Tender Book

About

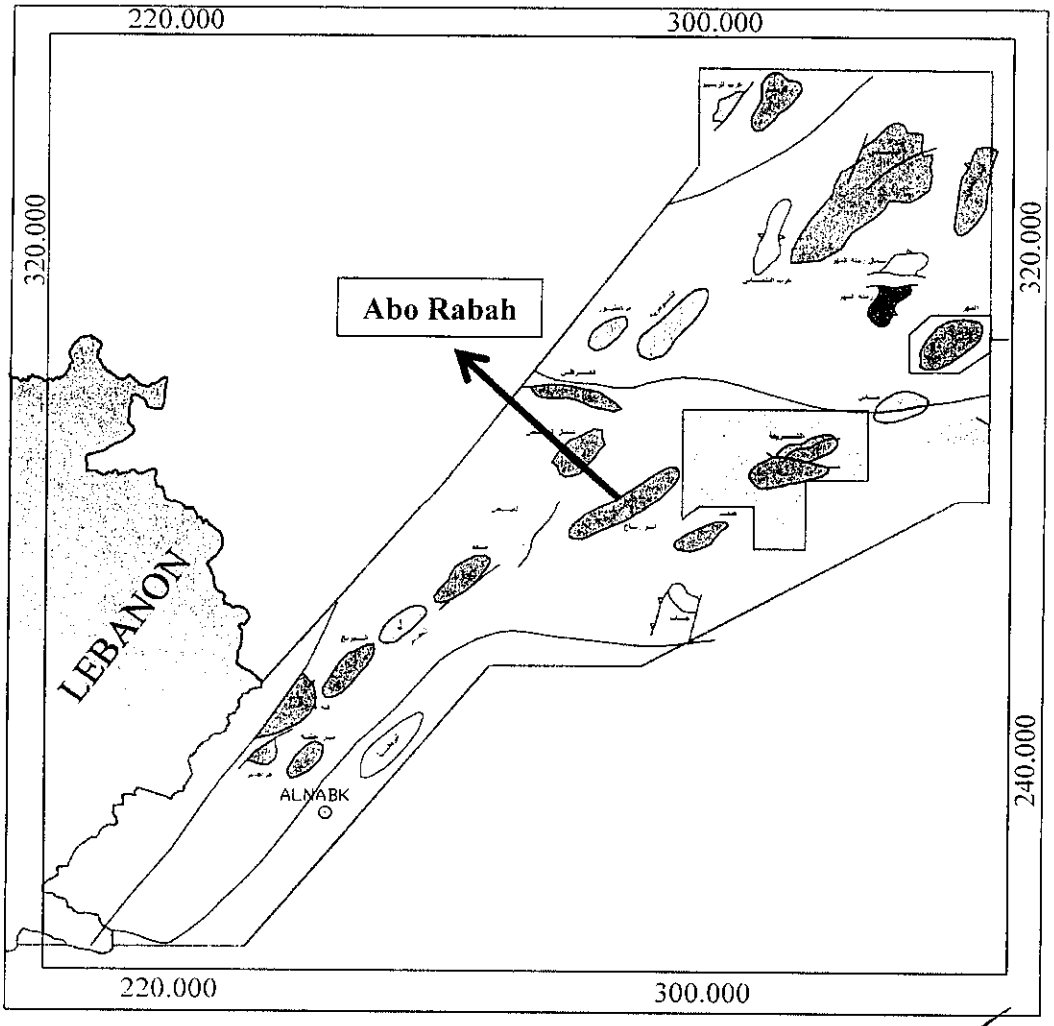
Reservoir study for Abu Rabah field

1 INTRODUCTION:

Abu Rabah area is considered one of the highly prospective hydrocarbon regions due to the availability of all the appropriate geological conditions for the presence of a reservoir: (source rocks, reservoir rocks, cap rocks, burial depth, and generation). The Syrian Petroleum Company resumed exploratory activities in the Dou Basin in 1996 after Marathon Oil Company relinquished the area. The dimensions of the structure on the Kurachine Dolomite reflector are approximately 24 × 7 km.

Geographical Location: Abu Rabah structure is located in the central-western part of Syria within an area known as Block Abu Rabah, approximately 135 km northeast of the city of Damascus. It is surrounded by the North Al-Fayd, Al-Sharifa, and Qumqum fields and is part of the Dou Unit, which is one of the segments of the Tadmur fold belt known for its high gas potential. It is situated on the western edges of a local depression that lies between the Tadmur mountain ranges and is classified as one of the most important gas-producing fields in Syria, relying on the reservoir of the Kurachine Dolomite formation.

Structural Setting: The geological time map of the Kurachine Dolomite formation shows that the Abu Rabah structure has a subsurface geological structure that reflects topographically on the surface in the form of an elongated fold, with its axis oriented in a northeast-southwest direction. This fold is bounded by two major faults: on the eastern side, there is a reverse fault with a throw estimated at 200-250 m, and on the western side, there is a normal fault with a significant throw exceeding 500 m. The structure is divided into an upthrown wing representing the main body of the structure and a downthrown wing on the eastern side.



Surface Geology: The geological map of the area shows a clear geological reflection of the structure on the surface, appearing as an elongated fold oriented northeast-southwest. At its crest, Upper Cretaceous sediments are exposed, represented by the Ramah Shale formation, which consists of limestone and chert, followed by the Ark Marl formation and then the Shiranish formation, which is composed of limestone. The wings of the fold reveal Lower Paleogene sediments.
Exploratory Drilling: The Abu Rabah field was discovered in 1997 and began production in 2008. It is a gas reservoir from the Kurachine Dolomite formation, specifically from the C2 D1 strata.

2 LITHOLOGY OF RESERVOIRS:

The reservoirs formations belong to (Middle Triassic) which consists predominately of various carbonate types, dolomite and limestone, evaporates, shale.

3 TYPES OF RESERVOIR:

The producing formation:

1. The gas- condensate with oil rim Kurachine Dolomite C2 reservoir
2. Oil rim Kurachine Dolomite D1 reservoir
   The Kurachine Dolomite C2 & D1 consider as one hydrodynamic unit,

These two reservoirs are the subject of this Reservoir study.

4 DRILLED WELLS:

A total of 27 wells have been drilled in the Abu Rbah Field Development Area, as the following:

Well	Type of HC	Status	Reservoir	Total Depth (m)	Production Date	Second Target	Date of Change zone
Abu Rbah -1	Gas	Producer	C2, D1	2742	Dec/2008		
Abu Rbah -2	Gas	Producer	D1	3507	Dec/2008		
Abu Rbah -3	Gas	Producer	D1	2775/2413	Dec/2008		
Abu Rbah -4	Gas	Producer	C2	3149/2820	Aug/2009		
Abu Rbah -5	Gas	Producer	C2	3001/2709	Aug/2010		
Abu Rbah -6	Gas	Producer	D1	2800	Oct/2009		
Abu Rbah -7	Gas	Producer	D1	2820	Oct/2009		
Abu Rbah -8	Gas	Producer	D1	2749	Jan/2009		
Abu Rbah -9	Gas	Producer	D1	2840/2611	Feb/2009		
Abu Rbah -10	Gas	Producer	C2	2893/2553	Dec/2009		
Abu Rbah -11	Gas	Producer	C2, D1	2823	Feb/2013		
Abu Rbah - 12	Gas	Producer	D1	2873	Mar/2013		
Abu Rbah -13	Gas	Producer	C2	2705	Aug/2016		
Abu Rbah -14	Gas	Producer	C2, D1	2552	Jul/2016		
Abu Rbah -15	Gas	Producer	C2, D1	2695	Jan/2017		
Abu Rbah -16	Gas	Producer	C2, D1	2764	Jun/2017		
Abu Rbah -18	Gas	Producer	C2, D1	2760	May/2017		
Abu Rbah -19	Gas	Producer	C2	2687	Oct/2017		
Abu Rbah -20	Gas	Producer	C2	2710	Jun/2018		
Abu Rbah -21	Gas	Producer	C2	2873	Apr/2020		
Abu Rbah -23	Gas	Producer	C2	2847	Jul/2022		
Abu Rbah - 24	Gas	Producer	C2, D1,D2	2642	Aug/2021		
Abu Rbah - 25	Gas	Producer	C2	2827	Jun/2022		
Abu Rbah – 1H	Gas	Producer	D1	3349/2698	Aug/2009		
Abu Rbah – 2H	Gas	Producer	C2	3340/2758	Aug/2009		
Abu Rbah – 3H	Gas	Producer	C2	3252/2515	Dec/2008		

5 AIM THE RESERVOIR STUDY:

The main purpose of this study is to, recalculate Geological and producible reserves, and develop production scenarios for optimaize field investment.

6 SPECIAL TERMS AND CONDITIONS:

Abu Rbah Reservoir Study (Kurachine Dolomite C2, D1) shall be performed in accordance with the following:
(Note: CONTRACTOR should be reviewed the existing data and the deficiency in it should be rebuilt through the necessary correlation procedure

6.1 PETROPHYSICS

The re-evaluate and reinterpret pertophysical logging and analysis will be in order to:

- Test the previous well logging data,
- Check and evaluate the pertophysical parameters.
- Perform analysis of reservoir fluid distribution
- Perform hydrocarbon saturation evaluation models

Through the following:

6.1.1 DATA COLLECTION AND QC

- An inventory of the data that is available.
- Audit listing of QC issues, and corrections taken, such as missing logs, miscalibrated data etc.

6.1.2 INITIAL FLUID DISTRIBUTION ANALYSIS - FIELD

- Fluid distribution plots at the beginning of the study to provide snapshot of the fluid distribution as has been previously identified. It aids to flag those wells with deviation or depth measurement problems.
- Comparison of tops and contacts from databases to those from logs.

6.1.3 DEPTH SHIFTING/ENVIRONMENTAL CORRECTIONS/LOG SPLICING

- Depth shifted and environmentally corrected logs in LOGIC (recognized by extensions to the curve name, and annotated by curve comments).
- Record of which curves have been sliced together, and over which intervals.
- Any major depth shifts should be recorded.
- A listing of the logs that were environmentally corrected.

6.1.4 LOG NORMALISATION AND RESISTIVITY INVERSION

- For normalized logs, the shifts and rescaling that has taken place must be documented and provided.
- The normalized (or inverted) curves.

6.1.5 DETERMINING LITHOLOGY

- The technique used for determining lithology (i.e. CLASS, CLUSTER).
- An inventory of the data that was used for the classification.
- If core data is present; a log plot that shows the log lithology plotted beside the lithology determined from core.
- A lithology curve that is identifiable, with curve comments.

6.1.6 DETAILED ANALYSIS OF RESERVOIR FLUID DISTRIBUTION

- An audit trail must be provided describing how the fluid contact was determined in each well for each reservoir.
- For key wells used in determining the fluid contacts, these wells must be plotted including all relevant information (SWS, neutron logs, production etc.) as 1:200 scale PDL's.
- A panel showing the fluid distribution must be provided for each reservoir. (XL based).
- Any large discrepancies from the field wide contact for any reservoir for any well must be rationalized.
- A summary table of the fluid contact data for each reservoir must be reported including the following information: GUT, GDT, GOC, OUT, ODT, HCWC and WUT.

6.1.7 PARAMETERS EVALUATION

6.1.7.1 CEMENTATION EXPONENT

- Description of how m was determined, and plots to support the choice from either core or log data.
- If there are differences between the different methods, then an explanation of why a given value was used must be provided.

6.1.7.2 SATURATION EXPONENT

- Description of how n was determined and resistivity index plot of core data if available.
- If determined from core data a description of the measurement should be included including brine salinity, stress measurement type, temperature etc.

6.1.7.3 GRAIN DENSITY

- Description of how the grain density was determined.
- If from core data, then a plot of this data.
- If based on a lithological interpretation, (i.e. output from FLAME) then a listing of the input parameters used in FLAME.

6.1.7.4 FORMATION WATER RESISTIVITY

- Description of how Rw was determined must be provided.
- If Pickett plots over wet zones were used, and then examples must be presented. A comparison of the Rw from Pickett plots with produced water should be made if both sources of data are used or available.
- If SP logs were used, then these results should also be compared to other data (produced water etc.).
- If there are differences between the different methods, then an explanation of why a given value was used must be provided.

6.1.7.5 OTHER

- This list is not exhaustive.
- If other interpreted parameters are used in the log evaluation they must be listed, and the process by which they were derived documented.

6.1.7.6 POROSITY EVALUATION

- For every well the technique for calculating porosity must be documented.
- If log data is calibrated to core data to calculate porosity, then the cross plot of core porosity vs the log (for example the density log) must be provided.
- If a correlation to core from the density log is made, then the value of the fluid and grain density that are calculated from that relationship must be reported.
- If a correlation to core from the sonic log is made, then the velocity of the calculated fluid and rock matrix that are calculated from that relationship must be reported.

- If an empirical relationship using a log is used to determine porosity, then the input parameters must be reported.

6.1.7.7 PERMEABILITY EVALUATION

- The relationship used to predict permeability must be reported. If this relationship is based on a correlation against some "non-standard" log, then the logic behind the correlation must be described. A black box correlation is not acceptable.
- The type of permeability that is being calculated must be reported.
- The effect of stress on the permeability should be reported. If a correction for stress is made, then the calculation of net hydrostatic pressure must be reported. The following plots should be available:
- permeability vs stress for all samples
- reduction factor vs permeability
- stressed vs atmospheric permeability
- If derived from core, and core porosity, a cross plot of porosity and permeability is required, along with any subdivision by facies.
- A comparison between the core permeability, and that compared from other sources must be made. This should include a comparison with production logs, and calculations of permeability from pressure build up data.

6.1.7.8 NET TO GROSS CALCULATIONS

Net to Gross is often calculated on the basis of some cut-off, used to determine which zones of the reservoir are to be included in the net sand count, and which are not. This discrimination will already have been made earlier (e.g. in the determining of lithology). However, it is only when the individual reservoir is investigated in detail that questionable zones are re-evaluated and perhaps re-assigned as reservoir rock or non-reservoir rock.

Deliverables:

- Description of the process used for differentiating net from gross.
- Curve that differentiates net from gross for subsequent calculations.

6.1.7.9 HYDROCARBON SATURATION EVALUATION MODELS

- When picking the model to evaluate the reservoir the following must be considered:
- The lithology of the reservoir (clean, shaly sand, dispersed clay, laminated shale, radioactive sand).
- The end use of the data (there is little point spending large amounts of time on a reservoir with marginal reserves).
- What this amounts to is that the evaluation model should be fit for purpose. Sophisticated models while more interesting should only be applied if there is merit in the application.

Deliverables:

- A description of the model that is used for calculating hydrocarbon saturation is required, along with the justification for using that model.
- If different models are used, then they must be compared to each other and plotted for comparison for key wells.
- Any parameters used in the models must be reported, and if interpreted supported by plots or other data.

6.1.7.10 CAPILLARY PRESSURE AVERAGING FOR DYNAMIC MODEL

In fact there is just core reports, CONTRACTOR based on these reports try to carry out the following:

- If the saturation-height functions are derived from core, then the fitted data vs the measured core CP data must be plotted and reported for each sample so that the quality of the fit can be assessed.
- Whether calculated from logs or core, the saturation that is calculated from the height function must be plotted for some key wells, along with the traditional log derived saturation to allow the quality of the fit to be assessed.
- The equation used to calculate the height function must be reported.
- The data used to generate the height function must be reported.
- The values used to convert lab data to height above the FWL in the reservoir must be reported.

- A plot of calculated CP curves as a function of reservoir quality (phi, k or combination) by facies.

6.1.8 SUMS AND AVERAGES

The petrophysical sums and averages of hydrocarbon saturation, net to gross, porosity, and permeability on a reservoir basis for all wells, and discriminated on the basis of fluid type, and/or lithology must be reported. The saturation values should be reported from all evaluation models used for comparison, (i.e. Waxman-Smits, MELARS, Height Functions, with and without inversion etc.)

Deliverables:

- Table with sums and averages for each well and reservoir.
- If resistivity inversion has been used, then the sums and averages must be calculated using the resistivity curves with and without inversion, and the difference noted and explained.
- If saturation-height functions are calculated, then the sums and averages must be calculated using the saturation-height function, and compared with the log derived saturation and the difference noted and explained.

6.1.9 UNCERTAINTY ANALYSIS

Uncertainty must be calculated for both the individual depth increment values (for example of porosity), as well as for the average well values.

The uncertainty in the value of porosity or saturation on a depth increment scale can be determined from a Monte Carlo analysis and then assigning an error to each of the input parameters that are used in that calculation.

Once the values of porosity, saturation, and net to gross have been determined for each well, along with their uncertainties, these values are used to calculate the uncertainty in the average properties of the reservoir (based on the finite sampling of a reservoir with a limited number of wells).

Deliverables:

- The technique used to calculate the uncertainty needs to be reported.
- The data used as input for the uncertainty analysis, along with the weighting must be documented.
- If the average values of porosity/saturation/net to gross are calculated in a 3D geological model, then these values must be compared to those calculated from well averages and the differences documented, and explained.

6.1.10 SYNTHETIC SEISMOGRAMS

- Synthetic seismograms for each well possible, along with the process used for generating the synthetic for each well. If the process is different for each well (perhaps because of missing data), then this needs to be documented.
- The T-Z function(s) used for converting depth to time needs to be recorded.
- Formation tops converted to time.
- Log panels with primary logs (sonic, density, gamma ray, SP and resistivity) plotted in time along with the acoustic impedance, filtered reflectivity curve and the formation tops.
- Description of filter used to filter the reflectivity or acoustic impedance.
- Table that identifies the shift that the seismologist applied to match the logs synthetics to the seismic panel.

6.1.11 REPORT FORMAT

The output of the petrophysical contribution in the sub-surface field study includes:

Auditable reports	methods and analysis reports etc.
Fluid distribution tables	These tables must be generated so that they can be used directly for: 1) generating the annotation curves on the PDL's. 2) generating the fluid curves. 3) updating fluid contacts in the Corporate database.
Sums and Averages Tables for tail of PDL	These tables will be created from the Sums and Averages tables in the main report
Petrophysical Data Log	The PP is responsible for plotting out and QC'ing one entire set of PDL's.
Uncertainty in Petrophysical Properties	The uncertainty in each petrophysical property must be reported (audit trail as in the section on uncertainty).

Compliant PDL's	These PDL'S are generated according to the specifications, (across sands of interest with adequate annotations).

6.1.12 PROJECT CLOSE OUT

At the end of the project, it is important to "clean up" database so that the curve data is readily available for upload to RDB. This often requires renaming the different curves, and as well providing a description of the curve so that they are readily identifiable for other users.

Deliverables:

- Project with curves named, and with curve comments describing each curve.
- Transfer all relevant data into corporate databases.
- Fluid contacts
- Final evaluation curves.

6.2 SEISMIC INTERPETATION:

Several two-dimensional (2D) and three-dimensional (3D) seismic surveys were conducted in the Abu Rabah field area over successive time periods, characterized by a clear variation in field constants and processing.

In 1999, the second survey team of the Syrian Petroleum Company executed a seismic survey program coded (QM) that covered the majority of the study area. The processing of its lines was carried out by PGS in 2001, with a return level of 600 meters. The field also encompasses a set of lines for the (CH.AR.SH) survey programs.

In 2014, the 3D survey (executed and processed in 2010) was reprocessed at the processing center of the Syrian Petroleum Company.
* All previous 3D/2D surveys were unified to a single seismic return level of DP: 600M (SRD).
* The quality of the seismic data varies between good and poor, with a primary reliance on 2D surveys, while the 3D survey was utilized in areas with limited coverage, particularly in the eastern wing of the Abu Rabah field..

The seismic interpretation and analysis will be in order to:

- Test the previous processing of 3D seismic data,
- Provide detailed seismic re-interpretation of structural styles,
- Interpret horizons that represents top of C2 and D1 reservoirs,
- Check and evaluate time depth conversion,
- Perform seismic attribute analysis,
- Perform seismic facies analysis.

6.2.1 DATA AVAILABILITY/PROJECT SET-UP

6.2.1.1 SEISMIC VOLUME AVAILABILITY & ORIGIN

CONTRACTOR must re-evaluate existing seismic volume if its need migration or re-processing and carry out the following:

- Inverted data
- Zero phase data
- Reflectivity volume
- Acoustic Impedance volume

6.2.1.2 WELL DATA AVAILABILITY

CONTRACTOR must re-evaluate existing well data and carry out the following:

- Confirm/ finalize Reservoir Tops
- Use Sequence stratigraphy concept

- Produce Correlation Panel
- Confirm/ finalize Faultcuts in well
- T-Z data
- VSP data
- well synthetic seismogram (s)
- Load all validated data on workstation

6.2.1.3 DOCUMENTATION AVAILABILITY

CONTRACTOR must review the following seismic acquisition and interpretation documents to Generate Final Terms of Reference:

- Previous seismic interpretation report
- Seismic acquisition report
- Seismic (re)processing report
- Liaison with exploration on existing studies

6.2.2 SEISMIC INTERPRETATION

To prepare seismic data for perform Static model, CONTRACTOR must carry out the following based on existing seismic data:

6.2.2.1 HORIZON INTERPRETATION

- Well to seismic match
- Identify key horizons to be mapped
- Tie in and map away from wells
- generate regular seed grid
- Use of autotracking/interpolation techniques
- QC horizon interpretation using 3D visualization tool
- Prepare time maps

6.2.2.2 FAULT INTERPRETATION

- Request attribute volumes
- Interpret fault planes on regular grid using attribute
- Cross check fault position with faultcut from wells
- Generate horizon attribute
- QC fault interpretation using 3D visualization tool
- Generate fault polygons

6.2.2.3 SEISMIC AMPLITUDE/ DHI'S ANALYSIS

- Use of 3D visualization technique to screen data for DHI's, flat spot, bright spots
- Generate amplitude maps
- Calibration of Prod. offtake/ Amplitude

6.2.2.4 TIME TO DEPTH CONVERSION

- Use of T-Z tables (single, combined)
- Use of Vo, K function
- Use of Pseudo velocity maps

- Use of Calibrated seismic velocities
- Use of Geostatistics
- Residual analysis (feed back to horizon interpretation)
- Prepare structure depth maps
- Infill maps generation: methodology (isochoring, ratio method etc.)

6.2.2.5 UNCERTAINTY HANDLING

- Seismic data positioning (De/Re-migration, well to seismic match)
- Residual analysis (standard deviation)
- Difference between depth conversion methods
- Use of Geostatistics

6.2.2.6 FAULT ANALYSIS

- Clay Smear Potential
- Fault population analysis
- Allan Diagrams

6.3 STATIC MODELLING

In aim to build structure of reservoirs, CONTRACTOR will use above data (pertophysical and seismic data) and previous reservoir studies reports to create static model through the following:

6.3.1 GEOLOGICAL MODEL AND LITHOLOGIES

- Analogue depositional model applied .
- Selected, express differences & similarities in regional setting, sediment type, scale.
- Sketches/block diagrams of reservoir facies architecture ("conceptual depositional model").
- Check use of core descriptions & interpretations.
- Provide type log illustrating key open-hole logs, subdivision and facies.
- Check lithology determination from logs; use of core information, Rule-Based Subdivision, etc.
- Summary of facies characteristics including proportions and distributions from well data.
- Translation of conceptual geological model into digital 3D geological model.

6.3.2 CORRELATION

- Explain logical basis for correlation - sequence stratigraphic, lithostratigraphic.
- Capture use of seismic surfaces and check ties.
- Tie faults in wells to seismic and to any input structural maps.
- Consider scale of expected lateral variation with respect to the actual well spacing.
- Account for any sudden thickness variations
- Capture use of biostratigraphy and special studies (isotopes, palaeosols, etc.)
- Explain which logs have been used for the correlations and why.
- Correlation decisions per correlatable bodies, including assumptions and alternatives.
- Provide hard copy correlation panels for inspection.
- Challenge correlatability of well bodies.

6.3.3 BODY MODELLING

- Sediment body geometries (thickness distributions, w/t, length. orientations), source data, reasoning.
- Document differences between correlatables, well bodies, and interwell bodies.
- Uncertainty assumptions and reasoning.

- Strike and dip sections through the wells in the undeformed model should be made using the fence tool to QC 3D reservoir model.

6.3.4 STRUCTURAL REPRESENTATION

- Match structural grids to well picks, Present scaled map with wells, picks & grid contours.
- Explain how unconformities were treated in the model.
- Explain how faults were treated in the model - any decimation, any well adjustments to allow for fault
- Cross-section representation of key well/fault intersections.

6.3.5 PROPERTY MODELLING

- Check that model property logs use latest petrophysics.
- Match of along-hole pseudologs through model to original well data. Explain any significant differences.
- Discuss impact of upscaling from raw logs to voxel thicknesses on property max & min values and on 3D interpolation.
- Document interpolation procedures applied (algorithm, linear or logarithmic scaling, etc), including seismic input.

6.3.6 MODEL GRV AND STOIIP

- The gross rock volume and GIIP of the reservoir above the hydrocarbon contacts should also be calculated for the 3D model and compared with the equivalent 2D map value. There should be a sound geological explanation for any significant differences.

6.3.7 FACIES PROPORTIONS

- Compare the average proportions of genetic elements (facies) at the wells with the proportions in the model as a whole. The geologist should provide a listing of well and model genetic element abundances for the key higher levels. e.g. per parasequence set or reservoir unit. A brief explanation and justification of the differences between the average well and average model values should accompany this.

6.3.8 RESERVOIR PROPERTIES

- Net/Gross, porosity and permeability should all be made available as 2D maps. The maps will reveal bullseyes (usually undesirable) and also any areal or local trends. These should have geological meaning or not contradict anticipated geological trends without reason.

6.3.9 THE DYNAMIC MODEL

- One of the most powerful Q/C tools available is a consistency check with the volumetrics and property distributions revealed by the upscaled simulation model. This should be performed on the first pass model as soon as possible to catch any major errors or inconsistencies.

6.3.10 WELL PLANNING

- Key subsurface depth maps
- Field Structural Cross-section of key reservoirs running north-south and east-west
- 3D models of key reservoirs.
- Key Seismic lines along well trajectories (blown up)
- Supporting attribute Maps
- Subsurface Targets/Tolerances
- Collision Risk Assessment/Calculations
- Supporting Sedimentological and Structural X-sections (with proposed well trajectories)
- Fluid contacts.
- Key subsurface uncertainties

6.3.11 UNCERTAINTY ANALYSIS

For each parameter and area e.g. Seismic, Modeling, depth maps etc. the following should be known and analyzed:

- Origin and Magnitude of Uncertainty
- Effect on seismic, modeling, planned wells etc.
- How was the uncertainty reduced/managed
- Recommendations for further study

6.3.12 PROJECT CLOSE-OUT

- Seismic interpretation Data Sheet.
- Computer Mapping Data Sheet.
- Document data availability, process/methodologies/applications/analysis used, findings/results obtained, uncertainties identified/managed, conclusions and recommendations in a comprehensive appropriate report (seismic/reservoir study/FR/FDP report)
- structural maps of all interpreted and infill levels on a scale of 1:25000
- Digital copy of project
- Field wide structural cross-section encompassing all the reservoirs in the field
- Listing of sand tops and bases as well as fault cut outs
- Clean up of Seismic Interpretation Project
- Clean up of Computer Mapping project
- Loading of all geological and geophysical data in corporate database following naming conventions
- Missing or anomalous data should be addressed. Notes must be made of data that are missing and the assumptions made to fill in the data gaps.

6.4 DYNAMIC MODELING

The document must contains a series of Reservoir Engineering related quality assurance checks and standard Deliverables: pertaining to integrated field studies.
Note: Missing or anomalous data should be addressed. Notes must be made of data that are missing and the assumptions made to fill in the data gaps.

6.4.1 DATA COLLECTION AND QC

- An inventory of available Pressure, Temperature, PVT, SCAL (rel. perm.), production test (pressure / kh / skin) and reservoir/well production data (including API gravity and surface viscosity data).
- Distinguish "raw" data from that previously reported.
- Audit listing of QC issues and corrections taken.

6.4.2 INITIAL TEMPERATURE / PRESSURE ANALYSIS

- Pressure, Temperature plots vs. true vertical depth. Temperature plots requiring split in data collected from short/long string, PVT sampling and dedicated temperature logs.
- Initial pressure and temperature vs. depth correlation.
- Comparison of field temperature gradient with regional data.

6.4.3 PVT ANALYSIS

- Validity checks of PVT samples.
- Modeled PVT data vs. actual data for black oil/ retrograde gas or, if appropriate to the study, EoS matched PVT data. Depict reservoir performance observed Rsi vs correlation/PVT derived Rsi.
- Temperature / field separator conditions corrected PVT parameters.

6.4.4 BHP ANALYSIS

- Test rate/pressure plots,
- Test derived permeabilities vs. log derived permeabilities (Table).
- Test evaluation plots (Horner, Type curves, etc.)
- Test evaluation data (Reservoir pressure, PI actual, PI ideal, permeability, skin, wellbore storage, etc.).
- For multi-rate gas well testing: Well deliverability at 100 psi drawdown and non-Darcy turbulence factor. Petrophysical input data (porosity, compressibility, drainage height, etc.)

6.4.5 MATERIAL BALANCE ANALYSIS

- Historical performance/pressure vs. simulated data plot; fluid contact movement plot (incl. water breakthrough data per well).
- Aquifer type and parameters. Comparison of aquifer parameters with overlying/underlying reservoirs.
- Forecasted production (oil/gas/water) data including assumptions with justification and fluid contact movements per reservoir (Tables and plots)

6.4.6 DEVELOPED RESERVES (DUR) ASSESSMENT

- Production/log oil cut extrapolated performance plots per drainage point and reservoir block.
- Cut-off criteria for DUR (watercut, min. economic hydrocarbon rate, gross rate, min. bottom hole pressure)
- Production forecast (yearly averaged daily rates of oil, gas and water) per well/reservoir.
- Tabulation of low, medium, high DUR volumes per drainage point and reservoir.
- Update of DUR database.
- Cross-check of DUR volumes with ARPR Ultimate Recovery values.

6.4.7 RESERVOIR SIMULATION MODELLING

- Static model description.
- Uncertainty analysis (parameters having impact on simulation predictions such as volumetrics, connectivity, permeability levels and distribution, aquifer response and fluid properties) for multiple scenario modelling approach.
- Tables and Figures of capillary pressure and three phase relative permeability data per lithology.
- Fluids in place tabulations for each of the static model realisations (oil and gas per layer for (gridblock) model(s)).
- Comparison of model derived Fluids in Place volumes with ARPR data and explanation of changes.
- Dynamic model description (incl. aquifer placement).
- Reservoir Simulation model QA/QC. Figures showing comparison of permeability levels for (gridblock) model(s) for selective layers and cross-sections. Histograms showing porosity and permeability distribution for (gridblock) model.
- Reservoir simulation model history match. Short description of well matches incl. matching criteria for pressure, oil, gas and water. Figures showing historical vs. simulated performance (pressure, oil, gas and water) per well and per reservoir. Table with cumulative oil/gas and water production per well and reservoir (in standard surface volumes and in reservoir barrels)
- No Activity Forecast for existing wells (Figures and Tables with yearly averaged daily rates of oil, gas and water per well/reservoir).
- Optimum Reservoir development Forecast (Yearly averaged daily rates of oil, gas and water per drainage point in Table and Figure format).
- Tabulation of UR variations for various development options and surface production constraints
- Tabulation of new drainage point data [objective, subsurface co-ordinates, initial potential (range), reward (range) and major uncertainties (e.g. structural, oil saturation)].
- Saturation plots for selective layers and cross-sections at end history match, end of life cycle "No Activity Forecast" and end of life cycle "Optimum Development forecast".
- Analysis of displacement mechanism(s), stability of G/O, W/O displacements related to, e.g., heterogeneities, aquifer drive characteristics.

- Quantification of uncertainty in model predictions (Tabulation of UR sensitivity towards main static model uncertainties (Optimum Development Case only).
- Development plan, well surveillance plan and special data acquisition (SCAL, PVT)

6.4.8 PROJECT CLOSE-OUT

- Field Study report (paper copies and CD-Rom)
- Transfer of pertinent data into corporate databases.
- Installation and testing of simulation models.

6.5 PRODUCTION SENARIOS:

6.5.1 DATA COLLECTION AND QC

- An inventory of available data: well histories (drilling, initial completion, workover and TT re-entries), completion diagrams, BHP data, production test data and plots, PI, flowstation reports, surveillance reports, reservoir properties (API gravity, viscosity, temperature, Bo) and logs (PDLs, Sonic).
- Compiled checklist of what is available against requirement.

6.5.2 INITIAL DATA ANALYSIS

Unreconciled and reconciled production data should be reviewed. Sound engineering judgement to be used to screen production anomalies.

Deliverables:

- Production plots per well, per field.
- A listing of Production data (rates, THP, GOR, BSW) errors or inconsistencies.
- Analyses of data.

6.5.3 BHP, PI AND WELL TEST DATA ANALYSES

The validity of bottom hole pressure and temperature, PI, and well tests data to be assessed.

Deliverable:

- Provide an analysis, evaluation, validation and a review of PI, BHP&T surveys, well test data with recorded comments and approved interpretation.
- Well testing follow up.
- Provide a list of any remedial actions to improve well production or injection

6.5.4 WELL REVIEW AND WELL REVIEW DOCUMENTATION

- Attend a well review meeting with other field team employees from other disciplines regularly.
- Document the well review.

6.5.5 WELL HISTORY GENERATION

Review of well completion, workover and drilling reports, programmes and summaries for consistency. Missing or anomalous data should be addressed. Ensure the completion diagram is the latest version. Notes must be made of data that are missing and the assumptions made to fill in the data gaps.

Deliverables:

- A complete set of well data sheets for all wells in the field.
- Well completion and current status summary.

6.5.6 WELL PERFORMANCE ANALYSIS

Using the generated well history and well completion status overview, production performance evaluation on a drainage point basis should be carried out.
Investigate (reservoir or mechanical reasons) why a well is under or over performing at various stages of its producing life.

Deliverables:

- *Recommendations to rectify any production problems as well as further production optimization activities.*
- A table of drainage point evaluation, results and recommendations for short term action points. (This list provides a starting point for production optimization e.g. TT repair, stimulation, bean-up and other through tubing or CTU activities to increase field production).
- Estimated production gain from each activity
- Detailed program for each activity execution.

6.5.7 INITIAL WELL MODELLING (INFLOW AND OUTFLOW)

Each major reservoir should be modeled and evaluated with WePS/ HORVIP.

Deliverables:

- Well calibrations and models.
- Preliminary lift tables for the reservoir engineer for use in simulation
- *Watercuts at which wells will no longer flow naturally.*
- Artificial lift requirement.
- Assessment and selection of artificial lift.
- Well head abandonment pressure

6.5.8 FACILITY DATA REVIEW

Flow station layouts and reconciliation reports as well as engineering diagrams of the main separators and flow stations are the main source of data to assess facility and identify system de-bottlenecking opportunities.

Deliverables:

- Brief description / overview (or schematics) of the existing production and gathering facilities (flowstation).
- Statement on the capacity of existing surface production facilities and identification of possible de-bottlenecking opportunities to cater for additional production.
- Well head abandonment pressure for the field and the wells

6.5.9 DETAILED MODELLING & WELL DESIGN

- *Carry out well modeling using to accurately represent the well/ reservoir and to predict future performance of the drainage points.*

Deliverables:

- Assessment of completion efficiency of existing drainage points.
- Natural flow limit of existing wells.
- Estimated production rates for proposed repairs, re-completions or new wells.
- Optimum tubing size for proposed new completions / well repairs
- Estimated maximum water-cut levels that existing wells can sustain on natural flow.
- Lift tables for reservoir simulation. The lift tables generated should cover a wide range of operating conditions expected over the life of the field.

- Detailed well models.
- Assessment of various well designs and selected options (conventional, horizontal, ML wells).

6.5.10 STIMULATION AND WATER SHUT OFF REQUIREMENT

Indications of reservoirs requiring stimulation methods to flow as a result of declining reservoir pressure or increase in watercut. The advantages and disadvantages of various types of Stimulation and water shut off methods to be discussed.

Deliverables:

- List of reservoirs that require stimulation and water shut off in the short and medium term with inflow /outflow output as supporting evidence.
- Preferred choice of stimulation and water shut off methods.
- Detailed work program for these jobs.

6.5.11 FINAL SHORT-TERM OIL/GAS GENERATION AND DEVELOPMENT ACTIVITIES

Short term gas (or oil) generation activities (e.g. repair, stimulation and other through tubing activities, etc.) can now be firmed up.

Deliverables:

- A table of short-term oil / gas generation activities with descriptions of the proposed activities and their associated oil / gas gain.
- A table of development activities.

6.5.12 REQUIREMENT FOR NEW FACILITY

New facilities required to handle the production forecasts (oil, gas and water) should be identified.

Deliverables:

- A list of recommended new facilities required to handle additional fluids from the proposed development scenarios.

6.5.13 REPORT

Report should be integrated with sections from other disciplines.

6.5.14 CLOSE OUT AND DATA TRANSFER

At the end of the project, it is essential to save valuable data including well models. All the data should be saved electronically as much as possible. Data should be compatible with the corporate databases.

6.5.15

- Sending a specialized technical team consisting of five members to the offices of the studying company to discuss the static model and the findings achieved during the first phase.
- Sending a specialized technical team consisting of five members to the offices of the studying company to discuss the dynamic model, The surface facilities and equipment from the well to the station, discussing abandonment pressure for the wells, installing suitable compressors, and adopting the reservoir study after addressing the observations made by the technical team.

Deliverables:

- Final report.

7 PROPOSAL REQUIREMENT

CONTRACTOR is required to submit technical proposal in the following format:

T-1) introduction
T-2) CONTRACTOR Organization Chart
T-3) Key Personnel Resume
T-4) Project management
T-5) Execution plan

T-1) Introduction:

CONTRACTOR is required to demonstrate a comprehensive understanding of the scope of work.

T-2) Organization Chart:

CONTRACTOR is required to provide a general organization chart schematic and a specific organization chart for conducting the work as specified in Scope of Work.

T-3) Key Personnel Resume:

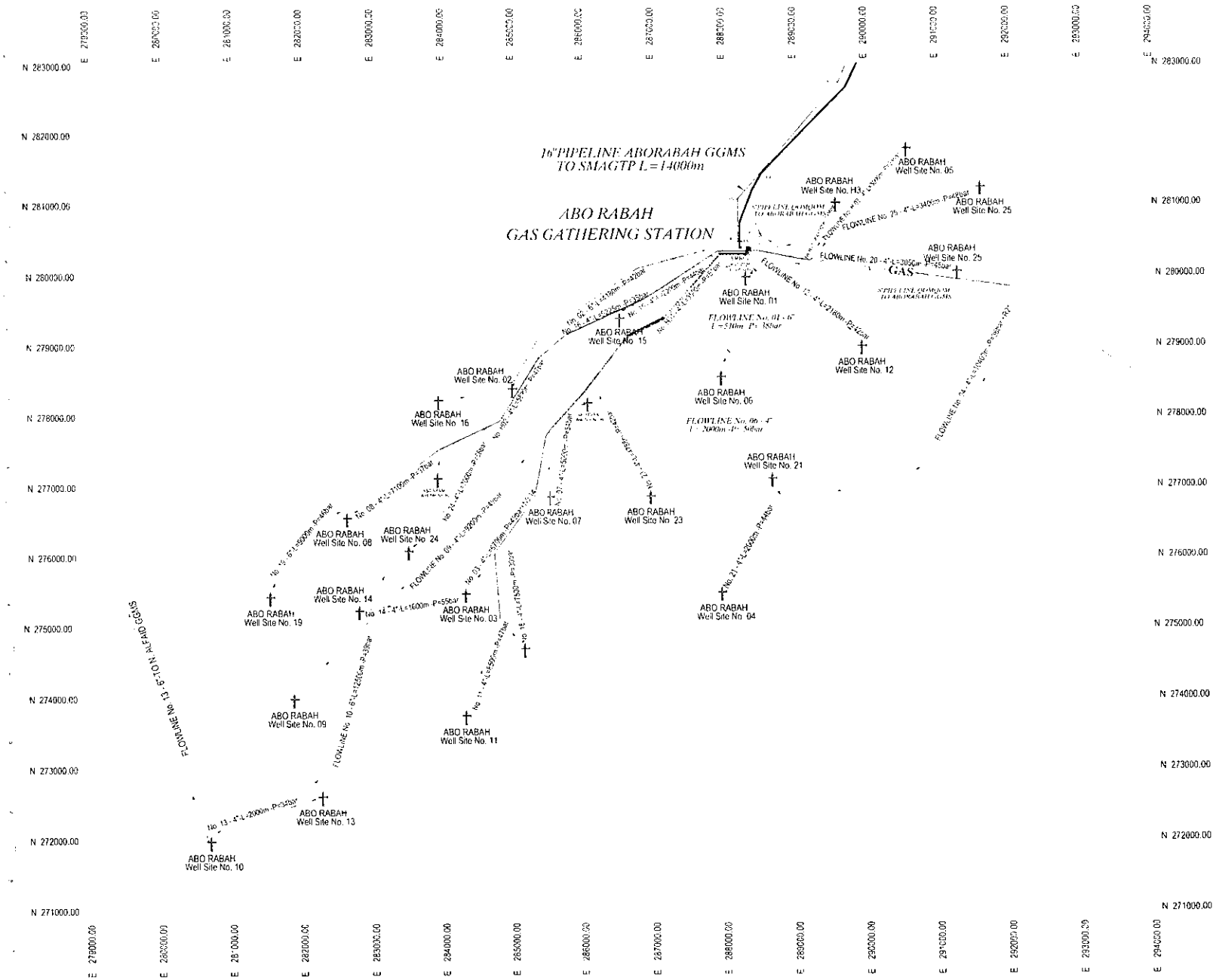
CONTRACTOR shall provide a team of technically qualified and experienced personnel to perform this reservoir study in accordance to international standards.

T-4) Project management:

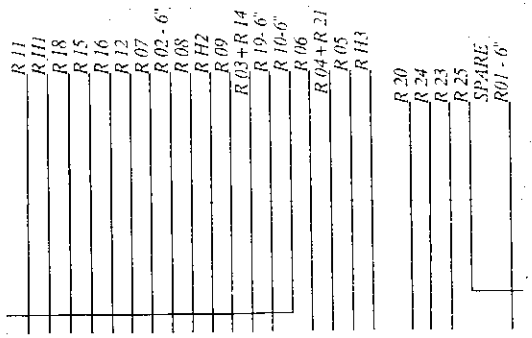
CONTRACTOR is required to provide project management plan demonstrating its ability to provide required equipment and services within time schedule.

T-5) Execution plan:

CONTRACTOR is required to provide an execution plan (with all technical documents for above division which mentioned in special terms and condition) showing that all the works shall be executed in strict conformity with the provisions of the contract documents and with such explanatory detailed drawings, specifications, and instructions as may be required. CONTRACTOR is required to show its responsibility for ensuring that works throughout are executed in the most substantial, proper and workman in strict accordance with close out of each above main items.



ABO RABAH MANIFOLT



WELL N0.	Diameter	Length m	End Point	Pressure
R 01	6"	510	AR GGMS	38 bar
R 02	6"	4180	AR GGMS	42 bar
R 03	4"	6700	AR GGMS	49 bar
R 04	4"	10400	AR GGMS	36 bar
R 05	4"	3000	AR GGMS	33 bar
R 06	4"	2000	AR GGMS	50 bar
R 07	4"	5000	AR GGMS	54 bar
R 08	4"	7100	AR GGMS	37 bar
R 09	4"	9200	AR GGMS	49 bar
R 10	6"	12500	AR GGMS	39 bar
R 11	4"	8500	AR GGMS	47 bar
R 12	4"	2180	AR GGMS	42 bar
R 13	4"	2000	R 10-N.F	34 bar
R 14	4"	1600	R 03	55 bar
R 15	4"	2200	AR GGMS	44 bar
R 16	4"	5225	AR GGMS	35 bar
R 18	4"	7500	AR GGMS	30 bar
R 19	6"	9000	AR GGMS	46 bar
R 20	4"	3050	AR GGMS	45 bar
R 21	4"	2000	R 04	44 bar
R 23	4"	4788	AR GGMS	42 bar
R 24	4"	7000	AR GGMS	58 bar
R 25	4"	3400	AR GGMS	48 bar
R H1	4"	3500	AR GGMS	51 bar
R H2	4"	5890	AR GGMS	47 bar
R H3	4"	1820	AR GGMS	38 bar

Scope of work

For

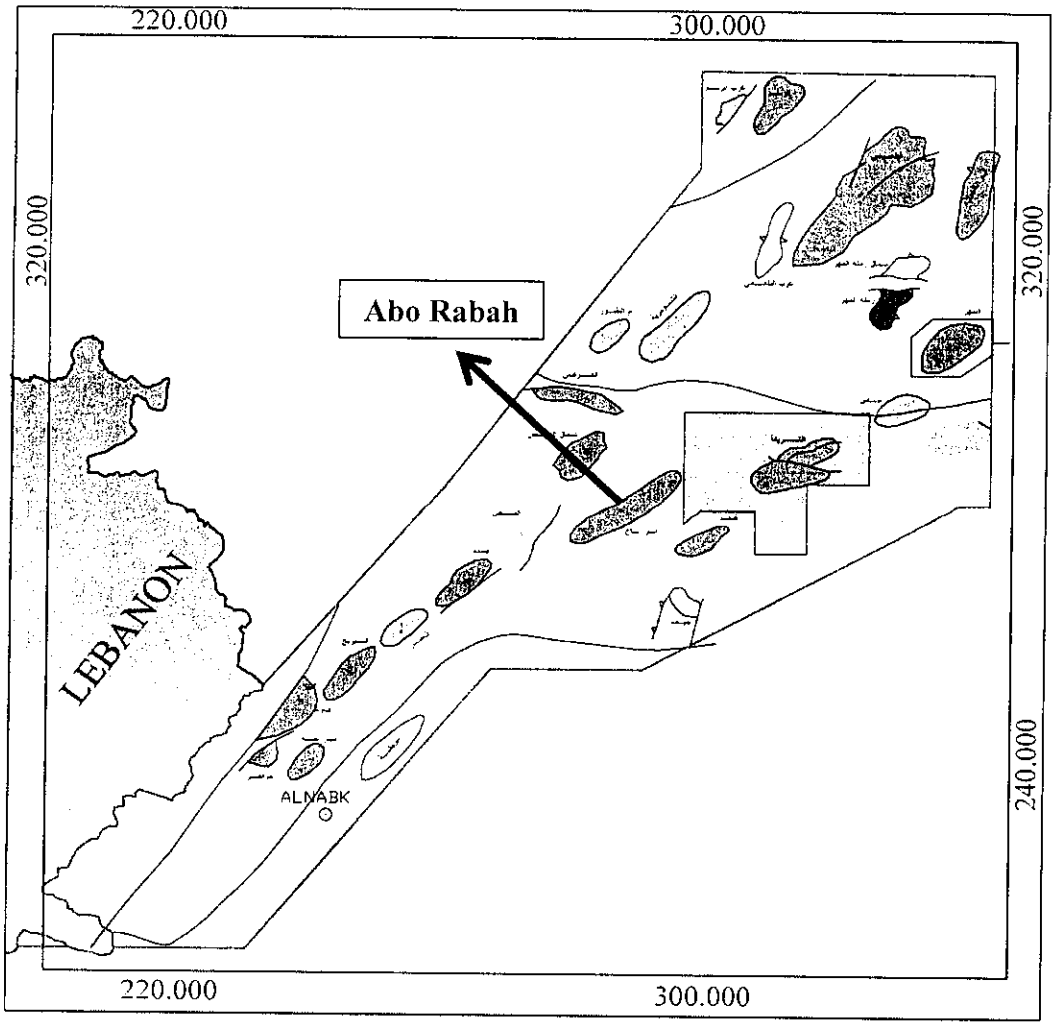
Reservoir study for Abu Rabah field

1 INTRODUCTION:

Abu Rabah area is considered one of the highly prospective hydrocarbon regions due to the availability of all the appropriate geological conditions for the presence of a reservoir: (source rocks, reservoir rocks, cap rocks, burial depth, and generation). The Syrian Petroleum Company resumed exploratory activities in the Dou Basin in 1996 after Marathon Oil Company relinquished the area. The dimensions of the structure on the Kurachine Dolomite reflector are approximately 24 × 7 km.

Geographical Location: Abu Rabah structure is located in the central-western part of Syria within an area known as Block Abu Rabah, approximately 135 km northeast of the city of Damascus. It is surrounded by the North Al-Fayd, Al-Sharifa, and Qumqum fields and is part of the Dou Unit, which is one of the segments of the Tadmur fold belt known for its high gas potential. It is situated on the western edges of a local depression that lies between the Tadmur mountain ranges and is classified as one of the most important gas-producing fields in Syria, relying on the reservoir of the Kurachine Dolomite formation.

Structural Setting: The geological time map of the Kurachine Dolomite formation shows that the Abu Rabah structure has a subsurface geological structure that reflects topographically on the surface in the form of an elongated fold, with its axis oriented in a northeast-southwest direction. This fold is bounded by two major faults: on the eastern side, there is a reverse fault with a throw estimated at 200-250 m, and on the western side, there is a normal fault with a significant throw exceeding 500 m. The structure is divided into an upthrown wing representing the main body of the structure and a downthrown wing on the eastern side.



Surface Geology: The geological map of the area shows a clear geological reflection of the structure on the surface, appearing as an elongated fold oriented northeast-southwest. At its crest, Upper Cretaceous sediments are exposed, represented by the Ramah Shale formation, which consists of limestone and chert, followed by the Ark Marl formation and then the Shiranish formation, which is composed of limestone. The wings of the fold reveal Lower Paleogene sediments.
Exploratory Drilling: The Abu Rabah field was discovered in 1997 and began production in 2008. It is a gas reservoir from the Kurachine Dolomite formation, specifically from the C2 D1 strata.

2 LITHOLOGY OF RESERVOIRS:

The reservoirs formations belong to (Middle Triassic) which consists predominately of various carbonate types, dolomite and limestone, evaporates, shale.

3 TYPES OF RESERVOIR:

The producing formation:

1. The gas- condensate with oil rim Kurachine Dolomite C2 reservoir
2. Oil rim Kurachine Dolomite D1 reservoir
   The Kurachine Dolomite C2 & D1 consider as one hydrodynamic unit,

These two reservoirs are the subject of this Reservoir study.

4 DRILLED WELLS:

A total of 27 wells have been drilled in the Abu Rbah Field Development Area, as the following:

Well	Type of HC	Status	Reservoir	Total Depth (m)	Production Date	Second Target	Date of Change zone
Abu Rbah -1	Gas	Producer	C2, D1	2742	Dec/2008		
Abu Rbah -2	Gas	Producer	D1	3507	Dec/2008		
Abu Rbah -3	Gas	Producer	D1	2775/2413	Dec/2008		
Abu Rbah -4	Gas	Producer	C2	3149/2820	Aug/2009		
Abu Rbah -5	Gas	Producer	C2	3001/2709	Aug/2010		
Abu Rbah -6	Gas	Producer	D1	2800	Oct/2009		
Abu Rbah -7	Gas	Producer	D1	2820	Oct/2009		
Abu Rbah -8	Gas	Producer	D1	2749	Jan/2009		
Abu Rbah -9	Gas	Producer	D1	2840/2611	Feb/2009		
Abu Rbah -10	Gas	Producer	C2	2893/2553	Dec/2009		
Abu Rbah -11	Gas	Producer	C2, D1	2823	Feb/2013		
Abu Rbah - 12	Gas	Producer	D1	2873	Mar/2013		
Abu Rbah -13	Gas	Producer	C2	2705	Aug/2016		
Abu Rbah -14	Gas	Producer	C2, D1	2552	Jul/2016		
Abu Rbah -15	Gas	Producer	C2, D1	2695	Jan/2017		
Abu Rbah -16	Gas	Producer	C2, D1	2764	Jun/2017		
Abu Rbah -18	Gas	Producer	C2, D1	2760	May/2017		
Abu Rbah -19	Gas	Producer	C2	2687	Oct/2017		
Abu Rbah -20	Gas	Producer	C2	2710	Jun/2018		
Abu Rbah -21	Gas	Producer	C2	2873	Apr/2020		
Abu Rbah -23	Gas	Producer	C2	2847	Jul/2022		
Abu Rbah - 24	Gas	Producer	C2, D1,D2	2642	Aug/2021		
Abu Rbah - 25	Gas	Producer	C2	2827	Jun/2022		
Abu Rbah – 1H	Gas	Producer	D1	3349/2698	Aug/2009		
Abu Rbah – 2H	Gas	Producer	C2	3340/2758	Aug/2009		
Abu Rbah – 3H	Gas	Producer	C2	3252/2515	Dec/2008		

5 AIM THE RESERVOIR STUDY:

The main purpose of this study is to, recalculate Geological and producible reserves, and develop production scenarios for optimaize field investment.

6 SPECIAL TERMS AND CONDITIONS:

Abu Rbah Reservoir Study (Kurachine Dolomite C2, D1) shall be performed in accordance with the following:
(Note: CONTRACTOR should be reviewed the existing data and the deficiency in it should be rebuilt through the necessary correlation procedure

6.1 PETROPHYSICS

The re-evaluate and reinterpret pertophysical logging and analysis will be in order to:

- Test the previous well logging data,
- Check and evaluate the pertophysical parameters.
- Perform analysis of reservoir fluid distribution
- Perform hydrocarbon saturation evaluation models

Through the following:

6.1.1 DATA COLLECTION AND QC

- An inventory of the data that is available.
- Audit listing of QC issues, and corrections taken, such as missing logs, miscalibrated data etc.

6.1.2 INITIAL FLUID DISTRIBUTION ANALYSIS - FIELD

- Fluid distribution plots at the beginning of the study to provide snapshot of the fluid distribution as has been previously identified. It aids to flag those wells with deviation or depth measurement problems.
- Comparison of tops and contacts from databases to those from logs.

6.1.3 DEPTH SHIFTING/ENVIRONMENTAL CORRECTIONS/LOG SPLICING

- Depth shifted and environmentally corrected logs in LOGIC (recognized by extensions to the curve name, and annotated by curve comments).
- Record of which curves have been sliced together, and over which intervals.
- Any major depth shifts should be recorded.
- A listing of the logs that were environmentally corrected.

6.1.4 LOG NORMALISATION AND RESISTIVITY INVERSION

- For normalized logs, the shifts and rescaling that has taken place must be documented and provided.
- The normalized (or inverted) curves.

6.1.5 DETERMINING LITHOLOGY

- The technique used for determining lithology (i.e. CLASS, CLUSTER).
- An inventory of the data that was used for the classification.
- If core data is present; a log plot that shows the log lithology plotted beside the lithology determined from core.
- A lithology curve that is identifiable, with curve comments.

6.1.6 DETAILED ANALYSIS OF RESERVOIR FLUID DISTRIBUTION

- An audit trail must be provided describing how the fluid contact was determined in each well for each reservoir.
- For key wells used in determining the fluid contacts, these wells must be plotted including all relevant information (SWS, neutron logs, production etc.) as 1:200 scale PDL's.
- A panel showing the fluid distribution must be provided for each reservoir. (XL based).
- Any large discrepancies from the field wide contact for any reservoir for any well must be rationalized.
- A summary table of the fluid contact data for each reservoir must be reported including the following information: GUT, GDT, GOC, OUT, ODT, HCWC and WUT.

6.1.7 PARAMETERS EVALUATION

6.1.7.1 CEMENTATION EXPONENT

- Description of how m was determined, and plots to support the choice from either core or log data.
- If there are differences between the different methods, then an explanation of why a given value was used must be provided.

6.1.7.2 SATURATION EXPONENT

- Description of how n was determined and resistivity index plot of core data if available.
- If determined from core data a description of the measurement should be included including brine salinity, stress measurement type, temperature etc.

6.1.7.3 GRAIN DENSITY

- Description of how the grain density was determined.
- If from core data, then a plot of this data.
- If based on a lithological interpretation, (i.e. output from FLAME) then a listing of the input parameters used in FLAME.

6.1.7.4 FORMATION WATER RESISTIVITY

- Description of how Rw was determined must be provided.
- If Pickett plots over wet zones were used, and then examples must be presented. A comparison of the Rw from Pickett plots with produced water should be made if both sources of data are used or available.
- If SP logs were used, then these results should also be compared to other data (produced water etc.).
- If there are differences between the different methods, then an explanation of why a given value was used must be provided.

6.1.7.5 OTHER

- This list is not exhaustive.
- If other interpreted parameters are used in the log evaluation they must be listed, and the process by which they were derived documented.

6.1.7.6 POROSITY EVALUATION

- For every well the technique for calculating porosity must be documented.
- If log data is calibrated to core data to calculate porosity, then the cross plot of core porosity vs the log (for example the density log) must be provided.
- If a correlation to core from the density log is made, then the value of the fluid and grain density that are calculated from that relationship must be reported.
- If a correlation to core from the sonic log is made, then the velocity of the calculated fluid and rock matrix that are calculated from that relationship must be reported.

- If an empirical relationship using a log is used to determine porosity, then the input parameters must be reported.

6.1.7.7 PERMEABILITY EVALUATION

- The relationship used to predict permeability must be reported. If this relationship is based on a correlation against some "non-standard" log, then the logic behind the correlation must be described. A black box correlation is not acceptable.
- The type of permeability that is being calculated must be reported.
- The effect of stress on the permeability should be reported. If a correction for stress is made, then the calculation of net hydrostatic pressure must be reported. The following plots should be available:
- permeability vs stress for all samples
- reduction factor vs permeability
- stressed vs atmospheric permeability
- If derived from core, and core porosity, a cross plot of porosity and permeability is required, along with any subdivision by facies.
- A comparison between the core permeability, and that compared from other sources must be made. This should include a comparison with production logs, and calculations of permeability from pressure build up data.

6.1.7.8 NET TO GROSS CALCULATIONS

Net to Gross is often calculated on the basis of some cut-off, used to determine which zones of the reservoir are to be included in the net sand count, and which are not. This discrimination will already have been made earlier (e.g. in the determining of lithology). However, it is only when the individual reservoir is investigated in detail that questionable zones are re-evaluated and perhaps re-assigned as reservoir rock or non-reservoir rock.

Deliverables:

- Description of the process used for differentiating net from gross.
- Curve that differentiates net from gross for subsequent calculations.

6.1.7.9 HYDROCARBON SATURATION EVALUATION MODELS

- When picking the model to evaluate the reservoir the following must be considered:
- The lithology of the reservoir (clean, shaly sand, dispersed clay, laminated shale, radioactive sand).
- The end use of the data (there is little point spending large amounts of time on a reservoir with marginal reserves).
- What this amounts to is that the evaluation model should be fit for purpose. Sophisticated models while more interesting should only be applied if there is merit in the application.

Deliverables:

- A description of the model that is used for calculating hydrocarbon saturation is required, along with the justification for using that model.
- If different models are used, then they must be compared to each other and plotted for comparison for key wells.
- Any parameters used in the models must be reported, and if interpreted supported by plots or other data.

6.1.7.10 CAPILLARY PRESSURE AVERAGING FOR DYNAMIC MODEL

In fact there is just core reports, CONTRACTOR based on these reports try to carry out the following:

- If the saturation-height functions are derived from core, then the fitted data vs the measured core CP data must be plotted and reported for each sample so that the quality of the fit can be assessed.
- Whether calculated from logs or core, the saturation that is calculated from the height function must be plotted for some key wells, along with the traditional log derived saturation to allow the quality of the fit to be assessed.
- The equation used to calculate the height function must be reported.
- The data used to generate the height function must be reported.
- The values used to convert lab data to height above the FWL in the reservoir must be reported.

- A plot of calculated CP curves as a function of reservoir quality (phi, k or combination) by facies.

6.1.8 SUMS AND AVERAGES

The petrophysical sums and averages of hydrocarbon saturation, net to gross, porosity, and permeability on a reservoir basis for all wells, and discriminated on the basis of fluid type, and/or lithology must be reported. The saturation values should be reported from all evaluation models used for comparison, (i.e. Waxman-Smits, MELARS, Height Functions, with and without inversion etc.)

Deliverables:

- Table with sums and averages for each well and reservoir.
- If resistivity inversion has been used, then the sums and averages must be calculated using the resistivity curves with and without inversion, and the difference noted and explained.
- If saturation-height functions are calculated, then the sums and averages must be calculated using the saturation-height function, and compared with the log derived saturation and the difference noted and explained.

6.1.9 UNCERTAINTY ANALYSIS

Uncertainty must be calculated for both the individual depth increment values (for example of porosity), as well as for the average well values.

The uncertainty in the value of porosity or saturation on a depth increment scale can be determined from a Monte Carlo analysis and then assigning an error to each of the input parameters that are used in that calculation.

Once the values of porosity, saturation, and net to gross have been determined for each well, along with their uncertainties, these values are used to calculate the uncertainty in the average properties of the reservoir (based on the finite sampling of a reservoir with a limited number of wells).

Deliverables:

- The technique used to calculate the uncertainty needs to be reported.
- The data used as input for the uncertainty analysis, along with the weighting must be documented.
- If the average values of porosity/saturation/net to gross are calculated in a 3D geological model, then these values must be compared to those calculated from well averages and the differences documented, and explained.

6.1.10 SYNTHETIC SEISMOGRAMS

- Synthetic seismograms for each well possible, along with the process used for generating the synthetic for each well. If the process is different for each well (perhaps because of missing data), then this needs to be documented.
- The T-Z function(s) used for converting depth to time needs to be recorded.
- Formation tops converted to time.
- Log panels with primary logs (sonic, density, gamma ray, SP and resistivity) plotted in time along with the acoustic impedance, filtered reflectivity curve and the formation tops.
- Description of filter used to filter the reflectivity or acoustic impedance.
- Table that identifies the shift that the seismologist applied to match the logs synthetics to the seismic panel.

6.1.11 REPORT FORMAT

The output of the petrophysical contribution in the sub-surface field study includes:

Auditable reports	methods and analysis reports etc.
Fluid distribution tables	These tables must be generated so that they can be used directly for: 1) generating the annotation curves on the PDL's. 2) generating the fluid curves. 3) updating fluid contacts in the Corporate database.
Sums and Averages Tables for tail of PDL	These tables will be created from the Sums and Averages tables in the main report
Petrophysical Data Log	The PP is responsible for plotting out and QC'ing one entire set of PDL's.
Uncertainty in Petrophysical Properties	The uncertainty in each petrophysical property must be reported (audit trail as in the section on uncertainty).

Compliant PDL's	These PDL'S are generated according to the specifications, (across sands of interest with adequate annotations).

6.1.12 PROJECT CLOSE OUT

At the end of the project, it is important to "clean up" database so that the curve data is readily available for upload to RDB. This often requires renaming the different curves, and as well providing a description of the curve so that they are readily identifiable for other users.

Deliverables:

- Project with curves named, and with curve comments describing each curve.
- Transfer all relevant data into corporate databases.
- Fluid contacts
- Final evaluation curves.

6.2 SEISMIC INTERPETATION:

Several two-dimensional (2D) and three-dimensional (3D) seismic surveys were conducted in the Abu Rabah field area over successive time periods, characterized by a clear variation in field constants and processing.

In 1999, the second survey team of the Syrian Petroleum Company executed a seismic survey program coded (QM) that covered the majority of the study area. The processing of its lines was carried out by PGS in 2001, with a return level of 600 meters. The field also encompasses a set of lines for the (CH.AR.SH) survey programs.

In 2014, the 3D survey (executed and processed in 2010) was reprocessed at the processing center of the Syrian Petroleum Company.
* All previous 3D/2D surveys were unified to a single seismic return level of DP: 600M (SRD).
* The quality of the seismic data varies between good and poor, with a primary reliance on 2D surveys, while the 3D survey was utilized in areas with limited coverage, particularly in the eastern wing of the Abu Rabah field..

The seismic interpretation and analysis will be in order to:

- Test the previous processing of 3D seismic data,
- Provide detailed seismic re-interpretation of structural styles,
- Interpret horizons that represents top of C2 and D1 reservoirs,
- Check and evaluate time depth conversion,
- Perform seismic attribute analysis,
- Perform seismic facies analysis.

6.2.1 DATA AVAILABILITY/PROJECT SET-UP

6.2.1.1 SEISMIC VOLUME AVAILABILITY & ORIGIN

CONTRACTOR must re-evaluate existing seismic volume if its need migration or re-processing and carry out the following:

- Inverted data
- Zero phase data
- Reflectivity volume
- Acoustic Impedance volume

6.2.1.2 WELL DATA AVAILABILITY

CONTRACTOR must re-evaluate existing well data and carry out the following:

- Confirm/ finalize Reservoir Tops
- Use Sequence stratigraphy concept

- Produce Correlation Panel
- Confirm/ finalize Faultcuts in well
- T-Z data
- VSP data
- well synthetic seismogram (s)
- Load all validated data on workstation

6.2.1.3 DOCUMENTATION AVAILABILITY

CONTRACTOR must review the following seismic acquisition and interpretation documents to Generate Final Terms of Reference:

- Previous seismic interpretation report
- Seismic acquisition report
- Seismic (re)processing report
- Liaison with exploration on existing studies

6.2.2 SEISMIC INTERPRETATION

To prepare seismic data for perform Static model, CONTRACTOR must carry out the following based on existing seismic data:

6.2.2.1 HORIZON INTERPRETATION

- Well to seismic match
- Identify key horizons to be mapped
- Tie in and map away from wells
- generate regular seed grid
- Use of autotracking/interpolation techniques
- QC horizon interpretation using 3D visualization tool
- Prepare time maps

6.2.2.2 FAULT INTERPRETATION

- Request attribute volumes
- Interpret fault planes on regular grid using attribute
- Cross check fault position with faultcut from wells
- Generate horizon attribute
- QC fault interpretation using 3D visualization tool
- Generate fault polygons

6.2.2.3 SEISMIC AMPLITUDE/ DHI'S ANALYSIS

- Use of 3D visualization technique to screen data for DHI's, flat spot, bright spots
- Generate amplitude maps
- Calibration of Prod. offtake/ Amplitude

6.2.2.4 TIME TO DEPTH CONVERSION

- Use of T-Z tables (single, combined)
- Use of Vo, K function
- Use of Pseudo velocity maps

- Use of Calibrated seismic velocities
- Use of Geostatistics
- Residual analysis (feed back to horizon interpretation)
- Prepare structure depth maps
- Infill maps generation: methodology (isochoring, ratio method etc.)

6.2.2.5 UNCERTAINTY HANDLING

- Seismic data positioning (De/Re-migration, well to seismic match)
- Residual analysis (standard deviation)
- Difference between depth conversion methods
- Use of Geostatistics

6.2.2.6 FAULT ANALYSIS

- Clay Smear Potential
- Fault population analysis
- Allan Diagrams

6.3 STATIC MODELLING

In aim to build structure of reservoirs, CONTRACTOR will use above data (pertophysical and seismic data) and previous reservoir studies reports to create static model through the following:

6.3.1 GEOLOGICAL MODEL AND LITHOLOGIES

- Analogue depositional model applied .
- Selected, express differences & similarities in regional setting, sediment type, scale.
- Sketches/block diagrams of reservoir facies architecture ("conceptual depositional model").
- Check use of core descriptions & interpretations.
- Provide type log illustrating key open-hole logs, subdivision and facies.
- Check lithology determination from logs; use of core information, Rule-Based Subdivision, etc.
- Summary of facies characteristics including proportions and distributions from well data.
- Translation of conceptual geological model into digital 3D geological model.

6.3.2 CORRELATION

- Explain logical basis for correlation - sequence stratigraphic, lithostratigraphic.
- Capture use of seismic surfaces and check ties.
- Tie faults in wells to seismic and to any input structural maps.
- Consider scale of expected lateral variation with respect to the actual well spacing.
- Account for any sudden thickness variations
- Capture use of biostratigraphy and special studies (isotopes, palaeosols, etc.)
- Explain which logs have been used for the correlations and why.
- Correlation decisions per correlatable bodies, including assumptions and alternatives.
- Provide hard copy correlation panels for inspection.
- Challenge correlatability of well bodies.

6.3.3 BODY MODELLING

- Sediment body geometries (thickness distributions, w/t, length. orientations), source data, reasoning.
- Document differences between correlatables, well bodies, and interwell bodies.
- Uncertainty assumptions and reasoning.

- Strike and dip sections through the wells in the undeformed model should be made using the fence tool to QC 3D reservoir model.

6.3.4 STRUCTURAL REPRESENTATION

- Match structural grids to well picks, Present scaled map with wells, picks & grid contours.
- Explain how unconformities were treated in the model.
- Explain how faults were treated in the model - any decimation, any well adjustments to allow for fault
- Cross-section representation of key well/fault intersections.

6.3.5 PROPERTY MODELLING

- Check that model property logs use latest petrophysics.
- Match of along-hole pseudologs through model to original well data. Explain any significant differences.
- Discuss impact of upscaling from raw logs to voxel thicknesses on property max & min values and on 3D interpolation.
- Document interpolation procedures applied (algorithm, linear or logarithmic scaling, etc), including seismic input.

6.3.6 MODEL GRV AND STOIIP

- The gross rock volume and GIIP of the reservoir above the hydrocarbon contacts should also be calculated for the 3D model and compared with the equivalent 2D map value. There should be a sound geological explanation for any significant differences.

6.3.7 FACIES PROPORTIONS

- Compare the average proportions of genetic elements (facies) at the wells with the proportions in the model as a whole. The geologist should provide a listing of well and model genetic element abundances for the key higher levels. e.g. per parasequence set or reservoir unit. A brief explanation and justification of the differences between the average well and average model values should accompany this.

6.3.8 RESERVOIR PROPERTIES

- Net/Gross, porosity and permeability should all be made available as 2D maps. The maps will reveal bullseyes (usually undesirable) and also any areal or local trends. These should have geological meaning or not contradict anticipated geological trends without reason.

6.3.9 THE DYNAMIC MODEL

- One of the most powerful Q/C tools available is a consistency check with the volumetrics and property distributions revealed by the upscaled simulation model. This should be performed on the first pass model as soon as possible to catch any major errors or inconsistencies.

6.3.10 WELL PLANNING

- Key subsurface depth maps
- Field Structural Cross-section of key reservoirs running north-south and east-west
- 3D models of key reservoirs.
- Key Seismic lines along well trajectories (blown up)
- Supporting attribute Maps
- Subsurface Targets/Tolerances
- Collision Risk Assessment/Calculations
- Supporting Sedimentological and Structural X-sections (with proposed well trajectories)
- Fluid contacts.
- Key subsurface uncertainties

6.3.11 UNCERTAINTY ANALYSIS

For each parameter and area e.g. Seismic, Modeling, depth maps etc. the following should be known and analyzed:

- Origin and Magnitude of Uncertainty
- Effect on seismic, modeling, planned wells etc.
- How was the uncertainty reduced/managed
- Recommendations for further study

6.3.12 PROJECT CLOSE-OUT

- Seismic interpretation Data Sheet.
- Computer Mapping Data Sheet.
- Document data availability, process/methodologies/applications/analysis used, findings/results obtained, uncertainties identified/managed, conclusions and recommendations in a comprehensive appropriate report (seismic/reservoir study/FR/FDP report)
- structural maps of all interpreted and infill levels on a scale of 1:25000
- Digital copy of project
- Field wide structural cross-section encompassing all the reservoirs in the field
- Listing of sand tops and bases as well as fault cut outs
- Clean up of Seismic Interpretation Project
- Clean up of Computer Mapping project
- Loading of all geological and geophysical data in corporate database following naming conventions
- Missing or anomalous data should be addressed. Notes must be made of data that are missing and the assumptions made to fill in the data gaps.

6.4 DYNAMIC MODELING

The document must contains a series of Reservoir Engineering related quality assurance checks and standard Deliverables: pertaining to integrated field studies.
Note: Missing or anomalous data should be addressed. Notes must be made of data that are missing and the assumptions made to fill in the data gaps.

6.4.1 DATA COLLECTION AND QC

- An inventory of available Pressure, Temperature, PVT, SCAL (rel. perm.), production test (pressure / kh / skin) and reservoir/well production data (including API gravity and surface viscosity data).
- Distinguish "raw" data from that previously reported.
- Audit listing of QC issues and corrections taken.

6.4.2 INITIAL TEMPERATURE / PRESSURE ANALYSIS

- Pressure, Temperature plots vs. true vertical depth. Temperature plots requiring split in data collected from short/long string, PVT sampling and dedicated temperature logs.
- Initial pressure and temperature vs. depth correlation.
- Comparison of field temperature gradient with regional data.

6.4.3 PVT ANALYSIS

- Validity checks of PVT samples.
- Modeled PVT data vs. actual data for black oil/ retrograde gas or, if appropriate to the study, EoS matched PVT data. Depict reservoir performance observed Rsi vs correlation/PVT derived Rsi.
- Temperature / field separator conditions corrected PVT parameters.

6.4.4 BHP ANALYSIS

- Test rate/pressure plots,
- Test derived permeabilities vs. log derived permeabilities (Table).
- Test evaluation plots (Horner, Type curves, etc.)
- Test evaluation data (Reservoir pressure, PI actual, PI ideal, permeability, skin, wellbore storage, etc.).
- For multi-rate gas well testing: Well deliverability at 100 psi drawdown and non-Darcy turbulence factor. Petrophysical input data (porosity, compressibility, drainage height, etc.)

6.4.5 MATERIAL BALANCE ANALYSIS

- Historical performance/pressure vs. simulated data plot; fluid contact movement plot (incl. water breakthrough data per well).
- Aquifer type and parameters. Comparison of aquifer parameters with overlying/underlying reservoirs.
- Forecasted production (oil/gas/water) data including assumptions with justification and fluid contact movements per reservoir (Tables and plots)

6.4.6 DEVELOPED RESERVES (DUR) ASSESSMENT

- Production/log oil cut extrapolated performance plots per drainage point and reservoir block.
- Cut-off criteria for DUR (watercut, min. economic hydrocarbon rate, gross rate, min. bottom hole pressure)
- Production forecast (yearly averaged daily rates of oil, gas and water) per well/reservoir.
- Tabulation of low, medium, high DUR volumes per drainage point and reservoir.
- Update of DUR database.
- Cross-check of DUR volumes with ARPR Ultimate Recovery values.

6.4.7 RESERVOIR SIMULATION MODELLING

- Static model description.
- Uncertainty analysis (parameters having impact on simulation predictions such as volumetrics, connectivity, permeability levels and distribution, aquifer response and fluid properties) for multiple scenario modelling approach.
- Tables and Figures of capillary pressure and three phase relative permeability data per lithology.
- Fluids in place tabulations for each of the static model realisations (oil and gas per layer for (gridblock) model(s)).
- Comparison of model derived Fluids in Place volumes with ARPR data and explanation of changes.
- Dynamic model description (incl. aquifer placement).
- Reservoir Simulation model QA/QC. Figures showing comparison of permeability levels for (gridblock) model(s) for selective layers and cross-sections. Histograms showing porosity and permeability distribution for (gridblock) model.
- Reservoir simulation model history match. Short description of well matches incl. matching criteria for pressure, oil, gas and water. Figures showing historical vs. simulated performance (pressure, oil, gas and water) per well and per reservoir. Table with cumulative oil/gas and water production per well and reservoir (in standard surface volumes and in reservoir barrels)
- No Activity Forecast for existing wells (Figures and Tables with yearly averaged daily rates of oil, gas and water per well/reservoir).
- Optimum Reservoir development Forecast (Yearly averaged daily rates of oil, gas and water per drainage point in Table and Figure format).
- Tabulation of UR variations for various development options and surface production constraints
- Tabulation of new drainage point data [objective, subsurface co-ordinates, initial potential (range), reward (range) and major uncertainties (e.g. structural, oil saturation)].
- Saturation plots for selective layers and cross-sections at end history match, end of life cycle "No Activity Forecast" and end of life cycle "Optimum Development forecast".
- Analysis of displacement mechanism(s), stability of G/O, W/O displacements related to, e.g., heterogeneities, aquifer drive characteristics.

- Quantification of uncertainty in model predictions (Tabulation of UR sensitivity towards main static model uncertainties (Optimum Development Case only).
- Development plan, well surveillance plan and special data acquisition (SCAL, PVT)

6.4.8 PROJECT CLOSE-OUT

- Field Study report (paper copies and CD-Rom)
- Transfer of pertinent data into corporate databases.
- Installation and testing of simulation models.

6.5 PRODUCTION SENARIOS:

6.5.1 DATA COLLECTION AND QC

- An inventory of available data: well histories (drilling, initial completion, workover and TT re-entries), completion diagrams, BHP data, production test data and plots, PI, flowstation reports, surveillance reports, reservoir properties (API gravity, viscosity, temperature, Bo) and logs (PDLs, Sonic).
- Compiled checklist of what is available against requirement.

6.5.2 INITIAL DATA ANALYSIS

Unreconciled and reconciled production data should be reviewed. Sound engineering judgement to be used to screen production anomalies.

Deliverables:

- Production plots per well, per field.
- A listing of Production data (rates, THP, GOR, BSW) errors or inconsistencies.
- Analyses of data.

6.5.3 BHP, PI AND WELL TEST DATA ANALYSES

The validity of bottom hole pressure and temperature, PI, and well tests data to be assessed.

Deliverable:

- Provide an analysis, evaluation, validation and a review of PI, BHP&T surveys, well test data with recorded comments and approved interpretation.
- Well testing follow up.
- Provide a list of any remedial actions to improve well production or injection

6.5.4 WELL REVIEW AND WELL REVIEW DOCUMENTATION

- Attend a well review meeting with other field team employees from other disciplines regularly.
- Document the well review.

6.5.5 WELL HISTORY GENERATION

Review of well completion, workover and drilling reports, programmes and summaries for consistency. Missing or anomalous data should be addressed. Ensure the completion diagram is the latest version. Notes must be made of data that are missing and the assumptions made to fill in the data gaps.

Deliverables:

- A complete set of well data sheets for all wells in the field.
- Well completion and current status summary.

6.5.6 WELL PERFORMANCE ANALYSIS

Using the generated well history and well completion status overview, production performance evaluation on a drainage point basis should be carried out.
Investigate (reservoir or mechanical reasons) why a well is under or over performing at various stages of its producing life.

Deliverables:

- *Recommendations to rectify any production problems as well as further production optimization activities.*
- A table of drainage point evaluation, results and recommendations for short term action points. (This list provides a starting point for production optimization e.g. TT repair, stimulation, bean-up and other through tubing or CTU activities to increase field production).
- Estimated production gain from each activity
- Detailed program for each activity execution.

6.5.7 INITIAL WELL MODELLING (INFLOW AND OUTFLOW)

Each major reservoir should be modeled and evaluated with WePS/ HORVIP.

Deliverables:

- Well calibrations and models.
- Preliminary lift tables for the reservoir engineer for use in simulation
- *Watercuts at which wells will no longer flow naturally.*
- Artificial lift requirement.
- Assessment and selection of artificial lift.
- Well head abandonment pressure

6.5.8 FACILITY DATA REVIEW

Flow station layouts and reconciliation reports as well as engineering diagrams of the main separators and flow stations are the main source of data to assess facility and identify system de-bottlenecking opportunities.

Deliverables:

- Brief description / overview (or schematics) of the existing production and gathering facilities (flowstation).
- Statement on the capacity of existing surface production facilities and identification of possible de-bottlenecking opportunities to cater for additional production.
- Well head abandonment pressure for the field and the wells

6.5.9 DETAILED MODELLING & WELL DESIGN

- *Carry out well modeling using to accurately represent the well/ reservoir and to predict future performance of the drainage points.*

Deliverables:

- Assessment of completion efficiency of existing drainage points.
- Natural flow limit of existing wells.
- Estimated production rates for proposed repairs, re-completions or new wells.
- Optimum tubing size for proposed new completions / well repairs
- Estimated maximum water-cut levels that existing wells can sustain on natural flow.
- Lift tables for reservoir simulation. The lift tables generated should cover a wide range of operating conditions expected over the life of the field.

- Detailed well models.
- Assessment of various well designs and selected options (conventional, horizontal, ML wells).

6.5.10 STIMULATION AND WATER SHUT OFF REQUIREMENT

Indications of reservoirs requiring stimulation methods to flow as a result of declining reservoir pressure or increase in watercut. The advantages and disadvantages of various types of Stimulation and water shut off methods to be discussed.

Deliverables:

- List of reservoirs that require stimulation and water shut off in the short and medium term with inflow /outflow output as supporting evidence.
- Preferred choice of stimulation and water shut off methods.
- Detailed work program for these jobs.

6.5.11 FINAL SHORT-TERM OIL/GAS GENERATION AND DEVELOPMENT ACTIVITIES

Short term gas (or oil) generation activities (e.g. repair, stimulation and other through tubing activities, etc.) can now be firmed up.

Deliverables:

- A table of short-term oil / gas generation activities with descriptions of the proposed activities and their associated oil / gas gain.
- A table of development activities.

6.5.12 REQUIREMENT FOR NEW FACILITY

New facilities required to handle the production forecasts (oil, gas and water) should be identified.

Deliverables:

- A list of recommended new facilities required to handle additional fluids from the proposed development scenarios.

6.5.13 REPORT

Report should be integrated with sections from other disciplines.

6.5.14 CLOSE OUT AND DATA TRANSFER

At the end of the project, it is essential to save valuable data including well models. All the data should be saved electronically as much as possible. Data should be compatible with the corporate databases.

6.5.15

- Sending a specialized technical team consisting of five members to the offices of the studying company to discuss the static model and the findings achieved during the first phase.
- Sending a specialized technical team consisting of five members to the offices of the studying company to discuss the dynamic model, The surface facilities and equipment from the well to the station, discussing abandonment pressure for the wells, installing suitable compressors, and adopting the reservoir study after addressing the observations made by the technical team.

Deliverables:

- Final report.

7 PROPOSAL REQUIREMENT

CONTRACTOR is required to submit technical proposal in the following format:

T-1) introduction
T-2) CONTRACTOR Organization Chart
T-3) Key Personnel Resume
T-4) Project management
T-5) Execution plan

T-1) Introduction:

CONTRACTOR is required to demonstrate a comprehensive understanding of the scope of work.

T-2) Organization Chart:

CONTRACTOR is required to provide a general organization chart schematic and a specific organization chart for conducting the work as specified in Scope of Work.

T-3) Key Personnel Resume:

CONTRACTOR shall provide a team of technically qualified and experienced personnel to perform this reservoir study in accordance to international standards.

T-4) Project management:

CONTRACTOR is required to provide project management plan demonstrating its ability to provide required equipment and services within time schedule.

T-5) Execution plan:

CONTRACTOR is required to provide an execution plan (with all technical documents for above division which mentioned in special terms and condition) showing that all the works shall be executed in strict conformity with the provisions of the contract documents and with such explanatory detailed drawings, specifications, and instructions as may be required. CONTRACTOR is required to show its responsibility for ensuring that works throughout are executed in the most substantial, proper and workman in strict accordance with close out of each above main items.