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Pragmatic Measures to Preventing Fire around Refinery Flammable Facilities in the Surrounding Communities: A Case Study of PHRC

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Abstract:- Fire hazards usually tantamount to devastating outcomes ranging from; damage to environment to loss of lives and property. Thus there is a need for the adoption of pragmatic measures to prevent the hazard. This paper assess the pragmatic measure in the communities around Port Harcourt Refinery Company (PHRC), with a view of establishing the communal practices that can lead to fire outbreak and to suggest measure to reduce such practices. The research was sort via an intensive literature review alongside the administration of a well-structured questionnaire. A total of seventy questionnaires with sixty returned adequately filled giving a percentage response of 85.7%. The responses were analyzed using computer based software (SPSS) and the result presented in percentages and Relative Importance Indices (RII). The result revealed among others that show that incineration of refuse at disposal point was also a great cause of fire hazard. Other pragmatic fire prevention measures arranged in their other of efficacy as opined by the respondents are:the control on the bush burning activities and then the appropriate disposal of flammable pollutant, appropriate disposal of flammable pollutant and Strategic positioning of fire sensing device which ranked second, third and fourth respectively. , Thus it is recommended that such disposal points should be located very far from PHRC flammable facilities.

Keywords:- *Pragmatic measures, Fire prevention.*

I. INTRODUCTION

Fire safety compliance of any building is said to be the measures set in place by various authorities and regulatory bodies from the design to completed structures; which a building meet in order to prepare the building and its occupant well in advance in the event of any fire incidence (Drysdale, 2002). Fire safety refers to the precautions that are taken to prevent or reduce the likelihood of a fire that may result in death, injury, or property damage, alert those in a structure to the presence of an uncontrolled fire in the event one occurs, better enable those threatened by a fire to survive, or to reduce the damage caused by fire. Fire safety measures include those that are planned during the construction of a building or implemented in structures that are already standing, and those that are taught to occupants of the building (Amernic and Jerry, 2008).

Recently, occupants neglect the aspect of general fire safety regulation and also with regard to the carelessness such as discarding the lighted ends of cigarettes, faulty considerations or workmanship especially in the electrical installations of the building (Harper, 2004). Fire disasters in both public and private buildings are very disastrous and can tantamount to huge loss of life and properties. However, one of the peculiars properties of fire is that it can be transferred from the point of generation to a surrounding building provided that a combustible material is present. Thus, even if an organization has grown to the point of establishing fire control measure, absolute negligence of the possibility fire out break from the surrounding environment, will obviously ruin the effort of preventing fire outbreak. (Chudley, 1995).

Thus, an assessment of the current pragmatic measures of fire prevention in the communities surrounding Port Harcourt Refining and Petrochemical Company Limited is a basis requirement owing to the combustible pollutant that the company is kwon for and as a result of practices by the members of these communities that are capable of endangering or exposing flammable facilities belonging to the refinery to fire accidents. PHRC, being primarily a chemical process plant made up of process units, storage facilities-both crude oil and finished products, building facilities, warehouses for storing general goods, as well as chemicals and catalysts, etc.

The surrounding communities, namely **Okirka**,**Abuloma**, **Onne** and **Alese**are basically rural settlements that are engaged in farming and low level industrial activities such as bakeries, packaged water plant, grinding machines of various kinds and capacities. But, gas plants have also been established in the communities because of ease of gas supplies from the refinery. As a result of these activities it is easy to deduce that fires could result from industrial accidents, bush burning, particularly during dry seasons in preparation of the land for farming activities. Even fireworks are common especially during festivities, which are known to be a common cause of fires. Bush burning in particular is a very common phenomenon among the communities and therefore poses very serious threats of fire to the PHRC flammable facilities. Local hunters equally engage in bush burning activities in their efforts to catch wild animals.

The communities are also serves as hosts to many gas plants due primarily to ease with which they can source their

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feed, as well as cheap lands upon which such plants are sited. As at today there are eight (8) gas plants spread across the communities. This obviously, poses a very serious fire hazard to PHRC flammable facilities.

Fires, regardless of their immediate or remote cause(s), always have very serious consequences whenever they occur. The consequences of fire outbreak are damage to environment, loss of lives and properties, disruption of work process resulting in decrease in productivity and profitability. To a very large extent also, the corporate image of the company is affected.

Though, it would seem extremely impossible to eliminate bush fires, for example, the next best thing would be to suppress them while they are still small or managing the forest fuel in a strategic manner to minimize the intensity of the fire. And beyond endangering the flammable facilities, they can also destroy valuable infrastructure, cause wide spread damage to vegetation and even cause death of trees.

Exposure of facilities to fire often results in explosions, this often occurs in facilities that are flammable. Such materials include petroleum, petroleum products such as petrochemicals and natural gas. PHRC flammable facilities all belong to these categories and more. It processes flammable substances at very high temperature and pressure making the hazards event more severe.

This study is necessitated owing to the disastrous consequence of fire outbreak particularly to a big investment like Port Harcourt Refining Company Limited (PHRC). Consequently it seeks to assess fire prevention measures in the communities surrounding the PHRC flammable facilities. The investments of the company in terms of manpower, plant and equipment etc must be protected. It is in this light that study is considered and seen to be very significant.

II. LITERATURE REVIEW

A. Fire Safety Regulation

The Proposed National Fire Code (2008), outline the following regulations on building structures to ensure safety against fire.

- Fire Suppression Systems
  - Installation and maintenance – fire suppression systems shall be installed and maintained in full operating conditions in the following occupancies:
  - Assembly use – in all buildings or structures or portions thereof when more than 500 square meters in area. Or when more than one storey in height.
  - Buildings and structures with stages – over the stage:

A. Stage grid – irons when side wall sprinklers with 57 ½ degrees Celsius. Rate heads with heat-baffle plates are installed around the entire perimeter of the stage at points not more than 75 millimeters below the grid-iron, or more than 150 millimeters below the baffle plate; Under all fly galleries; Over all proscenium opening on the stage side;Under the stage;

B. In all basements, cellars, work rooms, dressing store rooms and property rooms; and in toilet, lounge and smoking rooms.

(i) Business and institutions uses – in all buildings or structures or portions thereof with the exception of the following:

A. One storey hospitals with patient rooms having direct escape to grade level at the exterior of the buildings, when protected by automatic fire systems.

B. In hospitals of Type A construction, the automatic fire suppression system may be omitted from operating X-ray rooms, delivery rooms, cardiac and intensive care rooms and patient sleeping rooms not exceeding 60 square meters in area when each such room is protected by an automatic fire alarm system connected to a central annuciator panel, or fire alarm systems would be detrimental to the specific use or occupancy.

(ii) Mercantile, high hazard storage or factory and industrial uses – in all buildings or structures of use groups:

- When more than 1100square meters in area, or
- When more than 2200square meters in total area on all floors, or
- When more than three storeys in height.

(iii) Residential uses – in all buildings or structures of use groups when more than four floors or 12 meters in height.

(iv) Public garages – in all public garages;

- When more than 930 square meters in area; or
- When more than 700 square meters in area and more than one storey in height, or
- When more than 500 square meters in area, and more than 2 storeys in height, or
- When more than 3 storeys in height, or
- When located in buildings where the upper storeys are designed for other uses; or
- When located in any storey that is more than 50 per cent below ground level.

(v) Cellar or basement – in every storey, cellar or basement of all buildings where no provision is made for at least 2 square meters of opening entirely above the adjoining ground level in each 15 meters of exterior wall in the storey, cellar or basement, on at least two side of the buildings. Openings shall be unobstructed to allow fire-fighting and rescue operations from the exterior.

Note: - if the area of a cellar exceeds 230 square meters an automatic fire suppression system is required. For purposes of this section, an opening in an exterior wall qualifies as follows:

A. Doors or access panels may be included in the determination of openings,

B. Windows may be included in the determination of openings if they provide a breakable glazed area of

not less than 500 millimeters in its least clear dimension.

(vi) High-rise-buildings – high-rise buildings shall be designed with the consequence of uncontrolled fire in mind, since there are too hazardous to tolerate. The design shall ensure that;

- The structure of the building is capable of withstanding a burn-out of the contents at any level, without dangerous deformation or collapse.
- The fire-resistance of the walls and floors is sufficient to withstanding a burn-out of the contents without fire spreading from one fire-resisting compartment to another, or from floor to floor.
- The nature of the wall linings and furnishings is such as to preclude rapid surface spread of flame liable to trap the occupants.
- All potential paths for some and fire from one compartment to compartment and floor to floor is adequately smoke-fire-stopped.
- All lift-shafts and staircases which are used as escape routes are treated as separate fire-resisting compartments and preferably pressurized to prevent escape of smoke from the building.
- Since in high rise the evacuation of all occupants by stairs is a very lengthily process, the possibility of lateral movement to safety is always considered. Each floor shall be divided to give at least two separate fire-resisting compartments with self-closing smoke/fire doors, each compartment having its own means of escape towards ground level. (Drysdale,2002).
- An automatic detection system shall give an alarm at a stage in the development of a fire which is dependent upon the sensitivity of the detectors used. It shall not, in itself, affect the subsequent development of the fire. An automatic sprinkler system shall not only give an alarm, but shall also restrict the rate of growth of the fire, limit its output and cool the hot gases produced. On the operation of a sprinkler, it shall not necessarily reduce the volume of smoke produce directly, but the reduction of temperature of the volume of smoke produced directly, but the reduction of temperature of the hot gases would reduce their buoyancy and thus restrict or delay the penetration of smoke to other parts of the building. The functional requirements of a sprinkler system in a high-rise building, therefore, are:
- Rapid control of fire in the compartment in which it starts,

1) Restriction of the production of flames, hot gases and smoke from the fire to the room of the origin,
2) Alarm to fire service or other fire-fighting rescue service(Marylene 2012)

B. Description Of Port Harcourt Refining Company (Phrc)

The Port Harcourt Refining Company Limited is in business to optimally process hydrocarbon into petroleum products for the benefit of all stakeholders. The company's vision is to be an innovative international hydrocarbon processing company of choice.

PHRC Limited is made up of two refineries. The old refinery commissioned in 1965 with current nameplate capacity of 60,000 barrels per stream day (bpsd) and the new refinery commissioned in 1989 with an installed capacity of 150,000 bpsdThis brings the combined crude processing capacity of the Port Harcourt Refinery to 210,000 bpsd. It has five (5) process areas - Areas 1-5. The new refinery is made up of Areas 1-4 while the old refinery is Area 5.

Area 1 is made up of the Crude Distillation Unit (CDU), where kerosene and Automotive Gas oil (AGO) are produced as finished products. Other intermediate products from CDU are Straight –Run Naphta (SRN). Straight Run Gasoline (SRG) used for PMS blend, Liquefied Petroleum Gas (LPG) and Atmospheric residue (AR). Vacuum Distillation Unit (VDU) where AR (CDU bottoms) are further processed under vacuum, or significantly less than atmospheric pressure to produce high –vallue products without cracking like vacuum gas oil (VGO) fccu feedstock and light as gas oil.

Area 2 is made up of Naphtha Hydrotreatung unit (NHU), where naphtha is hydro-desulphurised; the Catalytic Reforming Unit (CRU), responsible for upgrading naphtha to reformate which has a higher octane value for PMS blend; the keroHydrotreating Unit (KHU) where kero is treated to make it acceptable for aviation use: Area 2 also has the Continuous Catalyst Regeneration Unit (CCR), which constantly reactivates the deactivated catalyst from the reformer. Other units in Area 2 include, the Hydrogen Purification, Fuel Gas Vaporizer, Sour Water Treatment and Caustic Treatment units.

Area 3 is made up of a Fluid Catalytic Cracking Unit (FCCU), where Vacuum Gas Oil (VGO) and heavy diesel oil (HDO) are cracked to obtain more valuable products, like FCC gasoline used as pms blend and Light Cycle as blend component for LPFO and LPG. Other units in Area 3 include the Gas Concentration, Gas Treating and Mercaptan Oxidation units.

Area 4 has three process units namely Dimersol, ButamerIsomerisation and Alkylation units. The units are designed to produce high octane gasoline blend component.

Area 5, which is the old refinery, is made up of the Crude Distillation Unit (CDU); the Platform Unit (CRU), the LPG Unit, as well as utilities section. PHRC has a department (Health, Safety and Environment), mainly responsible for the administration of matters on occupational health, safety and environmental protection. The unit renders services that include environmental protection, safety management, and compliance with safety standards, pollution control, fire prevention, emergency preparedness and response. It also conducts health, safety and environmental awareness campaigns, enforcement of compliance, carry out compliance audit and HSE internal training.

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PHRC takes very seriously safety of people, protection of environment and its assets. Of equal priority is to prevent avoidable emergencies and such other incidents such as fire disasters, oil spill, effluent discharges, gas emissions, and releases, but, when they occur, a swift response is effected, lessons are learnt and readiness for future occurrences are improved. But after all is said and done, fire prevention is one issue that must be on the front burner, especially fires arising from flammable facilities. Such facilities include: crude oil tanks, product tanks such as PMS, AGO, DPK, asphalt etc. This is because when fire breaks out, as they often do, among issues to worry about is its effect on the communities surrounding the PHRC, especially in terms of possible loss of lives and property, air and water pollutions, environmental degradation, etc.

III. METHODOLOGY

This chapter will elucidate the research work design and methodology for the study. This research work was carried out via an extensive literature review of relevant text books, journals and conference proceedings were the source of data for the study. The field survey was by means of a structured questionnaire and via a physical inspection of the communities under study as well as the interview of individuals where necessary for data collection instrument.

A. Population Of The Study

The population of this study comprises the responses of people living in the surrounding of KPRC in the villages such as Onne, Okirka ,Abuloma and Alese, Okirka . This study will require an assessment on the fire prevention measures among the communities surrounding Port Harcourt Refinery Company as well as the impact on the PHRC.

B. Sampling Size And Administration Of Data Collection Instrument

The sample size of this study comprise of the sixty (60) respondents residing in the surrounding of KPRC in the villages such as Onne, Okirka , Abuloma and Alese, Okirka with each town being administered with twenty (20) questionnaires even though an average of fifteen was returned from each town amounting to sixty(60) respondents.

C. Data Collection Instrument

The study was designed to sought data using a questionnaire through field survey as described below

- Questionnaire:
  the questionnaire was designed to be filled by respondents from the surrounding communities as well as PHRC personnel's who resides in such communities so as to assess their professional opinion on the ways the activities of the communities inhabitant can or has ever lead to fire outbreak. The questionnaire sought information in the following aspect of fire prevention measure:
  - The kind of activities that the communities are exposed to that posse's threat of initiating fire especially around the PHRC flammable facilities.
  - To identify the extent to which the activities and the measure to limit or eradicate such activities in an attempt to proffer a fire resistance measure
  - Identify the opinion of the respondent on how the pollutant from the company will not also contribute to fire hazard within the surrounding communities.

D. Data Analysis

The data collected for this study was subjected to various statistical analyses. The questions was analyzed using the Statistical Package for Social Sciences (SPSS) for questions that does not entail ranking. However, for questions that entails ranking, the Relative Importance Index (RII) was used.

The five and four point scale was transformed to Relative Importance Indices for each of the construction documents. The weighted average items were determined and ranks were assigned to each item representing the perception of the respondents.

The numerical scores for the completed questionnaires provided an indication of the varying degrees of the use of the construction documents. To further analyse the data with a view to establishing the significance of the variables considered, the Relative Importance Index (RII) was calculated for each document according to their frequency of use as suggested for use by Memon et al, (2006) and Othman et al, (2005).

It was calculated using the formulae

$$RII = \frac{4n5+3n4+2n3+1n2+0n1}{4N}$$

Where;
n1= number of respondents for 'never'
n2 =number of respondents for 'seldom'
n3=number of respondents for 'sometimes'
n4=number of respondent for 'often'
n5=number of respondents for 'always'
N=total number of respondents

RII ranges between zeros to one. The four-point scale ranking was transformed to relative importance indices (RII) for each of the construction contract documents. The weighted average for each item was determined and ranks were assigned to each item, representing the perception of the respondents.

Results are classified into three categories as follows (Othman et al, 2005) when;

$RII<0.60$ -it indicates low frequency in use
$0.60 \leq RII<0.80$ -it indicates high frequency in use.
$RII \geq 0.80$ –it indicates very high frequency in use.

Data was also presented in graphic form namely pie charts, and tabulations. Descriptive analysis of data relating to rating/frequency, simple percentages were used to analyse data.

The results of the analysis are presented in the forms of table for the purposed of easy comparism and clear expression of the findings. Descriptive analysis of data relating to rating/frequency, simple percentages were used to analyze data.

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IV. DATA PRESENTATION, ANALYSIS AND DISCUSSION

Data for this research was obtained from respondents living within the neighborhood of Port Harcourt Refining Company Limited (PHRC) and the PHRC flammable facilities via a well-structured questionnaire.

- Questionnaires Administered

A total of seventy (70) questionnaires were administered, with a total turn of sixty questionnaire giving a percentage response of response of 85.7% as illustrated in Table1

Questionnaire Administered	Frequency (No)	Percentages (%)
Questionnaires Returned	60	85.7%
Questionnaires not Returned	10	14.3%
Total	**70**	**100**

Table 1: Questionnaire Administered

Source: Field survey, (2021)

- Respondents Profile and Proximity to refinery flammable facilities

From the response of the respondents it can be established that some of the respondents were PHRC staff and some others were not; the respondents have different educational qualification; varying duration of abhorred in the area of interest and their houses were at varying distances from PHRC flammable material. These variations are given below:

S/N	Profile	Option	Frequency (No)	Percentage (%)
1	Staff of PHRC:	Yes	48	80.0
		No	12	20.0
		Total	60	100
2	Highest educational qualification	Secondary Cert	3	5.0
		ND/NCE	9	15.0
		HND/BSc	12	20.0
		Post Graduate	36	60.0
		Total	60	100
3	Proximity of Residence from PHRC Flammable Facilities	0- 50km	12	20.0
		51- 100km	38	63.3
		Above 100km	10	16.7
		Total	60	100
4	Duration of Stay in the Community	0-5yrs	3	5.0
		6-10yrs	9	15.0
		11-15yrs	40	66.7
		20 and above	8	13.3
		Total	60	100

Table 2: Respondent Profile

Source: Field Survey, (2021)

From the Table.2 it can be established that 80% of the respondents were both residents of the community in study area as well as staff of PHRC, this corresponds to a frequency of 48 respondents, while 20% corresponding to a frequency of 12 respondents were only residents of the community of interest and not the staff of the PHRC.

Also, the varying educational qualification of the respondents is presented in the Table. From the table it can be established that 60% of the respondents possess a post graduate certificate while 20% a HND/BSc and 15% possess an ND or an NCE certificate. This suggest that a greater portion of the respondents have a post-secondary education and consequently will be able to read effectively and comprehend the content of the questionnaire so as to give their candid opinion on the questions asked.

Also, from the analysis of the opinion of the respondents on the proximity of their house to the PHRC flammable materials the following can be established as shown in Table2.From the Table above, 63.3% of the respondents attested that their houses were 0- 50km from PHRC pipe and PHRC flammable facilities, with only 20% considering the distance of their houses from PHRC flammable facilities as just being 51- 100km from underground pipe. Thus it can be gather that houses are not located at close proximity from the PHRC flammable facilities.

With regards to the duration of residency of the respondents in the community of interest, it can be seen a greater majority of the respondent have spent much time in

the area as evident in the percentages. From the table, 66.7% of the have spent 11-15yrs in the community and 13.3% have spent over 20yrs in community. Only 15% of the respondents have spent between 6-10yrs. Thus, from the percentages it can be established that the respondents have stayed in the community for a considerable long number of time and thus are in a good footing to give a true view about the happening in the community.

- Ranking Of the Measure to Preventing Fire around PHRC Flammable Facilities
  The table 3 below gives the ranking of the fire prevention measure as opined by the respondents. From the response of the table it can be established that respondents ranked the removal of refuse disposal point from flammable facilities as the highest measure to prevent fire hazard. This was followed closely by the control on the bush burning activities and then the appropriate disposal of flammable pollutant. However the least in the ranking is education of the public on the fire prevention measure. Also with reference to the RII value it can be established that the respondents opined that all the identified measure is effective because all the values were above 0.6, which suggest their agreement.

S/N	Fire Prevention Measure	No Of Respondents	Mean	Std. Deviation	Variance	Relative Importance Indices	Ranking
1	Distancing disposal point from flammable facilities.	60	2.66	0.663	0.439	0.93	1
2	Strategic positioning of fire sensing device.	60	3.64	1.039	1.079	0.81	4
3	Control of bush burning	60	2.65	0.480	0.230	0.85	2
4	appropriate disposal of flammable pollutant.	60	3.550	0.951	0.903	0.82	3
5	Proper storage of flammable material	60	2.60	0.548	0.300	0.76	6
6	Enlightening the public on fire prevention measure	60	2.65	0.951	0.903	0.74	7
7	Severe penalty for any unlawful use of fire	60	2.43	0.864	0.747	0.77	5

Table 3: Ranking Of the Fire Prevention Measure

Source, Survey 2021

V. SUMMARY CONCLUSION AND RECOMMENDATIONS

A. *Summary of Findings*

The primary essence of this research study is to assess the fire prevention measure in the communities surrounding the PHRC flammable facilities. in view of this four communities were studied in a quest to assess the fire prevention measure in the communities as they were the communities surrounding PHRC flammable facilities. These communities were studied via the use of a well-structured question and from the opinion of the respondents the following can be established:

- Fire hazard are more often within the month of December to February of the year
- Careless is a major cause of fire hazard in the communities studies as opined by the respondents
- There is no fire prevention measure enlightenment done in that communities
- It can also be established that respondents ranked the removal of refuse disposal point from flammable facilities as the highest measure to prevent fire hazard. This was followed closely by the control on the bush burning activities and then the appropriate disposal of flammable pollutant.

VI. CONCLUSION

From the ongoing the following conclusions can be reached;

- Bush burning is the most reoccurring cultural practice in the areas studied that is a major cause of fire outbreak around PHRC flammable facilities like the PHRC pipe networks. Other practices that possess fire hazard threat include; incineration of refuse close to the PHRC pipe network, electrical fault resulting from illegal electrical connections and Arson.
- There is a pressing need for PHRC at interval to sensitize the member of the fire prevention measure and the danger of some practice around the PHRC pipe networks and other flammable facilities.
- There is a need for PHRC to position some indicators to show the position of it pipe network to help the people of the communities identify and consequently guide against fire at such points.

B. *Recommendation*

Based on the finding of this research study in the areas of study, the following are recommended:

- There should be fire prevention measures enlightenment in those communities as this will help reduces the occurrence of fire hazard as well as combat fire even if it occurs to reduces damages to the

minimum before the intervention of the fire service agents

- Owing to the fact that the PHRC employs more of the smoke detector as identified from the respondents it is recommended that such devices be placed as strategic points that fire outbreak or any mal-function that can lead to fire outbreak can easily be sense and guided against
- It was also discovered that incineration of refuse at disposal point was also a great cause of fire hazard, thus it is recommended that such disposal points should be located very far from PHRC flammable facilities or from spots that it can intercept the flow of combustible pollutants from the PHRC.

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