Radioactive Waste Management

This section will discuss the sources, handling, and ultimate disposal of radioactive wastes (sometimes referred to as radwaste) generated by nuclear power plant operation.

Solid, liquid, and gaseous materials from nuclear operations that are radioactive or become radioactive (contaminated) and for which there is no further use

Radioactive waste is material that is radioactive that is no longer needed at the plant and can be disposed of. The following are some examples of the sources of radioactive waste.

After a fuel assembly has been used in the reactor core to generate power, there is a large inventory of fission products held inside the cladding of the fuel. Since the processing of spent fuel is not done for commercial power plants, the fuel must be disposed of in some safe fashion.

The activation products that are carried by the reactor coolant system are collected by the filters and demineralizers in the cleanup systems. When the filters and demineralizer resins are full, they must be disposed of as radioactive waste.

A paper towel or rag used to wipe up radioactive water must be disposed of as radioactive waste.

A contaminated piece of equipment that is no longer useable must be disposed of as radioactive waste.

High Level Radioactive Waste

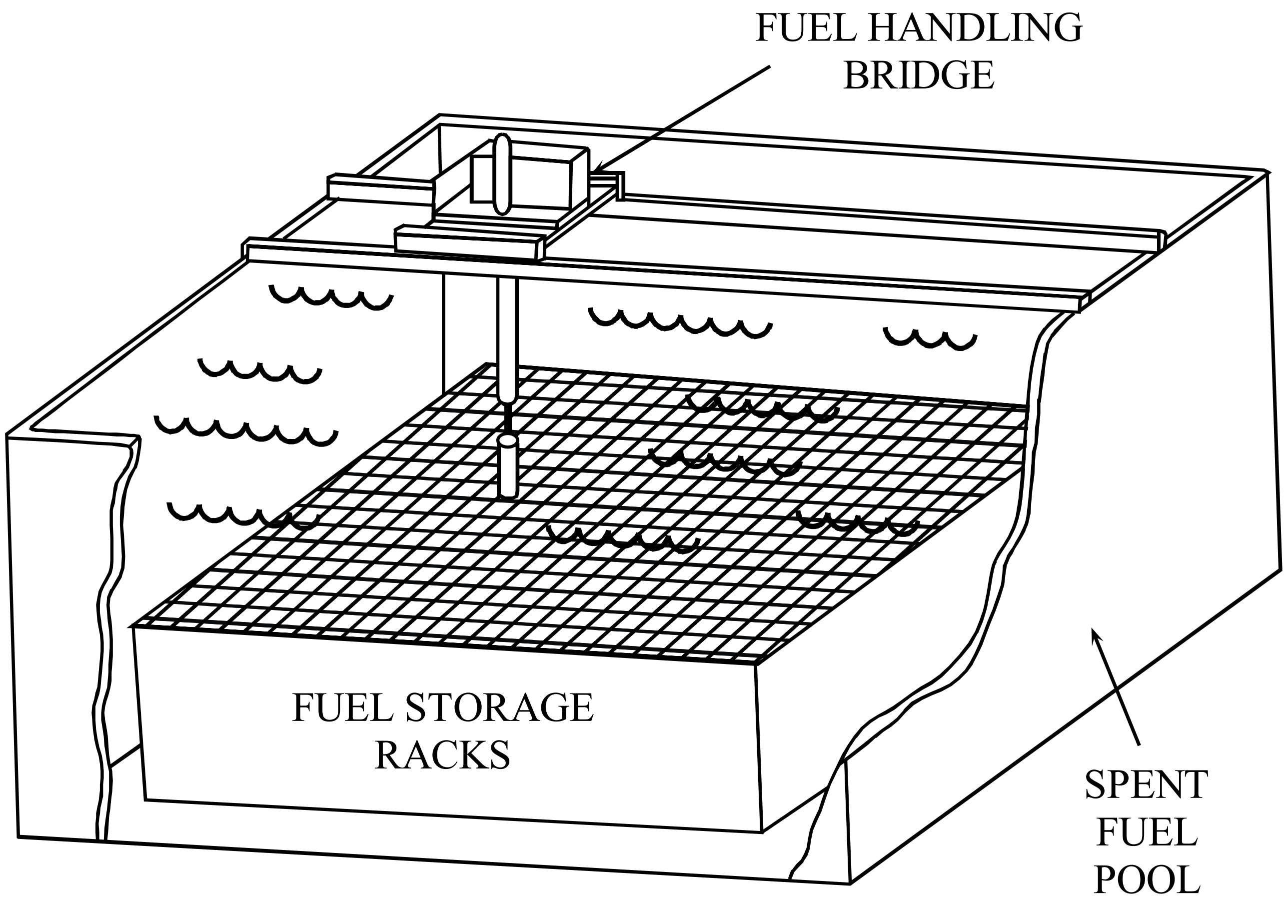
Low Level Radioactive Waste

There are two general classifications of radioactive waste. These are:

High Level Radioactive Waste
and
Low Level Radioactive Waste

Disposal of high level radioactive waste is the responsibility of the Department of Energy. The licensing of high level waste disposal facilities is the responsibility of the USNRC, as specified in 10 CFR Part 60, "*Disposal of High-Level Radioactive Waste in Geologic Repositories*."

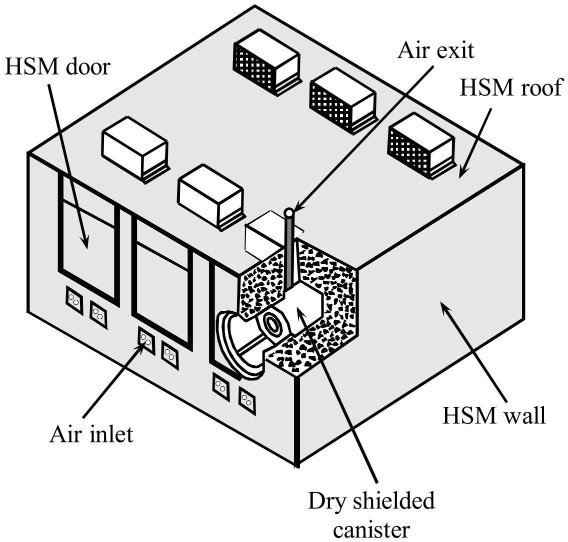
Disposal of low level radioactive waste is also subject to licensing by the USNRC. The regulations for these disposal facilities are in 10 CFR Part 61, "*Licensing Requirements for Land Disposal of Radioactive Waste*."

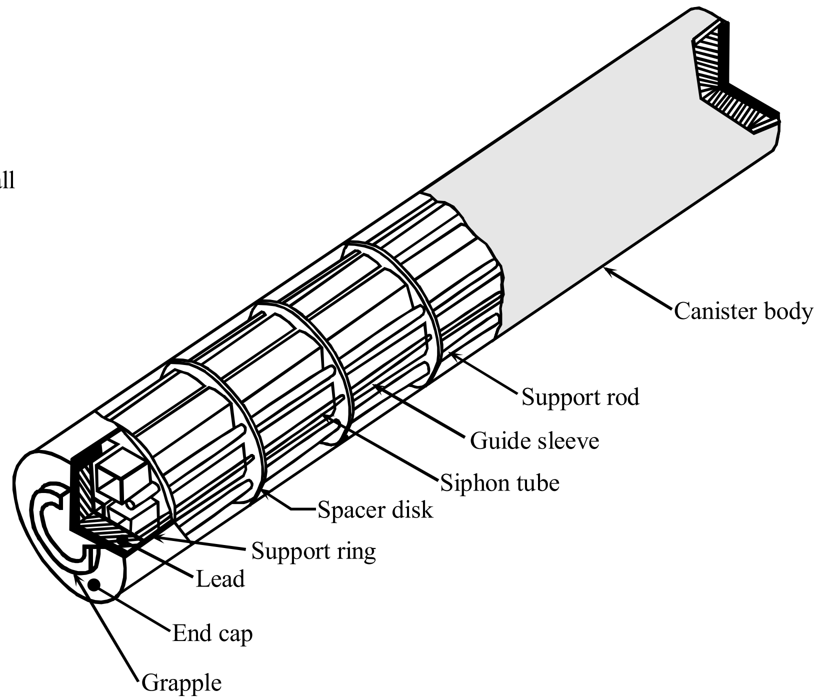


Spent fuel is classified as high level radioactive waste. This is due to the buildup of very highly radioactive fission products as the fuel is used in the reactor.

When the spent fuel is removed from the reactor to be replaced with new fuel, it must be stored for a period of time in the spent fuel pool. The spent fuel must be kept under water due to the heat being generated by the decay of the fission products and to limit the radiation levels in the area of the spent fuel pool. The spent fuel pools are usually located onsite. However, due to the amount of fuel some power plants must store, there are some offsite storage pools.

Presently, there are no disposal facilities for commercial high level radioactive waste.





After several years, the heat generated by the decay of the fission products decreases sufficiently to allow the storage of the spent fuel in an air-cooled, dry, above ground storage facility. These facilities must be designed to remove the heat from the spent fuel and be designed to limit the radiation in the areas around the facilities.

The illustration above is a horizontal storage module (HSM) with shielded canister. The fuel would be inside the canister, which would then be placed inside the HSM. This is just one of several designs of dry fuel storage, some horizontal and some vertical.

Low Level Radioactive Waste:

Liquid:

Equipment leakoff points
Equipment vents and drains
Floor drain system

Solid:

Contaminated rags, tools, clothing, etc.
Spent filter cartridges
Spent demineralizer resins

Gaseous:

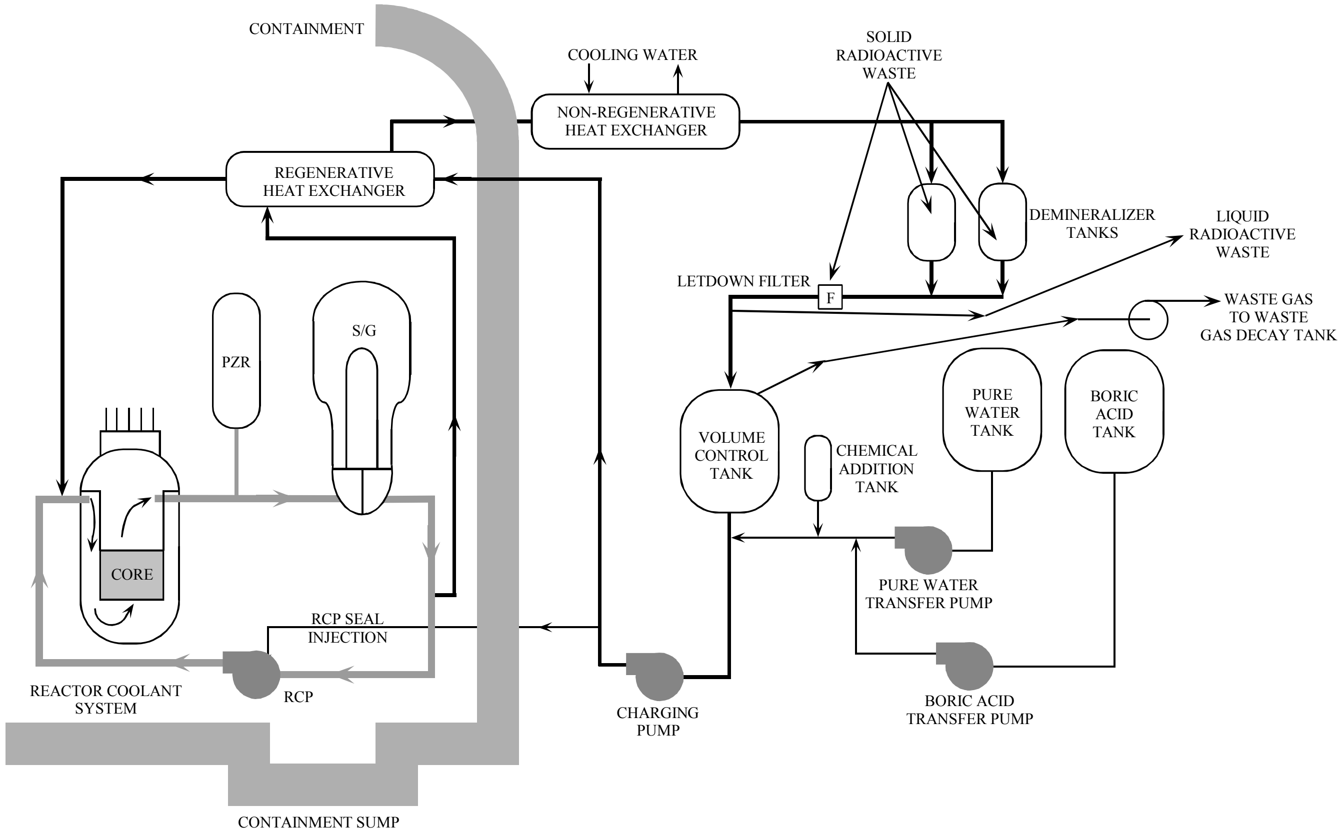
Equipment vents
Liquid waste system (evaporator gas stripper)

All radioactive waste that is not high level radioactive waste is low level radioactive waste. The principal sources of low level radwaste are the reactor coolant (water) and the components and equipment that come in contact with the coolant. The major constituents of low level radwaste are activation products (crud) and a very small percentage of fission products (if any leak out of the fuel rods).

Low level radioactive wastes can be in the form of solids, liquids, or gases. The list above gives some examples of the sources of each form of low level radwaste.

Low level radioactive waste is also classified based upon the concentration and type of radionuclides involved (10 CFR Part 61).

Class A waste is usually segregated from other waste at the disposal site. It must meet the minimum requirements. In addition to minimum requirements, Class B waste must meet more rigorous requirements on waste form to ensure stability after disposal. Class C waste must meet all of the Class B requirements and requires additional measures at the disposal facility to protect against inadvertent intrusion.



The chemical and volume control system (CVCS) on a pressurized water reactor is used to remove the activation products and fission products from the reactor coolant. It will be used to show some of the sources of solid, liquid, and gaseous radioactive wastes.

As the reactor coolant flows through the chemical and volume control system, it passes through demineralizers and filters. The demineralizer resins and filter cartridges become contaminated due to the impurities they remove from the coolant. After use, the resins and cartridges will be disposed of as solid radioactive waste. In the volume control tank, the reactor coolant is sprayed into a hydrogen gas bubble. As the water is sprayed, gases are stripped out of solution. These gases can then be vented to the waste gas system to be processed as gaseous radioactive waste. If water needs to be removed from the reactor coolant system, there is a flow path that can be lined up to divert the reactor coolant flow from the chemical and volume control system to the liquid radwaste system for processing.

The chemical and volume control system is only one example of how radioactive waste is generated by the operation of a power plant system. Wastes are also generated due to the cleanup of areas (rags, clothing, etc.), the replacement of equipment (used parts, contaminated tools, etc.), and by improper housekeeping (contaminated clothing from stepping in a puddle, etc.).

Low Level Radwaste Handling

Because of the different characteristics of solids, liquids, and gases, each must be processed differently. The waste must also be processed in such a manner as to minimize the risk of exposure to the public. The block diagram on page 10-9 shows the layout of a simple radwaste handling system. A discussion of the dose a member of the public can receive from releases from the plant can be found on page 10-11.

Liquids are processed to remove the radioactive impurities. These processes might include:

- Filtering,
- Routing through demineralizers,
- Boiling off the water (evaporation) and leaving the solid impurities (which are then processed as solid radioactive waste), and/or
- Storing the liquid for a time period to allow the radioactive material to decay.

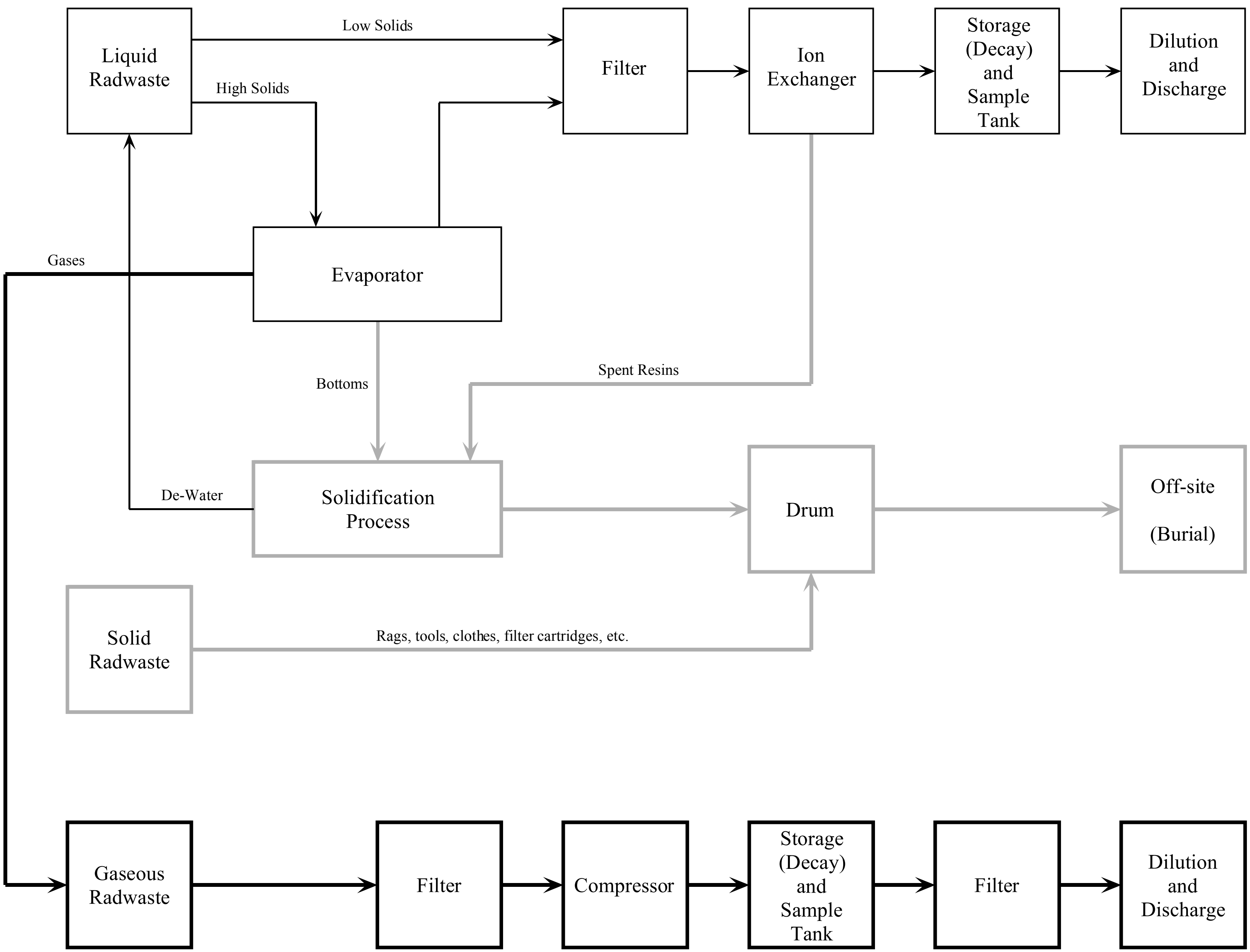
After processing, the water will be sampled. If samples show the water meets the required standards, the water can be placed in the storage tanks for use in the plant or be released to the environment. If the samples show the water does not meet the standards, it will be reprocessed.

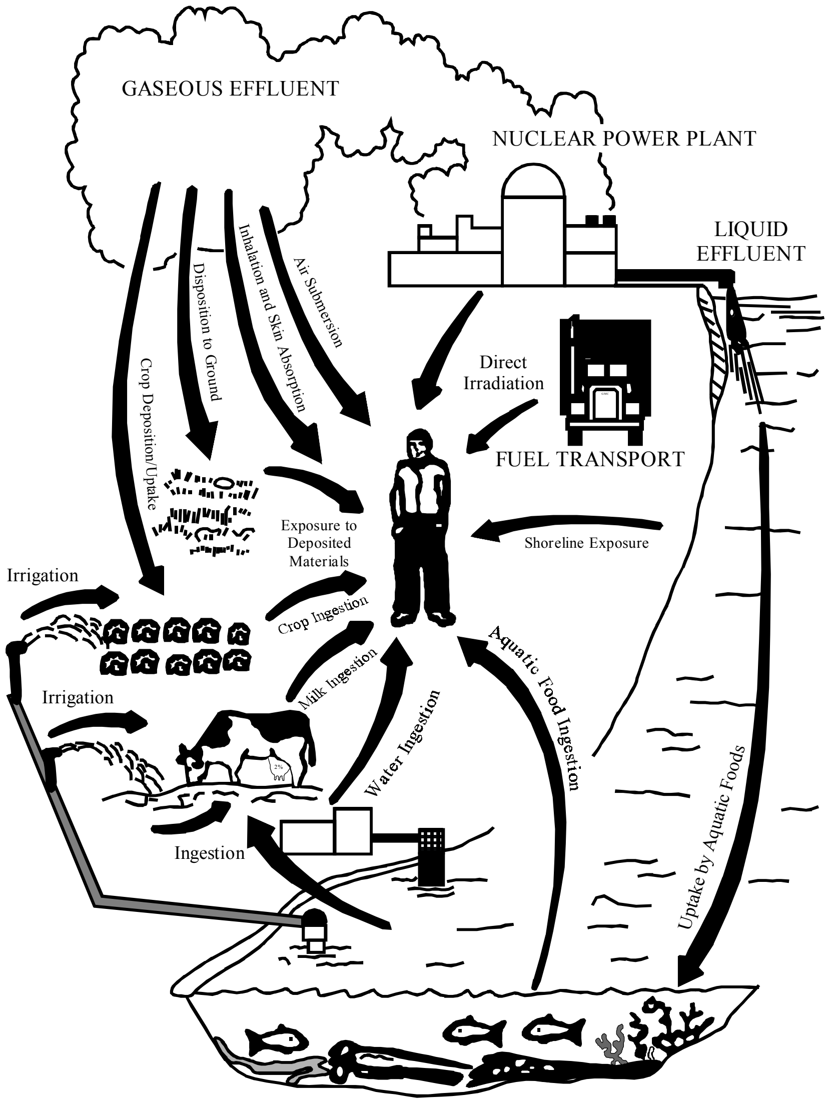
Some materials, such as the evaporator bottoms (solids that remain after the water is evaporated off), will be mixed with some material to form a solid (such as concrete). This is also sometimes done with spent demineralizer resins. After mixing with a hardener, the material is processed as solid radioactive waste.

Gaseous wastes are filtered, compressed to take up less space, and then allowed to decay for some time period. After the required time has passed, the gases will be sampled. If the required limits are met, the gases will be released to the atmosphere, or sometimes the gases will be reused in specific areas of the plant.

Solid wastes are packaged as required and shipped to a burial site for disposal (transportation of radioactive material is discussed in Chapter 11).

Radioactive Waste Handling System





Gaseous and liquid radioactive wastes, after processing, may be released to the environment. This can result in the exposure of members of the public. The diagram above shows some of the pathways that could result in the exposure of a member of the public.

Liquid releases could be taken in by the aquatic growth, which could then be consumed by an individual. The water could be used to irrigate crops, or processed as drinking water. Also, the individual could receive direct exposure from the release if in the vicinity of the water, such as swimming or sunbathing.

Gaseous releases could result in exposures by being inhaled by the individual. Also, if the individual is in the vicinity of the release, a direct exposure could be the result.

The transport of solid radwaste and fuel also contribute to the exposure of the average individual.

The amount of exposure received due to all of these processes is very small, when compared to the average yearly dose received (see Chapter 8). Also, there are limits placed on the amount of exposure a member of the public can receive from a nuclear power plant.

10 CFR Part 20 Dose Standards

2 millirems in any one hour from external sources in an unrestricted area

100 millirems in a calendar year
(sum of external and internal radiation)
in a controlled or unrestricted area

10 CFR Part 50 Design Objectives

Liquids

3 millirems/year to the whole body
10 millirems/year to any organ

Gases

5 millirems/year to the whole body
15 millirems/year to the skin

Solids and Iodine

15 millirems/year to any organ

As discussed in Chapter 9, 10 CFR Part 20 states that the licensee must control radioactive material such that no member of the public in an unrestricted area receives a dose of 2 millirems in any one hour from external sources or 100 millirems in a calendar year from external and internal sources in a controlled or unrestricted area. This control of radioactive material would also include the release of radioactive material to the environment, air, or water.

In addition to the limits of 10 CFR Part 20, the NRC has issued numerical design objectives for each reactor unit for exposure from radioactive material releases into water and air. These design objectives are published in 10 CFR Part 50 and are considerably lower than the limits published in 10 CFR Part 20.

Regional Low-Level Waste Compacts

Northwest
Alaska
Hawaii
Idaho
Montana
Oregon
Utah
Wyoming
Washington

Southwestern
Arizona
North Dakota
South Dakota
California

Rocky Mountain
Colorado
Nevada
New Mexico

Midwest
Indiana
Iowa
Minnesota
Missouri
Ohio
Wisconsin

Central
Arkansas
Kansas
Louisiana
Oklahoma
Nebraska

Central Midwest
Kentucky
Illinois

Appalachian
Delaware
Maryland
West Virginia
Pennsylvania

Atlantic
Connecticut
New Jersey
South Carolina

Southeast
Alabama
Florida
Georgia
Mississippi
Tennessee
Virginia

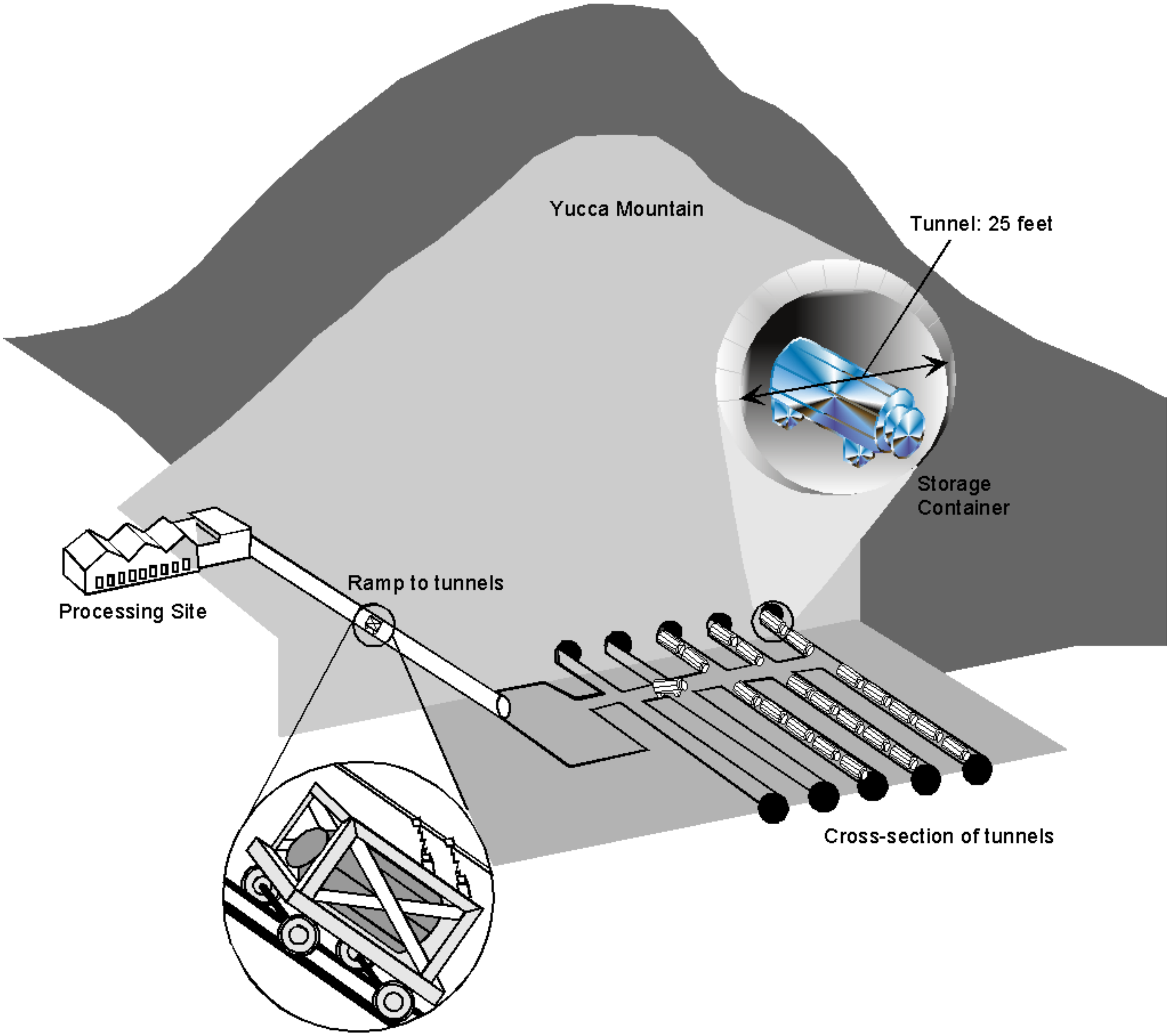
Texas
Maine
Vermont
Texas

Unaffiliated
District of Columbia
Massachusetts
Michigan
New Hampshire
New York
North Carolina
Puerto Rico
Rhode Island
U. S. Army

In addition to proper handling, the proper disposal of radioactive waste will help to minimize the dose received by members of the public. Currently, low level radioactive waste is all that is accepted for disposal at burial sites. There are three disposal sites which are presently operating. Barnwell, South Carolina can accept all low-level waste. Hanford, Washington can accept waste from the Northwest and Rocky Mountain compacts. Clive, Utah is only authorized to accept Class A, low-activity, high-volume waste.

The Nuclear Waste Policy Act of 1980 gives States the responsibilities for management and disposal of most civilian low-level radwaste. Disposal is regulated by a State entering into an agreement with the NRC (Agreement State).

The Act also divided the US into regional low level waste compacts. Each compact has a host State which will contain the low-level waste disposal site. Some compacts have more than one host State. Some disposal sites are being reviewed at this time.



Even though there is not presently a high-level waste repository accepting spent fuel for disposal, the Nuclear Waste Policy Act of 1982, as amended, directed the Department of Energy to site, design, construct, and operate a high-level waste repository.

YUCCA MOUNTAIN

AND

REGULATIONS

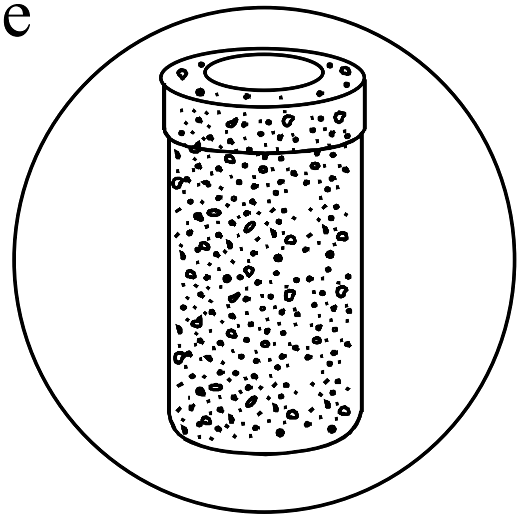
The proposed site for the high level waste geologic repository is Yucca Mountain, Nevada. The site will resemble a mining complex. On the surface will be the waste handling facilities (offices, repair shops, etc.). About 1000 feet below the surface will be the disposal site for the containerized waste.

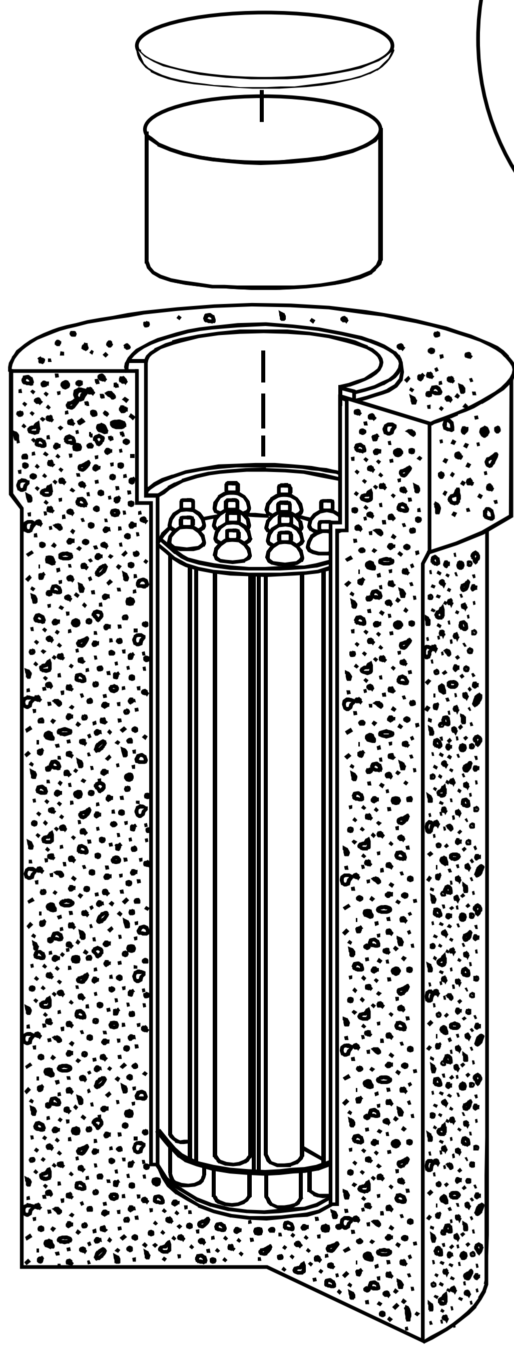
The EPA has published its final regulations for the site. They can be found in 40 CFR Part 197, "Environmental Radiation Protection Standards for Yucca Mountain, Nevada." The regulations limit the dose to the public to 15 mrem/year from the facility. The regulations also impose an additional groundwater protection dose limit of 4 mrem/year from beta and photon emitting radionuclides.

The NRC final regulation (10 CFR Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada") conforms to the EPA regulations.

Previously, it was mentioned that 10 CFR Part 60 dealt with the disposal of high level wastes. This regulation will continue to apply to all other high level facilities except for Yucca Mountain. As for 10 CFR Part 63, it will only apply to a geologic repository at Yucca Mountain.

Sealed Storage Cask





Cask Dimensions

Height:	22 ft
Diameter:	12 ft
Weight:	200 tons (empty)
	220 tons (loaded)

The container would be a large storage cask that would hold the high-level radioactive waste.