DEVELOPING SUSTAINABLE ELECTRICAL POWER FOR NIGERIA FROM NATURAL GAS: MEASUREMENTS AND DOCUMENTATION FOR CONSTRUCTION OF NATURAL GAS DISTRIBUTION PIPELINES FROM GATHERING FACILITIES TO POWER PLANTS

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Key words: Natural Gas, Electricity generation, Oil Pipeline License, Alignment Drawings

SUMMARY

Nigeria needs investment in almost all sectors of the economy. However, there is serious power shortage as a result of gas crisis, arising from the Niger Delta crisis. Investors are sceptical about investing in an economy where power supply for industry is in short supply.

This is why the Federal Government has accelerated efforts to resolve the Niger Delta crisis. The gas industry is relatively new in Nigeria but a network of gas pipelines is being developed to transport gas both to power plants, local domestic consumption and for export. All these gas lines require mapping at various stages of their development.

For instance in order to plan, design and construct the pipelines, it require Right of Way surveys, alignment sheets, Population Density, maps of crossing and other types of maps. All these maps have to be produced to meet the requirements and demand of both the EPC Contractor and the Client. They are also needed to secure Pipeline License from Government. There is therefore, the need to diligently execute all these types of surveys using Modern technology for field works, data Processing and production of the final maps.

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1.0 INTRODUCTION

In order to accelerate the growth of small, medium and large scale industries in Nigeria it became imperative that other sources of power supply must be explored to supplement the electricity generated by the existing three hydropower and two thermal power generating stations in Nigeria,

In the first instance, the federal Government of Nigeria set up the National Integrated Power project in 2003 to **explore** ways of developing Gas powered electricity power stations to increase the electricity production in the country.

As a result of the studies carried out by the body, the Geregu, Omotosho and Papalanto Power stations were developed. These three stations were to rely solely on gas supply from the Niger Delta region of Nigeria. While the Geregu power plant was to be supplied gas from Oben fields in Edo State, Omotosho and Papalanto were to rely on the Escravos Lagos Gas pipeline (ELP) which also supply gas to the Egbin power plant in Lagos.

The power Holding Company of Nigeria the main body responsible for generation and distribution of electricity had installed capacity to generate 6000 mega watts of electricity by December 2009 if gas was made available to power the plants. (Technical report by PHCN 2009)

Apart from the above, the Niger Delta Integrated power project was set up by the government in 2006.

The purpose of setting up this body was to develop independently of PHCN, seven new power plants which if finally implemented will help to accelerate rapid industrialization and development of the Niger Delta region. All these power plants were planned and designed to be powered by natural gas.

In order to transfer these gas requirements to the power plants, hundreds of kilometre of gas pipelines are required to be laid.

To lay the pipes require various types of surveys to be carried out. Such surveys allows for the planning, design and laying of pipe lines from the gas source to the power plants

2.0 PIPELINE NETWORK OPERATIONS FOR POWER PROJECTS IN NIGERIA

The development of all export pipe lines to power plants require a multi disciplinary approach.

The teams consists of the followings:

- Surveying and mapping team
- Soil survey
- Environmental Impact Assessment
- Engineering Procurement and Contracting (EPC)

The soil survey was to be based on a base map as all the sampling points have to be georeferenced.
The environmental impact Assessment sampling and measurement also needed to be based on appropriate map and geodata for displaying and analyzing impact severity and sensitivity. The EPC contractor also required maps and geodata for pipeline design and construction. Thus the surveying and mapping team represented the centre upon which all the other teams revolve.
Three Gas pipelines projects for which the author and his team were involved included the Oben – Ajaokuta – Geregu Power Plant. Gas Pipeline, ELP – To Omotosho Power plant, EPL Itokin – Papalanto Power plant projects under the National Integrated power project and the Oredo – Panocean – Ihovbor power plant project in Edo state under the Niger Delta Integrated power project. (See Fig. 1a).

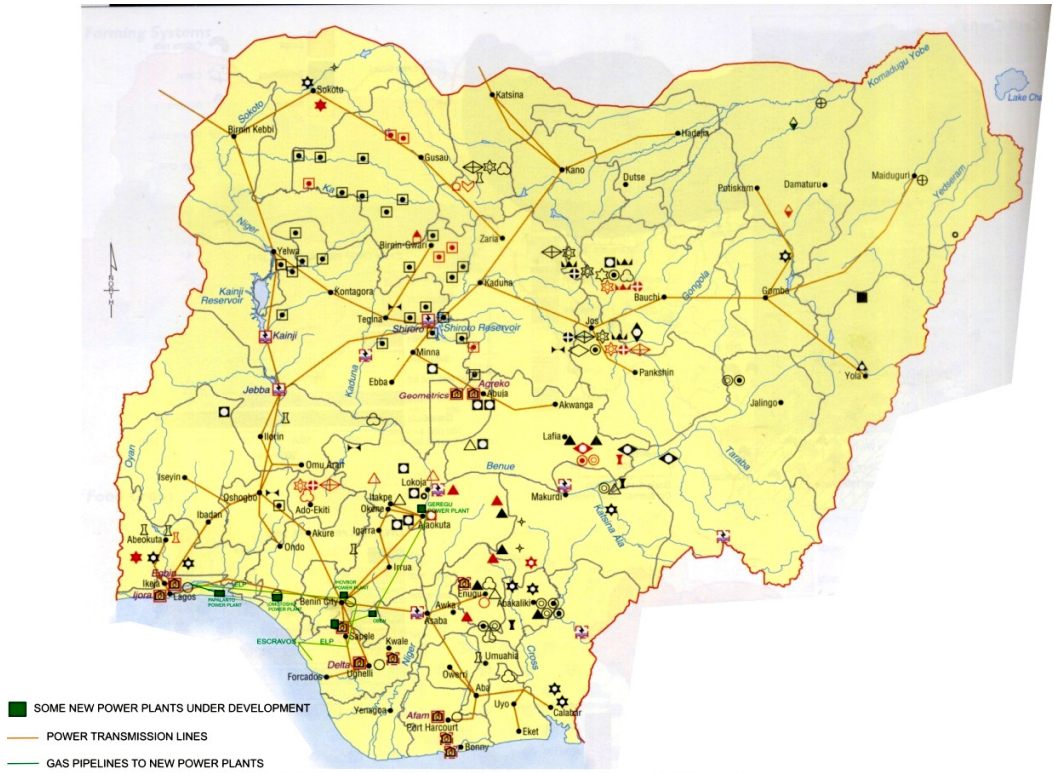


FIG I: SOME NEW POWER PLANTS AND GAS LINES

3.0 PIPELINE SURVEY LAWS AND SPECIFICATIONS IN NIGERIA

There are certain requirements for pipeline surveys that have been established primarily for the need to ensure state control of survey practices in the oil and gas industry and to ensure a sound basis for design, construction tendering and the actual construction of the pipeline itself.

As provided for in the oil pipelines Act of 1956 cap 145 and as amended by oil pipeline Act of 1965, a permit to survey shall entitle the holder subject to the provision of section 6, to enter together with his officers, agents, workmen or other servants and with any necessary equipment or vehicles on any land upon the route specified in the permit or reasonably close to such route for the purpose of (Oil Pipeline Act 1965)

- To survey and take levels of the land
- To dig and bore into the soil and subsoil
- To cut and remove such trees and other vegetation as may impede the purpose specified in this subsection
- To do all other acts necessary to ascertain the suitability of the land for the

establishment of the pipelines.

Where a route crosses any other type of short term different terrain, such as river or creek or an existing facility such as road, railway, power transmission line, other pipeline, etc large scale detailed survey shall be carried out.
The intersection of tangents to the curve of Pipelines where the route changes direction shall be surveyed.

3.1 Requirements For Surveys In Accordance With The Provision Of The Pipeline Acts

The requirements shall include:

- Selecting the best of a number of alternative routes for the pipeline.
- Mapping the selected route for submission to Government agency responsible for granting pipeline License.
- To depict details in areas where the pipeline route crosses other facilities in order to inform Government of intentions
- To Provide all necessary data for the design of the line and the planning and production of contract documents for contractors tendering.
- To assess the land for lease and compensation to land owners.
- For cadastral and determination of land titles.
- For the production of As-Built drawings.

4.0 MEASUREMENT AND DOCUMENTATION FOR DESIGN AND CONSTRUCTION OF GAS PIPELINE FROM GAS PLANTS TO POWER PLANTS

Although linear projects such as pipelines are easy to define by placing a pipe of known diameter and characteristics from origin to destination require extensive planning, Engineering and Environmental Impact Studies (Akkus et al 2007, Ehiorobo 2008)

Such studies require the availability of maps at appropriate scale and cadastral plans showing ownership of lands through which the pipelines should pass.

In Nigeria, such maps are not available in most cases. Satellite imageries can therefore be used in planning the pipeline route. The final route is determined from results of preliminary route surveys and in combination with environment and geological data.

Once the route has been selected, detailed investigation and mapping of the pipeline route follows. The types of survey carried out include:

- Right of Way Surveys
- Centreline Profiling
- Survey of Crossings
- Population density Surveys
- Bathymetric Survey
- General Detailing

4.1 Right Of Way Surveys

The major route the Oben – Ajaokuta Geregu Gas Pipeline covers a total distance of 202.4Km.

The route was divided into sections of approximately 40Km interval, the division into sections of 40Km was to allow ease of management and coordination. At the beginning of each section, two GPS points were established. The GPS points were then connected by Total Station traverses along both sides of the Right of Way. The section with the corresponding No of GPS points are shown in table 1 below:

S/No	Sections	Total Distance (Km)	No of GPS points	Remark
1	Oben - Agbor	39.74	4	Commences from Oben Metering Station
2	Agbor - Ugbegun	40.5	4	
3	Ugbegun – Km 120	40.0	4	
4	Km 120 – Km 160	38.3	4	
5	Km 160 – Ajaokuta Geregu Power Plant	43.86	4	Terminates at Geregu Power Plant Metering Station
	TOTAL	202.4		

The GPS observation was carried out by Differential GPS in static mode using 3 Nos dual frequency Leica 300 GPS receivers.

The processing of GPS data was carryout using SKI version 2.3 Software. Traversing along the Right of Way was carried out in loops of five kilometres maximum using the Total Station Instrument.

4.2 Mapping Of The Right Of Way

The Mapping of the Right of Way included:

- Levelling within the Right of Way
- Bathymetric Surveys of water courses
- Survey of Crossings
- Survey of existing pipelines and other services
- Population density Surveys

4.3 Population Density Surveys

All individual houses and dwellings within 200 meter from pipeline route axis were surveyed with the aid of the Total Station instrument.

For other settlements between 200m and 500m of the pipeline Right of way, their position and distances from the pipeline right of way were measured and their boundaries and names recorded for inclusion in the population density maps.

4.4 Soil Survey

Soil characteristics, types and texture, crops and vegetations were observed and recorded on field notes

5.0 RESULTS AND DISCUSSIONS

The results of the survey work were presented in various types of Drawings and tables as follows:

- Right of Way (ROW) Drawings
- Pipeline Route (Alignment Drawings)
- Survey Map of Areas
- Oil Pipeline License OPL Map
- Population Density Maps

5.1 Population Density Survey Results

The computed population density survey results are presented in table II.

TABLE II: POPULATION DENSITY TABLE (FIELD DATA)															
SECTION I FROM NPDC FLOW STATION (OLOGBO) TO PAN OCEAN GAS PLANT (OVADE-OGHAREFE)															
Community Name	**Houses**	**Uncompleted building**	**Storey Building**	**Churches**	**Hospitals**	**Mosque**	**Market**	**Schools**	**Town halls**	**Banks**	**Public Buildings**	**Others**	**Sections**	**Population**	**Class**
Ologbo	0	0	0	0	0	0	0	0	0	0	0	0	00+00 - 01+500	0	I
Ologbo	0	0	0	0	0	0	0	0	0	0	0	0	00+500 - 03+000	0	I
Ologbo	0	0	0	0	0	0	0	0	0	0	0	0	03+000 - 04+500	0	I
Ologbo	0	0	0	0	0	0	0	0	0	0	0	0	04+500 - 06+000	0	I
Ologbo	0	0	0	0	0	0	0	0	0	0	0	0	06+000 - 07+500	0	I
Oghobaye (Ologbo)	57	8	0	3	1	0	0	2	0	0	2	1	07+500 - 09+000	399	III
Ologbo	0	0	0	0	0	0	0	0	0	0	0	0	09+000 - 10+500	0	I
Ologbo	0	0	0	0	0	0	0	0	0	0	0	0	10+500 - 12+000	0	I
Ologbo	0	0	0	0	0	0	0	0	0	0	0	0	12+000 - 13+500	0	I
Ologbo	0	0	0	0	0	0	0	0	0	0	0	0	13+500 - 14+750	0	I
Ovade-Ogharefe	0	0	0	0	0	0	0	0	0	0	0	0	14+750 - 15+000	0	I
Ovade-Ogharefe	0	0	0	0	0	0	0	0	0	0	0	0	15+000 - 16+500	0	I
Ovade-Ogharefe	0	0	0	0	0	0	0	0	0	0	0	0	16+500 - 17+218	0	I

The results showed that on this pipeline section between Ch. 00 + 000 and Ch. 20 + 000, population exist only between Chainnage 08 + 000 and Ch. 09 + 000.

5.2 Drawings

5.2.1 Row Drawings

The Right of Way drawings for a section of the pipeline is shown in Fig 1. The Right of Way drawings are designed to show the pipeline corridor, 25m wide with details and this makes them useful for Land acquisition and compensation purposes.

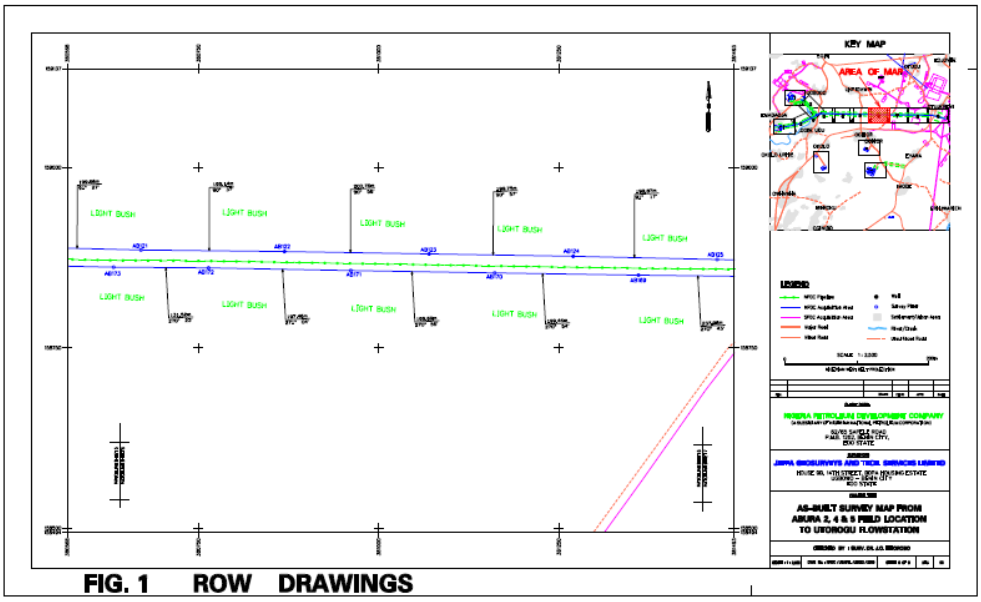


FIG. 1 ROW DRAWINGS

5.2.2 Alignment Sheets

Alignment drawings were used to present the ground profile and these are used for the pipeline design.

The alignment drawings were prepared at scale 1 in 5000 horizontal and 1 in 500 vertical. Typical alignment drawing plan is shown in Fig. 2 below:

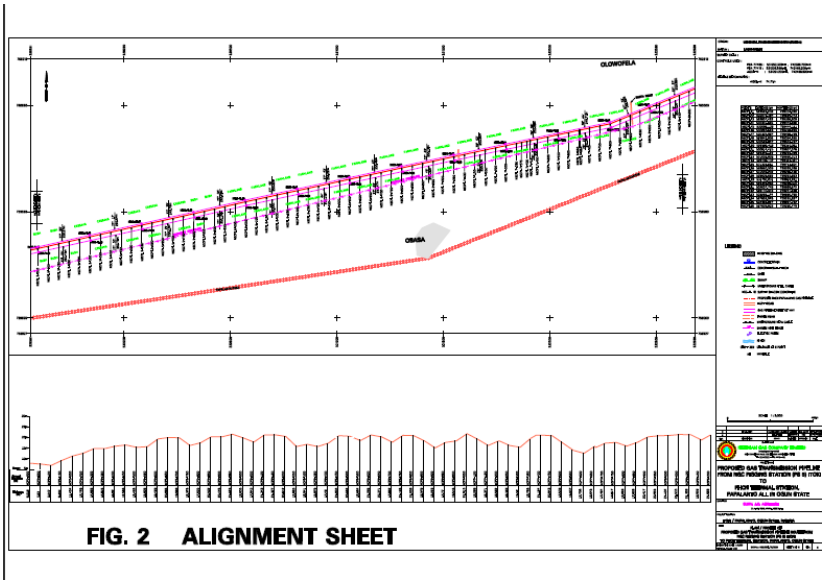


FIG. 2 ALIGNMENT SHEET

5.2.3 Population Density Drawings

The population density drawings were prepared at scale 1 : 2000 and the population density map between Ch. 08 + 000 and 09 + 000 is shown in Fig 3.

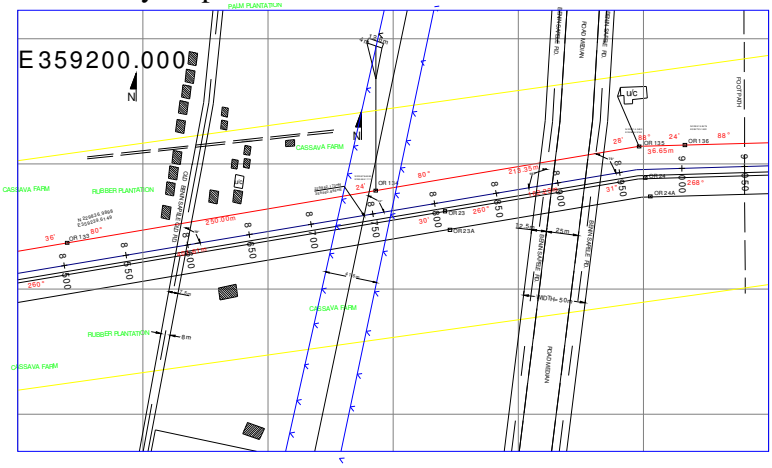
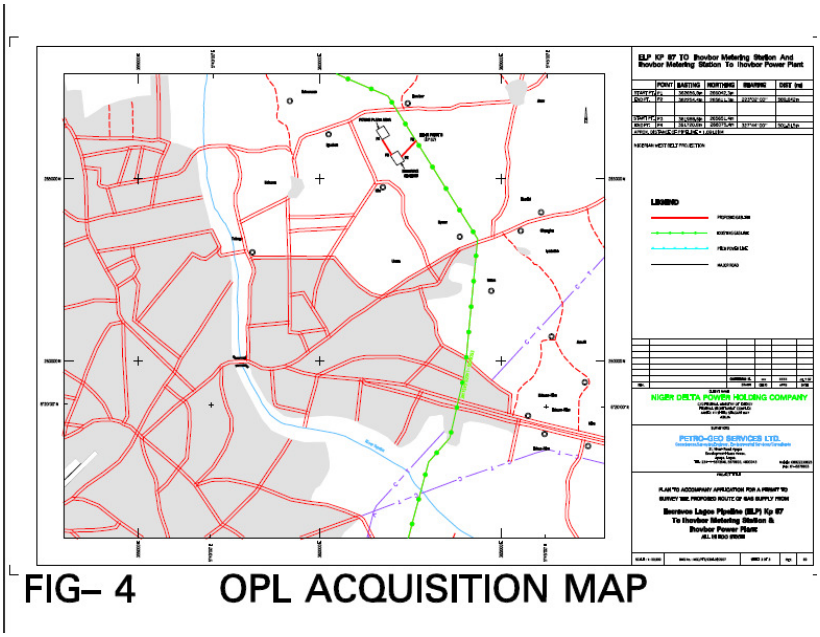


Fig 3: Population Density Map

5.2.4 Oil Pipeline License Opl Map

OPL are based on existing topographical maps at scale 1:50, 000 or 1: 25, 000. The map shows the position of the pipeline route axis, coordinates of starting and end points, intermediate intersection points with grid azimuth and distances between points annoted. OPL map prepared to accompany application to survey a proposed Gas pipeline route is shown in Fig. 4 below:



FIG– 4 OPL ACQUISITION MAP

CONCLUSION

On completion of all field work, data processing and map and reports were prepared which included the description of survey methods used, data processing software used, Geodetic parameters, list of pipeline route intersection points with their coordinates, progressive kilometres, list of beacons installed in the Right of Way with relevant coordinates, elevation and I. D numbers, quality control results and safety evaluation report. It is to be noted that all the survey data are needed for the proper planning, design, construction and management of pipelines in their various locations.

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BIOGRAPHICAL NOTES

Jacob Ehiorobo is a senior lecturer in the department of Civil Engineering, University of Benin, Benin City, Nigeria where he teaches Engineering Mathematics, Engineering Surveying, Photogrammetry, Remote Sensing and GIS. He obtained an M.Sc Surveying Engineering Degree from MIIGAIK, Moscow in 1983, and PhD in Geomatics Engineering from the University of Benin in 2008. HE has served as a Consultant on various roads and water infrastructure development Projects and in the Oil and Gas Industries in Nigeria. His research interests are in Deformation Surveys and Analysis, Engineering and construction Surveys, GIS and Land Information Management. He is a member of the Editorial Board in various Journals in Nigeria. He is also a member of FIG Commission 6.

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