored outside in an unprotected earthen area called the 903 pad storage area , where they corroded and leaked radionuclides over years into the soil and water . An estimated 5,000 gallons of plutonium contaminated oil leached into the soil between 1964 and 1967 . Portions of this waste , mixed with dust that composed Pad 903 , became airborne in the heavy winds of the Front Range and contaminated offsite areas to the south and east .

Leaking storage barrels at Pad 903 released 1 Ci (19 ? 208 grams or 0.042 ? 0.459 pounds) of plutonium as airborne dust during the storage and subsequent attempts at cleanup . Much more remains interred under the Pad 903 area , which has been paved over with asphalt .

=== 1969 fire ===

Another major fire occurred on May 11, 1969 in building 776 / 777 (the Plutonium Processing Facility) , again starting due to spontaneous combustion of plutonium shavings in a glove box . Fire fighters again resorted to fighting the fire with water after dry extinguishers proved ineffective . Despite recommendations after the 1957 fire , suppression systems were not built into the glove boxes .

While the fire bore marked similarities to the 1957 fire , the level of contamination was less severe because the HEPA filters in the exhaust system did not burn through (After the 1957 fire , the filter material was changed from cellulose to nonflammable fiberglass) . Had the filters failed or the roof (which sustained heavy fire damage) been breached , the release could have been more severe than the 1957 fire . About 1,400 kilograms (3,100 lb) of plutonium was in the storage area where the fire occurred , and about 3,400 kilograms (7,500 lb) total plutonium was in building 776 / 777 .

The 1969 fire released 13 mCi (140 ? 900 milligrams or 0.00031 ? 0.00198 pounds) of plutonium , about 1000th as much as was released in the 1957 fire . The 1969 fire , however , led local health officials to perform independent tests of the area surrounding Rocky Flats to determine the extent of the contamination . This resulted in the first releases of information to the

public that populated areas southeast of Rocky Flats had been contaminated .

= = = Other sources = = =

Hundreds of other small plutonium fires and intentional incinerations also occurred at Rocky Flats that were not nearly as destructive .

Rockwell workers mixed hazardous and other wastes with concrete to create one @-@ ton solid blocks called pondcrete . These were stored in the open under tarps on asphalt pads . The pondcrete turned out to be weak storage , an outcome that had been predicted by Rockwell 's own engineers . Relatively unprotected from the elements , the blocks began to leak and sag . Nitrates , cadmium and low @-@ level radioactive waste began to leach into the ground and run downhill toward Walnut Creek and Woman Creek .

Most of the plutonium from Rocky Flats was oxidized plutonium , which does not readily dissolve in water . A large portion of the plutonium released into the creeks sank to the bottom and is now found in the streambeds of Walnut and Woman Creeks , and on the bottom of local public reservoirs just outside Rocky Flats : Great Western Reservoir , (no longer used for city of Broomfield drinking water consumption as of 1997 but still used for irrigation) , and Standley Lake , a drinking water supply for the cities of Westminster , Thornton , Northglenn and some residents of Federal Heights . As one of several forms of remediation and once the extent of the lapses at Rocky Flats became public knowledge , several streams that were formed by drainage through the contaminated areas of the Rocky Flats Plant were diverted such that they would no longer flow directly into some of the local reservoirs , such as Mower Reservoir and Standley Lake . Also , a surface water control system was built to allow runoff from contaminated creeks to collect in holding ponds and thus reduce or prevent direct runoff into Standley Lake . Proposals to remove or breach some of these dams to reduce the cost of maintenance have been protested by the cities downstream .

= = Reporting of contamination = =

No radioactivity warning , advisement or cleanup was provided to the public in the 1957 fire , the worse of the two major fires . At the time of the 1957 fire , AEC officials told the Denver Post that the fire ? resulted in no spread of radioactive contamination of any consequence . ? The public was not informed of substantial contamination from the 1957 plutonium fire until after the highly visible 1969 fire , when civilian monitoring teams confronted government officials with measurements made outside the plant of radioactive contamination suspected to be from the 1969 fire , which consumed hundreds of pounds of plutonium (850 kg) .

The 1969 fire raised public awareness of potential hazards posed by the plant and led to years of increasing citizen protests and demands for plant closure . Releases from previous years had not been reported publicly prior to the fire ; airborne @-@ become @-@ groundborne radioactive contamination extending well beyond the Rocky Flats plant was not publicly reported until the 1970s .

In 2002 , the U.S. Fish and Wildlife Service surveyed tissues harvested from deer that lived at Rocky Flats for plutonium and other actinides . Isotopes of plutonium , americium , and uranium were detected , with the highest measured activity being 0 @. @ 0125 pCi / g (2360 seconds per disintegration) for uranium @-@ 233 or uranium @-@ 234 . The increased cancer risk , as reported by the study , to an individual who ate 28 kilograms (62 lb) of Rocky Flats deer meat per year over a 70 @-@ year lifetime was estimated to be as high as 1 in 210 @, @ 000 . This is near the conservative end of the EPA 's acceptable risk range .

In 2010 , samples of plutonium were found off @-@ site from Rocky Flats by citizens of the area . " High concentrations of plutonium were found in dust collected in a crawl space under a house where it had accumulated for 50 years . Specialist Marco Kaltofen of the Boston Chemical Data Corp. , who did the technical analysis of the samples , pointed out that this plutonium laden dust certainly endangered the health of anyone who spent much time in this crawl space . "

= = Contamination and health studies = =

Plutonium @-@ 239 and 240 emit ionizing radiation in the form of alpha particles . Inhalation is the primary pathway by which plutonium enters the body , though plutonium can also enter the body through a wound . Once inhaled , plutonium increases the risk of lung cancer , liver cancer , bone cancer , and leukemia . Once absorbed into the body , the biological half life of plutonium is about 200 years .

Following the public 1969 fire , surveys were taken of the land outside the boundaries of Rocky Flats to quantify the amount of plutonium contamination . Researchers noted that plutonium contamination from the plant was present , but did not match the wind conditions of the 1969 fire . The 1957 fire and leaking barrels on Pad 903 have since been confirmed to be the main sources of plutonium contamination . Authors Krey and Hardy estimated the total quantity of plutonium contamination outside of Rocky Flats 's boundaries to be 2 @.@ 6 Ci (36 grams or 0 @.@ 079 pounds) , while Poet and Martell estimated the value to be 6 @.@ 6 Ci (92 grams or 0 @.@ 203 pounds) . The study also noted that plutonium levels just outside the boundaries of the plant were hundreds of times higher than the background level caused by global fallout from nuclear testing , and that contamination to the north of the plant was probably caused by normal operations rather than accidental releases .

In a 1981 study by Dr. Carl Johnson , health director for Jefferson County , showed a 45 percent increase in congenital birth defects in Denver suburbs downwind of Rocky Flats compared to the rest of Colorado . Moreover , he found a 16 % increase in cancer rates for those living closest to the plant as compared to those on the outer perimeter of the area , and he estimated 491 excess cancer cases whereas the DOE estimated one . Real estate interests pressed the county to fire Johnson , claiming his findings hurt their industry . After electing a real estate investor to the county board , they succeeded . A 1987 study by Crump and others did not find the cancer rates in the northwestern portion of Denver to be significantly higher than other parts of the city and attributed variance in cancer rates to the population density of urban areas . Crump 's conclusions were contested by Johnson in a letter to the journal editor . In a 1992 survey of radiation risk analysis , the authors concluded , " Johnson failed to describe an effective and complete model for the cause of the cancers and its relationship to other knowledge as Crump et al. have done . Therefore , Crump et al . ' s explanation must be preferred . "

In 1983 , Colorado University Medical School professor John C. Cobb and the EPA reported plutonium concentrations from about 500 persons who had died in Colorado . A comparison study was done of those who lived near Rocky Flats with those who lived far from this nuclear weapons production site . The ratio of Pu @-@ 240 to Pu @-@ 239 was " minutely lower " for persons who lived within 50 km of Rocky Flats , but was more strongly correlated to age , gender , and smoking habits than proximity to the plant .

In 1991 , the Department of Energy 's public affairs group published a pamphlet stating that the inhalation of sediments that become resuspended in the air is considered the most significant pathway that could expose human beings to plutonium from the contaminated local reservoirs , but also stated that the airborne plutonium concentrations as measured by downwind air monitors remained below the DOE standard .

In a 1999 analysis , it was found that " the major event contributing the highest individual risk from plutonium released from Rocky Flats was the 1957 fire , " with wind distribution of plutonium from the 903 Pad Storage Area being the next greatest source of health risk . In this report , health risk estimates for off @-@ site humans had a variance of four orders of magnitude , from " between 2 @.@ 0×10^{-4} (95th percentile) and 2 @.@ 2×10^{-8} (5th percentile) , with a median risk estimate of 2 @.@ 3×10^{-6} . " The DOE maintains a list of Rocky Flats epidemiological studies .

In 2003 , Dr. James Rutenber led a study on the health effects of plutonium . Conducted by the University of Colorado Health Sciences Center and the Colorado Department of Public Health and Environment , the study concluded that lung cancer is linked to plutonium inhalation . " We have supporting evidence from other studies that , along with our findings , support the hypothesis that plutonium exposure causes lung cancer , " Rutenber said . His group 's findings were part of a

broader study that tracked 16 @, @ 303 people who worked at the Rocky Flats plant between 1952 and 1989 . Their research also found that these workers were 2 @. @ 5 times more likely to develop brain tumors than other people .

= = Legal actions = =

Subsequent to reports of environmental crimes being committed at Rocky Flats , the United States Department of Justice sponsored an FBI raid dubbed " Operation Desert Glow , " which began at 9 a.m. on June 6 , 1989 . The FBI entered the premises under the ruse of providing a terrorist threat briefing , and served its search warrant to Dominick Sanchini , Rockwell International 's manager of Rocky Flats .

The FBI raid led to the formation of Colorado 's first special grand jury , the juried testimony of 110 witnesses , reviews of 2 @, @ 000 exhibits and ultimately a 1992 plea agreement in which Rockwell admitted to 10 federal environmental crimes and agreed to pay \$ 18 @. @ 5 million in fines out of its own funds . This amount was less than the company had been paid in bonuses for running the plant as determined by the GAO , and yet was also by far the highest hazardous @-@ waste fine ever ; four times larger than the previous record . Due to DOE indemnification of its contractors , without some form of settlement being arrived at between the U.S. Justice Department and Rockwell the cost of paying any civil penalties would ultimately have been borne by U.S. taxpayers . While any criminal penalties allotted to Rockwell would not have been covered by U.S. taxpayers , Rockwell claimed that the Department of Energy had specifically exempted them from most environmental laws , including hazardous waste .

As forewarned by the prosecuting U.S. Attorney , Ken Fimberg (later Ken Scott) , the Department of Justice 's stated findings and plea agreement with Rockwell were heavily contested by its own , 23 @-@ member special grand jury . Press leaks by both members of the DOJ and the grand jury occurred in violation of secrecy Rule 6 (e) regarding Grand Jury information . The public contest led to U.S. Congressional oversight committee hearings chaired by Congressman Howard Wolpe , which issued subpoenas to DOJ principals despite several instances of the DOJ 's refusal to comply . The hearings , whose findings include that the Justice Department had " bargained away the truth , " ultimately still did not fully reveal the special grand jury 's report to the public , which remains sealed by the DOJ courts .

The special grand jury report was nonetheless leaked to Westword . According to its subsequent publications , the Rocky Flats special grand jury had compiled indictments charging three DOE officials and five Rockwell employees with environmental crimes . The grand jury also wrote a report , intended for the public 's consumption per their charter , lambasting the conduct of DOE and Rocky Flats contractors for " engaging in a continuing campaign of distraction , deception and dishonesty " and noted that Rocky Flats , for many years , had discharged pollutants , hazardous materials and radioactive matter into nearby creeks and Broomfield 's and Westminster 's water supplies .

The DOE itself , in a study released in December of the year prior to the FBI raid , called Rocky Flats ' ground water the single greatest environmental hazard at any of its nuclear facilities . From the grand jury 's report : " The DOE reached this conclusion because the groundwater contamination was so extensive , toxic , and migrating toward the drinking water supplies for the Cities of Broomfield and Westminster , Colorado . "

A class action lawsuit , Cook v. Rockwell International Corp. , was filed in January 1990 against Rockwell and Dow Chemical (due to the indemnity of nuclear contractors , the award would have been paid by the federal government) . Sixteen years later , the plaintiffs were awarded \$ 926 million in economic damages , punitive damages , and interest . The 10th U.S. Circuit Court of Appeals subsequently threw out the verdict and ordered a retrial . A further appeal was rejected without comment by the United States Supreme Court in June 2012 .

Carl Johnson sued Jefferson County for unlawful termination , after he was forced to resign from his position as Director of the Jefferson County Health Department . He alleged that his termination was due to concerns by the board members that his reports of contamination would lower property values . The suit was settled out of court for \$ 150 @, @ 000 .

= = Legacy = =

Denver 's automotive beltway does not include a component in the northwest sector , partly due to concerns over unremediated plutonium contamination .

In 2006 , according to DOE , " The selected remedy / corrective action for the Peripheral OU is no action . The RI / FS report (RCRA Facility Investigation @-@ Remedial Investigation / Corrective Measures Study- Feasibility Study) concludes that the Peripheral OU is already in a state protective of human health and the environment . "

In 2007 , the " Peripheral Operable Unit " (Peripheral OU) land area of Rocky Flats was redesignated as the Rocky Flats National Wildlife Refuge and fell under U.S. Fish and Wildlife Service (USFWS) stewardship in 2007 following the EPA ' s determination that final corrective actions had been completed . According to the USFWS , " the refuge has remained closed to the public due to a lack of appropriations for refuge management operations " . The U.S. Government 's efforts to make the area surrounding the former plant into the Rocky Flats National Wildlife Refuge have been controversial due to the contamination , much of which is underground and not remediated . The substantially contaminated " Central Operable Unit " (COU) land area of Rocky Flats remains under DOE control , and is now surrounded by the refuge .

Plutonium 239 , with a 24 @,@ 000 year half life , will persist in the environment hundreds of thousands of years . The DOE 's assessment of the Central Operating Unit indicates that the long @-@ term risk to citizens living outside the boundaries of Rocky Flats is negligible , but citizen organizations state that the remediation of the site was inadequate .

= = Public opposition = =

On the weekend of April 28 , 1979 , more than 15 @,@ 000 people demonstrated against the Rocky Flats Nuclear Weapons Plant . The protest was coordinated with other anti @-@ nuclear demonstrations across the country . Daniel Ellsberg and Allen Ginsberg were among the 284 people who were arrested . The demonstration followed more than six months of continuous protests that included an attempted blockade of the railroad tracks leading to the site . Large pro @-@ nuclear counter demonstrations were also staged that year .

On October 15 , 1983 , about 10 @,@ 000 demonstrators turned out for protest at Rocky Flats (well short of the 21 @,@ 000 hoped for by protest organizers) . No arrests were made . On August 10 , 1987 (the 42nd anniversary of the atomic bombing of Nagasaki) , 320 demonstrators were arrested after they tried to force a one @-@ day shutdown of the plant . A similar protest with a turnout of about 3 @,@ 500 was staged on August 6 , 1989 (the anniversary of the nuclear bombing of Hiroshima) .

Though public demonstrations against plant operations ceased with the decommissioning of the plant , protests have continued regarding the disposal of nuclear waste from the site and the scale and scope of cleanup operations . Since 2013 , opposition has focused on the Candelas development located along the southern border of the former Plant site .