Onshore Engineering Nigeria
(Operations Support & WRFM)

TECHNICAL NOTE: Gbaran Flared Gas Reduction during TNP Outage

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Revision History

REVISION STATUS			SIGNATORIES		
Rev.	**Date**	**Description**	**Originator**	**Reviewer**	**Approver**

- Preliminary issue will be issued as P01
- Revisions for review will be issued as R01, with subsequent come as R02 etc.
- Revisions approved for Implementation/Design Issue/Eng. will be issued as A01, with subsequent come as A02 etc.
- Revisions approved for Tender will be issued as T01, with subsequent come as T02 etc.
- Revisions approved for Construction (AFC)/Purchase will be issued as C01; with subsequent comes as C02 etc.
- Highlights of sections revised from previous approved issues or reasons for version change are to be listed in the description box
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Signatures for this revision

Role	Name	Signature	Date
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1. BACKGROUND

The Gbaran central processing facility (CPF) is the main hub of Gbaran-Ubie Integrated Oil and Gas project. Its primary function is to collect Non-Associated Gas (NAG) from several reservoirs and separate the gas from condensate and associated water at approximately 90 - 100 barg. It consists of a NAG processing system and crude oil/condensate stabilization units where condensate from the NAG processing Facility and oil from the oil wells are stabilized and afterward transported to Bonny Oil and Gas Terminal (BOGT) via the Trans Niger Pipeline(TNP). Flash gas from the condensate and oil stabilization trains is compressed via the booster and main associated gas (AG) compressors.

During TNP outage, Gbaran CPF usually flare ca 20 MMscfd of flash-off from the condensate stabilization train. This is because oil production is stopped and only NAG is produced during such periods and the flash-off gas from condensate is insufficient to meet the minimum flow requirement (ca. 40 MMscfd) for the main AG compressors, hence the gas is flared. This technical note aims to address this by proposing a piping modification that would enable routing of ca 20 - 30 MMscfd of fuel gas from the HP fuel gas unit to the main AG compressor manifold to make up the minimum flow of 40 MMscfd required for the main AG compressors to run during TNP outage.

2. PIPING MODIFICATION TO ROUTE HP FUEL GAS TO THE AG MAIN COMPRESOR

The figure below is a schematic for routing HP fuel gas to the main AG compressor inlet manifold.

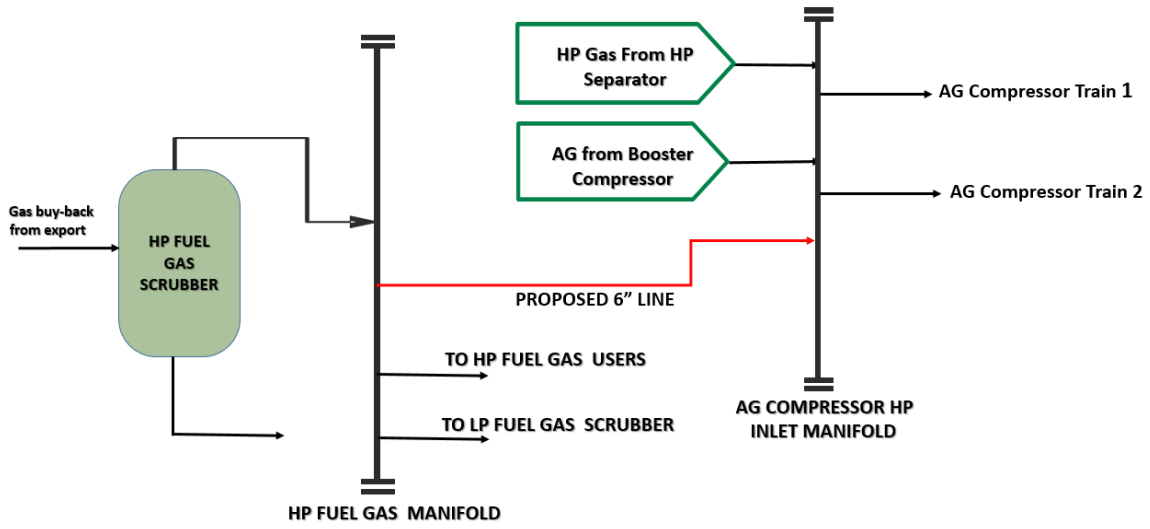

Fig.1: Schematic showing proposed line from HP fuel gas manifold to main AG compression inlet manifold

3. LINE SIZING

The proposed modification is to determine the optimal size for a gas line which would safely route 20 MMscfd to 30 MMscfd of fuel gas from the HP fuel gas unit to the main AG compressor manifold to

make up the minimum flow of 40 MMscfd required for the main AG compressors in the event there is TNP outage. The line sizing calculation carried out showed that a 6-inch carbon steel piping is adequate for routing 30 MMscfd (maximum) to the main AG compressor inlet manifold. The sizing criteria is based on maximum allowable gas velocity of 60 ft/s provided the gas momentum of 50000 Pa is not exceeded as specified in the DEP 31.38.01.11-Gen (Piping - General Requirements, Feb. 2017). The relevant line sizing equation as specified in API RP 14E and is given by:

$d = [60*Z*Q_g*T/(V_g*P)]^{0.5}$

Where: d is the pipe inside diameter in inches

Z is the gas compressibility factor

Q_g is the gas flow rate in MMscfd

T is the operating temperature in °R

V_g is the gas velocity in ft/s, and

P is the operating pressure in psia

The results of the line sizing calculation is shown in Table 1 below.

Table 1: Line Sizing Calculation Input Data and Results.

Parameter	Value	Unit	Remark
Gas rate, Q_g	30	MMscfd	-
Gas Density, ρ_g	19.91	kg/m3	-
Gas compressibility, Z	0.9376	-	-
Operating temperature, T	563.67	R	-
Operating Pressure, P	391.5	psia	-
Gas velocity, V_g	60	ft/s	-
Calculated pipe inside diameter, d	6.36	in	6-inch line size adequate
Gas momentum ($\rho_g V_g^2$)	6658.9	Pa	ok (not more than 50000 Pa)

4. CONCLUSION AND RECOMMENDATION

The result from the line sizing calculation shows that a 6-inch line is adequate for routing 30 MMscfd of fuel gas from the HP fuel gas unit to the main AG compressor manifold to make up the minimum flow of 40 MMscfd required by the main AG compressors. A carbon steel pipeline is adequate since the gas is already water and hydrocarbon dew pointed (fuel gas). This modification will eliminate flaring ca 20 MMscfd during periods of TNP outage, thus reducing GHG emissions.

It is recommended that an opportunity realization note be prepared for routing maximum of 30MMscfd of HP fuel gas to the main AG compression inlet manifold. The line will be put in use to make up the gas volumes for the compressors to run during periods of TNP outage when flash-gas from condensate is insufficient to meet the compressor minimum flow of ca 40 MMscfd. MoC approval, design and construction should also be progressed to fully realize the benefit from this study.