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RADIOACTIVE WASTE MANAGEMENT

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ABSTRACT

Today one of the major challenges facing by mankind is to provide proper management for radioactive waste management. Any industrial activity results in generation of some waste material. Nuclear industry is no exception and the presence of radiation emitting radioactive materials which may have adverse impact on living beings and which is likely to continue to the subsequent generation as well is what sets nuclear or radioactive wastes apart from other conventional hazardous wastes. Another unique feature of the radioactive waste is the decay of radioactivity with time. This fact is gainfully exploited by the nuclear waste managers. The NRC regulates the management, storage and disposal of radioactive waste produced as a result of NRC-licensed activities. The agency has entered in to agreements with 32 states, called Agreement States, to allow these states to regulate the management, storage and disposal of certain nuclear waste. Any industrial activity results in generation of some waste material. Nuclear industry is no exception and the presence of radiation emitting radioactive materials which may have adverse impact on living beings and which is likely to continue to the subsequent generation as well is what sets nuclear or radioactive wastes apart from other conventional hazardous wastes. Another unique feature of the radioactive waste is the decay of radioactivity with time. This fact is gainfully exploited by the nuclear waste managers. The Department of Energy (DOE) is responsible for radioactive waste related to nuclear weapons production and certain research activities. The Nuclear Regulatory Commission (NRC) and some states regulate commercial radioactive waste that results from the production of electricity and other non-military uses of nuclear material. Various other federal agencies, such as the Environmental Protection Agency, the Department of Transportation, and the Department of Health and Human Services, also have a role in the regulation of radioactive material.

KEYWORDS: High level waste, Low level waste, Verification, Radioactive waste, Radionucleids.

INTRODUCTION:

This section will discuss the sources, handling, and ultimate disposal of radioactive wastes (sometimes referred to as radwaste) generated by nuclear power plant operation. Radioactive wastes are the leftovers from the use of nuclear materials for the production of electricity, diagnosis and treatment of disease, and other purposes. The materials are either naturally occurring or man-made. Certain kinds of radioactive materials, and the wastes produced from using these materials, are subject to regulatory control by the federal government or the states. The Department of Energy (DOE) is responsible for radioactive waste related to nuclear weapons production and certain research activities. The Nuclear Regulatory Commission (NRC) and some states regulate commercial radioactive waste that results from the production of electricity and other non-military uses of nuclear material. Various other federal agencies, such as the Environmental Protection Agency, the Department of Transportation, and the Department of Health and Human Services, also have a role in the regulation of radioactive material.

What is high-level waste? After uranium fuel has been used in a reactor for a while, it is no longer as efficient in splitting its atoms and producing heat to make electricity. It is then called “spent” nuclear fuel. About one-fourth to one-third of the total fuel load is spent and is removed from the reactor every 12 to 18 months and replaced with fresh fuel. The spent nuclear fuel is high-level radioactive waste.

What is the role of NRC? The NRC regulates all commercial reactors in the United States, including nuclear power plants that produce electricity, and university research reactors. The agency regulates the possession, transportation, storage and disposal of spent fuel produced by the nuclear reactors.

How hazardous is high-level waste? Spent nuclear fuel is highly radioactive and potentially very harmful. Standing near unshielded spent fuel could be fatal due to the high radiation levels. Ten years after removal of spent fuel from a reactor, the radiation dose 1 meter away from a typical spent fuel assembly exceeds 20,000 rems per hour. A dose of 5,000 rems would be expected to cause immediate incapacitation and death within one week. High-Level Radioactive Waste Some of the radioactive elements in spent fuel have short half-lives (for example, iodine-131 has an 8-day half-life) and therefore their radioactivity decreases rapidly. However, many of the radioactive elements in spent fuel have long half-lives. For example, plutonium-239 has a half-life of 24,000 years, and plutonium-240 has a half-life of 6,800 years. Because it contains these long half-lived radioactive elements, spent fuel must be isolated and controlled for thousands of years. A second hazard of spent fuel, in addition to high radiation levels, is the extremely remote possibility of an accidental “criticality,” or self-sustained fissioning and splitting of the atoms of uranium and plutonium. NRC regulations therefore require stringent design, testing and monitoring in the handling and storage of spent fuel to ensure that the risk of this type of accident is extremely unlikely. For example, special control materials (usually boron) in spent fuel containers to prevent occurring. Nuclear engineers and physicists carefully analyze and monitor the conditions of handling and storage of spent fuel to guard further against an accident. A barrier or radiation protection shield must always be placed between spent nuclear fuel and human beings. Water, concrete, lead, steel, depleted uranium or other suitable materials calculated to be sufficiently protective by trained engineers and health physicists, and verified by radiation measurements, are typically used as radiation shielding for spent nuclear fuel.

How and where is the waste stored? Spent fuel may be stored in either a wet or dry environment. In addition, it may be stored either at the reactor where it was used or away from the reactor at another site.

OBJECTIVE:

To achieve global harmonization in policies, criteria, standards governing waste safety, public, environmental protection, together with provisions for their application which includes includes state of the art technologies and methods for demonstrating their adequacy.

Waste and Environmental Safety

Radioactive waste and spent fuel management In September, the Agency launched an international project on ‘Human Intrusion in the Context of Disposal of Radioactive Waste’ (HIDRA). This two year project seeks to provide guidance on how to address the aspects of potential human intrusion and human actions in the demonstration of safety of radioactive waste disposal facilities.

Assessment and management of environmental releases
In November, the Agency launched a four year project entitled ‘Modeling and Data for Radiological Impact Assessments’ (MODARIA) to strengthen of former uranium production sites, primarily inCentral Asia but in other regions as well. In August, the Agency and the United States Department of Energy jointly hosted scientific visits to former uranium processing facilities in Utah and Colorado, as well as an international workshop on‘ Management and Regulatory Oversight of Uranium Legacy Sites: Perspectives from Regulators and Operators’ The workshop was organized under the International Working Forum on Regulatory Supervision of Legacy Sites.

SOURCES OF RADIOACTIVE WASTE

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.

CLASSIFICATION OF RADIOACTIVE WASTE:

i. Low level redioacive waste
ii. Intermediate level radioactive waste
iii. High level radioactive waste

a) Liquid waste
b) Solid waste
c) Gaseous waste

SOLID WASTE

Waste Type	Classification
Drummed solid waste	Low level
Contaminated items	Low level
Used filters	Low level
Used charcoal	Low level
Solid waste from HIFAR Operation	Intermediate Level
Mixed waste	Intermediate Level
Residues	Intermediate Level
Metal scrap	Intermediate Level

1 Low and intermediate level radioactive waste:

Low and intermediate level wastesare further categorized as short lived and long-lived wastes. Radiological hazards associated with short lived wastes (<30 years half-life) get significantly reduced over a few hundred years by radioactive decay.

a.Liquid waste

Low and intermediate level (LIL) liquid wastes are generated in relatively large volumes with low levels of radio-activity. If a particular stream of radioactive liquid waste contains short-lived isotopes, it may be stored for adequate time period to ensure that majority of the radionuclides die down, thus, following the ‘delay and decay’ principles. Similarly, if the level of radioactivity present in the liquid waste is small, it may be pragmatic to dilute it sufficiently to render the specific activity levels well below the stipulated limits set by the regulators and discharge it to a large water body following the ‘dilute and discharge’ principles. In all other cases, the waste may call for suitable treatment in order to make the waste amenable to discharge.

b. Solid waste

Significant quantities of solid LIL wastes of diverse nature are generated in the different nuclear installations. They are essentially of two types: 'primary wastes' comprising components and equipment contaminated with radioactivity (e.g., metallic hardware), spent radiation sources, etc. and 'secondary wastes' resulting from different operational activities. Some solidwastes include protective rubber and plastic wear, miscellaneous metallic components, cellulosic and fibrous materials, spent organic ion-exchange resins, filter cartridges, etc.

Figure 1. Modules of near surface disposal facility

c.Gaseous wastes

Radioactive gases and particulates carrying adsorbed radionuclides are the two pollutants inthe gaseous waste. These must be removed before the off-gases are released to the atmospherethrough tall stacks. That is why always a comprehensive off-gas treatment and ventilation system,designed to handle normal and anticipated off-normal conditions, is installed in nuclearpower plants and other fuel cycle facilities in order to keep the air in the working area and theenvironment free from radioactive contamination. Various designs of scrubbers are deployedwherein off-gases are intimately contacted with suitable liquid media so as to retain the activityin the liquid phase.

HIGH LEVEL WASTE:
High level radioactive liquid waste (HLW) containing most (99%) of the radioactivity in theentire fuel cycle is produced during reprocessing of spent fuel. In addition, hull waste i.e., thehollow clad tubes, is generated as solid HLW after the spent fuel is dissolved for the

purposeof reprocessing. Public acceptance of nuclear energy largely depends on safe management ofradioactive waste, especially the HLW.

VITRIFICATION PROCESS:

The vitrifiedproducts are evaluated for various properties like melt temperature, waste loading, homogeneity,thermal stability, radiation stability and chemical durability using advanced analytical instruments.The solidified waste form must also meet the criterion for its interim and long term storagefollowed by its ultimate disposal in deep geological repository.India has rich experience in operation of verification plants at Trombay and Tarapur. The design of induction heated metallic melter operating at Trombay and theJoule heated ceramic melter operating at Tarapur.

India is one of the few countries to have mastered the technology of verification. Owing to thehigh radiation fields, various operations are carried out remotely in specially designed and stateof-the-art cubicles made of 1.5 meter thick concrete walls known as ‘hot cells’. These hot cellsare equipped with remote handling gadgets and systems. Some of the major remotisation gadgetsinclude custom designed robots, remote welding units, remote inspection/surveillance devicesand manipulators. Indigenous development of the remote handling equipment has been pursuedin active collaboration with the Indian industries, academic and national institutions.

DEEP GEOLOGICAL DISPOSAL:

Among the options considered for disposing of vitrified high level waste, international consensus has emerged that deep geological disposal is the most appropriate means for isolating such wastes permanently from man’s environment. The basic requirement for geological formation to be suitable for the location of the radioactive waste disposal facility is remoteness from environment, absence of circulating ground water and ability to contain radionuclides for geological periods of time. India has wide spectrum of rock types especially those offering good potential as natural barrier for isolation and confinement of vitrified waste products. Even though the need for deep geological repository in India will arise only after a few decades, nonetheless, research and development work is in progress in the field of natural barrier characterization, numerical modeling, conceptual design and natural analogues of waste forms and repository processes. A system of multiple barriers that gives greater assurance of isolation is followed for disposal of radioactive wastes. Model formulations, implementation and data are essential for safety assessment of disposal facilities under various scenarios. This is systematically assessed through predictive modeling of the gradual failure of the engineered barriers (i.e., the waste form, waste package, and backfill) and the subsequent transport to environment of radionuclides by circulating groundwater. Such safety assessments are based on a good physical understanding of the processes involved in the release and transport of radionuclides, and also those affecting the repository and the geological formation.

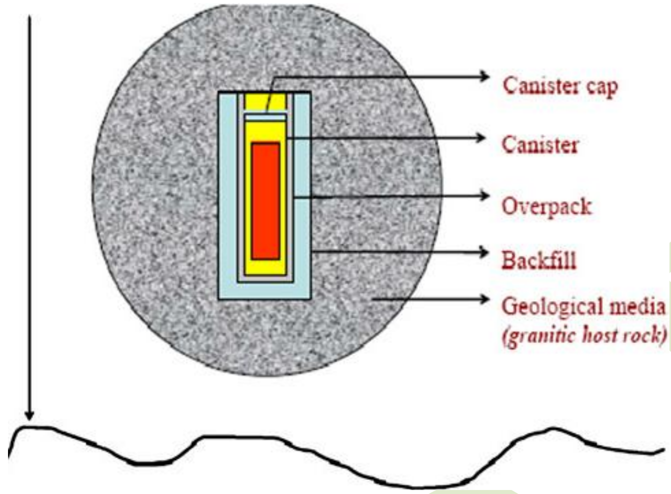

Figure 2.Schematic of the multi-barrier disposal concept.

RECYCLE AND REUSE:

The need for resource utilization along with technological advancement has led to emergingscenarios of recycle options, which may also reduce the burden on future generation. Significantreduction in the potential radioactivity of the waste can be achieved through improvedrecovery and recycling of plutonium. For sustained development of nuclear power, the environmentalimpact of the long term radio-toxicity of HLW needs to be reduced. In the partitioningand transmutationtechnology, the long lived minor actinides (Np, Am, Cm) and fission products(129I, 99Tc, etc.) are isolated from the waste and transmuted by subjecting them to neutronbombardment whereby they either become non-radioactive or convert into elements with muchshorter half-lives than the original.

CONCLUSION:

India has achieved self-reliance in the management of all types of radioactive waste arising during the operation of the nuclear fuel cycle facilities. Decades of safe and successful operation ofour waste management facilities are testimony to the Indian waste management practices beingon par with international standards. Apart from having made immense technological progress inthis field, a valuable human resource base has been created consisting of scientific and technicalman power well-versed in the design, construction, operation and maintenance aspects of thesefacilities. In line with global scenarios, technologies are constantly upgraded for minimizationof discharges to the environment.

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