Environmental Radiation Protection

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Abstract

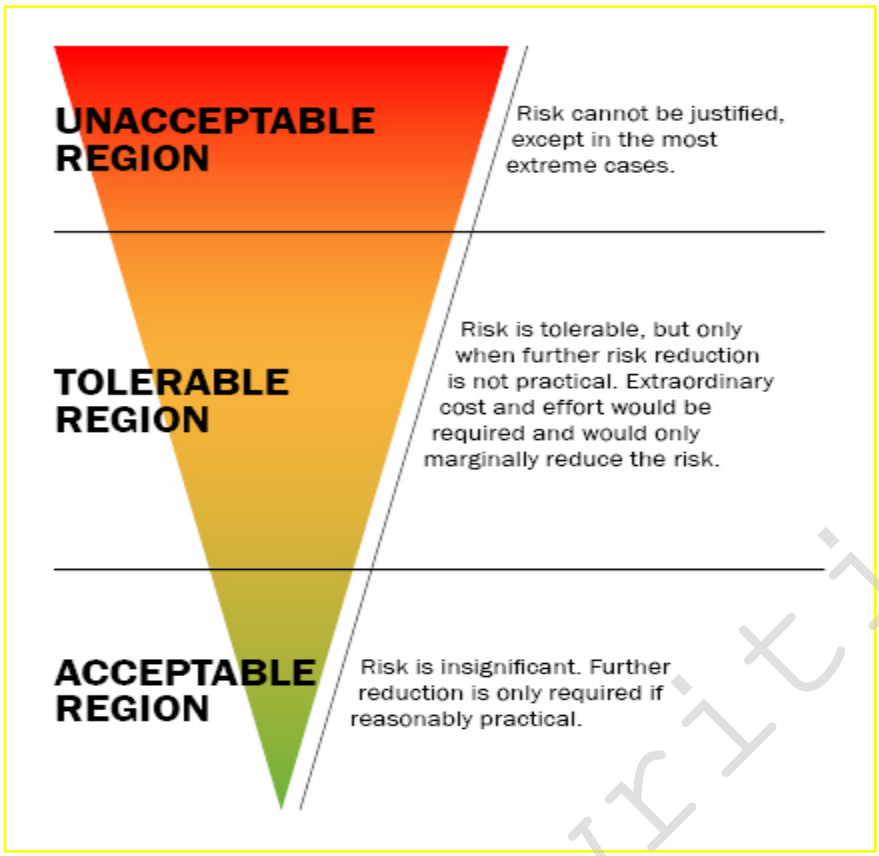
The use of radioactive materials for industrial purposes is increasing in popularity despite the known potential hazards that may result from exposure to such substances. Both sealed and unsealed radiation sources are used in industries to evaluate the integrity and safety of structures and equipment. The increasing popularity of the industrial use of radioactive materials puts the health of staff in such sectors at higher risks in case the materials are not handled correctly. Acute exposure of the environment to radiation from such sources leads to destructive environmental impacts. With the known potential risks of exposure to these sources of radiation, there arises the need for people who handle them to understand all the applicable safety standards. A proper understanding of the safety standards by people who work with radioactive materials improves their safety. This capstone project aimed at investigating the main principles and concepts of radiation protection. It also examined the importance of complying with the radiation protection standards and consequences to workers in case the policies are not adhered to. The project entailed a review of the related literature on radiation protection as well as the health effects and barriers associated with exposure to radioactive sources.

Results

Radiation Protection Standards

Employees working with radioactive materials need to be adequately protected from the potential risks of exposure to radiation. At the international level, the most recommended safety principle for people who work with radioactive materials is the "As Low As Reasonably Achievable" (ALARA) safety principle (Berkhout, 2015). This guideline employs practical and cost-effective measures to lower radiation doses that radiation workers receive during their work. ALARA entails three major principles; "time, distance and shielding." The time principle recommends that workers minimize the time of exposure to radiation (Berkhout, 2015). The distance principle recommends doubling the distance between a worker's body and the source of radiation (Berkhout, 2015). The shielding principle recommends the use of absorber materials by radiation workers with the most recommended absorber materials being Plexiglas to absorb beta particles and lead to absorb gamma and X-rays (Berkhout, 2015). ALARA also suggests that pregnant women should stay away from any exposure that exceeds 55 millirems during any month of their pregnancy.

Figure 1.0: Map of Risks in the ALARA Safety Principle



Adverse Effects of Occupational Radiation Exposure

Various regulatory agencies oversee the implementation of radiation protection standards to limit the potential biological impacts of exposure. One strategy is to ensure adherence to set annual dose limits. The annual effective dose limit is 20 mSv per year and is usually averaged over five year periods in which no year should exceed 50 mSv (Christensen, Iddins & Sugarman, 2014). For pregnant women, the dose limit should never exceed one mSv for the entire pregnancy period.

Despite the existence of these dose limits, exposures that exceed the set limits can still occur. Such exposure may occur due to the lack of knowledge on the part of some workers. Whenever one is exposed to excess radiations, they may suffer both stochastic and deterministic

effects. “The stochastic effects occur by chance, and while their probability depends on the dose, the dose does not influence their severity (Christensen et al., 2014).” Cancer is the main stochastic effect. “Deterministic effects, conversely, occur when an exposure threshold is exceeded, and their severity increases with an increase in dose (Christensen et al., 2014).” They include hair loss, skin erythema, cataracts, sterility and irreversible skin damage.

Roles of Radiation Safety Officer

According to Bradley (2018) and Koth & Smith (2016), the roles of radiation safety officer include:

1. Exposures to radiation are ALARA.
2. Investigational levels and 10 CFR part 20 are followed.
3. Development, distribution, and implementation of protection procedures.
4. Accidents are reported to proper authorities.
5. Proper security of licensed material.
6. Proper documentation of dosimetry.
7. Records from personnel monitoring devices are maintained.
8. Records and surveys of dose are reviewed quarterly.
9. New users are reviewed for their qualifications before their first use of materials.
10. Implementation of commitments in the license submittal.
11. Maintenance of up-to-date license.
12. Transportation of licensed materials comply with applicable regulations.
13. Radiation protection programs are audited at least annually.
14. Proper disposal of licensed material.

Tackling Lack of Awareness amongst Workers

Lack of awareness is a major cause of exposures to radiation amongst employees working with radioactive materials. This lack of awareness can be tackled through education to teach workers on the various safety procedures during their work. Lack of awareness can also be tackled through appropriate labeling of radioactive materials to aid the workers in their identification.

Characterization of NORM Exposure

An exposure situation refers to a process that entails either a human-made or natural source of radiation as well as the transfer of such radiations resulting in the exposure of individuals to them (Lecomte, 2015). “Exposure situations fall into three categories; planned, emergency, and existing exposure situations.” “Planned exposure situation” refers to a case where individuals get exposed to radiation from a source as a result of a planned activity. “Emergency exposure situation” occurs when people get exposed to radiation from an unexpected event like a malicious act or an accident. “Existing exposure situation” describes a situation where the exposure already exists before decisions to implement control are reached.

In the ICRP system of protection, there are three principles: optimization, justification and dose restriction are applied. In applying the principle of optimization, the exposure situation is characterized by its nature and other societal criteria (Lecomte, 2015). The practicality of reducing or preventing the exposure is then determined. To apply justification, intentional modification of a cause is justified as a deliberate new source introduction (Lecomte, 2015). Dose restriction is used in “planned exposure situations," and it entails the determination of dose levels above optimization of protection is less likely (Lecomte, 2015).

Lecomte (2015) posits that all industries dealing with NORM should adopt and implement a NORM management plan that should include the following strategies:

1. Identification of potential exposure sources.
2. Identification of potential environmental impacts.
3. Identification of exposures.
4. Selection of appropriate source restrictions.
5. Selection of the most suitable protective options.
6. Management of environmental impacts.

Conclusion

The purpose of this project was to clarify critical issues that have to do with the hazards involved in the utilization of ionizing radiation for various purposes. Specifically, the project aimed to:

i. Identify the standards that protect workers from harmful exposure to ionizing radiations as they go about their work.
ii. Evaluate the roles and responsibilities of the radiation safety officer (RSO) within an organization towards the prevention of radiation exposure.
iii. Investigate the serious health implications that ensue because of lack of awareness pertaining the accidental exposures to ionizing radiation.
iv. Evaluate ways of dealing with the issue by avoiding the unnecessary exposure to radiation to prevent the exposure instead of dealing with the consequences
v. Explore the educational needs of people that use radiation in their work and identify training opportunities to impart safety training skills and rapid emergency response

This capstone project is relevant for both academics and practice in the field of environmental radiation protection. The project investigated issues around exposure to radiation including the safety measures, effects of exposure as well as the management of naturally occurring radioactive materials. Findings from this project can help companies that use radioactive sources in their operation to minimize adverse health effects. Once these companies have increased awareness of the threats of exposure to radiation as well as the applicable safety regulations, all stakeholders will strive to create an environment that is safe from radiation. Companies can use the results to inform decisions to improve adherence to radiation safety and protection protocols. The project was, however, subject to the limitation of strict inclusion criteria that eliminated gray literature on radiation exposure. Future research should use inclusion criteria that allow gray literature to be considered.

References

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