

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

MOHD ABU YAZID BIN ABU BAKAR

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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 undertaken 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.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	SUPERVISOR’S DECLARATION	
	TITLE PAGE	i
	STUDENT’S DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	ABSTRAK	vi
	TABLE OF CONTENTS	vii
	LIST OF TABLES	xii
	LIST OF FIGURES	xiii
	LIST OF ABBREVIATIONS	xvi
	LIST OF APPENDICES	xix
1	INTRODUCTION	
	1.1 Project Overview	1
	1.2 Definition of Independent Risk Assessment.....	3
	1.3 Problem Statement	4
	1.4 Objectives	5

1.5	Scope of Project	6
1.5.1	Number of Wells	6
1.5.2	Parameters	6
1.5.3	Risk Matrix.....	7
2	LITERATURE REVIEW	
2.1	Background and History	8
2.2	Well Integrity	11
2.2.1	What is Well Integrity?	11
2.2.2	What Can Go Wrong in Wells?.....	12
2.2.3	How Likely is Loss of Well Integrity?	13
2.2.4	What are the Consequences of Loss of Well Integrity?	14
2.3	Well Barriers.....	16
2.3.1	Well Barrier Philosophy	18
2.3.2	Primary Barrier	19
2.3.2.1	Production Packer	20
2.3.2.2	Completion Tubing	21
2.3.2.3	Surface Control Subsurface Safety Valve (SCSSV).....	22
2.3.3	Secondary Barrier.....	24
2.3.3.1	Casing Cement	24
2.3.3.2	Casing	26
2.3.3.3	Wellhead	27

2.3.3.4	Tubing Hanger	29
2.3.3.5	Annulus Access Line and Valve	30
2.3.3.6	Christmas Tree (body and valves)	31
2.4	Operational.....	33
2.4.1	Maximum Allowable Annulus Surface Pressure (MAASP).....	33
2.4.2	Leak Testing	35
2.4.3	Pressure Monitoring / Surveillance	37
2.5	Technical Standards and Procedures	40
2.5.1	Audit and Compliance	41
2.6	Risk Assessment	42
2.6.1	Introduction	42
2.6.2	Team Members.....	45
2.6.3	Failure Modes.....	47
2.6.4	Post-Assessment Implementation.....	49

3 METHODOLOGY

3.1	Planning	50
3.1.1	Selection of Assessors	52
3.2	Assessment.....	53
3.2.1	Rating Classification	54
3.2.2	Recommendations	56
3.3	Validation.....	58

3.4	Reporting.....	59
3.5	Gap Closure	60
3.5.1	Verification of Gap Closure	63
4	CASE STUDY	
4.1	Well Barrier Elements (WBE)	67
4.2	Primary Barriers	69
4.2.1	Case 1 – Packer Leak	69
4.2.2	Case 2 – Tubing Leak.....	69
4.2.3	Case 3 – SCSSV Passing.....	70
4.3	Secondary Barriers.....	71
4.3.1	Case 4 – Cement Failure.....	72
4.3.2	Case 5 – High Annulus Pressure (CCP, SCP, ICP, PCP)	72
4.3.3	Case 6 - Christmas Tree Valves Passing (CV, WV, SSV, LMV)	74
5	RESULTS AND DISCUSSION	
5.1	Results.....	75
5.1.1	Ti-A Platform.....	75
5.1.2	Ti-B Platform	79
5.1.3	S-A Platform	82
5.1.4	P-A Platform	85
5.1.5	P-B Platform	87
5.1.6	L-D Platform	88

5.2 Discussion	89
5.2.1 Well Barrier Elements (WBE).....	89
5.2.2 Well Primary Barriers.....	90
5.2.3 Well Secondary Barriers.....	92
5.2.4 Risk Ranking	94
6 CONCLUSION AND RECOMMENDATIONS	
6.1 Conclusion	96
6.2 Recommendations.....	99
REFERENCES.....	102
APPENDICES.....	105

LIST OF TABLES

TABLE NO.	TITLE	PAGE
Table 1	Number of Wells for each Platform	6
Table 2	Risk Matrix (5 x 5)	7
Table 3	Likelihood Categories	43
Table 4	Consequence-Severity Description	43
Table 5	Risk Matrix	44
Table 6	Risk Categories	44
Table 7	Risk Matrix (5 x 5)	54
Table 8	Finding Rating Classification	55
Table 9	Control Acceptability	57
Table 10	Risk Matrix (5 x 5)	64
Table 11	Recommendation Priority Classification	65
Table 12	Wells Barrier Elements (WBE)	68
Table 13	Allowable Leak Rates for SCSSV	71
Table 14	Christmas Tree Valves Passing Rate Limit	74
Table 15	Well Utilization Matrix	74

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
Figure 1	Failure Statistics with Age	12
Figure 2	Barrier Element Failures	14
Figure 3	Deformed casing hanger after failure	15
Figure 4	Hole in the production tubing	15
Figure 5	Failed production casing and tubing	15
Figure 6	Primary Barrier (blue) and Secondary Barrier (red) (a) Drilling Phase ; (b) Production Phase ; (c) Intervention Phase	17
Figure 7	Production packer installed downhole in a well	20
Figure 8	Corroded tubing due to incompatibility between the tubing material and injection water quality	22
Figure 9	Schematic of a Surface Control Subsurface Safety Valve (SCSSV) in opened and closed position	23
Figure 10	Casing cement acting as part of both the primary (blue) and secondary (red) well barriers	25
Figure 11	Picture of cut and retrieved intermediate casing, cemented production casing and tubing string with control line	27

Figure 12	Wellhead with Christmas Tree installed	28
Figure 13	Tubing hanger installed in dry wellhead with control line feed	29
Figure 14	Different types of dry Christmas Trees	32
Figure 15	Christmas Tree and production Upper Master Valve as part of the Secondary Barrier envelope	32
Figure 16	(A) Annulus pressure between production casing and tubing; (B) Annulus pressure between intermediate and production casings; (C) Annulus pressure between surface and intermediate casings	34
Figure 17	Potential leak paths resulting in SCP	38
Figure 18	Hierarchy of Technical Standards and Procedures	40
Figure 19	Potential failure-mode pathways in a well	47
Figure 20	Sections of well for evaluation	48
Figure 21	Process Stages	50
Figure 22	Traffic Light System	56
Figure 23	Gap Closure Process	61
Figure 24	Verification of Gap Closure Process	63
Figure 25	Endorsement Guideline for Closure and Extension	64
Figure 26	Wells Risk Ranking and Categorization	66
Figure 27	Hardware Barriers (8 elements)	67
Figure 28	Annulus Limit Level Classification	73

Figure 29	Well Barrier Elements by Platforms	89
Figure 30	Overall Well Barrier Elements	89
Figure 31	Primary Barriers by Platforms	90
Figure 32	Overall Primary Barriers	90
Figure 33	Secondary Barriers by Platforms	92
Figure 34	Overall Secondary Barriers	92
Figure 35	Risk Ranking by Platforms	94
Figure 36	Overall Risk Ranking	94

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

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	Sample of Risk Assessment Form	106
B	List of Wells	107
C	Sample of Gap Closure Workshop Template	108

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	2	3	4	5
			Insignificant	Minor	Moderate	Major	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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