

= Hanford Site =

The Hanford Site is a mostly decommissioned nuclear production complex operated by the United States federal government on the Columbia River in the U.S. state of Washington . The site has been known by many names , including : Hanford Project , Hanford Works , Hanford Engineer Works and Hanford Nuclear Reservation . Established in 1943 as part of the Manhattan Project in Hanford , south @-@ central Washington , the site was home to the B Reactor , the first full @-@ scale plutonium production reactor in the world . Plutonium manufactured at the site was used in the first nuclear bomb , tested at the Trinity site , and in Fat Man , the bomb detonated over Nagasaki , Japan .

During the Cold War , the project expanded to include nine nuclear reactors and five large plutonium processing complexes , which produced plutonium for most of the more than 60 @,@ 000 weapons in the U.S. nuclear arsenal . Nuclear technology developed rapidly during this period , and Hanford scientists produced major technological achievements . Many early safety procedures and waste disposal practices were inadequate , and government documents have confirmed that Hanford 's operations released significant amounts of radioactive materials into the air and the Columbia River .

The weapons production reactors were decommissioned at the end of the Cold War , and decades of manufacturing left behind 53 million US gallons (200 @,@ 000 m³) of high @-@ level radioactive waste stored within 177 storage tanks , an additional 25 million cubic feet (710 @,@ 000 m³) of solid radioactive waste , and 200 square miles (520 km²) of contaminated groundwater beneath the site . In 2011 , DOE emptied 149 single @-@ shell tanks by pumping nearly all of the liquid waste out into 28 newer double @-@ shell tanks . DOE later found water intruding into at least 14 single @-@ shell tanks and that one of them had been leaking about 640 US gallons (2 @,@ 400 l ; 530 imp gal) per year into the ground since about 2010 . In 2012 , DOE discovered a leak also from a double @-@ shell tank caused by construction flaws and corrosion in the bottom , and that 12 double @-@ shell tanks have similar construction flaws . Since then , DOE changed to monitoring single @-@ shell tanks monthly and double @-@ shell tanks every 3 years , and also changed monitoring methods . In March 2014 , DOE announced further delays in the construction of the Waste Treatment Plant , which will affect the schedule for removing waste from the tanks . Intermittent discoveries of undocumented contamination have slowed the pace and raised the cost of cleanup .

In 2007 , the Hanford site represented two @-@ thirds of the nation 's high @-@ level radioactive waste by volume . Hanford is currently the most contaminated nuclear site in the United States and is the focus of the nation 's largest environmental cleanup . Besides the cleanup project , Hanford also hosts a commercial nuclear power plant , the Columbia Generating Station , and various centers for scientific research and development , such as the Pacific Northwest National Laboratory and the LIGO Hanford Observatory .

On November 10 , 2015 , it was designated as part of the Manhattan Project National Historical Park alongside other sites in Oak Ridge and Los Alamos .

= = Geography = =

The Hanford Site occupies 586 square miles (1 @,@ 518 km²) ? roughly equivalent to half of the total area of Rhode Island ? within Benton County , Washington . This land is closed to the general public . It is a desert environment receiving under 10 inches of annual precipitation , covered mostly by shrub @-@ steppe vegetation . The Columbia River flows along the site for approximately 50 miles (80 km) , forming its northern and eastern boundary . The original site was 670 square miles (1 @,@ 740 km²) and included buffer areas across the river in Grant and Franklin counties . Some of this land has been returned to private use and is now covered with orchards and irrigated fields . In 2000 , large portions of the site were turned over to the Hanford Reach National Monument . The site is divided by function into three main areas . The nuclear reactors were located along the river in an area designated as the 100 Area ; the chemical separations complexes were located inland in

the Central Plateau , designated as the 200 Area ; and various support facilities were located in the southeast corner of the site , designated as the 300 Area .

The site is bordered on the southeast by the Tri @-@ Cities , a metropolitan area composed of Richland , Kennewick , Pasco , and smaller communities , and home to over 230 @,@ 000 residents . Hanford is a primary economic base for these cities .

= = Climate = =

= = Early history = =

The confluence of the Yakima , Snake , and Columbia rivers has been a meeting place for native peoples for centuries . The archaeological record of Native American habitation of this area stretches back over ten thousand years . Tribes and nations including the Yakama , Nez Perce , and Umatilla used the area for hunting , fishing , and gathering plant foods . Hanford archaeologists have identified numerous Native American sites , including " pit house villages , open campsites , fishing sites , hunting / kill sites , game drive complexes , quarries , and spirit quest sites " , and two archaeological sites were listed on the National Register of Historic Places in 1976 . Native American use of the area continued into the 20th century , even as the tribes were relocated to reservations . The Wanapum people were never forced onto a reservation , and they lived along the Columbia River in the Priest Rapids Valley until 1943 . Euro @-@ Americans began to settle the region in the 1860s , initially along the Columbia River south of Priest Rapids . They established farms and orchards supported by small @-@ scale irrigation projects and railroad transportation , with small town centers at Hanford , White Bluffs , and Richland .

= = Manhattan Project = =

During World War II , the Uranium Committee of the federal Office of Scientific Research and Development (OSRD) sponsored an intensive research project on plutonium . The research contract was awarded to scientists at the University of Chicago Metallurgical Laboratory (Met Lab) . At the time , plutonium was a rare element that had only recently been isolated in a University of California laboratory . The Met Lab researchers worked on producing chain @-@ reacting " piles " of uranium to convert it to plutonium and finding ways to separate plutonium from uranium . The program was accelerated in 1942 , as the United States government became concerned that scientists in Nazi Germany were developing a nuclear weapons program .

= = Site selection = =

In September 1942 , the Army Corps of Engineers placed the newly formed Manhattan Project under the command of General Leslie R. Groves , charging him with the construction of industrial @-@ size plants for manufacturing plutonium and uranium . Groves recruited the DuPont Company to be the prime contractor for the construction of the plutonium production complex . DuPont recommended that it be located far away from the existing uranium production facility at Oak Ridge , Tennessee . The ideal site was described by these criteria :

A large and remote tract of land

A " hazardous manufacturing area " of at least 12 by 16 miles (19 by 26 km)

Space for laboratory facilities at least 8 miles (13 km) from the nearest reactor or separations plant

No towns of more than 1 @,@ 000 people closer than 20 miles (32 km) from the hazardous rectangle

No main highway , railway , or employee village closer than 10 miles (16 km) from the hazardous rectangle

A clean and abundant water supply

A large electric power supply
Ground that could bear heavy loads .

In December 1942 , Groves dispatched his assistant Colonel Franklin T. Matthias and DuPont engineers to scout potential sites . Matthias reported that Hanford was " ideal in virtually all respects , " except for the farming towns of White Bluffs and Hanford . General Groves visited the site in January and established the Hanford Engineer Works , codenamed " Site W " . The federal government quickly acquired the land under its eminent domain authority and relocated some 1 @, @ 500 residents of Hanford , White Bluffs , and nearby settlements , as well as the Wanapum people , Confederated Tribes and Bands of the Yakama Nation , the Confederated Tribes of the Umatilla Indian Reservation , and the Nez Perce Tribe .

= = = Construction begins = = =

The Hanford Engineer Works (HEW) broke ground in March 1943 and immediately launched a massive and technically challenging construction project . DuPont advertised for workers in newspapers for an unspecified " war construction project " in southeastern Washington , offering " attractive scale of wages " and living facilities .

The construction workers (who reached a peak of 44 @, @ 900 in June 1944) lived in a construction camp near the old Hanford townsite . The administrators and engineers lived in the government town established at Richland Village , which eventually had accommodation in 4 @, @ 300 family units and 25 dormitories .

Construction of the nuclear facilities proceeded rapidly . Before the end of the war in August 1945 , the HEW built 554 buildings at Hanford , including three nuclear reactors (105 @- @ B , 105 @- @ D , and 105 @- @ F) and three plutonium processing canyons (221 @- @ T , 221 @- @ B , and 221 @- @ U) , each 250 meters (820 ft) long .

To receive the radioactive wastes from the chemical separations process , the HEW built " tank farms " consisting of 64 single @- @ shell underground waste tanks (241 @- @ B , 241 @- @ C , 241 @- @ T , and 241 @- @ U) . The project required 386 miles (621 km) of roads , 158 miles (254 km) of railway , and four electrical substations . The HEW used 780 @, @ 000 cubic yards (600 @, @ 000 m³) of concrete and 40 @, @ 000 short tons (36 @, @ 000 t) of structural steel and consumed \$ 230 million between 1943 and 1946 .

= = = Plutonium production = = =

The B Reactor (105 @- @ B) at Hanford was the first large @- @ scale plutonium production reactor in the world . It was designed and built by DuPont based on an experimental design by Enrico Fermi , and originally operated at 250 megawatts (thermal) . The reactor was graphite moderated and water cooled . It consisted of a 28 @- @ by @- @ 36 @- @ foot (8 @. @ 5 by 11 @. @ 0 m) , 1 @, @ 200 @- @ short @- @ ton (1 @, @ 100 t) graphite cylinder lying on its side , penetrated through its entire length horizontally by 2 @, @ 004 aluminium tubes . Two hundred short tons (180 t) of uranium slugs , 1 @. @ 625 inches (4 @. @ 13 cm) diameter by 8 inches (20 cm) long , sealed in aluminium cans went into the tubes . Cooling water was pumped through the aluminium tubes around the uranium slugs at the rate of 30 @, @ 000 US gallons (110 @, @ 000 L) per minute .

Construction on B Reactor began in August 1943 and was completed on September 13 , 1944 . The reactor went critical in late September and , after overcoming nuclear poisoning , produced its first plutonium on November 6 , 1944 . Plutonium was produced in the Hanford reactors when a uranium @- @ 238 atom in a fuel slug absorbed a neutron to form uranium @- @ 239 . U @- @ 239 rapidly undergoes beta decay to form neptunium @- @ 239 , which rapidly undergoes a second beta decay to form plutonium @- @ 239 . The irradiated fuel slugs were transported by rail to three huge remotely operated chemical separation plants called " canyons " that were about 10 miles (16 km) away . A series of chemical processing steps separated the small amount of plutonium that was produced from the remaining uranium and the fission waste products . This first batch of plutonium

was refined in the 221 @-@ T plant from December 26 , 1944 , to February 2 , 1945 , and delivered to the Los Alamos laboratory in New Mexico on February 5 , 1945 .

Two identical reactors , D Reactor and F reactor , came online in December 1944 and February 1945 , respectively . By April 1945 , shipments of plutonium were headed to Los Alamos every five days , and Hanford soon provided enough material for the bombs tested at Trinity and dropped over Nagasaki . Throughout this period , the Manhattan Project maintained a top secret classification . Until news arrived of the bomb dropped on Hiroshima , fewer than one percent of Hanford 's workers knew they were working on a nuclear weapons project . General Groves noted in his memoirs that " We made certain that each member of the project thoroughly understood his part in the total effort ; that , and nothing more . "

Initially six reactors or " piles " were proposed , when the plutonium was to be used in the gun @-@ type Thin Man bomb . In mid @-@ 1944 a simple gun @-@ type bomb was found to be impractical for plutonium , and the more advanced Fat Man bomb required less plutonium . The number of piles was reduced to four and then three ; and the number of chemical separation plants from four to three .

= = = Technological innovations = = =

In the short time frame of the Manhattan Project , Hanford engineers produced many significant technological advances . As no one had ever built an industrial @-@ scale nuclear reactor before , scientists were unsure how much heat would be generated by fission during normal operations . Seeking the greatest possible production while maintaining an adequate safety margin , DuPont engineers installed ammonia @-@ based refrigeration systems with the D and F reactors to further chill the river water before its use as reactor coolant .

Another difficulty the engineers struggled with was how to deal with radioactive contamination . Once the canyons began processing irradiated slugs , the machinery would become so radioactive that it would be unsafe for humans ever to come in contact with it . The engineers therefore had to devise methods to allow for the replacement of any component via remote control . They came up with a modular cell concept , which allowed major components to be removed and replaced by an operator sitting in a heavily shielded overhead crane . This method required early practical application of two technologies that later gained widespread use : Teflon , used as a gasket material , and closed @-@ circuit television , used to give the crane operator a better view of the process .

= = Cold War expansion = =

In September 1946 , the General Electric Company assumed management of the Hanford Works under the supervision of the newly created Atomic Energy Commission . As the Cold War began , the United States faced a new strategic threat in the rise of the Soviet nuclear weapons program . In August 1947 , the Hanford Works announced funding for the construction of two new weapons reactors and research leading to the development of a new chemical separations process . With this announcement , Hanford entered a new phase of expansion .

By 1963 , the Hanford Site was home to nine nuclear reactors along the Columbia River , five reprocessing plants on the central plateau , and more than 900 support buildings and radiological laboratories around the site . Extensive modifications and upgrades were made to the original three World War II reactors , and a total of 177 underground waste tanks were built . Hanford was at its peak production from 1956 to 1965 . Over the entire 40 years of operations , the site produced about 63 short tons (57 t) of plutonium , supplying the majority of the 60 @,@ 000 weapons in the U.S. arsenal . Uranium @-@ 233 was also produced .

= = = Decommissioning = = =

Most of the reactors were shut down between 1964 and 1971 , with an average individual life span of 22 years . The last reactor , N Reactor , continued to operate as a dual @-@ purpose reactor ,

being both a power reactor used to feed the civilian electrical grid via the Washington Public Power Supply System (WPPSS) and a plutonium production reactor for nuclear weapons . N Reactor operated until 1987 . Since then , most of the Hanford reactors have been entombed (" cocooned ") to allow the radioactive materials to decay , and the surrounding structures have been removed and buried . The B @-@ Reactor has not been cocooned and is accessible to the public on occasional guided tours . It was listed on the National Register of Historic Places in 1992 , and some historians advocate converting it into a museum . B reactor was designated a National Historic Landmark by the National Park Service on August 19 , 2008 .

= = Later operations = =

The United States Department of Energy assumed control of the Hanford Site in 1977 . Although uranium enrichment and plutonium breeding were slowly phased out , the nuclear legacy left an indelible mark on the Tri @-@ Cities . Since World War II , the area had developed from a small farming community to a booming " Atomic Frontier " to a powerhouse of the nuclear @-@ industrial complex . Decades of federal investment created a community of highly skilled scientists and engineers . As a result of this concentration of specialized skills , the Hanford Site was able to diversify its operations to include scientific research , test facilities , and commercial nuclear power production .

As of 2013 , operational facilities located at the Hanford Site include :

The Pacific Northwest National Laboratory , owned by the Department of Energy and operated by Battelle Memorial Institute

The Fast Flux Test Facility (FFTF) , a national research facility in operation from 1980 to 1992 (its last fuel was removed in 2008)

LIGO 's Hanford Observatory , an interferometer searching for gravitational waves

Columbia Generating Station , a commercial nuclear power plant operated by Energy Northwest .

A US Navy nuclear submarine reactor dry storage site contains sealed reactor sections of 114 US Navy submarines (as of 2008) .

The Department of Energy and its contractors offer tours of the site . Sixty public tours , each five hours long , were planned for 2009 . The tours are free , require advance reservation via the department 's web site , and are limited to U.S. citizens at least 18 years of age .

= = Environmental concerns = =

A huge volume of water from the Columbia River was required to dissipate the heat produced by Hanford 's nuclear reactors . From 1944 to 1971 , pump systems drew cooling water from the river and , after treating this water for use by the reactors , returned it to the river . Before its release into the river , the used water was held in large tanks known as retention basins for up to six hours . Longer @-@ lived isotopes were not affected by this retention , and several terabecquerels entered the river every day . The federal government kept knowledge about these radioactive releases secret . Radiation was later measured 200 miles downstream as far west as the Washington and Oregon coasts .

The plutonium separation process resulted in the release of radioactive isotopes into the air , which were carried by the wind throughout southeastern Washington and into parts of Idaho , Montana , Oregon , and British Columbia . Downwinders were exposed to radionuclides , particularly iodine @-@ 131 , with the heaviest releases during the period from 1945 to 1951 . These radionuclides entered the food chain via dairy cows grazing on contaminated fields ; hazardous fallout was ingested by communities who consumed radioactive food and milk . Most of these airborne releases were a part of Hanford 's routine operations , while a few of the larger releases occurred in isolated incidents . In 1949 , an intentional release known as the " Green Run " released 8 @, @ 000 curies of iodine @-@ 131 over two days . Another source of contaminated food came from Columbia River fish , an impact felt disproportionately by Native American communities who depended on the river for their customary diets . A U.S. government report released in 1992 estimated that 685 @, @ 000

curies of radioactive iodine @-@ 131 had been released into the river and air from the Hanford site between 1944 and 1947 .

Beginning in the 1960s , scientists with the U.S. Public Health Service published reports about radioactivity released from Hanford , and there were protests from the health departments of Oregon and Washington . In response to an article in the Spokane Spokesman Review in September 1985 , the Department of Energy announced to declassify environmental records and , in February 1986 , released 19 @,@ 000 pages of previously unavailable historical documents about Hanford 's operations . The Washington State Department of Health collaborated with the citizen @-@ led Hanford Health Information Network (HHIN) to publicize data about the health effects of Hanford 's operations . HHIN reports concluded that residents who lived downwind from Hanford or who used the Columbia River downstream were exposed to elevated doses of radiation that placed them at increased risk for various cancers and other diseases . A mass tort lawsuit brought by two thousand Hanford downwinders against the federal government has been in the court system for many years . Two of six plaintiffs who went to trial in 2005 were awarded \$ 500 @,@ 000 in damages .

On February 15 , 2013 , Governor Jay Inslee announced that a tank storing radioactive waste at the site had been leaking liquids on average of 150 to 300 gallons per year . He said that the leak posed no immediate health risk to the public , but said that should not be an excuse for not doing anything . On February 22 , 2013 , the Governor stated that " 6 more tanks at Hanford site " were " leaking radioactive waste " As of 2013 , there are 177 tanks at Hanford , 149 of which have a single shell . Historically single shell tanks were used for storing radioactive liquid waste and designed to last 20 years . By 2005 , some liquid waste was transferred from single shell tanks to (safer) double shell tanks . A substantial amount of residue remains in the older single shell tanks with one containing an estimated 447 @,@ 000 gallons of radioactive sludge , for example . It is believed that up to six of these " empty " tanks are leaking . Two tanks are reportedly leaking at a rate of 300 gallons (1 @,@ 136 liters) per year each , while the remaining four tanks are leaking at a rate of 15 gallons (57 liters) per year each .

Since 2003 , radioactive materials are known to be leaking from Hanford into the environment . " The highest tritium concentration detected in riverbank springs during 2002 was 58 @,@ 000 pCi / L (2 @,@ 100 Bq / L) at the Hanford Townsite . The highest iodine @-@ 129 concentration of 0 @.@ 19 pCi / L (0 @.@ 007 Bq / L) was also found in a Hanford Townsite spring . The WHO guidelines for radionuclides in drinking @-@ water limits levels of iodine @-@ 129 at 1 Bq / L , and tritium at 10 @,@ 000 Bq / L. Concentrations of radionuclides including tritium , technetium @-@ 99 , and iodine @-@ 129 in riverbank springs near the Hanford Townsite have generally been increasing since 1994 . This is an area where a major groundwater plume from the 200 East Area intercepts the river ... Detected radionuclides include strontium @-@ 90 , technetium @-@ 99 , iodine @-@ 129 , uranium @-@ 234 , ? 235 , and ? 238 , and tritium . Other detected contaminants include arsenic , chromium , chloride , fluoride , nitrate , and sulfate . "

= = = Occupational health concerns = = =

Since 1987 , workers have reported exposure to harmful vapors after working around underground nuclear storage tanks , with no solution found . More than 40 workers in 2014 alone reported smelling vapors and became ill with " nosebleeds , headaches , watery eyes , burning skin , contact dermatitis , increased heart rate , difficulty breathing , coughing , sore throats , expectorating , dizziness and nausea , ... Several of these workers have long @-@ term disabilities . " Doctors checked workers and cleared them to return to work . Monitors worn by tank workers have found no samples with chemicals close to the federal limit for occupational exposure .

In August 2014 , OSHA ordered the facility to rehire a contractor and pay \$ 220 @,@ 000 in back wages for firing them for whistleblowing on safety concerns at the site .

On November 19 , 2014 , Washington Attorney General Bob Ferguson said the state planned to sue the DOE and its contractor to protect workers from hazardous vapors at Hanford . A 2014 report by the DOE Savannah River National Laboratory initiated by ' Washington River Protection Solutions ' found that DOE 's methods to study vapor releases were inadequate , particularly , that

they did not account for short but intense vapor releases . They recommended " proactively sampling the air inside tanks to determine its chemical makeup ; accelerating new practices to prevent worker exposures ; and modifying medical evaluations to reflect how workers are exposed to vapors " .

= = Cleanup era = =

On June 25 , 1988 , the Hanford site was divided into four areas and proposed for inclusion on the National Priorities List . On May 15 , 1989 , the Washington Department of Ecology , the United States Environmental Protection Agency , and the Department of Energy entered into the Tri @-@ Party Agreement , which provides a legal framework for environmental remediation at Hanford . As of 2014 the agencies are engaged in the world 's largest environmental cleanup , with many challenges to be resolved in the face of overlapping technical , political , regulatory , and cultural interests . The cleanup effort is focused on three outcomes : restoring the Columbia River corridor for other uses , converting the central plateau to long @-@ term waste treatment and storage , and preparing for the future . The cleanup effort is managed by the Department of Energy under the oversight of the two regulatory agencies . A citizen @-@ led Hanford Advisory Board provides recommendations from community stakeholders , including local and state governments , regional environmental organizations , business interests , and Native American tribes . Citing the 2014 Hanford Lifecycle Scope Schedule and Cost report , the 2014 estimated cost of the remaining Hanford clean up is \$ 113 @. @ 6 billion ? more than \$ 3 billion per year for the next six years , with a lower cost projection of approximately \$ 2 billion per year until 2046 . About 11 @, @ 000 workers are on site to consolidate , clean up , and mitigate waste , contaminated buildings , and contaminated soil . Originally scheduled to be complete within thirty years , the cleanup was less than half finished by 2008 . Of the four areas that were formally listed as Superfund sites on October 4 , 1989 , only one has been removed from the list following cleanup .

While major releases of radioactive material ended with the reactor shutdown in the 1970s and many of the most dangerous wastes are contained , there are continued concerns about contaminated groundwater headed toward the Columbia River and about workers ' health and safety

The most significant challenge at Hanford is stabilizing the 53 @, @ 000 @, @ 000 US gallons (200 @, @ 000 @, @ 000 l ; 44 @, @ 000 @, @ 000 imp gal) of high @-@ level radioactive waste stored in 177 underground tanks . By 1998 , about a third of these tanks had leaked waste into the soil and groundwater . As of 2008 , most of the liquid waste has been transferred to more secure double @-@ shelled tanks ; however , 2 @, @ 800 @, @ 000 US gallons (11 @, @ 000 @, @ 000 l ; 2 @, @ 300 @, @ 000 imp gal) of liquid waste , together with 27 @, @ 000 @, @ 000 US gallons (100 @, @ 000 @, @ 000 l ; 22 @, @ 000 @, @ 000 imp gal) of salt cake and sludge , remains in the single @-@ shelled tanks . DOE lacks information about the extent to which the 27 double @-@ shell tanks may be susceptible to corrosion . Without determining the extent to which the factors that contributed to the leak in AY @-@ 102 were similar to the other 27 double @-@ shell tanks , DOE cannot be sure how long its double @-@ shell tanks can safely store waste . That waste was originally scheduled to be removed by 2018 . As of 2008 , the revised deadline was 2040 . Nearby aquifers contain an estimated 270 @, @ 000 @, @ 000 @, @ 000 US gallons (1 @. @ 0 × 10¹² l ; 2 @. @ 2 × 10¹¹ imp gal) of contaminated groundwater as a result of the leaks . As of 2008 , 1 @, @ 000 @, @ 000 US gallons (3 @, @ 800 @, @ 000 l ; 830 @, @ 000 imp gal) of radioactive waste is traveling through the groundwater toward the Columbia River . This waste is expected to reach the river in 12 to 50 years if cleanup does not proceed on schedule . The site includes 25 million cubic feet (710 @, @ 000 m³) of solid radioactive waste .

Under the Tri @-@ Party Agreement , lower @-@ level hazardous wastes are buried in huge lined pits that will be sealed and monitored with sophisticated instruments for many years . Disposal of plutonium and other high @-@ level wastes is a more difficult problem that continues to be a subject of intense debate . As an example , plutonium @-@ 239 has a half @-@ life of 24 @, @ 100 years , and a decay of ten half @-@ lives is required before a sample is considered to cease its

radioactivity . In 2000 , the Department of Energy awarded a \$ 4 @. @ 3 billion contract to Bechtel , a San Francisco @-@ based construction and engineering firm , to build a vitrification plant to combine the dangerous wastes with glass to render them stable . Construction began in 2002 . The plant was originally scheduled to be operational by 2011 , with vitrification completed by 2028 . As of 2012 , according to a study by the General Accounting Office , there were a number of serious unresolved technical and managerial problems . As of 2013 estimated costs were \$ 13 @. @ 4 billion with commencement of operations estimated to be in 2022 and about 3 decades of operation .

In May 2007 , state and federal officials began closed @-@ door negotiations about the possibility of extending legal cleanup deadlines for waste vitrification in exchange for shifting the focus of the cleanup to urgent priorities , such as groundwater remediation . Those talks stalled in October 2007 . In early 2008 , a \$ 600 million cut to the Hanford cleanup budget was proposed . Washington state officials expressed concern about the budget cuts , as well as missed deadlines and recent safety lapses at the site , and threatened to file a lawsuit alleging that the Department of Energy is in violation of environmental laws . They appeared to step back from that threat in April 2008 after another meeting of federal and state officials resulted in progress toward a tentative agreement .

During excavations from 2004 to 2007 a sample of purified plutonium was uncovered inside a safe in a waste trench , and has been dated to about the 1940s , making it the second @-@ oldest sample of purified plutonium known to exist . Analyses published in 2009 concluded that the sample originated at Oak Ridge , and was one of several sent to Hanford for optimization tests of the T @-@ Plant until Hanford could produce its own plutonium . Documents refer to such a sample , belonging to " Watt 's group " , which was disposed of in its safe when a radiation leak was suspected .

Some of the radioactive waste at Hanford was supposed to be stored in the planned Yucca Mountain nuclear waste repository , but after that project was cancelled due to the opposition of citizens of Nevada , Washington State sued . They were joined by South Carolina . Their first suit was dismissed , and second suits have been filed .

A potential radioactive leak was reported in 2013 ; the clean up was estimated to have cost \$ 40 billion with \$ 115 billion more required .

= = Hanford organizations = =

The Hanford site operations were initially directed by Colonel Franklin Matthias of the U.S. Army Corps of Engineers . Postwar the Atomic Energy Commission took over , and then the Energy Research and Development Administration . Hanford operations are currently directed by the U.S. Department of Energy . It has been operated under government contract by various private companies over the years ? the table which follows summarizes the operating contractors through 2000 .

= = Other divisions of the site (historical) = =

Plutonium Finishing Plant (PFP) ? made plutonium metal for use in weapons

B Plant , S Plant , T Plant ? processing , separation , and extraction of various chemicals and isotopes

Health Instruments Section ? an attempt to keep workers and the environment safe

REDOX Plant / C Plant ? recovered wasted uranium from World War II processes

Experimental Animal Farm and Aquatic Biology Laboratory

Technical Center ? radiochemistry , physics , metallurgy , biophysics , radioactive sewer , neutralization , metal fab , fuels manufacturing

Tank Farms ? storage of liquid nuclear waste

Metal Recovery Plant / U Plant ? recover uranium from tank farms

Uranium Trioxide Plant (aka Uranium Oxide Plant aka UO₃ Plant) ? took output from other plants (i.e. liquid uranyl nitrate hexahydrate from U plant and PUREX plant) , made uranium trioxide

powder

Plutonium @-@ Uranium Extraction Plant / PUREX Plant ? extracted useful material from spent fuel waste (also see the PUREX article)

Plutonium Recycle Test Reactor (PRTR) ? experimented with alternative fuel mixtures

Plutonium Fuels Pilot Plant (PFPP) ? see PRTR

= = Historic photos = =

= Åråsen Stadion =

Åråsen Stadion is an all @-@ seater football stadium located in Lillestrøm , a city east of Oslo in Skedsmo , Norway . With a capacity for 12 @, @ 250 spectators , the venue is home of Norwegian Premier League side Lillestrøm SK (LSK) . The venue has four stands , of which the West Stand has luxury boxes and club seating for 700 . Because of the stadium 's proximity to Kjeller Airport , it has retractable floodlights . The record attendance of 13 @, @ 652 dates from 2002 . In addition to league , cup and UEFA Cup matches for LSK , the venue has been used for one Strømmen IF top @-@ league match in 1986 , the UEFA Women 's Euro 1997 , eight other Norway women 's national football team matches , the 2002 UEFA European Under @-@ 19 Football Championship , and seven Norway national under @-@ 21 football team matches .

LSK started purchasing land for their own stadium in 1947 , having previously played at Lillestrøm Stadion . Construction started in 1950 and Åråsen opened on 7 July 1951 , having cost 150 @, @ 000 Norwegian krone (NOK) . The grandstand was supplemented with a second stand in 1960 . On 7 April 1967 , the stadium burned down , but was rebuilt by September 1968 . Another stand opened on the east side in 1974 , the same year as LSK was promoted to the 1 @. @ divisjon , then the highest division of Norwegian football . The East Stand was moved to the north side and a new 3 @, @ 700 @-@ seat stand built on the east side in 1978 , which remains today . Between 1999 and 2002 , the other three sides were redeveloped , costing NOK 240 million . This included luxury boxes , a new pitch with under @-@ soil heating , three grandstands , and adjacent commercial and residential property .

= = History = =

Lillestrøm SK originally used Jenseberg Stadion in Strømmen for their matches , as there was no suitable stadium in Lillestrøm . On 6 June 1920 , the municipality opened Lillestrøm Stadion , where Lillestrøm SK moved their matches . In 1930 , the club started working on plans for their own stadium . Led by the chairman Erling Nicolaysen , a stadium fund was established , which grew to NOK 200 . However , during the Second World War , the club 's funds eradicated .

On 2 June 1947 , the club 's board appointed a committee to work with the stadium issue . They determined that the area Sørumsbrenna , part of a farm belonging to Knut Sørum , was the ideal location , despite it being fallow and scrub on a marsh . Holthe og Ahlsen made plans for developing the 4 @. @ 5 @-@ hectare (11 @-@ acre) lot . The purchase was approved by the club 's annual meeting on 29 September . Additional land was bought in 1948 and 1950 , raising the area to 7 @. @ 2 hectares (18 acres) .

Construction was mostly done by volunteers ; the building of the stadium required 31 @, @ 000 man @-@ hours in volunteer work and cost NOK 150 @, @ 000 . After the land was cleared , a layer of mixed sand and earth were laid . The pitch , with the dimensions 108 by 68 meters (118 by 74 yd) , was sown in mid @-@ 1950 . The work also included a grandstand , changing rooms , a watering system and kiosks . The stand could accommodate 2 @, @ 500 spectators , and the stadium had a total permitted capacity of 6 @, @ 000 people . The inaugural match was played against Sarpsborg on 7 July 1951 in front of 3 @, @ 500 spectators . A training pitch beside the stadium pitch opened in 1953 . The following year , a new steel entrance was built , following in

1955 with a referees ' changing room and administrative offices . In 1959 , after eight years of planning , construction of an additional terrace started , which opened in 1960 .

On 7 April 1967 , the grandstand caught fire and the entire structure burned down beyond repair . The buildings and stands were subsequently demolished . At the same time , the Norwegian Public Roads Administration proposed that the Fetveien road , which runs to the south of the stadium , should be moved to run through the stadium , which would have required the stadium to be moved . However , the Public Roads Administration abandoned their plans and a building permit was issued . New changing rooms , club house and terraces were completed in September 1968 .

To accommodate increasing interest for the club following good results during the early 1970s , the board approved a new grandstand on the east long side . Construction started in late 1973 , with the stand covering two @-@ thirds of the length of the pitch , and opened ahead of the 1974 season with capacity for 1 @, @ 056 spectators . The club house was expanded to 200 square meters (2 @, @ 200 sq ft) . In 1974 , the club won promotion to the First Division , and the new grandstand was extended by 352 seats . On the west side , two wooden and steel standing terraces were built . The expansion was done with help of volunteer work , with 30 to 40 people helping each weekday evening and up to 80 people helping at the weekends .

The grandstand was moved to the north side and a new grandstand with seating for 3 @, @ 700 people was opened on the east end in 1978 . The new stand was the first in Norway to have plastic seats and is the oldest part of the current stadium . Construction cost NOK 2 @. @ 8 million , which was largely loan @-@ financed . Between 1980 and 1986 , the area under the new grandstand was built to include new changing rooms , meeting rooms , offices and other facilities totaling 1 @, @ 300 square meters (14 @, @ 000 sq ft) . Some of the office space was rented out .

After five years of planning , construction of a completely renovated stadium started in February 1999 . To finance the stadium , a limited company , Åråsen Stadion AS , was established , and owned by the club , rather than by the limited company which runs the elite team . Only the East Stand from 1978 was kept . In 2000 , new grass was laid on the pitch , replacing the original grass from 1950 . This included installation of under @-@ soil heating and an automatic irrigation sprinkler system . The new pitch had the dimensions 105 @-@ by @-@ 65 @-@ meter (115 by 71 yd) . Combined , this cost NOK 12 million . The first new stand to be completed was the West Stand , which opened ahead of the 2000 season . In addition to luxury boxes , it consists of 6 @, @ 500 square meters (70 @, @ 000 sq ft) of commercial property , including a car dealer , a medical center and a restaurant .

The investments at Åråsen cost NOK 800 million , of which NOK 240 million was used on the stadium itself . Other investments in the area were carried out by private investors and public agencies , who bought land from Lillestrøm SK . The training pitch to the north was demolished to make way for student housing for 100 people . The area to the west of the stadium was turned into a car retailer . Immediately surrounding the stadium was a complex of commercial and residential properties . This included a 8 @, @ 500 @-@ square @-@ meter (91 @, @ 000 sq ft) section to the north which consists of 96 apartments , some with balconies facing the pitch , and a grocery store . Construction of the South Stand and affiliated buildings started on 15 November 2000 and was completed ahead of the 2002 season . In conjunction with the stand was a 2 @, @ 000 @-@ square @-@ meter (22 @, @ 000 sq ft) commercial area rented by Akershus County Municipality , which hosts a psychiatric clinic for children and youth .

Because of the stadium 's close proximity to Kjeller Airport , the stadium is limited to a height of 12 meters (39 ft) , which meant the upgrade could not incorporate floodlights . When mounted on four posts , the flood lights need to be 40 meters (130 ft) above ground to give 1 @, @ 200 lux on the field . In 2000 , this caused Lillestrøm SK to have to play their home match in the 2000 ? 01 UEFA Cup against Alavés at Marienlyst Stadion in Drammen . In 2001 , an evening league game was played using floodlighting mounted on four temporary cranes . A retractable floodlighting system was installed in January 2002 .

In 2006 , team @-@ owner Per Berg stated that Lillestrøm SK would be in need of a new venue and indicated that one could be built at Kjeller , should the airport close . By 2007 , the club 's management was working on ideas to building new stadium , as the luxury boxes were all sold out

and the club could not make more than NOK 22 to 23 million per year on commercial income from Åråsen . In 2009 , Lillestrøm launched itself as one of six candidate cities for Norway 's joint bid with Sweden to host Euro 2016 . This would involve building a new venue seating between 35 @, @ 000 and 44 @, @ 000 in Lillestrøm . The stadium would be built in modules , so the upper tiers could be dismantled after the championship and installed on other venues . The proposal was selected as one of four for the bid , but the bid was never sent . In January 2009 , the club sold 25 percent of their ownership in Åråsen Eiendom , which is responsible for operating the commercial facilities at the stadium , to Lillestrømbanken , a local bank , for NOK 9 million . The club retained full ownership of Åråsen Stadion AS , the company which owns the venue . In a 2012 survey carried out by the Norwegian Players ' Association among away @-@ team captains , Åråsen was found to be the league 's third @-@ best stadium , with a score of 4 @. @ 33 on a scale from one to five .

= = Facilities = =

Åråsen Stadion has a capacity of 12 @, @ 250 spectators , all seated . The stadium consists of four single @-@ tier stands . The western stand is the main stand , with the upper section consisting of luxury boxes and club seating for 700 people . For sponsorship reasons it is known as the Lillestrøm Torv Stand , after a local shopping center . The southern part of the East Stand houses the Kanarifansen , the official LSK supporters ' group , while the northern part has unreserved seating . The South Stand is named for Romerikes Blad , the local newspaper , while the North Stand is named for Legea , a sportswear manufacturer . The latter is used for away fans . The stadium is owned by Åråsen Stadion AS , which is again wholly owned by Lillestrøm SK . Operation of the venue 's commercial properties is done by Åråsen Eiendom AS , which is owned 75 percent by Åråsen Stadion and 25 percent by Lillestrømbanken . The stadium is within walking distance of both the town center of Lillestrøm and Lillestrøm Station . Lillestrøm SK hold their training sessions in the nearby Lillestrøm Stadion and LSK @-@ Hallen .

= = Events = =

Åråsen has been the home venue for Lillestrøm SK since the 1951 season and has been the venue for all their home league games . Since the 1975 season , LSK has played every season in the top tier of the league system . Åråsen has also been the venue for most LSK matches in UEFA tournaments , including the Champions League and the UEFA Cup , but the club has previously played some home matches at Ullevaal Stadion in Oslo and Marienlyst Stadion . The record attendance of 13 @, @ 652 spectators was set on 16 May 2002 in the match between Lillestrøm and their rivals Vålerenga . The second @-@ highest attended match was a cup match against Rosenborg in 1993 , which attracted 13 @, @ 595 people . The team 's highest average league attendance was set in the 2007 season , when there was an average of 9 @, @ 018 spectators per match . The team 's season average has been above 6 @, @ 000 during the 2000s , and was as low as 6 @, @ 165 in 2010 and 6 @, @ 448 in 2001 . The team also saw high attendances in the 1970s , attracting its fourth @-@ ever highest average in 1977 with 8 @, @ 430 spectators , and attendances of 6 @, @ 531 and 6 @, @ 346 in 1978 and 1976 , respectively . LSK 's club seats was in 2009 the most expensive tickets in the league , costing NOK 660 per match .

When Strømmen IF were promoted to First Division ahead of the 1986 season , the team originally announced that they would play their fall games at Åråsen , as Strømmen Stadion was in need of a new pitch . In the end , Strømmen only played one of their matches at Åråsen , drawing 1 ? 1 against Rosenborg on 10 August 1986 in front of 1 @, @ 649 spectators .

Norway co @-@ hosted UEFA Women 's Euro 1997 , and three group @-@ stage matches and a semi @-@ final were held at Åråsen . This included Norway playing two matches , against Denmark and Italy , which attracted 4 @, @ 221 and 4 @, @ 067 spectators , respectively . Norway 's national women 's team has also played eight other matches at Åråsen : 3 ? 0 against Finland in 1983 , 2 ? 2 against Sweden in 1984 , 1 ? 0 against Finland in 1985 , 4 ? 0 against England in 1997 , 2 ? 0 against England in 1998 , 4 ? 0 against Ukraine in 2001 , 4 ? 1 against Ukraine in 2005 and 3 ? 0

against Austria in 2007 .

Norway hosted the 2002 UEFA European Under @-@ 19 Football Championship , with two group @-@ stage matches being played at Åråsen . On 23 July , Slovakia beat the Czech Republic 5 ? 2 , and on 26 July Germany beat Belgium 2 ? 1 . The former attracted 611 spectators . The Norway national under @-@ 21 football team has played seven home matches at Åråsen : 1 ? 3 against Sweden in 1979 , 1 ? 2 against France in 1987 , 3 ? 2 against San Marino in 1992 , 0 ? 0 against Georgia in 1999 , 3 ? 0 against Germany in 2001 , 0 ? 0 against Slovenia in 2004 , and 1 ? 0 against Turkey in 2007 .