**Nuclear Waste Management**

**Radioactive Element:**

An element is radioactive when it has an unstable nucleus that spontaneously releases energy. Energy released from a radioactive elements in the form of radiation.

**Radiation Emitted from a Radioactive Element:**

Following types of radiation emit when the nucleus of any element is unstable:

- Alpha radiations
- Beta radiation
- Gamma radiations
- Neutrons

These particles and says emitted in the process of radioactivity effects other atoms, causing them to becomes unstable emitters of radioactivity themselves, with the potential to contaminate what ever they are near.

**Radioactive waste:**

The nuclear chain consist of human activities that begin with disturbing natural radioactive uranium deep in the earth, and includes every stage of mining, milling, transporting, enriching, fabricating, processing and so-called disposal. Every link in this chain results in contamination of the biosphere. As wind and water, microbes, insects, seeds, birds and other life forms move through all ecosystems, unconfined radioactivity eventually disperses through biosphere. These particles move through the air in the form of dust from both the mining of uranium and the wind moving over the tailing mountains of uranium laced earth left on the ground after 3-4 % of uranium is removed for processes. Extracting the usable uranium contaminates the equipment used, the liquid that washes it, and the vehicles that transport it, workers, and air.

**Sources of Contamination:**

Sources are as following:

1. Loss of control of radioactive materials during production or use of radioisotopes.
3. Nuclear fallout is the distribution of radioactive contamination by an explosion.
4. During the processes of milling and mining radioactive rays release and contaminate the environment.
Radioactive Waste Management:

When radioactive material is used in any industry such as thermal generation of electricity, it produces wastes whatever fuel is used, these wastes must be managed in ways which safeguard human health and minimize their impact on the environment.

Nuclear power is the only energy industry which takes full responsibility for all its wastes, and costs this into the product Nuclear power is characterized by the very large amount of energy available from a very small amount of fuel. The amount of waste is also relatively small. However much of the waste is radioactive and therefore must be carefully managed as hazardous waste.

One of the most difficult problem associated with nuclear power is the disposal of wastes produced during mining, fuel production and reactor operation.

Commonly there are following practices applied to manage this waste.

1. Ocean dumping of Radioactive Wastes.
2. Land disposal of Nuclear Waste.
3. Decommissioning of Nuclear Reactors.
4. Fusion Reaction.

Ocean Dumping of Radioactive Wastes:

It means that all the radioactive material is dumping in the oceans. This practice is done by USA, UK France and Japan until 1970. These all countries disposed of radioactive wastes in oceans. Especially the Soviet Union dumps its all wastes in Arctic Ocean. The rumors of Soviet Union dumping circulated from year, but the world know about the exact extent of what happened, after the collapse of Soviet Union in 1965, Soviet Union dumped 18 Nuclear Reactor.

- Total nuclear reactor dumped = 18
- Nuclear reactor dumped in kara.
- Sea of the eastern coast of Novaya Zemlya islands contain nuclear fuel = 7
- Millions of liters of liquid waste in Barent Sea.
- Reactor sunk in Sea of Japan = 2
  - Farmer Soviet Union dumped 2.5 million curies of radioactive waste into the ocean. It is about twice as much as the combined amount of nuclear dumping in oceans by other 12 nations.
  - In 1993 Russia dump 900 tons of waste in Sea of Japan. Japan protest on this dumping of wastes nuclear reactor because wit aging storage tanks overflowing with millions of liters of highly radioactive wastes and no funds to repair them.


**Land disposal of Nuclear Waste:**

The nuclear wastes are dumped on the land. Another serious problem posed to nuclear power is enormous piles of mine wastes and abounded mill tailings in uranium producing countries represent another serious waste disposal problem. When 1,000 tons of Uranium fuel is produce than it generates 1,00,000 tons of tailing and 3.5 million liters of waste. Approximately 200 million tons of radioactive wastes in piles are disposed on land around mines and processing plants in U.S.A. This is carried by wind and washings into the stream contaminating areas far form its source Canada has more radioactive mine waste on the surface than U.S.A.

About 1,00,000 tons level wastes such as contaminated tools, clothing, building material etc and about 15,000 tons of high level wastes of spent fuel roads and wastes from nuclear weapons.

- For last two decades, these spent fuel from reactors stored in deep water filled pools at the power plants. These are only temporary storage until and unless these were shopped to reprocessing or disposal.
- Then fuel but neither reprocessing nor permanent storage available. The nuclear waste is stored in large metal dry casks placed out side the power plant. The resident of area opposed this because they think that these reactors will leak.

Mostly the power plant built near water bodies’ extremely toxic material spread quickly over large area. Such as H$_2$ gas explosion and fire in 1997 in a day storage cask at Wisconsin’s point beach nuclear plant terrified the people.

**Waste deposit in Barren land:**

In 1987 the U.S department of Energy announced plans on a barren desert ridge near Yucca Mountain it is hoped that they will remain unexposed to groundwater and earthquakes for many years required to radioactive decay to a safe level but we can’t be sure that it always remain that way although the area is dry now.

**Monitored and Retrievable Storage of Wastes:**

This involves holding wastes in underground mines and secure surface facilities where they can be watched. If canisters begin to lack they could be removed for repacking. Safeguarding the wastes would be expensive and the sites might be susceptible to wars or terrorists attack. There should be monitoring system or committee which monitor that the waste is released into the environment.

**Decommissioning of Old Nuclear Plants:**

After useful life the power plant themselves eventually become waste. Mostly plants built for a life 30 years. After that the pipes of power plant become brittle and entrusted for use because of the corrosive material and hog radioactivity to which they are subjective. Now the plant build in
1950s and 1960s are at the end of lives. So they must be disposed of due to fear of leakage. All the radioactive pieces must also be treated just like other wastes. This includes not only the corroded pipes but also the meter thick steel reinforced concrete containment buildings. The pieces must be cut by remote control reboots becomes they are harmful to humans. This all is known as decommission of plant.

Few plants are decommissioned but it cost two to ten times as much as expenditure which is working now a days cost between 200 billion dollars to build and 1 trillion dollars to decommission. This cost too much we face with this problem if no electric power plants are working due to following to reasons.

1. Plutonium productions plants.
2. Nuclear marines.

These both must also be decommissioned. Navy solve this problem by sinking these in sea but there is a risk of corroding of material and release of radioactivity. So this is not an acceptable method.

**Changing Fortune of Nuclear Power:**

Nuclear power has its own significance. If no one hand it opens the door to weather and abundance them on other hand it produces wastes and also used for destructive purposes. Many organizations opposed it. Antinuclear groups include clamshell. Alliance, Northern sun and green peace have organized mars protest rallies featuring popular actors, musicians and celebrities who help raise funds and attract attention of their cause. Due to protest, already build Nuclear Reactors abounded or changed into fossil fuels plant. Some other places rallies in support of Nuclear power plants also occur. They raid it is foolish to close the reactors because it deals great of money.

The public opinion is fluctuated over recent year in U.S.A. with about 113 in favor and 2/3 opposed. People fear due to the careless management e.g., an internal study in 1997 at Ontario Hydro North Americas largest electric utility is documented where people are playing games sleeping and etc. the company announced to shut down seven of its 9 Nuclear reactors. This shut down eliminate about ¼ of Electric power and require increase of use of fossil fuel which will add to Canada's already high green house emissions.

In U.S.A. 40,000 MW of Nuclear Power could face retirement as utility deregulation opens up competition with cheaper alternatives. Up to 1-3 of all existing nuclear plants could be prices of the market by high operating costs. Al together about ½ of the nations with nuclear power has chosen to reduce or dismantle axis ting and few new plants has been ordered in recent years. Opponent of nuclear theory claim that nuclear fission may have very brief history, but one whose legacy will remain with us for a long time.
**Nuclear Fusion:**

Fusion energy production is apposite to nuclear fission. In nuclear fission reaction a heavy element is broken and large amounts of energy is released and in fusion reaction two lighter nuclear is joined and energy is released.

Nuclear fusion energy is released when two smaller atomic nuclear fuse into one larger nuclear – Nuclear fusion reaction the energy source for the sun end for hydrogen bombs, have not yet been harnessed by humans to produce useful net energy. The fuels for this reaction are deuterium and tritium two heavy isotopes of hydrogen.

It has been known for 40 years that if temp is an appropriate fuel mixture are raised to 100 million degree C and pressure to several billion atmospheres are obtained fusion of deuterium and tritium will occur. Under these conditions electrons are stripped away from atoms and the forces that normally some of their mars is obtained is converted into energy some of which is in the form of heat.

**Types for Function Reaction:**

There are two types of mechanism of fusion reaction.

1. Magnetic Confinement.
2. Inertial Confinement.

**Magnetic Confinement:**

It involves the containment and understaicen of plasma a hot electrically neutral gas of ions and free electrons in a powerful magnetic field inside a vacuum chamber compression of the plasma by the magnetic field should raise temperature and pressure enough for the fusion to occur. Example is Russian design called Tokomak (torodial magnetic chamber), in this vacuum is like donut shape.

**Inertial Confinement:**

It involves a small pellet bombarded from all sides at once with extremely high intensity laser light. The sudden absorption of energy causes an implosion that will increase densities by one thousand to two thousand times and raise temperatures about the critical minimum. No powerful enough lasers to create fusion conditions have been built.

In both these cases high energy neutrons escape from the reaction and are absorbed by the reactor vessel. The hi absorbs the neutrons and transfer heat to water via a heat exchanger, making
steam tat drivers a turbine generator as in any steam power plant. The advantages of fusion reaction are there.

**Advantages of Fusion Reaction:**

- More feasible, produce fewer radioactive waste.
- Eliminate fissionable products that could be made into bombs.
- Fuel supply that is much larger and less hazardous than uranium.

Despite 50 years of research and $25 billion cost, fusion reactor never able to produce as much energy as they cost. In 1997 Princeton University’s Tokamak Fusion Test Reactors was shut down 3 years earlier this set a world’s record by generating to 10.7 million watts for one second but it was said that the self staining power generation system is decades away. Proponents of fusion power urge that research be contained, maintaining that success could be just around the corner. Opponents view this technology as just another expensive wild goose chase and predict that it will ever generate enough energy to pay back the fortune spent on its development.

**Nuclear Power Plant of Pakistan and Their Waste Management:**

In Pakistan, nuclear power makes a small contribution to total energy production and requirements, supplying only 2.4% of the country electricity. Total generating capacity is 19,540 MWe and in 2005, 94 billion KWh was produced, 44% of it from gas.

Pakistan Atomic Energy Commission is responsible for all nuclear energy and research applications in the country.

There are three nuclear power plants in Pakistan

1. Kanupp.
2. Chasnupp 1.
3. Chasnupp 2.

- 1\textsuperscript{st} nuclear power reactor mall (125 MWe) (produced) contioion pressurized heavy water rector (PHWR) started in 1971, under international safeguards NANUPP (Karachi nuclear power plant) near Karachi which is operated at reduced power.
- 2\textsuperscript{nd} unit Chasma-2 started in 2005 at kundian in Punjab 300 MWe pressurized water reacter (PWD) supply by china.

Enriched fuel for PWD is imported from china. A small (15,000 SWU/y) Uranium centrifuge enrichment plant at kahuta has been operated by the PAEC since 1984. It does not have any apparent civil use, it is not under safeguards.
Enrichment plants at Chak Jhumra and Faisalabad in Punjab have 150,000 SWU/yr capacities.

Pakistan also has 10MW research reactor parr-1 of 1965 operated by Pakistan institute of Technology.

Another multipurpose reactor near Khoshab started in 1998 producing weapon grade plutonium. A similar larger heavy water reactor has been under construction at Khushab since 2002.

PAEC responsible for management of waste. A radioactive waste management fund is proposed. Waste management centers are proposed for Karachi and Chasma.

Used fuel is currently stored at each reactor in Poole longer term storage at each site is proposed for nuclear waste management, 5000 to 1000 feet deep tunnels formed in which waste buried in containers. However the question of future reprocessing remains open.