INDEPENDENT RISK ASSESSMENT: AN INNOVATIVE APPROACH OF QUALITATIVE RISK MITIGATION MEASURES – PRIORITIZATION FOR WELL INTEGRITY ASSURANCE

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To my beloved parents, Abu Bakar Bin Amir and Roziah Lee Binti Abdullah, who continuously giving advice and guidance. To my beloved wife, Alifah Binti Muhammad, who tirelessly giving supports and always believes in me whenever I felt depressed.

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ABSTRACT

Degradation of original well barrier elements might occur after some time in operations. Due to huge number of wells and increasing matured field issues, the key challenge faced is to prioritize the remedial measures and pro-active health checks based on well risk level, barrier status and available resources to ensure that wells operate in safe operating envelope. Knowledge of well integrity status at all times enables company to take the right actions in a proactive manner to prevent incidents. In 2015, management has undertook this project with the goal of understanding and minimizing risk of well barriers failure. The operations include 5 fields, 7 platforms, for a total of 135 active wells. This project present a study in which well integrity was evaluated by independent reviewer as approach for an efficient visualization and description of interrupted well barriers. Then, the responsible parties involved can take action more accurately according to the type of failure that has been revealed to verify and reinstate barrier integrity of the wells. Well integrity risk assessment operational methodology approach includes comparison between measured leakage rate/pressure with maximum allowable limit to estimate how close each well is losing its barriers safety condition. Total of 6 case studies have been performed, which are packer leak, tubing leak and SCSSV passing for primary barrier, while cement failure, high annulus pressure and Christmas Tree valves passing for secondary barrier. Result shows that SCSSV (75%) and Christmas Tree valves (65%) passing are the highest barrier failures which contributes to 53% of high (H) risk ranking. Only 35% of serious (S) risk ranking reported which requires immediate intervention or else shut-in until further approval. In future study, strong focus should be on development of site-specific performance standard in order to demonstrate compliance and ensure well integrity. Operators can benefit by efficiently identifying the critical wells among the thousands being operated so that limited resources can be applied to gain most benefit.

ABSTRAK

Degradasi unsur-unsur asal halangan telaga mungkin berlaku selepas beberapa lama dalam operasi. Oleh kerana bilangan telaga yang banyak dan peningkatan isu-isu lapangan matang, cabaran utama yang dihadapi adalah untuk mengutamakan langkah-langkah pemulihan dan pemeriksaan kesihatan proaktif berdasarkan tahap risiko telaga, status halangan dan sumber yang ada untuk memastikan bahawa telaga beroperasi dalam operasi yang selamat. Pengetahuan tentang status integriti telaga pada setiap masa membolehkan syarikat untuk mengambil tindakan yang betul dengan cara yang proaktif untuk mencegah kejadian. Pada tahun 2015, pihak pengurusan telah melaksanakan projek ini dengan matlamat untuk memahami dan mengurangkan risiko kegagalan halangan telaga. Operasi termasuk 5 lapangan, 7 platform, untuk sejumlah 135 telaga aktif. Projek ini membentangkan kajian di mana integriti telaga telah dinilai oleh pengulas bebas sebagai pendekatan untuk visualisasi yang cekap dan penerangan halangan telaga yang terganggu. Kemudian, pihak bertanggungjawab yang terlibat boleh mengambil tindakan yang lebih tepat mengikut jenis kegagalan yang telah didedahkan untuk mengesahkan dan mengembalikan integriti halangan telaga. Penilaian risiko integriti telaga pendekatan metodologi operasi termasuk perbandingan antara kadar/tekanan kebocoran diukur dengan had maksimum yang dibenarkan untuk menganggarkan sejauh mana setiap telaga kehilangan keadaan halangan keselamatannya. Sebanyak 6 kajian kes telah dijalankan, kebocoran pembungkus, kebocoran tubing dan kelepasan SCSSV untuk halangan utama, manakala kegagalan simen, tekanan anulus tinggi dan kelepasan injap Christmas Tree untuk halangan sekunder. Keputusan menunjukkan bahawa kelepasan SCSSV (75%) dan injap Christmas Tree (65%) adalah kegagalan halangan tertinggi yang menyumbang kepada 53% daripada kedudukan berisiko tinggi (H). Hanya 35% daripada risiko serius (S) dilaporkan yang memerlukan campur tangan segera, jika tidak, ditutup sehingga kelulusan selanjutnya. Dalam kajian masa depan, tumpuan lebih harus diberikan pada pembangunan standard prestasi khusus untuk menunjukkan pematuhan dan memastikan integriti telaga. Operator boleh mendapat manfaat dengan mengenal pasti telaga kritikal di kalangan beribu-ribu yang dikendalikan supaya sumber yang terhad boleh digunakan untuk mendapat manfaat terbaik.

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LIST OF ABBREVIATIONS

ALARP	-	As Low As Reasonably Practicable
API	-	American Petroleum Institute
BOP	-	Blowout Preventer
CBL	-	Cement Bond Log
CCP	-	Conductor Casing Pressure
CDFT	-	Critical Device Function Test
CL	-	Control Line
CM	-	Corrective Maintenance
CMP	-	Corrosion Management Plan
COT	-	Crude Oil Terminal
CO2	-	Carbon Dioxide
CV	-	Crown Valve
GCW	-	Gap Closure Workshop
HPHT	-	High Pressure High Temperature
HSE	-	Health, Safety, Environment
H2S	-	Hydrogen Sulphide
ICP	-	Intermediate Casing Pressure

ID	-	Internal Diameter
IMG	-	Inspection and Maintenance Guideline
ISO	-	International Standard Organization
JHA	-	Job Hazards Analysis
JSA	-	Job Safety Analysis
LMV	-	Lower Master Valve
LOPC	-	Loss of Primary Containment
LOV	-	Line of Visibility
MAASP	-	Maximum Allowable Annulus Surface Pressure
MAH	-	Major Accident Hazards
MAWOP	-	Maximum Allowable Well Operating Pressure
MOC	-	Management of Change
PCP	-	Production Casing Pressure
PM	-	Preventive Maintenance
PS	-	Performance Standard
PSA	-	Petroleum Safety Authority
PTW	-	Permit to Work
QA	-	Quality Assurance
QC	-	Quality Controller
RA	-	Risk Assessment
RACI	-	Responsibility, Accountability, Consult, Inform

R&D	-	Research and Development
SCE	-	Safety Critical Element
SCP	-	Surface Casing Pressure
SCSSV	-	Surface Control Subsurface Safety Valve
SSV	-	Surface Safety Valve
TA	-	Technical Authority
TP	-	Technical Professional
USIT	-	Ultrasonic Imager tool
WBE	-	Well Barrier Element
WIMS	-	Well Integrity Management System
WRM	-	Wellbore Risk Management
WV	-	Wing Valve

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CHAPTER 1

INTRODUCTION

1.1 Project Overview

The area of study applies to oil production from a group of fields located 150 km offshore with water depth 63-75 m. Five fields (Ti, K, S, P, L) were on stream at the time of the B PSC awarded in 1995. The fields were originally developed as part of the 1976 PSC discoveries, and remain integrated to some extent. Total recoverable reserves was estimated about 735 MMbbls of oil. An infill drilling campaign began in 1998 leading to an increase in oil production, but output is now in the latter stages of decline. Report indicates there may be up to 70 MMbbls of oil remaining across the block which could be recovered as part of an EOR project.

A complex network of pipelines links the five oil fields to a pumping platform. From there, crude is piped via a 24-inch diameter along 150 km pipeline, which has a capacity of 360,000 b/d to onshore Crude Oil Terminal (COT) for stabilization before it is sent to storage and finally export. Associated gas from the fields is initially utilized to supply Gas Utilization project. Gas is collected before being transported via a 30-inch diameter along 150 km pipeline to onshore gas processing facilities.

The program calls for obtaining a clear picture of the current integrity condition of the wells through an independent observers' perspective to identify integrity issues with the clarity of an objective and impartial party. The objective is to review physical condition of wells, review records, conduct interviews / discussions, make physical observations, identify gaps and recommend remedial actions. This review was carried out in close cooperation with well integrity focal persons from each platforms personnel and support department.

This report presents the outcome of well integrity assessment that was carried out on the cluster (Ti, K, S, P, L fields). The purposes of this assessment are to review current well integrity condition (determine health of each well barriers) and provide recommendation (identify actions to be taken to rectify unhealthy barriers) accordingly. In achieving COMPANY well integrity target, it is essential to ensure all well related safety critical elements are in good condition, in compliance with Performance Standard (PS) and it is safe for operations (shut-in, production or injection).

The health of each well safety barrier elements are measured against the standards referred to Performance Standard (PS), Well Containment, Well

Isolation, Well Structure, Wellbore Risk Management (WRM) Rev.3 and Inspection and Maintenance Guideline (IMG) Rev.3. In the case of barrier integrity failure is not covered under any of the listed above guidelines, additional references such as COMPANY Procedure and Guideline for Upstream Activities Rev.3, COMPANY Technical Standard, or other International / Host Country Standards are to be referred.

1.2 Definition of Independent Risk Assessment

Risk Assessment is a systematic and objective examination process and primarily meant as a management tool and secondarily a technical tool. Reviews are planned and controlled checks of conformance against predefined specifications and standards or criteria. Consequently, review results shall be presented in management's terms, should generate management interest, and should convince management that any proposed corrective actions are necessary and will benefit the entity. Although reviews are in essence evaluations, the results should be regarded by all interested parties as an opportunity for improvement on the basis of external experience and industry best practice, rather than as a judgment of the quality of management systems and practices (Sanjay et al., 1996).

Independence means that assessors are neither the persons responsible for the assets being reviewed nor being part of the organization responsible for the assets. Assessors shall be free of any conflicts of interest, bias and influences that could affect objectivity. Despite the best intentions to remain objective, assessors with a conflict of interest may unconsciously bias the review by overlooking problems due to familiarity with the review effort or may unconsciously minimize the impact of any discovered deficiencies on the outcome of the review. Independence requirement helps to ensure that assessors have no stake in the outcome of the review, other than an objective interest that the integrity of the assets is continuously safeguarded. If the results of a technical review are to be treated seriously, everyone involved in the review process should accept the review as being objective. Although assessors should have technical knowledge of the equipment and procedures being used in the review, this knowledge should not influence the objectivity of the reviewers' observations (Hareesh et al., 2015).

1.3 Problem Statement

According to a number of authors, Smith, G.H. et. al. (1996), Pattillo, P.D. (2003), Darren, J.W. (2008), Guen, Y.L. (2011), performing risk assessment on various types of well will increase understanding of the potential negative impact/consequences, reduce risk from well operations and minimize well integrity problems. This may include updating or modifying processes, procedures, and practices used during the construction and operations of the wells.

This supported with the similar findings of Dethlefs, J. C. (2012) by developing a Qualitative Model which proven to be successful for identifying and ranking well-barrier failures in well integrity risk assessment.

1.4 Objectives

The primary objectives of this wells independent risk assessment are:

- To validate the state (physical condition) of wells and ongoing maintenance for good repair and condition.
- To identify any related wells weaknesses which may result in unacceptable risk and recommend possible solutions and corrective actions
- To assess whether wells condition, system and practice continue to be suitable across the lifecycle, particularly when knowledge, technology or standards change.

In order to assure independence and objectivity, the reviews shall therefore be performed by independent external technical experts.

1.5 Scope of Project

1.5.1 Number of Wells

The project has been conducted on total of 135 wells at 7 platforms for the 5 Fields which located on the following facilities:

Table 1: Number of Wells for each Platform

FIELD	PLATFORM	NO OF WELLS
Ti	Ti-A	34
	Ti-B	15
K	K-A	10
S	S-A	33
P	P-A	30
	P-B	8
L	L-D	5

1.5.2 Parameters

Parameters measured in this project can be categorized as primary and secondary barriers and only consider operational phase.

1) Primary Barriers

- Production Packer Leak
- Completion Tubing Leak
- Surface Control Subsurface Safety Valve (SCSSV) Passing

2) Secondary Barriers

- ➢ High Annulus Pressure

  Conductor Casing Pressure (CCP), Surface Casing Pressure (SCP), Intermediate Casing Pressure (ICP), Production Casing Pressure (PCP)

- ➢ Christmas Tree Valves Passing

  Crown Valve (CV), Wing Valve (WV), Surface Safety Valve (SSV), and Lower Master Valve (LMV)

1.5.3 Risk Matrix

Risk Matrix 5 x 5 as in Table 2 has been used for assessment of probability/likelihood and consequences/impacts in this project.

Table 2: Risk Matrix (5 x 5)

IMPACT		Severity	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
		People	Slight Injury	Minor Injury	Major Injury	Single Fatality	Multiple Fatalities
		Environment	Slight Impact	Minor Impact	Localized Impact	Major Impact	Massive Impact
		Asset	Slight Damage	Minor Damage	Local Damage	Major Damage	Extensive Damage
		Reputation	Slight Impact	Limited Impact	Considerable Impact	Major National Impact	Major International Impact
LIKELIHOOD	E Almost Certain	Happens several times per year at location	E1	E2	E3	E4	E5
	D Likely	Happens several times per year in company	D1	D2	D3	D4	D5
	C Possible	Incident has occurred in our company	C1	C2	C3	C4	C5
	B Unlikely	Heard of incident in industry	B1	B2	B3	B4	B5
	A Remotely likely to happen	Never heard of in industry	A1	A2	A3	A4	A5

Risk requires immediate controls in place
Risk requires controls with high priority
Risk requires controls with low priority
Risk is tolerable

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