

ENVIROMENTAL SAFETY OPERATIONS OF LIQUIFIED PETROLEUM GAS (LPG) FILLING PLANTS IN NIGERIA: GAPS BETWEEN GUIDELINES AND PRACTICE

Margaret Olusolape Jegede

African Institute for Science Policy and Innovation

Obafemi Awolowo University

Ile-Ife, Nigeria

Abstract. The study compared the stipulated guidelines of the Nigeria Directorate of Petroleum Resources for safety practices in the siting, construction and operations of LPG filling plants in Nigeria. The study employed observational survey. Forty two LPG filling plants were sampled from 3 states of southwestern geo-political zones of Nigeria. An Interview guide and Safety Compliance Checklist were used to elicit relevant information. Data were qualitatively discussed and analyzed using descriptive statistics. Results showed that wide gap existed between guidelines and existing practice as plants did operate with no approval of relevant regulatory agencies, trainings for safety were uncoordinated. Plant siting were largely hazardous, guidelines regarding safety, disaster prevention and safety instruments as well as emergency management were grossly violated. The guidelines also requires review so as to be responsive to current realities. Supervision from the regulating agencies need improvement for adherence to safety and best practices.

INTRODUCTION

Gas explosion is attracting global concerns and attention. This is because of several recorded gas-related disasters across the world. For example in Korea alone 25 cases of fire and explosions that were LPG related were recorded between 1992 and 2003 [1]. In Tehran, 481 gas related fires were reported between 2002 and 2006 [2]. The explosion at San Juanico, Mexico of an LPG plant on the 19th November, 1984 was the deadliest in human history, about 600 lives were lost and between 5000-7000 others suffered terrible burns. It wasted 11,000m² of LPG, which was one third of the Liquid Petroleum Gas supply to Mexico City, much facilities were destroyed and the local town of San Juanico was devastated. The cause was not unconnected with gas leakage resulting from pipe rupture which was promoted by an ineffective gas detection system [3]. Nigeria as a nation had her share, on February 2018, three people were left dead and others seriously injured after a gas explosion in Abuja. Other cases have been recorded in places like Warri, Osogbo, Owerri all also in Nigeria. A recent cooking gas explosion in Ogun State recorded the loss of six lives and another in sub-urban Lagos had four people wounded [4]. On the 18th day of January, 2018; two lives were lost as a result of an explosion which occurred due to a gas leakage at an LPG plant in Lagos. According to the national Department of Petroleum Resources, more than thirty-nine lives have been claimed by gas explosion at different times in the last five years. The relatively small casualty experienced in Nigeria is largely due to the fact that LPG is being newly adopted as domestic source of energy. However with increasing trend of gas consumption in Nigeria, worries and concerns are being expressed by relevant stakeholders. The Directorate of Petroleum resources reported that LPG storage capacity in Lagos alone increased from 6000 MT in 2014 to 30,000 MT in 2017, It is also expected that this trend will continue as the use of cooking gas by Nigerians has

increased from 110,000 metric tons (MT) in 2013 to 400,000MT in 2016 [5]. It was noted that this exponential growth had come with growing challenges especially on safety. The level of efforts put in place by regulatory agencies to monitor and enforce strict compliance with rules and standards of operation in the Liquefied Petroleum Gas (LPG) subsector is currently being questioned [6]. This is much more so with the influx of gas filling plants and gas retailing outlets located in corridors, shops and open spaces close to residential areas and thereby posing threats to safety of residents and hired workers. It is known that the Directorate of Petroleum Resources produced and published the procedure and conditions to be fulfilled before the grant of approval and license for the construction, modification, relocation of a LPG filling plant and Auto gas station. It is not known the extent of compliance of plants to the stipulated regulations. Informal observation had shown that LPG are located within residential areas. It was also found that some of the gas cylinders which were used in some of these plants were already rusty and as well questioned the form of training possessed by the operators in these gas plants. Most LPG explosions occur as a result of Vapour Cloud Explosion (VCE) events, starting with leakages due to damages of the connecting tube or defective valve sealing the cylinder. It was reported that those incidences occurred due to, "Mishandling of gas cylinders, Wrong location of liquefied petroleum gas outlets, and refusal of proprietors to follow laid down procedures for the establishment of gas stations". Most of the LPG management and their staff were said to lack enough training on how to adequately secure their stations. It was also said that most of the LPG materials and equipment are substandard and imported second-hand accessories, these materials were said to have been brought into Nigeria after they have been used in Europe, North America and other parts of the world. The fact remains that if appropriate practice and due processes are not observed, more explosions will be expected in the coming years.

Studies bordering on compliance have been underpinned by the Theory of Regulatory Compliance (TRC) which was put forth by [7] deals with the importance and significance of complying with set rules or regulations. This has implications for all rules and regulatory standards in all human services. It deals with the relationship between compliance with rules and those of best practices. This theory proposes that as facilities were in 100% compliance with all rules, their overall best practices scores and positive outcomes began to drop off, [8] later built on this by demonstrating that the pure deterrence model of regulatory compliance is focused primarily on the certainty and severity of sanctions as key determinants of compliance. It is highly necessary to regulate industries that deal in natural resources due to the prevalence of externalities and the goods of the public. The issue of public/environmental safety and security are potential problems hence the need for regulations. And such regulations are carried out through surveillance, monitoring and enforcement.

There are usually little or no recognition of how policies and the process may affect the extent of compliance with regulation. Policy analysis and formulation most often assume perfect compliance can be achieved at no cost, yet, when things go wrong, enforcement is seen as the major reason for the failure.

It is therefore cardinal to assess the level of compliance of the stations with the guidelines stated by the Nigeria Department of Petroleum Resources vis-a-vis plants citing and constructions, machineries specifications, operations and management with safety in focus. Many formulated policies in Nigeria had failed in the course of implementation, [9]&[10] was of the opinion that there is a wide disparity between policy pronouncements and policy implementations. This situation may not have changed after all. Whether the written guidelines were adhered to, the extent of the adherence and the quality of supervision put in place by the supervisory agency towards achieving safe and hazard free environment becomes the burden of this study .Specifically, the following objectives will guide the study.

- 1) Examine the compliance of LPG filling plants with the published guidelines regarding the process and procedure for siting and establishing the plant.
- 2) Compare the stipulated safety specifications regarding siting, construction, facility and operations of the LPG filling plants with the existing practice.

- 3) Examine the aspects of needs uncovered by the written guidelines but required for safe practices of LPG filling plants.

METHODS

The study adopted observational survey design. Three Nigerian southwestern states, namely Oyo, Ondo and Osun were selected for the study. The southwestern zone was adjudged to be most appropriate for the study as it is deemed to be the most urbanized of the six geo political zones with likely higher prevalence of LPG usage. Forty two LPG plants in the three state capitals were used for the study. Data were collected with the aid two instruments, (an interview guide and an observation checklist). The interview guide was used to elicit information from managers and owners on processes and procedures observed by them in the course of plant location/ establishment, this was meant to determine the extent of compliance with due process and clearance for regulatory agencies. Plant characteristics such as number of workers, capacity in tones, year of operations etc. were also obtained. The Observation checklist was of 22 items generated from the guidelines for siting, location and operations of LPG plants in Nigeria. The purpose of the checklist was to compare existing facilities, operations and locations with of the plants with stipulated guidelines. The checklist was divided into 5 subscales viz, Storage tank accessories (6 items), operational safety (4 items), sundry plant safety instrument (3 items), plant construction (5 items) and emergency management (2 items). Storage tank accessories verified the availability of pressure gauge, devices for measuring liquid content and temperature, excess flow valve, shut-off valve, water sprinkler and access ladder for maintenance and inspection. Operational safety subscale verified safe storage of cylinders, filling of cylinders in designated area, level of illumination of work area, general plant safety instrument examined the availability of seal provision for water drains, mechanical leak tester and gas detector. Plant construction subscale examined the presence of a minimum of 2 meters fence, safe distance between storage tanks, level of aeration at the filling points, distance between plant and neighboring buildings, as well as land area covered by plant while emergency management subscale checked the existence of fire extinguishers at strategic places and conspicuous display of emergency telephone numbers.

The resulting data were analyzed and discussed using descriptive statistics.

RESULTS

In examining the compliance of LPG filling plants with the published guidelines regarding the process and procedure for siting and establishing the plants, the guidelines stipulated the government agencies that must be contacted with approval sought and obtained before siting, construction and operations. The cardinal regulatory agency was the Directorate of Petroleum Resources (DPR), however the Town Planning Division was to monitor and grant approval for siting, designing and construction of the plant so as to ensure both functionality and safety, the Standard Organization of Nigeria (SON) was meant to ensure compliance of the facilities' materials with prescribed standards (i.e. pressure vessels and LPG containers). The Fire department was meant to be satisfied with the proposed fire prevention or management arrangement. The weight and measure unit of the Federal Ministry of Commerce (though of non-safety concerns) ascertains the satisfactory calibration of the measuring equipment. Resulting data using the interview guide are as stated in table 1. From the table, Fire department (85%) was the most contacted before operation. However the DPR (78%) and the Town Planning Authority (78%) ranked second. DPR reported the highest visit (83%) before operation. But 93% were certified by DPR before operation. It follows that some LPG plants were operating without being licensed. It also follows that some were licensed by the DPR without certification or approval from SON, Town Planning Authority and Fire Department as stipulated in the guideline.

In comparing the stipulated specifications regarding siting, construction, facility and operations of the LPG filling plants with the existing practice, the 22-items checklist was used to assess the plant facilities and locations under 5 subheadings as previously discussed. The result is stated

in table 2, Storage tank accessories and Plant construction had the highest compliance (with means 4.63, 3.86) respectively. Safety operations had mean 2.88 with sundry plant facilities and emergency management constituting the least (with means 1.21 and 1.41) respectively. In all the safety index had the mean of 14 on the scale of 22.

For clearer presentation so as to further locate points of possible deficiencies, the item by item responses were collated in table 3. In Plant accessories, shut-off (57%) valves and ladder (73%) for climbing the storage tanks for maintenance and inspection were the most deficient. Under operational safety, Cylinders are not stored in the cylinder filling area (57.1%), personal protective wears used (43%) had the poorest compliance. All the 3 items in general plants safety instruments showed very poor compliance. Plant construction enjoyed a relatively higher compliance. However lack of conspicuous display of telephone numbers was the bane of the emergency management.

In examining the areas of needs uncovered by the written guidelines but required for safe practices of LPG filling plants, free responses from some LPG plant managers recommended the inclusion of muster points in the guidelines, this was anticipated for better emergency management. The need for specific requirement for emergency exit was also noted as most of the plants had no emergency exits. Needs also existed for coordinated training. Pockets of training were held or provided by different training providers with different focus. It may be necessary to stipulate in the guideline, mandatory operational safety training coordinated by the DPR themselves that would constitute the minimum. Other trainings as deemed fit by individual plants can be added.

Table 1: extent of compliance of lpg filling plants with stipulated guidelines regarding the process and procedure for establishing plants facilities.

REGULATORY/APPROVING AUTHORITY	CONTACT APPROVING BODIES BEFORE OPERATION	VISITED BEFORE OPERATION	CERTIFIED BEFORE OPERATION
1. Standard Organization of Nigeria (SON)	28 (66.7%)	30 (71.4%)	27(64.2%)
2. Town Planning Authority	33 (78.6%)	30 (71.4%)	26 (61.9%)
3. Federal or State Fire Department	36 (85.7%)	30 (71.4%)	29 (69.0%)
4. Weight and Measures Division of Federal Ministry of Commerce	24 (57.1%)	29 (69.0%)	30 (71.4%)
5. Directorate of Petroleum Resources	36(78.6%)	35(83.3%)	39(92.9%)

Table 2: safety compliance level of lpg filling plants

	N	Minimum	Maximum	Mean	Std. Deviation
Storage Tank Accessories	42	1.00	6.00	4.6429	1.14384
Operational Safety	42	1.00	4.00	2.8810	.94230
Sundry Plant Safety Instrument	42	.00	3.00	1.2143	1.13773
Plant Construction	42	.00	5.00	3.8571	1.15972
Emergency Management	42	.00	2.00	1.4048	.82815
Total	42	5.00	20.00	14.0000	3.49913
Valid N (listwise)	42				

table 3: extent of compliance with safety specifications of lpg plants

STORAGE TANKS	
ACCESSORIES	
1. Storage tanks are fitted with pressure gauge.	41(97.6%)
2. Storage tanks are fitted with devices for measuring the liquid content and its temperature.	36 (78.6%)
3. Excess flow valves are fitted to storage tanks.	38 (90.4%)
4. Remote control hydraulically operated shut-off valves are fitted to each storage tanks.	24 (57.1%)
5. Water sprinkler systems are provided on top of the gas level.	37 (88.0%)
6. Access ladder is available for climbing the top of the gas storage for inspection and maintenance needs.	31 (73.8%)
OPERATIONAL SAFETY	
1. Cylinders are not stored in the cylinder filling area.	24 (57.1%)
2. Cylinders are filled with LPG only in buildings designed for that.	32 (76.1%)
3. Adequate lightings are provided to illuminate the working and the storage areas of the plant.	32 (76.1%)
4. Personnel Protective Wears are used.	18(42.9%)
SUNDRY PLANT SAFETY	
INSTRUMENTS	
1. Water drains from the filling area are provided with effective seals.	17(40.5%)
2. Gas Detector.	19 (45.2%)
3. Mechanical Leak Tester.	15 (35.7%)
PLANT CONSTRUCTION	
1. A fence of at least 2 meters high is provided.	41 (97.6%)
2. Storage tanks are at least 1 meter apart.	31 (73.8%)
3. Filling buildings are open-sided.	34 (80.9%)
4. Plant is at least 15 meters from neighboring buildings.	27 (64.3%)
5. The plant occupies a minimum of two plots of land	34 (80.9%)
EMERGENCY MANAGEMENT	
1. Fire extinguishers exist and are provided in strategic places within the premises.	40 (95.2%)
2. Emergency telephone numbers for assistance are conspicuously displayed.	16(38.1%)

DISCUSSIONS

Results from the study shows clearly that wide gap existed between guideline stipulations and practices. It was obtained that some plant did operate without approval from the DPR; the supervisory agency i.e. no application, no inspection and no certification. This gross violation portends great hazards to the environment as the absence of approval implies absence of supervision. The implication of this is that minimum standard for safe practices could not be ensured. Also contacts and visits (on-the-site-inspection) did not align. Some agency visited the facility without invitation, this could be in the process of routine check. This effort should be strengthened as it seemed to be yielding better compliance. A major area of poor compliance

was in that of sundry plant equipment such as leak testers or smoke detectors, this would prevent early emergency response thus leading to major disaster an otherwise preventable hazards. Even though, majority of the plants were situated on a minimum of two plots of land as stipulated, distances from combustible or inflammable materials were not reasonably maintained. Eighteen (43%) of the 42 plants were situated within gasoline filling station, this appears to be an issue that require clear statement in the course of guidelines review. It would seem that the supervisory agency was permissive of this practice which may lead to an uncontrollable inferno. Few plants were also located under high tension cable, another area of concern was the non-challance in the display of warning notices. Majority of the plants (83%) displayed “No Smoking” warning, 40% displayed “No phone calls”. Other warning notices such as “Liquefied Petroleum Gas”, “Highly Flammable”, “Switch off Engine”, “Apply Handbrake”, “No Naked Flames” were largely ignored. Mandatory coordinated training is also needed before operations and from time to time for best practices and uniform attitude to operational safety. The summary of this is that more supervision is needed for safe operation of the LPG filling gas plants.

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