



**Materials, Corrosion and Inspection.  
(Civil/Structural Asset Integrity &  
Maintenance Team)**

**Structural Integrity Assessment of  
Foundations and Pipe Supports in Spiking  
Pumps Area of SOKU Gas Plant**

4<sup>th</sup> February 2021

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## Revision History

REVISION STATUS			SIGNATORIES		
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<b>Revision Philosophy</b> <ul style="list-style-type: none"> <li>Preliminary issue will be issued as P01</li> <li>Revisions for review will be issued as R01, with subsequent come as R02 etc.</li> <li>Revisions approved for Implementation/Design Issue/Eng. will be issued as A01, with subsequent come as A02 etc.</li> <li>Revisions approved for Tender will be issued as T01, with subsequent come as T02 etc.</li> <li>Revisions approved for Construction (AFC)/Purchase will be issued as C01; with subsequent comes as C02 etc.</li> <li>Highlights of sections revised from previous approved issues or reasons for version change are to be listed in the description box</li> <li>All revisions to this document must be signed by the relevant Technical Authority (TA1, TA2 or TA3)</li> </ul>					

## Signatures for This Revision:

Role	Name	Signature	Date
Originator	Edson Akpotha		12/02/2021
Reviewer	Ezenwelu Forster		
Approver	Forster Ezenwelu		

More field(s) could be added for signature if additional agreement/approval is required.

## Executive Summary

The Civil/Structural Asset Integrity and Maintenance Team carried out a structural integrity assessment of the foundations in the Spiking Pump area of Soku Gas Plant on 28<sup>th</sup> January 2021. The aim of the report was to assess the current state of the foundations and proffer solutions to the increased levels of vibrations when the Pumps are in operations. The assessment method was general and closed visual inspections including measurements and pictures for further assessments.

It was observed that gaps exist between the Suction Lines and Discharge Headers of the Pumps and their supports. The gaps which range from 35mm to 100mm resulted from consolidation settlements of the shallow foundations due to underlying silty clay soil in the area. The estimated maximum settlement based on previous settlement calculations is 389mm and would have been completed in the year 2019.

Hence, it is recommended to use Neoprene Bearing Pads or Electrometric Bearing Pads to pack into the spaces between the Pipes and their supports. This should be monitored throughout the life of the assets.

# STRUCTURAL INTEGRITY ASSESSMENT OF FOUNDATIONS IN SPIKING PUMPS AREA OF SOKU GP

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## 1.0 BACKGROUND

Following the email report on the vibrations observed in the Spiking Pump area of Soku Gas Plant, which become severe during operations, the Asset Owners requested for an assessment of the facilities by the Civil/Structural Asset Integrity & Maintenance Team with a view to proffering the best possible solutions that will mitigate the vibration problem.

An assessment to identify the probable cause of the vibration was carried out on the 28<sup>th</sup> January 2021. The inspection was limited to visual inspections, linear measurements, and discussions with Operations Personnel working in the Gas Plant.

## 2.0 SPIKING PUMPS:

The Spiking Pumps A and B in Soku Gas Plant were installed transfer condensate from the Gas Plant into the Gas Pipeline for transportation to Bonny Oil and Gas Terminal BOGT). The Spiking Facilities were installed in 2009.

The suction lines and discharge headers of the Pumps are supported on steel stanchions on shallow foundation concrete footings

## 3.0 STRUCTURAL INTEGRITY ISSUES:

Close visual inspection showed that some of the Pipe Supports are currently not in contact with the Pipes they support. Structurally, the weight of the Pipes under gravity should rest on the Pipe supports which have been designed to support the Pipes.

However, in the discharge header of Spiking Pump B, there is a 35mm gap between the Pipe Supports and the Pipe. See pictures below.

## STRUCTURAL INTEGRITY ASSESSMENT OF FOUNDATIONS IN SPIKING PUMPS AREA OF SOKU GP



**Gap between Pipe and Pipe Support due to Consolidation Settlement of Shallow Foundation**

Wooden packing (80mm thick) placed in the gap between the Suction Line of Spiking Pump B and its support has deteriorated. This has rendered the packing non-functional – see picture below.



**Deteriorated Wooden Packing between Suction Line of Pump B and and Support**



## STRUCTURAL INTEGRITY ASSESSMENT OF FOUNDATIONS IN SPIKING PUMPS AREA OF SOKU GP

The Suction Line of Spiking Pump A has detached from its support with a gap of 100mm – see picture below.



**Gap between Pipe and Pipe Support due to Consolidation Settlement of Shallow Foundation**



**Wooden Packing used to close Gap between Suction Pipe of Pump A and its Pipe Support**

**This gaps between the Pipe Supports and the Pipes is an indication that foundations of the supports are undergoing consolidation settlements.**

The effects of this settlement on the Manifold are as follows.

- The free unsupported length of the Pipes will cause them to behave like a slender/flexible structural members, thus causing them to vibrate at a larger amplitude than when it is firmly secured at the supports under normal working operations.
- The vibrations will be propagated back to the Pumps and where the operating frequencies of the Pumps coincides with that of the vibrating force, resonance will occur causing the vibrations to occur at higher amplitudes.

#### **4.0 ASSESSMENT OF SETTLEMENT EXTENTS & BEHAVIOUR:**

Assessments carried out earlier on foundations at the Gas Plant showed that due to underlying silty clay materials in the area, shallow foundations therein undergo consolidation settlements. As shown in the gaps between the Pipes and Pipes supports, there are different levels of settlements within the Spiking Pumps area, ranging from 35mm to 100mm..

From settlement analysis carried out earlier (ref: SPDC-2017-06-00000184), the maximum settlement predicted by mathematical model is 363mm and will occur over a period of about 10years due mainly to consolidation settlement of the silty clay stratum underlying the site. Since the Pipes and Supports were installed in 2009, the consolidation settlements may have reached the maximum value by 2019.

#### **5.0 RECOMMENDED SOLUTION:**

The solution for the vibrations is to ensure that the Pipes have contacts with their Supports to allow efficient load transfer from the piping to the support members. The packing material should be flexible, tough and resistant to wear and tear.

Hence, it is recommended use **Neoprene Bearing Pads** or **Electrometric Bearing Pads** This will effectively reduce the vibration in the Pumps by providing a damping effect at the support positions.



## **STRUCTURAL INTEGRITY ASSESSMENT OF FOUNDATIONS IN SPIKING PUMPS AREA OF SOKU GP**

The maintenance plan will be to continuously use the support packs throughout the life of the asset to manage the settlement problems. However, if the estimated settlement exceeds safe limits where it becomes unsafe to still use the Pumps, then a strategy for Life