Table of Contents

Foreword	ix
Executive Summary of Findings	x
Technical Findings	Х
Management Findings Regulatory Findings	X
Chapter 1 Scope of Investigation and Methodology	XI 1
Nature of Report	
Scope of Investigation and Report	1
Investigation Methodology	2
Structure of the Report	3
Chapter 2 Drilling for Oil in Deepwater	5
Oil and Gas in Deepwater How to Drill a Deepwater Well	5 8
Chapter 3 Background on the Macondo Well, the Deepwater Horizon,	
and the Companies Involved	25
The Macondo Well	25
The Deepwater Horizon	26
Companies and Individuals Involved in the Macondo Blowout	30
Chapter 4 Technical Findings	35
Underlying Technical Causes Underlying Management Causes	35 37
Chapter 4.1 Flow Path	39
Potential Flow Paths	40
Forensic Evidence Suggests That Hydrocarbons Did Not Flow up the Annulus and Through the Seal Assembly	42
Hydrocarbons Appear to Have Flowed Into and up the Production Casing	42
Technical Findings	52
Chapter 4.2 Well Design	53
Deepwater Well Design	53
The Macondo Well Design Drilling the Macondo Well	55 58
Technical Findings	50 62
Management Findings	64
Chapter 4.3 Cement	67
Well Cementing	67
Preparing for the Macondo Cement Job	77
Designing the Macondo Cement Job Planning for and Installing Centralizers at Macondo	78 81
Float Collar Installation and Conversion at Macondo	87
Pre-Cementing Wellbore Conditioning at Macondo	90
Cementing Process at Macondo The Floet Check at Macondo	92
The Float Check at Macondo Cement Evaluation at Macondo	93 94
Technical Findings	94 95
Management Findings	102

Chapter 4.4 Foamed Cement Stability	111
Foamed Cement Foamed Cement at Macondo Technical Findings Management Findings	111 113 120 123
Chapter 4.5 Temporary Abandonment	
Temporary Abandonment Temporary Abandonment at Macondo Technical Findings Management Findings	127 128 135 139
Chapter 4.6 Negative Pressure Test	143
Well Integrity Tests Negative Pressure Test at Macondo Technical Findings Management Findings	143 147 160 161
Chapter 4.7 Kick Detection	165
Well Monitoring and Kick Detection Well Monitoring at Macondo Technical Findings Management Findings	165 174 182 184
Chapter 4.8 Kick Response	193
Well Control Equipment Kick Response at Macondo Technical Findings Management Findings	193 195 198 200
Chapter 4.9 The Blowout Preventer	203
Blind Shear Rams Blind Shear Ram Activation at Macondo ROV Hot Stab Activation at Macondo Automatic Blind Shear Ram Activation at Macondo Potential Reasons the Blind Shear Ram Failed to Seal BOP Recertification Technical Findings Management Findings	204 206 208 212 215 216 217
Chapter 4.10 Maintenance	221
Transocean's Rig Management System Competing Interests Between Drilling and Maintenance Lack of Onshore Maintenance Maintenance Audits and Inspections Maintenance Findings	221 222 222 223 223 224
Chapter 5 Overarching Failures of Management	225
Leadership Communication Procedures Employees Contractors Technology Risk Closing	225 227 232 235 237 240 242 249

Chapter 6 Regulatory Observations	251
MMS Background MMS Regulations Did Not Address Many Key Risk Factors for the Blowout BOP Recertification Ethical Considerations	251 253 260 261
Endnotes	
Appendix A Blowout Investigation Team	
Appendix B Commission Staff	
Appendix C Acronyms	
Appendix D Chevron Laboratory Report Cover Letter	351
Appendix E Nile and Kaskida	353
Schedule When the <i>Deepwater Horizon</i> Arrived at Macondo Request to Suspend Operations at Kaskida	353 354

Figures and Tables

Figures

Chapter 2 Drilling for Oil in Deepwater	
 Figure 2.1. Schematic geological cross section. Figure 2.2. Drilling. Figure 2.3. Pore pressure and fracture gradients. Figure 2.4. Casing strings (greatly simplified). Figure 2.5. Rig structures. Figure 2.6. Rig structures. Figure 2.7. Early drilling phases. Figure 2.8. Wellhead assemblies. Figure 2.9. BOP components. Figure 2.10. Flow in a typical mud system. Figure 2.11. Casing hanger. Figure 2.12. Wiper plugs. Figure 2.13. Cementing. Figure 2.14. Perforating the production casing. Figure 2.15. Barriers in a well. Figure 2.16. Simplified AMF control system schematic. 	5 9 10 11 12 14 15 16 17 18 19 20 21 22
Chapter 3 Background on the Macondo Well, the <i>Deepwater Horizon</i> , and the Companies Involved	
The Deepwater Horizon. Figure 3.1. Deepwater Horizon. Figure 3.2. Main deck. Figure 3.3. Decks. Figure 3.4. Mud pits and moon pool. Figure 3.5. Subsurface portion of the Deepwater Horizon. Figure 3.6. Blowout preventer. Figure 3.7. Blowout preventer. Figure 3.8. Deepwater Horizon's organizational structure.	24 26 27 28 28 29 29 30 31
Chapter 4.1 Flow Path	U
 Figure 4.1.3. Flow up the production casing. Figure 4.1.4. Exterior of the Macondo production casing hanger and seal assembly. Figure 4.1.5. Interior of the Macondo production casing hanger compared to new equipment. Figure 4.1.6. Undamaged metal edges of the casing hanger and seal assembly. Figure 4.1.7. Halliburton post-cement-job report. 	39 40 41 44 45 46 48
Figure 4.1.8. Erosion of the inside of the casing hanger. Figure 4.1.9. 16-inch casing and rupture disks.	49 50
Chapter 4.2 Well Design	
 Figure 4.2.1. Artist's rendering of the Macondo well. Figure 4.2.2. Narrow drilling margins. Figure 4.2.3. Annular pressure buildup (APB). Figure 4.2.4. Offset wells and seismic data. Figure 4.2.5. Rupture disks. Figure 4.2.6. Protective casing. Figure 4.2.7. Casing options in deepwater drilling. Figure 4.2.8. Timeline of drilling events. Figure 4.2.9. Cementing a long string vs. cementing a liner. 	53 54 55 56 57 57 58 59 62

Chapter 4.3 | Cement

Figure 4.3.1. Typical completed cement job.	67
Figure 4.3.2. Sample caliper log data showing open hole diameter by depth.	68
Figure 4.3.3. Centralizer.	68
Figure 4.3.4. Top view of off-centered casing.	69
Figure 4.3.5. Centralizer sub.	69
Figure 4.3.6. Float valve conversion.	70
Figure 4.3.7. Full bottoms up.	70
Figure 4.3.8. Wiper plugs cause cement contamination.	71
Figure 4.3.9. Lift pressure.	72
Figure 4.3.10. Bumping the plugs.	73
Figure 4.3.11. Cement bond log tool.	74
Figure 4.3.12. Remedial cementing—squeeze job.	75
Figure 4.3.13. Centralizer sub (top) and slip-on centralizer with stop collars (bottom).	83
Figure 4.3.14. Gregg Walz April 16, 2010 email to John Guide about centralizers.	84
Figure 4.3.15. Centralizers delivered to the <i>Deepwater Horizon</i> on April 16, 2010.	85
Figure 4.3.16. John Guide April 16, 2010 email to Gregg Walz about centralizers.	85
Figure 4.3.17. Auto-fill float collar.	88
Figure 4.3.18. BP's pre-cementing mud circulation.	91
Figure 4.3.19. Decision tree. Figure 4.3.20. Clogged reamer shoe.	94 101
Figure 4.3.20. Clogged reamer shoe. Figure 4.3.21. Ball forced through tube.	
Figure 4.3.21. Ban forced through tube. Figure 4.3.22. Page 23 of Halliburton's April 18, 2010 OptiCem™ report.	101
Figure 4.3.22. Tage 23 of framburton's April 10, 2010 Opticem Teport.	109
Chapter 4.4 Foamed Cement Stability	
Figure 4.4.1. Foam testing apparatus.	112
Figure 4.4.2. Foam testing apparatus.	112
Figure 4.4.3. Foam testing apparatus.	112
Figure 4.4.4. Halliburton evidence of test times.	118
Chapter 4.5 Temporary Abandonment	
	0
Figure 4.5.1. Planned configuration after temporary abandonment.	128
Figure 4.5.2. Lockdown sleeve.	129
Figure 4.5.3. BP subsea wells organization.	130
Figure 4.5.4. Multiple last-minute revisions to the temporary	100
abandonment procedure.	132
Figure 4.5.5. Bridge plug.	137
Chapter 4.6 Negative Pressure Test	
Figure 4.6.1. Well integrity tests.	143
Figure 4.6.2. Seal assembly test.	144
Figure 4.6.3. Positive pressure test.	145
Figure 4.6.4. Negative pressure test.	146
Figure 4.6.5. End of cement to temporary abandonment.	146
Figure 4.6.6. Preparations for the negative pressure test.	147
Figure 4.6.7. First test failure.	148
Figure 4.6.8. Second test failure.	148
Figure 4.6.9. Negative pressure test progress, 3 p.m. on April 20, 2010.	149
Figure 4.6.10. 4 p.m.	150
Figure 4.6.11. 4:53 p.m.	151
Figure 4.6.12. 4:55 p.m.	152
Figure 4.6.13. 4:58 p.m.	153
Figure 4.6.14. 5:10 p.m.	154
Figure 4.6.15. 5:26 p.m.	155
Figure 4.6.16. 5:53 p.m. Figure 4.6.17. Bladder effect.	156
Figure 4.6.18. 6:40 p.m.	157
Figure 4.6.19. Spacer migration.	158
i guie 4.0.19. opacei inigration.	159

Chapter 4.7 Kick Detection	
Figure 4.7.1. Active pit volume in a closed-loop system. Figure 4.7.2. Active pit volume in a non-closed-loop system.	166 167
Figure 4.7.3. Hitec data display.	169
Figure 4.7.4. Sperry-Sun data display.	169
Figure 4.7.5. Flow-out sensors and flow line camera.	170
Figure 4.7.6. Transocean's <i>Deepwater Horizon</i> Emergency Response Manual.	171
Figure 4.7.7. Rig personnel on duty during the final displacement.	174
Figure 4.7.8. Erratic vs. normal flow-out.	175
Figure 4.7.9. Typical flow-out signature vs. spike at 9:08 p.m. Figure 4.7.10. Drill pipe pressure anomalies from 9:01 to 9:14 p.m.	178
Figure 4.7.10. Drill pipe pressure and kill line pressure anomalies from	179
9:27 to 9:40 p.m.	180
Figure 4.7.12. Last two hours of Sperry-Sun data.	191
Chapter 4.8 Kick Response	
Figure 4.8.1. Diverter system.	195
Figure 4.8.2. BOP control panels on the rig floor and bridge.	197
Figure 4.8.3. BOP control panels on the rig floor and bridge.	197
Figure 4.8.4. Transocean's "procedures for handling gas in the riser."	201
Chapter 4.9 The Blowout Preventer	
Figure 4.9.1. Transporting the <i>Deepwater Horizon</i> BOP.	203
Figure 4.9.2. The <i>Deepwater Horizon</i> blowout preventer stack.	204
Figure 4.9.3. The <i>Deepwater Horizon</i> blowout preventer stack.	204
Figure 4.9.4. Blind shear ram.	204
Figure 4.9.5. Tool joint in the blind shear ram.	205
Figure 4.9.6. <i>Deepwater Horizon</i> blowout preventer's closed blind shear ram (top view).	207
Figure 4.9.7. AMF system.	207 209
Figure 4.9.8. BOP's electrical schematic.	209
Figure 4.9.9. Erosion in the BOP.	212
Chapter 5 Overarching Failures of Management	
Figure 5.1. BP internal presentation slide.	226
	220
Chapter 6 Regulatory Observations	
Figure 6.1. Chapter 3 of the Commission's full report.	251
Figure 6.2. BOEMRE organizational chart for the Gulf of Mexico region	
in July 2010.	252
Figure 6.3. MMS regulation 30 C.F.R. § 250.428. Figure 6.4. MMS regulation 30 C.F.R. § 250.401.	255
Figure 6.5. BP's April 16 application for permit to modify.	257 258
rigure 0.5. Dr 8 April 10 application for permit to mouny.	250

Tables

Chapter 4.3 Cement	
Table 4.3.1. Low pressure observed after circulation established.	90
Table 4.3.2. Plans reduce pre-cement circulation volumes and rates.	92
Table 4.3.3. Cementing volumes.	93
Table 4.3.4. Flow rate and differential pressure needed to convert.	100

Chapter 4.4 | Foamed Cement Stability

Table 4.4.1. Halliburton's internal laboratory data concerning the stability of the Macondo cement slurry.	122
Chapter 4.7 Kick Detection	
Table 4.7.1. Personnel and places with access to the rig's Sperry-Sun data.	173
Chapter 4.9 The Blowout Preventer	
Table 4.9.1. Control pod battery replacements (based on available records). Table 4.9.2. Leaks on the <i>Deepwater Horizon</i> blowout preventer (partial list). Table 4.9.3. Modifications to the <i>Deepwater Horizon</i> blowout preventer.	211 214 218-19
Chapter 5 Overarching Failures of Management	
Table 5.1. Timeline of changes to the temporary abandonment procedure. Table 5.2. Examples of decisions that increased risk at Macondo while potentially	233
saving time.	246