Columbia Generating Station

News Media Handbook

ENERGY NORTHWEST
People · Vision · Solutions

Contents

Introduction

The events of September 11, 2001, have focused public attention on the issue of emergency planning for the nation's commercial nuclear power plants. In the event of an emergency, poor communications would result in confusion and undue alarm. The Nuclear Regulatory Commission and the Federal Emergency Management Agency have set specific criteria to be used by nuclear plant owners in the event of a radiological emergency. It is the responsibility of Energy Northwest to impart factual, accurate, and easy-to-understand information to the public, but this cannot be accomplished without the news media also conveying this information accurately and objectively.

This News Media Handbook is designed to help the news media fulfill its responsibilities to the public and to assist news reporters in their coverage of a radiological emergency at Columbia Generating Station.

Emergency Preparedness Program

The Nuclear Regulatory Commission requires utilities and local communities to have approved emergency preparedness plans in place for all licensed nuclear reactors.

The three key elements of the emergency plan are: classifying the severity of the emergency, alerting agencies responsible for emergency response activities, and taking appropriate action in areas surrounding the power plant that could be affected by an emergency.

Emergency classifications

In the event of a significant problem at Columbia Generating Station, Energy Northwest will declare one of four classes of emergencies that require varying responses from the utility, government agencies and the public. They are (in increasing severity):

Unusual Event: An Unusual Event indicates a potential degradation of plant safety margins, which is not likely to affect personnel on-site, or the public off-site or result in radioactive releases requiring off-site monitoring.

Unusual Event conditions do not cause serious damage to the plant and may not require a change in operational status. The purpose of declaring an unusual event is to make emergency responders (on site and off site) aware that their assistance may be required later.

Alert: An Alert indicates a substantial degradation of plant safety margins which could affect on-site personnel safety, could require off-site impact assessment, but is not likely to require off-site public protective action.

Actual releases of radioactivity may be involved, and thus radiation monitoring and dose projection may be an integral portion of the emergency response required. Note that the regulatory limits on radiation released at a minor emergency classification are a tiny fraction of the amounts judged to affect public health.

The purposes of declaring an Alert are to provide additional help in responding to the situation and provide systematic handling of information and decision making. Declaring an Alert will bring all emergency centers to full activation.

Site Area Emergency: A Site Area Emergency indicates an event, which involves likely or actual major failures of plant functions needed for the protection of the public.

The events included in this Site Area Emergency category represent a potential for off-site releases, which could impact the public to the extent that protective actions may be necessary.

Emergency broadcast radios would be activated and emergency messages broadcast. Sirens would alert people using the Columbia River near the plant and the river would be evacuated within 10 miles of the plant. Schools within 10 miles of the plant are also evacuated as a pre-emptive measure.

General Emergency: A general Emergency involves substantial degradation or melting of fuel in the reactor vessel with potential for loss of containment integrity.

Possibilities exist for amounts of contamination to be released. Station procedures require monitoring these releases and providing protective action information to state and county authorities. Prompt notification of the population at risk is made by local authorities in a General Emergency. Any decision to evacuate or shelter will be made by them.

The purpose of declaring a General Emergency is to initiate predetermined protective actions for the public; to provide for continuous off-site assessment and take additional measures as indicated by the nature of the radiological release; and to provide for consultation and flow of information to and from various off-site authorities.

Responsibilities of emergency response agencies

Energy Northwest is in charge of the emergency response within the boundaries of the plant site. The Nuclear Regulatory Commission monitors the activities at the plant, provides expert analysis and consultation, and assures that actions taken to manage the accident are in the best interests of public health and safety. Every operating nuclear power plant in the country has a hotline directly to the Nuclear Regulatory Commission's Operations Center near Washington, D.C., which is staffed around the clock.

The Federal Emergency Management Agency is responsible for coordinating the federal off-site response to a nuclear plant emergency. It is responsible for helping state and local governments respond to, and recover from, all sorts of large-scale crises. The Federal Emergency Management Agency has developed guidelines for state and local agencies and assists them in developing their radiological emergency response plans.

Community leaders and local government agencies are responsible for making protective-action decisions, mobilizing their resources and enlisting public cooperation. They are also responsible for developing and publicizing emergency preparedness plans and conducting annual exercises. Benton and Franklin Counties have developed nuclear emergency plans and they coordinate emergency activities from the Benton County Emergency Operations Center in Richland, and the Franklin County EOC in Pasco. The U.S. Department of Energy office in Richland is responsible for the health and safety of its workers on the Hanford Reservation. The state of Washington also activates the state Emergency Operations Center (EOC) at Camp Murray near Olympia. Employees of the state Department of Health and the Emergency Management Division staff the state EOC. State representatives are also dispatched to Energy Northwest's emergency centers.

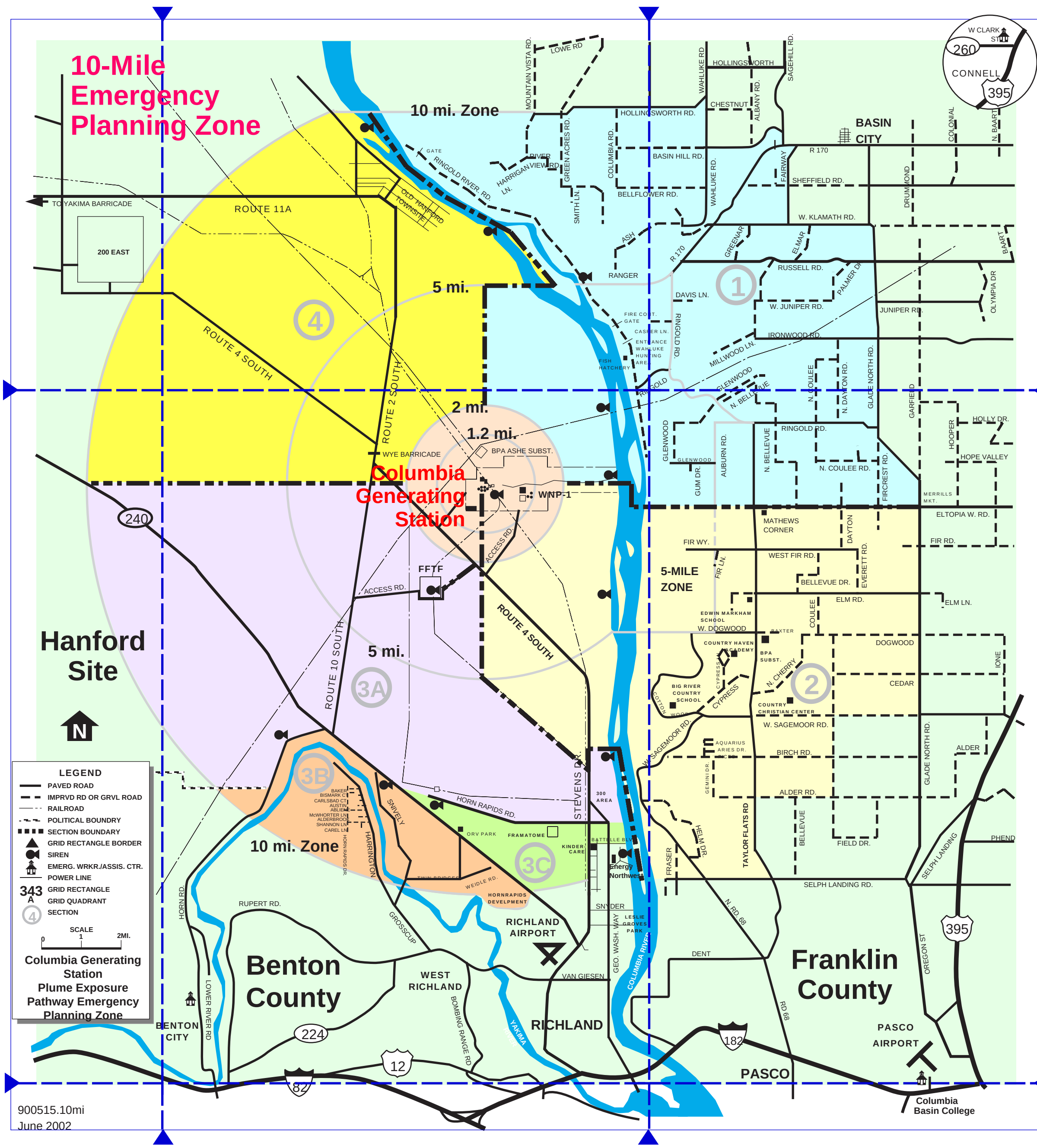
Emergency planning zones

Off-site plans identify two zones. One covers an area within a 10-mile radius of the plant, in which direct exposure to radiation from a plume (an invisible cloud of radioactive materials) is possible. Most airborne radioactivity would be dissipated to safe levels within 10 miles of the plant. The other zone covers a 50-mile radius from the plant, where people could be exposed indirectly to radioactive elements through contamination of water supplies, food crops or grazing lands over an extended period of time.

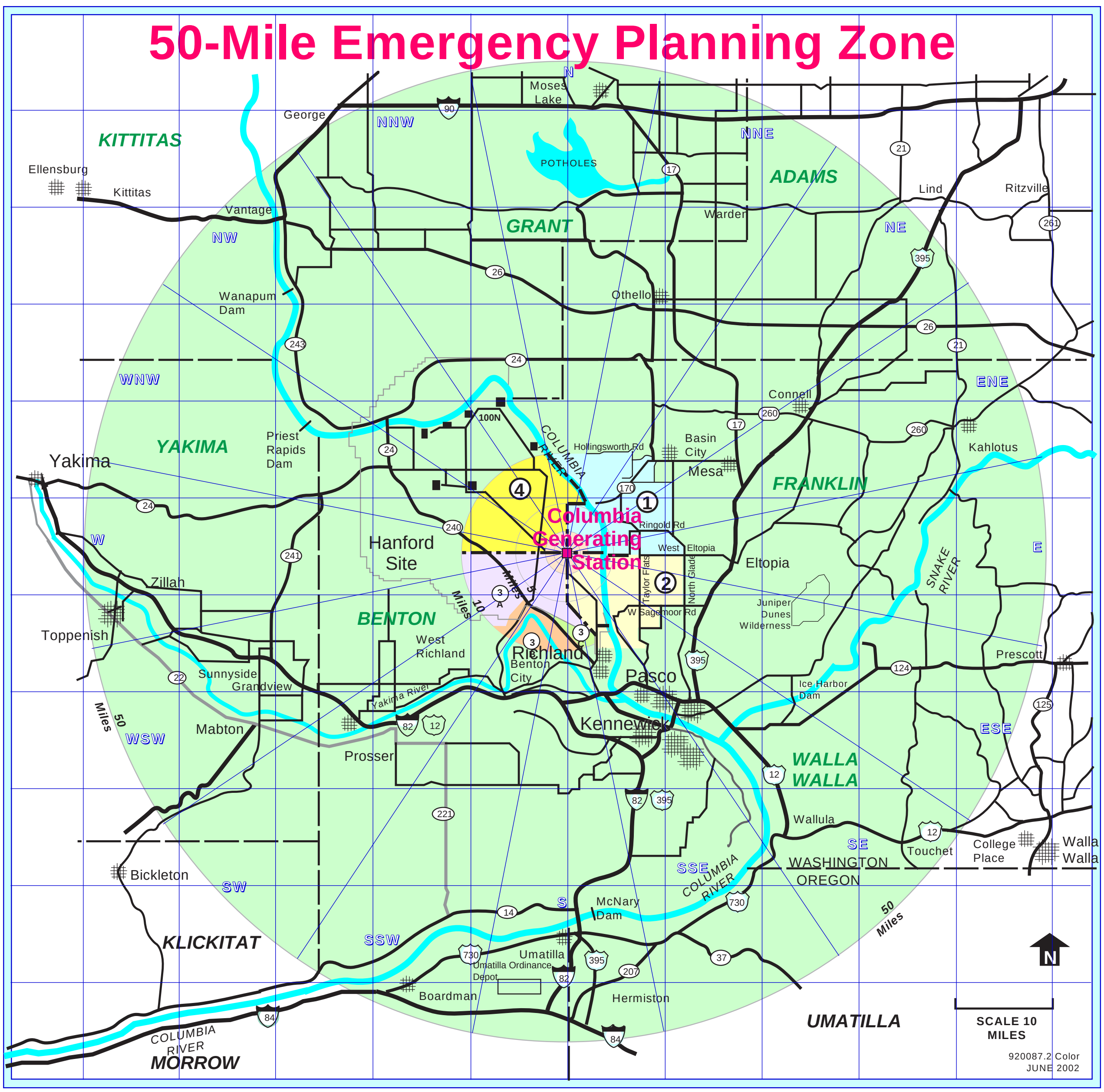
In the event of an accident, residents of the 10-mile zone must be alerted promptly. This is done with sirens, radio and television broadcasts and tone-alert radios. Tone-alert radios are activated on receipt of special tones - the ones heard during radio tests of the Emergency Alerting System. Residents will be advised of appropriate protective actions, such as seeking shelter or evacuating the area. Their response will depend on the nature of the accident, how quickly it is evolving and how much, if any, radioactive material is likely to be released.

An accidental emission could consist of an invisible plume containing radioactive materials. The path of the plume would depend on the weather. For instance, stagnant air conditions could stall the plume over a small area, or rain could wash radioactive particles to the ground. During unstable conditions, the plume could rise into the air, possibly hundreds or thousands of feet, and then disperse.

There are three ways to minimize radiation exposures: *shielding, distance* and *time.* In a serious reactor accident, residents of the zones may be asked to seek shelter or leave the area until the plume passes or the radioactivity dissipates. Emergency broadcasts will advise residents of the appropriate action.

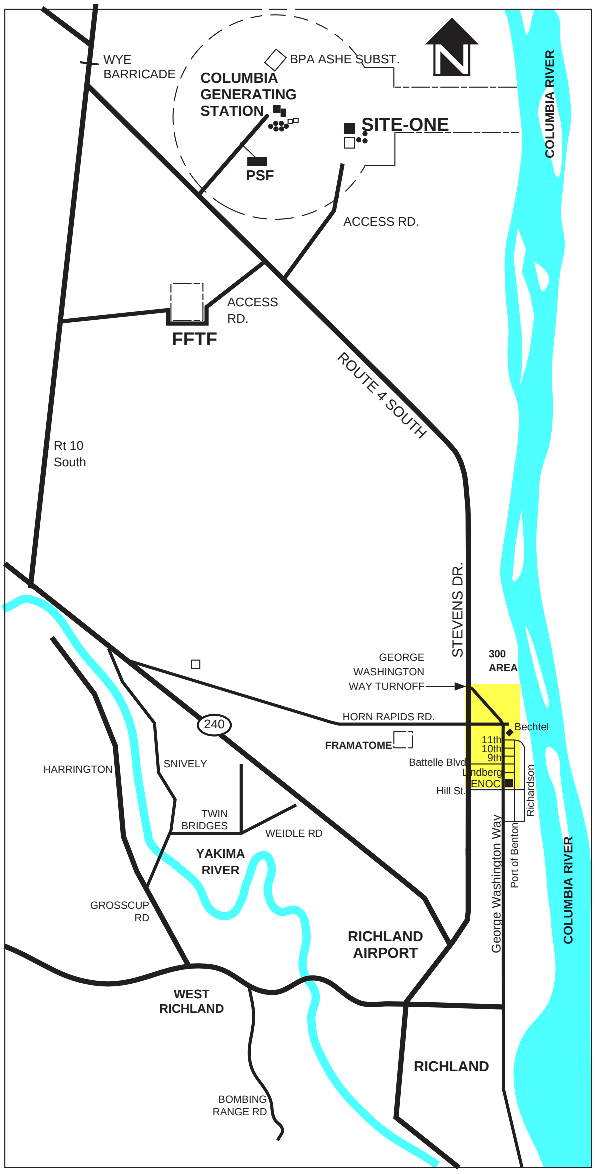


In a severe radiological emergency involving the release of radioactive iodine, the drug potassium iodide might be used to prevent radiation injury to the thyroid gland by saturating it with nonradioactive iodine. This blocks the thyroid from absorbing radioactive iodine from the air, contaminated water, milk or foods. Emergency workers who remain or work in an area contaminated by radioactive iodine may use it. The state and local authorities plan to evacuate the general public before the hazard exists and avoid public distribution of potassium iodide.



Public Information During Emergencies

Location of Emergency Centers



Energy Northwest's Communications & Industry Affairs organization is responsible for ensuring an accurate and reliable flow of information to the news media and public. Public information activities are required to be initiated for alert, site area and general emergencies.

A Joint Information Center will be established at 3000 George Washington Way in Richland. The building can accommodate large numbers of news media personnel. Representatives from the Department of Energy, the state, the counties, the Nuclear Regulatory Commission and the Federal Emergency Management Agency will be available to meet there with news media reporters.

Twenty-four-hour information services include:

media briefings - held at regular intervals with technical personnel available to answer questions;

media work space - with telephones with local access and operator assistance;

support materials - including readily available news releases and videotapes of briefings;

telephone response team - responding to incoming media calls with the latest available information;

public response team - responding to incoming calls from the public with the latest available information.

The Emergency Operations Facility will be activated in an emergency. Located in the Plant Support Facility near the plant site, the building has an area set aside that may be used for press briefings. Tours may be set up at the Joint Information Center to bring news media reporters to the Emergency Operations Facility.

General Plant Operation

Columbia Generating Station is a General Electric boiling water reactor with a Westinghouse turbine generator rated at 1,183 megawatts - enough power to meet the needs of a city the size of Seattle.

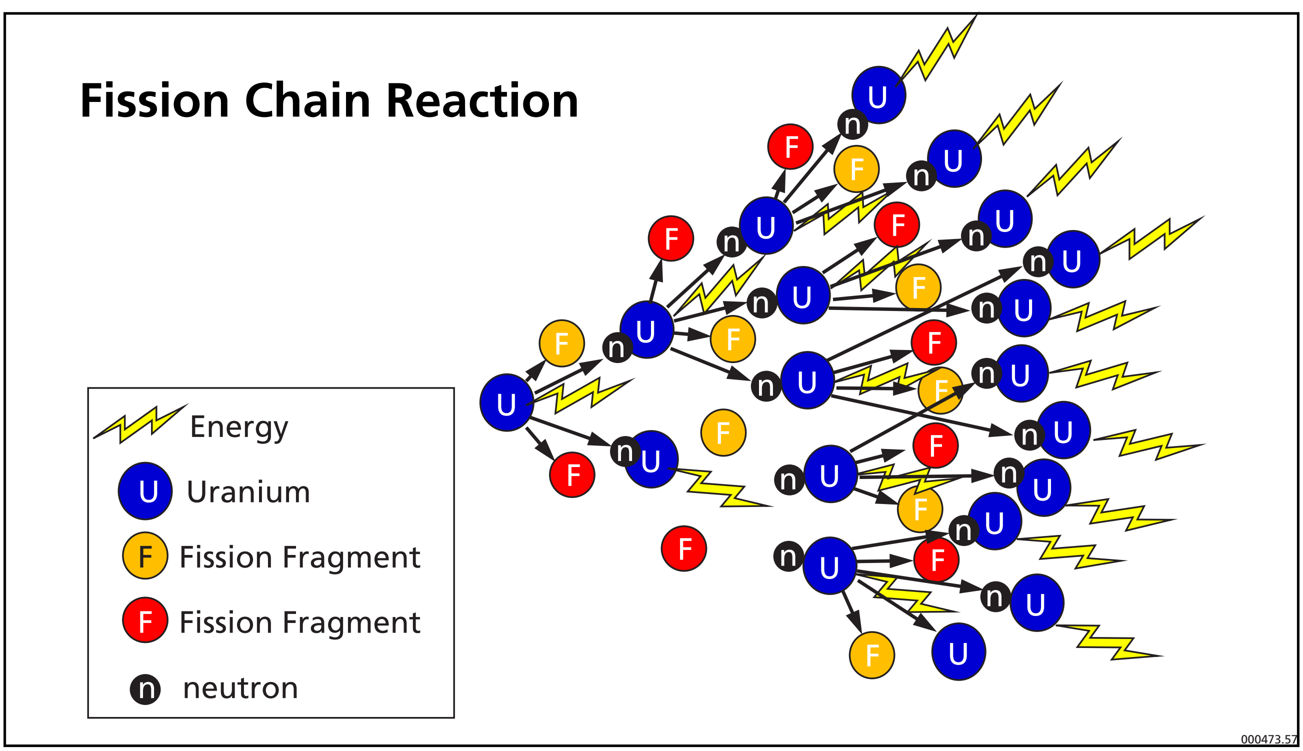
All thermal power plants, whether fossil or nuclear fueled, generate electricity in much the same way. Energy in the form of steam is used to spin a turbine, which drives an electrical generator to produce electricity. The major difference between fossil and nuclear plants is the method used to generate the heat to produce steam.

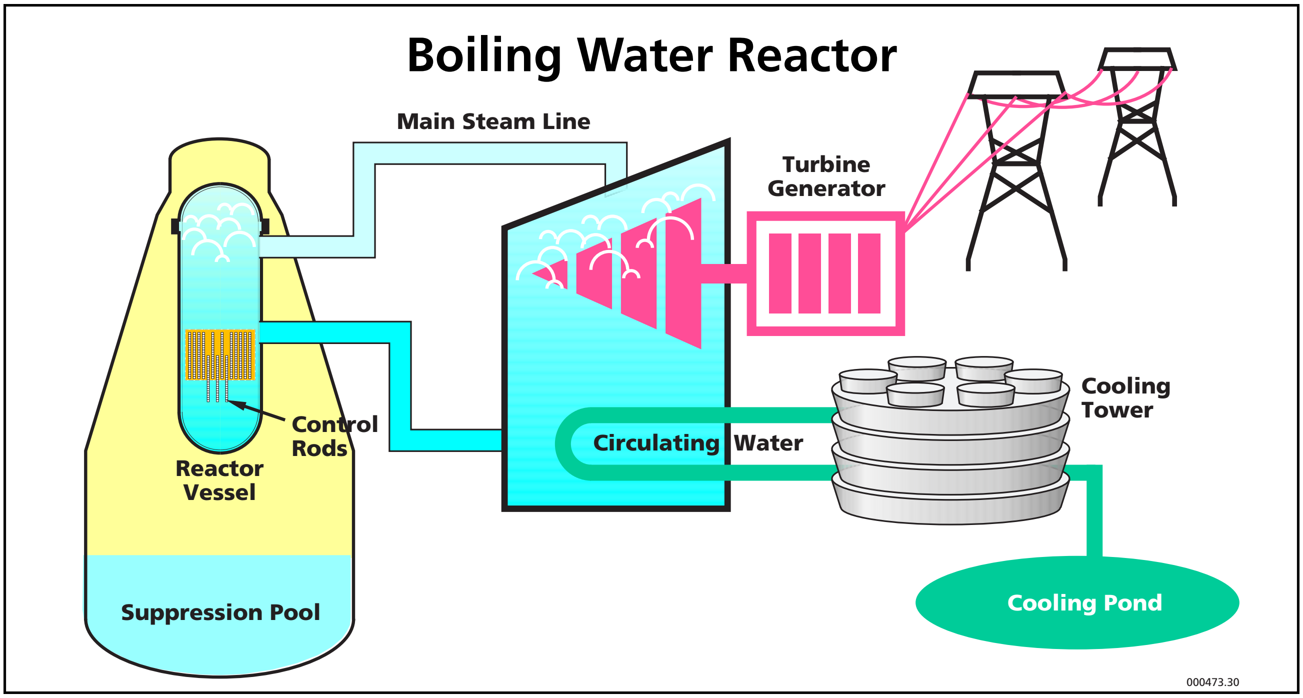
Fossil-fueled plants (fueled by oil, coal and natural gas) use the heat of combustion to convert water to steam. Nuclear plants, such as pressurized water reactors and boiling water reactors, use heat created by the fissioning, or splitting apart, of uranium atoms to convert water to steam.

At the core of an atom is a nucleus made up of protons and neutrons. Orbiting the nucleus is a third type of particle, called an electron. Protons are positively charged, electrons negatively charged and neutrons have no charge. Usually the atom exists in balance between these forces, but sometimes atoms can be unstable. In an attempt to reach a stable state, the atom rids itself of excess energy by giving off radiation.

Some atoms become so unstable that their nucleus splits apart, or fissions. This is the process that powers nuclear reactors. When a neutron strikes the nucleus of an atom of uranium-235 in the reactor fuel, it is absorbed, making the nucleus unstable. The nucleus will split into two fragments, releasing energy in the form of heat. This splitting of the nucleus also releases two or three neutrons that can be potentially absorbed by other atoms of uranium-235 causing more fissions and sustaining the chain reaction.

A boiling water reactor is one of two major types of light-water reactors used for commercial power generation in the United States. It differs from a pressurized water reactor in that the coolant is boiled in the reactor and sent directly to the turbine.





Reactor components

All nuclear reactors have four major components: fuel to produce energy; coolant to remove heat from the fuel; a moderator to slow the neutrons and increase the chances of their being absorbed by a uranium-235 atom, and a control material that absorbs neutrons and regulates the fission process.

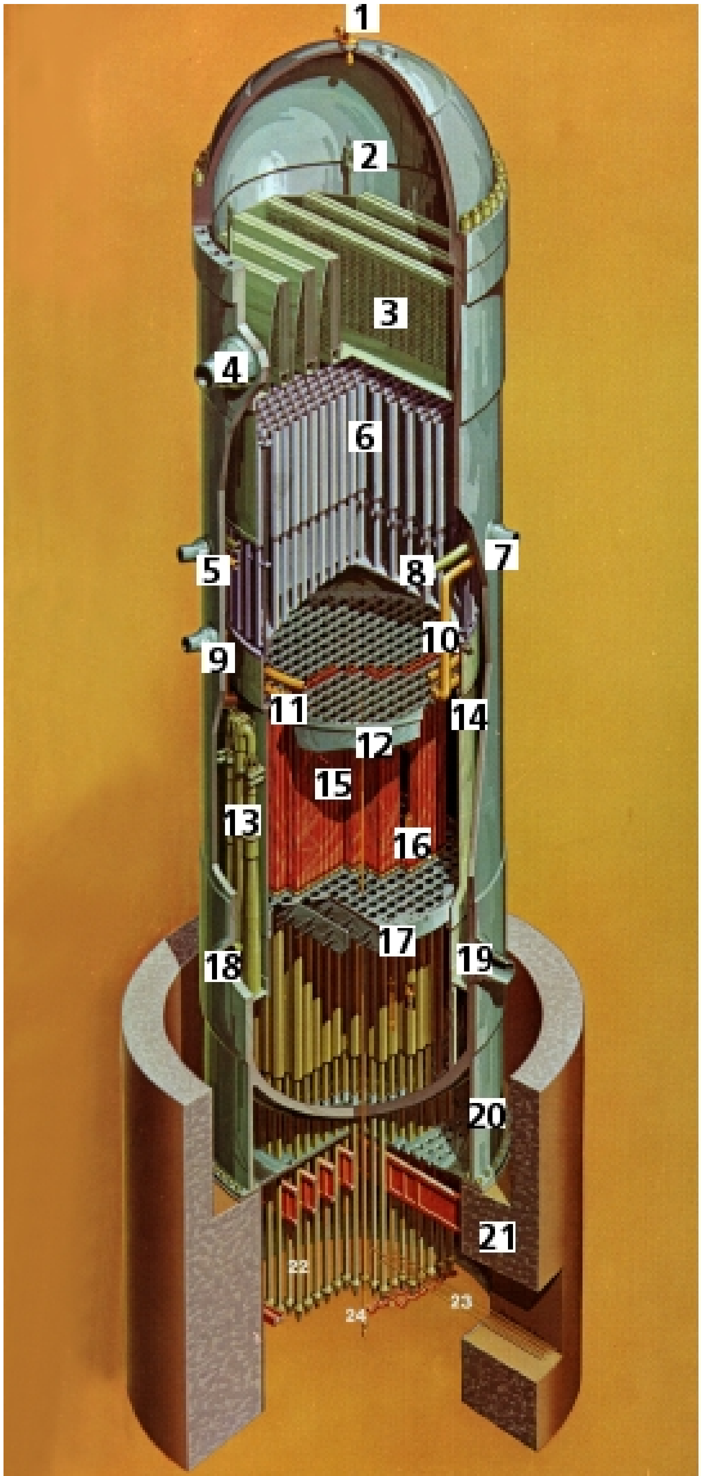
Uranium dioxide is used as fuel. The fuel is made up of uranium-238 with a small percentage (about 3 percent) of uranium-235. This fuel is in the form of a hard ceramic material pressed into small cylindrical pellets. These pellets are stacked in long metal tubes known as fuel rods. The fuel rods are housed in the reactor core. In Columbia Generating Station, the reactor core holds 764 fuel bundles (also known as fuel assemblies), each containing 72 fuel rods. The reactor core holds a total of 153 tons of uranium-dioxide fuel.

Purified water is used as the coolant. The coolant is pumped around and between the fuel rods to remove heat from the fuel and produce steam to generate electricity.

Water also serves as the moderator. The moderator slows fast neutrons produced by fission. Fast neutrons have a tendency not to interact with the nucleus of uranium-235 atoms. By slowing them, these neutrons are more readily absorbed by uranium-235 atoms, causing more fissions and sustaining the nuclear chain reaction. Without the moderator, a chain reaction could not be sustained. Boiling reduces the density of the water, making it loss effective in slowing down the neutrons and making the reactor more stable (i.e. the more it tries to generate, the greater the tendency to reduce power).

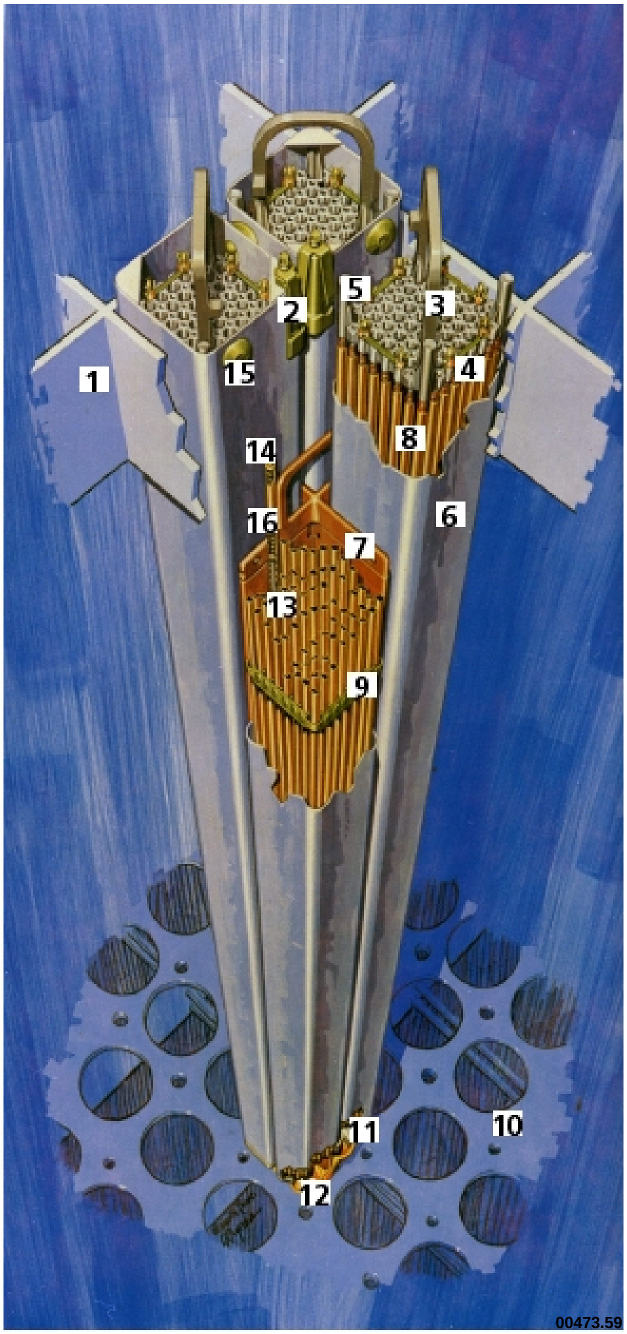
Boron is used as a control material. Boron absorbs neutrons and regulates the number of fissions. The boron is encased in metal rods, called control rods, and inserted into the reactor core from the bottom of the reactor vessel. By inserting or withdrawing the control rods, the nuclear chain reaction can be slowed down, speeded up or stopped.

Reactor Assembly



00473.59

1. Vent and head spray
2. Steam dryer
3. Steam outlet
4. Core spray outlet
5. Steam separators
6. Feedwater inlet
7. Feedwater sparger
8. Low-pressure coolant injection inlet
9. Core spray pipe
10. Core spray sparger
11. Top guide
12. Jet pump
13. Core shroud
14. Fuel assemblies
15. Control blade
16. Core plate
17. Jet pump/ recirculation water inlet
18. Recirculation water outlet
19. Vessel support skirt
20. Control rod drives
21. In-core flux monitor



Fuel Bundles and Control Rod Modules

1. Top fuel guide
2. Channel fastener
3. Upper tie plate
4. Expansion spring
5. Locking tab
6. Channel
7. Control rod
8. Fuel rod
9. Spacer
10. Core plate assembly
11. Lower tie plate
12. Fuel support piece
13. Fuel pellets
14. End plug
15. Channel spacer
16. Plenum spring

Plant systems

The plant can be divided into two major areas: the nuclear steam supply system and the balance of plant systems.

The major purpose of the nuclear steam supply system is to generate the steam used to spin the turbine. Water is converted to steam in the reactor vessel by heat from the nuclear fuel.

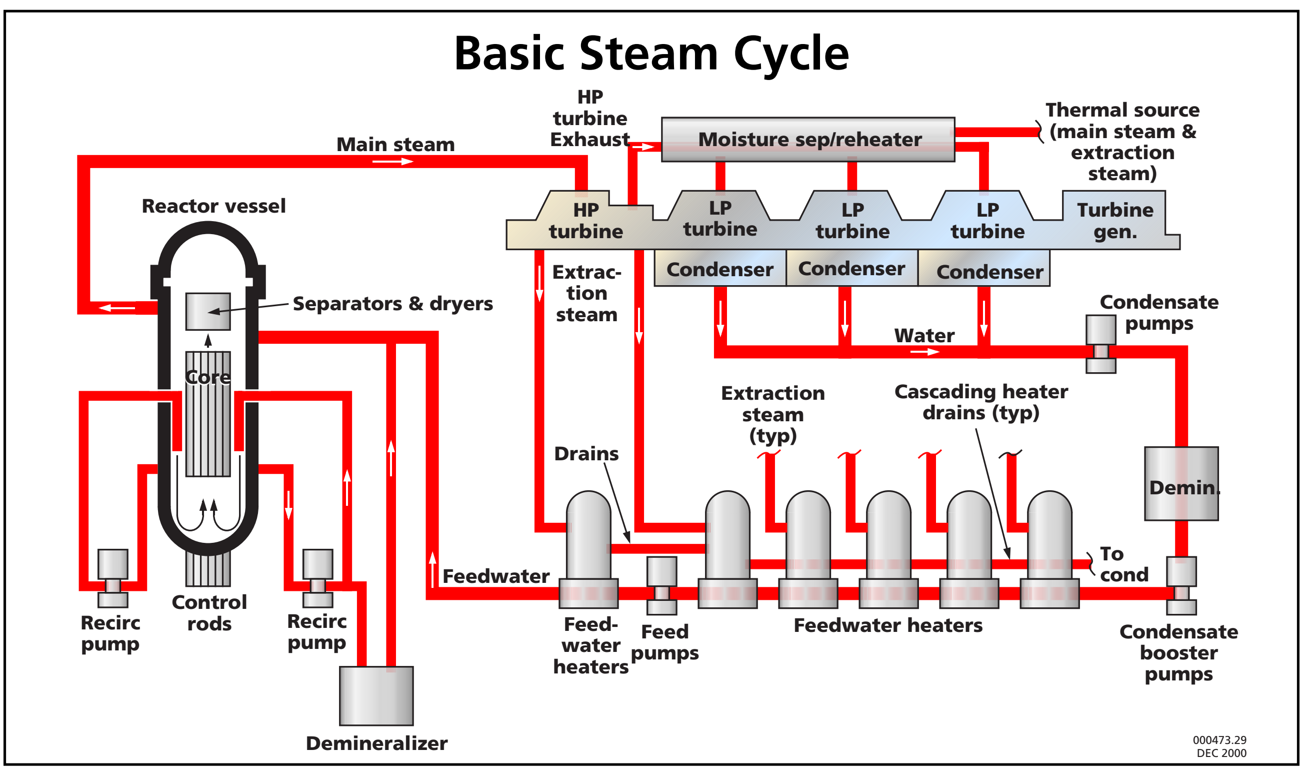
The purpose of the balance of plant systems is to accept the steam, use it to generate electricity, condense the steam back into water and pump the water back into the reactor vessel.

Nuclear steam supply system

The heart of the nuclear steam supply system is the reactor assembly. It consists of the reactor vessel, internal jet pumps, control rods and their drive mechanisms, the fuel core, and the steam separator and dryer assemblies. Water returning to the reactor vessel flows to the jet pumps where it is forced to the bottom of the vessel under the nuclear fuel core. The water then flows up through the fuel where part of it is converted to steam. This steam-water mixture flows from the top of the fuel core to the steam-separator assemblies, located in the top portion of the reactor vessel. The steam separator removes most of the water and passes the steam to the dryer assembly. The steam dryer removes the remaining moisture from the steam and the dried steam is sent to the turbine. (Moisture removal from the steam is very important - water droplets striking the fast-moving turbine blades cause rapid blade deterioration.)

Moisture removed by the separator and dryer mixes with the feedwater and returns to the jet pumps. A portion of this water provides the suction for the reactor water recirculation system. The recirculation systems forces additional cooling water through the core, increasing the coolant's ability to remove heat and resulting in more power being generated. The recirculation system also controls the number of fissions in the reactor core by varying the flow of water through the fuel. As the flow of coolant is increased, fewer steam bubbles are formed in the fuel core. Since water is a better moderator than steam, more neutrons are slowed and there are more fissions. If the recirculation flow is decreased, more steam bubbles are formed, there is less moderation and few fissions occur. Basically, the control rods are used to make major fluctuations in the power level of the reactor while the recirculation flow is varied to make minor adjustments.

Control rod drive: The control rod drive system positions the reactor control rods in the core to provide reactor power control and rapid reactor shutdown (scram). The control rods are "X" shaped and move up and down between fuel assemblies.



In Columbia Generating Station there are 185 separate control rods, each with its own hydraulic drive mechanism. The drive mechanism positions the rods at precisely spaced intervals or notches. Each notch is 6 inches apart on the 12-foot-long drive mechanism. The control rods are either inserted or removed, one or more notches at a time, to achieve the desired power level.

Fuel assemblies: The nuclear fuel core in Columbia Generating Station contains 764 fuel assemblies. These assemblies consist of 72 rods bound together in a 9-by-9 array. There is space between the rods to allow for flow of cooling water.

Each rod is about 1/2-inch in diameter and 12 feet long. It is hollow and is filled with hundreds of pellets of uranium dioxide fuel, each about 3/8-inch in diameter and 3/8-inch long. The rods are made from zirconium (Zircaloy-2), a metal that is particularly well suited for this application.

Balance of plant systems

The turbine-generator used in Columbia Generating Station is similar to those used in pressurized water reactors and fossil-fueled plants. It consists of a high-pressure turbine, a moisture-removal device and three low-pressure turbines all joined on a common shaft and coupled to the main generator.

Steam supplied by the main steam system passes first into the high-pressure turbine section. After the high-pressure turbine, it passes through a moisture separator to remove excess moisture trapped in the steam. The steam is reheated before being piped to the low-pressure turbine sections, where more energy is extracted to drive the generator rotor. Finally the steam is exhausted to the main condenser situated beneath the low pressure turbine sections.

In the condenser, the steam is cooled by contact with thousands of tubes containing cold water. Water collected in the bottom of the condenser is picked up by the condensate pumps and sent to several filter demineralizer units, where it is mechanically filtered and purified by ion exchange. (Clean, chemically pure water is necessary to minimize deposits on reactor core components and reduce corrosion and radiation levels.)

Condensate booster pumps force the purified water through a series of heaters to preheat the water before it is returned to the reactor vessel. Preheating this water increases the overall efficiency of the plant by reducing the amount of heat required to boil the water.

Reactor feedwater pumps provide the pressure required to return the feedwater to the reactor vessel. High-pressure heaters further raise the water temperature before it is injected into the reactor vessel.

The circulating water system supplies cooling water to the main condenser. As it flows through the tubing in the condenser, the water in this system absorbs heat from steam exhausted from the turbine. This heated water is circulated to six mechanical-draft cooling towers, each of which has six large fans to draw cool air past the circulating water. The fans can be operated in any combination to provide the proper cooling. These towers are the source of the vapor clouds seen rising from the plant.

Plant Safety Features

Nuclear power plants are designed using a multiple-barrier concept to protect the public from harm by preventing the release of radiation or contamination to the environment. These barriers include:

Fuel pellet: The fuel itself is in the form of hard ceramic pellets to hold together the uranium and solid radioactive waste materials.

Fuel cladding: The fuel pellets are contained within corrosion, heat and radiation-resistant, zirconium metal tubes, or cladding.

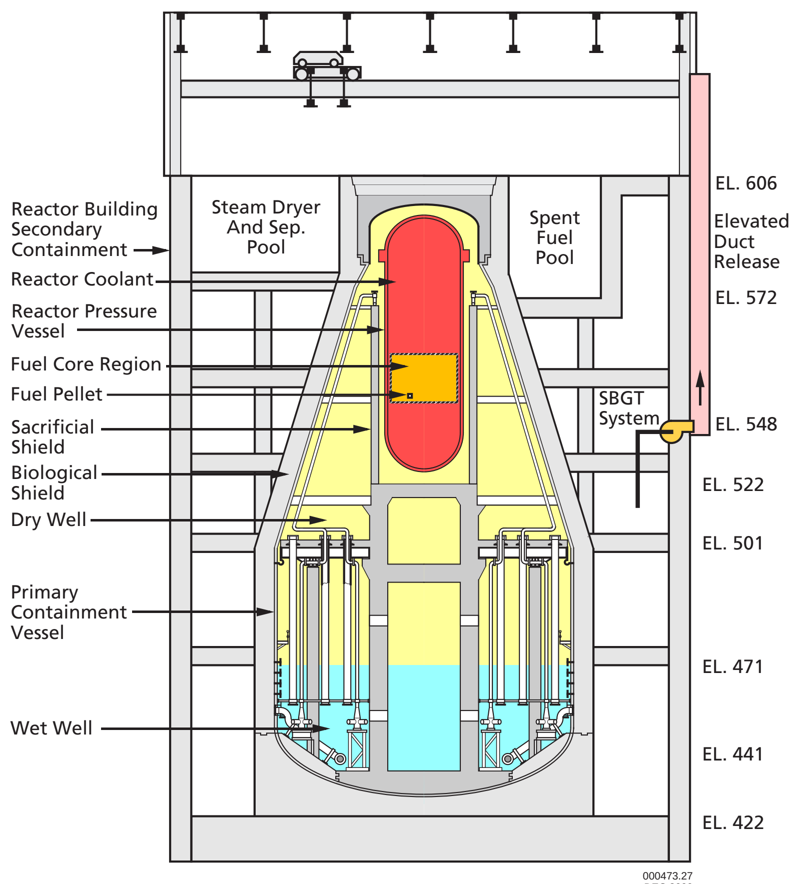
Reactor vessel: The fuel is housed in a steel pressure vessel with 6-inch thick walls. The vessel is designed to withstand internal pressures well in excess of the highest pressure seen during operation.

Primary containment: A leak-tight steel shell encloses the reactor to prevent the escape of any radioactive material during an emergency.

Shield wall: The reactor vessel is encircled by a 6-foot thick concrete shield wall, which protects the primary containment, and shields plant personnel against radiation.

Secondary containment: The concrete and steel reactor building is the final protective barrier. A ventilation system maintains a slight vacuum in the building so any leakage will be into rather than out of the building.

Containment Concept



The design redundancy concept is another way safety is assured. A nuclear power plant has many overlapping safety features to provide additional barriers to the release of radiation or contamination. The most important of these features is the emergency core cooling system.

The emergency core cooling system ensures that a back-up water supply will prevent the reactor core from overheating if the normal water supply is lost or reduced. This system is automatically activated when sensors indicate a low water level in the reactor vessel.

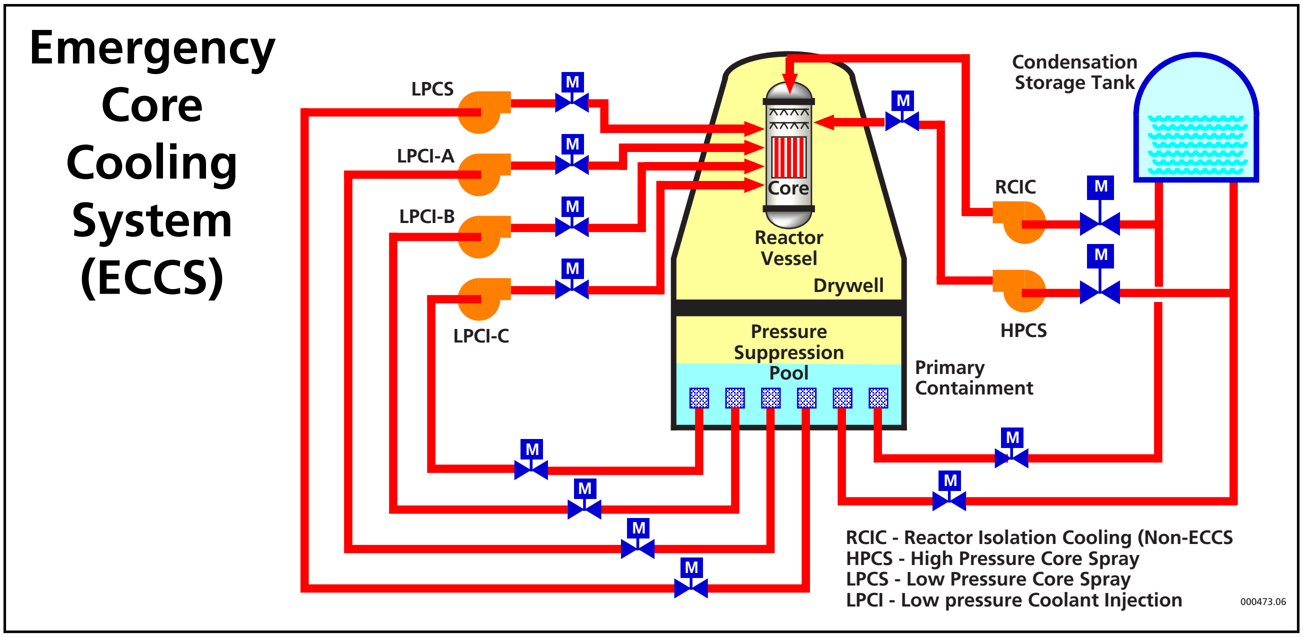
The emergency core cooling system is made up of the following subsystems:

High-pressure core spray: The purpose of this subsystem is to depressurize the boiler system and replace water lost in a loss-of-coolant accident. It also prevents fuel damage by spraying cooling water onto the fuel assemblies if the water level in the reactor drops low enough to uncover part of the fuel. The high-pressure core spray has a large enough volume to supply total emergency cooling requirements and is completely independent of other plant systems, with its own diesel generator, batteries, valves and piping.

Low-pressure core spray: This subsystem prevents fuel-cladding damage if the core is uncovered by a loss-of-coolant accident. It sprays water onto the reactor core after reactor pressure is reduced or if other systems cannot adequately cover the fuel.

Automatic depressurization system: This system reduces reactor-vessel pressure to enable the flow from the low-pressure core spray and low-pressure coolant injection system to enter the vessel and cool the fuel core. This subsystem uses seven safety relief valves to blow down high-pressure steam from the reactor vessel to the suppression pool. The suppression pool is a tank of water in the bottom of the reactor containment. It holds approximately 130,000 cubic feet of water.

Residual heat removal: This system cools suppression pool water, reduces reactor water temperature and provides decay heat removal. The low-pressure coolant injection is a subsystem of the residual heat removal system. It works in conjunction with other emergency core cooling system components to restore and maintain the desired water level in the reactor vessel after a loss-of-coolant accident. Decay heat is the energy released by atoms in the core after the chain reaction has been stopped.



Principal Structures

Reactor building
230 feet high, 135 feet wide and 151 feet long. The reactor building houses the primary containment and provides secondary containment for the reactor. It also houses spent fuel storage, refueling equipment, emergency core cooling and auxiliary equipment.

Radwaste and control building
105 feet high, 220 feet wide and 171 feet long. This building houses the liquids and solids radwaste system (the systems used to consolidate and dispose of low-level radioactive wastes generated during the plant operation), components of the off-gas system and the main control room.

Turbine building
143 feet high, 190 feet wide and 300 feet long. The turbine building houses the turbine generator.

Diesel generator building
The three standby diesel generators and associated controls are housed in this building.

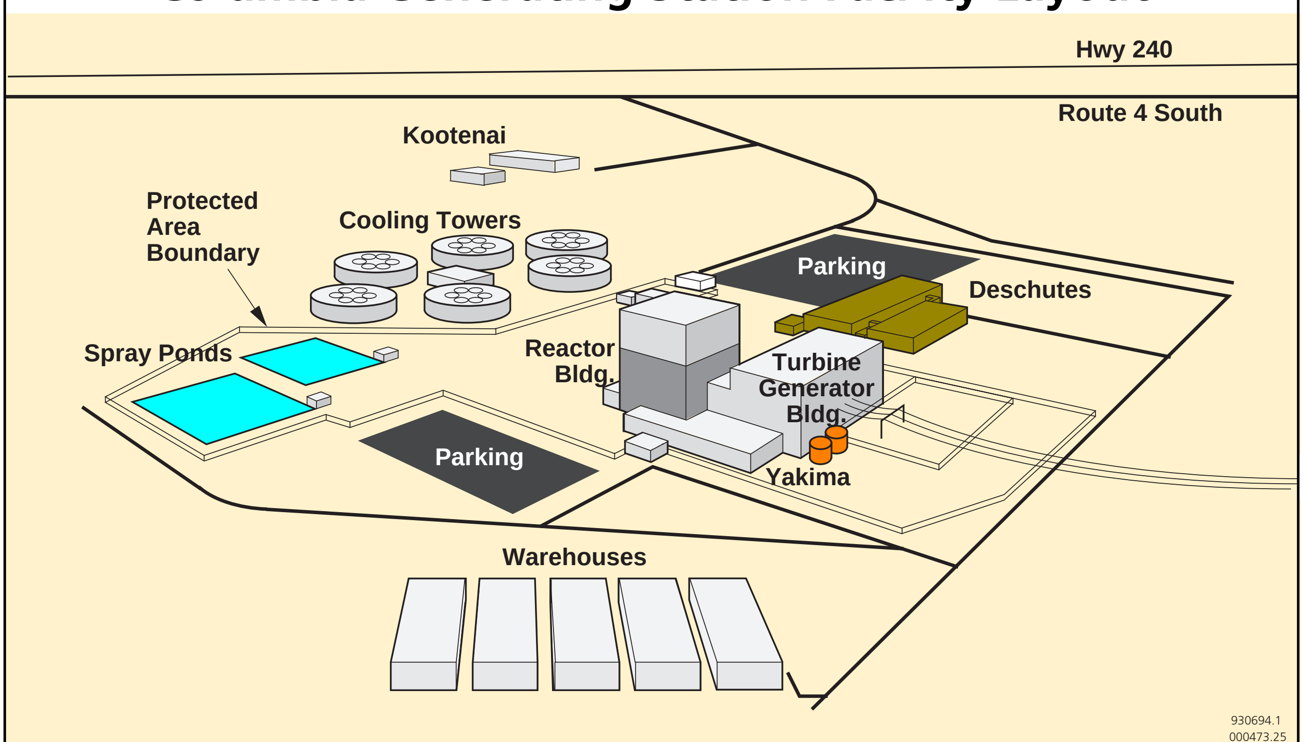
Cooling towers
Six mechanical-draft cooling towers, each 185 feet in diameter and 60 feet high. These mechanical-draft cooling towers are used to dissipate heat from the condenser cooling water to the atmosphere.

Circulating water pumphouse
This building houses the circulating water pumps, plant-service water pumps and fire-protection pumps.

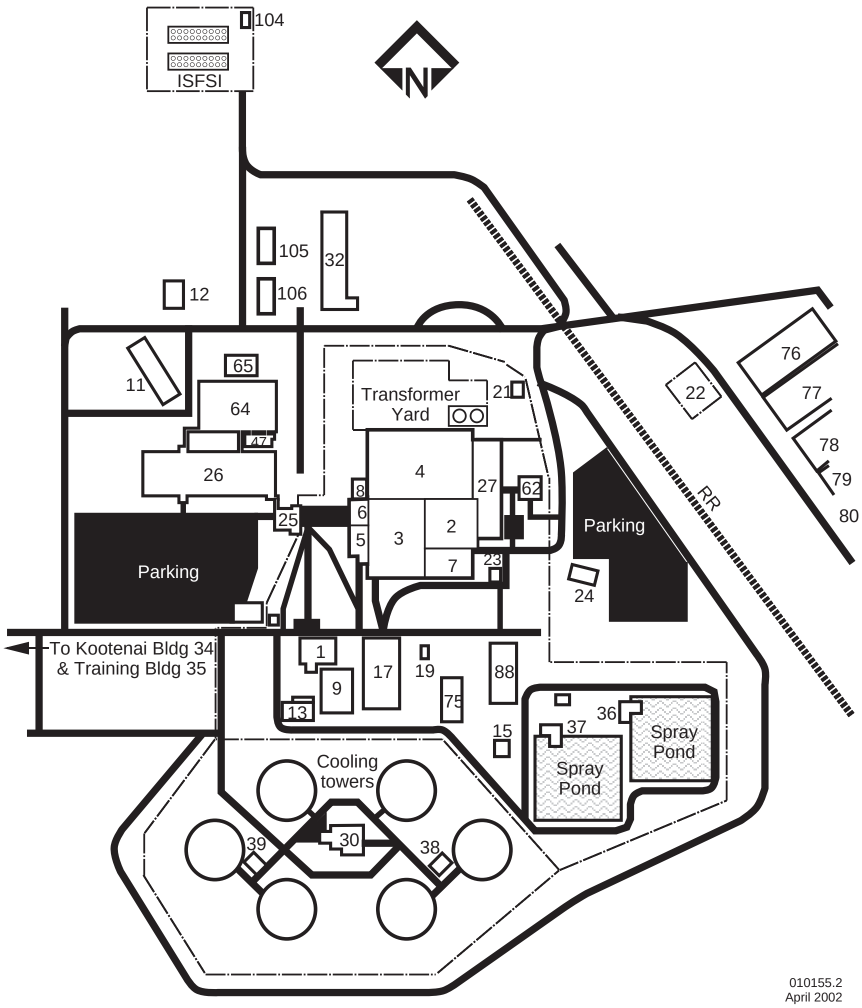
Spray ponds
During emergency shutdown, the spray ponds are the heat sink providing back-up cooling for the reactor and associated safety equipment.

Yakima building
The Yakima services building houses the make-up water treatment system, machine shop and office area.

Columbia Generating Station Facility Layout



Site Map



Bldg No.	New Name - bldg. Description/Old Name
1	Administration Building
2	Reactor Building
3	Radwaste Building
4	Turbine Generator Building
5	Technical Support Building
6	Health Physics Access Point
7	Diesel Generator Building
8	ASD Building
9	Palouse - Engineering
11	Chelan - Construction & Maint. Services
12	Heavy Equip. Maintenance
13	Cowlitz - Facilities
15	Laborers Storage
17	Wenatchee - Site Maintenance
19	Battery Storage
21	Backflow Preventer Building
22	Service Substation
23	Diesel Fuel Polishing Building
24	Visitor Center (closed)
25	Protected Area Access Point (P.A.A.P.)
26	Deschutes - Plant Engineering Center
27	Yakima - General Service Building
30	Wind River - Circ Water Pumphouse
32	Colville - Site Contractor Fab Shop
34	Kootenai building - Plant Support Facility
35	Klickitat Training Building
36	Standby Service Water Pumphouse 1A
37	Standby Service Water Pumphouse 1B
38	Electrical Building #1
39	Electrical Building #2
47	Document Storage
62	Primary Access Point (P.A.P.)
64	Willamette - Records Mgmt./C&MS/Fitness for Duty Facility/First Aid/Access Authorization
65	Craft Lunchroom
75	Warehouse /Painters
76 thru 80	Snake River Complex (Warehouse Area)
88	Okanogan - Outage/NDE/Security/NRC
100	Vacant
104	ISFSI Switchgear
105	Saluce - ISFSI Equipment Storage
106	Dry Creek - ISFSI Office Building

Reactor Facts

Location
On a 1,089-acre site within the U.S. Department of Energy's Hanford Site in southeastern Washington state. The plant is about 12 miles north of Richland and 3 miles west of the Columbia River.

Reactor type
General Electric boiling water reactor.

Turbine-generator
Westinghouse-one high-pressure turbine in tandem with three low-pressure turbines.

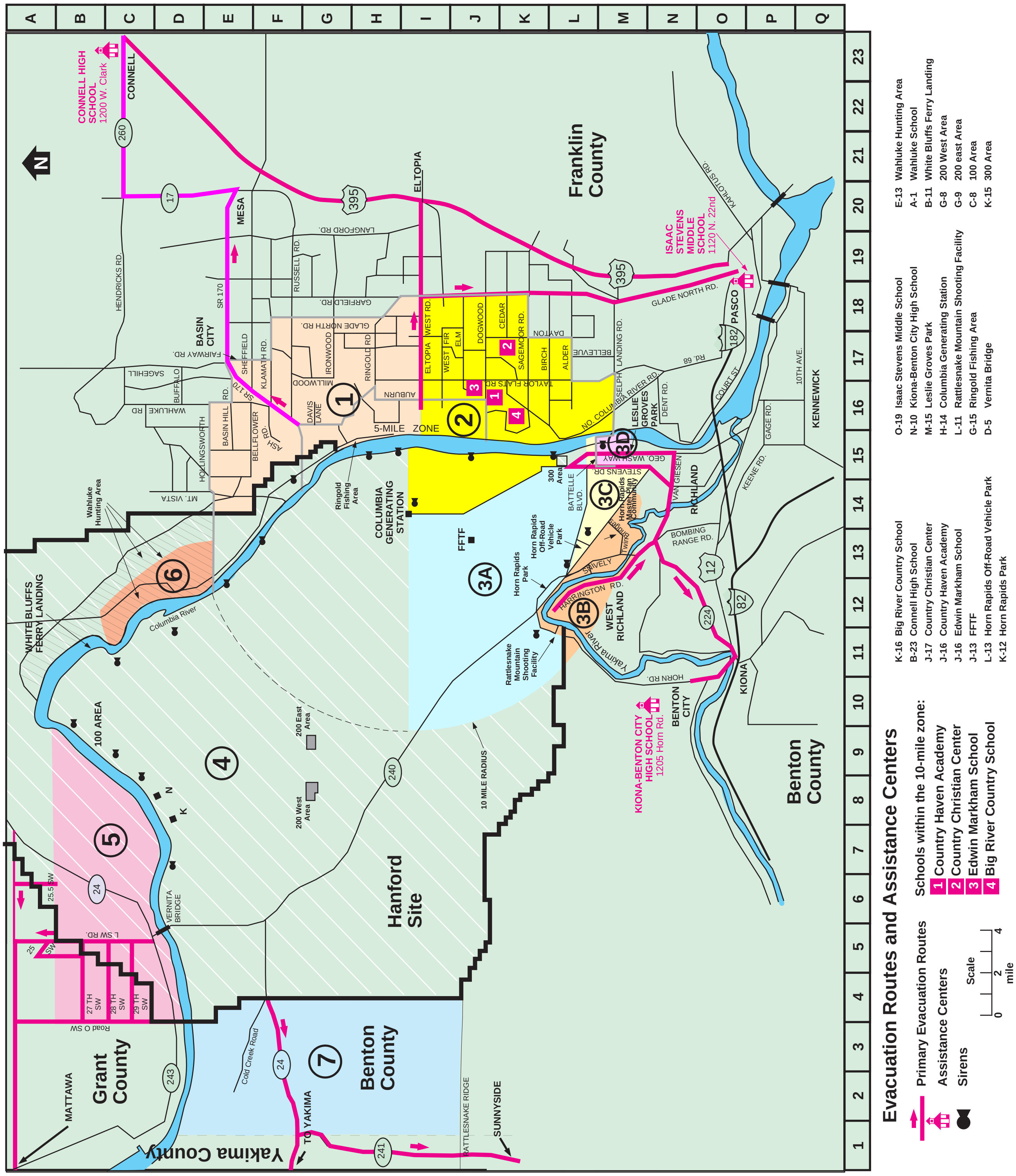
Generating capacity
1,183 megawatts electrical (net) at 1,800 revolutions per minute.

Reactor vessel
Weight: 1,140 tons
Height: 76 feet
Inside diameter: 21 feet
Wall thickness: 6 to 9 inches
Coolant inlet temperature: 420 degrees F.
Coolant outlet temperature: 547 degrees F.
Steam flow: 14.7 million pounds per hour
Steam pressure: 1005 pounds per square inch
Steam temperature: 543 degrees F.

Fuel assemblies
764 assemblies
72 fuel rods per assembly
Length: 150 inches
Rod diameter: 0.48 inches
Fuel material: Uranium dioxide, low enriched
Control rod drives: 185
Control rod length: 12 feet

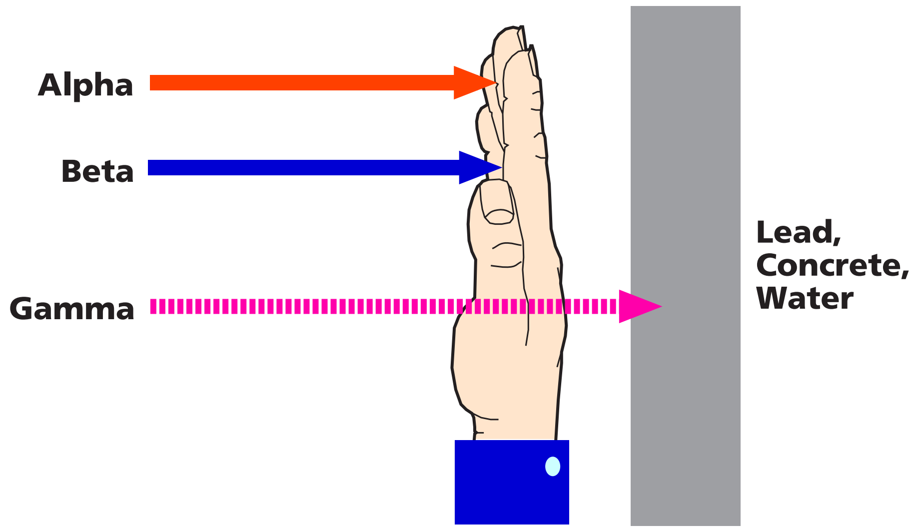
Reactor recirculation pumps
Number: Two
Capacity: 47,200 gallons per minute
Height: 21 feet
Motor: 8,900 rated horsepower
Speed: 1,780 revolutions per minute.

Hanford Site



Radiation

Penetrating power of radiation



After more than 80 years of intensive scientific study, radiation is the most understood, easily detected, precisely measured and strictly regulated of all environmental agents.

Man has been exposed to radiation from his beginning–from cosmic rays and the sun; deposits of radium and thorium in the soil; radon in the air; and radioactive potassium in food and water.

Radiation contributed by man's technology is identical in all respects to naturally occurring radiation. Most of this radiation comes from X-rays and radioactive materials used in medicine. Mining, burning fuels, and buildings also contribute to radiation doses. So does fallout from past testing of nuclear weapons, color television and smoke detectors.

Usually when the word "radiation" is used it means ionizing radiation - radiation that has so much energy that it changes the electric charge of the atoms it strikes. Ionizing radiation can take the form of either particles or waves. The waves include X-rays and gamma rays. Particle radiation is made up of alpha and beta particles and neutrons.

Gamma rays are penetrating enough to be used for industrial radiology and cancer treatment. Dense materials such as lead or concrete can stop X-rays and gamma rays most effectively.

Alpha particles are not very penetrating - a sheet of paper or the outer layers of human skin will stop them. Therefore, they do not pose any external threat. However, if alpha-emitting particles enter the body–inhaled or swallowed-they can damage nearby tissue in any area in which they lodge. Beta radiation is usually more penetrating than alpha radiation, but its range is still limited to a few feet in air.

Neutrons are released during fission or by other nuclear reactions. A few radioactive materials decay by emitting neutrons, but most of these materials decay in a few seconds. Although they play an important role in the control and operation of nuclear reactors, neutrons are not a concern in external releases of radioactive materials. They are a significant concern only inside operating nuclear reactors.

Measuring radiation exposure

Usually radiation doses are measured in millirems, or 1/1,000 of a rem. Measured in millirems, a lethal radiation dose would be 500,000 millirem (lethal to 50 percent of persons exposed).

Radiation exposure to humans is measured in rems (roentgen equivalent in man), the unit of measure for the biological effect of radiation. An acute dose of 500 rem will kill half of those exposed within a month. A dose of 100 rem may not produce outward signs of radiation injury. An exposure of 10 rem may produce minor blood changes in some people. Accidental doses due to the effects of a passing plume are expected to be in the range of 10 to 50 millirem (0.010 to 0.050 rem).

Very large amounts of radiation may result in cancer and genetic defects. Convincing medical evidence that radiation increases chances of developing cancer comes mostly from the few groups of people subjected to massive doses of radiation - pioneers in medical radiology, patients treated with X-rays and victims of Hiroshima and Nagasaki.

Many more people have been studied extensively over several decades to determine if there is a link between radiation and cancer at lower levels of exposure. There has been generally no effect at exposure below 10 rem.

Genetic problems related to radiation have been observed only in laboratory experiments with animals. No heredity problems have been discovered in man, although it is prudent to assume that similar damage could occur.

Naturally occurring sources of radiation expose an individual in the U.S. to an average of about 100 millirem each year, depending primarily on altitude and the concentration of radioactive minerals in the ground. For instance, in Florida the typical radiation dose is about 60 millirem annually, but in Colorado it is about 170 millirem per year.

Radiation from X-rays and other medical treatments using radioactive materials adds an average of about 90 millirem per year to a person's exposure.

Living or working in stone buildings, fallout, and consumer products such as color television and smoke detectors add about 10 millirem a year.

Nuclear power plants add an average of about 1/10 of 1 millirem per year. Emissions from coal- burning power plants also add about 1 millirem to an individual's average annual exposure.

Relative Health Risks

Health Risk	Average Days of Lost Life Expectancy
Smoking 20 Cigarettes a day	2400 (6.5 years)
Overweight by 20%	1000 (2. years)
All Accidents Combined	450 (1.2 years)
Auto accidents	200
Alcohol consumption	130
Home accidents	95
Drowning	40
Natural background radiation	8
Medical diagnostic X-rays	6
All catastrophes (earthquakes tornadoes, etc.)	3.5
1 rem occupational radiation dose	1
1 rem/year for 30 years	30

000473.49

Glossary of Nuclear Terms

activation: The process of making a material radioactive by bombarding it with neutrons, protons or other particles.

acute exposure: An exposure to radiation which occurs over a short period of time, usually in less than an hour.

air sampling: The collecting and analyzing of samples of air to detect the presence of radioactive substances.

alpha particle: A positively charged particle emitted by some radioactive materials. Alpha particles are identical to the nucleus of a helium atom, consisting of two protons and two neutrons bound together. They are the least penetrating of the three common types of radiation (alpha, beta, gamma) and can be stopped by a piece of paper.

americium: There are several isotopes of americium, but americium-241 is formed in a nuclear reactor. An alpha emitter, americium is a problem only if it enters the body. It is used in smoke detectors, in the glass industry and in research.

argon: Argon is an inert gas which does not react chemically with other elements. The radioactive isotope, Ar-41, is one of the inert gases formed in a reactor.

atomic number: The number of protons in the nucleus of an atom; also its positive charge.

background radiation: The level of naturally occurring radiation in the environment. Sources include air, water, soil, potassium-40 in the body and cosmic radiation from the sun.

beta particle: A particle emitted from a nucleus during radioactive decay. Most beta particles can be stopped by aluminum foil.

body burden: The amount of radioactive material present in the body of a human or animal.

boiling water reactor: A nuclear reactor in which water, used both as coolant and moderator, is allowed to boil in the reactor vessel. The resulting steam is used directly to drive a turbine.

boron: A chemical element with two naturally occurring isotopes, one of which efficiently absorbs neutrons. It is used to control nuclear reactors, being put into both control rods and emergency shutdown systems.

breeder reactor: A nuclear reactor which produces or "breeds" more fissionable material than it consumes. The reactor is built with a core of fissionable plutonium-239, surrounded by a blanket of uranium-238. As the plutonium fissions, neutrons bombard the uranium converting the uranium blanket to more plutonium-239.

burnup: A measure of reactor fuel consumption.

chain reaction: A fission chain reaction occurs when a fissionable nucleus absorbs a neutron and fissions, releasing additional neutrons. These in turn can be absorbed by other fissionable nuclei, releasing more neutrons. A chain reaction is achieved when this process becomes self-sustaining.

chronic exposure: Exposure to small doses of radiation over an extended period of time.

cladding: The outer jacket of nuclear fuel elements. It prevents corrosion of the fuel and the release of fission products into the coolant. Aluminum or its alloys, stainless steel and zirconium are common cladding materials.

cobalt-60: A radioactive isotope formed from natural cobalt-59 by neutron activation in reactors. It is used for medical and industrial applications.

containment: A gas-tight shell or other enclosure around a reactor that confines fission products and prevents their release to the environment in an accident.

contamination: A frequently misunderstood term, contamination refers to radioactive materials not in their intended containers. “Fixed” or “loose” contamination depends on the degree of effort required to unfix or remove the contamination from a surface.

control rod: A rod containing a material that readily absorbs neutrons (such as boron). It is used to control the power of a nuclear reactor. By absorbing neutrons, a control rod slows the fission chain reaction by preventing neutrons from causing further fission.

coolant: A substance, usually water, circulated through a nuclear reactor to remove or transfer heat.

core: The grouping of fuel assemblies in the central part of the reactor pressure vessel.

critical: Able to sustain a nuclear reaction at a constant level.

critical mass: The mass of fissionable material needed to support a self-sustaining chain reaction.

curie: The basic unit to describe the intensity of radioactivity in a sample of material. One curie is equal to 37 billion disintegrations per second. So in one curie, 37 billion atoms decay in one second. Several commonly used fractions of the curie include:
Millicurie: 1/1000th of a curie
Microcurie: 1/11,000,000 of a curie
Nanocurie: 1/1,000,000,000 of a curie
Picocurie: 1/11,000,000 of a microcurie

daughter: See decay product.

decay, radioactive: The spontaneous radioactive transformation of an unstable nuclide by emission of charged particles.

decay heat: The heat produced by the decay of radioactive nuclides. Decay heat is released in a reactor following shutdown.

decay product: A nuclide, either stable or radioactive, resulting from the radioactive disintegration of a radionuclide.

decontamination: The removal of radioactive contaminants from surfaces or equipment by cleaning and washing with chemicals.

design basis accident: The most serious reactor accident that can reasonably be imagined from any combination of equipment malfunction, operating errors and other causes. The term is used to analyze the safety characteristics of a reactor. Nuclear power plants are designed to protect the public from the effects of an accident.

dose: The total amount of radiation energy absorbed in a material.

dose rate: The radiation dose delivered per unit time and measured; for instance, in rems per hour.

dosimeter: A device that measures radiation dose, such as a film badge.

early warning system: A system designed to alert residents and transients within specific areas of the 10-mile Emergency Planning Zone with sirens and tone-activated radios.

electron: A stable, negatively charged elementary particle of matter. Electrons orbit the positively charged nucleus of the atom.

Emergency Decontamination Facility (EDC): A Department of Energy facility adjacent to Kadlec Hospital in Richland. The facility is used to treat persons highly contaminated in a radiological accident.

emergency director: Responsible for overall management of Energy Northwest resources during an accident and plant-recovery activities following an accident. The Emergency Director operates from the Emergency Operations Facility.

Emergency Operations Facility: A shielded area of the Plant Support Facility, which is located about three-quarters of a mile from Columbia Generating Station.

emergency planning zone, 50 mile: A zone around the plant in which planning for protective actions by the public is based on possible ingestion of contaminated water or food. Protective actions may include removing dairy cows from contaminated pastures or discontinuing use of river irrigation water.

emergency planning zone, Ten mile: A zone around the plant in which planning for protective action by the public is based on exposure to or inhaling radioactive materials from a passing plume released during an accident. Protective actions may include evacuation and sheltering.

enriched material: Material in which the percentage of a given isotope has been artificially increased. Enriched uranium contains more of the fissionable isotope uranium-235 than is found in naturally occurring uranium.

exclusion area: The area up to 1.2 miles from Columbia Generating Station.

exposure: A measure of radiation dose received by a person, usually broken down and used to refer to whole-body exposure compared with exposure to the hands only.

fissile material: Usually used as a synonym for fissionable material.

fission: The splitting of an atomic nucleus into two approximately equal parts accompanied by the release of large amounts of energy and one or more neutrons.

fission products: The nuclei formed by the fission of heavy elements.

fissionable material: Used in reactor operations to mean fuel, this term includes materials that can be fissioned by neutrons, such as uranium-235 and plutonium-239.

food chain: The pathway of any material through the environment to edible plants, animals and ultimately to man.

fuel cycle: The series of steps involved in supplying fuel for nuclear power reactors. It includes mining, fabrication of fuel elements and assemblies, their use in a reactor, reprocessing spent fuel and refabrication into new fuel elements.

fuel element: A rod or other form into which nuclear fuel is fabricated for use in a nuclear reactor.

fusion: The formation of a heavier nucleus from two lighter ones, with the release of energy.

gamma rays: The most penetrating of the three types of ionizing radiation, gamma rays are electromagnetic radiation–like light, radio waves and microwaves. Similar to X-rays, they have no mass, they are only energy. Gamma rays are best stopped or shielded against by dense materials such as concrete or lead.

half-life: The time required for half of the atoms of a particular radioactive substance to disintegrate. Half-lives vary from millionths of a second to billions of years.

Hanford Reservation: A federally-owned reservation under the control of the Department of Energy. The reservation covers 570 square miles to the north of Richland.

health physics: The science of recognizing, evaluating and controlling health hazards from ionizing radiation.

high-level waste: No longer useful materials from nuclear operations which have radioactivity concentrations of hundreds to thousands of curies per gallon or cubic foot.

inert gases: Gases which do not react with other elements. Radioactive gases formed in nuclear-fission reactors include neon, xenon, argon and krypton. If released, they are hard to filter out and collect, but if inhaled they do not interact with anything in the lungs. These gases produce an exposure hazard to someone standing in the radioactive cloud.

iodine: Only one stable isotope exists, the rest are radioactive and artificially created. The most common, iodine-131 and iodine-125, are used for medical treatment of the thyroid gland and in research. Radioactive iodine is significant due to its tendency to concentrate in the thyroid gland.

ion: An atom or molecule with a negative or positive electrical charge.

ionization: The process of adding or removing electrons from atoms or molecules, thereby creating ions. Ionization can be caused by high temperatures, electrical discharges or radiation.

ionizing radiation: Any radiation which displaces electrons from atoms or molecules, thereby producing ions. Alpha, beta and gamma radiation are examples. Ionizing radiation may damage skin and tissue.

isotope: Atoms of the same chemical element (atomic number) but with differing numbers of neutrons. Having varying numbers of neutrons can cause some isotopes to be radioactive.

low-level waste: Wastes containing types and concentrations of radioactivity that require little or no shielding to minimize personnel exposure.

moderator: Material, such as graphite or water, used to slow down high-velocity neutrons released in a fission reaction and increase their chances of being absorbed by a uranium atom and causing more fissions.

neutron: An uncharged particle found in the nucleus of every atom heavier than hydrogen. Neutrons sustain the fission chain reaction in a reactor.

nondestructive testing: Testing to detect internal and concealed defects in materials using techniques, such as X-rays and ultrasonics, that do not damage the items being tested.

nucleus: The dense, central, positively charged core of an atom. All nuclei contain protons and neutrons except the nucleus of hydrogen, which has a single proton.

plume: A cloud of radioactive materials that can be emitted from a nuclear reactor in an accident. This cloud is not visible to the eye, but can be measured, or “seen” with radiation measurement equipment.

plutonium: Plutonium-239, with a half-life of 24,360 years, is the most important isotope of this radioactive, metallic element. It is formed in reactors from natural uranium and is used as fuel in some nuclear reactors. Being an alpha emitter, it is only a health problem if inhaled or swallowed. It localizes in the bone and lungs and can remain there indefinitely.

potassium-40: A naturally occurring radioactive isotope of potassium. It is a beta and gamma emitter and has an exceedingly long half-life. The average person receives about 20 millirems a year from the potassium-40 in his/her body.

pressurized water reactor: A reactor in which heat is transferred from the core to a heat exchanger by water kept under high pressure. The primary system is pressurized to allow the water to reach high temperatures without boiling. Steam is generated in a secondary circuit.

pressure vessel: A strong-walled container housing the core of most types of power reactors.

primary coolant: Water used to cool and carry heat away from the core of a pressurized water reactor. Heat is transferred from the primary coolant to a secondary loop using a heat exchanger, producing steam to drive the turbine.

protective action guides: Radiation dose levels that are trigger points for initiating protective actions such as sheltering or evacuation.

proton: Positively charged particles that, along with neutrons, are the prime components of atomic nuclei. The atomic number of an atom is equal to the number of protons in its nucleus.

rad: Acronym for radiation absorbed dose. The basic unit of absorbed dose of ionizing radiation. (See Rem below.)

radioactivity: The spontaneous decay or disintegration of an unstable atomic nucleus, usually accompanied by the emission of ionizing radiation.

radioisotope: A radioactive isotope.

Rem: A unit of radiation dose relating to the biological effect or risk from radiation. (See rad.)

roentgen: A unit for measuring the amount of radiation energy imparted to a volume of air. The roentgen can be used only to measure X-rays or gamma rays.

scram: The sudden shutdown of a nuclear reactor, usually by rapid insertion of the control rods. Emergencies or deviations from normal reactor operation cause the reactor to automatically scram.

shielding: Material such as lead, water, or concrete that, when placed between a radiation source and people or equipment, provides protection by absorbing the radiation.

special nuclear material: By law, includes plutonium, uranium-233, and uranium containing more than the natural concentration of uranium-235. Holders of special nuclear material must be licensed and have specific plans and procedures.

spent fuel: Nuclear reactor fuel that has been irradiated to the extent that it can no longer effectively sustain a chain reaction.

strontium: Four naturally stable and 12 unstable isotopes exist. The most common unstable isotope is strontium-90, a product of nuclear fallout with a half-life of 28 years. It is a high-energy beta source and can be used as an energy source for satellites, remote weather stations and navigation buoys. Strontium is a biological hazard because it tends to concentrate in bones.

TLD: Thermoluminescent dosimeters used to measure an individual's level of radiation exposure.

transuranic elements: All elements above uranium on the periodic table-those with an atomic number greater than 92. All transuranics are produced artificially and are radioactive.

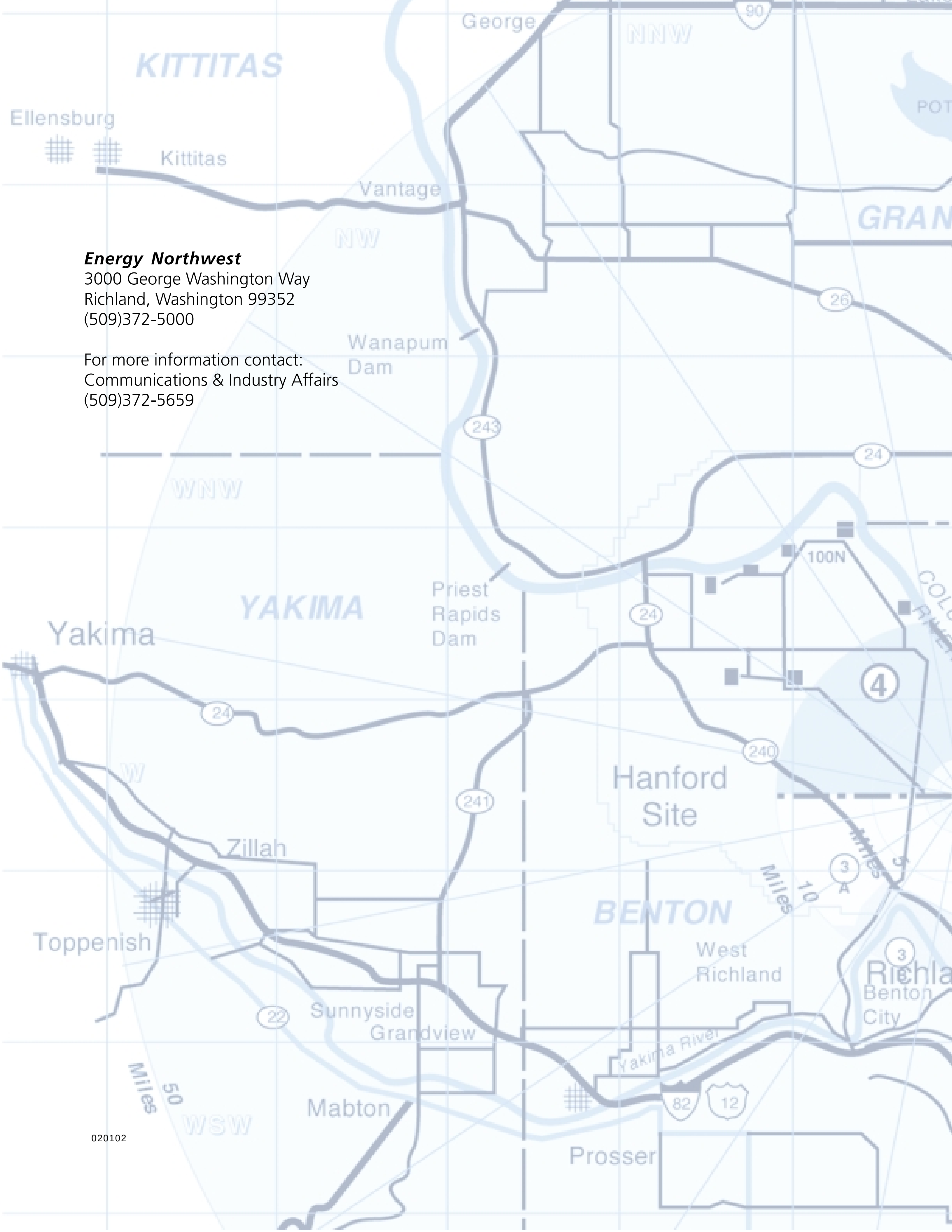
tritium: The one radioactive isotope of hydrogen. A small percentage of natural hydrogen is tritium, but the primary source of tritium is nuclear reactors. It has a half-life of 12 years, but will remain in the body only a few days if taken internally. It is not considered a major health hazard since it is a very weak beta emitter and not harmful unless consumed in very large quantities.

uranium: There are two primary isotopes: Uranium-238, which accounts for 99 percent of all uranium; and uranium-235, the fissionable isotope which sustains the fission reaction in a nuclear reactor.

whole body counter: A device used to identify and measure radioactive material in the body.

x-ray: A penetrating form of electromagnetic radiation which is used in medical and industrial application.

Index



Energy Northwest
3000 George Washington Way
Richland, Washington 99352
(509)372-5000

For more information contact:
Communications & Industry Affairs
(509)372-5659

020102