

## CHAPTER 5 – WELL PLUG AND ABANDONMENT

The content of this chapter is more specific for well plug and abandonment (well P&A) activity and it applies to both onshore and offshore wells, unless specify. This chapter will provide guidance to the Duty Holder on the process flow associated with well P&A activity from the Declaration of Well Cessation of Production (or Operation) to submission of a Well Abandonment report.

---

## Contents

<b>1.0</b>	<b>INTRODUCTION.....</b>	<b>97</b>
<b>2.0</b>	<b>TECHNICAL REQUIREMENT.....</b>	<b>97</b>
2.1	Sub-surface Abandonment.....	97
2.2	Post Sub-surface Abandonment Monitoring.....	99
2.3	Surface/Seabed Abandonment .....	100
2.4	Well Signage - For Onshore Wells .....	101
<b>3.0</b>	<b>WELL PLUG AND ABANDONMENT SUBMISSION .....</b>	<b>102</b>
3.1	Well P&A Programme.....	102
3.2	Notification of Well Operation .....	102
3.3	D&R Notification.....	102
<b>4.0</b>	<b>WELL PLUG AND ABANDONMENT SUBMISSION PROCESS &amp; TIMELINE.....</b>	<b>103</b>
4.1	Well P&A Submission Process Flowchart .....	103
4.2	Well P&A Process Timeline.....	105
<b>5.0</b>	<b>ANNEX FIVE: WELL PLUG AND ABANDONMENT PROGRAMME TEMPLATE.....</b>	<b>106</b>

## 1.0 INTRODUCTION

When a well is no longer in use, either due to the well having ceased to produce (or operate) or when the well has reached the economic limit or due to some technical reasons during drilling operations or due to operational constraints or because it stopped being productive or failure of exploration well etc., then there is a requirement for the well to be permanently abandoned.

When wells are required to be permanently abandoned it involves partial components of the well to be removed and zones with different pressure regimes to be permanently isolated. The primary objectives of well P&A are as follows:

- Provide downhole isolation especially pressure
- Prevent migration of formation fluids between the zones and also to surface or seabed
- Protect fresh water aquifers from being contaminated
- Minimize interference from human activities post well P&A activity.

It is recognized, that each well design is unique depending on the individual well abandonment objectives. Over time, new techniques and technologies may also emerge and these will be considered on case by case basis.

## 2.0 TECHNICAL REQUIREMENT

The technical requirement in this guideline outlines the principle criteria to be considered when planning and executing the well P&A activity. In addition, the Duty Holder are also encouraged to explore various options and application of new technologies in designing and executing the well P&A.

### 2.1 Sub-surface Abandonment

The well abandonment design shall be based on an assessment of the subsurface isolation requirement and the well integrity conducted and documented by the Petroleum Engineers and assured by the company's subject matter expert. The subsurface assessment will provide justification for zonal isolation requirements and the well integrity assessment will identify the remedial actions required prior to any well abandonment activity commences.

The key elements to be considered by the Duty Holders are as follows:

- **Caprock Restoration**

Permanent isolation shall be done by restoring the Caprock penetrated by the well. Caprock or Shale is an impermeable rock, which is continuous over the field without natural or induced fractures. A permanent barrier shall be use to restore a suitable caprock and seal all fluid passage ways. It shall be positioned at a depth where the formation is impermeable and has a rock strength that can withstand the maximum anticipated pressure.

- **Type of permanent barrier**

Cement is currently used in wells as the prime material for abandonment. Mechanical barriers such as packer, bridge plug etc. are also commonly used as a firm support to prevent slumping of the cement slurry.

The permanent barrier shall have the following main characteristics.

- Impermeable
- Long term integrity
- Non shrinking
- Ductile (non-brittle) – able to withstand mechanical loads/impact
- Resistant to different chemicals/substances (H<sub>2</sub>S, CO<sub>2</sub> and hydrocarbons)
- Wetting, to ensure bonding to steel

- **Number and length of permanent barrier**

There shall be two barriers, each barrier of at least 30m (100ft) in length, to isolate potential outflow from the borehole to surface if the permeable zone is hydrocarbon bearing or over pressured and water bearing. The two permanent barriers may be combined into a single permanent barrier provided it is as effective, as reliable and achieving the objectives of the two independent barriers.

All permeable zones penetrated by the well that have different pressure regimes and with flow potential should be isolated from each other. Where there are unacceptable cross flow between the zones, there shall be a minimum of one barrier of at least 30m (100ft) in length to isolate those zones.

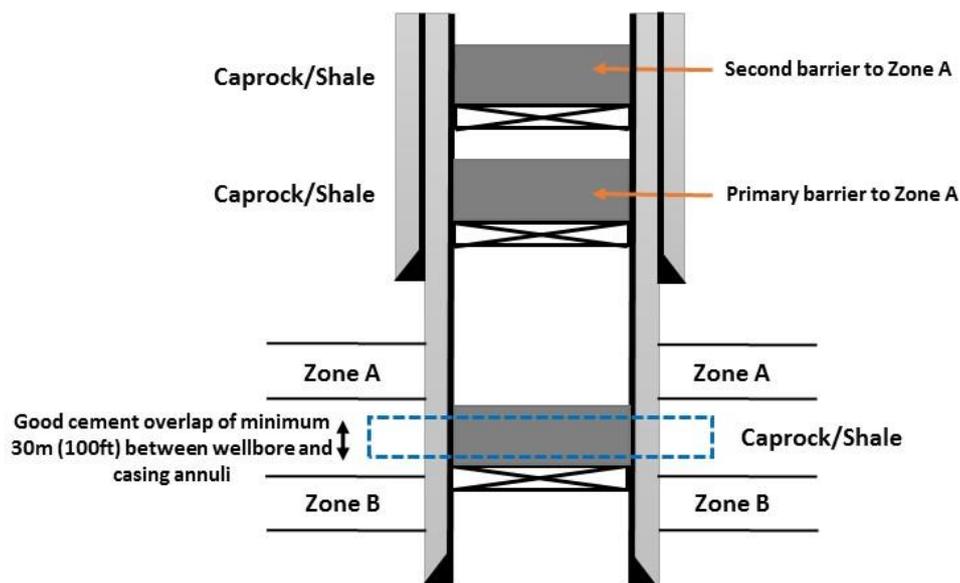


Figure 1: Example of Well P&A design in cased hole

Where there is an overlap between the cement plug in the wellbore and cement in the casing annuli, there shall also be overlap of at least 30m (100ft) in length of good cement (Figure 1).

- **Position of permanent barrier**

When selecting a suitable caprock for permanent isolation, it may be immediately above the permeable zone to be isolated or shallower and have the required sealing capability.

Where more than one permeable zones are being isolated, any potential cross flows from these zones must be acceptable by the respective Petroleum Engineers.

- **Open hole abandonment**

The same considerations to a cased-hole abandonment should be applied to open-hole abandonment. In addition to the permanent barrier set in the open-hole, an additional permanent barrier somewhere within the casing will be required, to fully seal the open-hole section (Figure 2).

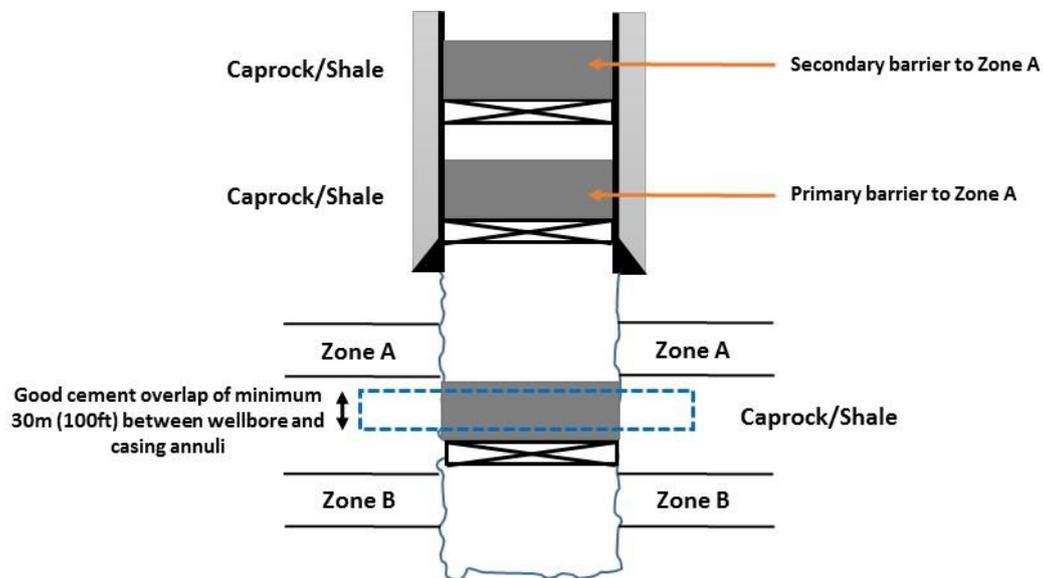


Figure 2: Example of Well P&A in open hole

- **Verification of a permanent barrier**

Once a barrier is in-place, it shall be verified to have the required sealing capability. Recommended form of verification is pressure testing or alternatively based on industry best practice. Verification shall conform to pre-defined acceptance criteria.

## 2.2 Post Sub-surface Abandonment Monitoring

It shall be the duty of every occupier of any workplace to take, so far as is reasonably practical, such measures to ensure that the workplace and any equipment kept at the workplace are safe (Workplace Safety and Health Order, 2009, as amended).

Prior to the removal of the wellhead, minimum of six (6) months monitoring is recommended based on risk assessment that is justified by the Duty Holder and agreed by the Authority. Well monitoring can be in any form e.g. visual inspection of bubbling, gas detection, pressure reading at wellhead etc. Records of the monitoring activity will be maintained by the Duty Holder.

In the event of any anomalies e.g. increase in pressure, gas detected etc., it is the responsibility of the Duty Holder to execute appropriate remedial actions. Subsequently, it is recommended to monitor again for a minimum period of 6 months until the wellhead is removed. The Authority may require additional monitoring depending on the severity of the anomalies.

### 2.3 Surface/Seabed Abandonment

Surface abandonment which includes removal of the wellhead and site restoration, to be executed after completion of the recommended well monitoring. Prior to surface abandonment, all annuli pressure shall be verified to confirm isolation and integrity.

For onshore wells, the well cellar are to be demolished to a depth that will not obstruct future use of the land (Figure 3b). All casing strings are to be typically cut off at a about 2m below the final contour elevation (though some situations may dictate cutting lower than this e.g. future land uses such as farming or urban development). Production or intermediate casing is plugged at surface with cement slurry on top of a wiper plug or a 1" thick steel plate welded across the casing (Figure 3a).



**Figure 3a: Abandoned well with steel plate**



**Figure 3b: Excavated site with cement to be backfilled**

Similarly for offshore wells, casing strings are to be retrieve to a about of 2m below the seabed or 2m below the maximum scouring depth whichever is deeper.

In principle, the onshore well location shall be restored to the final declared state. Any well equipment and tubulars left behind could be a hazard to public, an obstruction to public activities and should be disposed of by the Duty Holder in an environmentally friendly manner.



**Figure 4: Example of Well P&A Site Restoration**

## 2.4 Well Signage - For Onshore Wells

Once surface abandonment is completed, all abandoned wells are to be marked with a signage with information on the Well Name, the name of the Operator and completion data of well abandonment. The signage must be visible at all times and not affected by weathering. Physical signage remains a requirement until at a time of transfer of ownership, or the final declared state is achieved. Example of the signage is in Figure 5 below:

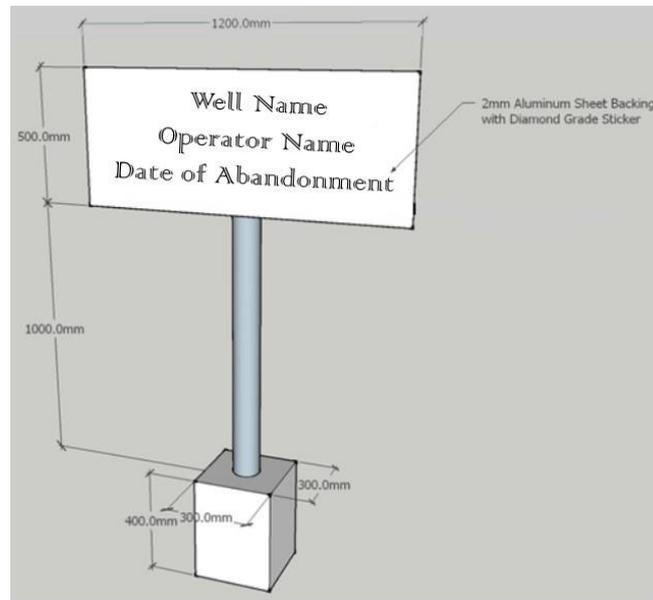


Figure 5: Example of Well P&A Signage

## 3.0 WELL PLUG AND ABANDONMENT SUBMISSION

The Well Plug and Abandonment Submission, shall be aligned to the requirements of the Control of Major Accident Hazards (COMAH) Regulations (Amendment) 2017.

The Duty Holder having received consent for the Declaration of Well COP (COO) from the Authority, shall in line with the COMAH requirements submit a 'Well P&A Submission'. The contents of the 'Well P&A Submission' consist of a total of three items to be submitted to the Authority as follows:

- (1) The Well Plug and Abandonment Programme, as per Annex Four of this Guidelines
- (2) The Notification of Well Operation, as per COMAH Regulations
- (3) The D&R Notification, as per COMAH Regulations

The expectation however remains, that the contents provided under each items in the Well P&A Submission should be sufficiently detailed such as to demonstrate that a viable strategy & associated cost estimate has been suitably developed by the Duty Holder to enable the Authority to make the requisite decisions on whether the Well P&A Programme, Notification of Well Operation and the D&R Notification are acceptable for the well concerned.

The Well Plug and Abandonment Programme should follow the model template set out in Annex Four of this guideline, in line with the description of the materials to be provided under each section heading. The model template is fit for purpose for use across all Brunei Darussalam well P&A activities and fully satisfies the requirements for adequately describing how well P&A is to be conducted.

### 3.1 Well P&A Programme

The well P&A Programme shall be completed by the Duty Holder on individual well basis outlining all the relevant information associated with the well P&A activity. The contents of the programme are as per Annex Five of this Guidelines:

- Executive Summary
- Hazards and Controls
- Abandonment Proposal
- Detailed Abandonment Programme
- Environmental Management
- Management of well P&A Activities

### 3.2 Notification of Well Operation

The Duty Holder shall submit the Notification of Well Operations as required under Schedule 6, Control of Major Accident Hazards (COMAH) Regulations (Amendment) 2017.

### 3.3 D&R Notification

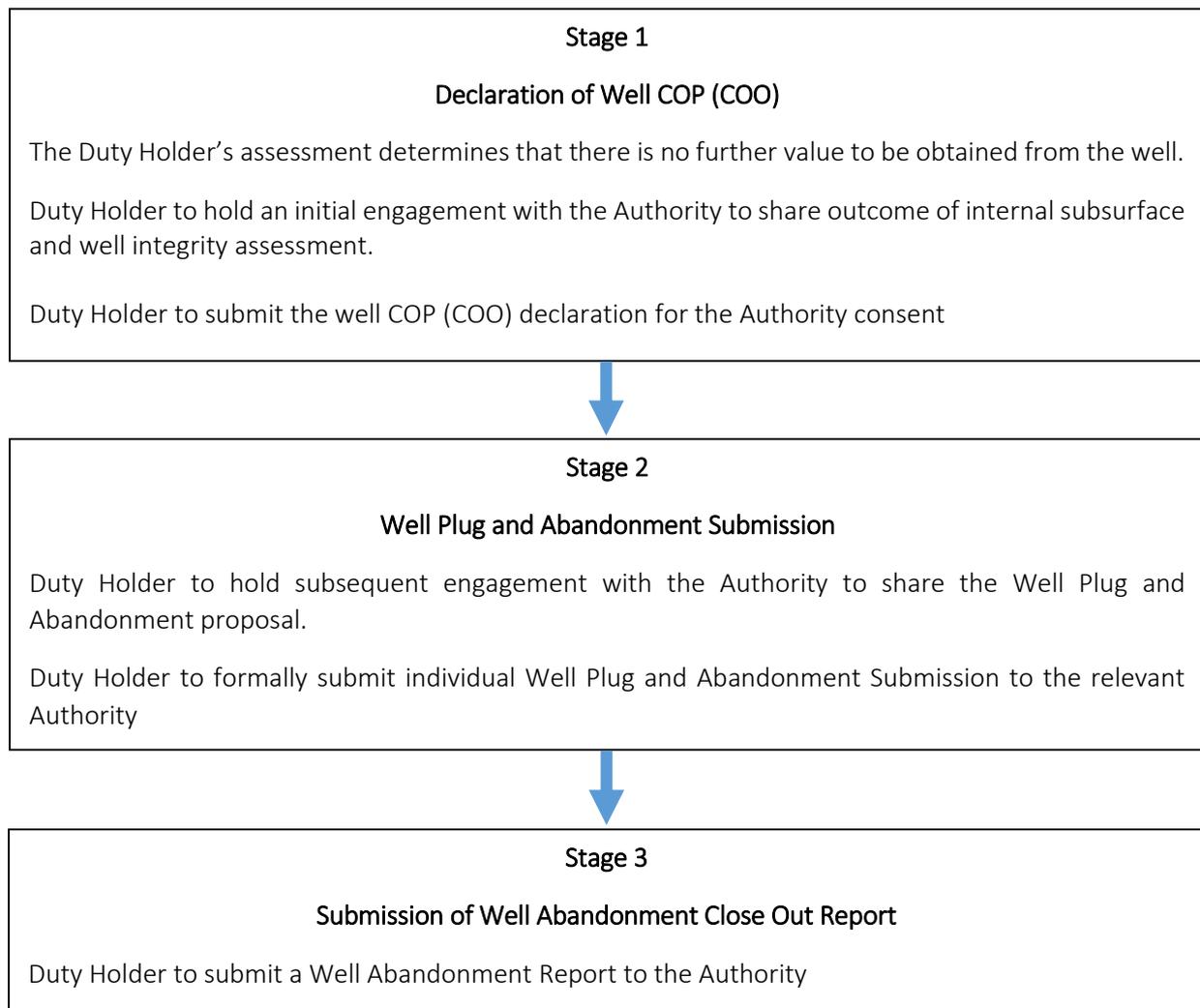
The Duty Holder shall submit the Decommissioning and Restoration Notification as required under Schedule 1A, Control of Major Accident Hazards (COMAH) Regulations (Amendment) 2017.

## 4.0 WELL PLUG AND ABANDONMENT SUBMISSION PROCESS & TIMELINE

Details of the process and expectations on timely completion are set out below.

The following flowchart indicates the key stages required for Well P&A Submission.

### 4.1 Well P&A Submission Process Flowchart



#### STAGE 1: Declaration of Well COP (COO)

Under Stage 1 of the well P&A Submission process, the Duty Holder shall conduct an engagement with the Authority to share outcome of internal subsurface and well integrity assessment with justifications including supporting documents for well COP (COO) declaration. The engagement will be in the form of presentation style and the outline of the contents includes but not limited to the followings:

Key Data	Supporting Document
<p><b>Well information:</b></p> <ul style="list-style-type: none"> <li>✓ Platform / area</li> <li>✓ Well number and type e.g. X-152, Oil</li> <li>✓ Block</li> <li>✓ Reservoir</li> <li>✓ Well age and closed in period</li> <li>✓ Well conditions (integrity &amp; HSE issues)</li> <li>✓ Potential remaining reserves (Develop ultimate recovery)</li> <li>✓ Cumulative production</li> <li>✓ HCIIP, Recovery factor (current and TQ)</li> <li>✓ Well status e.g. plugged/open</li> <li>✓ Other drainage points with colour coded for well status</li> <li>✓ Completion Status</li> <li>✓ Uphole opportunity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Well Production history</li> <li>▪ Reservoir map with latest fluid contact</li> <li>▪ Cross-section with latest fluid contact</li> <li>▪ Current and proposed completion diagram</li> <li>▪ Reservoir penetration chart</li> <li>▪ Well logs with latest fluid fill</li> <li>▪ Supporting evidences on well integrity</li> <li>▪ Well pressure data</li> <li>▪ Drainage points and their current status in detail</li> <li>▪ Annual Review of Petroleum Resources</li> </ul>
<p><b>Well Justification:</b></p> <ul style="list-style-type: none"> <li>✓ Selection Criteria e.g. Economic</li> </ul>	<ul style="list-style-type: none"> <li>▪ Economic – opportunity scope, cost, production profile and economic outcome.</li> <li>▪ Opportunity – reservoir map, cross section reservoir map, well logs, penetration chart, upside potential, deeper reservoir, re-use well</li> </ul>
<p><b>Well Planning:</b></p> <ul style="list-style-type: none"> <li>✓ Cost</li> <li>✓ Schedule</li> </ul>	<ul style="list-style-type: none"> <li>▪ Historical and Level 2 well cost</li> <li>▪ Historical and Level 2 schedule</li> </ul>

Such engagement shall be conducted with the Authority maximum of 14 months prior to the well P&A execution start date. As a follow up from the engagement, maximum of 2 months after such engagement, the Duty Holder shall submit a formal letter of Well COP (COO) Declaration for the Authority's consent.

### STAGE 2: Well Plug and Abandonment Submission

Prior to the Well P&A Submission, the Duty Holder to hold an engagement with the Authority to ensure alignment of expectations and requirement of the well abandonment.

The Duty Holder shall then submit a well P&A submission in electronic format along with two hard copies to the Authority for review and acceptance.

Where there is any Material Change to the acceptance of a well P&A submission, the Duty Holder shall amend the Well P&A Submission accordingly and resubmit for assessment.

### STAGE 3: Submission of Well Abandonment Close Out Report

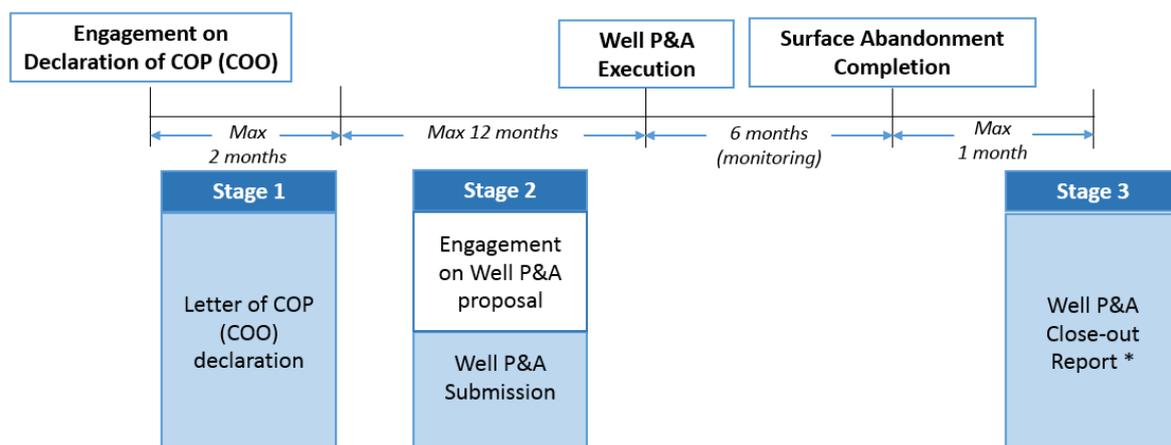
The Duty Holder shall submit the Well Abandonment Close out Report, with a cover letter confirming that the well P&A has been completed, to the Authority not later than one month after the completion of the surface abandonment. The close out report includes but not limited to the followings:

- Actual well P&A execution
- Actual site restoration including signage with photos for onshore wells
- Any deviations (from well P&A programme submission) with justifications
- Result and outcome of the well monitoring including remedial actions, if applicable
- Safety and environmental performance during well abandonment
- Actual abandonment execution duration and actual cost vs. plan with descriptions for deviations
- Lessons learnt and recommendation during the various phases of the Well P&A process

#### 4.2 Well P&A Process Timeline

The expected timeline for the Well P&A submission process are outline in Figure 6 below. The key milestones along the process are as follows:

- It is anticipated that the first engagement with Authority to be held maximum of fourteen (14) months before the execution of the well P&A.
- The Letter of COP (COO) Declaration is to be submitted to the Authority maximum of two (2) months after the engagement for the Authority’s consent.
- Subsequent engagement with Authority prior to Well P&A submission to ensure alignment of expectations and requirement of the well abandonment.
- The Well P&A submission is to be submitted to the Authority maximum of twelve (12) months after the consent of the COP (COO) Declaration.
- Upon completion of the subsurface abandonment, it is recommended to conduct a minimum of 6 months monitoring prior to removal of the wellhead and subsequently surface abandonment.
- Lastly, the Well P&A close report is be submitted one (1) month after the completion of well P&A activity including site restoration.



\* Acceptance via email

Deliverables by Operator to MEI Upstream

Figure 6: Well P&A Submission Timeline

---

## ANNEX FIVE: WELL PLUG AND ABANDONMENT PROGRAMME TEMPLATE

'WELL NAME'

'CONCESSION /BLOCK NAME'

ONSHORE / OFFSHORE

WELL PLUG AND ABANDONMENT PROGRAMME

**Document Revision Control**

Insert contents into the table of document revisions.

Revision	Date	Description

**Distribution List**

Insert contents into the table of applicable distribution.

Revision	Date	Description

**ABBREVIATIONS & ACRONYMS USED IN THIS DOCUMENT**

Include a table of the Abbreviations used in this document.

Abbreviation	Explanation

**TERMS USED IN THIS DOCUMENT**

Include a table of the Terms used in this document.

Term	Explanation

**FIGURES**

Include a list of Figures used in this document.

Figure	Description

**TABLES**

Include a list of Tables used in this document.

Table	Description

**APPENDICES**

Include a table of the appendices included in this document.

Appendix	Description

---

## CONTENTS

### 1.0 EXECUTIVE SUMMARY

### 2.0 HAZARDS AND CONTROLS

- 2.1 Hazard / Risk Register
- 2.2 Well Control Equipment and Test Summary
- 2.3 Concurrent Production and Rig Activities
- 2.4 Emergency Response Plan

### 3.0 ABANDONMENT PROPOSAL

- 3.1 Well Location and History
- 3.2 Well Production and Ultimate Recovery
- 3.3 Current Well Schematic
- 3.4 Wellhead
- 3.5 Well Trajectory
- 3.6 Geological Strata and Fluids
- 3.7 Pore Pressure Prediction
- 3.8 Proposed Well Schematic
- 3.9 Basis of Abandonment Design
- 3.10 Abandonment Fluids
- 3.11 Cementing Programme
- 3.12 Monitoring
- 3.13 Site Restoration

### 4.0 DETAILED ABANDONMENT PROGRAMME

### 5.0 ENVIRONMENTAL MANAGEMENT

- 5.1 Potential Environmental Impacts & Mitigations
- 5.2 Waste Management

### 6.0 TIMELINE AND COST ESTIMATE

- 6.1 Timeline
- 6.2 Cost Estimate

## 1.0 EXECUTIVE SUMMARY

The Duty Holder will provide summary of the proposed Well Plug and Abandonment activities for all related components of the well, in order to provide a suitable overview of the Well Plug and Abandonment Submission. The summary includes but not limited to the followings:

- Geographical location map
- Field/Block map and locations (include nearby wells and/or facility)
- Well to be abandoned and current status
- Production pipelines associated to the well abandonment
- Waste management strategy
- Project timeline and cost estimate
- Final Well P&A concept

## 2.0 HAZARDS AND CONTROLS

### 2.1 Hazard / Risk Register

Identify the potential hazard / risk associated with the well plug and abandonment activity including but not limited to the followings:

- impact of any associated risks
- likelihood of the risks occurring
- mitigation actions to minimize the impact or prevention from risk to occur
- recovery actions in the event that the risk do happen
- action party to carry out the mitigation actions
- status of the mitigation measures

### 2.2 Well Control Equipment and Test Summary

Summary of all the well control equipment that will be tested in accordance of applicable standards.

### 2.3 Concurrent Production and Rig Activities

Highlight the concurrent production and rig activity associated with this particular plug and abandonment operations, if applicable. Any hazard/risk associated with the concurrent production and rig activities will be captured in the hazard and risk register in Section 2.1

### 2.4 Emergency Response Plan

To include but not limited to the followings:

- Crisis and Emergency Response Management Team organization chart
- A table of the list of the Crisis and Emergency Response Management team members that will be on duty during the particular well abandonment activity with their job position and emergency contact number
- Summary details of arrangements in place to deal with any relevant emergencies pertaining to planned or unplanned scenarios.

---

## 3.0 ABANDONMENT PROPOSAL

### 3.1 Well Location and History

Description of the location of the well proposed to be abandoned. Insert location map especially onshore wells in the vicinity of residential/public areas.

Historical well summary of the proposed well to be abandoned which includes but is not limited to key events and dates i.e. spud date, recompletion, well intervention, production, integrity issues, closed-in date, reason for closed-in etc.

### 3.2 Well Production and Ultimate Recovery

Provide historical production plots. Historical production summary of the proposed well to be abandoned which includes but is not limited to initial/last production rates, cumulative production volume, current UR of the well, remaining reserves, potential up-hole recompletion etc. for each of the production zones and/or sands.

Proposed alternative drainage to produce the remaining reserves from the particular zones/sands of the well to be abandoned.

### 3.3 Current Well Schematic

Insert the current well schematic diagram of the proposed well to be abandoned. This schematic diagram includes and not be limited to depth referencing, elevation of drill floor, casing design, completion design including tubing and completion accessories, production zones, fish-in-hole, top of cement, suspension mechanism, etc. where applicable with the depths for each items.

### 3.4 Wellhead

Insert a diagram of the existing wellhead at the proposed well to be abandoned.

### 3.5 Well Trajectory

Insert the well trajectory diagram and a table of the well trajectory information for the proposed well to be abandoned which includes but not limited to depths, inclination, azimuth, Northing, Easting etc.

### 3.6 Geological Strata and Fluids

Insert a table or copy of interpreted well logs of the subsurface information penetrated by the proposed well to be abandoned which includes but is not limited to block, sand, formation tops, fluid type etc.

### 3.7 Pore Pressure Prediction

Insert a chart of the pore pressure prediction of the proposed well to be abandoned which includes but is not limited to low, expected and high case for both estimated reservoir pressure and fracture closure pressure (FCP) on each key horizons.

### 3.8 Proposed Well Schematic.

Insert the proposed well abandonment schematic diagram of the proposed well to be abandoned. The schematic diagram includes and not be limited to mechanical and cement plugs, abandonment fluids, fish left in-hole etc. where applicable with the depths information of each items.

### 3.9 Basis of Abandonment Design

Briefly describe the rationale of the proposed abandonment design i.e. requirement for zonal isolation plugs, setting depth for mechanical and cement plugs, cement squeeze in casing annulus etc. where applicable

### 3.10 Abandonment Fluids

Summary of the abandonment fluids planned to be used during the execution of well abandonment, which includes and is not limited to fluid type and fluid density for each hole section, if more than one type of abandonment fluids is to be used.

### 3.11 Cementing Programme

Summary of the type of cement planned to be used during the execution of well abandonment which includes and is not limited to cement type, density, interval (thickness) and justifications of quality of cement chosen for each of the proposed section and/or cement plugs

### 3.12 Monitoring

Summary of the strategy for implementation of well monitoring post subsurface abandonment associated with the well plug and abandonment activity, if applicable.

### 3.13 Site Restoration

Summary of the strategy for implementation of site restoration to final declared state for onshore wells.

## 4.0 DETAILED ABANDONMENT PROGRAMME

Description of detailed step by step abandonment programme to be executed. The programme includes but not limited to the followings:

- Rig Move
- Secure Well
- Retrieval of components of the well
- Subsurface Abandonment
- Surface Abandonment
- Site Restoration

## 5.0 ENVIRONMENTAL MANAGEMENT

### 5.1 Potential Environmental Impacts & Mitigations

A description of the main potential environmental impacts arising as a result of undertaking the proposed well plug and abandonment activity particularly for onshore wells which are in the vicinity of residential and public areas, along with a description of the proposed mitigation, where applicable.

### 5.2 Waste Management

Describe how the waste streams arising from the plug and abandonment activity will be managed including any potential issues regarding the transportation of hazardous and non-hazardous waste, if applicable. Also includes how the well components will either be re-used, recycled, recovered or disposed of in line with applicable regulations.

## 6.0 TIMELINE AND COST ESTIMATE

### 6.1 Timeline

Summary of the well abandonment execution timeline and duration along with key dates and defined milestones. Insert current drilling sequence, where applicable.

### 6.2 Cost Estimate

Provide a provisional breakdown and total cost estimate for undertaking the well plug and abandonment activity. Note that costs may be subject to change.