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Terrestrial Radiation Around Oil And Gas Facilities In Ughelli Nigeria

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Abstract: An environmental radiation survey in oil and gas facilities of oil fields and their host communities in Ughelli Delta State has been carried out, using a digilert nuclear radiation monitor and a Geographical Positioning System (GPS). Measurements were made in 21 stations and control readings in the host communities. Measured average values ranged between 12.00±0.1 μR h^{-1} (5.33±0.35 μSv/week) to 22.00±21 μR h^{-1} (9.79±0.16 μSv/week) in the fields and 09.00±1.0 to 11.00±0.5 μR h^{-1} in the host communities with the maximum deviation value of 88.9% recorded at Eriemu field. The average dose equivalent obtained are within the safe radiation limit of 0.02 mSv/week recommended by UNSCEAR. The radiation level within these facilities are far above the standard background level of 0.013 mR h^{-1}.

Key words: Terrestrial, radiation, Ughelli, oil and gas

INTRODUCTION

The human environment is the basis for any economic, social and Cultural development. It is therefore important that its quality be maintained in a good state to ensure a high level of social performance, which can be achieved by closer monitoring of pollution factors (Avwiri and Ebeniro, 1998). The quest for oil fields development and exploration in the Niger Delta of Nigeria has led to various forms of activities that tend to perturb the fragile ecological, biophysical systems and the Socio-economic and political structures.

Oil and gas industry in the Niger Delta is a multi-faceted Industry that includes the construction, exploration, production, downstream and marketing sectors. In most of these sectors, radioactive materials and radiation generators are used on a large scale. The application of radioactive materials in both the onshore and offshore oil and gas industries includes industrial radiography, automated ionizing radiation gauge, well logging, use of radiotracers, mapping and evaluation of geological formations and the extraction of other natural hydrocarbon resources (Arogunjo *et al*., 2004).

Foland *et al*. (1995) reported that human activities, that have led to the depletion of the ozone layer, increased the cosmic rays reaching the earth's surface thereby affecting the background radiation.

Kuroda (1991) reported that the background radiation levels are from a combination of terrestrial (^{40}K, ^{232}Th, ^{226}Ra etc.) and cosmic radiation (Photons, Muons etc.). He reported that the level is fairly constant over the world, being 0.008-0.015 mR h^{-1}. But Brazil, India and China have higher background ionizing radiation, primarily due to the high concentrations of radioactive minerals (Monozite) in the soil (Ron Kathren, 1991):

Ebong and Alagoa (1992a and b) studied the background radiation pattern of the Pre- and Post-Industrial pattern of a fertilizer plant and reported an increase in the background radiation.

Avwiri and Ebeniro (1998) studied the external environmental radiation in an industrial area of Rivers State. They reported an average of 0.014 mR h^{-1} of background. The results indicated significant elevation from the standard background radiation of 0.013mR h^{-1}.

Arogunjo *et al*. (2004) studied the impact of oil and gas industry to the natural radioactivity distribution in the Niger Delta region of Nigeria and revealed that, the mean activity concentrations for ^{40}K, ^{238}U and ^{234Th} radionuclides are 34.8±2.4, 16.2±3.7 and 24.4±4.7 Bq kg^{-1}, respectively, with oil extraction activities areas having activity concentration values greater than areas without any known oil extraction activity in the region. The environmental Radioactive levels in Ikot Ekpene area of Akwa Ibom State of Nigeria have also been studied by Louis *et al*. (2005) and reported a value average activity level of 201.0±0.05 mBq. An outdoor gamma radiation exposure dose rate of 0.067×10^{-2} μR h^{-1} was recorded at Ikot Ekpene.

On the effect of oil and gas activities on the radiation level of the environment, Stanislav and Elena (1998) carried out studies on the environmental impact of the offshore oil and gas facilities and showed that produced

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waters from oil and gas production contain naturally occurring radioactive elements (uranium and thorium) and their daughter products (Ra-226 and Ra-228).

Also, the Rail Road Commission of Texas (RRC, 2007) showed that Naturally Occurring Radioactive Materials (NORM) associated with oil and gas production originate in sub-surface formations which may contain radioactive materials like uranium and thorium and their daughter products, Ra-226 and Ra-228.

According to United States Environmental Protection Agency (www.epa.gov/radiation), field surveys have shown that petroleum pipe scale originating from oil production may have very high Ra-226 concentration,and on disposal exposes the environment to associated radioactive contaminants.

Ughelli and its environs are major oil producing communities in the Niger Delta region of Nigeria. The areas are criss-crossed with network of pipelines carrying either oil or gas to the flow stations from many locations (oil wells). Excessive exposure to background radiation by staff and host communities can result to associated known health-hazards. Research findings on the level of background radiation in respect to these areas are lacking. The need to properly document the level of background ionizing radiation of the areas and provide a base-line data for future studies lay credence to this study. The health implications of the obtained information were also carefully examined.

MATERIALS AND METHODS

This study was conducted in November, 2006 around oil and gas facilities in Ughelli, Nigeria.

The study areas lie within longitude 6°.04′E and 5°.56′E and latitude 5° 38′N and 5°.30′N. An *insitu* approach of background radiation measurement was adopted and preferred to enable samples maintain their original environmental characteristics. A Digilert nuclear radiation monitor and a Geographical Positioning System (GPS) were used. The tube of the radiation monitoring meter was raised to a standard height of 1.0 m above the ground (Ebong and Alagoa, 1992b) with its window facing first the oil facility and then vertically downward while the GPS readings taken at that spot. Readings were obtained between the hours of 1300 and 1600 h, since the exposure rate meter has a maximum response to environmental radiation within these hours as recommended (Ebong and Alagoa, 1992b). Three readings were taken at each facility and the average calculated. For adequate coverage of the various facilities, four to six different facilities radiation levels were taken within a field. Measurements were also taken within the host communities outside the oil installations. The count rate per minute was converted to micro-roentegen per hour ($\mu R\ h^{-1}$) using the relation:

$$\text{Count rate per minute (CMP)} = 10^6\ \text{Roentegen} \times Q.F \quad (1)$$

where Q.F is the quality factor which is unity.

The Exposures dose equivalent in micro-Sieverts per week were obtained using the relation.

$$R/hr = 0.445\ Sv/week. \quad (2)$$

RESULTS AND DISCUSSION

Table 1 shows exposure rate determined for the twenty-one facilities within the four fields. The values obtained range from 12.00 to 22.00, $\mu R\ h^{-1}$ for exposure rate and 5.34 to 9.79 μSv/week for dose equivalent. Eriemu

Table 1: Data obtained from stations studied

Geographical stations	Location	Radiation ($\mu R\ h^{-1}$)	Dose equivalent (μSv/week)
Kokori flow station	N05° 38.664′ E006° 04.224′	14.00±3.0	6.23±0.31
Kokori flare site	N05° 39.108′ E006° 04.200′	12.00±1.0	5.34±0.20
Kokori flare knock-out drum	N05° 39.016′ E006° 04.166′	15.00±1.2	6.68±0.36
Ughelli East UPS Manifold	N05° 30.750′ E005° 56.272′	15.00±4.0	6.67±0.50
Ughelli East flow Station	N05° 30.878′ E005° 56.255′	17.00±4.0	7.57±0.34
Ughelli East Gas Plant	N05° 30.860′ E005° 56.199′	19.00±6.2	8.46±0.26
Ughelli East flare site	N05° 30.954′ E005° 56.271′	12.00±2.0	5.34±0.10
Ughelli East buster station	N05° 31.004′ E005° 55.940′	18.00±11.3	8.01±0.32
Afiesere flow and compressor station	N05° 32.886′ E006° 00.892′	16.00±3.0	7.12±0.40
Afiesere flare site	N05° 32.906′ E006° 00.801′	14.00±6.0	6.23±0.14
Afiesere flare knockout vessel	N05° 32.861′ E006° 00.776′	12.00±0.1	5.33±0.35
Afiesere Manifold	N05° 32.861′ E006° 00.888′	13.00±2.0	5.79±0.10
Afiesere natural gas compressor (NGC) station	N05° 32. 648′ E006° 01.100′	19.00±1.6	8.46±0.38
Afiesere well location 4	N05° 32.508′ E006° 02.479′	12.00±2.1	5.34±0.40
Afierese well location 7,10 $ 14	N05° 32.329′ E006° 01.808′	12.00±1.6	5.34±0.24
Eriemu well location 13 and 19	N05° 32.181′ E006° 02.251′	18.00±4.2	8.01±0.09
Eriemu Pigging Manifold	N05° 31.564′ E006° 01.063′	15.00±4.4	6.68 ′ 0.24
Eriemu natural gas compressor (NGC) station	N05° 31.211′ E006° 03.428′	22.00±2.1	9.97±0.16
Eriemu flow station	N05° 31.224′ E006° 03.428′	19.00±2.1	8.46±0.10
Eriem flare knock-out vessel	N05° 31.268′ E006° 03.492	16.00±7.0	7.13±0.15
Eriemu flare site	N05° 31 E006°	15.00±3.6	6.67±0.43

Table 2: Studied fields and host communities data

Area code	Field	Host community	Geographical field location	Mean field radiation	Mean community radiation (μR h^{-1})	Deviation (%)
A	Koroki oil field	Erhoike	N05° 39′ E006°	13.67±1.7	11.00±0.5	24.27
B	Ughelli east oil and gas field	Eruemukohwarie	N05° 31′ E006° 56′	16.00±5.4	10.00±1.2	60.0
C	Afiesere oil	Emeragha	N05°. 32′ E006°. 01	14.00±2.3	09.00±2.1	55.6
D	Eriemu oil and gas field	Gana, Agbaraha-Oto	N05° 31′ E006° 03′	17.00±3.6	09.00±1.0	88.9

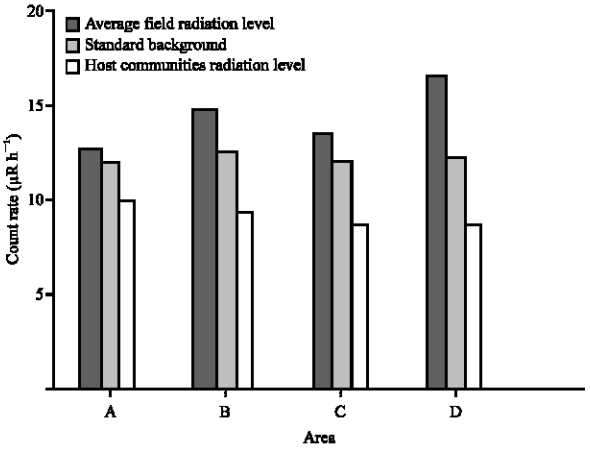

Fig. 1: Measured count rate, compared with count rate for standard and host communities

N.G.C station recorded the highest radiation levels of 22.00±0.1 μR h^{-1} while the least radiation levels of 12.00±0.1 μR h^{-1} was recorded in Afiesere flare knock-out vessel. Table 2 shows the average exposure rate in the fields and Host Communities with Eriemu field recording the highest average and percentage deviation of 17.5±3.6 μR h^{-1} and 88.9% respectively.

Figure 1 shows the comparison between the radiation levels within the fields, standard background radiation and Host Communities radiation levels. In all the four fields the exposure rates exceeded the standard background and the previous values reported by Avwiri and Ebeniro (1998). Also, there is a significant elevation of the radiation levels in agreement with previous study in a similar environment (Arogunjo *et al*., 2004; Louis *et al*., 2005). The difference in the exposure rates between Host Communities and fields could be due to the input, outputs or effects associated with the activities of the facilities.

Furthermore, the levels recorded for gas flare stations and natural gas stations are fairly higher than other stations. This could be attributed to the heavy metals, normally associated with gas flares (Arogunjo *et al*., 2004).

These results obtained do not indicate any immediate health side-effects on the staff and the host communities. The highest radiation exposure level of 9.79 μSv/week (recorded for NGC Station) is below the recommended value of 0.2 mSv/week by the Texas Regulation for Control of Radiation (above background) and protection of public health (RRC, 2007; UNSCEAR, 1998)

There is still likelihood of future health- side effects due to precipitation of produced formation waters (which contain radioactive elements) which on condensation as rain constitute radioactive pollution of rain water. Unfortunately, this serves as a major source of water for drinking and agriculture in the surveyed area. Also a greater proportion of these formation waters are leached from the oil/gas reservoir and carried to the sub- surface where they can make contact with sea water. The associated radionuclides interact with sulphates in the sea water where they partly precipitate and the rest consumed by aquatic animals and hence pose a radioactive risk to the aquatic family (Stanislav *et al*., 1998) and beyond.

As a result of this indirect ingestion of these radionuclides, the level of exposure by the host communities is enhanced. According to Ballinger (1991), most radiation biology researches describing the quantitative relationship between the radiation dose and biological effect indicates a threshold dose level below which no health side-effect occurs(for short term exposure). Late effects of low level radiation exposure do not have threshold dose level rather every small exposure exacerbates the health side-effect response curve.

CONCLUSION

The measurements of the external environmental radiation around oil and gas facilities in four oil fields and Host Communities have been carried out. The study revealed that the terrestrial radiation level of the areas have been affected by the activities of the oil company. Though the dose equivalent is still within the safe radiation limit of 0.02 mSv/week recommended by UNSCEAR (1998), the radiation levels within the facilities are far above the normal background levels.

Generally, the high values obtained can be attributed to the operation of the oil company in the environment, since the geology of the area shows no trace of (monazite) radionuclide bearing mineral (Ron, 1991; Arogunjo *et al*., 2004).

We therefore recommend as follows.

- The oil operating companies in the area should device means of reducing their radionuclide input.
- In the interim, both life and health insurance policies should be acquired for employers and contract staff of these multi-national companies working within these fields, to take care of their long-term health problems.
- There should be a regular monitoring of radiation level in these environments.

REFERENCES

Arogunjo, A.M., I.P. Farai and I.A. Fuwape, 2004. Impact of oil and gas industry to the natural radioactivity distribution in the delta region of Nigeria. Nig. J. Phys., 16: 131-136.

Avwiri, G.O. and J.O. Ebeniro, 1998. External environmental radiation in an industrial area of rivers state. Nig. J. Phys. 10: 105-107.

Ballinger, P.W., 1991. Radiographic Positions and Radiological Procedures, Mosley-Year Book Inc.

Ebong, I.D.U. and Alagoa, 1992a. Estimates of gamma-ray background air exposure at a fertilizer plant. Discovery Innovat., 4: 25-28.

Ebong, I.D.U. and Alagoa, 1992b. Fertilizer Impact. In: Ionization radiation background at a production plant. Nig. J. Phys. 4: 143-149.

Foland, C.K., T.K. Kirland and K. Vinnikoov, 1995. Observed Climatic Variations and Changes (IPCC Scientific Assessment). Cambridge University Press, New York, pp: 101-105.

Kuroda, P.K., 1991. Estimation of burnup in the Oklo natural nuclear reactor from ruthernium isotopic composition. J. Radioanal. Nucl. Chem., Lett., 155: 107-113.

Kathren, R., 1991. Radioactivity in the Environment, Taylor and Francis Publishers, USA.

Louis, E.A., E.S. Etuk and U. Essian, 2005. Environmental radioactive levels in Ikot Ekpene Nigeria. Nig. J. Space Res., 1: 80-87.

Rail Road Commission of Texas, 2007. www.rrc.state.tx.us.

Stanislav, P. and C. Elena, 1998. Environmental Impact of the Off-shore Oil and Gas Industries, East Northport, USA.

United States Environmental Protection Agency, 2006. www.epa.gov/radiation.

UNSCEAR, 1988. In sources: Effects and risks of ionizing radiation. 1988 report to the General Assemble with annexes: United States Publication. E881×17 (United Nations) New York.