TERMS OF REFERENCE

FOR HIRING OF SERVICES FOR FULL FIELD INTEGRATED RESERVOIR SIMULATION STUDY

OF

UCH GAS FIELD

Note:

Bid bond of **USD 10,000/- (US Dollar Ten Thousand Only)** to be submitted with the technical bid.

The master set of tender documents (services) uploaded on OGDCL website (www.ogdcl.com) is the integral part of this TOR.

TERMS OF REFERENCE

1 BACKGROUND INFORMATION

1.1 Uch Gas Field is located in Dera Bugti District in the eastern part of Baluchistan. The discovery well Uch-01 was drilled in 1955 by Pakistan Petroleum Limited. However, the well was abandoned due to high CO_2 content and the license was relinquished. OGDCL acquired the license in 1986 and evaluated the area through three 2D seismic surveys of different vintages. Main reservoir comprises of Eocene age Sui Main Limestone. This formation occurs in several other gas fields located in the central part of Pakistan's Western Fold Belt.

1.2 During the appraisal of the field it was discovered that Uch structure is compartmentalized into three lobes with varying gas composition. By 1995, 10 wells had been drilled in the field. Two of the wells, Uch-4 and Uch-5, were drilled to delineate the flanks and proved to be wet. A technical evaluation and plan for development was carried out (OGDCL / UNOCAL 1995). In 1996, a license of 121 $Km^2$was applied for and granted to OGDCL with extension of ten years till 2036. Production from the field started in 1999 with fifteen producing wells.

1.3 Uch field is located on an elongate anticline, trending WNW to ESE. Surface exposure of the structure is about 49 Km by 5 Km. The structure is asymmetrical with the southern flank of the structure having a steeper dip than the northern flank. The feature is bound to the south by a high angle reverse fault identified on seismic.

1.4 Main reservoir Sui Main Limestone is 364 meters thick and conformably overlies the Upper Paleocene Dunghan Limestone. The reservoir is conformably overlain by the Lower Eocene Ghazij Shale which forms the top seal for the gas reservoir. Sui Main Limestone has been interpreted as an offshore carbonate build-up, deposited on an old paleo high. The reservoir is subdivided into four units (A, B, C, D). Most of the gas occurs in the porous upper three units (A, B, and C) and these average 175 meters in thickness.

1.5 The reservoir is compartmentalized into three lobes. These lobes are referred as Western, Central and Eastern lobes. Each lobe contains gas of varying composition and heating value. The lowest BTU rated gas (higher inert) is in the Western lobe. The BTU rating progressively increases in the Central lobe and is highest in the Eastern lobe.

1.6 OGDCL has completed the development of Uch Gas Field in two different Project Trains:

1.6.1 **Uch–I**

It came online in 1999 with 20 drilled wells (including Uch Deep-01 (Blow out) and Uch Deep-01A (Relief Well), two abandoned wells (Uch-04 and 05) and Uch-01 (abandoned due to odd casing size). Uch-17 has been abandoned due to communication developed between tubing and annulus. A replacement well has been marked and will be drilled before commencement of this study. A total of 106,000 MMBTU/D of gas for 20 years and thereafter 102,000 MMBTU/D for next 3 years with an average heating value of 430-480 BTU/SCF from 15 producer wells is being supplied to M/s UPL (Uch Power limited). The GSA is valid for a period of 23 years.

1.6.2 **Uch–II:**

Work on Uch-II started in June 2009 with drilling of 15 new development wells on or near the crest of the structure (Uch-19 to Uch-33) taking the total number of wells in this field to 35. OGDCL has signed Uch-II Gas Sales Agreement with Uch Power Limited (UPL) to supply 72,000 MMBTU/D gas with average heating value of 430-480 BTU/SCF for 25 years starting from first quarter of 2014. These "Uch-II" wells have been drilled without any significant surprise and provide improved control on the structural mapping.

1.6.3 **Exploratory Well:**

Uch Deep-01B has been drilled to evaluate the deeper prospects which proved to be wet in this well and thus the said well was completed in Sui Main Limestone taking the total number of drilled wells in Uch Gas Field to 37 (including replacement well of Uch-17), which will be the tentative number of wells to be included in this study. However, the number of wells, to be included in this study, may increase if further development / replacement wells are drilled till finalization of static model.

1.7 Five international Consultants have conducted reservoir studies of Uch Gas Field to estimate the recoverable reserves and suggested optimum development plan along with gas production forecasts.

1.8 Uch Gas Field Reservoir studies based on number of drilled wells are tabulated below:

Consultant	Year	Wellbores
D&S, USA	1990	6
D&M, Canada	1992	8
UNOCAL, USA	1995	11
IPR International, USA	2004	18
CGG Vostok, Russia	2015	36

1.9 M/s D&S USA conducted full field reservoir study in 1990 with 6 drilled wells (Uch-01 to Uch-06B) and updated by D&M, USA 1992 by using data of 8 wells. In 1995 M/s UNOCAL did a joint technical evaluation with OGDCL and prepared a field development plan. Nine wells were drilled till that time and study recommended six more wells in all three lobes. A full field Reservoir simulation study was carried out by M/s IPR in August 2004. This study incorporated geological, petrophysical data as well as production history of fifteen (15) wells on production up to that time. The gas analysis showed the hydrocarbon contained in the reservoir is "dry gas". M/s IPR study demonstrated that Uch field reserves and reservoir deliverability are sufficient to supply gas to a second power generation plant. After update of Dynamic model in 2018, M/s Schlumberger has recommended to install the compression by 2021.

1.10 The field was brought on production in 1999 with fifteen (15) producing wells. Till that time total drilled wells were 20 (Uch-01 to 18, Uch Deep-01 and Uch Deep-01A). Presently the field is producing around 450-465 MMSCFD of raw gas under natural flow. At present 30 wells are producing for Uch-I and Uch-II projects. Only Uch-06B is shut-in due to high water cut. All the wells are completed only in SML.

1.11 The future development plan of the field is to enhance maintain the gas production for both Uch-I and Uch-II projects as per GSA, as well as to exploit the possibility of revising Uch-I beyond 2023 and deplete the reserves assigned to the field in the most economical way.

2 OBJECTIVE

The main objective is to carry out a detailed integrated reservoir simulation study of Uch Gas Field with different raw and sale gas targets to achieve the maximum recovery in the most economical way as well as to address the significant difference in Gas in-place calculated from Static and Dynamic model. The objective is also to confirm the revision of Uch-I project with MDQ of 102,000 MMBTU/D beyond 2023 in case additional gas is available after fulfillment of contractual obligations of Uch-I and Uch-II. In order to achieve the objective following steps are to be taken:

2.1 Build new Depositional, Geophysical, Petrophysical and Geological Model (Static Models) in the light of available 2D reprocessed seismic data (**457 Line Km**) for SML (producing reservoir) and deeper and shallower reservoir if any. The consultant will also review wells drilled up to date and the available data of the offset wells / fields, including the available core data, VSP / VSI, seismic data and generate fresh time & depth structure maps, stratigraphic and amplitude maps calibrated with petrophysical data of producing and prospective horizons if any.

2.2 Estimate the total GIIP by volumetric methods (Geostatistical and Deterministic) using newly generated Static Models for producing formation in Uch gas field and classify them as P90, P50 & P10.

2.3 Apply Material Balance technique to estimate the GIIP and determine the drive mechanism and its strength for all three lobes using updated pressure / production data. Develop reservoir tank models for all three lobes Uch gas field. This will include different blocks and different reservoir levels. Tank models shall be history matched. Sensitivity analysis on uncertain tank model parameters shall be performed. Details of the matching procedures and sensitivity analysis results should be reported. Estimates of hydrocarbon volumes and production drive mechanism should be provided.

2.4 Also, review / analyze the production and pressure data for possible inconsistencies / correction. However, it should be done in close collaboration with OGDCL.

2.5 Analyze in detail all available well log data, transient test data, production test data and any other data that can contribute to improve the characterization of all reservoir layers in each lobe of Uch gas Field. Consultant will submit separate report of interpretation.

2.6 Carry out basic reservoir engineering analysis including production tests, well test including PLT / PSP data and incorporate it during petrophysical modeling.

2.7 Petrophysical modeling should capture the variability and trends in the data at fine scale and upscaled model levels and should clearly be established through graphs and displays during presentations / reporting.

2.8 Upscale, if required, however, the fine scale and upscale model should be representative of the fine scale model. This should be achieved, by incorporating state of the art upscaling tools and confirmed through streamline simulation modeling. This should be presented before embarking on history matching exercise.

2.9 Develop a representative fluid PVT model based on available PVT lab data which can fully capture / predict the change in fluid properties.

2.10 Perform grid size sensitivity and clearly establish the optimum size to be used during the history matching phase. This should be presented in Phase-I results.

2.11 Initialize the simulation model using finite difference simulator, e.g. Petrel RE etc. A clear comparison / matching of actual versus model predicted water saturation with depth along the wellbore should be established for acceptance of model initialization.

2.12 Estimate the Gas initially in place (GIIP) and average reservoir pressures using different realizations (Geostatistical & Deterministic) of newly generated Static Model for producing / tested formation in Uch gas field and provide reserves as per PRMS / WPC.

2.13 Develop a representative 3D reservoir dynamic model for all the producing / tested reservoirs. All fields may be included in the same model, given that it does not increase simulator run exponentially and there is no communication which is required to be model among different modeled formations.

2.14 Prepare a history matched model to fully capture the production and pressure quantities including trends of production and pressure. Identify the major impact parameters that are used for obtaining history match and quantify individual parameter impacts. Detailed report should include exactly what modifications have been made in the model, their rational and consequent impacts.

2.15 Prepare a surface facilities network model and run it coupled with reservoir simulator to properly evaluate the future strategies and to identify possible bottlenecks and their remedies in current setup and future system constraints / implications with solutions.

2.16 Study, in close collaboration with client, different realistic development options to optimally exploit the different reservoirs while maximizing the reserves which may include but not limited to compression, fracturing, artificial lift requirement with timing, additional perforations, zonal isolations, dual / commingled production, completion strategy including well types i.e. vertical / deviated / horizontal wells, optimum well locations with expected incremental / accelerated production from each of the reservoirs.

2.17 Also, identify production enhancement opportunities in existing wells by using techniques like compression, fracturing, artificial lift (timing and requirement), additional perforations, commingled production, completion strategy, etc. to optimally drain the hydrocarbons from current wells and production facilities.

2.18 Any difference in GIIP from volumetric, material balance and simulation is to be resolved.

2.19 Identify most suitable locations of any additional future wells for optimum depletion of Sui Main Limestone. The additional well locations for optimum depletion of Sui Main Limestone also need to be worked out in the presence of well head / front end compression whichever applicable.

2.20 Identify new prospect on shallow / deeper level within the AOI with consultation of OGDCL and recommend a suitable well location for identified prospect evaluation. Any new prospect identified shall be characterized as contingent recourses and may be assigned GIIP and Reserves as 1C, 2C and 3C categories.

2.21 Recommend the optimum further development and production plans for maximum gas recovery in the most economical way until field abandonment (including gathering and surface facilities system) for both projects (Uch-I & Uch-II) and Uch-1 revision subject to availability of additional gas. It should be noted that Eastern Lobe has the highest BTU and apparently lowest volume comparing to central and western lobes. Therefore, consultant will perform optimum depletion strategy of the field so that volumes of eastern lobe should not be exhausted before fulfilling of GSA's of Uch-I, Uch-II and Uch-I revision if any additional gas available.

2.22 Field optimization of Uch Gas Field coupling with surface network as an integrated asset modeling approach to accommodate response of network on reservoir production performance.

2.23 Estimate the ultimate recoverable reserves in respective 1P, 2P, 3P, and 1C, 2C, 3C categories as per SPE and WPC definitions and provide certification for these reserves.

2.24 Consultant will run different forecast scenarios as required by the OGDCL, and generate pressure production profiles for these scenarios. Consultant should honor erosional velocity for the tubing sizes for wells of Uch-I and Uch-II projects to avoid erosion of the flow tubing. Consultant will recommend optimum flow rates of all producing wells to avoid erosion velocity.

2.25 Study the technical and economic feasibility of compression systems for optimizing production and recovery from reservoir and recommend the most feasible scheme and its detailed breakup for implementation in the light of the prevailing Gas Sales / Purchase Agreement with the buyer. Presently the compression is being designed to fulfill existing GSAs of Uch-I and Uch-II projects and is planned to be installed in 2021. Consultant will recommend with timing, additional compression facilities and modifications to the existing compression facilities, required to fulfill contractual obligations of existing GSAs of (Uch-I & Uch-II) Projects and revision of Uch-I project if any additional gas available, along with estimation of the required compression strength.

2.26 In compression evaluation process, consultant will also evaluate adjustments of high potential wells within the wells of Uch-I and Uch-II to meet contractual obligations of Uch-I, Uch-II and Uch-I revision if any additional gas available, before recommending timing of additional compression. Assessment of time when additional compression will be required to

fulfill contractual obligations of Uch-I and Uch-II projects, along with estimation of the required compression strength in order to "optimize" the reservoirs performance. (The word "Optimize" in this paragraph covers: Production enhancement, EUR improvement, Right timing, viable economics, Asset value maximization etc.).

2.27 Determine the optimum timings of additional compression facilities and modifications.

2.28 This study should provide the optimum production operation conditions for maximum hydrocarbon recovery including compression

2.29 Undertake the technical and pre-tax point-forward economic feasibility study for optimum development plan of the field including gathering, surface and subsurface facilities design with the following options:

2.29.1 With and without compression.

2.29.2 Stimulation / Re-stimulation (reduction / removal of skin), re-perforations / additional perforations / opening new zones etc., to maintain the production for fulfillment of contractual obligations of Uch-I and Uch-II projects as well as for supply of any available additional gas for Uch-I after expiry of present arrangement.

2.30 Independent comments on:

2.30.1 Contractual obligation fulfillment. ACQs / DCQs for further life of the field in the light of existing GSAs and prediction forecasts.

2.30.2 To assess economic viability of both projects.

2.30.3 Availability of any additional gas after fulfilling of Uch-I and Uch-II projects and contractual obligations. Optimum case for revision of Uch-I, will also be recommended.

2.31 Uch Model Updation and Compression Evaluation report 2018 by M/s Schlumberger shows that there is a significant increase in GIIP, and there is also a potential to revise Uch-I project with MDQ of 102,000 MMBTU/D up to 2028. Consultant will confirm revision of Uch-I project with MDQ of 102,000 MMBTU/D up to 2028.

3 SCOPE OF STUDY

a. Review all technical data available on Uch Gas Field to develop reservoir characterization model for the known reservoir / producing horizon and develop a comprehensive petrophysical & geological model to perform three-dimensional full field reservoir simulation study with different sale gas targets to achieve the maximum gas recoveries and best economics till field abandonment.

b. The data to be reviewed will include 2D Seismic, VSP/VSI data, Geological data, core data, Wireline logs, regional structural configuration and stratigraphic correlations / cross sections, well tests data, BHP data, PVT data, production data, completion histories and all relevant data related to drilling of existing or proposed well(s).

c. Review the available dynamic data and develop comprehensive Petrophysical & Geological Models to perform 3-D reservoir simulation study to achieve the optimum hydrocarbon recovery.

d. Develop a representative network simulation model for performing prediction runs in combination with the reservoir simulation model. Also review applicable DCA, GPA, GSA both for the Uch-I & Uch-II, and other covenants with Government, UPL (buyer) and regulator (if any).

e. Consultant will produce pressure-depth plot incorporating all DST's reservoir pressure and MDT pressure measurement to determine fluid levels i.e. GWCs in different fields. The determined fluid levels will be incorporated in petrophysical analysis.

f. The consultant will also incorporate all the existing data of the Uch wells drilled so far and any upcoming data from existing wells and new wells, if any.

g. Prepare estimates of proven, probable and possible in-place and recoverable reserves of hydrocarbons using volumetric, decline curve analysis and material balance methodologies based on available data.

h. This study should provide the optimum production operation conditions for maximum gas recoveries for SML reservoir. The study should provide different forecast scenarios, including raw gas, sale gas and water recoveries with BHP and WHFP till ultimate recoveries of the field.

i. The consultant will work out the flow lines / gathering system with sizes and the optimum surface facilities

j. This study should include the feasibility study providing the economic viability of the project for different possible development scenarios.

k. Recommendations on future optimization of surface network and compression facilities should also be included.

The detailed scope of work is as under:

3.1 **Data Collection / Inputs**

3.1.1 For data collection a team of experts from consulting firm will visit OGDCL office in Islamabad from the location earmarked by the bidder for this project. The team will comprise at least three professionals; one from each discipline i.e. Geologist, Geophysicist and Reservoir Engineer, out of the dedicated team for this project.

3.1.2 Data will be provided to the consultant's team after a kickoff meeting at OGDCL office in Islamabad.

3.1.3 The team will stay in Islamabad to review and scrutinize the data and will provide report about the quality of available data before leaving Pakistan.

3.1.4 The data obtained from the field during the study period will be provided continuously to the consultant to refine their work for a concrete recommendation for the full field development program.

3.1.5 G&G data till the finalization of Static model and production data till the finalization of Dynamic model will be provided.

3.1.6 Data collection must start with signing of the contract / issuance of service order and to be completed within two to three (02-03) week time. Any delay in collection of data within specific time of two to three (02-03) weeks will be on part of the consultant.

3.1.7 All geological, geophysical, drilling, production testing, well logs, core and fluid analysis data required for study will be available to the consultant free of charge. Such material will be the property of OGDCL. The consultant will treat all data and information supplied by OGDCL and those acquired by him during the study with utmost confidentiality and will sign an agreement of confidentiality in the same contract.

3.1.8 All such type of data collected by the consultant in this regard will be returned to OGDCL after the completion of the study.

3.1.9 OGDCL will also provide adequate space to the consultant during their visit to OGDCL for data collection / review or presentation.

3.2 **Seismic & Geological Analysis**

3.2.1 Geological model should be established to determine the pertinent geological features and geometry of the reservoir in sufficient detail to allow an adequate description of the reservoir for reservoir simulation purposes through seismic data interpretation. The available data will be provided to help in evaluation of geological interpretation and geological setting of the area.

3.2.2 Structural and stratigraphic interpretation of Uch structure is to be carried out by using 2D reprocessed seismic data of about 457 Line Km. Time, Depth contour maps are to be generated on main reservoir Sui Main Limestone as well as prospective shallower / deeper reservoirs levels including shallower Habib Rahi Limestone, and deeper prospects of Fort Manro, Pab, Mughalkot, Parh and Chiltan Formation, total of seven levels. Seismic interpretation should be performed on PETREL G&G.

3.2.3 Synthetic seismograms will be generated using available VSP / VSI and wireline logs data. For complete coverage Synthetic seismograms of total 09 wells in the field will be generated by selecting 03 wells in each lobe through close coordination with OGDCL Geophysicist, Petrophysicist and Reservoir Geologist.

3.2.4 Highlight any lateral velocity variation and comment on time-depth relation. Also elaborate the uncertainties in used depth conversion function in the light of gross rock volume.

3.2.5 Workout the feasibility of Post-Stack Acoustic Inversion of existing processed 2D seismic data in terms of its use in reservoir characterization.

3.2.6 Consultant will elaborate the trapping mechanism in the light of mapped vertical closure and gas column in well. Consultant will also explain the structural and stratigraphic element involved.

3.2.7 Iso-pach maps will be produced using iso-chore map and interval velocity map. The resultant iso-pach map will be calibrated with well results.

3.2.8 For completion / finalization of the Static Model, the available data will have to be imported to the Geological Modeling software (Petrel). The interpreted seismic data will have to be integrated / calibrated (such as structural features / faults and picked horizons) with the well data.

3.2.9 The seismic interpretation should be carried out with complete involvement of OGDCL Geophysicist and all the aspects of seismic interpretation shall be approved by OGDCL before moving forward.

3.2.10 Geological aspect (Structural / Stratigraphic Cross Sections / Correlations) needs to be discussed and approved by OGDCL Development Geologist. OGDCL may prefer to receive Structural / Stratigraphic Cross Sections / Correlations on OGDCL's approved format.

3.2.11 Geological model should be prepared using Petrel G&G.

3.3 Petrophysical Analysis

The Petrophysical properties of the reservoir and formation water will be determined by the analysis of the DSTs, production, core and quantitative well log data. The objective of this analysis will be to determine the best possible evaluation of porosity, permeability, capillary pressure, relative permeability, initial fluid saturation, saturation of reducible and irreducible water, total hydrocarbon saturation and residual hydrocarbon saturation. Water resistivity (R_w) measurement and methods used for it will also be determined.

3.3.1 All logs will be analyzed independently. The basic data for all wells will be processed and interpreted independently too. Normalization of the logs should be attempted wherever required. Complete interpretation should be carried out on TechLog or any other petrophysical interpretation software used by OGDCL or as recommended by OGDCL Petrophysicist to the data collection team. The workflow of the interpretation module should be provided by the consultant.

3.3.2 **Clay Parameter Selection:** Log data will be cross-plotted / Pickett plot to establish various clay parameters. Statistical techniques will be employed in an attempt to establish clay types, and also compared to any clay analyses that have been carried out in the laboratories if available. Shale parameters will be chosen from cross-plot techniques and from the individual logs as required.

3.3.3 **Shale Volume:** Shale volumes will be calculated using *SP*, Gamma Ray and CNL-FDC cross-plot methods as minimum requirements besides other indicators and as is

applicable. If Spectral Gamma Ray and core data are available, the V_{sh} will be calculated and compared for accuracy.

3.3.4 **Porosity Calculation:** Porosity will be calculated using multiple porosity log analysis which is available. The calculated porosity will be compared against core porosity to establish a log-core porosity relationship. This relationship will then be utilized to establish a core-derived porosity transformation for all the wells in the analysis. The consultant will be required to identify different rock types and produce transformation, correlations and curves for each rock type.

3.3.5 **Permeability:** Permeability should be computed using different approaches based on available data (logs, cores and testing results). However, the derived permeability index from different approaches will be provided to OGDCL.

3.3.6 Correlation between core and log derived data will be obtained.

3.3.7 **Porosity-Permeability:** Cross-plots of K-Max, K-Relative, K-Vertical and K-Horizontal of core versus log porosity will be created to establish relationship between permeability and log-derived porosity. These relationships will then be used to generate permeability logs for the zone of interest in all the wells evaluated.

3.3.8 **Water Saturation:** For water saturation calculation different models should be attempted using different available methodologies to come up with most suitable model. Formation water resistivity will be established from raw techniques and compared to water analysis from tests from the field and from analogue values as are available.

3.3.9 Saturation height functioning modeling will be carried out for the wells where data is available.

3.3.10 J-function modeling (capillarity) for defining transitional zone saturation.

3.3.11 Fluid contacts modeling will be reviewed and reestablished.

3.3.12 Cut-off sensitivities will be reestablished in the light of gas production and reservoir behavior.

3.3.13 Based on SCAL, core, log and DST data, reservoir characterization of Sui Main Limestone reservoir will be established.

3.3.14 The interpreted results will be used to determine original GWC / GDT. The transition zone should be correlated with capillary pressure results.

3.3.15 Standard conventional log analysis will be carried out with color output of corrected S_{xo} (Water Saturation in Flushed zone), h, V_{sh}, S_w (Saturation of Water in Reservoir zone), Porosity, HCPV (Hydrocarbon Pore Volume), BVW (Bulk Volume of Water), Permeability, V_{sh}, moveable hydrocarbon and residual hydrocarbon etc.

3.3.16 C.P.I. outputs of graphical plot will be in color along with log derived permeabilities. The plots will include produced formation analysis by volume (clay, matrix porosity and fluid

analysis) and average grain density meter by meter in a scale of 1:200. Six copies of each plot will be prepared. All Cross / Pickett plots developed should also be provided to OGDCL with brief results on the same page.

3.3.17 Computer processed interpretation tabular output will include S_x, S_w, saturation of hydrocarbon, V_{sh}, moveable hydrocarbon, grain density, ϕh, $\phi h(1-S_w)$ and cumulative $\phi h(1-S_w)/B_{gi}$ meter by meter.

3.3.18 Optimum numbers for porosity, S_w and clay volume cut-offs will be determined by testing data at variable sensitivities.

3.3.19 **Summary Tables:** A set of summary values for each zone in each well, listing pay, net pay, average porosity, water saturation, HCPV, BVW, porosity thickness, hydrocarbon thickness and permeability thickness will be generated, based on a series of cut-offs. A maximum of twelve sets of summary values will be generated and included in the final report. Accordingly, GWC, GDT (Gas Down To) will be established.

3.3.20 The log interpretation should be correlated to define reservoir scale parameters e.g. saturation profile or variation in GWC / GDT.

3.3.21 Consultant will provide all the answer log data on Digital Storage Device while summaries, spread sheet / Excel data will also be provided in respective formats. Petrophysical work is to be carried out on TechLog or any other petrophysical interpretation software used by OGDCL or as recommended by OGDCL Petrophysicist to the data collection team.

3.3.22 Consultant will review the current logging suit and recommend any changes for future wells.

3.3.23 The transition zone should be correlated with capillary pressure results.

3.4 **Static Modeling**

3.4.1 Static Model (Integrated Geophysical, Geological and Petrophysical Models) will commence after approval of Geophysical, Geological and Petrophysical work from OGDCL. Final Static Model should be provided in Petrel software.

3.4.2 Build consistent stratigraphic / structural models by picking up the stratigraphic surfaces based on geological, geophysical and Petrophysical information.

3.4.3 The vertical and lateral dimensions of various zone / formation units will be delineated independently by the consultant. The consultant will prepare structure and stratigraphic cross sections using the logs and other data and will determine the gas water contact (GWC / GDT) specifying the transition zone.

3.4.4 For the purpose of reservoir description, each reservoir / zone will be subdivided into a number of layers as per geological model. Following maps should be generated for every reservoir layer on 1:50000 map scale:

i. Time contour maps on top & base of Sui Main Limestone as well as prospective shallower / deeper reservoirs levels including shallower *Habib Rahi Limestone*, and deeper prospects of *Fort Manro, Pab, Mughalkot, Parh and Chiltan Formation*, total of seven levels
ii. Depth structure maps on top & base of Sui Main Limestone as well as prospective shallower / deeper reservoirs levels including shallower *Habib Rahi Limestone*, and deeper prospects of *Fort Manro, Pab, Mughalkot, Parh and Chiltan Formation*, total of seven levels
iii. All volumes of attribute analysis / maps of horizon attributes
iv. Iso-pach maps
v. Calibrated Amplitude maps overlain by depth maps
vi. Gross hydrocarbon maps
vii. Hydrocarbon pay maps
viii. Net Pay maps (the cut-off values as used should be mentioned on each reservoir level map)
ix. Absolute & Effective Porosity maps
x. Hydrocarbon Pore Volume
xi. Water Saturation maps
xii. Facies map

3.4.5 A Facies model is to be constructed on Sui Main Limestone reservoir with the help of petrophysical analysis. The model should address the vertical and lateral distribution of different facies. A relationship between facies and reservoir quality / performance should also be established. Incorporation of Sedimentology study results to assess facies model and Rock Typing to understand behavior of rock quality variation throughout the reservoir.

3.4.6 Populating petrophysical properties as a function of Facies Model and incorporation of rock physics data.

3.4.7 Preparing Discrete Fracture Model and recalibrating it with PTA to match populated fracture density with Dual porosity response on well test analysis.

3.4.8 Calculate volumetric gas in place for each geological layer. If a model layer consists of two or more geological layers, or a geological layer is subdivided in two or more model layers, the gas in place is to be estimated for each model layer as well individually.

3.4.9 Total hydrocarbons in place has to be calculated using proper cut off for porosity, water saturations and shale value with technical justification for each conventional as well as for unconventional reservoir / zone / layer.

3.4.10 The Consultant should select a representative geological model (Using Geo-screening approach) for reservoir simulation modeling.

3.5 **Basic Reservoir Engineering & Determination of Gas Initially in Place**

3.5.1 Review the PVT laboratory analysis reports on fluid samples from Uch gas field. The reports will be reviewed for completeness and examined for systematic variation of key properties for final input into the material balance and simulation model in consultation with OGDCL professionals.

3.5.2 Review the available Rock Properties data for relative permeability and capillary pressure curves required for simulation model for each identified rock type.

3.5.3 Well test data obtained from all the wells will be reviewed and analyzed by the consultant for reservoir parameter estimations and model validation. The procedures to analyze the well test data should be clearly mentioned in the consultant's proposal. Proposals for future testing procedures and practices should also be submitted. Multilayer well test analysis software would be required for the analysis. Separate report of well test analysis will be provided. Ecrin (Kappa Sapphire) software will be used for well test analysis and soft copies of well test interpretation will be provided.

3.5.4 Recalibrating Discrete Fracture Model with PTA to match populated fracture density with Dual porosity response on well test analysis.

3.5.5 The skin from well test analysis should be evaluated further and skin due to completion and damage should be estimated separately. Furthermore, skin due to completion be elaborated to include skin due to well trajectory and / or stimulation. Also, skin due to turbulence and geology must be incorporated. If more than one well test models fit to data, consultant will mention all models. The Model matching geological and geophysical data will be used to characterize reservoir. The consultant will submit a separate report exclusively for well test analysis for SML. WTA on entire rate history must be provided along with de-convolution results. Apart from this DST, BHP surveys of all wells prior to history matching shall be reviewed and results be incorporated in the model.

3.5.6 The permeabilities estimated from the short and long term pressure transient analysis will be correlated with the data obtained from core analysis.

3.5.7 Review all the well completions and convert to match with the simulation model layers at each well location.

3.5.8 Review the available Production data, encompassing well test results carried out on different times, for their completeness and accuracy to be used for Simulation and Material balance. Also prepare 'wellbore hydraulics tables' to allow the simulator to account for the effects of the vertical flow system in conjunction with assigned tubing head pressure in the predictive mode.

3.5.9 The Consultant will apply DCA (Decline Curve Analysis) on all the wells of Uch by using OFM Software. DCA will also be applied for each lobe as well as to the whole field. The consultant will use at least 02 methods of Decline Curve (Exponential / Hyperbolic / Harmonic) depending on Production History of wells and Reservoir Properties. The DCA will verify the Reserves figures calculated by the Volumetric, Material Balance & Simulation and will also verify the Production Forecast by simulation model.

3.5.10 Combine the results of geophysical, geological, petrophysical, fluid property analysis and reservoir geometry to calculate volumetric gas in-place for each geological layer. If a model layer consists of two or more geological layers, or a geological layer is subdivided in two or more model layers, the gas in-place is to be estimated for each model layer as well. Total hydrocarbons in place has to be calculated using proper cut off for porosity, water saturation and shale volume with technical justification.

3.5.11 An estimate of hydrocarbons initially in-place of the producing, tested and potential reservoirs should also be calculated using Material Balance method by developing reservoir tank models using industry standard software. P/Z method should be applied to three lobes and field. This will include different blocks and different reservoir levels. Tank models shall be history matched. Perform sensitivity analysis on uncertain tank model parameters. Details of the matching procedures and sensitivity analysis results should be reported. Estimate hydrocarbon volumes and reserves throughout the field life. Models should be provided in digital format. Aquifer Model should be used to estimate the water influx rate for producing formations.

3.5.12 Assess Uch Field Material balance analysis to advocate presence/absence of aquifer. Calibrate Static model volumetrics as per Material Balance results.

3.5.13 The consultant will develop wellbore hydraulics models and generate Vertical Flow Performance (VFP) tables for all the current and future wells covering all the possible wellbore flowing conditions including natural flow and flow through compressor. This information will be used in various scenarios for production optimization in the simulation model.

3.5.14 The consultant will perform Nodal Analysis for all flowing wells and also the wells (if any) which have loaded up and have seized to flow or sidetracked. This information will be used for production optimization in the simulation model.

3.6 Model Initialization

3.6.1 A two phase, three-dimensional simulation model capable to handle dual porosity and dual permeability reservoir covering all the three lobes and full field would be required for the study. The areal grid size and layering of reservoir will be dictated from the areal and vertical variation of the petrophysical properties, facies studies and structure of the reservoir.

3.6.2 The aquifer should be represented by proper cells in all directions. After the completion of the first phase of study (Geological Phase), the consultant will propose the X-Y grid of the reservoirs, the number of cells to represent the reservoir and number of model layers. This will be decided after discussion and satisfaction of OGDCL. A preprocessor run with all basic data and initial gas in-place obtained by the model is to be compared with that obtained by volumetric method. These values should be comparable. A sensitivity run with no production is to be run for five years or till the stability to understand the smoothness of initial data.

3.6.3 Consultant should also determine the possibility of communication between lobes / fault blocks / wells at reservoir level.

3.6.4 All simulation work must be performed on **Petrel RE Simulator**.

3.7 Radial Model Study

3.7.1 At least nine (09) wells (three from each lobe) will be selected for radial model study, to assess the coning behavior near the original gas water contacts. The selection of wells will be made in consultation with OGDCL Reservoir Engineers.

3.7.2 The results will be analyzed to allow development of wellbore pseudo permeability curves for break through response.

3.7.3 It is estimated that each well model may have up to 300 cells, covering the reservoir.

3.7.4 Prediction of each case for 20-25 years at five varying rates will be conducted to determine the behavior of the well as a function of rate.

3.7.5 The calibration of the model will be made with the well test, G&G and Petrophysical data available for the respective wells.

3.7.6 Complete tubing head pressure, wellhead pressure and flow line network model based on PipeSys, PipeSim or PipePhase must be built to see the plant inlet pressure. The pressure drop calculations and pipeline network model must be shared with OGDCL in raw form as well.

3.8 Full Field Simulation Study:

3.8.1 Construction of Static Reservoir Model for;

- Sui Main Limestone Reservoir (SML)

3.8.2 Grid Dimension of reservoir is to be used depending on Rock properties.

3.8.3 Study the effect of aquifer strength in reservoir.

3.8.4 Corner point geometry of grid should be used in the Model.

3.8.5 Local Grid Refinement(LGRs) should be used around the wellbore region or away from the wells where we have no control on reservoir properties.

3.8.6 Full field reservoir simulation model covering three lobes and field will be constructed by using all information from items above. Field wise and lobe wise simulation will be performed.

3.8.7 The location of hydrocarbon interfaces, the variation in pool composition and location of remaining producible hydrocarbons will be delineated.

3.8.8 Special emphasis will be given to high permeability layers due to probable fracture presence during model construction and to study the behavior for any possible difficulty in reservoir management due to these.

3.9 **Full Field History Match**

3.9.1 The Schedule section of data file will be prepared by the consultant and examined by the OGDCL Professional before the start of History match.

3.9.2 Recurrent data, such as the well specification, perforation, rates, log of completion etc., will be prepared and the need to make necessary corrections to pressure data before history matching be also evaluated.

3.9.3 History match runs using the most appropriate time steps (to be agreed between OGDCL and the consultant firm to maintain the necessary accuracy and consultant's model stability) be carried out.

3.9.4 Reservoir parameters to be adjusted as necessary (within acceptable limits) to get the best well by well history match. A log of all the changes made on the parameters in order to obtain acceptable history match should be intimated to OGDCL and all computer runs be kept in record for OGDCL review.

3.9.5 Layer wise porosity, permeability, pressure and hydrocarbon saturation maps; initially, in between and at the end of history match will be provided. The match should account for all history parameters in addition to pressures.

3.9.6 Fully implicit model technique should be used in the single well, cross-sectional models and three dimensional model studies to ensure the stability and accuracy of the solution for each lobe and the whole field.

3.9.7 The model should be able to perform accurately under stable conditions. The time step should be chosen in such away which reduces the run time and proper convergence is achieved in shorter time.

3.9.8 Regardless of the number of the time steps proposed by Consultant, an acceptable history match should be obtained. However, the proposed number of time steps should be maintained at minimum.

3.9.9 Maximum of 5% saturation change and a pressure difference of 100 Psia in successive time steps will be always maintained in any cell in all simulation studies. The incremental material balance tolerance should not exceed 0.1 percent in all studies (single well, cross section and full field). The parameters will be decided with consultation of OGDCL professionals.

3.9.10 Develop validated model for each gas gathering system of SML. The validated model should be connected to the new 3D model in Petrel RE (using coupling software) to predict performance of SML reservoir.

3.10 **Performance Prediction**

3.10.1 Consultant should perform one sensitivity prediction run excluding two years' available pressure production data to validate model.

3.10.2 Following prediction cases will be run, if required. Final decision will be made with consultation of OGDCL professional at time of study:

3.10.2.1 Base case, future performance of reservoir as it is.

3.10.2.2 Future performance of reservoir with in-fill wells, if some areas of any reservoir are not properly drained in the base case.

3.10.2.3 Future performance of reservoir with re-completion cases if some layers of reservoir are not depleted in base case.

3.10.2.4 Pressure Maintenance (compression) for all above cases if applicable.

3.10.2.5 Coupled run by combining reservoir with surface network.

3.10.3 At least six final prediction cases, including above mentioned five cases, will be required over the life of the field (minimum thirty years). Each with different production rate, aquifer strength, water conning problems etc., as agreed with OGDCL.

3.10.4 The prediction runs of the lobes and full field model should not be done in a single go but rather segments. The criteria of such selection need to be discussed and agreed upon.

3.10.5 Field optimization of Uch Gas Field coupling with surface network as an integrated asset modeling approach to accommodate response of network on reservoir production performance.

3.10.6 In all these cases, the reservoir simulator interfaced with surface facility network shall be used.

3.10.7 The consultant will recommend the optimum development, alternative and will run the prediction case till the abandonment criteria and calculate the ultimate recoverable reserves for the three independent lobes.

3.10.8 The optimum case will be selected after reviewing the results of all predication cases and discussions with OGDCL.

3.10.9 Consultant should name the prediction cases properly like Base Case, Base Case with compression, Infill wells with compression, Recompletion wells with compression and other cases with consultation of OGDCL professionals.

3.10.10 AOF deliverability and permeability-thickness maps will be prepared, to be used for new wells.

3.10.11 In each prediction case optimum number of wells (including the drilling techniques) will be investigated.

3.10.12 End of Life case considering the fulfillment of GSAs of Uch-I and Uch-II and revision of Uch-I (if any additional gas available) will be performed.

3.10.13 The consultant will provide the following parameters in each prediction run in graphs and tables:

3.10.13.1 Each lobe gas and water production rate, each lobe gas and water cumulative recovery, each lobe gas production potential, each lobe hydrocarbon in-place, each lobe WGR (Water Gas ratio), Water Cut and reservoir pressure.

3.10.13.2 Well gas and water production rate, well gas and water cumulative recovery, well gas production potential, well WGR, water cut, wellhead pressure, bottom-hole flowing pressure.

3.10.13.3 Number of additional production wells (vertical & horizontal), location and drilling time in the reservoir.

3.10.13.4 Reservoir pressure, wellhead and bottom hole pressure profiles for the life of the producing wells.

3.10.13.5 Full field node wise pressure drop based on network model with full field production plateau.

3.10.13.6 Evaluate need and timing for pressure maintenance scheme.

3.10.14 The consultant will recommend the optimum development plan and will run the prediction case till the abandonment and calculate the ultimate recoverable reserves for all independent reservoir layers.

3.10.15 The consultant will provide the following data in each prediction run:

3.10.15.1 Production profile of existing wells (Q_g and Q_w) with cumulative recoveries.

3.10.15.2 Reservoir pressure, well head and bottom hole pressure profile for the life of the producing wells.

3.10.15.3 Time of installation of compression, and recovery by it.

3.10.16 Forecast Scenarios of raw gas, sale gas, raw gas calorific value, sale gas calorific value, condensate, water production and WHFP for Uch-I, Uch-II and Uch-I revision (if any additional gas available), will be generated. Field wise, lobe wise and well wise forecast Scenarios of raw gas, sale gas, raw gas calorific value, sale gas calorific value, condensate, water production and WHFP will also be generated.

3.10.17 Consultant will evaluate shrinkage factor for all three lobes and field with consultation of OGDCL professionals.

3.10.18 Consultant shall provide reserves in units of Standard Cubic Feet and Calorific Value (BTU) lobe wise and field wise.

3.11 Compression System

3.11.1 Recommend the required type and strength of Compression System by screening all static and dynamic reservoir data to select the optimum technique to recover maximum hydrocarbon.

3.11.2 Perform a simulation run for recommendation of the optimum type and strength of compression system. Number of simulation runs and other specifications will be decided with the consultation of OGDCL professionals.

4 WELL COMPLETION, STIMULATION & DRILLING

4.1 The Consultant will perform NODAL analysis for the existing wells and future wells. This information will be used for production optimization in network simulation model.

4.2 After review of existing drilling, completion and stimulation practice, tests and other pertinent information, recommendations will be given for optimum depletion of the reserves assigned to the field.

4.3 Study the feasibility of drilling new wells. Recommend optimum flow rates, completion size, and number of wells and well locations.

5 SURFACE FACILITIES

5.1 The network simulation from wellhead to pressuring plants would be used to design and optimize the production, enabling OGDCL to deliver the gas at present and future at a delivery pressure of 750 Psi.

5.2 The requirement for compression should be predicted to meet the contractual requirements of Uch-I, Uch-II projects and Uch-I revision (if any additional gas available) by using the coupling network simulation.

5.3 PipePhase, PipeSim or PipeSys surface network model must include:

5.3.1 Erosional velocities calculations based on conservative and progressive API values.

5.3.2 Pressure drops through nodal analysis.

5.3.3 Mothballing of facility, optimization of either of the plants (Uch-I & II), and / or any of the train / unit of the OGDCL owned processing units must be deliberated in terms of best revenue generation model.

6 ECONOMIC ANALYSIS & EVALUATION

6.1 Estimate the ultimate recoverable reserves in proven, probable and possible categories as per SPE and WPC definitions and provide certification for proven recoverable reserves.

6.2 For each prediction case, economic analysis (NPV at different discount rates and at hurdle rate of 18%, ROR / IRR, Payout and other profit ability ratios) is required.

6.3 Yearly capital investment and revenue are to be agreed with OGDCL as provided by an independent engineering consultant.

6.4 Economic analysis under Government of Pakistan (GoP) applicable fiscal regime for Petroleum Concession Agreement (PCA) for Uch-I & II must be modeled on PEEP software and detailed input, raw sheet / files must be shared at the project phase.

6.5 As Uch-II gas is currently modeled at higher price than that of Uch-I, therefore, fiscal model must reconfirm OGDCL interest to optimize, mothball / curtailment of facilities and / or production in terms of PCA, GSA, GPA and other covenant of GoP and OGDCL versus UPL.

6.6 Based on the economic results, an optimum development plan should be provided by the consultant.

6.7 A clear plan of action shall be recommended which will be then followed to achieve maximum economic recovery based on the techno-economic analysis of the various prediction case studies. The plan must include recommendations for reservoir management, subsurface and surface facilities for the life of the field.

6.8 Development plan must have Level-II project phasing with cost break up. All the project costs must be from IHRDC cost center or some equivalent World Bank (WB) global cost database.

6.9 Provide certification for reserves of Uch gas field separately in proven, probable and possible categories in accordance with the definitions of reserves classifications carried by Society of Petroleum Engineers (SPE) / Petroleum Resources Management System (PRMS).

6.10 Remaining Recoverable Reserve shall be provided in units of Standard Cubic Feet and Calorific Value (BTU) lobe wise and field wise.

7 REPORTS AND PRESENTATION

7.1 Phases of the Study

For proper reporting and presentation management, study is divided into three phases i.e. I, II and III.

7.1.1 Phase I:

It covers the work done to make static model by using Geophysical, Geological and Petrophysical data. It also includes basic Reservoir Engineering analysis including material balance, P/Z analysis, well test analysis and decline curve analysis for populating static model and volumetric estimates based on static model.

7.1.2 Phase II:

This phase includes history match and proposed prediction runs for OGDCL approval. All aspects related to gridding, history match prediction runs would be agreed upon prior to proceeding to Phase III.

7.1.3 Phase III:

It consists of optimum revised development, depletion plans, economic analysis and reserve certification. All aspects have to be discussed and agreed upon prior to proceeding to the final presentation.

7.2 Reports

7.2.1 The consultant will submit at the end of each fortnight, a detailed fortnightly progress report to OGDCL in soft form, covering the work performed during that period.

7.2.2 The consultant will submit only **soft copies** for **Draft** reports in all phases.

7.2.3 Final report of all phases will be submitted as two hard copies complete set for OGDCL as a final copy of each phase as well as complete soft copies.

7.2.4 Final report for each phase (or as required) will be submitted to OGDCL (soft copies) after incorporating the suggested information / improvements within one week of oral presentation so that approval for next phase may be accorded.

7.2.5 A draft report (soft copy), for all three phases of the study should reach OGDCL at least two weeks ahead of oral presentation, comprised of the results of that particular phase or all phases in case of final report. This is meant to combine the discussions on the layout of the final report with discussion of the Phase-III so that if everything goes smoothly, the submission of the final report will meet the target date.

7.2.6 After final presentation, the consultant will provide two hard copies complete set for OGDCL of the final report along with management executive summary reports with necessary amendment / changes as an outcome of discussion in presentation.

7.2.7 Final report will be submitted within one week after the receipt of the comments from OGDCL on draft report / final presentation and incorporating / amending the same in the final version.

7.2.8 The report will include in detail, all aspects of the study with the conclusions and recommendations derived from the study.

7.3 **Presentations**

During the course of study, there will be three oral presentations at Head office OGDCL Islamabad. Consultant will present all the work done in below mentioned milestone events to OGDCL professionals.

7.3.1 First oral presentation will be made at the end of Phase-I (Static Model).

7.3.2 Second oral presentation will be made at the end of Phase-II.

7.3.3 Third (Final) oral presentation will be made at the end of Phase-III.

7.4 Final version of the simulation model and initialization data will be preserved for a period of five years so that if OGDCL desire another prediction run or incorporation of other data, and / or update of study, it could be obtained without much difficulty.

7.5 The Consultant has to supply OGDCL with a copy of computer outputs of each phase right after their completion, readable on OGDCL computer as well as hard copy.

7.6 The consultant will provide all the final work done on electronic data storage device so that study could be updated on OGDCL's computers as and when required.

7.7 The pressure and fluid saturation maps to be prepared for each five years in prediction cases and will be included in the final report.

7.8 Well and field wise summaries (e.g. pressure, prod, and no. of wells) in all prediction cases will be provided once for every 3 months in tabular form in the final report.

8 TIMING

8.1 The project will commence with the issuance of Service Order / signing of the Contract. A detailed work plan and study timeline in the form of Gantt chart should be submitted with the Technical Proposal.

8.2 Total time of the study should not exceed 47 weeks including Phase-I and Phase-II reports and presentations and Phase-III scope of work and draft final report, however, data collection (02-03 weeks), Final presentation (01 week) and draft final report review (01 week) will be exclusive of the 47 weeks.

9 PARTICIPATION OF OGDCL PROFESSIONALS

9.1 Consultant will associate Four (04) OGDCL's Reservoir department professionals and One (01) OGDCL's Exploration department professional (Total 05 OGDCL professionals), for duration as approved by OGDCL for individual professional, however, not exceeding maximum of 20 man days, during the course of conducting the study. OGDCL will bear all the expenses of participation of OGDCL's professionals in the study.

9.2 Accomplishment of all kind of Work / Studies will be responsibility of the consultant. However, OGDCL professionals from different disciplines will be attached with the consultant from time to time for sharing necessary inputs / experience about the fields in their relevant phase.

9.3 It is strongly recommended that all technical work must be carried out with active participation of OGDCL professionals.

9.4 The consultant will take all necessary measures regarding visas (invitation letters & residence / hotel booking etc.) and will courier to the OGDCL Head Office in Islamabad from abroad. Any delay in the departure of OGDCL professional due to visa / tickets problems would have to be accommodated by the consultant in their Participation Plan.

9.5 In addition to professionals mentioned at Clause-9.1, OGDCL may also depute a professional / focal person from RMD for one week at any stage of the study if it deems necessary.

9.6 Consultant will provide office space, computers, internet and fax facility as well as a local mobile phone with Data Package for mobile internet connectivity.

9.7 The consultant shall propose a program for the participation / training of OGDCL's professionals in the study.

10 GENERAL TERMS / INSTRUCTIONS FOR BIDDERS

10.1 It is highly preferred that all phases of the study should be completed at one location. This is for information of those bidders who have various offices at different locations and may be planning to carry out some parts of the study in any one of them. OGDCL feels that the integration and team work of professionals dedicated by the bidder to carry out various stages of the study is very important for quality results of Integrated Reservoir Simulation studies.

10.2 The study shall be carried out by the same office and the same professionals, mentioned in the technical proposal by the bidders for the study.

10.3 Bidders shall note that complete study as per scope of work defined in this TOR shall be carried out only by the bidder's dedicated team whose CVs the bidders will submit in their technical proposal. Bidder's Pakistan office shall also serve for coordination and liaison between OGDCL and bidder's office abroad where study shall be conducted.

10.4 The personnel who shall conduct the study should be dedicated fully to this study and shall be available throughout their relevant phase of this study and their dedication to this study shall not conflict with any other study of OGDCL or other companies.

10.5 OGDCL reserves the right to discontinue the study at any stage without any payment to the consultant, in case OGDCL finds out that during the course of the study, without bringing in OGDCL knowledge, any part of the study is or has been carried out by technical staff different than consultant's dedicated team for the project.

10.6 All geological, geophysical, drilling, testing, production, well logs, core and fluid analysis data required for the study will be available to the consultant free of charge. Such material will be the property of OGDCL. The Consultant will treat all data and information supplied by OGDCL and those acquired by him during the implementation of the study with utmost confidentiality.

10.7 OGDCL reserves the right to discontinue any study / any task / any service related to above scope of work at any stage. OGDCL reserves the right to reject the services of any consultant provided by the consultancy firm at any time / any stage and hence it will be the responsibility of the consulting firm to provide the replacement without any delay accordingly.

10.8 Bid bond of USD 10,000/- (US Dollar Ten Thousand Only) to be submitted with the technical bid.

10.9 The master set of tender documents (services) uploaded on OGDCL website (www.ogdcl.com) is the integral part of this TOR.

11 SUBMISSION OF PROPOSALS

11.1 Technical & Financial proposals should be given separately in two sealed envelopes clearly marked "Full Field Integrated Reservoir Simulation Study of Uch Gas Field" **(Technical Proposal)** & **(Financial Proposal)**.

11.2 Technical Proposal

11.2.1 The technical proposal must contain a brief history of consulting firm, the nature of services provided, the key projects undertaken and its experience in the field of integrated reservoir simulation & production optimization studies. A soft copy on CD / DVD of the technical proposal should also be submitted along the hard copy.

11.2.2 Technical proposal should also contain a tentative work program, methodology and time schedule to complete each phase of study. Detailed technical approach to perform various activities, as defined in the scope of work, shall also be submitted.

11.2.3 It should indicate other similar projects completed by the consulting firm and their manpower allocation along with their Resume. The Resume should be submitted in the following format:

a) Academic Qualification.
b) Total relevant experience. Particularly emphasizing experience in Carbonate Reservoirs.
c) Experience / description of job assignments of the personnel with the bidding company.
d) Total overall experience of the person

11.3 **Financial Proposal**

11.3.1 Bidders shall submit their financial cost estimates and invoices phase-wise, as defined in Clause-7.1 above, and will get payments accordingly.

11.3.2 Bidders would mention their cost estimates of each phase separately, however, for award / issuance of contract / service order, OGDCL will evaluate the bid on total cost basis.

11.3.3 OGDCL may arrange a pre-bid meeting on request to explain the present status of field and objective of study. The bidders will participate in the meeting at their own cost.

11.3.4 The **financial** section of the proposal should contain:

a) Phase-wise break down of the cost.
b) Total cost of the study.
c) The information mentioned above, in accordance with Clause-7.1 & Clause-11.3.2, may be provided in the following format:

S. No.	Study Phase	Total Cost
1	Phase-I including Phase-I presentation & report	
2	Phase-II including Phase-II presentation & report	
3	Phase-III, Final Presentation & Final Report	
4	Total Lump sum Cost inclusive of all applicable taxes duties and Levies except provincial sales tax / ICT tax on services	

d) Financial evaluation will be carried out for Total lump sum cost inclusive of all applicable taxes duties and levies except provincial sales tax / ICT tax on services, however, payment will be made phase-wise, accordingly.

e) Any bidder not following the financial format given in the table above, will be declared financially non-responsive

12 EVALUATION CRITERIA

12.1 The **Technical** evaluation will be based on the following criteria.

		POINTS
a)	Experience of the firm / bidder in constructing Static & Dynamic Models	05
b)	Number of similar projects (reservoir studies) completed during last five (05) years	15
c)	Technical approach	45
d)	Work plan	10
e)	Skill / Technical transfer plan	02
f)	Personnel (Qualification, Experience & Capability of conducting reservoir studies)	23
	Total :	**100**

Note : Details of Technical Evaluation Criteria is attached at Annexure-I & Annexure-II

12.2 Criteria for selection will be based on Quality & Cost Based Selection.

12.3 80% weightage will be given to technical evaluation and 20% to financial evaluation. The lowest bidder will attain maximum points in financial evaluation and others would be ranked on the sliding scale in comparison to the lowest bidder.

12.4 Points obtained in technical evaluation and financial evaluation will then be combined and bidder attaining maximum points in technical and financial evaluation as a whole will be hired for the services.

12.5 Bidders securing less than 70% points overall and in any category in the technical evaluation will be treated as NON RESPONSIVE.

12.6 Complete detail and breakup of points as per Evaluation Criteria given at Clause-12.1 above is attached at "Annexure-I & Annexure-II".

12.7 Apart from detailed CVs of dedicated professionals for this project, the bidders will also provide the following information required for technical evaluation:

12.7.1 The bidders shall provide, at their own expense, suitably qualified personnel to ensure efficient performance of the study to achieve the objectives. The bidder will designate in writing one of its staff as Project Coordinator.

12.7.2 The Project Coordinator shall act on behalf of the successful bidder and shall be responsible for supervising all of the consultant's Work responsibilities, and also for maintaining liaison between the Company and the Consultant.

12.7.3 Bidders should submit the name, academic qualification and experience of the technical personnel to conduct the study. Bidders should clearly mention team experience in reservoir studies and terrains (Pakistan, Middle East etc.).

12.7.4 A team comprised of geoscientists and engineers will work at all phases of study to ensure that the study meets all the requirements of OGDCL and for timely completion of work.

12.7.5 Team of professionals will comprise of disciplines as given in table below:

Sr. No.	Disciplines
1.	Geophysics
2.	Reservoir Geology
3.	Petrophysics
4.	Geo-Modeling
5.	Reservoir / Simulation Engineering

12.7.6 Each team, including team leader, must not exceed more than three professionals. Bidders will ensure that once assigned to the team, personnel shall remain dedicated to the project till its completion and shall not be engaged in any other project at the cost of OGDCL's project.

12.7.7 Present contact number and email address should be mentioned on the CVs submitted for the dedicated team leader and team members.

12.7.8 In case of defection of any dedicated team member, bidders will be responsible to engage a professional of similar domain / caliber.

12.8 **Detail of Software**

12.8.1 Following G&G, RE etc. software are available with OGDCL. The successful bidder will be required to conduct all the work / interpretation and provide the final output on software listed below:

a) Petrel (G&G, RE)
b) Petrel (Seismic Interpretation)
c) Eclipse (Office, Black Oil, Compositional, Local Grid Refinement, PVTi)
d) Ecrin (Sapphire, Topaz)
e) MatBal
f) OFM
g) Merak Volt
h) TechLog
i) PEEP & SNL
j) PipePhase

12.8.2 Petrel RE software must be used for Reservoir Simulation.

12.8.3 Software for Static Modeling, Dynamic Modeling and Economic Analysis should be used as mentioned above.

12.8.4 It will be the responsibility of the successful bidder to provide OGDCL with the output compatible with OGDCL's software listed above. Moreover, the bidder's professionals will also be responsible to load the data / Static / Dynamic Models on OGDCL's computers and enable them into working state.

Annexure-I

Detail of Points for Technical Evaluation Criteria (Clause-12.1)

- **12.1-a) Experience of Firm / Consultant: Total Points 05**

- **Number of 3D Static Models Constructed in the past 5 years**

15 or more (list to be attached)	2.5 points
11 to 14 (list to be attached)	2.0 points
5 to 10 (list to be attached)	1.25 points
1 to 4 (list to be attached)	0.25 points
No **3D Static Model**	0 points

- **Number of Dynamic Models Constructed in the past 5 years**

15 or more (list to be attached)	2.5 points
11 to 14 (list to be attached)	2.0 points
5 to 10 (list to be attached)	1.25 points
1 to 4 (list to be attached)	0.25 points
No **Dynamic Model**	0 points

Note:

- All of the above criteria is mandatory.
- Documentary evidence should be submitted for each of the requirement.

- **12.1-b) Number of Similar Projects: Total Points 15**

Sr. No.	Criteria	List	Points
1.	Minimum 10 similar integrated reservoir studies with satisfactory completion certificates carried out by bidder in last five years, less than 10 will be ranked on sliding scale (Year, in which the listed reservoir studies are carried out, shall be clearly mentioned)	1. 2. 3. 4. 5. 6. 7. 8. 9. 10.....	8
2.	4 or more reservoir studies carried out for oil / gas fields of Pakistan with satisfactory completion certificates in last five years, Less than 5 will be ranked on sliding scale (Year, in which the listed reservoir studies are carried out, shall be clearly mentioned)	1. 2. 3. 4.	4
3.	3 or more similar reservoir studies carried out for OGDCL oil / gas fields with satisfactory completion certificates in last five years, Less than 4 will be ranked on sliding scale (Year, in which the listed reservoir studies are carried out, shall be clearly mentioned)	1. 2. 3.	3
		Total	**15**

- **12.1-c) Technical Approach: Total Points 45**

  45 points will be given to the firm having best Technical approach to conduct the study according to the defined scope of work and using software as per TOR. The technical part of the proposal will be evaluated point to point with regards to compliance of Scope of Work explained in the TOR and each part will be marked by a relevant professional (evaluation committee comprised of geoscientists and engineers). The technical approach which fulfils the maximum requirement of the TOR will be given maximum points. Distribution of 45 points will be as under:

Category	**Max. Points**	**Bidder#1**	**Bidder#2**	**Bidder#3**
Geophysics	8			
Reservoir Geology	4			
Petrophysics	4			
Geo-Modeling	8			
Reservoir/Simulation Engineering	12			
Software	4			
Reserve Certification	3			
Project Completion	2			
Total	**45**			

- **12.1-d) Work Plan: Total Points 10**

  Having total 10 points, bidders submitting same time as at Section-8, for completion of Scope of Work in TOR will get 7 points, however, 10 points will be given to the bidder quoting less time than prescribed time given in TOR. Rest of the bidders will be ranked on sliding scale in comparison to the bidder quoting least time. Bidders will be required to submit their work plan in the form of Gantt Chart where timing for data collection, each phase and final presentation and draft final report review will be mentioned in weeks.

- **12.1-e) Skill / Technical Transfer Plan: Total Points 02**

  02 points will be given to the bidder submitting the best and comprehensive way of skill / technical transfer plan.

- **12.1-f) Personnel: Total Points 23**

- **<u>CVs OF ONLY DEDICATED TEAM (WITH ONE TEAM LEADER and TWO TEAM MEMBERS) as given in below mentioned Table will be evaluated for this project. Other / extra CVs will not be entertained</u>**.

- For evaluation purpose maximum points will be given to those personnel having highest relevant educational credentials, capability in relevant software as per TOR and maximum experience of conducting integrated reservoir simulation studies as well as previous experience of working in Pakistan and working on OGDCL projects. Details of distribution of 23 points is available at "Annexure-II".

- Following information about the professionals dedicated by the bidder will be required, supported by documentary evidence:

Sr. #	**Discipline**	**One Team Leader**	**Two Team Members**	
1.	Geophysics			
2.	Reservoir Geology			
3.	Petrophyiscs			
4.	Geo Modeling			
5.	Reservoir / Simulation Engineering			

12.1-f Personnel (Qualification, Experience & Capability of Conducting Reservoir Studies) Points = 23 **Annexure-II**

Name of Bidder: **Project Coordinator:**

Discipline	Category	Name	Qualification			Overall Experience				Capability of Reservoir Studies			Aggregate of Highest Education, Maximum Experience, Experience in Pakistan, Experience with OGDCL and Expertise on Relevant Software as per Clause-12.10
			B.Sc	M.Sc.	Ph.D.	>15 y	15-10 y	10-5 y	5-1 y	Experience in Pakistan	Experience with OGDCL	Software Expertise	
Geophysics Team (05)	Breakup of 05 Points		0.35	0.85	1.25	2.25	1.75	1.15	0.45	0.75	0.50	0.25	5
	Team leader												
	Member-1												
	Member-2												
												Total Score of the Team	
												Average Score of Geophysics Team for Evaluation	
Reservoir Geology Team (03)	Breakup of 03 Points		0.20	0.50	0.75	1.25	1.00	0.65	0.20	0.50	0.35	0.15	3
	Team leader												
	Member-1												
	Member-2												
												Total Score of the Team	
												Average Score of Reservoir Geology Team for Evaluation	
Petrophysics Team (03)	Breakup of 03 Points		0.20	0.50	0.75	1.25	1.00	0.65	0.20	0.50	0.35	0.15	3
	Team leader												
	Member-1												
	Member-2												
												Total Score of the Team	
												Average Score of Petrophysics Team for Evaluation	
Geo. Modeling Team (05)	Breakup of 05 Points		0.35	0.85	1.25	2.25	1.75	1.15	0.45	0.75	0.50	0.25	5
	Team leader												
	Member-1												
	Member-2												
												Total Score of the Team	
												Average Score of Geo-modeling Team for Evaluation	
Reservoir / Simulation Engineering Team (07)	Breakup of 07 Points		0.50	1.25	1.75	2.75	2.10	1.35	0.50	1.10	0.85	0.55	7
	Team leader												
	Member-1												
	Member-2												
												Total Score of the Team	
												Average Score of Reservoir / Simulation Engineering Team for Evaluation	
Average Score of Each Team Aggregated to Evaluate the Bidder for Points Obtained out of 23													