4 Scope of Work

4.1 Service Requirements

The Scope of Work of this Contract covers integrated services from a single Contractor for drilling, hydrofrac, testing and completion of 4 HPHT wells (2 in Periyakudi Field and 2 in Bantumilli South Field) for which the temperature, pressure and well depths are given elsewhere. The Contractor has to provide following services along with required manpower:

- Civil work of drill sites
- Construction of DSAs
- Detailed well engineering of these wells taking into account the testing and multistage fracturing
- > Drilling rig & allied services
- > Drilling of the wells
- > Well materials
- Surface testing equipment and testing
- > Down hole testing equipment, completion fluid and services
- Mud Logging equipment and services
- Mud Engineering Services (WBM & SOBM), Supply of Mud Chemicals & Brine Chemicals and Waste Management Services
- MWD & LWD tools and services
- Logging & perforation services along with the equipment
- Cementing unit and services along with materials/chemicals
- > Hydro-fracturing equipment, materials/chemicals
- > Hydro-fracturing design and execution
- ➢ Well Completion
- Reservoir study and services along with sampling equipment

The expected reservoir characteristics and broad guidelines are provided in the Information document. The reservoir temperature and pressure of the fields are in the HPHT window requiring specialized knowledge of drilling, completion, hydrofrac and testing. Detailed planning has to be made by the Contractor from drilling to completion synchronizing the various operations right from well engineering, drilling to testing. Contractor has to make all the necessary planning and mobilization including on the technologies and services to achieve the intended objective which should be clearly brought out in the technical bid. However, the successful bidder will be required to make further micro-planning, which should be submitted to ONGC representatives at appropriate time prior to each phase of operation. However, the final responsibility for successful drilling, stimulation, testing and completion is the sole responsibility of the Contractor only. The well should be handed over to ONGC in a state suitable for long term production. Though every attempt has been made to specify and define each and every component, parameter, activity, rights and obligations of the Contractor, as felt necessary for fulfillment of the Scope of Work of Contractor under this Contract, there may be few unintentional omissions in this regard. Contractor has to include all such components, parameters, activities, rights, obligations, inputs and their costs as may be necessary for successful completion of the scope of the Contract.

4.2 Statutory Clearances & HSE

- 1. All statutory clearances have to be obtained by the contractor. However, letters if any required in this regard can be provided by ONGC.
- 2. Contractor shall comply with the applicable environmental laws, regulations and practices and is required to perform work so as to minimize the generation of hazardous waste to the extent technically feasible.
- 3. Contractor shall ensure safe conditions and methods of work, and maintain the same throughout the period of contract. Contractor shall carry out all activities in accordance with the highest international standards of the onshore oil and gas industry, ensure safe conditions and methods of work and maintain the same for the entire period of contract
- 4. ONGC has a weapons, alcohol and drug free policy on all its sites, both onshore and offshore. Contractor shall comply with and shall ensure that Contractor personnel comply with ONGC's requirements in relation to its weapons, alcohol and drug free policy as below:
- 5. Contractor shall provide ONGC representative with a copy of any report or statement or written evidence concerning any accident or dangerous event which occurs during the performance of the WORK or any other incident indicating the existence of adverse safety conditions of which Contractor Personnel may become aware.
- 6. Contractor shall ensure all standard safety practices are adhered to during all operations and that the persons being deployed on the rig are well versed in standard safety practices.
- 7. The operation, maintenance, repair, modification, testing and inspection of lifting and rigging equipment must comply with Indian regulations.
- 8. Contractor shall observe all local customs, rules and regulations. Where unclear, prior consultation must be conducted with ONGC.
- 9. Contractor shall protect environmental resources by applying best available techniques to eliminate or minimize any direct or indirect impact from operations
- 10. Contractor shall at all times maintain the surfaces of the well site in good condition, shall conduct all operations so as to prevent damages to the environment and reduction in bearing capacity and drainage capability of the top soils at the well site and shall maintain the well site free of all wastes.
- 11. Contractor is responsible for disposal of any waste produced or occurring as a consequence of its activities under the contract, all such disposals shall be in accordance with ONGC standards, legislation and best practice whether same is for hazardous waste or non-hazardous waste. Contractor shall be responsible for ensuring that all necessary approvals or licenses are obtained and that any sub-Contractors utilised for this purpose shall fully comply with such requirements.
- 12. Contractor has to clear the site in all respect after execution of all jobs under the Contract to make the site suitable for regular production.

4.3 Civil Work and Maintenance

- 1. The land for the drill sites will be provided by ONGC, measuring 120m x 120m for each of the 4 sites. Land for flare point along with pathway as per statutory requirement will also be provided by ONGC. The approach roads to the drill sites will be made by ONGC in consultation with the Contractor.
- 2. The land size mentioned above considers without rig HF job execution. However, Contractor has to inform ONGC for their specification on drill site size, as per their planned methodology for HF.
- 3. Contractor has to construct the drill sites along with cellar pit and conductor casing as per their rig layout plan.
- 4. All aspects of the warehouse are the responsibility of the Contractor.
- 5. Storage space for HF equipment and other allied units is also the responsibility of the Contractor.
- 6. Contractor should construct mud pits in appropriate manner to avoid seepage of contaminated mud and water.
- 7. All Civil works required for maintenance of the sites, DSA and approach roads during the entire contract will be the exclusive responsibility of the Contractor.
- 8. Provision of adequate earthen ring bund around each site/DSA is mandatory so that no water from site seeps to the surrounding land.
- 9. Fire water tank, waste pit and flare point are necessary to be fenced.
- 10. One no. air conditioned bunk house office accommodation having two equal partitions for ONGC Mud and Geology Officers has to be provided by the contractor at drill site.
- 11. One no. A/C Office cum accommodation Bunk house for company man with attached bathroom & toilet, Table, Chair, Almirah, Refrigerator, Computer with Internet facility, UPS, Color Printer, photo copier, fax, TV with DTH facility and other essential office facilities.

4.4 **Drilling**

- 1. The well depths vary from 4800m to 5100m. Minimum 2000 HP capacity VFD rig is to be deployed along with necessary Crew for the drilling operations.
- 2. All materials related to well i.e. well head, casings, tubing, drill bits and allied materials are to be provided by Contractor.
- 3. The suggested hole size and casing design for all the four wells indicated below may be used as a guideline. However, the detailed plan of casing design has to be provided by the Contractor taking into account the drilling depth, reservoir fluid characteristics, HPHT condition of the field and the required multi-stage fracturing objective.
- 4. For the well PDDA in Periyakudi field, 30" conductor casing may be run for about 30m. The $18^{5}/8$ " surface casing may be set at around -600m and cemented to surface.
- 5. The $13^3/_8$ first intermediate string may be planned to be set in around -3070m. The second intermediate string i.e. the $9^5/_8$ casing shoe may be planned to be set at approximately -4200m. This places the shoe in the pressure ramp above the PDS-30.

- 6. The $8^{1/2}$ hole may be drilled to ~50m above the top of the PDS-30 formation and the 7" liner run to -4325m. The well will then be drilled to the total depth of -5100m with $5^{7}/8$ " bit and completed with an uncemented $4^{1}/2$ " liner and open hole isolation packers.
- 7. As per the indicative design for well PDAD, 30" conductor casing may be run for about 30m. The $18^{5}/_{8}$ " surface casing may be set at around -600m and cemented to surface.
- 8. The $13^3/_8$ first intermediate string may be planned to be set in at -2975m. The second intermediate string i.e. the $9^5/_8$ casing shoe may be planned to be set at approximately -4025m. This places the shoe in the pressure ramp above the PDS-30.
- 9. The $8^{1}/2^{"}$ hole may be drilled to ~50m above the top of the PDS-30 formation and the 7" liner run to -4175m. The well will then be drilled to the total depth of -4850m, may be with $5^{7}/8^{"}$ bit and completed with an uncemented $4^{1}/2^{"}$ liner and open hole isolation packers.
- 10. As per the indicative design of BTSDA and BTSDB wells of Bantumilli South Field, 30" conductor casing may be run for about 30m. The surface casing may be set at around -800m and cemented to surface.
- 11. The first intermediate casing may be set at approximately -2800m. It may be planned to set second intermediate casing at approximately -4150m. This places the shoe in the pressure ramp above the Raghavapuram / Nandigama boundary.
- 12. 7" production liner/casing can be run to -4800m TD of the wells.
- 13. The well engineering of each well has to be provided by Contractor and has to be submitted to ONGC. However, the final responsibility for successful drilling, stimulation, testing and completion is the sole responsibility of the Contractor only.
- 14. All required casings have to be provided by the Contractor. The casings must have proper grade, premium joint and gas tight connection.
- 15. All Bits required for drilling have to be provided by the Contractor. The bits are to be selected to optimize the drilling operation.
- 16. MWD has to be necessarily used during drilling of last two phases of Bantumilli South wells.
- 17. In case of any complication in the well during drilling/fishing, Contractor shall rectify the problem which includes side tracking and drilling and ensure achieving of target depth in each well.
- 18. All types of fishing tools and fishing services have to be provided by the Contractor.
- 19. Required liner hangers and services, casing driving system, turn torque services and casing running in services have to be provided by the Contractor.

4.5 Mud Engineering Services

The Scope of Mud Engineering Services include WBM as well as SOBM (or equivalent). The Top hole for conductor casing will be drilled with Spud mud. The isolation section will be drilled with KC1-PHPA-Glycol Polymer DF. The last two phases of all the four wells are to be drilled with SOBM or equivalent mud system. However, the section presently defined as 12 ¹/₄" hole can also be considered for drilling with SOBM or equivalent mud system subject to overall casing plan of contractor. The broad points of SOW are given below.

- 1. Providing Mud Engineering Services using, Spud Mud, KCl-PHPA-Glycol Polymer DF & SOBM.
- 2. Supply of Mud Chemicals and Contingency Chemicals, preparation and maintenance of Mud system as per the requirement of well conditions.
- 3. Personnel for Mud Engineering Services(Base coordinator & Mud Engineers)
- 4. Clear Brine Services.
- 5. Centrifuge, Cutting Drier, Centrifuge and Cutting drier Engineer.
- 6. Mud Cooler and Mud Cooler Engineer (as per requirement).
- 7. Brine Filtration Unit (BFU) and BFU operator
- 8. Spacer for SOBM and Brines
- 9. Well Bore Clean up Services & Casing wash
- 10. Waste management for SOBM soaked drill cuttings
- 11. Mud laboratory and testing equipment
- 12. Transportation of balance SOBM at designated site

Suitable Clear fluid has to be used as Testing and Completion fluid for two Periyakudi wells. In Bantumilli South wells, Cesium Formate up to 16.9 ppg has to be used as completion fluid. However, suitable non-corrosive underbalanced packer fluid in annulus may be used.

Contractor shall provide complete drilling fluid testing equipment, chemicals/reagents, glassware and consumables for testing of mud as per API standards. Contractor shall also provide test procedures including relevant software for estimation of the chemicals in mud.

4.6 Cementing & Services

- 1. For all casings, slurry design and cementation job is to be carried out by the Contractor.
- 2. All required materials such as cements, additives, shoes & collars, packers, centralizers etc. and cementing service has to be provided by the Contractor.
- 3. Secondary cementation jobs and plug jobs, if required, have to be carried out by the Contractor.
- 4. All cement testing should be done in accordance with API RP-10B.
- 5. Cement plug for Well abandonment, if required, has to be done by the Contractor.

4.7 Mud Logging Unit and Services

Mud Logging Requirements for the four wells are given below:

Requirement	Comments				
Cuttings Sampling	- 10 m interval above 1 st intermediate casing shoe				
	- 5 m interval from 1 st intermediate casing shoe to T				
Carbide Lag	Every 200m				
Gas Analysis	- From - Below Surface casing shoe to TD				
	- CO_2 and H_2S (if any) to be monitored				
Cuttings Analysis	- Cuttings Bulk Density				
	- Mineralogy Analysis				
	- Clay Ion exchange				

Core Analysis	Detailed megascopic study
Standard Mud Logging Services	Surface Casing Shoe to TD
Real Time Formation Pressure Prediction	Below Surface casing shoe

4.8 Logging & Services

The indicative open hole and cased hole logging program is given below. However, the hole sizes/depths may undergo changes as per the well construction and drilling plan made by the Contractor keeping HPHT conditions and multi-stage fracturing requirement.

PDAD Open Hole logging plan:

Hole/Bit Size (in.)	24"	17½"	12¼"	8½'	5 ⁷ /8"
Logging Interval (m) (depths in TVD MSL)	Surf 600	600 - 29 75	2975 - 4025	4025 - 4175	4175 – 4850
Mud Type	WBM	WBM	SOBM	SOBM	SOBM
Max. Mud Weight, SG (ppg)	1.06 (8.8)	1.20 (10)	1.62 (13.5)	1.68 (14.0)	1.84 (15.3)
Max Static Temp, °C (°F)	48° (118°)	95.5° (204°)	114° (238°)	120° (248°)	157° (315°)
Expected Formations		Kamalapuram Porto Novo Nannilam Kudvasal Sh. Bhunanagiri Sattapadi Sh. Andimadam	Andimadam	Andimadam Barremian Shale (Periyakudi)	Periyakudi
Open <mark>hol</mark> e logs		¥			
Deep a <mark>nd</mark> Medium Focused Resistivity & Micro Resi <mark>stivi</mark> ty		R	R	-	-
Borehole Compensated Sonic		R	R	-	-
Gamma Ray Spectrometry		R	R	R	R
Formation Density- Porosity			R	R	R
Dual Spaced Neutron Log			R	R	R
High Resolution Array Induction Service				R	R
Shear Stoneley Sonic Imager				_	R

Hole/Bit Size (in.)	24"	17½"	12 ¹ / ₄ "	81⁄2'	5 ⁷ /8"		
Formation Resistivity Imager Service-Oil Based Mud					R		
Dynamic Formation Tester(Modular) - 347°F				R	R		
Dual Packer Module of DFTS - 325°F				R	R		
Fluid Analyzer Module of DFTS - 347°F				R	R		
DFTS-SAMPLE (NORMAL & PVT)				R	R		
Nuclear Magnetic Resonance Log (fluid typing)					R		
Multi level Triaxial Well Seismic		R	R	R	R		
Side Wall Core with GR					R		
Quick Formation Pressure Tester - 395°F					R		
PDDA Open Hole logging plan:							

PDDA Open Hole logging plan:

Hole/Bit Size (in.)	24"	17½"	12¼"	8½'	5 ⁷ /8"
Logging Interval (m) (depths in TVD MSL)	Surf 600	600 - 3070	3070-4200	4200 - 4325	4325 – 5100
Mud Type	WBM	WBM	SOBM	SOBM	SOBM
Max. Mud Weight, SG (ppg)	1.06 (8.8)	1.2 (10)	1.62 (13.5)	1.68 (14.0)	1.86 (15.5)
Max Static Temp, °C (°F)	48° (118°)	96° (205°)	121° (250°)	128° (262°)	161° (322°)
Expected Formations		Kamalapuram Porto Novo Nannilam Kudvasal Sh. Bhunanagiri Sattapadi Andimadam	Andimadam	Andimadam Barremian Shale (Periyakudi)	Periyakudi
Open hole Logs					
Deep and Medium Focused Resistivity & Micro Resistivity		R	R	-	-
Borehole Compensated Sonic		R	R	-	-
Gamma Ray Spectrometry		R	R	R	R
Formation Density- Porosity			R	R	R
Dual Spaced Neutron			R	R	R

Hole/Bit Size (in.)	24"	17½"	12¼"	81⁄2'	5 ⁷ /8"
Log					
High Resolution Array Induction Service				R	R
Shear Stoneley Sonic Imager				-	R
Formation Resistivity Imager Service-Oil Based Mud					R
Dynamic Formation Tester (Modular) - 347°F				R	R
Dual Packer Module of DFTS - 325°F				R	R
Fluid Analyzer Module of DFTS - 347°F				R	R
DFTS-SAMPLE (NORMAL & PVT)				R	R
Nuclear Magnetic Resonance Log (fluid typing)					R
Multi-level Triaxial Well Seismic		R	R	R	R
Side Wall Core with GR					R
Quick Formation Pressure Tester - 395°F					R

BTSDA & BTSDB Open Hole Logging Plan:

Hole/Bit Size (in.)	24"	17.5"	12.25"	8.5"
Logging Interval (m)	Surf 800	800 - 2800	2800 - 4100	4100 - 4800
Mud Type	WBM	WBM	SOBM	SOBM
Max. Mud Weight, SG (ppg)	1.08 (9.0)	1.32 (11.0)	1.85 (15.4)	2.03 (16.9)
Max Static Temp, °C (°F)	53.3° (128°)	113° (236°)	176.7° (350°)	200°C (393°F)
Expected Formations		Younger sequence, Razole Tirupati RGP	RGP HG-HR	Raghavapuram Nandigama
Open hole logs				
Array Induction (HRAIS)	R (GR only)	R	R	R
Gamma Ray Spectroscopy (GRSS)		R	R	R
Density with Pe, Neutron (FDPS- DNPS)			R	R
Dipole Shear Sonic Imager (SSSI)		R (only Sonic)	R	

Hole/Bit Size (in.)	24"	17.5"	12.25"	8.5"
Formation Tester Pressure / Sampler with Fluid analysis (open hole / cased hole) (QFPT / DFTS-DP-FA)			R	
Percussion Side Wall (SWC)			R	R
Vertical Seismic Profile (TWSS)		R	R	
Density with Pe, Neutron (FDPS- DNPS-HPHT)				R
Dipole Shear Sonic Imager (SSSI-HPHT)				R
Elemental Capture Spectroscopy (ECL-HPHT)				R
Percussion Side Wall (SWC-HT)				R
Formation Tester Pressure / Sampler with Fluid analysis (open hole / cased hole) (QFPT- HPHT / DFTS-DP-FA-HPHT)				R
Vertical Seismic Profile (TWSS- HPHT)				R
Pipe Conveyed Logging Equipment (PCLS-HPHT)				R

BTSDA & BTSDB LWD Plan:

LWD logs are intended to be recorded in the final drilling section ($8\frac{1}{2}$ " as per guideline design) in the two Bantumilli South wells. As per information from different sources, this log is available for maximum 350°F and hence not built in the scope where the temperature is expected to be around 400°F. In case the LWD log is available for temperature of 400°F or more, the Contractor has to include it for BTSDA and BTSDB wells.

Perforation Services: (up to 400°F)

The perforation requirement is dependent on the type of completion planned by the Contractor to facilitate multi stage fracturing. The following is the likely requirement in case of cemented casing/liner completion.

Requirement	Remarks
Conventional Perforation (PERF-	$3^{3}/_{8}$ ", 4" and 4½" guns with 5/6/8/12 spf
HNS)	
Tubing Conveyed Perforation with	$3^{3}/_{8}$, 4 and $4\frac{1}{2}$ guns with $5/6/8/12$ spf
shoot & pull / shoot & drop (TCP-	
HNS)	
TTP Perforations (PERF-TTP)	$1^{11}/_{16}$ " / 2" / $2^{1}/_{8}$ " strip / gun with 6 spf charges
Squeeze perforation (SQ-HNS)	For cement squeeze
Plug / Packer / Cement Retainer Setting Tool (PPST)	Temperature rating up to 400°F or maximum temperature rated available in industry

The above mentioned perforation services are just a guideline and may change (e.g. Hydra jet perforation) as per the Contractor's well design, hydrofrac methodology and completion plan.

Salvaging Operations: (up to 400°F)

Services	Remarks
Free Pipe Indication Tool (FPI)	All types of Tubing / drill pipes
Back off / string shot (Back-off)	All types of Tubing / drill pipes
Colliding / Severing Tools (COLD- HNS)	All types of drill pipes / drill collars
Tubing Cutters (CUT-TUBE)	All types of tubing with different ppf
Tubing Punctures (PUN-TUBE-HNS)	All types of tubing with different ppf
Pressure Control Equipment (PCE) for 15000 psi	To use during Tubing Puncture / Tubing Cutter / Production Logging

Cased Hole Logging Services:

The likely requirement of cased hole services for different hole sizes are indicated below. However, the requirement is a function of the well construction to be planned by the Contractor. For the production casing, the cased hole requirements like CBL/VDL, Junk basket etc. is dependent on the type of completion planned by the Contractor to facilitate multi-stage fracturing.

PDAD & PDDA Cased Hole Logging Plan:

Casing size (in.)	18 ⁵ /8"	13 ³ /8"	9 ⁵ /8"	7"	4½"
CBL/VDL/GR/CCL (and Ultra Sonic Imaging Tool as required)			R	R	R*
Cased hole Dual Spaced Neutron Log					
Cement Channel Analyser and					
Corrosion					
Junk Basket				R	R*
Plug & Packer Setting Tool				R	
Slim Cement Bond Evaluation					
Tubing Collar Locator					R
#Compact Production Logging Stack - 347° F					R

(Remarks: R – Required)

*Depending upon the open hole or cased hole completion planned by Contractor

to be kept in standby mode

Bantumilli South Cased Hole Logging Plan:

Casing size (in.)	18-5/8"	13-3/8"	9-5/8"	7"
Cased Hole Logging				
CBL/VDL/GR-CCL (BESS-				
BCS) Cement Bond Image				
Logs and azimuthal coverage		П	п	П
of formation and cement		ĸ	ĸ	R
arrivals (CCAS)/Ultra Sonic				
Imaging Tool as required)				

Production Logging Tools (PLT)#				R
For correlation (GR-CCL-TCL)	R	R	R	R
R: Required #To be kept in Standby mode				

Log interpretation Services:

Interpretation of Magnetic Resonance Logging, Formation Micro Imager, Shear Sonic Imaging, Formation Pressure Tester (pressure and sample) and Elemental Capture Spectrometry by the Contractor to be provided to ONGC.

4.9 Coring

Coring Requirements in Periyakudi wells are as follows:

coring requirements in retryakadi wens are as follows.					
Coring Requirements	Comments				
Potential Coring Interval for well PDAD: 4209 - 4516 m (TVD-MSL) in PDS-30 4576 - 4780 m (TVD-MSL) in PDS-20	Coring is to be performed within the final phase of drilling covering the objective sand (Actual depth of coring will be intimated by well site geologist)				
Potential Coring Interval of well PDDA: 4371- 4696 m (TVD-MSL) in PDS- 30 4776 - 5000 m (TVD-MSL) in PDS- 20	Coring is to be performed within the final phase of drilling covering the objective sand (Actual depth of coring will be intimated by well site geologist)				
Number of Cores to be cut and Core length	2 (Two) cores of 18m length within each sand PDS-30 & PDS-20 respectively (i.e. total 4 (four) cores)				
Full size conventional Core	9m or 18m core barrel (18m preferred)				

Coring Requirements in Bantumilli wells are as follows:

Requirement	Comments
Potential Coring Interval; 4160 - 4800 m TVDSS	All coring may be planned for the $8^1/2$ " hole section only. (exact depth of coring will be provided by the site geologist)
Minimum core length	Two cores of 18m each in the Upper and Lower part of the Nandigama Formation (within sandstone reservoir section)
Full size conventional Core	9m or 18m core barrel (18m preferred)

4.10 Hydrofracturing, Completion and Production Testing

4.10.1 Common HF Requirements

- 1. Testing equipment, surface facilities, testing services, well completion services, hydro-fracturing services and service engineers is to be provided by the Contractor.
- 2. It is intended to carry out HF jobs in all the four wells without rig, after completion of drilling. However, final decision on with or without rig will rest with the Contractor depending on the technology and the confidence level.
- 3. The overall plan for hydro-fracturing and completion involves the following essential requirements:
 - Multi-stage frac with 3 stages
 - High volume job of about 150 Tons per stage in Periyakudi wells
 - 45 Tons per stage in Bantumilli wells
 - No killing of the well in between the fracturing stages
 - Use of Frac-cum-production string i.e. no killing of well between frac and completion
- 4. Keeping the above essential requirements in mind, the bidders can make their own plan for completion as well as the execution methodology for hydro-fracturing. However, certain methodologies are given in the Information document for reference.
- 5. Hydro-fracture units of appropriate HP, capable of execution and monitoring of planned multistage fracturing have to be deployed by the Contractor.
- 6. All materials/chemicals like proppant, carrier fluid, additives etc. have to be provided by the Contractor.
- 7. The detailed fracturing design for the planned job size has to be done by the Contractor using industry standard hydro-fracturing design software.
- 8. Suitable chemicals compatible to the formation to obtain best fracturing efficiency should be used in hydro-fracturing jobs.
- 9. The fracturing job will be executed by the Contractor and the Contractor will provide all fracturing equipment.
- 10. Required set of sub-surface gauges have to be lowered in the well during fracturing for real time monitoring of fracture job. The post-frac job evaluation report for each stage has to be provided by the Contractor.

4.10.2 HF requirement for Periyakudi Wells PDAD and PDDA

- 1. The Periyakudi wells will be encountering two reservoirs PDS-30 and PDS-20 separated by 40-50m shale. The expected reservoir thickness in the wells is about 300m for each sand.
- 2. The object which will be hydro-fractured (PDS-20/PDS-30) and completed in each well will be decided after drilling of both the wells and on the basis of final log evaluation. However, one well is intended to be completed in PDS-20 and the other in PDS-30.
- 3. In case desired production is not achieved after fracturing of one sand as per the essential SoW of the Contract, the well has to undergo fracturing in the second sand by isolating the first. For this second multi-stage fracturing job, a separate cost estimate has to be given by the Contractor. Further, zone transfer option has to be built in the first completion design itself to facilitate future requirement after exhausting the first zone. The completion should enable to switch lower sand to upper sand and vice versa.
- 4. To achieve the desired rate of production, a three stage fracturing is planned with around 150 Tons proppant volume in each stage. The

detailed design and execution plan has to be worked out by the Contractor.

- 5. The tentative modelled fracture parameters for about 150 Tons job in Periyakudi wells are given in the Information document. Fractures of similar dimensions have to be planned by the Contractor in Periyakudi wells.
- 6. Frac-cum-well completion plan and its execution with either cemented or un-cemented liner/casing and related completion-cum-production string and jewelries for applicable HPHT ratings have to be provided by the Contractor. The plans are to be clearly indicated in the technical bid.

4.10.3 HF requirement for Bantumilli South Wells BTSDA and BTSDB

- 1. The Bantumilli South wells have two objectives. The objective above 4400m is already tested in offset well BTS-1. The expected object below 4400m is not tested in any of the wells.
- 2. In Bantumilli South wells, subject to development of sand, it is planned to complete one well below 4400m and one well above 4400m. The object to be finally completed will be hydro-fractured up to 3 stages. However, in both the wells, the other object (which is not completed for final completion) may also be tested without HF for assessment purpose.
- 3. In case desired production is not achieved after fracturing of one sand as per the essential SoW of the Contract, the well has to undergo fracturing in the second sand by isolating the first. For this second multi-stage fracturing job, a separate cost estimate has to be given by the Contractor. Further, zone transfer option has to be built in the first completion design itself to facilitate future requirement after exhausting the first zone. The completion should enable to switch lower sand to upper sand and vice versa.
- 4. A job size of around 45 Tons proppant volume is planned for each stage of fracturing. The detailed design and execution plan has to be worked out by the Contractor.
- 5. The tentative modelled fracture parameters corresponding to the tested zone in BTS-1 is for about 45 Tons job as given in the Information document. However, the Contractor may make suitable frac plan taking into account the encountered pay thickness and heterogeneity within the pay and mobilise the proppant and other materials accordingly.

4.10.4 Testing and Flow back requirements

- 1. The flow back/activation job will be carried out by the Contractor, for which all the required HPHT surface equipment/facilities will be provided by the Contractor. During well flow back, proper care to be taken to avoid any erosion and cuts of the surface equipment. Wells have to be made ready for reservoir studies and multi rate tests by properly cleaning the well by flowing back the leftover proppant and gelled water with chemicals from near well bore vicinity.
- 2. None damaging completion/clear fluid as well as annulus fluid has to be provided by the Contractor keeping in view the well production life for about 20 years.

- 3. The Contractor shall make adequate arrangement of gas, condensate, water separation, sand fines removal (strainer / filter) to ensure accurate flow measurement.
- 4. The Contractor shall make suitable arrangement for disposal of produced water, frac fluids, proppant etc. at the time of testing, conforming to the norms of Pollution Control Board.
- 5. The Contractor shall make suitable arrangement for flaring the produced gas conforming to the norms of DGMS.
- 6. The Contractor shall record gas, oil/condensate and water flow rate and THP/CHP on hourly basis and report the same as instructed by ONGC in a prescribed format on a daily basis.
- 7. All wellhead equipment including drive head, surface equipment for well testing shall be fitted by the Contractor.
- 8. During the entire production testing phase, supply of power, technical water as well as availability of communication system is to be ensured by the Contractor.
- 9. In case of any complication in the well during production testing phase, Contractor shall rectify the problem, replace equipment / tubulars, if required, and bring the well back to production.
- 10. During production testing and completion, if any complication or fishing job arises, Contractor has to plan for such exigencies and take necessary remedies including re-drilling of well.
- 11. The Contractor shall follow all the statutory norms and guidelines of the industry.
- 12. Any isolation job for temporary or permanent abandonment of well in case of non-hydrocarbon bearing or for going from one object to other including sand plug, cement plug, bridge plug and packer isolation has to be carried out by Contractor.

4.11 Testing Equipment and Services

The Contractor shall provide one set of Production Testing Surface (PTS) equipment along with accessories in operating condition and services including manpower required for carrying out testing in 2 Periyakudi wells of Cauvery Basin of around 15,000 psi BHP & 350°F BHT and 2 Bantumilli South wells of KG Basin of around 15000 psi BHP and 400°F BHT.

Following is the list of Surface well test equipment but not limited to:

- Surface Test Tree
- Surface Test Line
- Emergency shutdown device valve
- Surface safety valves
- Choke Manifold
- Steam Exchanger
- Steam Generator
- > Three phase test separator
- Surge Tank
- Transfer Pumps

- Oil diverter manifold
- Flare Burner Head and Propane supply
- Chemical injection system
- Air Compressor
- Emergency shutdown system
- Sand pot filters
- Sand Detection and probes
- Surface fluid sampling equipment
- Data acquisition system
- Flow line data header
- ➢ Well test data lab

Detailed specifications are given in the technical scope of work.

4.12 Reservoir Studies

- 1. Necessary experienced crew and suitable equipment to carry out reservoir studies operations i.e. long duration pressure transient studies like build up, draw down and RLT as well as sampling are required to be provided by the Contractor.
- 2. Testing string should enable down hole shut in during pressure build up studies.
- 3. Pressure and temperature gauges (Quartz/Strain) should be equipped with surface read out facilities. At least 2 pressure and temperature gauges have to be used for each study to have data backup in case of gauge failure. Standby high precision mechanical gauges of required HPHT rating should also be made available.
- 4. The gauges and battery packs should be capable of continuous data recording at temperatures up to 400°F and should have a pressure rating of 20,000 psi.
- 5. The required slick line should be compatible with the above mentioned HPHT ranges. The down hole shut in tools and the pressure-temperature gauges should be resistant to the completion/testing fluids.
- 6. The detailed production/reservoir test program is given in the table below. These mentioned tests and the durations are considered over and above the time required for sufficient post frac flow back and cleaning of the well (Well has to be proppant free at the time of reservoir studies).
- 7. The slickline/wireline winch should be capable of carrying out bottom hole studies/operations in wells up to 6000m depth.
- 8. Equipment and services for trapping of bottom hole samples in such HPHT conditions, as well as recombination surface samples for PVT analysis should be provided by the Contractor. The sampling program should be planned for gas, condensate and water analysis at the production manifold or test separator for PVT studies. A minimum of two sample bottles should be collected at each sample period.
- 9. Analysis and interpretation of the pressure transient (Build up/Drawdown) and multi-bean study data acquired during reservoir studies has to be carried out by the Contractor. The suggested modifications in the interpretation after discussion with ONGC, if any, needs to be incorporated

in the final report. The final reports thereof are required to be submitted in hard copies (2 copies) and soft copies. The soft copy should include the raw data and the interpretation files.

- 10. Samples should be collected in certified approved containers for transport to a testing laboratory. Specialized containers should be provided such as Sulfinert® coated cylinders for collection of pressurized gas and liquid samples and pre-treated containers for collection of atmospheric liquid samples for mercury and arsenic testing. All samples must be packaged and labelled according to Indian regulations.
- 11. The crucial reservoir study data for daily monitoring of wells like FBHP Gradient, SBHP Gradient or Influx study data along with corresponding surface THP/Production data have to be communicated to ONGC within 2 (two) hours of interpretation.

Production Well Test Program						
Time	Flow Period Reference	Shut In Location				
(hrs.)		Downhole (STV)	Surface (Choke)	Test Objective/Description		
6 to 12	Flow stabilization	No	No	• Time shortens if well cleans up • The same bean size will be maintained as used in final stage of flow back		
12 to 24	1 st Shut in	Yes	Yes	• Shut-in 1.25 to 2 times the clean-up flow time		
36	Main Flow	No	No	 Obtain sub-surface Samples immediately after opening well for main flow Flow chokes and times depend on findings of clean-up flow Multi-rate test dependent on largest choke size 		
72	Main Shut- In	Yes	Yes	Initial pressure, permeability, final skinShut-in 1.5 to 2 times the main flow time		
118to146Live well operating time						
 This table will be modified prior to the well test after analysis of Formation evaluation information obtained during drilling, logging and MDT – post fracturing – suggest four step rates test The Well flow and Shut in periods for the wells may be modified on the basis of real 						

time surface readout data interpretation. Moreover, the Periyakudi wells may require longer time in each stage as this reservoir has very low permeability.

4.13 Handing over of Wells

At the end of all the activities in a well, the Contractor shall handover all the four wells with well head assemblies including X-mas tree, tubular etc. in running and safe condition.

