Onshore Engineering Nigeria
(Operations Support & WRFM)

BOGT Emulsion Treatment Unit Opportunity Realization Note

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Revision History

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- 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
- All revisions to this document must be signed by the relevant Technical Authority (TA1, TA2 or TA3)

Signatures for this Revision

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1.0. The Opportunity

This opportunity is aimed at replacing the dysfunctional displacer type interface level control system in the BOGT Emulsion treatment units with a Guided Wave Radar based interface measurement Technology. This is in line with the recommendations from the technical study carried out on the treatment unit. The Intent is to get the Emulsion Treater units back on stream thereby reducing current crude processing cycle time of about 40hrs to just 8hrs. This opportunity will potentially result in gains of circa 5million USD in cash equivalent from freed-up ullage in storage tanks and improved processing efficiency.

1.1. Background

The Bonny Oil and Gas Terminal (BOGT) receives, dehydrates, stabilizes, stores and exports all crude produced by SPDC Eastern division. Additionally, it receives oil from third parties. The processed oil is exported by pipelines to tankers and to the nearby NNPC refinery at Port Harcourt. Five incoming crude streams from Land Light, Land Medium, Swamp Light, Cawthorne Light and East Coast trunk lines enter the Terminal and the streams are blended into one common header. From the common header, crude is sent to the dehydration train for processing where it is dehydrated and degassed and then sent to the tanks for storage and export.

An upgrade project, Bonny Terminal Integrated Project (BTIP) was commissioned in 2008 to restore technical integrity and provide a more efficient processing system at Bonny Terminal. However, some units have been underperforming significantly, after the upgrade. One of the underperforming units is the emulsion treatment unit (unit 12). During the operation of unit 12 after the BTIP, BS&W targets were not being met. In an attempt to meet the target by increasing heater treater temperature, the high flame temperature unit is usually tripped hence the non-operation of the unit till date. This underperformance is currently alleviated by using product storage tanks for supplementary dehydration by gravity settlement. This utilization of receiving tanks for off-spec inventory has the following effect on BOGT operational efficiency:

- Places additional demand on inter-tank transfer
- Reduces tank storage capacity and availability of crude export cargo, resulting in reduction of time/endurance before tank tops occurs and in the long run reduces cash surplus for the hub.
- Increases vulnerability of SPDC's eastern crude production to shipping nominations and in the long run reduces cash surplus for the hub

A multi-disciplinary integrated team consulted the operating envelope study, production chemistry experimental results and the 2014 OEM's start up report for this evaluation. Findings showed that:

- In general, the current operating envelope evaluation for unit 12 showed that the unit should work as designed and should be adequate to handle emulsion rates.

- The production chemistry experiments showed that heat alone is not sufficient to break the sample emulsion tested. It also showed that chemical demulsifier is able to reasonably resolve emulsion at ambient temperature. A combination of heat and chemical treatment should sufficiently treat the emulsion in Unit 12 in line with the original design intention.
- The key finding from the OEM's 2014 report was that the Unit 12 heater treaters have not been sustainably run on automatic mode and the level control loops are ineffective. In line with this, the SPDC PACO team also concluded that the current measurement technology applied for interface control system of unit 12 (Displacer Type technology) is sub-optimal with regards to the properties of the BOGT process fluid.

2.0. The Problem with Existing Interface Control System

The emulsion treatment system (unit 12) has two distinct interface measurement systems. Interface controller 12 LICA-060A/B/C control oil/water interface in the Emulsion Treater Package A-1201A/B/C by controlling the speed of the separated water pumps through a variable speed drive. Meanwhile activation of the interface level switch 12LSALL-063A/B/C stops the pumps and closes the water outlet valves.

In 2014, BOGT operations team and Aker Solutions attempted to start up unit 12. One of the key findings from the SPDC PACO team was that the current measurement technology applied for interface control system of unit 12 is the 'Displacer Type' technology. However, this technology is considered sub-optimal with regards to the properties of the BOGT process fluid. There are two issues associated with this technology:

1. Displacer type measurement instruments detect interface using difference in the densities of the constituents of the stream. Thus, the sensitivity of the measurement is directly proportional to the difference in densities; and measurement accuracy is reasonable only when there is significant difference in densities. For the BOGT stream, the datasheet shows that the specific gravity of oil is 0.849 while that of water is 0.985 at 65^{0}C normal temperature. This results in a difference of about 0.136 which is too close for most interface instruments to be effective.
2. A side tapped stilling well chamber installation technique was used for this displacer type interface measurement. An important requirement for this technology is that the displacer be fully submerged always. If this rule is violated, the instrument will not be able to sense the difference between a low (total) liquid level and a low interface level. If the displacer instrument has its own "chamber," it is important that both pipes connecting the chamber to the process vessel (sometimes called "nozzles") be submerged. The problem with this technique is that, if these conditions are not met, both the liquid level and the interface within the stilling well chamber will be markedly different from the liquid level and interface levels in the main vessel. This is a proven problem, usually due to presence of a lighter liquid layer existing between the connection ports of the transmitters. If a lighter (less dense) liquid exists above a heavier (denser) liquid in the process vessel, the level transmitter will not show the proper interface.

2.1. Proposed Solution

For liquid-liquid interface measurement, the suggested optimal technology is the Guided Wave Radar (GWR) type level and interface measurement technology. Guided Wave Radar depends on the di-electric constants of the process stream's constituents to measure interface. When electromagnetic signal travels through the fluid, at the boundary (interface) of oil and water, the signal is reflected due to the sudden change in the permittivity of the fluids. As with other measurement technologies, the sensitivity and accuracy of the measurement depend on the difference in the properties being measured. In general, the di-electric constant (ratio of the permittivity of a substance relative to air) of water is 80 while that of hydrocarbon is between 1.4 and 4. This wide difference in the properties being measured makes GWR excellent both in level and interface measurement.

The Rosemount 5301 and 5302 Guided Wave Radar Level transmitters provide industry leading measurement capabilities and reliability in liquids; and have been selected as replacement for the displacer level measurement system. The key characteristics of these transmitters include:

- Direct Switch Technology and Probe End Projection to handle low reflective media and long measuring ranges.
- Wide range of probe styles, materials, and temperatures and pressures for application flexibility
- HART 4-20 mA, FOUNDATION fieldbus, Modbus, or IEC 62591 (*Wireless* HART) with the Smart Wireless THUM adapter
- Advanced Diagnostics (D01 & DA1 Options)

2.2. Installation Requirement

The current Displacer Type transmitter installed in the emulsion treaters of unit12 has a side chamber where the sensing element is placed (Refer to attachment 2). However, with GWR, the installation would be at the top of the vessel. Relevant installation nozzles (nozzles N10a and N9a) and vessel details has been captured by OEM, as such no vessel modification is envisaged at this time. The data obtained during site visit shall form the basis for Transmitter type and probe length selection. The site inspection and confirmation from as-built isometric drawing suggest nozzle N9a is too close to the weir/fixed saddle which could have negative impact on the performance of the transmitter due to potential metal interference with the GWR signal. Thus, nozzle 10a has been chosen for the installation of the transmitters. Two set of interface transmitters 1201-LICA-060A/B/C and 1201-LICA-063A/B/C have been identified for replacement. The former is for control of the discharge pumps while the latter is intended to trip the same pumps. Wiring details such as cables lengths, JB type and tags as captured. No new JBs expected, however a few lengths of cable will need to be procured to cover for the spur length from new transmitter to existing JBs. The existing JB is based on HART protocol; hence a HART protocol compliant transmitter will be procured to leverage reuse of existing wiring installations.

3.0. Management of Change Approval

A management of change request covering all modification works will be submitted to the Central Change Control Management Panel for approval before commencement of any physical activities on site.

4.0. Scope of Modification Works

The scope of required for this modification works include:

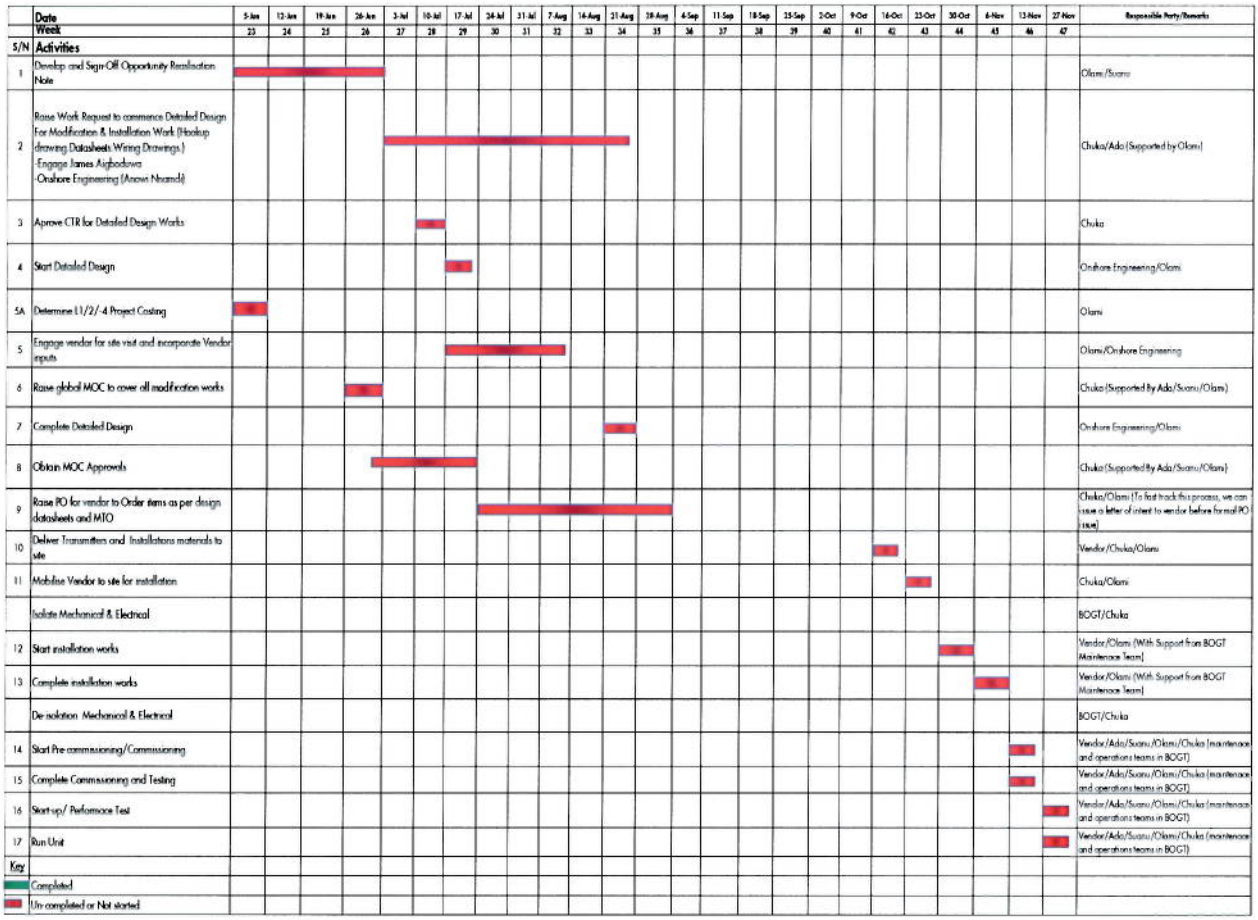
- Procurement, supply and installation of 6 nos. interface measurement transmitters (1201-LICA-060A/B/C) and 1201-LICA-063A/B/C. Two nos. to be installed on each package) and required to be supplied complete with all accessories and fully functional on all three Emulsion Treater Packages A-1201A/B/C.
- Develop relevant drawings and documentation (such as hook-up drawings, datasheet, and wiring drawings) required for the installation and commissioning of the Transmitters. These documents will be handed over to Company after commissioning.
- Hook-up, wiring and testing of all mechanical and electrical sub-systems, interfaces to the DCS; and all associated accessories required to enable a fully functional interface measurement system for the three Emulsion Treater Packages A-1201A/B/C.
- Commissioning of 6 nos. interface measurement on all three Emulsion Treater Packages 1201A/B/C (Two nos. to be commissioned on each package). This includes commissioning of all interfaces to the DCS; electrical and mechanical connections.

Note: 3nos of the six transmitters (1201-LICA-060A/B/C) should be SIL 3 rated while the others (201-LICA-060A/B/C) will be non-SIL rated. No SIF classification has been done at this time but this should be done as part of the risk assessment process for the MoC.

Spare nozzle N10a on each Treater package has been identified for the installation of the transmitters. At this time, no mechanical modification works on the vessel is envisaged.

5.0. Schedule

The high level schedule for delivering this opportunity is as shown below.



	Date	5-Jun	12-Jun	19-Jun	26-Jun	3-Jul	10-Jul	17-Jul	24-Jul	31-Jul	7-Aug	14-Aug	21-Aug	28-Aug	4-Sep	11-Sep	18-Sep	25-Sep	2-Oct	9-Oct	16-Oct	23-Oct	30-Oct	6-Nov	13-Nov	27-Nov	Responsible Party/Remarks
	Week	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	
S/N	Activities																										
1	Develop and Sign-Off Opportunity Realisation Note																										Olomi/Suanu
2	Raise Work Request to commence Detailed Design For Modification & Installation Work (Hookup drawing Datasheets Wiring Drawings.) -Engage James Aigbodawa -Onshore Engineering (Anowi Nnamdi)																										Chuka/Ada (Supported by Olomi)
3	Aprove CTR for Detailed Design Works																										Chuka
4	Start Detailed Design																										Onshore Engineering/Olomi
5A	Determine L1/2/-4 Project Costing																										Olomi
5	Engage vendor for site visit and incorporate Vendor inputs																										Olomi/Onshore Engineering
6	Raise global MOC to cover all modification works																										Chuka (Supported By Ada/Suanu/Olomi)
7	Complete Detailed Design																										Onshore Engineering/Olomi
8	Obtain MOC Approvals																										Chuka (Supported By Ada/Suanu/Olomi)
9	Raise PO for vendor to Order items as per design datasheets and MTO																										Chuka/Olomi (To fast track this process, we can issue a letter of intent to vendor before formal PO issue)
10	Deliver Transmitters and Installations materials to site																										Vendor/Chuka/Olomi
11	Mobilise Vendor to site for installation																										Chuka/Olomi
	Isolate Mechanical & Electrical																										BOGT/Chuka
12	Start installation works																										Vendor/Olomi (With Support from BOGT Maintenance Team)
13	Complete installation works																										Vendor/Olomi (With Support from BOGT Maintenance Team)
	De-isolation Mechanical & Electrical																										BOGT/Chuka
14	Start Pre-commissioning/Commissioning																										Vendor/Ada/Suanu/Olomi/Chuka (maintenance and operations teams in BOGT)
15	Complete Commissioning and Testing																										Vendor/Ada/Suanu/Olomi/Chuka (maintenance and operations teams in BOGT)
16	Start-up/ Performace Test																										Vendor/Ada/Suanu/Olomi/Chuka (maintenance and operations teams in BOGT)
17	Run Unit																										Vendor/Ada/Suanu/Olomi/Chuka (maintenance and operations teams in BOGT)
Key																											
	Completed																										
	Un-completed or Not started																										

6.0. Cost

The cost estimates for delivering opportunity is attached. (HOLD.)

7.0. References

1. BOGT Emulsion Treatment Unit (Unit 12) study **(Document Number: SPDC-2017-04-00000206)**

8.0. Appendices

1. Rosemount 5301 and 5302 catalogue

5302 details (3).pdf

2. As-built with identified spare nozzles

ME040-S1201-001_r
AB2_Emulsion Nozzles

3. Emulsion treater existing transmitters data sheet

Equipment Name	EMULSION TREATER TRAINS A/B/C		C1	DB	16-Sep-02	For Construction	Req #		
			C1	DB	4-Nov-03	For Purchase	PO #	3032-088	
Purchase Order #	JE-BTP-TQ-40		C2	EB	January 6, 2004	Revised As Noted	Appd by:		
			A5	DR	Mar.02,2004	As Built	Chkd by:		
	1	Tag Number			12-LT-060A/B/C			12-LT-063A/B/C	
	2	Service			Emulsion Treater Interface			Emulsion Treater Interface	
	3	Line No./Vessel			A-1201A/B/C			A-1201A/B/C	
	4	Body or Cage Material			Carbon Steel			Carbon Steel	
		Rating			150 ANSI			150 ANSI	
	5	Conn. Size & Location Upper			2" Side (By KPS)			2" Side (By KPS)	
		Type			150 #RF			150 #RF	
	6	Conn. Size & Location Lower			2" Side (By KPS)			2" Side (By KPS)	
BODY/CAGE		Type			150 #RF			150 #RF	
	7	Cage Mounting			Flanged			Flanged	
		Head Flange			4" - 300# RF			4" - 300# RF	
	8	Rubble Head			Yes			Yes	
	9								
	10	Orientation			Vertical			Vertical	
	11	Cooling Extension			N/A			N/A	
	12	Pipe Span							
	13	Dimensions			2.5" X 14"			2.5" X 14"	
	14								
DISPLACER/ FLOAT	15	Displacer Elevation			8" From Fof F To Top Of Displacer			8" From Fof F To Top Of Displacer	
	16	Displacer Material			304 SS			304 SS	
	17	Displacer Spring/Tube Mat'l			SS			SS	
	18	Displacer Orientation			Vertical			Vertical	
	19								
	20	Function			Transmit			Transmit	
	21	Output			4 - 20 mA Hart (Note 4)			4 - 20 mA Hart	
	22	Control Modes							
	23	Differential							
XMTR/CONT.	24	Output Action Level Rise			Increase			Increase	
	25	Mounting			Integral			Integral	
	26	IP			IP65			IP65	
	27	Area Class			EEx Ia IIC T6			EEx Ia IIC T6	
	28	Electric Power or Air Supply			24 VDC Two Wire			24 VDC Two Wire	
	29	Approval Required			CENELEC			CENELEC	
	30	Upper Liquid			Oil			Oil	
SERVICE	31	Lower Liquid			Water			Water	
	32	sp. gr. : Upper	Lower	.849	.995		.849	.995	
Units	33	Pressure: Max.	Normal	4	2.1		4	2.1	
Press - Barg	34	Temp. : Max.	Normal	100	65		100	65	
Temp - °C	35								
	36	Notes			1,2,3,4,7			1,2,3,4,5,6,7	
	37	Air Set (I/A Filter Regulator)							
	38	Supply Gage							
	39	Output Gage							
	40	Controls: No.	Form						
OPTIONS	41	Contact Rating							
	42	Action of Contacts							
	43								
	44	P&ID No.			D3032-00-021/022/023			D3032-00-021/022/023	
	45	Scur Spec. Required							
	46	Remote Connecting Cable			N/A			N/A	
	47	Manufacturer			Magnetrol			Magnetrol	
	48	Model Number			XE61-2H4A-E5D			XE61-2H4A-E5D	

NOTES:
1. All instruments shall be identified with a stainless steel tag.
2. X = Level controller cage to be fabricated by KPS.
3. X = 8" from face of flange to top of displacer.
4. Current to Field Bus converter provided. (see data sheet 3032-123 sheet 01)
5. No SIL.
6. Case colour to be manufacturers standard.
7. MTL Lightening protector to be provided by KPS.

VD-E-09335-ME040-S1201-413-083-SHT-05
Shell Doc.# ME040-S1201-413-083-SHT-05-AB