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Studies of Gramma Radiation Profile of Oil and Gas Installations in the Niger Delta Region of Nigeria

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Abstract
The gamma radiation profile assessment of some flow stations facilities and their host communities in the Niger delta region of Nigeria have been carried out. the survey was conducted twice monthly for five months in six flow stations facilities two each from delta Bayelsa and rivers state in situ, using diligent 50 nuclear radiation monitor and a geographical positioning system (GPS) reading were taken in 11 facilities in each of the flow station and the host communities. measured radiation values in the facilities ranged from 08.00±0.70μRh^{-1} in Afiesere flow station entrance gate to 25.00±4.20uRh in adibawa flare knockout vessel, while the flow stations mean exposure rate ranged from 14.82±1.74 μRh^{-1} (6.70±0.78 μRh^{-1}/wk) to 18.60±2.64 μRh^{-1} (8.28±1.17 μRh^{-1}/wk) with fields mean radiation level of 17.14±2.22 μRh^{-1}. the host community's radiation exposure values obtained were (2100±2.10,17.00±2.00, 15.00±1.40,18, 00±1.60, 1000±0.70 and 14.00±1.10) uRh for emeragha, Ekakpamre, Nedugo, Imirigin, joinkrama 4, and Egbema community respectively. the radiation levels at gas facilities were observed to be higher than those of oil facilities. the highest average dose equivilant rate obtained is within the safe radiation limit of 20uSv/wk recomended by UNSCEAR (1993). but the mean radiation levels within these areas investigated are far above the standard background levels value of 13.00uRh. these results obtained indicate no immediate health hazard but may put some long-term health risk to the staff working in the facilities and residents of the host communities. the researchers recommended some proactive measures that may help to reduce this health threatening enviromental pollution.

Keywords: *Estimation, Radiation profile, oil and Gas installations, Niger Delta. Nigeria.*

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I. Introduction

The deleterious radiological health hazard posed by human activities especially in the production of energy research and medical applications of nuclear facilities and oil and gas application of radionuclide elements have attracted great concern and tremendous interest over the years in the field of radiation protection (Arogunjo et al 2004a) The oil and gas industry in the Niger delta are a multifaceted industry that inludes the construction, exploration, exploitation, production, downstream and marking sectors (Agbalagba et al 2007). in most of these sectors radioactive materials and radiation generators are used on a large scale. this application of radioactive materials in both the onshore and offshore oil and gas industry includes industrial radiography, use of radiotracers, mapping and evaluation of geological formations and the extraction of other natural hydrocarbon resources (Arogunjo et al, 2004b). petroleum on the other hand is a naturally occurring liquid mineral deposited beneath the earth surface. its occurrence is sometimes accompanied with the existence of natural gas. the oil, gas and associated gas are generally contaminated with radionuclide in the earth crust. all these provide the source of radiation such as α, β and ɣ often found in the petroleum matrix (mendinpet and Agba 2006) contamination with radium is known to be common in oil producing facilities, whereas contamination with radon decay products is more prevalent in natural gas production also contributing to the production of a, B and y radiation (gray, 1993, laogun et, al,2006). because radium is widely distributed in the earth's crust radon is also widely distributed and once formed. radon is free to either dissolve in the crude oil matrix or migrate as a gas (gray, 1993). thus, migrating through the rocks and soil, radon is produced with the oil and natural gas at the well head. moreso, if present in sufficiently high concentration, radon can be distributed externally to storage vessels pumps and other facilities. also dissolved in the petroleum matrix are various cations such as barium, calcium and sodium and anions such as sulphate, chloride and bicarbonate. the levels of the cations and anions indeed vary over a wide and their reactions with atoms also result in the production of α, β and ɣ radiations due to energy exchange. but because the gamma (ɣ) radiations emitted by the various reactions are more penetrating and energetic than the alpha (a) and beta (B) radiations, the prevalence of gamma radiation in the oil and gas installation environment can be easily monitored using Geiger muller counter.

Gamma rays are known to be highly penetrating and are part products of the radioactive materials

containing radon which may be ingested or inhaled into the human body e.g., during repairs and maintenance of oil facilities, if inhaled the dust particles and aerosols containing radon may attach themselves to the lungs where gamma rays emitted in the decay may pose increase risk lung cancer, eye cataracts and mental imbalance to personnel and host communities (laogun et, al, 2006). In recent time, the measurement of occupational radiation levels in industrial environments has gained significantly, mainly due to the fact that researchers have found a strong correlation between radiation exposure and health hazard on the workers in this environment eco system (Ebong and alagoa, 1992ab; Agbalagba et, al; 2013) which are attributed to the industries input raw materials, effluents discharged as in gas flare and output products.

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

Ebong and Alagoa (1992a, b) studied the bckground radiation pattern of the pre and postindustrial activities of a fertilizer plant and reported an increase in the background. Avwiri and Ebeniro, (1998) studied the external environmental radiation levels in -an industrial area of rivers state and reported that there is a significant elevation from the normal background radiation levels in the area. Anogunjo et. al, (2004b) 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 concentration for 40k, 238µ and 234Th radionuclide are 34.8$\pm$2.4, 16.2$\pm$3.7 and 24.4$\pm$4.7 Bq/kg respectively with oil extraction activities areas having activity concentration values of greater than areas without any known oil extraction activity in the region. on the impact oil and gas activities on the radiation levels of the environment, Stanislaw and Elena (1998) studied the environmental impact of the offshore oil and gas facilities and showed that produced waters from oil and gas production contain naturally occurring radioactive elements (uranium and thorium) and their daughter progenies (Ra226 and Ra228).there is also a report on radiation safety study of the use of radioactive source and radiation producing machines for radiographic purpose in the Nigerian petroleum industry (Abison, 2001).

Laogun et. al, (2006) studied the variation in well head gamma radiation levels at the Nigerian petroleum development company oil field in ologbo and reported that the values obtained are fairly higher than the normal background level, but they are in agreement with the international atomic energy agency's standard on ionizing radiation background level.

According to the united states environmental protection agency 2006 (www.epa.gov/radiation), field surveys have shown that petroleum pipe scale originating from oil production may have very high Ra226, concentration and on disposal exposes the environment to associated radioactive contaminants. also, the rail road commission of Texas (RRC, 2007) showed that naturally occurring radioactive materials (NORMS) associated with oil and gas production originate in subsurface formations which may contain radioactive materials like uranium and thorium and their daughter products Ra226 and Ra228.

Recently, Agbalagba et, al., (2007) studied the terrestrial radiation around oil and gas facilities in ughelli Nigeria and reported average value range of 12.00+0.1uRh (5. 33+0. µSv/wk) to 22. +2,1 μRh^{-1} (9,79+0.16. µSv/wk) and concluded that the activities of the oil companies have impacted negatively on the environment.

The Niger delta states particularly delta, Bayelsa and rivers has been known for the get contribution to the Nigerian economy through oil and gas resources. these states have gas reserve of over 80 trillion standard cubic feels (ft3) about ten times its crude oil reserves. (1 barred oil=3.2ft3 gas pm chemical conversion basis). (osuji and Avwiri, 2005). the region has a network of flow stations. highly crises crossed with network of pipelines carrying either oil or gas to the flow stations for onward piping to either the refineries or terminals for exportation. see appendix, in all these processes radiations (radon) are always give out. excessive exposure to these ionizing radiation from gas flare, gas and crude piping/spillage, use of radioactive elements within the flow stations on the staff, host communities and their immediate environments have been a growing concern to researchers. this is because, recent research findings have shown that increase in the background ionizing radiation from numerous sources have various long term health hazard on workers and the general public like, cancer, mental disorder, genetic mutation etc. (jibiri, et, al, 1999; Abison, 2001 and Agbalagba et al, 2007).

The need for precise and acurate information on the background ionizing radiation levels of the flow stations and their host communities in the Niger delta states and the inadequate data on background radiation levels in oil facilities in the region lay credence to this study. moreso, the heighten fear and agitations of workers in the installations and host communities in the region on their health safety due to the input man hour at the flow stations and the proximity of the oil facilities to the host communities make this research work most timely. the result of this study will therefore provide a baseline data for future detail studies on the gamma radiation impacts of oil and gas installations in the Niger delta region. the health implications of the obtained valued on the staff and residents of the host communities will also be examined.

II. Experimental Method

This study was conducted between April and august 2008 in two stations two flow station each from Delta, Bayelsa, and Rivers state. This studied area lies between latitude 04^o 53'N and 05^o 34'N and longitude 05^o52'E and 006^o35'E.

an in-situ approach of background radiation measurement was preferred and adopted to enable sample maintain their original environmental characteristics. A digital nuclear radiation monitoring meter (S.E international, inc. summer town, USA) containing a Geiger Muller tube capable of detecting α, β, ɣ and x-rays within the temperature range of $10^o c$ to $50^o c$ was used to measure the radiation levels, while a geographical positioning system (GPS) was used to measure the precise location of sampling, and before each measurement equipment where characterized for environmental measurement. Measurements were taken twice in the month in each of the flow station in different installations within flow station for five consecutive months and the average value obtained.

The meter usage and readings taken was carried out as reported by (Laogun et al. 2006 and Agbatagba et. al, 2007). Readings were obtained between 1300 hours and 1600hours, since the exposure rate meter has the maximum response to environmental radiation within these hour as recommended by NCRP (1993).

The count rate per minute recorded in the meter was converted to micro-roentgen per hour (μRh^{-1}) using the expression.

Count rate per minute (CMP) = 10^{-6} roentgen × Q.F (Agbatagba et. al. 2007).

Where Q.F is the quality factor, which is unity for external environment.

The dose equivalent rate was obtain as reported by agbatagba et. al. 2007.

III. Results And Discussion

Table 1: Flow Stations Geographical Locations

Field code	Flow station field	Host community (proximity)	Geographical location		State located
			Latitude	longitude	
Afie	Afiesere	Emeraigha	$05^o32'$	$006^o00''$	Delta
Ughw	Ughelli west	Ekekpamre	$05^o34'$	$006^o52''$	Delta
Etel	Etelebou	Nedugo	$05^o01'$	$006^o21''$	Bayelsa
Kolo	Kolo-creek	Imiringi	$04^o53'$	$006^o22''$	Bayelsa
Adib	Adibawa	Joinkrama 4	$05^o11'$	$006^o29''$	Rivers
Egbe	Egbema	Egbema	$05^o21'$	$006^o35''$	Rivers

Tables 3: Comparison of Flow Station and Host Communities

S/N	Oil Field/Flow Station	Host Community	Mean Fields Radiation Levels μRh^{-1}	Mean Host Community Radiation Level μRh^{-1}	Exposure rate diff(%)
1	Afiesere	Emeraigha	$14.82.\pm1.74$	$21.00.\pm2.10$	17.3
2	Ughelli west	Ekekpamre	$18.00.\pm2.54$	$17.00.\pm2.00$	2.9
3	Etelebou	Nedugo	$16.30.\pm2.20$	$15.00.\pm1.40$	4.2
4	Kolo-creek	Imiringi	$17.10.\pm2.15$	$18.00.\pm1.60$	2.6
5	Adibawa	Joinkrama 4	$18.00.\pm2.02$	$10.00.\pm0.70$	28.6
6	Egbema	Egbema	$18.60.\pm2.64$	$14.00.\pm1.10$	14.1

Table 1 shows the flow stations, their host communities, their geographical locations and states where the oil fields are located. The table shows that two flow station each were examined in the three states.

Table 2 shows the exposure rates determined for the eleven facilities/installations in the six flow-station experimented. The radiation levels values obtained in the facilities range from $08.00\pm0.70\mu Rh^{-1}$ in Afiesere flow station entrance to $25.00\pm4.20\mu Rh^{-1}$ in Adibawa flare knockout vessel. The high value recorded at the Adibawa knockout vessel may be due to the spill of associated crude and the exposure of effluent to the environment. The mean exposure rates value obtained in the flow stations range from $14.82\pm74.1\mu Rh^{-1}$ ($6.70\pm78\mu$/wk) at afiesere flow station to $18.60\pm2.64\mu Rh^{-1}$ ($8.24\pm1.17\boldsymbol{\mu}$/wk) at Egbema flow station, with field mean radiation value of $17.14\pm2.22\mu Rh^{-1}$. The high radiation levels recorded at the various installations in an indication of high concentration gas in the environment of the flow station.

The high radiation level recorded at the National gas compressor station (NGC) Afiesere and Ughelli West flow station may be attributed to the High concentration of Radon in natural gas and gas producing facilities.

Table 3 show the comparison of flow station and host community radiation exposure rate. The lowest radiation exposure rate of $10.00\pm0.7\mu Rh^{-1}$ Was obtained and joinkrama 4 in River State. these low levels may be attributed to the geology (underlying rocks) of the area of the distance to the Host community from the flow station (- 2.5 km) which is the farthest among the six host communities. the highest average exposure rate of

$21.00 \pm 2.10 \mu Rh^{-1}$ was recorded in Emeregha community in Afiesere field.This value of 10 is well above the mean field radiation exposure levels. Radon 222 is a highly-mobile naturally occurring radioactive gas produced by the radioactive Decay of radium – 226, Radon gas which is being liberated from radium the key present in the crude oil/ gas products and facilities may be counted for the variation of radiation level within the facilities. this is also favoured by the wind direction and the point of liberation. the percentage exposure rate difference is minimum at kolo-Creek Oil field and its maximum at Adibawa oil field in Joinkrama 4. this also confirm that Joinkrama 4 is the least impacted community among the six investigated Fields.

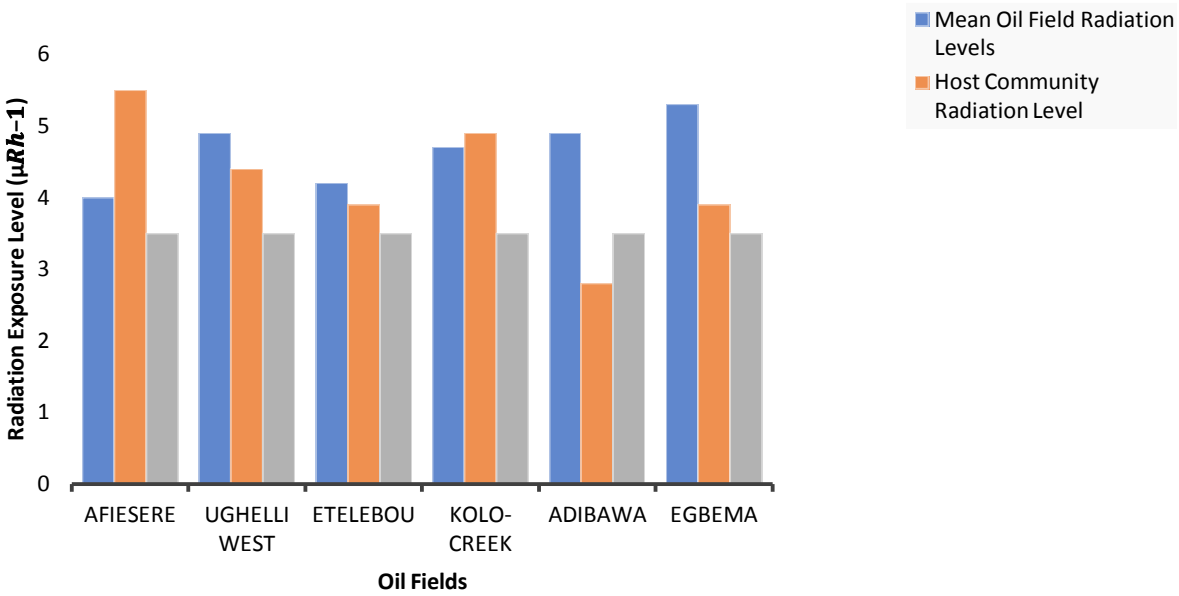

Figure 1: Comparison of Mean Oil Fields and Host Communities Radiation Level With Normal Background Radiation Level.

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Figure 1 show the comparison of the main or you feel and host Communities radiation levels with normal background radiation level. the comparisons show that the Afiesere oilfield graduation level is 114% of the normal background level while Emeregha The Host community is 161% of the normal background level. Ughelli West oil field radiation level is 138.5% of the normal background level while Ekappamre the Host community is 130.8% of the normal background radiation level. Etelebou oil field and nedugo the Host community relation levels are 125.4% and 115.4%respectively of the normal background radiation level. Kolo-creek oil field and Imiringi the Host community radiation are 131.5% and 138.3% of the normal background levels. Kolo Creek oil field and Joinkrama 4 (JK) communication levels are 138.4% and 76.9% respectively of the standard background radiation level, while Egbema oil field and Egbema community radiation levels are 143.1% and 107.7% respectively of the normal background radiation level.

the result shows that in all the six flow station facilities examine and their host community except Joinkrama 4, The explosion rate exceeded the standard background levels and the previous value reported by ebong and Alagoa (1992a); Avwiri and Ebeniro (1998). but these values reported are in agreement with some previously reported Result in similar environment (Arogunjo et al., 2004; Laogun et al., 2006; Agbalagba et al., 2007) the differences in the exposure rate between the Host Communities and flow stations could be attributed to the input, outputs effluent associated with the activities of the operating companies (IES) and the decay in the penetrating power due to the half-life of Radon as it is on Transit to host communities. the only exceptional case of Emeregha community may be attributed to the existence of oil well locations (Wells 7, 10 and 14) within the community which may have enhanced the concentration of Radon (radiation levels) in the company.

furthermore, the radiation levels recorded for gas flare facilities and natural gas compressor stations are fairly higher than other facilities. this confirms the high concentration of Radon gas and heavy metal normally associated with natural and associated gas (Arogunjo et al. 2004; Laogun et al, 2006). this wooden concentration of natural gas at these facilities and the region when compared to those obtained in other countries of the world such as USA Great Britain and Canada (Laogun et al., 2006), it may be seen that the facilities radiation level in Nigeria is very smaller compared to those reported in USA and Canada where Radon concentration (radiation levels) constitute enormous environmental problems requiring government legislation for the control of naturally occurring radiation materials (NORM) contamination India petroleum Industries.

This result of thing do not reveal any immediate (short-term) health hazard on the resident of those host Communities investigated and the flow stations attendance (staff),Reason being that the highest average radiation exposure levels of $18.60\pm2.64\mu Rh^{-1}$ ($8.28\pm1.17\mu/wk$) recorded in Egbema flow station and $21.00\pm2.10\mu Rh^{-1}$ ($9.35\pm931\mu/wk$) recorded at Emeragha community are within the UNSCEAR recommended permissible limits of 200 µSv/wk For the Protection of public health (UNSCEAR, 1993). However, there is still the possibility of future health side effects on the staff and host Communities due to long-term accumulative dose intake from direct and indirect radionuclide (Agbalagba et al. 2007). Moreso The prevalence of eye cataracts, lung and bone cancer,leukemia and mental disorder among host community members and Oil and Gas facilities staffs retirees as reported by (Undp 2006; Otarigho, 2007)Is a clear indication of a long-term ability to lose health side effects on staff and host communities.

IV. Conclusion

The survey of the terrestrial gamma radiation profile of oil and gas installations in selected flow station in the Niger Delta region on their host Communities have been conducted. the study revealed that the background radiation levels of the area have been impacted by the activities of these oil companies. the impact is mainly due to the contamination of the underneath crude oil and gas by radionuclide bearing rocks/ elements (uranium, thorium and radium loose bracket which when drilled to the surface and exposed to the terrestrial environment at the oil installations, releases radon Gas and other heavy metals which enhances the background level of the area or Direct materials. although the dose equivalent rate obtained in the flow stations are still within the safe radiation limits of 200µSv/wk recommended by UNSCEAR 1993, the radiation levels within the facilities of this flow stations facilities are far above the normal background radiation level of $13\mu Rh^{-1}$

These results indicate no immediate health hazard but may have some long-term (future) health effects on the staff and host communities. since radiation exposure in this environment may constitute serious health hazard on the long-term, especially to personnel and host communities. contaminated facilities and waste materials problems must therefore be adequately recognized and addressed in the oil and gas Industries.

we therefore, recommended as follows:

- The oil and gas operating companies in these areas should put in place means of reducing their radionuclide input.
- Both life and health insurance policies should be acquired for employees and contract staff working with the flow station to take care of their long-term health problems.
- Communities within oil and gas installation areas should have good, cheap and regular access to medical care.
- Communities within 500m proximity to flow stations and flare sites should be relocated for the safety of their health
- all oil and gas installations should meet all known international and ISO standard
- they should be a regular monitoring of radiation levels in this environment
- all government agencies responsible for the safety of the environment should enforce all the existing legislation on the environment especially those concerned with the Handling of radioactive materials.

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