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Section 2: Well and Reservoir Management

2.1 Introduction

This section provides Contractor(s) with the basic framework of the well, and reservoir management guidelines for the following:

- Continuous acquisition of well and reservoir data, and monitoring and analysis of well and reservoir performance with reasonable accuracy and as appropriate throughout field life cycle;
- Periodic reviews and studies for further development or ongoing reserves and production optimisation;
- Guidance on initial RMP and RMP review;
- Management of wells including strings and time-bound limits for well plug and abandonment;
- Approval requirements for Production Enhancement and IWR proposals;
- Objective driven surveillance requirements; and
- Maintenance or keeping of accurate records pertaining to all well and reservoir related data for submission in accordance with Volume 11, Section 4. An accurate well test and other reservoir and production related data shall be obtained in accordance with the requirements outlined in the relevant sections in this Volume.

2.2 Stages of Reservoir Management

2.2.1 Early Depletion Stage

Contractor(s) shall operate in a manner that is consistent with the optimum reservoir management strategy of the field as approved in the FDP. Contractor(s) shall ensure that prudent reservoir management policies or strategies are implemented at all times. The reservoir management strategy shall be revised or modified for any new data that is acquired during the initial development stage, if required. Upon new data from FDP, the FFR may require revision.

During the production operations, Contractor(s) shall establish and maintain a database which includes but is not limited to production, pressure, reservoir(s) performance and data relating to reservoir(s) geological description. Contractor(s) shall update models and/or performance forecast if there is new data available. Contractor(s) shall also submit a proposal for PETRONAS’ approval if the reservoir(s)
performance and other data indicate that a different reservoir management strategy is required for optimum reservoir management, other than the approved RMP in the FDP. Contractor(s) shall conduct technical review with PETRONAS prior to submitting the proposal for PETRONAS’ approval.

Due to uncertain drive mechanism and in accordance with prudent management practices, all GOR controls or reservoir pressure controls, where appropriate, shall be addressed in the approved FDP. If significant uncertainty exists in the reservoir drive mechanism, the FDP should provide multiple scenarios that cover the potential range of reservoir drive mechanisms and reservoir descriptions, to anticipate the range of reservoir behavior.

However, if no studies have been conducted, the reservoir GOR shall be limited to one and a half times the solution GOR at initial reservoir pressure i.e. “1.5 x Rsi” during the initial production stage.

Contractor(s) shall obtain PETRONAS’ approval for a revision of the GOR limit with technical justification and in accordance with good industry practices, before increasing the reservoir GOR limit.

Reservoir depletion shall not exceed ten percent (10%) of developed EUR per year. Any depletion rate exceeding ten percent (10%) needs to be supported by techno-commercial studies and approved by PETRONAS.

### 2.2.2 Middle and Late Stages

Contractor(s) shall continuously gather and analyse reservoir(s) performance data and operate in a manner that is consistent with the optimum reservoir management strategy of the field, in accordance with Volume 8, Section 2.3.1.

Contractor(s) shall apply the appropriate reservoir management tools and/or techniques for analysing field performance. All new data that becomes available during the course of producing the field and reservoir(s) shall be used to compare actual performance of the field or
reservoir(s) to the forecasted in the FDP and appropriate revision to the RMP shall be submitted to PETRONAS for approval.

2.2.3 Improved and Enhanced Recovery

Contractor(s) shall look for opportunities to add reserves at all stages of reservoir depletion. Improved recovery methods such as infill drilling, secondary recovery, artificial lift improvement, idle well reactivations, or other recovery improvement strategies shall be implemented in cases when it is economically viable to employ improved recovery methods. Contractor(s) shall submit the improved recovery program in the FDP or FDP revision for PETRONAS’ technical review and approval.

For fields with water injection or gas injection, Contractor(s) shall conduct voidage replacement analysis and volumetric sweep analysis of each reservoir(s) and present a summary of the results to PETRONAS on an annual basis, as part of AMIR. For water and immiscible gas injection, the voidage replacement policy of each reservoir(s) shall be determined by the optimum reservoir management strategy of the field and/or a group of fields sharing the same infrastructure.

Contractor(s) shall screen for enhanced recovery development opportunities during the initial FDP and/or investigate this as part of the FFR.

At any stage of depletion, Contractor(s) may seek PETRONAS’ approval for the application of enhanced recovery techniques.

Contractor(s) shall examine the potential for reserves optimization and geo-sequestration of GHG through immiscible and miscible CO₂ injection into fields that contain gas reservoirs with a high CO₂ content.

2.2.4 Gas Cap Blowdown

Gas cap blowdown opportunities shall be assessed in FFR and volumes, timing, and profile shall be captured in ARPR. RMP and operating strategy should include considerations for future gas cap blowdown. Further details on ARPR shall be referred to Volume 4, Section 2.
If gas cap volume is not a part of Contract Area as defined in the Contract, Contractor(s) may approach PETRONAS with notional development plan and associated value for commercial discussions.

2.3 Well and Reservoir Management Plan

Contractor(s) shall submit RMP and TWM plans to PETRONAS for approval on annual basis through AMIR. The content shall include, but is not limited to the following:

2.3.1 Reservoir Management Plan (RMP)

RMP shall include the various recommended operational conditions that have been developed during the field development stage with the purpose of maximizing the reserves or recovery.

The RMP shall be reviewed periodically during the production phase of the reservoir(s). Contractor(s) shall conduct a study to update the RMP if there is any deviation of reservoir performance from the predicted performance and to incorporate newly acquired data. Contractor(s) shall also provide PETRONAS with an updated simulation model of the reservoir(s) as and when requested in order to facilitate the review of the revision or update to the RMP. Any other technical study that supports the justification to revise or update the RMP shall also be submitted.

RMP review shall be required by Contractor(s) based on the following triggers:

a) Any changes in STOIIP/EUR or any changes in understanding of potential compartmentalisation and connectivity pattern;
b) If average reservoir pressure is not meeting the target as per RMP;
c) Any variation in areal or vertical fluid contact from expectation;
d) Any change in fluid or reservoir(s) VRR from RMP expectation;
e) Deviation in field or reservoir(s) decline rate from agreed or expected decline rate;
f) Unexpected variation in productivity index, injectivity index, drawdown and injection tubing head pressure;
g) Sand or fines production more than specified in RMP; and
h) Any change in topside or Facilities capacity or efficiency.
Any revision or update to the RMP requires PETRONAS’ approval prior to the implementation as stipulated in Volume 8, Appendix 1.

2.3.2 Well Flow Assurance Management

Contractor(s) shall ensure reliable and continuous flow of production stream from the formation to the processing Facilities, and of injection stream from processing Facilities to the formation.

Contractor(s) shall prevent and remove any obstruction to flow for example wax, asphaltene, scale, hydrate and sand that could cause suboptimal production or injection in order to maintain the integrity of the conduit.

Contractor(s) shall include integrated flow assurance studies or assessment in the FDP and shall be reviewed periodically or when the new information is available during production.

2.3.3 Total Well Management (TWM) Plan

Contractor(s) shall present TWM plan to PETRONAS on annual basis, or as required by PETRONAS. Wells may have single or multiple strings and Well Management shall include all strings covering well design from initial completion until abandonment.

TWM shall focus on, but not limited to the following:

- a) Production enhancement from active wells;
- b) Reactivation of idle wells;
- c) Minimising and controlling growth of idle strings;
- d) Locked in potential monetisation;
- e) Success rate for PE/IWR jobs;
- f) Overall well integrity performance;
- g) SWAP for wells with no remaining economic potential or with well integrity issue; and
- h) Abandonment of wells.

Further details on overall well integrity management performance shall be referred to Well Integrity Management Guidelines in Volume 7, Section 8.
PETRONAS may impose Well Management targets and/or other KPIs for Contractor(s) during AMIR. Contractor(s) shall prepare the action plan to implement the approved TWM plan and to include that plan in WPB.

Contractor(s) shall submit monthly Well Management data and reports comprise of actual performance against the KPI and/or targets. Further details shall be referred to Volume 11, Section 4.

### 2.3.3.1 Strings Classification

In general, strings refer to tubing that serves as the conduit through which oil and gas are brought from the producing formations to the field surface Facilities for processing.

Strings are classified into three (3) main categories, namely active, idle, and abandonment.

a) Active: string or well that is either flowing or injecting continuously or intermittently;

b) Idle: string or well that does not flow for ninety (90) consecutive days or more; and

c) Abandonment: well that has been declared of no further economic potential and has approved plan for either well abandonment or future wellbore utilisation. Dual string completion must have both strings declared to have no further economic potential. Abandonment category is further divided into five (5) sub-categories:

i. SWAP-1;

ii. SWAP-2A;

iii. SWAP-2B;

iv. Partial Well Abandonment or Partial P&A; and

v. Full Well Abandonment.

Further details of the abandonment sub-categories are defined in Volume 8, Section 2.3.3.3.

Refer to MPM Well Classification Guideline in Volume 8 Appendix 12 for further information on classification of strings.
2.3.3.2 Strings Performance and Status Submission

Contractor(s) shall update and submit to PETRONAS the monthly status and performance of each string under the three (3) categories indicated in Volume 8, Section 2.3.3.1. Contractor(s) shall carry out the necessary due diligence and quality checks prior to the submission to PETRONAS. Further details on the submission requirements shall be referred to Volume 11, Section 4.

2.3.3.3 Subsurface Well Abandonment Plan (SWAP)

SWAP is an official document issued by PETRONAS to Contractor(s) certifying that the well abandonment shall take place, either for permanent plug and abandonment or for partial well abandonment prior to any sidetrack and/or slot recovery. Detailed description and requirements are as follows:

a) SWAP-1

Well without remaining economic reserves or production, and/or well with integrity issues which are uneconomic to remediate, to be permanently plugged and abandoned.

SWAP-1 proposal shall include and fulfil but not limited to the following information and PETRONAS’ approval shall be obtained through AMIR:

i. Prove that reserves in the existing zones are depleted, or not economically feasible to be produced or extracted;

ii. Prove that there is no behind casing opportunities (BCO), or BCO is not economically feasible to pursue, or can be produced from another well;

iii. Complete well integrity risk rating as per WIMG;

iv. Outline well integrity monitoring and suspension plan;

v. Propose reservoir isolation requirements such as caprock or reservoir isolation for well abandonment; and

vi. Any other information as requested by PETRONAS.
b) SWAP-2A

Well with or without remaining economic reserves or production, which has an endorsed plan for future use as a donor well such as for sidetrack and/or slot recovery through ADIR Milestone Review #4 (MR#4).

SWAP-2A proposal shall include and fulfil but not limited to the following information and PETRONAS’ approval shall be obtained through AMIR:

i. Prove that reserves in the existing zones are depleted, or not economically feasible to be extracted, or that the proposed alternative wellbore utilisation opportunity has higher value than remaining opportunities in the existing wellbore;

ii. Prove that no BCO exist or BCO are not economically feasible to pursue or can be produced from another well;

iii. Define future wellbore utilisation opportunity such as for sidetrack and/or slot recovery and provide supporting documentation indicating valid plan to support future wellbore utilisation as endorsed in MR#4. The estimated date of wellbore future use should be included;

iv. Complete the well integrity risk rating as per WIMG;

v. Outline well integrity monitoring and suspension plan;

vi. Propose reservoir isolation requirements such as caprock or reservoir isolation for well abandonment; and

vii. Any other information as requested by PETRONAS.

c) SWAP-2B

Well without remaining economic reserves or production, and with possible future use as a donor well such as for sidetrack and/or slot recovery but has no
endorsed plan through ADIR. Decision to either fully abandon or to utilise the wellbore as a donor well such as for sidetrack and/or slot recovery shall be based on project maturation through ADIR.

SWAP-2B proposal shall include and fulfil but not limited to the following information and PETRONAS’ approval shall be obtained through AMIR:

i. Prove that reserves in the existing zones are depleted, or not economically feasible to be extracted;

ii. Prove that no BCO exist or BCO are not economically feasible to pursue or can be produced from another well;

iii. Define future wellbore utilisation opportunity such as for sidetrack and/or slot recovery and provide supporting documentation indicating valid plan to support future wellbore utilisation in the following documents, for example FFR, Opportunity Framing, AVF, AMIR. The estimated date of wellbore future use should be included;

iv. Complete the well integrity risk rating as per MPM WIMG;

v. Outline the well integrity monitoring and suspension plan;

vi. Propose reservoir isolation requirements such as caprock or reservoir isolation for well abandonment; and

vii. Any other information requested by PETRONAS.

d) Partial Well Abandonment or Partial P&A
Well that is isolated with permanent barriers as stipulated in Volume 7, Section 8 and 9. Barrier placement shall be verified and tested in accordance with Volume 7, Section 9 where tubing shall be cut and retrieved if barrier verification could not be satisfied with tubing in place. Well is secured with either existing leak tight christmas
tree or with suspension cap. The scope of partial P&A shall also include rectification of well integrity issue(s). Remainder of P&A scope such as cutting and pulling casing strings and placing surface plug, will be completed during Full Well Abandonment;

e) Full Well Abandonment
Well that is permanently plugged and abandoned in accordance with Volume 7, Section 8 and 9, with tubing and casing strings cut below the seabed and removed, christmas tree and wellhead removed and surface plug set in place. Site shall be restored at environmentally stable condition and protected from any future leakages. Any deviation from full well abandonment scope as defined in this Volume shall require PETRONAS’ approval prior to its execution.

Further details on the requirements for Partial and Full Well Abandonment shall be referred to Volume 7, Section 9.

PETRONAS may issue SWAP-1 or SWAP-2B certificate for well(s) classified as non-economic idle with idle duration greater than one (1) year, well(s) in “Orange” or “Red” category as per WIMG or active well(s) producing at uneconomic rates. Further details as per below:

a) For non-economic idle well without high well integrity risk, Contractor(s) is required to provide justification and obtain approval from PETRONAS that the well has remaining economic reactivation potential within six (6) months of SWAP certificate issuance date. If no approval from PETRONAS is obtained for the proposed idle well rectification activity, well shall remain in assigned SWAP-1 or SWAP-2B category. If approval for reactivation is obtained from PETRONAS, Contractor(s) shall complete the reactivation work within twelve (12) months.
b) For any well with high integrity risk of "Orange" or "Red" category as per WIMG, Contractor(s) is required to provide justification and obtain approval from PETRONAS that the well has remaining economic potential for integrity rectification within three (3) months of SWAP certificate issuance date. If no approval from PETRONAS is obtained for the proposed idle well integrity rectification and reactivation, well shall remain in the assigned SWAP-1 or SWAP-2B category. If approval for reactivation is obtained from PETRONAS, Contractor(s) shall complete the rectification and reactivation work within twelve (12) months.

c) For any active well producing at uneconomic rate, Contractor(s) is required to provide justification and obtain approval from PETRONAS that the well is economic to continue to produce or has economic production enhancement potential, within six (6) months of SWAP certificate issuance date. If no approval from PETRONAS is obtained, well shall remain in the assigned SWAP-1 or SWAP-2B category. If approval from PETRONAS is obtained, well shall remain in active category and Contractor(s) shall continue production from the well.

The analysis of well economic viability shall include estimated production revenue and cost to the end of Contract period, including well abandonment costs.

Further details on SWAP shall be referred to SWAP Guideline and for details on WIMG shall be referred to Volume 7, Section 8.

2.3.3.4 Time Bound Limits for Wells

Contractor(s) shall comply with time bound limits for wells to remain under "Idle" or "Abandonment" categories, which are specified as follows:

a) Idle well category
i. Effective / Non-Effective Idle well shall not remain “Idle” for more than three (3) years and shall either be reactivated or moved to abandonment category within this time frame. For wells with multiple strings, well is considered Effective / Non-Effective Idle if one (1) of the idle strings is classified as Effective Idle or Non-Effective Idle, and the three (3) years duration shall be applied when all strings become idle; or

ii. Non-Economic Idle well shall not remain “Idle” for more than one (1) year and shall either be reactivated or moved to abandonment category within this time frame. For wells with multiple strings, well is considered Non-Economic Idle if all idle strings in the well are classified as Non-Economic Idle, and the one (1) year duration shall be applied when all strings become idle.

b) Well with integrity issues

i. Well integrity issues must be rectified as soon as possible within one (1) year from the date that the well is categorised as “Orange” or “Red” as per WIMG, if the remaining reserves are economic; or

ii. If the well integrity issues is beyond remediation by well intervention or workover or if there is no economic potential remaining, the well must be abandoned as soon as possible within one (1) year from the date that the well is categorised as “Orange” or “Red” as per WIMG, or within one (1) year from the date of SWAP-1 issuance or before Contract expiry, whichever is earliest.

c) SWAP-1 Well Category

i. Full Well Abandonment shall be completed within three (3) years from the date of SWAP-1 issuance or before Contract expiry, whichever is earliest; or
ii. For SWAP-1 wells with high well integrity risk classified as “Orange” or “Red” as per WIMG, Full Well Abandonment shall be completed within one (1) year from the date of SWAP-1 issuance or before Contract expiry, whichever is earliest.

d) SWAP-2A Well Category

i. Partial Well Abandonment for donor well preparation shall be completed based on timeline agreed upon in MR#4, within five (5) years from the date of FDP approval or before Contract expiry, whichever is earliest;

ii. If approved SWAP-2A well utilisation opportunity is cancelled or not executed, status of the well shall be reverted to the status recommended by AMIR at the time of SWAP-2A issuance; and

iii. In the case of reclassification from SWAP-2A to SWAP-1 or SWAP-2B, the date for time bound limit shall be based on SWAP-2A issuance date.

e) SWAP-2B Well Category

i. Partial Well abandonment shall be completed within three (3) years from the date of SWAP-2B issuance or before Contract expiry, whichever is earliest; or

ii. For wells with high integrity risk classified as “Orange” or “Red” as per WIMG, Partial Well Abandonment shall be completed within one (1) year from the date of SWAP-2B issuance, and the partial abandonment scope shall include mitigation of well integrity issues;

iii. If there is no endorsed plan for project within five (5) years of SWAP-2B issuance or if donor well plan is cancelled, remaining scope of Full Well Abandonment shall be completed within six (6) years from the date of SWAP-2B issuance or prior to Contract expiry, whichever is earliest.
Contractor(s) shall keep the updated records of time period for each of the string being in a category other than active string.

Contractor(s) shall submit action plan in meeting the time bound limits for the strings’ categories in TWM plan and to include the approved action plan in WPB.

Further details on WIMG shall be referred to Volume 7, Section 8 and details on SWAP shall be referred to SWAP Guideline.

2.3.3.5 Well Abandonment Plan

Contractor(s) shall submit a well abandonment plan for PETRONAS’ approval within the time frame stipulated below:
   a) Well with low integrity risk: within twelve (12) months from the issuance of SWAP certificate;
   b) Well in “Orange” or “Red” category: within six (6) months from the issuance of SWAP certificate; and
   c) Well which poses threat to safety of people, Facilities, and environment: submission of well abandonment plan is waived if the work must commence within forty-eight (48) hours. PETRONAS must be notified before the work is performed. The request for approval shall be submitted as soon as possible, and approval from PETRONAS shall be obtained within two (2) weeks of commencing work.

The format and content of the well abandonment plan shall follow the format as per Abandonment Review (AR) process. Further details on AR process shall be referred to Volume 9. The well abandonment plan shall be approved by PETRONAS prior to the execution of the work.

2.3.4 Artificial Lift Plan

Contractor(s) shall evaluate effectiveness of existing artificial lift system. Contractor(s) should also assess alternative artificial lift strategy for existing well(s) in a field and apply alternative artificial lift strategy when it
is economically viable to do so. Assessment process shall compare major artificial lift methods such as gas lift, ESP and jet pump.

Artificial lift selection should consider, but not be limited to, the following:

a) Well condition and productivity;

b) Reservoir pressure and fluid properties;

c) Long term reservoir performance and facility requirements;

d) Current and future constraints with existing artificial lift strategy;

e) Evaluation of potential incremental reserves recovery from alternative artificial lift method;

f) Evaluation of initial costs, lifecycle operating costs, production capabilities and well economics; and

g) Evaluation of advantages and disadvantages of each method.

2.4 Production Enhancements (PE) and Idle Well Reactivation (IWR)

Contractor(s) shall take action to improve the productivity and injectivity performance of active wells where economical and reactivate idle wells with remaining economic potential.

PETRONAS shall set targets or KPIs annually for carrying out PE and IWR for Contract Area.

Contractor(s) shall include PE and IWR activities as approved by AMIR in TWM plan and WPB.

2.4.1 Well selection and approval for PE and IWR

Contractor(s) shall carry out due diligence in selecting the candidate wells and techniques for PE and IWR activities in accordance with Candidate Selection Guideline for PE and IWR Jobs, issued by PETRONAS.

Contractor(s) shall obtain PETRONAS’ approval for any PE and IWR activities on well, whenever the:

a) Estimated cost of proposed activities is greater than Ringgit Malaysia one million (RM1,000,000) per string;

b) Activity includes adding new perforations in the well;

c) Activity includes any cementation job; and
d) Activity includes isolating existing perforated interval or HC zones completed in a well permanently or irreversibly.

PE and IWR activity proposal shall consist of all sub-activities required to achieve the desired objective(s) of the activity for PETRONAS’ approval and cost criteria shall be based on total cost of all sub-activities for PE or IWR activity.

The proposal for PETRONAS’ approval shall be prepared in accordance with Candidate Selection Guideline for PE and IWR Jobs issued by PETRONAS and shall be submitted a minimum of one (1) month prior to job execution.

Approval requirements for workovers are listed in Volume 8, Appendix 1. Additional guidelines with respect to workover and well intervention operations are provided in Volume 7, Section 10.

Further details on selection for PE and IWR shall be referred to Candidate Selection Guideline for PE and IWR Jobs in Volume 8, Appendix 13.

2.4.2 Reporting of PE and/or IWR Plans and Results

PE and/or IWR plans by string and results of completed PE and/or IWR activities including actual cost and gain shall be submitted in ODU within four (4) months of job completion. Further details shall be referred to Volume 11, Section 4.

2.4.3 Reporting the Results of Well Intervention and PE activities, Post Job Analysis (PJA) and Lessons Learned (LL)

Contractor(s) shall report all well intervention and PE activities results to PETRONAS.

Contractor(s) shall conduct PJA and prepare a report containing LL as per the PJA and LL guidelines issued by PETRONAS for PE, IWR, surveillance and all other well intervention activities for which PETRONAS’ approval was obtained. For jobs which did not require PETRONAS’ approval and failed, PETRONAS may request Contractor(s) to submit PJA and/or LL report.
The PJA and LL Report shall be submitted to PETRONAS in the portal smart.petronas.com within four (4) months of job completion.

Report submission requirements for PE and/or IWR activities described in this Section and Volume 7, Section 10 are summarized in Table 2.4.3-1 below:

Table 2.4.3-1: Post Job report submission requirements for PE and/or IWR

<table>
<thead>
<tr>
<th>Report</th>
<th>Submission Criteria</th>
<th>Report Submission</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Well Report as per Volume 7, Sec. 10.5.2.3</td>
<td>All interventions that require PETRONAS approval.</td>
<td>Within 2 months</td>
<td>Submission to PETRONAS through MPM RDM</td>
</tr>
<tr>
<td>Post PE and/or IWR Results Submission in ODU</td>
<td>All PE and/or IWR activities</td>
<td>Within 4 months</td>
<td>Actual job cost and production profile, input into ODU</td>
</tr>
<tr>
<td>PJA and/or LLR Report</td>
<td>All interventions that require PETRONAS approval</td>
<td>Within 4 months</td>
<td>Submission to smart.petronas.com</td>
</tr>
</tbody>
</table>

2.5 Well Test and Surveillance

2.5.1 Introduction

This section provides the scope and requirements for the information to be acquired from development or production wells, for well and reservoir performance monitoring or management, and production allocations.

It also outlines the surveillance and data acquisition requirements for reservoir and Well Management.

2.5.2 Expectation and Aspiration

Contractor(s) shall continuously acquire data from the well(s) and perform analysis as required to prudently manage the well(s) and reservoir(s) of each developed field throughout its producing phase, in order to maximize the value of the field.
The well and reservoir surveillance shall be reservoir(s) and field specific and driven by the objective(s) of reduction of uncertainties in well or reservoir management, well and reservoir modelling, RMP optimization and/or well problem analysis. All the data acquisition or surveillance activities shall be justified based on any of the above objective. Approval for annual surveillance plan shall be obtained in AMIR.

2.5.3 Process and Procedures

2.5.3.1 Production Test

Contractor(s) shall conduct a well production test as soon as stable flow is established from a string and no later than thirty (30) days from the date of first continuous production upon initial completion, recompletion or producing interval change, reactivation from idle status, or after completion of production enhancement job.

Subsequently, Contractor(s) shall carry out monthly production tests on each active string.

Additional production tests shall be conducted when a new choke size is applied, production enhancement activity is completed, when considerable change of well performance is observed, or when there is significant deviation from expected performance.

After completion of a well test, well test results should be validated as soon as possible, not exceeding a total of seven (7) days from the date of well test.

A shut-in strings’ production rate shall be tested if required by an objective.

Interval between production tests on strings(s) may be extended beyond monthly if the Contractor(s) can:
   a) Prove with justification that string production rate can be accurately predicted with alternate prediction methods
and the rest of the parameters like water cut and GOR have not changed; and
b) Justify that testing the string(s) on monthly basis poses unacceptable risks and costs.

Request to increase the interval between production test on string(s) shall be submitted to PETRONAS for approval.

Contractor(s) shall record, keep and submit to PETRONAS the accepted production tests data. The production test report shall be submitted to PETRONAS as specified in Volume 11, Section 4.

The flow measurement devices used for well testing purposes, including the measurement of injection and produced gas, shall have an accuracy of at least +/- ten percent (10%). Pressure measurement devices should have a minimum accuracy of ten (10) psi.

Contractor(s) shall calibrate all the measurement devices at least annually or at a shorter interval when deemed necessary, to ensure the required accuracy.

2.5.3.2 Well Surveillance

Contractor(s) shall either continuously monitor, or monitor at sufficiently high frequency, the production and injection well(s) to ensure it is in an optimum condition.

The requirement for a monitoring program shall include, but not limited to the following parameters:
   a) FTHP, FTHT, flowline pressure and temperature;
   b) Annulus pressures;
   c) Bottom hole flowing pressure and temperature;
   d) Artificial lift parameters: gas lift injection rate, gas lift;
   e) Injection pressure and temperature, ESP parameters such as frequency, current, discharge pressure, intake pressure and temperature, motor temperature, motor vibration;
f) Injection rate, injection pressure and temperature;
g) Injection water quality including toxicants; and
h) Sand count.

2.5.3.3 Reservoir Surveillance

Contractor(s) shall design and propose an annual surveillance program for each reservoir which is aligned with RMP and Well Management and optimization strategy. This program shall specify the objective, analysis, data acquisition requirement such as value generated by data acquisition and the monitoring plan.

This annual surveillance program shall subject to PETRONAS’ approval as part of the FDP and subsequently the annual field management review through AMIR.

Contractor(s) shall include the approved annual surveillance program in WPB for the following year.

For any surveillance activity greater than Ringgit Malaysia one million (>RM1,000,000) per string, Contractor(s) shall submit more detailed justification for the activity and obtain PETRONAS’ approval.

Contractor(s) shall submit the results, PJA and LL reports for surveillance activities for PETRONAS’ approval. Further details shall be referred to Volume 8, Section 2.4.2.

2.6 Record Keeping and Data Quality

Contractor(s) shall record and keep all acquired data and analysis reports resulted from the monthly production tests and the surveillance program and submit to PETRONAS in accordance with Volume 11, Section 4.

Contractor(s) shall ensure that all data and information generated from well tests and reservoir surveillance are validated.
2.7 Production Allocation

2.7.1 Production Allocation to Each Producing String

Contractor(s) shall carry out production allocation of oil, gas, condensate (if applicable), and formation water for each string for each month within thirty (30) days after the end of the month.

2.7.2 Production Allocation to Each Producing Interval

The monthly production allocation of oil, gas, condensate (if applicable), and formation water assigned to each string shall be allocated to individual producing zones. The allocation shall be validated periodically through proper surveillance data. The production allocation or validation procedures shall follow industry best practices or standards.