MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

GOVERNMENT POLYTECHNIC, KARAD.

Part [B]
MICROPROJECT REPORT
For Micro-Project

"Study of Nuclear Waste Management System"

Course: -
Environmental Studies(22447)

Submitted By: -

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Certificate completion

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Acknowledgement

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Yours sincerely,

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1.0 INTRODUCTION

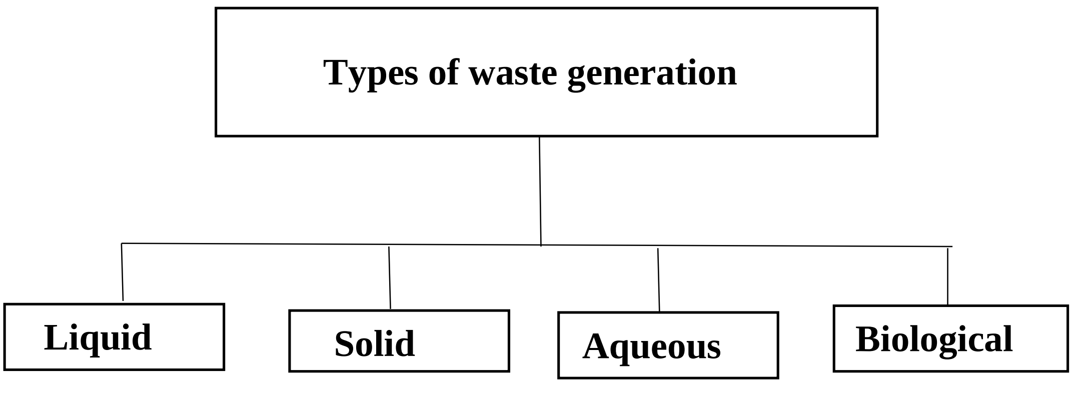
The study of nuclear waste management is crucial due to the potential long-term environmental and public health risks associated with radioactive waste. This research aims to develop safe, efficient, and sustainable methods for handling, storing, and disposing of nuclear waste produced by nuclear power plants and other sources.

Radioactive materials are extensively used in industrial and research activities into medical, agricultural and environmental applications, and in various other areas. During the production and use of these materials, radioactive waste will inevitably arise; this must be managed with particular care owing to its inherent radiological, biological, chemical and physical hazards. Producers and users of radioactive materials must be sure that a waste management strategy exists prior to the start of waste generation. A well developed waste management strategy should consider the entire sequence of waste management operations, from the waste's production until its final disposal, including the various regulatory, sociopolitical and economic issues.

2.0 RATIONALE

The overall goal of radioactive waste management is to deal with radioactive waste in a manner that protects both human health and the environment now and in the future, without imposing an undue burden on future generations. Waste management includes the handling, pre-treatment, treatment, conditioning, storage, transportation and disposal of conditioned radioactive waste, as well as the release and discharge of decontaminated materials.
The identified goal of radioactive waste management can be met with reasonable cost and resource use by implementing a carefully planned waste management strategy using appropriate technologies. For example, an important technique for the management of low level radioactive waste contaminated with short lived radionuclides is to store the waste under well controlled conditions until the radioactivity has decayed to a level such that the waste can be categorized as non-radioactive, or meets established exemption or clearance limits.

- **TYPES OF WASTE GENERATION**



2.2 Liquid waste generation

Radioactive organic liquid waste from medical, industrial and research centres forms a relatively small volume compared with other radioactive wastes. Typically, this waste includes oils, solvents, scintillation fluids and miscellaneous biological fluids.

2.2 Solid waste generation

Solid waste can be segregated into two main groups: compactible, combustible solid waste and non-compactible, non-combustible solid waste. Other possible groups may be processible (by compaction or incineration) and non-processible waste.

2.3 Aqueous waste generation

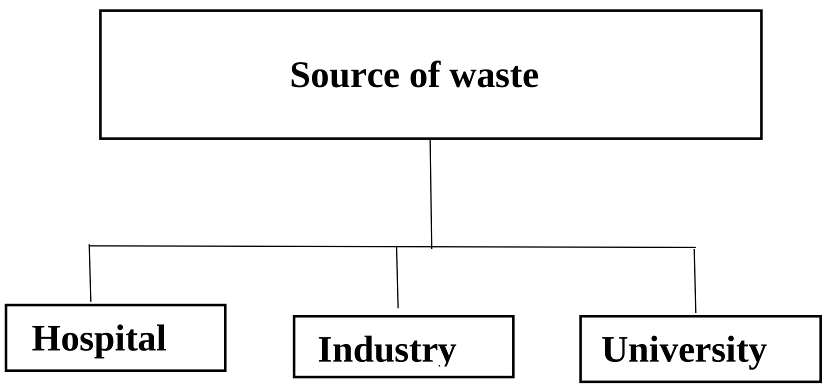
Aqueous (liquid) radioactive waste is generated during research reactor operations and in other operations involving the application of radioisotopes (e.g. medicine, research and education). The type of liquid waste produced depends upon the particular operation Most operations, particularly the larger ones, also produce a variety of radioactive liquid wastes from locations such as showers, laundries and analytical laboratories, and from decontamination services.

2.4 Biological waste generation

Biological radioactive waste arises from biological, research and teaching/training practices. This waste includes animal carcasses, contaminated body fluids and animal tissues.

The inclusion of materials having a biological origin clearly distinguishes this type of waste from inorganic materials. A primary example of biological waste is the waste from research involving animals. All discharges (e.g. faeces, urine and saliva) from animals used in research involving radioactive materials must be considered to be potentially contaminated.

- **Source of waste generation**



3.0 WASTE MANAGEMENT FACILITIES

The waste management consist of various methods such as documentation, minimization , Disposal, Transportation, Storage, Conditioning etc. following the some best ways to manage the waste effectively:

3.1. General

The central facility must have the necessary financial resources for the safe management of the waste; this should be considered during the initial stages of planning for the use of radionuclides. The government should also ensure by appropriate means that money for the safe management of radioactive waste is available for situations when an operator, for whatever reason, no longer has the financial resources properly to handle radioactive waste

The waste management facility should determine the location of equipment that may be needed in emergencies and ensure that it is readily available. Examples of such equipment are additional radiation protection monitors, shielded transport containers, decontamination equipment and remote handling devices.

3.2. Waste minimization

Minimization of radioactive waste generation is a vital requirement that must be addressed at all stages of the design and operation of facilities that use or produce radioactive materials.

To facilitate subsequent handling, treatment and storage, it is strongly recommended that waste be segregated at the place of origin. It is essential to segregate inactive waste from active waste and to isolate low specific activity waste and that containing short half-life radioisotopes from that requiring further treatment.

2.3. Pre-treatment

Segregation is one of the most important pre-treatment methods in managing waste originating countries. The collection of waste should provide for segregation according to half-life and chemical composition in order to facilitate subsequent storage for decay, or treatment, conditioning and disposal. Waste containing long lived radionuclides generally requires a more complex technological infrastructure. Waste treatment, conditioning, storage and eventual disposal may all be required, and in turn will require appropriate facilities, equipment and training of personnel.

4.0 AIM AND BENEFITS OF MICRO-PROJECT:

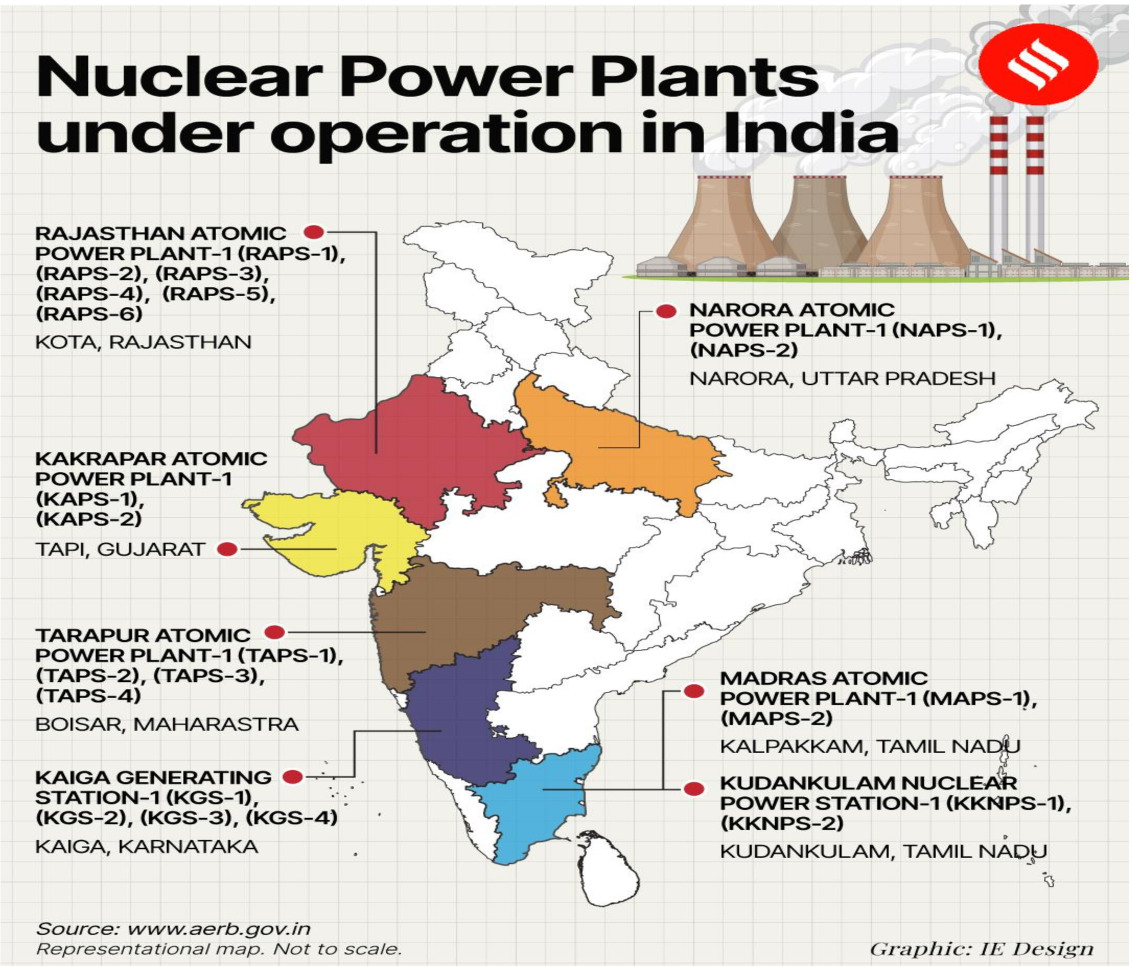
1. Analyze existing nuclear waste management techniques, policies, and regulations to identify strengths, weaknesses, and areas for improvement
2. Investigate the properties, composition, and decay rates of various types of radioactive waste to determine appropriate storage, treatment, and disposal methods.
3. Assess the economic feasibility of various waste management strategies, considering factors such as initial costs, operational expenses, and potential economic benefits.
4. Anticipate future trends in nuclear waste management, including advancements in Technology, changes in regulations, and potential shifts in energy policies.

5.0 COURSE OUTCOMES ADDRESSED:

b. Select alternative energy resources for Engineering Practice.
c. Conserve Ecosystem and Biodiversity.
d. Apply techniques to reduce Environmental Pollution
e. Manage social issues and Environmental Ethics as lifelong learning.

CHAPTER 1: Overview of Nuclear Power Plants in India

Nuclear power is the fifth-largest source of electricity in India after coal, gas, hydroelectricity and wind power. As of November 2020, India has 22 nuclear reactors in operation in 8 nuclear power plants, with a total installed capacity of 7,380 MW. Nuclear power produced a total of 43 TWh in 2020–21, contributing 3.11% of total power generation in India (1,382 TWh).10 more reactors are under construction with a combined generation capacity of 8,000 MW



Nuclear power in India has suffered from generally low capacity factors. As of 2021, the lifetime weighted energy availability factor of the Indian fleet is 66.1%. However, capacity factors have been improving in recent years. The availability factor of Indian reactors was 74.4% in the years 2019–2021.One of the main reasons for the low capacity factors is lack of nuclear fuel.

NUCLEAR POWER PLANTS

- Kudankulam Nuclear Power Plant, Tamil
- Tarapur Nuclear Reactor, Maharashtra
- Kalapakkam Nuclear Power Plant, Tamil Nadu
- Narora Nuclear Reactor, Uttar Pradesh
- Kaiga Atomic Power Station, Karnataka
- Rawatbhata, located on the Chambal River
- Madras Atomic Power Station, Kalpakkam

1.Tarapur Atomic Power Station (TAPS):

TAPS employs waste management techniques such as reprocessing and immobilization to minimize nuclear waste. Reprocessing involves extracting usable material from spent fuel, while immobilization converts waste into a more stable form.

2. Kaiga Generating Station:

Kaiga, located in Karnataka, likely follows similar waste management practices, including reprocessing and immobilization, to reduce nuclear waste.

Kaiga Atomic Power Station (KAPS) is operated by state-run Nuclear Power Corpora ..

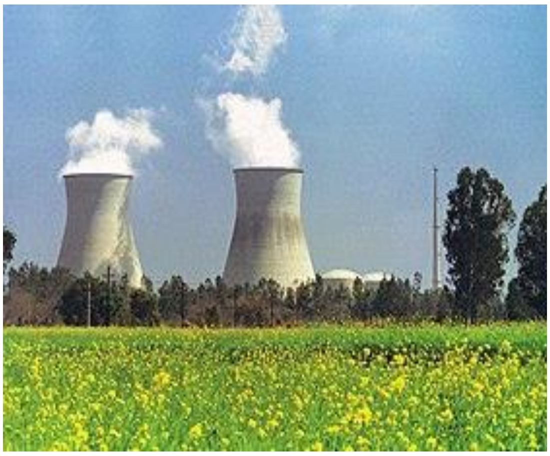
3. Rajasthan Atomic Power Station (RAPS):

RAPS utilizes reprocessing and vitrification (immobilization in glass) techniques to manage and reduce nuclear waste.

4. Kakrapar Atomic Power Station (KAPS):

KAPS, in Gujarat, may employ reprocessing and immobilization methods to reduce the volume and hazard of nuclear waste.

5. Madras Atomic Power Station (MAPS):

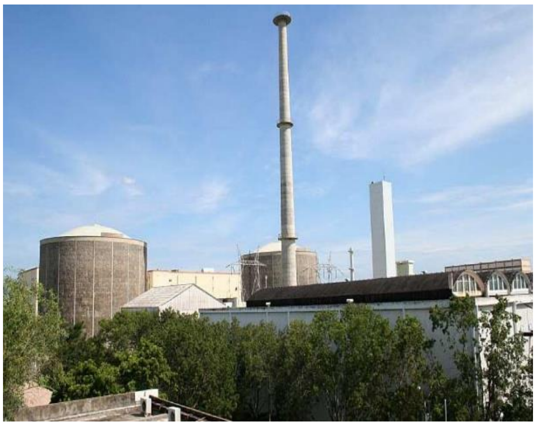


MAPS, located in Tamil Nadu, likely utilizes reprocessing and immobilization techniques to manage nuclear waste effectively.

6. Narora Atomic Power Station (NAPS):

NAPS, in Uttar Pradesh, may follow similar waste reduction practices, including reprocessing and immobilization.

7. Kudankulam Nuclear Power Plant (KKNPP):



KKNPP, in Tamil Nadu, may employ reprocessing and vitrification methods to reduce the quantity and long-term impact of nuclear waste.

CHAPTER 2 :Regulatory Frame Work

The Atomic Energy Regulatory Board was constituted on November 15, 1983, by the President of India by exercising the powers conferred by the Atomic Energy Act, 1962 to carry out certain regulatory and safety functions under the Act. The regulatory authority of AERB is derived from the rules and notifications promulgated under the Atomic Energy Act and the Environment (Protection) Act, 1986.

- **Atomic Energy Regulatory Board (AERB):**

The regulatory framework governing nuclear waste management in India is comprehensive and involves several key agencies. The primary regulatory body responsible for overseeing nuclear activities, including nuclear waste management, is the Atomic Energy Regulatory Board (AERB)

- **Department of Atomic Energy (DAE):**

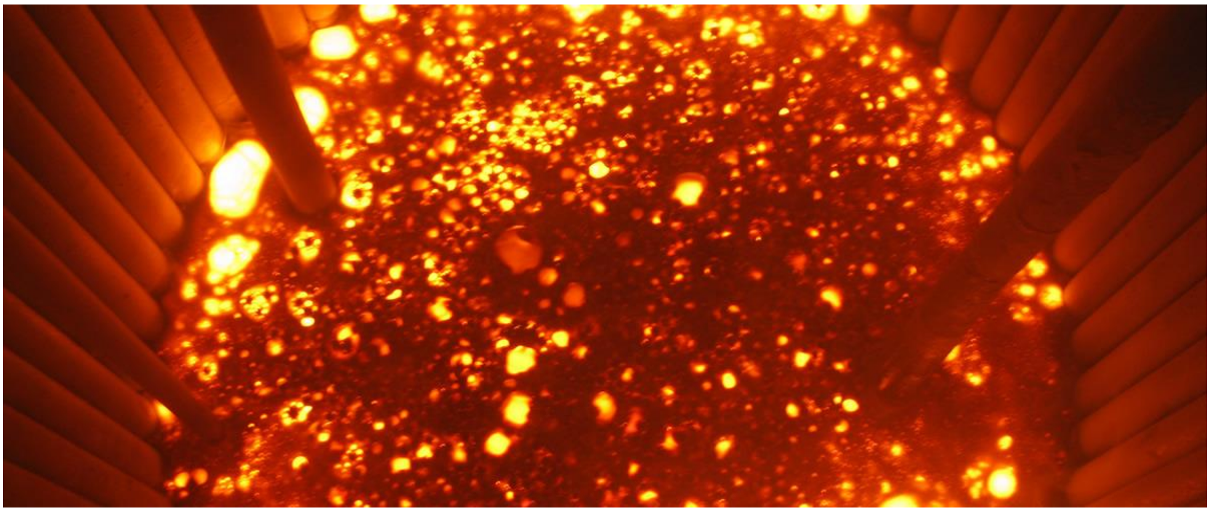
The DAE is the governmental department responsible for overseeing nuclear energy-related activities in India. It works in close coordination with the AERB to ensure the safe operation of nuclear facilities and proper management of nuclear waste. DAE establishments, including nuclear power plants, research facilities, and reprocessing plants, are subject to regulatory oversight by the AERB.

CHAPTER 3 : Effects of nuclear waste on earth

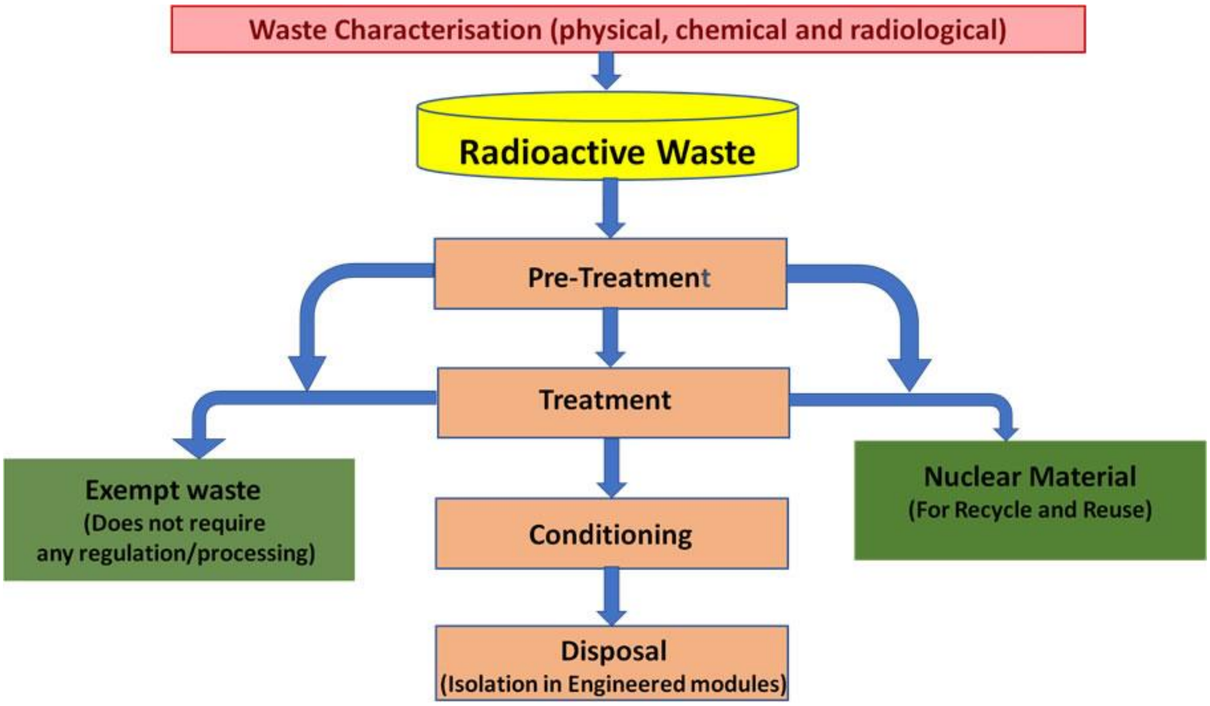
Nuclear waste can have harmful effects on humans and the environment if not properly managed and contained. The primary concerns include:

Radiation exposure: Nuclear waste emits ionizing radiation, which can damage living cells and increase the risk of cancer and other health issues if humans are exposed to it. Contamination of soil and water: Improper disposal or leakage of nuclear waste can contaminate soil and groundwater, posing risks to ecosystems and potentially affecting human drinking water sources. Long-term hazards: Some types of nuclear waste remain radioactive for thousands of years, necessitating secure storage and containment for extended periods to prevent future harm.

CHAPTER 4 : Management of nuclear waste:



Effective management involves segregation, characterization, handling, treatment, conditioning and monitoring prior to final disposal.



1. Immobilisation of high level liquid waste into inert vitrified borosilicate glasses through process called 'vitrification'.
2. Engineered interim storage of the vitrified waste for passive cooling & surveillance over a period of time, qualifying it for subsequent disposal.
3. Disposal of the vitrified waste in a deep geological repository.

7.0 ACTUAL RESOURCES USED:

Sr. No.	Name of Resource/ Material	Specifications	Quantity
1.	Computer System	**Device Name:** DESKTOP **Processor:** 11th Gen Intel® Core i5 **Type:** 64 bits operating system, x64-based processor version:21 hp	1
2.	Software	-International Atomic Energy Agency, Vienna, 2001. -Nuclear Waste Management	1
3.	Office S/W package	Microsoft Word Microsoft Power Point	1

8.0 Skill Development:

- It helps us to enhance our problem skills by providing solutions to complex problems related to data handling, processing and analysis.
- We learn how to work in a team, communicate effectively and collaborate to achieve a common goal.
- We learn how to manage tasks, timelines and resources.
- We are able to improve our java programming skills and concepts.

9.0 Applications of micro-project:

1. Helps to understand the techniques to reduce nuclear waste.