

# Radiation Hazards in the Oil & Gas Industry in KSA: A Comprehensive Analysis and Best Practices for Control and Management

Khaled Al-Qahtani<sup>1</sup>, Abdulkarim Mukhrish<sup>2</sup>, Seraj Albahrani<sup>1</sup>, Sufyan Alrubayyi<sup>1</sup>, Khaled Al-Athel<sup>1</sup>, Afaque Shams<sup>1</sup>

<sup>1</sup>Mechanical Engineering Department, King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia.

<sup>2</sup>Chemical Engineering Department, King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia.

**Abstract** - Radiation hazards in the oil and gas industry present a significant concern in the Kingdom of Saudi Arabia due to the potential risks they pose to human health and the environment. By understanding the specific context of radiation hazards, control, and management practices in the Saudi Arabian oil and gas industry, we can investigate the various sources of radiation, including naturally occurring radioactive materials (NORM) and technologically enhanced naturally occurring radioactive materials (TENORM), and their prevalence in the industry. With an in-depth understanding of radioactive materials, the oil and gas industry in the Kingdom of Saudi Arabia, with the support of regulatory bodies, will be able to demonstrate an appropriate standard for radiation safety and radioactive material management to meet the interests of the oil and gas industry and to ensure public safety by emphasizing the need for comprehensive risk assessments and mitigation measures tailored to the local context. Overall, this paper provides insights into the unique aspects of radiation hazards, control, and management practices in the Saudi Arabian oil and gas industry, with a focus on promoting safety and sustainability.

**Keywords:** Saudi Arabia, Radiation hazards, Oil and Gas industry, NORMs, TENORMs

## I. Introduction

The oil and gas industry is important for global energy production, providing the essential resources that power the economics. However, this industry is not without its challenges and risks, some of which extend beyond the immediate scope of drilling, extraction, and transportation. One such risk that has garnered increasing attention is the potential for radiation hazards within the oil and gas sector.

Radiation hazards are one of the most significant risks that the oil and gas industry faces in its operations. These hazards arise from the presence of radioactive materials that can be either naturally occurring or generated as byproducts during various industrial processes. These materials can pose serious threats to the health and safety of workers, nearby communities, and the environment. Therefore, it

is imperative to understand the sources, pathways, and consequences of radiation exposure to effectively manage and mitigate these risks.

The oil and gas industry needs to balance meeting global energy demand and protecting people and the environment. By studying the details of radiation hazards, industry professionals, policymakers, and stakeholders can work together to make sure that oil and gas resources are used in a sustainable, safe, and responsible way. Since Saudi Arabia is one of the largest oil and gas producers in the globe, the Kingdom needs to take a measure to indicate any possible hazard related to the oil and gas industry which include the radiation hazards.

Thus, this Paper provides insights into the unique aspects of radiation hazards, control,

and management practices in the Saudi Arabian oil and gas industry, with a focus on promoting safety and sustainability.

## II. The Definition of NORMs

Naturally occurring radioactive materials (NORMs) can be defined as the materials present in geological formations that require safety precautions to limit the harm they might cause to the surrounding environment and to the workers who may be affected by the radioactive doses [1]. This classification was implemented to differentiate between materials that may cause radiological harm and the vast majority that do not [1]. The International Atomic Energy Agency (IAEA) restricts the use of the term "NORM" in regulations to only apply to materials that are defined as radioactive in a regulatory sense, not to materials that are defined as radioactive in a scientific sense [1].

In the oil and gas industry the presence of NORMs can be found in the down hole tubing, internal safety valves, wellheads, production manifold, and water outlets [2], and these contaminated parts and instruments will cause external exposure and can be internal if inhaled or ingested by handling workers. The presence of NORMs in the oil and gas industry forces the regulatory authorities around the globe to regulate the process during operation, maintenance, transport of waste and contaminated equipment and also during the decommissioning of production facilities [2].

## III. Radiation Hazards in Oil & Gas Industry

Radiation in the oil and gas industry can pose a serious threat to both workers and the environment. The industry deals with various radioactive materials during the extraction, production, and refining processes. This makes it susceptible to radiation-related accidents. The risk is primarily due to the presence of NORMs such as Uranium, Thorium, and their decay products in oil and gas reservoirs.

Those radioactive materials can be brought to the surface during drilling and extraction, which leads to their accumulation in

pipes, tanks, and other equipment. This accumulation can lead to potential radiation exposure.

Exposure to low-level radiation does not have immediate health effects but can have an increase in cancer risk over the worker's lifetime. Workers who are exposed to a very high dose over a short time period due to large accumulations may experience symptoms such as nausea and vomiting [6].

The Nuclear and Radiological Regulatory Commission (NRRC) limits the planned occupational exposure for authorized adults to an effective dose of 20 mSv/year averaged over 5 consecutive years, and a maximum of 50 mSv in a single year [4]. Those limits are considered to be safe, where no adverse health effect can be observed.

## IV. Radiation Protection in Oil & Gas Industry

In Saudi Arabia, the oil and gas industry is a major contributor to the country's economy, and radiation protection is an important aspect of ensuring the safety of workers and the public. According to the NRRC in Saudi Arabia, NORMs are concentrated as a result of various industrial activities such as oil and gas extraction. These elements accumulate on the inside walls of pipes and separation facilities or tankers as petroleum is taken from the soil. Also, it can be present in the valves as well as the gas processing apparatus. As a consequence, employees as well as members of the general population in nearby locations may be subjected to radiation [7].

To protect workers and the public from the risks associated with NORMs, companies in the oil and gas industry in Saudi Arabia must implement effective radiation protection programs that include measures such as engineering controls, administrative controls, and personal protective equipment. These programs should be based on a thorough understanding of the potential sources of radiation hazards and the risks associated with each source. In addition to regulatory requirements for radiation protection in Saudi Arabia, companies in the oil and gas industry in the country may also be subject to

international standards and guidelines, such as those issued by the IAEA. For example, the IAEA has issued a Safety Guide on Radiation Protection in the Oil and Gas Industry, which provides guidance on best practices for radiation protection in this sector [2].

By implementing effective radiation protection programs that are based on a thorough understanding of the potential sources of radiation hazards and the risks associated with each source, companies in the oil and gas industry in Saudi Arabia can ensure the safety of workers and the public, comply with regulatory requirements, and minimize the environmental impact of their operations.

### V. Human Capacity Training

The responsibility of safe and secure management of the radioactive materials present in the oil and gas industry relies on the organizations involved in the process of oil or gas production [2]. And these organizations are Regulatory Bodies, Operating Organizations, Service Companies, and Contractors [2]. These four organizations must establish and follow strict and clear regulations to ensure that employees and workers are well trained and ready to deal with radiological hazards caused by radioactive materials present in the oil and gas industry. To ensure full and strong training, programs should be built on the basis that all workers involved must have a good understanding of the oil and gas industry, radiation awareness, and industrial safety.

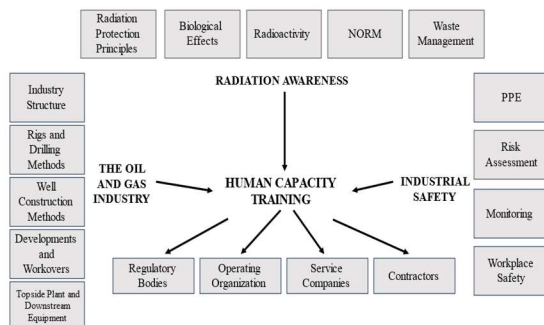


Fig. 1. Human capacity training

## VI. Radiation Management in Oil & Gas industry

Safe disposal of radioactive waste is essential to the safety of the environment and the workers. The Saudi Aramco plan for NORM waste disposal consists of three stages: temporary storage, interim storage, and permanent disposal. Each stage serves a purpose to limit exposure and contamination, while also being economical and feasible.

### VI.A. Temporary storage

The objective here is to prevent improper disposal of NORM waste by providing quick and effective solutions to operating facilities to control their NORM waste on temporary basis. The temporary storage in Saudi Aramco is a 200-liter metal or heavy-duty plastic drum [3]. This stage takes place in the site where the NORM waste is produced due to accumulation in pipes and other equipment. The waste is temporarily stored in a drum to be transported to the next stage.

### VI.B. Interim storage

The interim storage facility will receive the NORM waste generated by operating facilities, which could be accumulated over time depending on waste generation rate. The waste will be stored in large vessels that were previously used in gas/oil separation plants. These vessels provide greater integrity and containment than the individual drums used in temporary storage [3].

### VI.C. Permanent disposal

The goal of a permanent disposal is to develop a protocol that protects the environment from contamination of land and natural resources. Saudi Aramco has assessed the feasibility of several methods of NORM disposal in Saudi Arabia [3] that are used in the industry in other countries. These methods include:

- Salt cavern disposal
- Land spreading
- Landfill disposal
- Underground injection
- Offshore discharge

- Wetlands disposal

These methods were analyzed and ranked based on a criterion that took risk, cost, and public acceptance into consideration. From the above list, only landfill disposal and underground injection were considered to be feasible for further analysis. In the end, underground injection was chosen as the optimum solution. More specifically, Slurry Fracture Injection (SFI) was chosen by Saudi Aramco [3] as a permanent disposal method of NORM waste in Saudi Arabia.

NORM waste is delivered continuously to the SFI site by trucks where the waste is screened and then mixed with water to create slurry. The slurry is made with solid material concentration of 10 to 30 percent volume. The slurry is then injected deep into the ground with fracturing pressures. To ensure that the NORM waste is permanently immobilized, it is injected into thick and confined geological formations. The disposal depth can range from 350 to 2000 meters [5].

### Recommendations

Based on what have been discussed on the paper, the following measure can be used to reduce the radiation hazards in the oil and gas industry in the Kingdom of Saudi Arabia

Firstly, implementing a comprehensive radiation protection program that covers all aspects of the industry, from exploration to decommissioning. This program should include regular monitoring, training, and auditing of the radiation levels and exposure of workers and the environment.

Furthermore, adopting the best practices and standards for managing NORM waste and contaminated equipment. This includes proper identification, segregation, storage, transportation, and disposal of NORM waste. It also involves ensuring that the equipment is decontaminated or disposed of safely and securely.

Also, enhancing the collaboration and coordination among the industry stakeholders, regulators, and researchers. This can help to share

knowledge, experience, and resources on radiation hazards and their mitigation. It can also foster innovation and development of new technologies and methods for reducing radiation exposure and improving efficiency.

### Conclusion

In conclusion, radiation hazards are one of the most significant risks that the oil and gas industry faces in its operations. These hazards arise from the presence of radioactive materials that can be either naturally occurring or generated as byproducts during various industrial processes. These materials can pose serious threats to the health and safety of workers, nearby communities, and the environment. Therefore, it is crucial to understand the sources, pathways, and consequences of radiation exposure to effectively manage and mitigate these risks. This paper has provided insights into the unique aspects of radiation hazards, control, and management practices in the Saudi Arabian oil and gas industry, with a focus on promoting safety and sustainability.

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