



**TECHNOLOGY SELECTION PROCESS FOR
ERD WELLS IN MATURE ASSETS**

AUTHORISATION

	Name / Position	Signature	Date
Prepared by:	Ignacio Vuelta Red Stone Drilling – Drilling Engineer		20 August 2007
Reviewed by:	Derek Harrold Red Stone Drilling		23 August 2007
Approved by:	Harald Benning Red Stone Drilling		27 August 2007

DOCUMENT CONTROL			
Document:		TECHNOLOGY SELECTION PROCESS FOR ERD WELLS IN MATURE ASSETS	
File:			
Loc:			
Record of Issue:			
Rev No	Date	Modification Details	Inserted / Checked by
0	20 August 2007	Submittal	Ignacio Vuelta
1			
2			

Legal Disclaimer.

This report and recommendations made herein are made on the basis of good faith and Red Stone Drilling Limited who prepared this report, accept no responsibility nor liability for its accuracy or the conclusions drawn or the recommendations made. Red Stone Drilling Limited accepts no liability for the subsequent use by third parties of this report.

© **Copyright 2007 Red Stone Drilling Limited, Unpublished Work. All rights reserved.** This works contains the confidential and proprietary trade of Red Stone Drilling Limited and may not be copied or stored in an information retrieval system, transferred, used distributed, translated or retransmitted in any form or by any means, electronic or mechanical, in whole or in part, without the express written permission of the copyright owner.

ABSTRACT

Mature hydrocarbon basins such the North sea face numerous challenges to sustain and improve the successful drilling and exploitation of its remaining reserves. Thirty year old facilities, low recovery factors, brown fields and marginal or satellite reservoirs are an example of these.

It has been estimated that the costs of field development with subsea wells is nearly double that of a development with ERD wells at today's semi-submersible rig rates. Consequently, a high number of ERD wells are being drilled from platforms in the North Sea. Combining the risks and challenges of successfully exploiting mature assets with the inherent risks and challenges of executing ERD wells, demands a high degree of detailed well planning, innovation and effort in order to succeed. In most cases, the use of correct differentiating technologies is the key to achieving increased operational performance. Nevertheless, it is quite challenging for an oil operator to identify and select the right technology out of the many options available in the market. As a result, it is not unusual that good technology is rapidly discarded because of its weaknesses when deployed in isolation, or simply because its benefits are not properly identified.

This report has been conducted by Red Stone Drilling on behalf of CNR International to deliver a generic step by step sequence for the correct selection of differentiating technology, which incorporates a roadmap which interfaces directly with the typical well delivery process.

- Challenges faced by operators drilling ERD wells from mature assets have been identified and properly defined.
- A total of eleven differentiating technologies have been identified, reviewed and systematically classified.
- A base case study of a typical North Sea platform well was used to:
 - Select, combine and analyse - using well modelling software - differentiating technologies to address specific risk and challenges.
 - Conduct probabilistic cost and time estimates using an innovative Monte Carlo simulator.
 - Perform probabilistic risk assessment using Monte Carlo simulator

The results of this report are considered sufficiently generic to enable similar application by any oil company operating mature assets and facing similar challenges as CNR International in the UKCS.

TABLE OF CONTENTS

TITLE	Page
ABSTRACT	i
TABLE OF CONTENTS	iii
LIST OF FIGURES	vi
LIST OF TABLES	vii
ABBREVIATIONS AND UNITS	vii
INTRODUCTION	
BACKGROUND	1
PROJECT OBJECTIVES	2
SCOPE OF WORK	2
CHAPTER 1	
MATURE ASSETS CHALLENGES	3
1.1 INTRODUCTION	3
1.2 DEVELOPMENT OF SATELLITE RESERVOIRS	3
1.3 AGEING OF PLATFORM DRILLING EQUIPMENT	4
1.4 OPTIMIZATION OF PLATFORM DRILLING SLOTS AND DONOR WELLS	4
1.5 STRESS COUPLING IN DEPLETED RESERVOIRS	4
CHAPTER II	
ERD CHALLENGES	8
2.1 INTRODUCTION	8
2.2 TORQUE, DRAG & BUCKLING	8
2.3 HOLE CLEANING	14
2.4 HYDRAULICS	18
2.5 WELLBORE STABILITY	21
2.6 DIRECTIONAL DRILLING CONTROL	25
2.7 CASING WEAR	27
2.8 CASING RUNNING	28
CHAPTER III	
AVAILABLE DIFFERENTIATING TECHNOLOGIES TO UNLOCK MATURE ASSETS WITH ERD WELLS	30
3.1 INTRODUCTION	30
3.2 MPD WITH DYNAMIC ANNULAR PRESSURE CONTROL (DAPC)	30
3.3 DRILLING WITH CASING (DWC)	34
3.4 MULTILATERALS (ML) TECHNOLOGY	38

	3.5 FRICTION REDUCTION TOOLS (FRT)	43
	3.6 SOLID EXPANDABLES TUBULARS (SET)	45
	3.7 NEW DRILLING FLUIDS: TREATED MICRONIZED BARITE (TMB)	47
	3.8 STRESS CAGES	49
	3.9 GEOSTEERING	50
	3.10 NEW MWD TOOLS: PWD - DTORQ - MULTIAXIS VIBRATIONS TOOLS (MVT)	52
	3.11 ALTERNATIVE DRILL PIPE MATERIALS	54
	3.12 SELECTIVE CASING FLOTATION TECHNOLOGY (SCF)	56
CHAPTER IV	SELECTION OF DIFFERENTIATING TECHNOLOGY I; RIG CAPABILITIES REQUIREMENTS FOR ERD; CHECKLIST	57
	4.1 INTRODUCTION	57
	4.2 EXISTING RIG SPECIFICATION AND CONDITION	57
	4.3 WELL BASIS OF DESIGN	58
	4.4 SPECIFICATION FOR REQUIRED RIG	60
	4.5 RIG UPGRADE COMPARISONS FOR EXISTING RIG; CHECKLIST	64
	4.6 ALTERNATIVES TO RIG UPGRADE; CHECK LIST	65
CHAPTER V	SELECTION OF DIFFERENTIATING TECHNOLOGY II; WELL MODELLING	66
	5.1 INTRODUCTION	66
	5.2 SUMMARY OF WELL BASIS OF DESIGN	66
	5.3 ERD-1 RISKS AND CHALLENGES	68
	5.4 IDENTIFICATION OF DIFFERENTIATING TECHNOLOGY	70
CHAPTER VI	SELECTION OF DIFFERENTIATING TECHNOLOGY III; COST AND TIME RISK ANALYSIS; SWOT ANALYSIS.	76
	6.1 INTRODUCTION	76
	6.2 RISK ANALYSIS METHODOLOGY	76
	6.3 LEARNING CURVE	78
	6.4 SUMMARY OF RISK ANALYSIS RESULTS	80
	6.5 SWOT ANALYSIS	82

CHAPTER VII	SELECTION OF DIFFERENTIATING TECHNOLOGY	86
	IV; ROAD MAP	
	CONCLUSIONS AND RECOMMENDATIONS	88
	REFERENCES AND BIBLIOGRAPHY	90
APPENDIX 1	ERD-1 WELL GEOMETRY	95
APPENDIX 2	ERD-1 DRILLSTRING AND HYDRAULICS ANALYSIS REPORTS.	98
APPENDIX 3	FRictional REDUCTION TOOLS - ECD INCREMENT OUTPUT USING FLUID WORKS SOFTWARE	109
APPENDIX 4	ERD-1 WELLBORE STABILITY	111
APPENDIX 5	RIG CAPABILITY CHECKLIST	114
APPENDIX 6	RISK ANALYSIS - SIMULATION SUMMARY REPORT ERD-1 BASE CASE	117
APPENDIX 7	RISK ANALYSIS - RISKED WELL COST AFE ERD-1 BASE CASE	126
APPENDIX 8	RISK ANALYSIS - SIMULATION SUMMARY REPORT ERD-1 BASE CASE + WARP DRILLING FLUID	132
APPENDIX 9	RISK ANALYSIS - SIMULATION SUMMARY REPORT ERD-1 BASE CASE + MPD	136
APPENDIX 10	RISK ANALYSIS - SIMULATION SUMMARY REPORT ERD-1 BASE CASE + DWC	140
APPENDIX 11	RISK ANALYSIS - SIMULATION SUMMARY REPORT ERD-1 BASE CASE + DWC + MPD	145
APPENDIX 12	MONTECARLO ANALYSIS EXAMPLE	151
APPENDIX 13	FLOW CHART FOR INFLUENCE OF TECHNOLOGY TO ERD OPERATIONAL ISSUES and SENSITIVITIES	155