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## **Assessment of Naturally Occurring Radioactive Materials (NORM) at oil and gas industry in Pakistan**

Oil and gas drilling and processing operations have potential to unearth the naturally occurring radionuclides and subsequently accumulate them in the processing equipment. Pakistan Nuclear Regulatory Authority (PNRA) carried out a detailed study at Eleven (11) oil and gas fields with the objective to evaluate the concentration of Naturally Occurring Radioactive Material (NORM). Initial screening of each field was performed through survey meter and dose rates at surface and 1m from all major equipment notably wellheads, separators, production manifolds, well tubing, storage tanks etc. were recorded. Majority of the measurements were in the range of natural background level (0.07  $\mu\text{Sv/hr}$  –0.10  $\mu\text{Sv/hr}$ ). However, at one facility, dose rate value of 15  $\mu\text{Sv/hr}$  was recorded. The estimated annual effective dose to the occupational workers based upon their occupancy at the identified radiation areas was 2.0 mSv [1].

In order to complement the initial measurements, samples of scale, sludge, produced water and contaminated soil were collected from the areas in which dose rate higher than natural background was recorded. Gamma spectrometric analysis of samples, using HPGe detector, was performed and isotopes of Radium (226Ra and 228Ra) and Potassium (40K) were identified. In most of the samples (scale, sludge and produced water), activity concentration of Radium isotopes was below the exemption level as addressed in national regulations [2]. However, maximum activity concentration values of 226Ra (11606  $\pm$  244 Bq/Kg) and 228Ra (8857  $\pm$  187 Bq/kg) were observed in one sludge sample. Similarly, in one scale sample of the same facility, the activity concentration of 226Ra (4127  $\pm$  94 Bq/Kg) and 228Ra (3237  $\pm$  77 Bq/Kg) was measured. Consequent to this, the occupational workers were recommended to reduce their occupancy at radiation areas to avoid unnecessary radiation exposure. Moreover, use of protective equipment during cleaning/maintenance of contaminated equipment were also recommended.

#### References

[1] Canoba, A., Gnoni, G., & Truppa. W. (2008). NORM measurements in the oil and gas industry in Argentina. International Atomic Energy Agency (IAEA).

[2] Regulations on Radioactive Waste Management - PAK/915 (Rev-1). Pakistan Nuclear Regulatory Authority (PNRA).

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