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Assessment of Naturally Occurring Radioactive Materials (NORM) at Oil and Gas Industry in Pakistan

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BACKGROUND

- Naturally occurring radionuclides are indispensable constituents of the environment and appear at different levels in earth crust.
- Some human activities such as mining and processing of ores, production of phosphate fertilizer, oil and gas productions, etc. have potential to unveil the deeply buried radionuclides and to concentrate them in the resultant residue/waste during various industrial processes.
- Pakistan has established the criteria for the management of NORM residues/waste, based on activity concentration, in its "Regulations on Radioactive Waste Management- (PAK/915) (Rev. 01)".
- PNRA conducted a study at oil and gas production fields with the objective to monitor and assess the activity concentration of radionuclides of natural origin in residues/waste material and to estimate the annual effective dose received by the workers.

RADIATION SURVEY AND SAMPLE COLLECTION

- Radiation survey was conducted by PNRA at eleven (11) oil and gas fields in Pakistan during which the dose rates at the surfaces of all major equipment *viz* wellhead, separators, tubings, storage tanks was measured. The maximum values of dose rate, measured at various equipment, are presented in Fig. 01. Highest value of dose rate was recorded at Separator, installed in Facility 'F'.

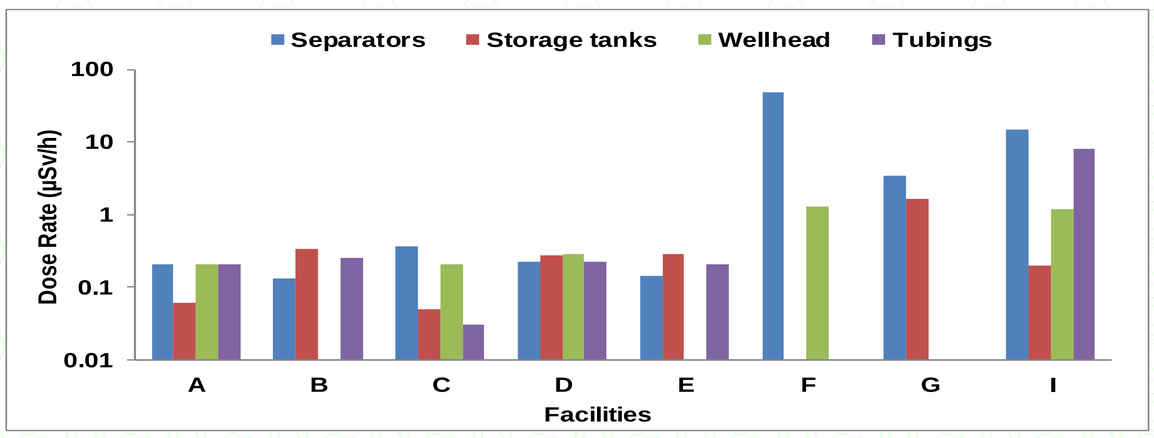

Fig. 01. Measured Dose Rate (µSv/h) at the Surfaces of Wellhead, Separators, Tubings, Storage tanks

Fig.02. Radiation Survey and Sample Collection Activities at Oil and Gas Fields

- More than 100 samples of scale, sludge, etc. were collected with focus on separators, produced water pits, storage tanks and tubings.

PROCESSING AND RADIOMETRIC ANALYSIS OF SAMPLES

- Aliquot of each sample was sealed for one month to attain secular equilibrium between ^{226}Ra, ^{228}Ra and their decay products.

- PNRA used Gamma Spectrometric System having energy resolution and relative efficiency of 1.80keV and 40% at 1.33MeV respectively for analysis. Gamma spectrum of one of the sludge samples is presented in Fig. 03.

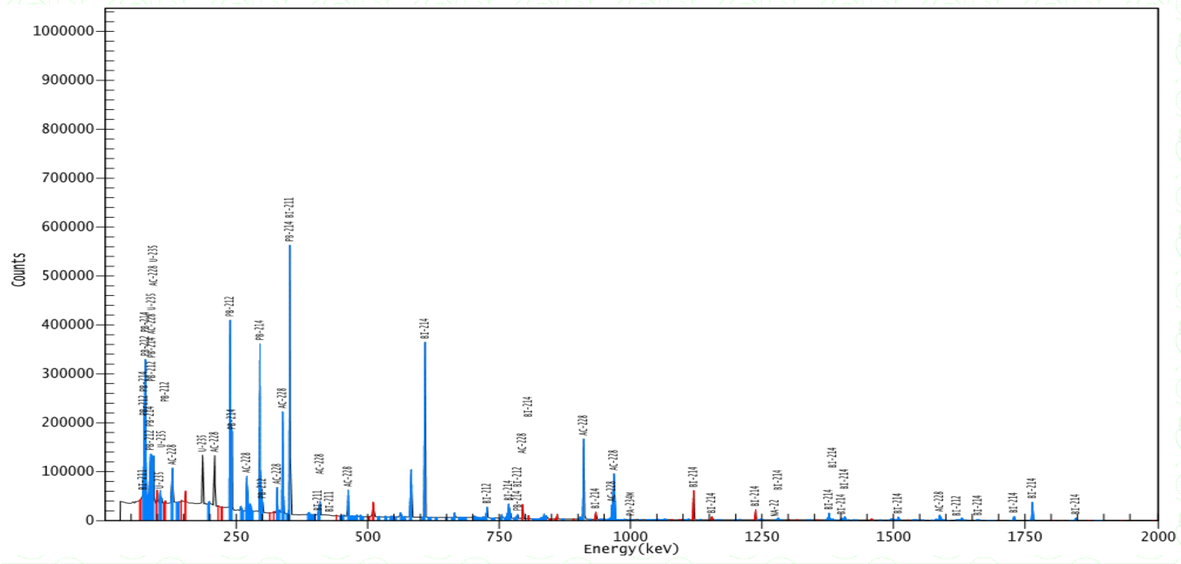

Fig. 03. Gamma Spectrum of Sludge Sample

- Activity concentration of ^{226}Ra and ^{228}Ra in Sludge/Scale samples, collected from Facilities 'F' & 'G', was observed higher than exemption level of 1000 Bq/kg.
- Graphical representation of average activity concentration of ^{226}Ra and ^{228}Ra in Sludge/Scale samples of various facilities, is presented in Fig. 04.

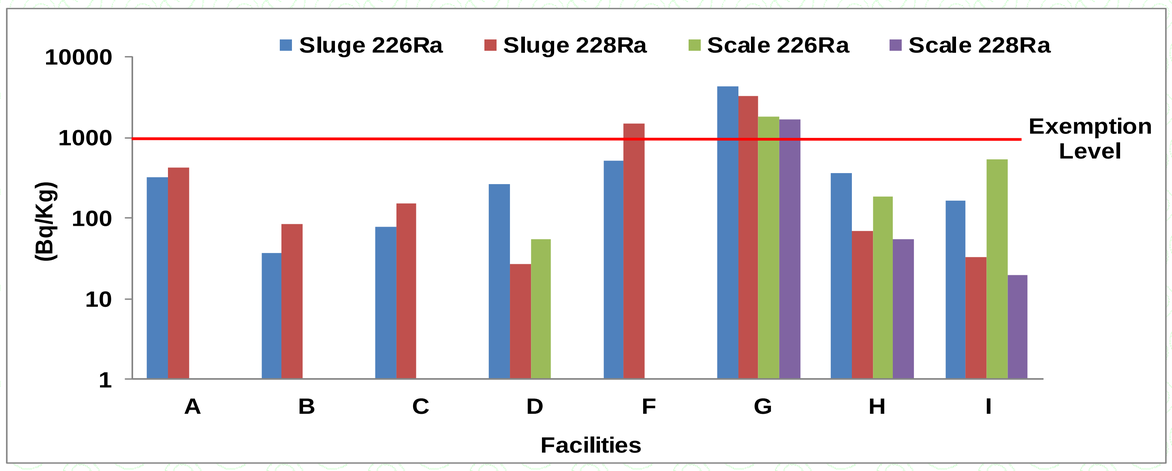

Fig. 04. Graphical Representation of Average Activity Concentration (Bq/Kg) of ^{226}Ra and ^{228}Ra in Sludge and Scale Samples

ESTIMATION OF ANNUAL EFFECTIVE DOSES (AED)

- The maximum annual effective dose of 2 mSv was estimated for workers of one facility which is higher than annual dose criteria of 1mSv defined in IAEA safety guide on "Management of Residues Contaning Naturally Ocurring Radioactive material from Uranium Production and Other Activities (IAEA-SSG-60)"
- Annual effective dose received by the workers was estimated by using the following formula:

$$\mathbf{AED = DR \times ET \times 1/1000}$$

Where;

AED= Annual Effective Dose (mSv/y)
DR= Dose Rate (µSv/h)
ET= Exposure Time (h)

CONCLUSIONS AND RECOMMENDATIONS

- The activity concentration of ^{226}Ra and ^{228}Ra in sludge/scale samples, collected from two (02) facilities, was observed higher then exemption/clearance level specified in PAK/915 (Rev. 01).
- Radiation survey results/dose rate values were used to estimate the Annual Effective Dose (AED) received by workers.
- Based on the maximum value of AED, measures to reduce annual exposure of workers by reducing their occupancies at the area of high dose rate along with the use of Personnel Protective Equipment (PPE) during cleaning/descaling operations were suggested.

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