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ATTACHMENT A: DETAILED **DRILLING AND COMPLETION ENGINEERING SCOPE OF WORK**

FEASIBILITY STUDY FOR THE PROPOSED DEVELOPMENT OF THE E-BK, E-AD and E-S FIELD IN OFFSHORE LICENCE BLOCK 9, SOUTH COAST, SOUTH AFRICA

1. INTRODUCTION

1.1 COMPANY requires Feasibility Drilling Engineering Services to be performed for its forthcoming infill development project which currently includes wells in the following fields: E-BK, E-AD, E-S in Block 9 offshore Southern South Africa. The COMPANY may revise these fields by adding and/or removing as it deems necessary.

1.2 E-BK Well

1.2.1 An E-BK Well is planned as a horizontal gas production well in the E-BK gas-condensate field, located approximately 130km south-south-west of Mossel Bay and ~50km south-west of the F-A Platform in a water depth of ~140m. The E-BK field was discovered by the E-BK1 well in 1991. E-BK1 proved a rich gas condensate accumulation in the 14A sandstone reservoir and tested at a maximum gas rate of 26.3 MMscf/d with a condensate rate of 4,155 stb/d. The reservoir is interpreted as a deep-marine turbidite sandstone within the 14A sand/channel-lobe complex.

1.2.2 The proposed E-BK development well is located approximately 800m north-west of the E-BK1 discovery well at surface location. The planned horizontal section passes the E-BK1 wellbore at a distance of approximately 200m. The well is designed to target the central area of the E-BK accumulation and to drill a horizontal section of approximately 700m close to the top of the 14AS reservoir while maintaining maximum stand-off above the gas-water contact.

1.2.3 The key E-BK reservoir parameters are:

- Top Reservoir : 2,590mTVDSS (T14AS horizon)
- Pressure : 3,803psia (at GWC)
- Temperature : 116 ºC (242ºF)
- Porosity (average) :15%
- Permeability (average) : 60mD
- GWC : 2,619mTVDSS
- GIIP : 60.8Bscf
- Gas formation volume factor : 0.0052rcf/scf
- Gas specific gravity : 0.81
- Initial condensate gas ratio : 180stb/MMscf

Previous dynamic reservoir simulation work evaluated alternative well types and development options and identified a single horizontal producer as the preferred development concept. The horizontal well is expected to deliver up to approximately 50 MMscf/d, subject to facilities and operating constraints. The preliminary well design, completion philosophy and detailed operating assumptions shall be confirmed during the feasibility and Basis of Design work.

1.3 **E-AD Well**

An E-AD well is planned as a vertical gas production well in the E-AD gas-condensate field, located within Block 9 of the South Coast Gas Production Right, approximately 36 m North of the discovery well E-AD1, in a water depth of ~120m. The E-AD field was discovered in 1987 when E-AD1 intersected several hydrocarbon-bearing intervals, proving gas-condensate accumulations in the 12A and 11A reservoirs. The E-AD reservoirs comprise deep-marine turbidite channel sandstones with limited well control and no appraisal drilling.

The principal development targets are the 12A, 11A Upper and 11A Lower gas-condensate reservoirs, with 11A Lower identified as the main producing interval. E-AD1 tested maximum gas rates of 10.9 MMscf/d from 12A, 13.9 MMscf/d from 11A Upper and 13.7 MMscf/d from 11A Lower, with associated condensate yields of 128, 36 and 41 stb/MMscf respectively as depicted in the Table below.

Reservoir Interval	**Maximum Qgas**	**Max Qcond**	**CGR**
	MMscf/d	**stb/d**	**stb/MMscf**
12A	10.9	1364	128
11A Upper	13.9	528	36
11A Lower	13.7	585	41

Maximum observed DST Production rates per reservoir

Dynamic reservoir simulation predicts that a single vertical development well producing commingled flow from the 12A and 11A reservoirs could produce a plateau rate of 10MMscf/d for 1 year before production is curtailed by water production.

1.3.1 The E-AD reservoir is a sandstone unit deposited as a deep-marine turbidite with a gas-condensate accumulation with the following properties:

Parameter:	Unit:	12A	11AU	11AL
Top of reservoir	mTVDss	2,801	2,883	2,899
Pressure	psia	3,990	4,127	4,130
Temperature	deg F	246	247	248
Porosity	%	12		
Permeability (WTA)	mD	6	4.9	29
GWC	mTVDss	2,822	2,898	2,914
GIIP	Bscf	3.17	4.05	15.75
Gas formation factor	rcf/scf	0.0046	0.0046	0.0046
Gas density	SG	0.703	0.705	0.707
CGR	stb/MMscf	128	37	41
CO2	Mol %	3.9	3.8	3.82

E-AD Reservoir Parameters

1.4 E-S8 Well

An E-S Well is planned as a deviated production well targeting the Fluvial reservoir as the primary objective and the Upper Shallow Marine (USM) reservoir as a secondary objective.

The E-S field was discovered by the E-S1 well in 1983. Well E-S1 was tested with a maximum gas rate of 38 MMscf/day and condensate rate of 670 bbl/day in 116m gross fluvial interval and 20 MMscf/day and condensate rate of 180bbl/day in 20m gross interval Upper Shallow Marine.

Well E-S7 was drilled several years later and flowed 6 MMscf/day and condensate rate of 16stbl/day in 34m gross interval (10m fluvial and 24m USM). The well shut in since 2016.

Reservoir Interval	Maximum Qgas	Max Qcond	CGR
	MMscf/d	stb/d	Stb/MMscf
E-S1 USM	20	180	12.8
E-S1 Fluvial	38	670	14.5
E-S7 Fluvial	6	16	

Maximum observed DST Production rates per reservoir

1.4.1 The prospect is located approximately 87–100 km south-south-west of Mossel Bay and 18 km south-west of the F-A Platform in a water depth of approximately 120 m.

1.4.2 The planned trajectory is designed to intersect three fault blocks between E-S1 and E-S7 to maximize reservoir contact and recovery potential. The proposed well location is approximately 95 m northwest of the E-S7 production well and 695 m north of the E-S1 discovery/appraisal well.

1.4.3 The Primary E-S reservoir is a sandstone unit deposited as a fluvial wet gas accumulation, with a secondary E-S reservoir is a sandstone unit deposited as an upper shallow marine wet gas accumulation with the following properties:

Parameter:	**Unit:**	**Fluvial**	**USM**
Top of reservoir	**mTVDss**	2,246.22	2,176
Pressure	**psia**	3,618	3,190
Temperature	**Deg F**	231	213
Porosity	**%**	14.5	15.8
Permeability (WTA)	**mD**	21	213
GWC	**mTVDss**	2,464.3(sand2) 2,504.5(sand3) 2,540.2(sand4) 2,561.3(sand5)	2,216.4
GIIP	**Bscf**	14.8-16.6-20.9	4.1-5.47-6.26
Gas formation factor	**rcf/scf**	0.00541	0.005510
Gas density	**SG**	0.747	0.659
CGR	**stb/MMscf**	14.5	12.8
CO2	**Mol %**	0.9	0.89

E-S Reservoir Parameters

Dynamic reservoir simulation predicts that a single slanted development well producing commingled flow from the fluvial and USM reservoirs could produce a plateau rate of 18MMscf/d for 15-20 months before production before field decline, while maximum rates from both the USM and the fluvial from E-S8 are expected to be as high as 75MMscf/d and 60MMscf/d respectively.

2. CONCEPTUAL STUDY

2.1 Historically COMPANY has run a four casing string; a conductor of either 36”or 30”, swaged the 20” to 17 ½” intermediate casing before running the 9 5/8” production casing and a contingency 7” Liner string to be able to run a 4 ½” production tubing and in the contingency case a 3 ½” production tubing run. These assumptions require to be firmed up with the requisite drilling engineering studies being undertaken during the feasibility phase.

2.2 Previously a semi-submersible rig and 18 ¾” well head run. However the technological developments and environmental changes in the sea states and weather requires these assumptions to be firmed up with the requisite drilling engineering studies being undertaken during the feasibility phase.

3. DESCRIPTION OF WORK: FEASIBILITY PHASE

3.1 CONTRACTOR shall provide and/or sub-contract the following engineering services necessary to firm up the conceptual design assumptions. These services shall include, but not be limited to (for CONTRACTOR to provide as optional any additional and/or perquisite studies):

3.1.1 Rig, Riser, Wellhead, Conductor Fatigue Analysis Study:

The ultimate focus for this study is to access the rig type to be used, taking into account the historical semi-submersible rigs usage, the technological advancement and any possible changes between the previous drilling campaign and now. The rig type study will therefore focus on the fatigue analysis and may include the following activities. The CONTRACTOR shall group activities and propose as optional any additional studies and further propose which of these studies to carry out in this feasibility phase and which to postpone to the next phase. CONTRACTOR may make proposals but COMPANY reserves the right to make final choice.

- The CONTRACTOR shall analyse weather and environmental conditions prevalent in the Block 9 area for the last 10 years and project into the next ten years.
- Specify the limits for the various rig types (semi-submersible, jack-up, dynamic positioning vessels, etc.) for these environmental conditions.
- For moored rig types undertake rig mooring assessment based on sea-bed assessment.
- Model the wait on weather for the various rig types usable in the South African Block 9 environment. Weather operating limits of different rig specifications.
- Consider the Structural Operating Capacities of the various rig types vs. what will be required (Hook Load, Setback, Deck Space, Liquid Mud Volume).
- Rig Fleet Market Availability & Commercial Assessment: Fleet supply, demand, and day rate trajectories, and possible rig upgrade/modification requirements.
- Procurement strategy & technical rig specifications shortlist
- From modelling and assessment specify different types of wellheads, conductors and casing loads.
- Produce different models of Rig/Riser/ Wellhead/Conductor load and fatigue assessments.
- Based on the above assessment derive acceptable fatigue life in days for drilling and completion activities.
- Allow access for two COMPANY personnel (drilling Engineers) exposure so as to review the software used and fine tune with CONTRACTOR the final window chosen.

- Outline the barrier philosophy for the well, during drilling and subsequent phases.
- Assessment for the different BOP types and weights to define the envelop for choice during detailed design phase.
- Assessment for the different SSXT types and weights to define the envelop for choice during detailed design phase.

3.1.2 Geo-mechanical and geo-chemical Assessment:

CONTRACTOR shall carry out studies to enable COMPANY to have an adequate description of the rock mechanics and its chemistry to enable COMPANY to assess optimal drilling trajectories, completion and production giving due regard to safety and without damaging the reservoir. The CONTRACTOR shall group activities and propose as optional any additional studies and further propose which of these studies to carry out in this feasibility phase and which to postpone to the next phase. CONTRACTOR may make proposals but COMPANY reserves the right to make final choice.

- Build a geo-mechanical model for each field
- Undertake wellbore stability studies zonal isolation assessment for each field
- Define ranges for the different mud, cement and completion fluid types and weights.
- Assess the use of the various casing string sizes and their limitations: 36”, 20”, 13 3/8”, 9 5/8”, 7”.
- Model different completion strategies and types (different ICV’s, water handling capabilities) for both initial production and future production and reservoir management.
- Trajectory constraints definition, Drilling Optimisation modelling,
- Document possible completion strategies including perforation techniques for the geo-mechanical model developed.
- Pilot hole versus geo-steering assessment requirements.
- Analyse drilling bit technology developments and performance in comparable formations as Block 9 field.
- Identify value-add technologies that have the potential to reduce well construction duration and/or cost.
- Document limitations and uncertainties of the models developed and work to be detailed during the next phase.
- Modelling of the different reservoirs and the associated fluids.

3.1.3 Drilling Engineering feasibility studies

The ultimate focus for this study is to develop preliminary design work and where some work has been done, review the same and identify and close any gaps to enable progressing the project to the FEED stage. The CONTRACTOR shall group activities and propose as optional any additional studies and further propose which of these studies to carry out in this feasibility phase and which to postpone to the next phase. CONTRACTOR may make proposals but COMPANY reserves the right to make final choice.

- Casing, Tubing and Downhole equipment Metallurgy Screening:
  - Definition of sour and sweet gas partial pressures, and evaluation based on well lifetime temperature/pressure profiles
  - Stress corrosion cracking (SCC) risk assessment
  - Carbon Steel vs. Corrosion Resistant Alloys
  - Preliminary elastomer and seal compatibility assessment

- Preliminary Well and Completion Design:
  - Trajectory Modelling: Develop preliminary well paths to optimize reservoir drainage
  - Standardisation considerations to the extent feasible across the three fields for inventory management and to promote learning curve accumulation over the campaign duration.
  - Casing & Tubing Design: Selecting preliminary tubular sizes and materials, and associated components.
  - Evaluate different options to determine the optimal Lower Completion concept (e.g. open-hole, slotted liner, cased & perforated)
    - Consider formation damage risks & reservoir stimulation feasibility
    - Consider the need to mitigate sand production and water breakthrough
  - Preliminary upper completion design, considering reservoir management & flow assurance requirements, e.g.
    - SSSV type & depth
    - Chemical Injection Systems (Hydrate, Scale, Corrosion Inhibitors, Foamer)
    - Permanent downhole P&T gauges
    - Capability to perform gas lift via A-annulus, without the need for rig intervention.
  - Smart completions feasibility (ICVs, ICDs zonal control)

- Preliminary Drilling & Completion Fluids Selection Strategy:
  - Water-Based Muds (WBM) vs. Non-Aqueous Fluids (NAF/OBM) Screening
  - Formation Damage and Wellbore Stability Fluid Compatibility
  - Packer Fluids & Fluid Loss Control Brines Screening

- Preliminary Cementing Design Aspects:
  - Cement slurry screening, considering fluid interactions and compatibility

- Outline cementing programs to ensure zonal isolation, prevent gas migration, and provide structural integrity over the life of the well.

- Develop a list of long lead items (LLI)
    - For each LLI, specify base case quantity, procurement lead time, latest order date to protect PAGS first gas, current market availability, existing PetroSA inventory of usable LLI stock.
    - Identify batch procurement opportunities across E-BK, E-S and E-AD.

- Logistics & Infrastructure:
    - Evaluate marine support, supply vessel requirements, helicopter operations, and port availability for tubular and bulk material storage.

- Drilling & Completions Risk Register:
    - Assess technical, environmental and operational risks
    - Specify residual risks that persist after the assessed risks are mitigated to ALARP.

- Timeline Estimation:
    - Develop high-level operational schedules and drilling sequence scenarios to determine the overall project duration.
    - Estimate drilling days per well section, and for completion operations, including contingency time.
    - Estimate total pre-FID expenditure phased by calendar year.

- Cost Estimation:
    - Generate Class 3 well AFE estimates (deterministic and/or probabilistic). (incl. day-rates, fuel, casing, cementing, services, vessels, etc.).

3.2 Basis of Design (BoD):

CONTRACTOR shall compile all gathered data and engineering criteria into a finalized Drilling & Completion Basis of Design document, which acts as the foundational blueprint for COMPANY to issue into the market for the FEED phase.