Power-knowledge and the performativity of risk regulation in the Australian pipeline industry

Dolruedee Kramnaimuang King

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A thesis submitted for the degree of Doctor of Philosophy of The Australian National University

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Declaration

I hereby declare that this thesis is authentic except where acknowledgment is made in the text. I also verify that I have fully cited and referenced all material and results that are not original to this work.

SIGNED:.................................................................

Dolruedee Kramnaimuang King
Acknowledgements

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Abstract

Questions about regulatory effectiveness arise in the wake of catastrophic events involving technological risk. Criticism is often couched in terms of ‘regulatory failure’ or ‘regulatory capture’, reproducing discourses of responsibility that take regulatory failure for granted. These discourses black box ideas of ‘failure’ and ‘capture’ and, in so doing, fail to address a range of alternative, albeit largely underexplored, discourses and assemblages implicated in the power relationships that shape regulatory knowledge and practices.

This thesis explores such discourses and assemblages employing a critical and empirical approach inspired by Actor-Network Theory (ANT) and the concept of Foucauldian power-knowledge. It asks how power-knowledge in relation to risk regulation is performed by and around regulators in the Australian pipeline industry, and how the process of power-knowledge in relation to risk regulation might be improved.

Key themes that emerged from the research include: the logics that underpin multiple regulatory assemblages across Australian states; the regulatory apparatuses through which regulation is enacted; technical-regulatory specifications; deregulation; and energy privatisation. Broadly, the findings indicate a number of incoherences of knowledge and practices in relation to risk regulation throughout the regulatory process.

Regulators have a certain logic of thinking and doing in relation to safety practices. This logic comprises the largely taken-for-granted assumptions that: the regulation of pipeline risk revolves around two interdependent parties – pipeline regulators and pipeline industries; pipelines are physically safe; risks can be regulated using technical-physical controls; regulation inevitably relies on industry knowledge and activities; and regulation depends on the establishment of good relationships with industry. This logic is, however, inadequate for dealing with differences of regulatory practices across Australian states and the challenges of adopting a harmonised Australian pipeline standard.

The regulatory apparatuses considered here included Safety Plans, risk-based regulation, and social-regulatory controls. Actual field safety practices were found to manifest differently from the text in Safety Plans – documents that contain regulatory requirements mandating pipeline industries to identify and control risks. These
differences were associated with: (a) organisational factors such as cost-cutting; (b) safety plans being seen as bureaucratic red-tape undertaken to secure pipeline licenses; (c) insufficient understanding of technical safety knowledge in relation to accountability in lieu of regulatory complexity; and (d) misunderstandings around the intentions and principles of workforce engagement.

Limitations in risk-based practice were evident in the contradiction between regulators’ reliance on industrial knowledge and self-regulatory activities when managing pipeline risks and industries’ reluctance to share safety knowledge with regulators. Regulators were able only to partially inspect risky activities due to limited resources. At the same time, potential to utilise social-regulatory controls was not realised due to limited familiarity among pipeline professions with opportunities for workforce and trade union engagement. Workforces were involved in the assessment and management of personal safety (low risk) but not in assessing major hazards (high-level process risk).

Investigation of technical-regulatory specifications revealed that knowledge about pipeline dangers was incoherent among actors. The ‘measurement length’ specification (referred to in lay terms as a ‘blast zone’) obfuscates understanding of pipeline dangers and leads to mismatching practices in risk accountability, risk assessment and risk communication. Knowledge about pipeline dangers in relation to measurement length tends to be limited to those involved with the encroachment of interested third parties (pipeline industries, associated authorities and entities) but not with those groups who live, study and work within danger zones.

Regulators face difficulties in using regulatory tools to cope with newly emergent risks arising from the complexity of pipeline ownership shaped by deregulation and energy privatisation. Regulators have become less effective in regulating pipeline risk in the face of multiple ownership and operation arrangements involving different companies. The effects of novel risk have also shaped the knowledge of other actors outside of regulatory control. The public lacks knowledge of additional costs for services, and of which institutions they can rely on to seek advice for gas repairs. The transferal of safety knowledge has become disassociated among pipeline engineers, field pipeline managers and pipeline technicians. As a consequence, regulators are enmeshed in incoherent discourses and practices involving deregulation, privatisation and the conduct of conduct within a ‘precarious regulatory regime’.
Finally, with the aim of improving risk regulation, the incoherences summarised above are re-framed into three stages: (a) re-arranging the risk knowledge of regulators; (b) co-producing regulatory practices with diverse actors apart from pipeline industries; and (c) strengthening the co-accountability of regulators and pipeline industries.
# Table of Contents

Declaration .................................................................................................................................. iii
Acknowledgements .................................................................................................................... v
Abstract ....................................................................................................................................... vii
Table of Contents .................................................................................................................. xi
Lists of Tables ......................................................................................................................... xv
Lists of Figures ......................................................................................................................... xvii
List of Abbreviations ............................................................................................................... xix

## PART I Context, theory and method

Chapter 1 Research setting, problems and questions .......................................................... 1
  1.1 Research into energy pipelines ....................................................................................... 1
    1.1.1 Who has been made responsible? .......................................................................... 2
  1.1.2 Who have become the focal actors for risk reduction? ............................................. 4
  1.1.3 A black box of discourses associated with regulatory failures ............................ 5
  1.2 Research setting .......................................................................................................... 8
    1.2.1 Energy pipeline industries ..................................................................................... 8
    1.2.2 The research setting in Australia .......................................................................... 12
  1.3 Thesis structure ........................................................................................................... 17
Chapter 2 Theories of risk regulation, ANT, and power .................................................. 21
  2.1 Regulating technological risks: exploring existing theories ...................................... 21
    2.1.1 Risk in regulatory approaches and theories ......................................................... 22
    2.1.2 Risk within organisations, in between and beyond ............................................. 38
    2.1.3 Inclusive risk governance: how risk ‘should be regulated’ ................................. 49
    2.1.4 Limitations of contemporary theories ................................................................ 53
  2.2 What approach does this thesis take? .......................................................................... 55
    2.2.1 ANT background and philosophy ...................................................................... 55
    2.2.2 Key features of ANT ......................................................................................... 58
    2.2.3 ANT Limitations .............................................................................................. 63
Chapter 3 Methodology: power-knowledge and risk regulation ....................................... 65
  3.1 Philosophical stance and reflexivity .......................................................................... 65
  3.2 Operationalisation of the methodological framework .................................................. 67
    3.2.1 Method assemblage ............................................................................................ 67
    3.2.2 Sampling justification and the symmetrical approach of ANT ......................... 72
  3.3 Difficulties with power-knowledge assemblages ....................................................... 74
3.3.1 Trust and confidentiality ..................................................................................... 74
3.3.2 Difficulties in accessing interviewees ................................................................. 76
3.4 Data analysis processes and strategies ......................................................................... 79
  3.4.1 Operationalising key research questions ............................................................... 80
  3.4.2 Four emerging relational assemblages ................................................................. 82
  3.4.3 Emerging research themes .................................................................................. 84
Conclusion ...................................................................................................................... 89

PART II Discussion section
Chapter 4 Regulator ontological stances and the multiplicity of regulatory practices ........................................ 90
  4.1 Ontological stance and the regulation of pipeline risks ................................................. 93
    4.1.1 Five constituents of the pipeline regulators’ ontological-epistemological logic ...... 94
    4.1.2 Ontological-epistemological logic: a form of regulatory capture ......................... 101
  4.2 Multiplicity of regulatory practices .......................................................................... 103
    4.2.1 Overarching multiple assemblages at different geographical levels .................. 104
    4.2.2 Multiplicity: differences among regulatory practices across Australian states ...... 105
    4.2.3 The incoherence of risk-based practices and the challenges ............................... 122
Conclusion .................................................................................................................... 123

Chapter 5 The incoherence of knowledge and practices within regulatory apparatus ........................................ 125
  5.1 The incoherence of safety knowledge and safety practices in safety plans .................... 127
    5.1.1 A safety plan and the reasons for investigation .................................................. 127
    5.1.2 Safety plans in the making ................................................................................ 128
    5.1.3 Tracing the reasons for incoherence between safety plans and field safety practices ................................................................................................................. 132
  5.2 Incoherence in understanding and implementing risk-based regulation in the Australian pipeline context ................................................................................................................................. 136
    5.2.1 How is risk-based regulation understood and implemented in Australian pipeline industries? .......................................................................................................................... 136
    5.2.2 Incoherence in advancing the implementation of risk-based regulation: a relational power-knowledge effect ...................................................................................... 139
  5.3 Power-knowledge in relation to tripartite collaboration and workforce engagement in the Australian pipeline context ................................................................. 142
    5.3.1 Understanding of tripartite and workforce engagement ......................................... 143
    5.3.2 Shaping the incoherence of risk assessment practice .............................................. 148
    5.3.3 Power-knowledge in relation to safety knowledge and safety practices in pipeline industries .................................................................................................................. 153
Conclusion .................................................................................................................... 154
Chapter 6  The incoherence of knowledge and practices in relation to pipeline risks and public safety ................................................................. 156

6.1 The enactment of technical-regulatory knowledge of pipeline risks ........................................ 159

6.1.1 Measurement length and its enactment in a power-knowledge assemblage .......... 162

6.1.2 Incoherence of knowledge about pipeline dangers among actors ....................... 166

6.2 Enacting measurement length and the distortion of risk accountability, assessment, and communication ............................................................. 167

6.2.1 The incoherent practice of accountability and risk assessment ......................... 170

6.2.2 The practice of risk communication is muddled ................................................. 173

6.2.3 The incoherent practice of risk communication ................................................. 176

6.3 Knowledge about pipeline risks is uncommon and made uncommon .................. 179

6.3.1 Knowledge of pipeline risks is uncommon among third parties ....................... 182

6.3.2 The incoherent knowledge of pipeline risks within pipeline industries, regulatory institutions, and other authorities ............................................. 187

Conclusion .................................................................................................................... 190

Chapter 7 The influence of deregulation and energy pipeline privatisation on the coherence of power-knowledge practices ................................................. 191

7.1 Existing concepts of deregulation and energy pipeline privatisation associated with power-knowledge ................................................................. 194

7.1.1 Neoliberalism ................................................................................................. 194

7.1.2 Neoliberalism in the energy sectors .................................................................. 195

7.1.3 Governmentality in governing pipeline risks at a distance ................................. 196

7.2 The performativity of deregulation, energy privatisation, and neoliberalism ............. 198

7.2.1 Deregulation .................................................................................................... 199

7.2.2 Energy privatisation ......................................................................................... 200

7.2.3 Other neoliberal forms or techniques ................................................................. 204

7.3 Complex stewardship structures: the unpredictable and uncontrolled effects of neoliberalism ......................................................................................... 211

7.3.1 Deficits of accountability .................................................................................. 212

7.3.2 The limitations of regulatory action in mitigating pipeline risks ....................... 215

7.3.3 Knowledge about services is unavailable to the public ..................................... 217

7.3.4 Discontinuities of knowledge transferral among pipeline companies ................ 218

Conclusion .................................................................................................................... 222

PART III Implications, conclusions and the future

Chapter 8 Performing new power-knowledge practices in a precarious regulatory regime ............................................................................................................. 224

8.1 Proposals for the improvement of regulatory practices and effectiveness .................. 226
8.2 Ontology of risk in association with power-knowledge practices ........................................ 235
  8.2.1 Multiplicity...................................................................................................... 237
  8.2.2 Negotiation...................................................................................................... 238
  8.2.3 Incoherence (or disassociation) ......................................................................... 238
8.3 Performing new power-knowledge practices in relation to risk regulation ....................... 239
  8.3.1 Re-arranging the ontology of risk regulation ...................................................... 239
  8.3.2 Co-performing power-knowledge practices in co-regulating risk ......................... 245
  8.3.3 Co-accountability............................................................................................. 254
Conclusion .................................................................................................................... 257
Chapter 9 Conclusions and the future ........................................................................... 260
Appendix. Interview Protocol (sample) ........................................................................ 265
References ..................................................................................................................... 271
Lists of Tables

Table 2.1: Three broader groups of theories that deal with hazardous industries and risk........21
Table 3.1: Interviewees and their details.................................................................71
Table 3.2: The operationalisation from ‘modified key research questions’ to
‘interview questions’ and interview themes. .........................................................80
Table 3.3: Examples of coding.................................................................................85
Table 4.1: Assemblages at different geographical levels. ........................................105
Table 4.2: The multiplicity of overall assemblages in each state.............................107
Table 4.3: Differences between regulatory practices associated with
accidents and their impacts.............................................................................109
Table 4.4: Differences between regulatory practices associated with
salary systems.................................................................................................110
Table 4.5: Differences between regulatory practices associated with
industrial policy and activities......................................................................113
Table 4.6: Differences between regulatory practices associated with
the organisational structure..........................................................................115
Table 4.7: Differences between regulatory practices associated with
styles of auditing process..............................................................................116
Table 4.8: Differences between regulatory practices associated with
the approval process of a safety plan..............................................................119
Table 4.9: Differences between regulatory practices associated with
the disclosure of industrial pipeline performance........................................121
Table 5.1: Reasons for the incoherence of safety knowledge between
a safety plan and safety field practices...........................................................132
Table 5.2: The interview-questions of this thesis..................................................142
Table 5.3: The incoherence of risk assessment practice between process safety
and personal safety. ....................................................................................149
Table 6.1: Physical and procedural controls employed by pipeline institutions
to prevent external interferences.....................................................................161
Table 7.1: Summary of national regulation............................................................202
Table 7.2: Summary of market institutions of key relevance to the national energy market..203
Table 8.1: Four sets of relational assemblages that shape knowledge and practices
in the process of risk regulation.....................................................................226
Table 8.2: Proposals for improving regulatory practices and effectiveness,
based on participant knowledge..................................................................229
Table 8.3: Examples of conventional and non-conventional actors..........................246
Table 8.4: Rationales to strengthen a hybrid regulatory forum, containing six criteria....252
Lists of Figures

Figure 1.1: The relative invisibility of pipeline risks .............................................................. 9
Figure 1.2: Examples of highly visible energy industries: nuclear power plants and coal mines .................................................................................................................. 10
Figure 1.3: Location of Australia’s gas pipelines and gas resources ....................................... 15
Figure 2.1: A diagram of a risk-based framework ................................................................ 24
Figure 2.2: AS2885.1 Risk matrix ........................................................................................ 26
Figure 2.3: A diagram showing the broad scoping of the risk-based approach encompassing a Pipeline Management System (PMS) .......................................................... 27
Figure 2.4: A diagram showing the broad scoping of the risk-based approach encompassing a safety case ................................................................................................ 28
Figure 2.5: A model regulatory pyramid for regulating pipeline risks ................................... 31
Figure 2.6: Relationship between stakeholder participation and risk categories in risk governance ................................................................................................................. 52
Figure 3.1: The research inquiry process, articulated using the model of Crotty ........................ 65
Figure 3.2 Example of sequential mind mapping of the complex and messy data ..................... 84
Figure 3.3: The process and practice of the methodological framework used in this thesis .... 88
Figure 4.1: Chapter 4 outline ............................................................................................. 92
Figure 5.1: The process of analysis and discussion of Chapter 5 ............................................. 126
Figure 6.1: The process of analysis and discussion of Chapter 6 ............................................. 159
Figure 6.2: An illustration of a blast zone (600 feet or 183 meters) of the San Bruno pipeline explosion and the consequence. The San Bruno gas transmission pipeline was 30 inches in diameter, had a 0.375 inch wall thickness, and a pressure of 375 pounds per square inch (psi) ................................................................................. 164
Figure 6.3: An overview of the fire at San Bruno .................................................................. 165
Figure 6.4: Burned houses around the site of the San Bruno pipeline explosion ................. 165
Figure 6.5: A summary of the assemblages and the research themes ..................................... 169
Figure 6.6: Illustrations of a sign post near a residential area .............................................. 180
Figure 7.1: The process of analysis and discussion of Chapter 7 ............................................. 193
Figure 7.2: An example of the complex assemblage through contractual arrangement ....... 204
Figure 7.3: Illustration of one interconnected pipeline located between two state authorities under a complex stewardship structure ................................................................. 215
Figure 7.4: Illustration of a contractual chain ..................................................................... 216
Figure 7.5: An illustration of pipeline stations and control office centres ............................... 220
Figure 8.1: The process of analysis and discussion of Chapter 8 ........................................... 225
Figure 8.2: The process and potential outcomes of performing new power-knowledge practices in the process of risk regulation .......................................................... 256
## List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>ACT</td>
<td>Australian Capital Territory</td>
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<tr>
<td>AEMA</td>
<td>Australian Energy Market Agreement</td>
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<tr>
<td>AEMC</td>
<td>Australian Energy Market Commission</td>
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<tr>
<td>AER</td>
<td>Australian Energy Regulator</td>
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<tr>
<td>ALARP</td>
<td>As Low As Reasonably Practicable</td>
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<tr>
<td>AFESAC</td>
<td>Australasian Fire and Emergency Service Authorities Council</td>
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<tr>
<td>ANT</td>
<td>Actor-Network Theory</td>
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<td>APGA</td>
<td>Australian Pipelines and Gas Association</td>
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<td>APD</td>
<td>Australian Pipeline Database</td>
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<tr>
<td>AS2885</td>
<td>Australian pipeline standard</td>
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<tr>
<td>BREE</td>
<td>Bureau of Resources and Energy Economics</td>
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<tr>
<td>COAG</td>
<td>Council of Australia Government</td>
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<tr>
<td>CSG</td>
<td>Coal Seam Gas</td>
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<tr>
<td>EIA</td>
<td>The U.S. Energy Information Administration</td>
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<td>EPCRC</td>
<td>Energy Pipelines Cooperative Research Centre</td>
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<td>HAZOP</td>
<td>Hazard and Operability Studies</td>
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<td>HROs</td>
<td>High Reliability Organisations</td>
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<td>HSRs</td>
<td>Workforce Health and Safety Representatives</td>
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<td>JHA</td>
<td>Job Hazard Analysis</td>
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<td>KPIs</td>
<td>Key Performance Indicators</td>
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<tr>
<td>LNG</td>
<td>Liquefied Natural Gas</td>
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<tr>
<td>MHIDAS</td>
<td>Major Hazardous Incident Data Service</td>
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<td>MHF</td>
<td>Major Hazard Facilities</td>
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<td>NGL</td>
<td>National Gas Law</td>
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<td>NGR</td>
<td>National Gas Rules</td>
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<td>NEM</td>
<td>National Energy Market</td>
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<td>NSW</td>
<td>New South Wales</td>
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<td>NT</td>
<td>Northern Territory</td>
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<td>PMS</td>
<td>Pipeline Management System</td>
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<tr>
<td>OECD</td>
<td>Organisation for economic co-operation and development</td>
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<td>OHS</td>
<td>Occupational Health and Safety</td>
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<td>OHSE</td>
<td>Occupational Health, Safety and Environment</td>
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<td>QLD</td>
<td>Queensland</td>
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<td>SA</td>
<td>South Australia</td>
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<td>SAOP</td>
<td>Safety and Operating Plan</td>
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<td>SMS</td>
<td>Safety Management Study</td>
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<td>TAS</td>
<td>Tasmania</td>
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<td>UK</td>
<td>United Kingdom</td>
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<tr>
<td>US or USA</td>
<td>United States of America</td>
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<tr>
<td>USSR</td>
<td>The Union of Soviet Socialist Republics</td>
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<td>VIC</td>
<td>Victoria</td>
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<td>WA</td>
<td>Western Australia</td>
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Chapter 1
Research setting, problems and questions

1.1 Research into energy pipelines

On Thursday evening the 6th of September 2010, a massive ambient temperature difference occurred in San Bruno, California, USA: massive, that is, compared to temperatures experienced on other nights. It was a generally peaceful evening: residents were cooking dinner, some were relaxing with their families, others were just arriving home. The sudden rupture of an interstate national gas transmission pipeline (Line 132) owned by the Pacific Gas and Electric Company (PG&E) transformed their evening into a chaotic event (National Transportation Safety Board, 2010b, p. 1). Initially, the residents could not comprehend what had happened. One person described it as ‘[w]hen you’re in a dream and you try to run as fast as you can but feel like you’re getting nowhere, like you’re in quicksand — that’s how it felt’ (Rebecca & Lisa, 2015, para. 3). The release of natural gas ignited resulting in an explosion that triggered an intense fire. The latter burned for two days, killed eight people, injured many, and destroyed 38 homes (Hayes, 2014, p. 1). Most of the buildings in the suburb of San Bruno were damaged (ibid).

Catastrophic events associated with energy pipeline industries have occurred in many countries. Ramírez-Camacho, Federica, Elsa, Roberto, and Joaquim (2017, p. 36) report that according to the Major Hazardous Incident Data Service (MHIDAS), 1,431 pipeline accidents (both on-shore and off-shore pipelines) were recorded in 95 countries between the beginning of the 20th century and November 2006. Energy accidents involving pipelines have resulted in massive social and economic costs. These accidents caused 182,156 deaths (Sovacool, 2008, p. 1802). The preliminary study conducted by Sovacool (2008) calculated the cost of failures resulting in 279 major global energy accidents, including natural gas pipelines, coal, nuclear, oil, hydroelectric, and renewable sources at approximately US$41 billion in property damage (p. 1802).
This study’s review of catastrophic energy accidents¹, including pipeline energy industries, raised two important questions: (a) who has been made responsible when industrial risks become manifest (discussed in Section 1.1.1); and (b) who have become the focal actors for risk reduction (discussed in Section 1.1.2)?

1.1.1 Who has been made responsible?

When accidents involving energy industries occur, discourses of risk that are critical of regulatory failures gain prominence. This phenomenon is observable in many catastrophic energy accidents. An assessment of the San Bruno incident investigation reads as follows:

The pipeline safety regulator within the state of California failed to detect the inadequacies in PG&E’s integrity management program and that the Pipeline and Hazardous Materials Safety Administration integrity management inspection protocols need improvement (National Transportation Safety Board, 2010b, p. xi).

An evaluation by the Deepwater Horizon Study Group of the Deepwater Horizon incident claimed that:

There was not any effective industry or regulatory checks and balances in place to counter act [sic] the increasingly deteriorating and dangerous situation on Deepwater Horizon. Thus, as a result of a cascade of deeply flawed failure and signal analysis, decision-making, communication, and organisational-managerial processes, safety was compromised to the point that the blowout occurred with catastrophic effects (Deepwater Horizon Study Group, 2011, p. 9).

Subsequent to the Fukushima incident in 2011, the following report was issued:

A major factor that contributed to the accident was the widespread assumption in Japan that its nuclear power plants were so safe that an

¹ Examples of catastrophic energy accidents include: the 2004 Ghislenghien pipeline incident (Belgium) (Hayes & Hopkins, 2014a); the 2010 Marshall pipeline incident (USA) (ibid); the 1980 offshore Alexander Kielland Flotel incident (Norway) (Lindoe, Baram, & Renn, 2014); the 1988 offshore Piper Alpha incident (UK) (ibid); the 2009 offshore Montara incident (Australia) (ibid); the 2010 offshore Deepwater Horizon incident (USA) (ibid); the 2010 Pike River Mine incident (New Zealand) (Royal Commission on the Pike River Coal Mine Tragedy, 2012) and the 2011 Fukushima incident (Japan) (Wang & Chen, 2012).
accident of this magnitude was simply unthinkable. This assumption was accepted by nuclear power plant operators and was not challenged by regulators or by the Government. As a result, Japan was not sufficiently prepared for a severe nuclear accident in March 2011 (Amano, 2015, p. Foreword).

An evaluation of the 2010 Pike River Mine incident in New Zealand reported that:

There was inadequate regulatory oversight of the electrical system from 2009 onwards, owing to a lack of expertise within the DOL mines inspectorate (Royal Commission on the Pike River Coal Mine Tragedy, 2012, p. 154).

The Royal Commission investigating New Zealand’s 2010 Pike River Coal Mine accident summarised the main themes appertaining to regulatory problems that occurred in mining cases. They included: ‘an insufficient regulatory framework and the health and safety regulator not properly conducting inspections nor ensuring legislative compliances’ (Royal Commission on the Pike River Coal Mine Tragedy, 2012, p. 261).

In light of these and other catastrophic accidents, the contemporary literature consistently targets the failures of regulators and regulatory frameworks (see for example: Royal Commission on the Pike River Coal Mine Tragedy, 2012, pp. 154, 261; Sanjour, 2012; Wang & Chen, 2012). Regulators are criticised for exercising inadequate regulatory oversight, for exhibiting insufficient regulatory expertise; and for enacting either weak or unduly complex regulatory frameworks.

In brief, a review of catastrophic accidents reveals that regulatory failures feature among the foremost causal themes peculiar to catastrophic accidents. It thus comes as no surprise that regulators have been made responsible for catastrophic accidents. However, such discourse has become problematic in research exploration and analysis, a controversy I address in Section 1.1.3. Next, the question of ‘who have been the focal actors for risk reduction?’ will be discussed.
1.1.2 Who have become the focal actors for risk reduction?

It is not unusual in the aftermath of catastrophic accidents to note a trend emerging *vis-à-vis* a particular discourse that renders certain types of actors the central focus for risk reduction.

After the pipeline explosion in Kern County in the US, it was reported that:

Dozens of families in a rural California town had to evacuate their homes after a natural gas pipeline under their neighbourhood started leaking toxic gas, the families claim[ed] in court. The families, including several minor children [sic], sued the owner of the pipeline, Petro Capital Resources, in Kern County Superior Court Thursday, claiming that Petro never disclosed that the pipeline ran under their Nelson Court neighbourhood in Arvin. "This is a legitimate case in which people were harmed with personal injury and property damage. Bottom line, they did nothing to cause this to happen," attorney Steven Archer told Courthouse News (Kearn, 2016, paras 1-3)

Omodanisi, Eludoyin, and Salami (2014) examined a pipeline explosion associated with pipeline vandalisation that impacted on the Ilado-Odo community in Lagos State in Nigeria. They stated that:

Our study involves the use of satellite imageries, ecological sampling, questionnaire and personal interaction with some of the victims of the December 2006 pipeline fire in Ilado-Odo community in Lagos State, Nigeria. We attributed the causes of pipeline fires to poor pipeline network monitoring, poor communication and transportation in the vulnerable communities, and the inability of the pipeline management agency to ensure adequate community participation. We found that the biotic and abiotic components of the Ilado-Odo community were severely impaired, and we think that the impact may last for a long time if there is no post-disaster recovery programme (Omodanisi et al., 2014, p. 1635).

Research exploring the BP Deepwater Horizon event concluded the following:

The BP Deepwater Horizon oil spill is recognized as the largest marine oil spill in U.S. history. In this article, we examine the impact of the BP oil spill on directly affected commercial fishers and indirectly affected residents of
the greater New Orleans metropolitan area. A sample of 148 participants responded to an open-ended question on the impact of the oil spill on self, family, and their community at least 12 months after the oil spill began. Content analysis of their narrative text yielded four emergent themes which we present here: 1) Economic Impact on the Seafood Industry and Local Businesses; 2) Commercial Fishers’ Financial Future; 3) BP’s Response: “Making it Right” or Making it Worse?; and 4) Lingering Worries and Fears: Threats to Fishers’ Health and Lifestyle. Implications of these findings for individuals and families exposed to a decade of natural and technological disasters are considered (Cherry et al., 2015, p. 576).

An assessment of the Chernobyl and Fukushima nuclear meltdown incidents asked:

What, then, have we learnt so far from the experiences of the Chernobyl and Fukushima accidents? For sure, confirmation that high whole-body doses received over a brief period will produce acute radiation syndrome and death if the doses are sufficiently high, and that high doses to the thyroids of children will increase the risk of thyroid cancer. Also, that unless the effect is clear (as with thyroid cancer among those exposed as children), obtaining reliable results from epidemiological studies of populations is challenging in countries where accurate and uniform tracing of individuals, and diagnosis and recording of diseases, is uncertain (Wakeford, 2016, p. E4).

My review of industrial catastrophe cases shows that there are certain types of actors who have become the focus of attention among social movements and social research. According to the statements above, they include: (a) affected residents; (b) affected communities; (c) affected fishers; and (d) affected children. In addition, I have found that affected groups in general have become the entry points for the investigation of risk around energy industries, both by social movements and social research. In contrast, research into regulatory institutions and the utilisation of their regulatory devices in regulating technological risks has remained relatively underexplored.

1.1.3 A black box of discourses associated with regulatory failures

Certain issues emerged from my review of the literature on catastrophic energy accidents (see Sections 1.1.1 and 1.1.2.). First, the discourses that circulate around catastrophic accidents focus consistently on the question of who is responsible. These
discourses of responsibility (or culpability) typically critique regulatory experts (or elite-expert institutions) and the regulatory devices (or regulatory apparatuses) they utilise. These instruments are problem solving tools that regulators use to regulate risk posed by energy industries. The majority of criticism targets the failures of regulators and their approaches to controlling risk. In a corresponding discourse involving the affected actors alluded to earlier, the ameliorative actions of relevant social movements and subsequent social research tend to focus on reducing the risks faced by affected groups of actors rather than on exploring what has been happening within the elite-expert institutions they critique. Questions that are not typically asked include: what forms of regulatory knowledge and practices are being implemented to regulate risk, what has worked well and what has not worked well, and how and in what way can regulatory knowledge and practices in relation to the regulation of risk (hereafter risk regulation) be improved? Furthermore, discourses pertinent to responsibility tend to set distinctions among experts, the public, affected groups, technical devices, society etc. Does the value and contribution of knowledge to reduce risk, as associated with these distinctive entities, become relatively isolated from the relational network and set of entities in which it is embedded?

Perhaps more importantly, do the discourses of responsibility alluded to above ‘black box’ the role of regulatory failure, in the process failing to address the power relationships that shape regulatory outcomes? In other words, has knowledge and practice around the processes of risk regulation in elite-expert institutions become disassociated from and unacknowledged in the existing literature detailing catastrophic events in energy industries?

This thesis is concerned with how regulatory entities interact through relationships of power to perform risk regulation and shape regulatory outcomes (the terminology associated with ‘perform’ is explained in Section 2.2.1.2). My approach and analysis, which are based on the notion that these entities are blended in heterogeneous assemblages, are underpinned and inspired by Actor-Network Theory (ANT). Latour (1996) suggests that: ‘it is utterly impossible to understand what holds society together without reinserting in its fabric the facts manufactured by natural and social sciences and the artefacts designed by engineers’ (p. 370).
I argue the need to open up the black box of discourses of responsibility relevant to both elite-expert institutions and their technical-regulatory devices. To this end, I engage in a process of analysing two key research questions. The first asks: how is power and knowledge in relation to risk regulation performed by and around regulators in a case study of pipeline industries in Australia? The first key question aims to investigate the process of involving power relationships that shape knowledge and practices in relation to regulatory outcomes (hereafter power-knowledge practices (discussed in detail in Chapter 2, Section 2.2.2.3)). This leads to the second key question: how can the processes of power and knowledge in relation to risk regulation be improved? These two research questions are explored with the goal of improving the process of risk regulation so as to improve regulatory practices and effectiveness (or regulatory outcomes).

This thesis adopts a critical and empirical approach. This thesis takes a stance derived from the critical theoretical approach of poststructuralism. It uses empirical findings to critically question and thence to propose a reconfiguration of existing theories and thinking. It utilises a critical process of analysis based on empirical grounds to explore assemblages of human and non-human entities and the ways in which they interact with regulators. These interactions are traced and re-traced with the intention of comprehending and mapping-out how power-knowledge relationships involving regulators are performed. Throughout this investigation, a number of research themes and assemblages implicated in knowledge practices vis-à-vis regulatory outcomes were revealed. In turn, the emergent themes and assemblages were empirically and theoretically reoriented with a view towards informing the performance of new power-knowledge practices in the process of risk regulation, the aim being to identify practical recommendations for improving regulatory practice.

The research setting used to explore the power-knowledge relationships that characterise the process of risk regulation takes the form of the Australian energy pipeline industry, a subject I discuss in the following section.
1.2 Research setting

1.2.1 Energy pipeline industries

Of all of the industries in the energy sector, energy pipelines attract by far the least attention including the attention of researchers. Pipelines are typically buried and, being physically invisible to the public eye, elicit comparatively little sense of risk or danger (McCutcheon & Skoien, 2017; Papadakis, 1999). Examples of the invisibility of pipelines are presented in Figure 1.1, and compared to other types of energy industry in Figure 1.2.

Some invisible hazards – such as the radiation associated with nuclear power plants – often elicit dread reactions and high levels of public concern (see for example: Hecht, 2012; Kuchinskaya, 2013; Reicher, Podpadec, Macnaghten, Brown, & Eiser, 1993). They are perceived as insidious as a consequence of their ability to affect our bodies without us being aware of them. The scale of nuclear accidents at Chernobyl and Fukushima reinforce these perceptions. Familiarity, however, can alleviate concern over hazardous facilities and normalise the presence of risk.

Members of the public are often familiar with using gas in domestic situations and, while they may be aware of risks associated with gas, it is reasonable to expect this familiarity will offset the potential for heightened perceptions of risk. Indeed, a common concern among members of the pipeline industry is ‘third party interference’; that is, damage to pipelines caused by incautious, dangerous activity.
Figure 1.1: The relative invisibility of pipeline risks.

Note: The photo on the left hand side was taken on the 10th September 2014. The photo on the right hand side was taken on the 1st April 2016. Photos by Dolrudee Kramnaimuang King.

Where are the energy pipelines in the above photos? Pipelines are invisible to the ordinary eye. They are indicated only by signposts such as those labelled ‘danger high pressure gasline’ or a sign on the path indicating ‘gas’. The image on the left hand side of Figure 1.1 shows the electricity line, which is part of the energy sector. But unlike electricity wires, energy pipelines are not visible to the public eye. They are out of sight, buried under the ground, despite traversing through densely-populated urban areas.
The majority of energy pipelines are invisible because they are commonly buried either underground or in the ocean. They pass quietly through towns, cities, regions and across countries and nations where they play their invisible roles in maintaining hydrocarbon economies and transmitting energy resources. Worldwide, approximately 3,500,000 km of transmission pipelines are transporting gas and oil (Hopkins, 2007b). Pipelines are ‘in between’ industries, transporting gas and oil and petroleum products from sites of energy production (e.g., drilling rigs both in offshore and onshore petroleum platforms, coal seam gas, and shale gas) to distribution points (e.g., petroleum refinery plants, power stations, pipeline pumping stations, and domestic households).

Pipelines are generally considered to be a safe approach to the transportation of dangerous substances (COWI, 2011, p. 27). Nevertheless, there are difficulties. As the majority of pipelines are buried underground or under water and oceans (Kandiyoti, 2008; Papadakis, Porter, & Wettig, 1999; Pates, 1996), and hence invisible to the human eye, people are not generally aware of their existence (Papadakis et al., 1999, p. 86). There is a particular concern that unacknowledged defects leading to pipeline risks can be obscured to detection by regulatory institutions and pipeline industries:
potentially leading to pipeline leaks, explosions, and posing a threat to the general public (Hayes & Hopkins, 2014a).

Although catastrophic pipeline accidents have occurred in many of the world’s countries, this section will briefly review three historical events only, including the San Bruno case and the Enbridge case (both in the USA), and the Ghislenghien case in Belgium. These events are chosen since they have been addressed comparatively by both pipeline scholars and practitioners.

The San Bruno (California, USA) event of 2010, described earlier, caused eight deaths and damaged much of the surrounding suburb. It was caused by an engineering error dating back to 1956 which had remained undiscovered by the operating company for over five decades despite significant regulatory oversight during the intervening period (Hayes, 2014). The Enbridge (Michigan, USA) pipeline rupture, which occurred in the same year as the San Bruno event, resulted in 320 people suffering serious health effects from crude oil exposure (National Transportation Safety Board, 2010a, p. xii). Following the accidental release of approximately 843,444 gallons of crude oil, the clean-up cost exceeded $US767 million (ibid). The Enbridge pipeline rupture was caused by external corrosion which had been identified in 2004, years before the rupture in 2010 (National Transportation Safety Board, 2010a, p. 37). And, while the regulator requirements were deemed adequate, the pipeline defects were overlooked (ibid).

The Ghislenghien (Belgium) incident in 2004 is considered by many to have been the worst natural gas accident in Europe (COWI, 2011, p. 27). It caused 24 fatalities, including five fire-fighters, and one police officer and five employees who were killed at the site of the explosion. One hundred and thirty-two people were injured (French Ministry for Sustainable Development, 2009, p. 3). In addition, the explosion resulted in material damage worth over $160 million and in addition to lost economic productivity (AFESAC, 2014a, p. 15). This incident was indirectly caused by previous disturbances associated with excavation activity during the final stages of constructing a car park (Stancliffe, circa 2008).

According to AFESAC (2014b), the Ghislenghien disaster was caused by a lack of understanding of simple policies and procedures Other causes were related to the inadequacy of knowledge transferred from the sub-contracting chain to workers, as well as insufficiency of pipeline operator supervision at the site (Stancliffe, circa 2008).
The European Commission and the Directorate-General for Environment claimed that a number of crucial issues – such as risk training for technicians – remained poorly addressed seven years after the accident (COWI, 2011, p. 29). Moreover, some evidence indicated that details of the number and the locations of underground pipelines were poorly documented and that pipeline markers were incorrectly located. These discrepancies created significant confusion among those dealing with accidents (COWI, 2011, p. 29). The legal proceedings of the case are still ongoing and the investigation reports are still not available more than ten years after the incident.

Despite the occurrence of catastrophic accidents, there has been a claim that major incidents in pipeline industries happen rarely (see COWI, 2011, p. 6; Desai, 2016, p. 636): albeit with consequences that can be technically, economically, socially, and politically catastrophic when they do occur. Claims of this type, which have been addressed by pipeline regulatory institutions and pipeline industries in Australia, constitute a focus of this thesis’s investigations.

1.2.2 The research setting in Australia

Internationally, Australia is the world’s ninth largest energy producer (Geoscience Australia & BREE, 2014). According to the U.S. Energy Information Administration (2016, p. 53), Australia is becoming the world’s second largest exporter of liquefied natural gas (LNG). Domestically, gas is the third largest energy resource after coal and uranium (Geoscience Australia & BREE, 2014, p. 3). The conventional gas resources are sufficient for 51 years at the current production levels (ibid). In addition, Australia has significant quantities of unconventional gas resources including coal seam gas (CSG), tight gas and shale gas (ibid). The roles of the Australian energy industry nationally and internationally indicate that pipelines are currently a crucial part of the energy industry for delivering and transporting products. And, this will likely continue unchanged into the future.

Pipeline institutions claim that the country’s energy pipeline industry has a good safety record based on a rate of pipeline failure that is below that of the US and Europe (Tuft & Bonar, 2009; Tuft & Cunha, 2013). This comparatively good safety record, it is claimed, reflects the effectiveness of the national Australian pipeline standard (AS2885) (see for example: Fletcher, Venton, Kimber, Haddow, & Bilston, 2003; Kimber, 2003).
However, a review of the literature reveals discords in the proclaimed good safety record and regulations. These will be addressed in the following sections.

1.2.2.1 Discords surrounding Australia’s safety record

Although Australian pipeline institutions claim a good safety record relative to the US and Europe, the reasons for this are not yet clear. There is, however, one obvious technical reason: Australian pipelines are relatively young compared to others. Hence, the negligible rate of corrosion failures (Tuft & Cunha, 2013).

A review of the accident literature in Australia reveals evidence that although Australian energy pipelines have never reported a major accident causing fatalities or injuries to workers and the general public, major and minor incidents have been reported in association with pipeline industries and petroleum industries. Examples of major pipeline incidents include: (a) a pipeline explosion at Varanus Island in Western Australia in 2008, resulting in significant economic loss; and (b) a pipeline explosion in South Australia in 2015, resulting in gas-supply disruption to approximately 10,000 homes and businesses. The empirical evidence indicates that risk from pipelines and petroleum industries, where pipelines are a key infrastructure carrying and delivering petroleum products, is diverse and has a high potential to cause accidents.

Some of the issues presented here are based on an analysis of the pipeline rupture and gas plant explosion at the complex Varanus Island hub in 2008. Operated by the Apache Corporation (Bills & Agostini, 2009, p. XVI), the plant was located off the North West coast of Western Australia. Four pipelines were ruptured and a subsequent explosion occurred at a gas processing plant. The incident resulted in the shutdown of all production facilities and connected platforms including gas export to the mainland (Bills & Agostini, 2009, p. 127). The accident was caused by severe external corrosion of a pipeline which then could not withstand the operating pressure (Bills & Agostini, 2009). The cause of accident went unnoticed and unreported before the incident happened, even though it had been documented. The pipeline had been inspected and audited more than 50 times by reputedly top international consultants and regulators (Bills & Agostini, 2009, p. 127).
Although there were no deaths reported and no injuries to workers or the general public, the pipeline failure had an adverse impact on the Western Australia economy of approximately AUD$2.6 billion (Bills & Agostini, 2009, p. 6). In addition, over 560,000 residential and small businesses were affected due to the significant disruption to gas and electricity supplies (ibid). The Apache Company had to pay approximately AUD$60 million to repair the pipeline and the plant repaired (ibid). Furthermore, the company and its joint venture partners had to deal with both financial loss and the loss of the facility, which was no longer fully operative after the incident for about a year (ibid).

There were also minor recorded incidents involving pipelines, documented and collected by the Australian Pipeline and Gas Association from members of its Pipeline Operators Group (POG) dating back to 1965 (Tuft & Cunha, 2013, p. 3). There were three types of incidents documented: loss of containment events (average one event each year, and zero to three events per annum in recent years); minor pipeline damage (130 items in total in the database); and ‘near miss’ incidents by unauthorised third party excavation activity on the pipeline easement (460 items in total in the database) (ibid).

1.2.2.2 Discords surrounding pipeline regulations

A review of evidence from the Australian pipeline literature indicates the complexity of pipeline regulatory structures in Australia that oversee a massive Australian pipeline system stretching more than 33,000 kilometres across Australia (see Figure 1.3). Among them, the majority are gas pipelines (comprising 83%). The remaining pipelines (17%) carry diverse fluids including oil, LPG, and ethane (Tuft & Cunha, 2013, p. 4).
Australian pipelines are regulated by a complex legislative structure involving 14 regulatory institutions and 46 pieces of legislation across the Australian Commonwealth, states and territories (McDermott & Hayes, 2014, pp. 61-67). The complexity of Australia’s pipeline regulatory system in Australia contradicts pipeline institutions’ claims regarding the ‘superior’ harmonisation of the national Australian Pipeline Standard (AS2885) by pipeline institutions (see for example: Fletcher et al., 2003; Kimber, 2003), described in the following paragraph.

The complexity of legislation and jurisdictions were reflected in the Varanus Island incident which involved three Western Australia government agencies: the Department of Mines and Petroleum (DMP) (formerly the Department of Industry and Resources (DOIR)); the Department of Consumer and Employment Protection (DOCEP); and the National Offshore Petroleum Safety Authority (NOPSA) (now the National Offshore
Petroleum Safety and Environmental Management Authority (NOPSEMA)). The complex interactions involving the agencies above were associated with regulatory muddle and confusion involving regulatory roles and responsibilities pertinent to safety knowledge and resources at the time of the incident. As Bills & Agostini (2009) noted while investigating the Varanus incident:

> This regulatory muddle complicates our examination of who should have known what and who should have done what in relation to ensuring appropriate safety measures are applied to Varanus Island and the 12 inch SGL. We have already discussed the information available to Apache regarding the 12 inch SGL and we consider that Apache had information available to it which would have allowed it to foresee an incident like that which occurred on 3 June 2008. The involvement of the three government agencies – DOIR, DOCEP and NOPSA – in regulation of the pipeline requires consideration of what these agencies may have known, what they should have known, and what they could or should have shared regarding the 12 inch SGL in order to enable them to also foresee the risk posed by the pipelines on the Varanus Island shore crossing (p. 87).

Evidence of historical gas transmission pipeline ruptures gleaned from pipeline accident cases in Australia and internationally emphasises the long and slow incubation periods of pipeline accidents, confirming the invisibility of pipeline risks. These events indicate that potential catastrophic accidents could happen at any time, and give rise to the following question: how can regulators be assured of the effectiveness of their regulatory knowledge and practices when dealing with the invisibility of pipeline risks? The regulatory systems that rely on the technical-physical nature of industries, industrial management and regulatory functions can be fallible to invisible pipeline risks. This is yet another discord peculiar to regulatory systems and how they regulate unseen pipeline risks. The scenario around the conflict of regulatory knowledge regulating invisible risk can be termed a ‘paradox of regulation’ (Haines, 2011).

The appearance of two black boxes: (a) the black box of discourses pertinent to criticisms of regulatory roles, institutions, and apparatuses; and (b) the black box of invisibility of pipeline risks, together with discords of safety record and the complexity

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2 The 12 inch SGL (12 inch Sales Gas Line) is the name of the pipeline that ruptured on Varanus Island (Bills & Agostini, 2009)
of pipeline regulations in dealing with the invisibility of pipeline risks (see Section 1.2), has led me to review the contemporary theories with their assumptions and limitations vis-à-vis regulating hazardous industries.

1.3 Thesis structure

This thesis aims to understand and improve the process of risk regulation and, by extension, to improve regulatory practices and effectiveness (or regulatory outcomes). The findings that emerge are employed to improve such processes. They facilitate a re-framing towards asking the question: how we can improve regulatory practices concerned with technological risk from energy industries? The new performance process illuminates alternative concepts, approaches and practices that can be considered for employment to improve risk regulation, reduce technological risk and prevent catastrophic accidents.

This thesis comprises three main parts and is divided into nine chapters.

Part I (Chapters 1-3) explores the thesis context and setting. Chapter 1 (this chapter) outlines the research problems and questions.

Chapter 2 seeks insight into how research can be operationalised to comprehend and analyse how power-knowledge in relation to risk regulation is performed through and around regulators. It reviews and explores relevant theories, traces their ontological stance, and analyses their limitations: in the process providing an alternative approach to tackle the research questions. As earlier sketched, this thesis employs a critical-empirical approach, inspired by the ANT theory in association with a concept of Foucauldian power-knowledge. I have drawn upon the above theoretical approach to ground my examination of what entities and who have influenced power-knowledge relationships throughout the processes of risk regulation. The philosophical stance of this thesis approach, together with the main features of this approach (i.e., ontological equality, semiotics of materiality, and a concept of power-knowledge) and their limitations are reviewed, discussed and analysed.

Chapter 3 will describe: (a) the philosophy behind methodological concepts (i.e., a semiotics of materiality, Actor Network Theory and discourse analysis of power-knowledge); (b) methodological techniques (i.e., semi-structured interviews,
documentation analysis); (c) sampling justification and a symmetrical approach of ANT in practice; and (d) processes of data analysis (i.e., coding categorisation, research themes). In addition, Chapter 3 will also provide insights into the use of the reflexivity concept together with how research questions are operationalised in empirical practice, and an analysis of limitations.

Employing a theoretical-methodological approach, I trace relational assemblages of those non-human and human actors that interact with regulators and pipelines to perform power-knowledge relationships. Research themes and assemblages implicated in power-knowledge relationships were revealed through the process of investigating these relationships. The research themes and assemblages were drawn from interviews and documents. For this purposes of my investigation, I conducted formal and informal interviews. My formal participants included both regulators and associates, and non-regulators. Regulators and associates included technical regulators across states and ex-regulators. Non-regulators included pipeline industry staff employed in different divisions, external auditors, pipeline industry lobbyist groups, pipeline consultants, members of Australian pipeline standard committees, unions, regulatory experts, planning panels, field managers and staff from pipeline companies and their contractors as well as members of the public.

Part II of this thesis circumscribes the discussion issues. There are four relational assemblages, emerging from empirical investigation, both inside, in between, and outside of organisations: they are laid out in four discussion chapters (Chapter 4 to Chapter 7). The four relational assemblages include: regulators and multiple assemblages across Australian States (discussed in Chapter 4); regulatory apparatuses (discussed in Chapter 5); the technical-regulatory specification which is measurement length (discussed in Chapter 6); and neoliberal rationalities, discourses about government (i.e., deregulation and energy privatisation), and neoliberal techniques (discussed in Chapter 7).

Chapter 4 discusses and analyses the first assemblage: how power-knowledge relationships are performed and shaped by regulators and multiple assemblages that interact with regulators. This chapter contains two sections. Section 1 discusses the findings surrounding the current ontological stance of pipeline regulators in regulating pipeline risks. An analysis of the ontology of pipeline regulators is employed to
challenge existing theory vis-à-vis regulatory capture. The second part of Chapter 4 discusses the findings surrounding multiple assemblages that shape regulatory practices across Australian states. This section reorganises the data regarding multiple assemblages into seven geographical states. Each state has different assemblages, indicating a multiplicity of regulatory practices across states. In addition, this section will question: what is multiplicity and what challenges follow from around the multiplicity of regulatory practices?

Chapter 5 discusses and analyses the second assemblage associated with three emerging regulatory apparatuses: safety plans; risk-based regulation; and social-regulatory controls (i.e., tripartite engagement or union engagement, and workforce engagement). This chapter discusses how regulatory knowledge and practices related to these regulatory apparatuses have been made, understood, implemented and communicated among actors. In addition, Chapter 5 traces and re-traces gaps in the knowledge and practices pertinent to these apparatuses.

In Chapter 6, the focus is upon discussing and analysing a third assemblage, specifically, a technical-regulatory specification under the Australian pipeline standard AS2885 – called measurement length. This chapter argues that the technical dimension is enacted as part of a negotiating process in performing power-knowledge relationships. It examines how the enactment of measurement length has influenced risk accountability, risk communication and risk knowledge among actors.

In the process of exploring measurement length, one emerging conflict and a newly emergent group of actors became manifest. Examination of the emerging conflict revealed the research themes that involve an incoherence of knowledge and practices in the process of risk regulation including risk communication, risk assessment, and risk accountability. The group of newly emergent actors is distinctive: I have named these actors – ‘interactors’. Who are interactors, why and to what they are crucial, and how are they different from other actors embedded within the existing literature? These questions are discussed and analysed in Section 6.2.2. The interactors will be employed to re-frame an alternative approach to improving regulatory practices and effectiveness (see Chapter 8).

Chapter 7, the last discussion chapter, explores and analyses knowledge and practices in relation to risk regulation as shaped by neoliberal rationalities, discourses about
government (i.e., deregulation and energy privatisation), as well as neoliberal
techniques embedded within deregulation and energy privatisation. As a result of
following these relations, the research themes representative of certain material impacts
on knowledge and practices involved in regulatory processes become apparent. The
findings indicate that these impacts went largely unacknowledged by the majority of
participants as well as by contemporary theorists. The impacts were described by a
regulatory expert participant in this thesis as ‘going to be a whole new thing in terms of
risk’. So, what are these new types of risk and how do they create adverse impacts on
actors? These questions will be analysed in the last section of Chapter 7.

Part III (Chapter 8 and 9) discusses the research implications, conclusions and the future.
It contains two chapters. The aim is ultimately to improve regulatory outcomes. Chapter
9 concludes with a discussion of reflexivity and what may be needed for the future?
Chapter 2

Theories of risk regulation, ANT, and power

This chapter explores theoretical perspectives with potential to provide insight into the nature of industrial risks, the causes of major accidents and the effectiveness of regulation. In so doing, this chapter critically engages with existing literature on the regulation of industrial risk and the causes of accidents with an aim to develop a conceptual and analytical framework that will serve as a foundation for investigating the research questions that guide this thesis. It explores Actor-Network Theory as a way to extend risk regulation literatures through the re-examination of their ontological assumptions.

2.1 Regulating technological risks: exploring existing theories

Understanding the regulation of technological risks involves theories relevant to three broad and inter-related concepts: risk, safety and regulation. Hopkins and Hale (2002) stress that: ‘[s]afety regulation is about the regulation of risk’ (p. 3). However, this chapter does not attempt to analyse all of the theories concerned with risk and safety; rather, its focus is more upon those theories that are associated specifically with experts, technologies, regulatory approaches, and power relations. Three groups of key theories are reviewed: theories of regulation; theories of organisational safety; and theories of risk. These are summarised in Table 2.1.

Table 2.1: Three broader groups of theories that deal with hazardous industries and risk.

<table>
<thead>
<tr>
<th>Groups of theories</th>
<th>Theories</th>
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<tbody>
<tr>
<td>Regulation</td>
<td>Risk-based regulation (Black, 2010)</td>
</tr>
<tr>
<td></td>
<td>Responsive regulation (Ayres &amp; Braithwaite, 1992)</td>
</tr>
<tr>
<td>Organisational safety</td>
<td>Swiss cheese model (Reason, 1997)</td>
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<tr>
<td></td>
<td>High reliability organisation (La Porte, 1996)</td>
</tr>
<tr>
<td>Risk</td>
<td>Risk society (Beck, 1992b)</td>
</tr>
<tr>
<td></td>
<td>Lay-expert understanding of science (Wynne, 1996)</td>
</tr>
<tr>
<td></td>
<td>Governmentality (Zinn, 2008b)</td>
</tr>
<tr>
<td></td>
<td>Inclusive risk governance (Renn, 2008c)</td>
</tr>
</tbody>
</table>
This section will begin by reviewing how risk is dealt with in regulatory approaches and theories.

2.1.1 Risk in regulatory approaches and theories

This section reviews two theories and the setting of their premises. The two theories are: (a) risk-based regulation; and (b) responsive regulation. These theories are primarily employed in regulating technological risk that is generated by hazardous industries.

2.1.1.1 Risk-based frameworks

(a) Risk-based frameworks: an overview

Contemporary regulatory practice in hazardous industries is predominantly based on risk-based regulation (also known as goal-setting regulation, outcome-oriented, performance-based legislation or self-regulation). The risk-based framework has been described ‘as a necessary attribute of “better regulation”’ (Black, 2010, p. 186), and is widely used by regulators in many countries for managing their resources and reputations (Black & Baldwin, 2010; Rothstein, Irving, Walden, & Yearsley, 2006b). Included among the above are regulators in Australia.

Risk-based regulation is based on the premise that beneficial outcomes are best achieved by allocating resources according to where risks are highest rather than according to fixed rules (Black & Baldwin, 2010, p. 184). The degree of risk posed to society is taken into account in order to prioritise regulatory resources and to set proper levels of controls (Rothstein et al., 2006b, p. 1057). This framework can use in combination with a range of approaches to risk management including voluntary agreements, trading schemes, environmental management systems, taxes, etc., in addition to more traditional regulatory instruments such as authorisation, checking and enforcement (Hood, Rothstein, & Baldwin, 2001).

Risk-based frameworks incorporate a range of strategies and activities ranging from objective and standard setting to compliance assessment and enforcement (Rothstein et

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3 The primary types of regulators involved in this thesis are technical regulators (or pipeline regulators) who regulate technological-hazardous risk from industries and who implement technical-safety regulations.
According to (Black & Baldwin, 2010, pp. 184-185), necessary steps include:

- Risk identification. Regulators and risk managers have to identify what types of risks they wish to control.

- Risk tolerance. Determination of what types of risks they are prepared to tolerate and to what level.

- Risk assessment. Risks are assessed with consideration for adverse events, especially the probabilities about how often such events may occur.

- Risk scoring or risk ranking. Regulators assign scores and/or rank the degree of risk to industrial firms and industrial activities with regard to outcomes of risk assessments.

- Monitoring and enforcement. Organisational strategies, inspections and, in particular, enforcement resources allocated to optimise risk management.

The risk-based approach is thus used by regulators to determine which industrial activities deserve the most regulatory attention and whether the measures firms propose to take are sufficient (Black, 2010, p. 187). An example of a risk-based framework is presented in Figure 2.1 below:
Figure 2.1 shows how the practice of a risk-based approach is generated from fixed, established and necessary elements in a closed framework. While on the one hand, it sets steps that are easy to follow and implement, on the other, the framework excludes factors outside of its criteria such as social-political factors that intervene at the level of risk acceptability. Discourses and relationships that influence regulatory practice are overlooked in risk-based regulatory models.

Nonetheless, risk-based approaches have a number of advantages. For example, they provide a better platform for regulators, compared to the conventional prescriptive approach which is rule-based and inflexible. The risk-based approach can accommodate the degree of risk and allow negotiation of knowledge and regulatory practices with industries. In addition, risk-based approaches provide firms subject to regulation with
flexibility. Each can find its own approach to optimising the cost of mitigating risks (Coglianese, Nash, & Olmstead, 2003, p. 711).

Risk-based approaches are efficient in as much as they maximise the benefits of regulation while minimising the burden of specific interventions on industries (Hampton, 2005). Risk-based approaches have been promoted as effective rational decision-making instruments for managing risks in relation to resource allocations (Rothstein, Huber, & Gaskell, 2006a, p. 97).

(b) Risk-based approaches in the Australian pipeline context

Risk-based approaches that regulate technological risks associated with pipeline industries in Australia are embedded in safety plans: a regulatory requirement under the Australian standard for pipelines (AS2885) and pipeline regulations across Australian states and territories. The broader scope of the risk-based approach is encompassed in safety plans. In the context of Australian pipelines, a safety plan is called a Pipeline Management System4 (PMS) or, in some jurisdictions, a safety case. So, what is a safety case? According to Hopkins (2012b):

A safety case is a case - an argument made to the regulator. Companies must demonstrate to the regulator the processes they have gone through to identify hazards, the methodology they have used to assess risks and the reasoning that has led them to choose one control rather than another. Finally the regulator must accept (or reject) the case (pp.4-5).

Generally, regulators have specified a safety policy goal and require facilitators to ensure worker and public safety (Hopkins & Hale, 2002, p. 4).

Pipeline licensees are required to submit safety plans to regulators prior to obtaining pipeline licenses to ensure the safe operation of the pipelines. In addition, they have to submit safety plans to regulators before commissioning and operating the pipelines (Standards Australia, 2012b). In the next step, pipeline licensees have to undertake a Safety Management Process or Safety Management Study (SMS) (Standards Australia, 2012a, p. 16), identifying and assessing risk to the pipeline system and applying

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4 Formerly known as a Safety and Operating Plan (SAOP).
controls to them (ibid). Risk assessment must be undertaken using the AS2885.1 risk matrix (Standards Australia, 2012a, pp. 187-190) (Figure 2.2).

Pipeline licensees have to ensure that residual risk is reduced to an acceptable level; that is, ‘as low as reasonably practicable’ (ALARP) (ibid, p. 8). Safety plans are an on-going part of SMS and pipeline licensees are required to revise safety plans every five years or when any changes to threat levels occur (ibid, p. 23). Both SMSs and risk matrices are examples of regulatory devices (or apparatuses). The regulatory apparatuses are problem-solving tools that regulators develop and design to control risks. This thesis will investigate what apparatuses are employed and how they are employed by regulators in pipeline industry contexts.

**Figure 2.2: AS2885.1 Risk matrix (Nilsson, 2011, p. 11).**

Although the process of SMS between a PMS and a safety case sounds similar, the components of PMSs are different from safety case documents. A PMS document contains five necessary elements (see Figure 2.3) including: management; planning; implementation; measurement and evaluation; and consultation, communication and reporting. A safety case document is composed of: (a) a facility description; (b) a formal safety assessment (FSA); and (c) a safety management system (see Figure 2.4).
Figure 2.3: A diagram showing the broad scoping of the risk-based approach encompassing a Pipeline Management System (PMS) (Standards Australia, 2012b, p. 90).
Figure 2.4: A diagram showing the broad scoping of the risk-based approach encompassing a safety case (Department of Mines and Petroleum, 2011b, p. 13).
The major difference between a PMS and a safety case involves the regulatory requirements. The safety case regime is designed to have requirements as equal to, or exceeding, the requirements of AS2885 (Standards Australia, 2012b, p. 95). In other words, the safety case regime appears to have more stringent requirements than a PMS. Whereas the core focus of the safety case regime is upon identifying hazards contingent to a major accident event (MAE)\(^5\) (Department of Mines and Petroleum, 2011b, pp. 2, 9), a PMS does not emphasise MAEs. More importantly, the safety case regime requires industries to involve workers in the process of developing, revising, and implementing the safety case document (ibid, p. 8).

The reasons for such differences between a PMS and safety case are associated with the background of the enactment process. The PMS regime was enacted for use with the Australian pipeline industries wherein pipeline catastrophes have never occurred. The enactment of the safety case regime and its core facet of workforce involvement were triggered by the *Piper Alpha* disaster that occurred in 1988 (Miller, 1991, pp. 183-184). A massive explosion on the oil platform not only killed 167 out of 226 workers on board, but caused substantial financial losses to the UK industry and government (National Offshore Petroleum Safety and Environmental Management Authority, 2015).

Investigation of the Piper Alpha incident showed that failures of risk management and risk communication contributed to the disaster (Miller, 1991, p. 181). The Cullen report stressed that workers had not been informed about the layout of the platform and had not been given adequate emergency procedures training (ibid). Such failures led to emphasis on workforce involvement (or workforce participation or workforce engagement) as a key element of producing and improving safety cases (Hart, 2002, pp. 486-487). This key element was underscored by the successful Norwegian case which resulted in unionised workforces assisting and strengthening the effectiveness of Norwegian regulatory regimes (Miller, 1991, p. 184).

The safety case regime has been widely applied in many countries, with the major exception of North America. A safety case approach is employed in Australia for offshore oil and gas facilities (National Offshore Petroleum Safety and Environmental

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\(^5\) A major accident event (MAE) is defined as ‘an event connected with a pipeline operation, including a natural event, having the potential to cause multiple fatalities of persons engaged in the operation or other protected persons’ (Standards Australia, 2012b, p. 95).
Management Authority, 2015) and for onshore hazardous process plants (or major hazard facilities (MHFs) in all states and territories (Safe Work Australia, 2012). For pipelines, safety cases are required in two Australian states: Victoria and Western Australia. In the state of Victoria, the safety case regime was employed among petroleum onshore and offshore industries following incidents at Longford⁶.

In summary, risk-based approaches are embedded in Australian pipeline regulations including the national, harmonised Australian pipeline standard AS2885 and other pipeline regulations across Australian states and territories. While risk-based approaches have various advantages, in effect they are limited to the assessment of technological risks which are perceived as tangible. Risk-based methods rely on necessary and fixed elements in an assessment process to imagine and predict what risks exist. What is unimagined remains disassociated and unacknowledged, in particular relationships of power-knowledge related to risk regulation and regulatory practices shaped by regulatory institutions and pipeline industries. In addition, regulators may encounter other difficulties when assessing invisible risks, in particular, difficulties due to limited resources together with complex regulatory problems (Black & Baldwin, 2010, p. 182).

2.1.1.2 Responsive regulation

(a) Responsive regulation: an overview

Responsive regulation theory emphasises the recursive relationships that obtain between regulatory practices and the responses and needs of the firms they regulate (Ayres & Braithwaite, 1992). It provides tools for regulators to interact with businesses in order to improve regulatory design and enforcement.

Responsive regulation theorists argue that regulatory strategies can be organised according to principles embedded in the idea of ‘regulatory pyramids’ (ibid, p. 38-39). The latter have two components: the support pyramid and the sanction pyramid (Figure

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⁶ The ‘Longford incident’ refers to an explosion that occurred at one of Esso Australia’s gas plants (in September 1998) in Longford in the state of Victoria (Dawson, 1999). Two workers were killed and the state’s gas supply was severely affected to Victorian industries and residential households (Hopkins, 2001). The accidents were variously caused by: the failure of safety management system audits, the failure of Esso’s incident report system, the failure of the alarm system, and inadequate oversight by senior staff (ibid). As a result of the Longford accident, the Longford Royal Commission required that Esso’s Longford facility and all major hazard facilities in the State of Victoria have to conform to a safety case regime (Dawson, 1999, p. 141).
2.5). The logic of a regulatory pyramid anticipates more cooperative strategies (e.g., education, persuasion) employed at the base of the pyramid. Punitive approaches (e.g., notices, prosecution, cancelling licenses) are used only when cooperative strategies fail or when more powerful incentives (e.g., subsidies, prizes) are considered inappropriate or ineffective (Braithwaite, 2011, p. 482). The strategies of staying at the bottom are related to cost and the rationales of firms taking self-regulation. It is generally considered to be least expensive for all stakeholders to stay at the bottom of the regulatory pyramid and more expensive to escalate to the top. Therefore, firms are incentivised to avoid carrying costs of non-compliance and to adopt a cooperative stance (Ivec & Braithwaite, 2015, p. 7).

![Diagram of regulatory pyramid](image)

**Figure 2.5: A model regulatory pyramid for regulating pipeline risks.**

Note: examples of supports and sanctions are drawn from the following reference: Energy Resources Division (2012).

The premises for effective responsive regulation include democratic deliberation and transparency (Ivec & Braithwaite, 2015, p. 6). The ideal at the base of the pyramid is respect for dialogue, not only with firms that are not complying with regulatory requirements, but also with broader publics (ibid). This is where the ideal of tripartism (or the empowerment theory of tripartism) enters the realm of responsive regulation theory (Ayres & Braithwaite, 1992, p. 81). Ayres and Braithwaite (1992) developed the ideal of tripartism by co-opting other social actors into the regulatory process, called third party actors (e.g., communities, labour unions, and non-governmental actors), into
the regulatory process. The theorists suggest that the regulatory process must include third parties to prevent regulatory capture, their aim being to remedy an inequality of power (ibid). Regulatory capture occurs when regulators fail to enforce the law against powerful business offenders (Makkai & Braithwaite, 1992). When regulators have been captured by regulated organisations, their responsibilities become distorted. Conflicts of interest occur because regulators serve their own interests rather than the public interest (Baldwin, Scott, & Hood, 1998, p. 10). Examples of regulatory capture include an absence of toughness and being sympathetic towards firms coping with compliance difficulties (Makkai & Braithwaite, 1992, p. 61). Ayres and Braithwaite (1992) suggest that in order to break regulatory capture and improve regulatory enforcement, tripartism should apply at any of the enforcement pyramid levels.

Although the theory of responsive regulation highlights the potential benefits of incorporating less powerful parties into regulation, it is important to acknowledge that such involvement raises questions of its own. For example, how can regulators encourage third parties to be effectively involved when regulators face their own constraints (e.g., limited resources, unclear regulatory objectives, limited legal power and limited knowledge in coping with rare events)? How can regulators overcome these constraints? Furthermore, although third parties can participate and add their voices to the regulatory process, they generally have different sets of knowledge from those of other parties. So, how do regulators reconcile these differences? These questions are associated with power-knowledge relationships that appear to be positioned outside the frame of regulatory pyramids. In other words, the strategies associated with responsive regulation theory do not deal explicitly with how to ensure effective deliberation vis-à-vis power-knowledge relationships.

(b) Responsive regulation in the Australian pipeline context

The theory of responsive regulation has been employed by pipeline regulators to regulate pipeline risks in Australia (see for example: Department of Natural Resources and Mines, 2011; Energy Resources Division, 2012; Energy Safe Victoria, 2014). Despite its practical use, the literature is limited to general indications about employing responsive regulation in line with government documents. The literature does not explain the constraints in relation to power-knowledge and pipeline regulators. For this reason, during my fieldwork I explored the question of what has worked well and what
has not worked well with respect to the responsive regulatory approach (see Chapter 4). In addition, I sought to identify and explore the assemblages that have shaped knowledge and practices associated with use of the responsive regulatory approach.

In the next section, I will examine the philosophical stances behind regulatory theories and trace some of the history of the development of a pipeline standard.

2.1.1.3 The philosophical stances of regulatory theories used within the Australian pipeline contexts

Regulatory theories have roots (or theoretical ontologies) that tend to be concordant with the criteria of realism (see for example: Hasle, Limborg, & Nielsen, 2014; Nourse & Shaffer, 2009). According to Law (2004), the term “realism” is defined as:

an approach to the philosophy of science that argues that empirical and experimental investigation is unintelligible in the absence of an external world, and human capacity to intervene in that world and monitor the results of their actions (Law, 2004, p. 163).

In accordance with the above definition, regulatory theories delineate (albeit in more pragmatic ways) how regulators using technical-regulatory tools (or devices or strategies) can objectively regulate technological risks. Techniques and technical-regulatory strategies including risk assessment and technical risk analysis have been developed to manage industrial risk and uncertainty. The philosophical stance of realism embedded in AS2885 is apparent here:

The philosophy under which Committee ME-038 has operated has been to use a first principles approach to the development of technical requirements. The Committee aims to first understand the laws of nature so that it can set down effective laws of man. Consistent with the style requirements of a Standard the rules are, wherever possible, accompanied by explanatory material in order to help the user understand the principles and intent of the Standard (Standards Australia, 2008, p. 20).

The ontology of AS2885 largely contains the premises of realism, joined here with an element of positivism: ‘[t]he Committee aims to first understand the laws of nature so that it can set down effective laws of man’. What is positivism? According to Law
(2004), positivism argues to the effect that: ‘scientific truths are rigorous sets of logical relations or laws that describe the relations between (rigorous) empirical descriptions’ (p. 15). Positivism tends to support fixed and inflexible regimes when applied in practice – technocratic regimes assuming scientific authority.

The following question arises: have regulators employed the realist approach to deal with complex regulatory problems in the Australian pipeline case? This section tracks some of the history of AS2885 development. It asks who has been involved, how, and what perspectives do pipeline experts bring to bear in managing risks? The questions I raise are consistent with the notion of regulation as put forth by Black (2002). Black has inferred that regulations should be understood as composed of core elements. The elements that are relevant to this thesis include: (a) the complexity of the regulatory context; and (b) the challenges pertinent to the fragmentation of knowledge and the exercise of power and control. These questions are examined through the field research of this thesis.

The process of performing pipeline risk and safety knowledge in Australia commenced after an oil and gas discovery in 1960 (Kimber, 2010, p. 1). The first long distance pipeline (Roma to Brisbane) was completed in 1969. Knowledge about how to build pipelines and manage risks was imported from the USA via consultants as a consequence of the worldwide recognition given to USA technology and standards at that time (Kimber, 2003, p. 1). The USA was the first country to develop high pressure pipelines for petroleum products and by extension to produce an industry-wide pipeline standard. The majority of pipelines in the 1960s were designed and built under the supervision of USA companies including Bechtel, Williams Brothers and Fluor.

Shortly after, Australia (and many other countries) developed their own standards. The Australian standard was developed in the early 1970s by Australian pipeline engineers. Drawing upon their overseas experience and knowledge, they constructed new, long distance but relatively small diameter and high pressure pipelines. Their development of the Australian Standard was strengthened by multilateral science and engineering research and with the cooperation of North American and European pipeline researchers.

The first Australian Standard (AS2885) was established in 1987. AS2885 was revised in 1997, 2007, and 2012, and has continued to be periodically revised up until the present. It is an engineering standard, and as such, technical aspects remain its key focus. In
1996, the pipeline industry set up research programs to produce technical knowledge that applied directly to the standard specifications. Modifications were made with the aim of developing innovative technology. The goal were to reduce costs and improve safety in relation to construction, welding methods, and other associated problems confronting operators in their daily management of the completed pipelines (Kimber, Haddow, & Chipperfield, 2003, pp. 1-3).

Although the standard was drawn-up by the pipeline industry, regulators have been actively involved in the ME-038 Committee⁷ in developing and revising the regulatory specifications and sharing knowledge and expertise. ME-038 makes representations to the Australian Standards Committee, which is comprised of industry representatives (two thirds) and of state regulators (one third). Critically, this standard has the same force of legislation as AS2885; which has been adopted by the legislative and regulatory frameworks across states subject to an agreement from the Council of Australian Governments (CoAG) to harmonise these diverse pipeline legislations (Standards Australia, 2008, p. 12).

Pipeline legislation and regulations in Australia are diverse across the Australian Commonwealth and the Australian States and Territories. They involve 14 regulatory institutions and 46 frameworks of legislation and regulation (McDermott & Hayes, 2014, pp. 61-67). But, how do regulators deal with these regulatory complexities in managing pipelines with long distances of up to and more than 33,000 kilometres across Australia?

The AS2885 Standard claims to be ‘the single and sufficient technical standard’ (Standards Australia, 2008, p. 9) for hydrocarbon pipelines (AS2885.0 Section 1.3). In addition, according to AS2885.0 part 1.3, ‘the Standard exists for: (i) the safety of the general public and pipeline personnel; (ii) the protection of the environment; and (iii) security of supply’ (Standards Australia, 2008, p. 8). Nevertheless, influential industry sources claim that the standard components and specifications have been revised over time, the purpose being to reduce costs and optimise safety (Kimber et al., 2003, p. 2). This raises an important issue about the role of the standard and its framing. How has the balance between cost and safety been determined, and in particular, how are non-technical questions taken into account when developing that balance? The technical

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⁷ This is the name given to the formally constituted committee that manages the standard and its revision.
factors specific to those aspects amenable to analysis using a realist or positivist approach are only one part. In order to govern risk, the integration of technical experts, consideration of regulatory requirements and reflection upon the values of different social actors are required (Renn & Schweizer, 2009). The underlying concern is that if technical aspects adopting a realist or positivist approach are prioritised over other aspects, then how can the industries be certain that they are considering the right issues, not only for themselves, but for others also?

The premises of the technical-regulatory approach, subject to mediation by regulatory theorists, form a characteristic discourse which carries the following features. According to regulators, risk can be both theoretically and practically controlled (Haines, 2011; Hood et al., 2001; Kirwan, Hale, & Hopkins, 2002). The linkage of theory and practice in this way indicates realism. The reasoning behind this discourse is based on premises that accompany a perception of modernity – whereby humans create and develop technical mastery over threats from technology (Haines, 2011, p. 3; Leiss, 1972). Regulators perceive the modernist project as involving the development of processes and styles of enforcement and compliance in order to minimise risk (ibid). Modernism has heavily informed regulatory rationalisation and systematisation (Meyer, 2000).

In accordance with technical-regulatory realist perspectives, regulations are acknowledged as vital instruments or problem-solving tools developed and designed to reduce harm or control risks (Baldwin, Cave, & Lodge, 2012b, p. 83; Gunningham, Grabosky, & Sinclair, 1998; Gunningham & Johnstone, 1999; Haines, 2011, p. 10; Hopkins & Hale, 2002; Sparrow, 2011). Regulatory tools and strategies range from conventional forms of regulation (command and control or compliance-based approaches) to those which are more flexible. The latter involve not only governments, but other actors including commercial interests and non-government organisations, communities, unions or even a combination of these. Alternative regulatory approaches include self-regulation, ‘responsive regulation’, ‘smart regulation’, ‘risk-based regulation’, ‘principles-based approaches’ and ‘co-regulation’.

While on the one hand, regulations are structured and can be implemented to mitigate pipeline risks, on the other, they are a paradox (Haines, 2011), for as Rothstein and colleagues suggest, regulations face epistemic challenges from science (2006b, p. 1061).
Technological risks are difficult to assess and manage (ibid). For example, regulated firms have faced difficulties measuring, evaluating and verifying their actual performance, although models are available to them for making predictions (Coglianese et al., 2003, p. 715). However, the said predictions may not be accurately related to actual performance; and additionally, they cannot easily be evaluated or verified, as is the case with rare and high-consequence events (e.g., pipeline explosions) (ibid). Not only can the factors involved in rare events be numerous and complex: they can lead to high levels of uncertainty (ibid). This is illustrated by how operators make their judgements vis-à-vis what is an acceptable threshold (ibid). In this process, many causes of uncertainty have been unrecognised or ignored (ibid). In addition, risk-acceptance criteria are unlikely to be open to public scrutiny (Melchers, 2001). In short, as invaluable as the contributions of the regulatory tools are, regulatory instrumentations are limited in coping with the complexity and uncertainty of technological risks.

This thesis evaluates the theoretical ontology of the literature that addresses regulations used within Australian pipeline contexts, and finds that social-political issues are often disassociated from the realist realm, leading to potential problems in research exploration and analysis. For example, risk-based approaches give less attention to engaging the concept of citizen deliberation and worker participation when compared to responsive regulation. The risk-based approach is more focused on resource allocations related to the degree of risk and the decisions made by regulatory institutions.

More importantly, regulatory practices constantly interact with the sorts of issues more traditionally viewed as the domain of social science. For example, regulators have faced difficulties when interpreting the acceptability of risk driven by political interventions (Black & Baldwin, 2010, p. 184). In addition, regulators are primarily involved with bureaucratic rational decision-making procedures; for this reason, they may not consider all of the aspects addressed by the stakeholders when weighing costs against benefits (Rothstein et al., 2006b, p. 1057). The big question is: how do regulators deal with this mixture of technical and social issues? As far as the extant literature is concerned, research exploration and analysis may be limited by uncritical assumptions. So, what regulations should researchers start with? What limitations of the technical-regulatory realist realm affect research design?
In the next section, attention will turn to how risks are regulated by other contemporary theories of regulation within organisations, in between and beyond.

2.1.2 Risk within organisations, in between and beyond

Technical-regulatory experts practise technical risk analysis in a manner that largely excludes social-political interactions from their analyses. These technical-regulatory realist approaches to regulating risk have been the subject of criticism, in particular by scholars from the social sciences. The social science cohort argues that risks cannot be understood as straightforward ‘objective’ of ‘technical’ phenomena. Risks, they claim, are filtered by human values and experiences, experts, and interventions, from political-institutional structures within, in between and outside of organisations (Dietz, Frey, & Rosa, 2002). Risks are constructed, in important ways, through social-political actors and processes. According to Law (2004), constructivism is ‘the claim that scientific statements or truths are constructed in a way that to a large degree (in some versions totally) reflects the social circumstances of their production’ (pp. 157-158).

Risk scholars have observed and developed the notion of how risk is constructed in several ways, not only in relation to technical factors but also through organisational factors, human factors, technologies, experts, the values and experience of laypeople and through power relations. This section will review how knowledge about risks is constructed through different viewpoints including: organisational factors and human factors (Section 2.1.2.1); social-political issues at macro and micro studies (Section 2.1.2.2); and power relations (Section 2.1.2.3). The overall approach aims to recognise that each viewpoint is framed or constructed by different theories. Each theory has its own assumptions and limitations. In addition, I explore the possibility of employing these theories to examine, explain and ameliorate problems associated with the existing power-knowledge relationships that shape the regulatory outcomes.

2.1.2.1 Organisational theories

The construction of risk in relation to organisational and human factors is influenced by theories about organisational safety. Theories on organisational safety set assumptions that indicate the performance of safety-instrumental systems in managing industrial safety is influenced by culture, organisational factors and human factors in addition to
technical factors in a wider socio-technical system. These theories have advantages for analysing the causes of accidents, and for proposing prevention strategies to prevent accidents: they include the Swiss Cheese Model theory and the High Reliability Organisation (HRO) theories.

(a) Swiss Cheese Model theory

The Swiss cheese model provides an analysis of accident causation with the aim of preventing catastrophes. The model uses the concept of an ‘accident trajectory’ (Reason, 1997, p. 9) which explains how accidents can happen as a result of interconnections among unsafe acts, caused by organisational factors such as decisions made by senior managers. Active failures and latent conditions are technical terms to describe contributors to human-caused accidents. Active failures that cause accidents are human decisions and actions which have direct impacts on the safety of the system (Reason, 1997, p. 10). Latent conditions are indirect impacts causing accidents by humans (e.g., poor design, undetected manufacturing defects, and unworkable procedures), which may be hidden for many years until they penetrate and destroy the systems (ibid).

Reason claims that technological risks are controlled by constructing a series of ‘defences in depth’ (Reason, 1997, p. 7) involving multiple layers of protection (ibid). Defensive functions that prevent accidents are composed of hard and soft defences (ibid). Hard defences are technical devices (e.g., engineered safety features, alarms, and protective equipment) and soft defences are a combination of paper and people (e.g., legislation, rules and procedures, training, and administrative controls) (ibid). Reason further suggests that one defence lies behind the others, bracing against the possible breakdown of the one in the front (ibid). For example, if the procedural guidance system fails to protect potential victims from hazards, alarms will alert operators to technological risks in a bid to maintain the safety of the system (ibid).

The model suggests the reality that defences are imperfect; each layer has holes, emulating the metaphor associated with the holes in Swiss cheese. The system becomes affected if a potential accident can enter the holes in the first defence. Should this occur, this potential accident will enter the second defence, and if the holes in all of the defences line-up in succession, the defences will collapse (Reason, 1997, p. 12).
Regulatory practitioners and scholars employ the Swiss Cheese Model to analyse accident cases. The pipeline failure at San Bruno and the Enbridge cases were subjected to this analysis (Hayes & Hopkins, 2014a). Regarding San Bruno, the maintenance work was not properly controlled. The resultant increase in operating pressure caused the existing weld defects to fail, by extension causing pipeline rupture. In the Enbridge case, the accident occurred due to a poor decision making process. The assigned leader of the team deferred its formal decision-makers to the operator on duty or to her/his subordinate. The latter was presumed to have expertise but the reality was unarguably different.

The original model has been criticised in terms of its structure and application. Luxhøj and Kauffeld (2003) note that the model provides insufficient details of the interrelationships among the causal factors, making it difficult to use in practice. Furthermore, the model does not provide guidelines for further in-depth investigation and analysis, in particular of the structure of the holes (Wiegmann & Shappell, 2012). So, how can the connection between latent conditions and accidents be identified before an accident occurs (Young, Shorrock, Faulkner, & Braithwaite, 2004)? What knowledge have regulators used in their current practices to identify latent conditions such as undetected manufacturing defects and unworkable procedures? Further, how can regulators regulate such conditions? More importantly, Besnard and Hollnagel (2014, p. 17) argue that the premise of improving safety by increasing the layers of protection can be considered as a myth because: (a) psychologically, people adjust their risk exposure according to the perceived level of protection; and (b) technically, adding layers of protection results in an increase in technical complexity thus making understanding of the system more difficult.

(b) High Reliability Organisation (HRO) theories

The literature on High Reliability Organisations is a leading guide to the explication of preventive strategies employed to ensure industrial safety. HRO research explores the conditions of large-scale and hazardous operating organisations that have excellent safety records and have conducted highly reliable operations over long periods of time (La Porte, 1996; Roberts, 1989). An understanding of how HROs operate is crucial if organisations are to avoid catastrophic accidents (ibid). Research suggests that the conditions needed to sustain HROs are variously related to internal processes and
external relationships of organisations (La Porte, 1996). The former include: HROs presenting a strong mission and goals; HROs having extraordinary technical competence; HROs having high operational performance accompanied by stringent quality assurance measures in maintenance; HROs considering flexibility to ensure safety and protect performance resilience; HROs having predominantly hierarchical patterns of authority; decision-making by HROs within authority patterns that tend to be decentralised to the level where action needs to be taken; and decisions being executed with little chance for review (La Porte, 1996). The importance of ‘safety culture’\(^8\) in HRO elements (Weick, 1987), referring to norms, shared perceptions, and having fraternal workways and informal traditions within operating groups (Roberts, 1990) is worthy of note. The organisations’ external relationships involve cooperation with external interest groups, with the aim of increasing and fostering public trust (La Porte, 1996).

HRO scholars suggest that organisations can become highly reliable and capable of preventing accidents by changing human and organisational factors. HRO theory addresses the extent to which social as well as technical dimensions are involved in regulating safety. A somewhat similar approach is taken by Resilience Engineering theory (RET) which focuses on the functions of industrial systems involving safety and efficiency. RET argues that to become resilient systems must be able to respond effectively to expected and unexpected situations, to monitor changes that happen in the environment and the system, to learn from experience, and to anticipate threats, potential changes, and constraints (see for example: Hollnagel, 2014; Hollnagel & Fujita, 2013). HRO and Resilience Engineering theory draw on complexity theory and the socio-technical systems approach to safety, highlighting the importance of unpacking the organisational characteristics of firms that operate hazardous facilities: in effect, also drawing attention to the ontology of risk.

HRO theorists additionally apply concepts of mindfulness to help organisations achieve high reliability in more effective ways (Weick, Sutcliffe, & Obstfeld, 1999). The process of organisational mindfulness comprises the following five processes: (i) preoccupation with failure; (ii) reluctance to simplify interpretations; (iii) sensitivity to

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\(^8\) A safety culture is part of an organisational culture (Hopkins, 2006). The concept of safety culture is that every organisation has its own culture (or a series of sub-cultures) and that culture has an impact on safety (ibid). HRO scholars examine the elements of cultures in HROs that can contribute to reliable operations (Weick & Sutcliffe, 2001).
operations; (iv) commitment to resilience; and (v) underspecified structuring (Weick et al., 1999). HRO theorists suggest that these five processes mitigate the blind spots that allow failures to accumulate and ultimately result in catastrophic outcomes (Weick et al., 1999). In addition, the concepts and processes of mindfulness have been advocated as essential for improving the safety of organisations (Hopkins, 2005).

While the HRO concept has proven valuable for improving industrial safety, it gives rise to a number of questionable premises. First, the criteria for classification of HROs are vague (Clarke & Short Jr, 1993). Second, the concepts of reliability and safety are different and neither concept can replace the other (Leveson, Dulac, Marais, & Carroll, 2009). Leveson et al. (2009) argue that the system can be reliable but unsafe, or safe but unreliable. Notwithstanding, HRO theorists treat these concepts as equivalents (Leveson et al., 2009). HRO studies indicate the absence of low frequency events as evidence of high reliability (Clarke & Short Jr, 1993). In practice, HRO operations may be difficult to maintain because of constraints including economic resources and declines in consensus vis-à-vis the value of organisations (La Porte, 1996). Here it is important to consider the following question: what are the organisational factors that regulators use to identify HRO operations? Specifically, to investigate: how regulators respond to active failures and latent conditions; and how can these responses be improved in order to maintain HROs and prevent future accidents?

(c) Limitations

In practice, the theories of organisational safety that are employed by regulators and practitioners (see for example: Bills & Agostini, 2009; Lekka, 2011; Royal Commission on the Pike River Coal Mine Tragedy, 2012) evidence the fact that regulators seek solutions to rectify malfunctions associated with the ‘social’ sides of organisations. However, although regulators may know what organisational and human factors could be proposed and made effective for enhancing safety practices, the factors often prove difficult – even impossible – to regulate (Royal Commission on the Pike River Coal Mine Tragedy, 2012, p. 147).

The major deficit of these theories is that their assumptions are based on plant-based safety (or organisation-based safety). Theorists focus on the management of risk by developing and using particular instrumental techniques and strategies. Uncritically, by
following these tools, other factors in the management of technological hazards are ignored; particularly social and political issues. Politics and power relations within organisations and regulatory processes can be overlooked. Or, these theories face difficulties in explaining, managing, and ameliorating problems associated with the power-knowledge relationships that shape regulatory knowledge and practices.

The social and political aspects of regulations figure already in the literature. For example, Rasmussen (1997) proposed a framework to analyse the causes of accidents occurring in a complex socio-technical system. Rasmussen linked the regulatory environment with social and political aspects of organisation and management processes, including human errors that influence accidents. Likewise, this thesis considers social and political aspects of regulations as they are related to the causes of accidents. It explores how accidents influence regulatory knowledge and practice in the Australian pipeline context. Further, it examines other assemblages apart from accidents that may influence regulatory practice? In addition, it investigates how regulators can overcome difficulties that are related to social issues and politics when dealing with industrial actors or managing hazardous industries.

The social and political also figured in Jasanoff (1998) who problematized the research on risk perception undertaken by psychometric researchers. That body of research was based on a dichotomy between ‘actual’ risk as measured by experts and ‘perceived’ risk as experienced by laypeople. The psychometric model contended that risk perception of laypeople can be distorted by a number of factors (e.g. faulty memory, inability to think probabilistically and strong prior beliefs). Jasanoff argued that the psychometric approach failed to conceptualise the nature of risk in relation to reality and power in risk perception. Taking this starting point, Jasanoff explored political dimensions in risk perception by using an approach involving social studies of science and risk together with a quantitative risk assessment. The study asserted that risk perception is embedded within three common models, namely: the realist, the constructivist and the discursive; where each model has influenced decision making and risk-related research processes. To that end, the study called attention to the need for greater sophistication in methods of studying expert risk perception.

Similar to Jasanoff’s study, this thesis explores political dimensions in regulatory practice, querying the nature of risk and its relation with power. It further proposes that
ANT, together with a critique based on Foucauldian power-knowledge, can help with such difficulties (see Section 2.1.2.3 and 2.2).

In the following sections, other theories that shape how risk is constructed in relation to social-political issues beyond organisations will be reviewed. These theories are relatively disengaged from regulatory theories and practices.

2.1.2.2 Risk and socio-political issues at the macro and micro scales

(a) Risk and socio-political issues at the macro scale: the theory of Risk Society

Beck (1992b) contended that modernity, through the application and unintended consequences of technology and science, introduced risks to society that led to what he termed ‘risk society’ – a society in which social organisation is increasingly shaped in response to the distribution of hazards. The complexity of these hazards exceeds the capacity of individuals and collectives to understand and so they are managed through regulatory institutions and industrial experts. But these institutions are scrutinised and challenged by the competing knowledge and expertise of the public, non-governmental organisations and industry (Lockie & Measham, 2012; Renn, 2008c, p. 29). The instrumental rationality of improving individual living conditions through technical-scientific progress has lost its authority. Individuals in modern societies strive to protect their own ontological security in the face of technological risks: those risks imposed by risk producers on members of society without asking for consent (Renn, 2008c, p. 29).

The concept of risk society has been criticised as an overgeneralisation because, in accordance with the rationality of modernity and its institutional settings, the risk society thesis treats risks as universal and unmanageable (Wynne, 1996, p. 44). In effect, the risk society thesis does not offer any solutions to cope with technological risk apart from emphasising the role of trust in the sub-politics of civil society actors (Renn, 2008c, p. 29). Furthermore, it fails to provide a process of in-depth analysis of the deficits of technical approaches at the micro-sociological study scale (Lockie & Measham, 2012, p. 6).

Such criticisms aside, the risk society thesis does provide a number of concepts that can be used to explore how risk is influenced by social and political processes. For example,
Beck (1999) proposed a concept of the ‘relations of definition’ (pp. 149-150) to explore risk associated with the social and political relations of law, regulations and institutions. Beck (1999) stressed that:

risk society’s relations of definition include the specific rules, institutions and capacities that structure the identification and assessment of risk in a specific cultural context. They are the legal, epistemological and cultural power matrix in which risk politics is conducted (Beck, 1999, p. 149).

Beck further organised the relations of definition into four clusters of questions where they could be employed to investigate the issues of risk related to social and political processes within legal institutions. The questions are:

1. Who is to define and determine the harmfulness of products, the danger and risk? Where does the responsibility – with those who generate the risks, those who benefit from them, those who are potentially affected by them or with public agencies?

2. What kind of knowledge or non-knowledge about the causes, dimensions, actors, and so on, is involved? To whom have evidence and ‘proof’ to be submitted?

3. What is to count as sufficient proof in a world where knowledge about environmental risks is necessarily contested and probabilistic?

4. Who is to decide on compensation for the afflicted, and what constitute appropriate forms of future damage limitation control and regulation? (Beck, 1999, pp. 149-150).

Despite the relevance of these questions when considering how the ‘relation of definitions’ operates, Beck’s questions and focus is on who makes risk, the causes and evidence of proof. Beck has taken the regulatory institutions that attempt to control risk for granted without contemplating and exploring the substantial empirical evidence associated with these following questions:

- How is risk identified, accessed and communicated, who has been engaged in the process of risk regulation and at what level? Have they been involved at the decision making levels, and if they have what issues relevant to decision-making have arisen?
• What regulatory apparatuses are used by regulatory institutions and how have they been developed and implemented among actors not only regulators but also various types of actors within regulated companies (e.g. CEO of companies, business managers, engineers and technicians) as well as other stakeholders (e.g. affected parties, planning authorities, unions, the public)?

These empirical questions and arguments need to be explored from other perspectives. An example of such a perspective is provided through this thesis (using ANT).

(b) Risk and socio-political issues at the micro scale: the theory of lay-expert understanding of science

An analysis of the construction of risk at micro scales is proposed by the theory of lay-expert understanding of science. The assumption of this theory is that lay people experience impacts from science and technologies and employ their local knowledge-experience to monitor and mitigate the said risks (Wynne, 1996). A well-known example drawn from risk research involves the case of sheep farmers in the hilly Lake District of Cumbria in northern England. In 1986, the Lake District was impacted by the fall-out of nuclear particles from Chernobyl (Wynne, 1996), which resulted in pastures and flocks being contaminated (Wynne, 1992, p. 288). The lay understanding of science is central to Wynne’s focus. The formal-technical experts and institutions dismissed the locally-experienced consequences of nuclear fall-out from Chernobyl (Wynne, 1992; Wynne, 1996). Furthermore, although local knowledge was used as evidence, the technocratic experts ignored it in their studies of sheep farms (Wynne, 1992, pp. 296-297). In this case, knowledge about risk was constructed by cultural and moral considerations rather than simply by competing technical facts between lay people and experts (Wynne, 1996). The Cumbrian case offers an analytical account of the construction of knowledge at the micro level, as a premise of further analysis. Who was involved in the interpretation of risk knowledge and how people should respond to such knowledge became important features for analytical outcomes (Lockie & Measham, 2012, p. 6; Wynne, 1996).

Despite the valued contribution of the theory of lay-expert understandings of science, the associated social construction of risk is built upon a model of conflict between lay people and experts. The influence of regulatory and industrial actors and institutions
that shape knowledge and practices in relation to regulatory outcomes is dismissed. The next section will discuss how risk is constructed and influenced by power relations.

### 2.1.2.3 Risk and power relations

The issue of power relations is the key focus of many social scientists, particularly of those are interested in power and the construction of risk. Foucault’s concept of governmentality has become influential in conceptualising the construction of risk associated with power relations (see Zinn, 2008a, pp. 191-192).

The concept of governmentality, which is drawn from the Foucauldian discursive concept of power (Zinn, 2008a, p. 192), re-theorises classical power structures that have been presented in a legitimated-hierarchical form and applied by governments to control the public. It also relates to discursive practices where power as knowledge (power-knowledge) is dispersed throughout society and generated by institutions, as well as by subjectivities that are part of discursive practices (ibid).

In such an understanding, the concept of government is reframed. It is not simply a political institution but, ‘the conduct of conduct: a form of activity aiming to shape, guide or affect the conduct of some person or persons’ (Gordon, 1991, p. 2). Foucault’s forms of power and knowledge are interrelated to inform his concept of power-knowledge. He emphasised that ‘power is not something that is acquired, seized or shared, something one holds on to or allows to slip away’ (Foucault, 1978, p. 94). Rather, power is relational and associated with strategies, technologies, and programs embedded in practices, techniques and procedures which have been managed by states that shape the lives of those upon whom power is exercised (Foucault, 1980). Foucault further contended that:

> The exercise of power itself creates and causes to emerge new objects of knowledge and accumulates new bodies of information ... the exercise of power perpetually creates knowledge and, conversely, knowledge constantly induces effects of power ... It is not possible for power to be exercised without knowledge, it is impossible for knowledge not to engender power (Foucault, 1980, p. 52).
The Foucauldian concept of power is important here for the following reasons. First, it focuses on the interrelationship between power and knowledge, especially with reference to the ability to do things. Second, it focuses on the fluidity of power where power is not held by one centre but is relational and exercised through various elements of apparatus (e.g. strategies, technologies, institutions, regulations, law and philosophy) which are linked to and supported by particular types of knowledge (Foucault, 1980, pp. 194-196). Third, it takes Foucault's insight that power is productive as well as repressive. Power here is not only a negative, coercive or repressive force. When its function is repression, people are forced to take actions against their will. Power rather is a necessary and productive force. Governmentality emphasises the productive aspect of power where power is a productive effect operating through the entire social body, inducing knowledge and producing discourses (ibid, p. 119).

Risk knowledge from the viewpoint of governmentality theory is shaped through technologies of government (or governmental technologies) (Rose & Miller, 1992, p. 175) and the calculative practices of governments and societal institutions with individuals as part of these practices. The governmentality concept focuses on strategic power manoeuvres that governments and other institutional actors employ to regulate risks which indirectly shape individuals’ conduct. This way, by avoiding a direct chain of responsibility, authorities can displace their responsibility for technological risk which may cause adverse impacts on citizens (Renn, 2008c, p. 36). Furthermore, it allows regulatory authorities to constantly perpetuate their interest-driven activities and maintain their powerful influence. Such practices are built into neoliberal institutions (Zinn, 2008a, pp. 191, 198-199), as part of current government.

More importantly, governmentality has been little used to study the processes of risk regulation in relation to power-knowledge relationships pertinent to regulators and regulated firms. In addition, governmentality scholars have faced difficulties when attempting to provide substantive and constructive advice on how to better regulate risks in the face of neoliberalism. For example, when regulating risk, it is necessary to involve natural-technical knowledge and apparatus. The constructivist group of theorists have tended to critique the technical practices used by institutions and governments rather than articulating how technical knowledge and practices can be used to handle technological risk. Instead, this thesis extends the concept of governmentality by
cooperating with ANT to explore power-knowledge relationships and ontological issues related to risk and power pertinent with elite-expert institutions.

In the next section, the influence of the theory on inclusive risk governance about how risk ‘should be regulated’ will be introduced and analysed.

2.1.3 Inclusive risk governance: how risk ‘should be regulated’

What has become apparent after reviewing theories that deal with risk is that the definitions of risk offered by the theoretical perspectives reviewed in this chapter reflect the varied ontological orientations of those perspectives. Strict realists, for example, define risk as:

> the combination of the *likelihood* of an adverse event (hazard, harm) occurring, and of the potential *magnitude* of the damage caused (itself combining number of people affected, and severity of the damage for each)  

Risk from this perspective reflects the view that risks and their manifestations are real and observable events which can be objectively identified, measured and controlled. Such realist notions of risk are used among regulatory practitioners to organise the activities of inspectors and to decide how resources should be allocated, according to the level of risk assessed (Organisation for Economic Cooperation and Development, 2014, p. 27).

Constructivists, on the other hand, define risk as socially constructed; shaped through varied processes including social interpretation and negotiation, history, politics, and culture associated with values, experiences, and interests (Renn, 2008c; Zinn, 2008b). In this view, risks and their manifestations are ‘social artefacts’ fabricated by social groups or institutions (Renn, 2008c, p. 24).

Many authors, of course, argue that risk is both real and constructed. Renn thus defines risk as ‘an uncertain consequence of an event or an activity with regard to something that humans value (definition originally in Kates et al, 1985, p21[^9]). Such consequences

can be positive or negative, depending upon the values that people associate with them’ (Renn, 2008c, p. 373). Renn also notes that specific risks are characterized by differing degrees of complexity, uncertainty, and ambiguity. In practice, social conflict is mundane in hazardous industries. It occurs where there is insufficient technical-scientific knowledge together with differences in social values about the potential impacts of sources of risk, the more so if these consequences are complex, uncertain or ambiguous (Renn, 2008c). Risks may be complex and difficult to identify: the relationships between cause and effect may be obscure (Renn, 2008a, p. 52) – testing the limits of scientific knowledge (Renn, 2008c, p. 179). And, risks may be ambiguous in the sense that different actors tend to interpret and value risks differently (ibid). In order to deal with these three components of risk characteristics, a procedure that transcends conventional risk management routines is required (Renn, 2008c).

Risk theorists recognise that each theory has its own advantages and limitations, underpinned by its theoretical propositions. Risk theorists offer some solutions to overcoming these difficulties. A possible solution is to integrate the risk concepts of different multidisciplinary socio-technical perspectives together with deliberative approaches for cooperating and communicating with different stakeholders in an open way (see for example: Lockie & Measham, 2012; Renn, 2008b; Renn, 2008c; Taylor-Gooby & Zinn, 2006; Wynne, 2002). The deliberative concept emerged from Habermasian discourse theory (Habermas, 1984; 1987) which advocates deliberative systems of public participation for legitimation and sustainability in political decision-making (Renn, 2008c, p. 297). The deliberative concept emphasises the importance of ‘equality’ among participants (Renn, 2008c, p. 285). To this end, a veridical approach from participants is required in order to develop mutual understanding and learning (ibid). A well-known example is the risk governance approach (Renn, 2008c).

The notion of inclusive risk governance is offered to ‘engage’ different groups of stakeholders in governing risk together on the same platform and, in so doing, to bridge realism and constructivism (Renn, 2008c, p. 3). The notion of inclusive risk governance aims to improve the traditional procedures of risk analysis and risk management (Renn, 2008b, p. 196). It offers a comprehensive means of integrating risk identification, risk assessment, risk management, and risk communication (ibid). In addition, it provides a tool or framework to improve governance structures and processes by involving
previously absent parties and shifting the political focus from government to governance. As Renn (2008b, p. 196) suggests:

“governance” implies, analyzing and managing risk cannot be confined to private companies and regulatory agencies. It rather involves the four central actors in modern plural societies: governments, economic players, scientists and civil society.

The risk governance concept aims: (a) to contextualise the complexity of risk-related decision-making when involving multiple actors; (b) to construct a new form of coordination by replacing the term ‘government’ with ‘governance’; and (c) to provide a platform for possible reconciliation of stakeholders who have different aims, goals and perspectives (Renn, 2014, p. 10).

The risk governance approach is used as a platform to achieve good governance for ‘robust regulation’ in the quest to prevent major accidents and improve safety performance among hazardous-technological industries (Lindøe et al., 2014, pp. 7-8). In addition, there are indications that the use of participatory scenarios that engage multiple stakeholders has proven a powerful tool to resolve social conflict and assess future consequences, as well as to change conditions in order to prevent future accidents. These changes may be overlooked if traditional risk assessment is undertaken (Kok, Biggs, & Zurek, 2007). To achieve robust regulation, regulators and risk managers must manage the challenges associated with risk characteristics: complexity, uncertainty and ambiguity (Renn, 2008c, p. 187).

When risks are well known by actors, the process of risk assessment and risk evaluation can be simple. Regulators and risk managers can apply cost-benefit analysis to make risk acceptable or tolerable together with using technical standards, safety manuals and routine monitors (Renn, 2014, p. 20).

However, (a) when risk is complex, (b) risk is difficult to identify, but (c) uncertainty and ambiguity of risk is low: the process of risk assessment and risk evaluation should be left to experts. In these cases, scientists or researchers can deliberately work with regulators and risk managers to obtain good outcomes. Examples occur in HRO industries (e.g. oil platforms and petrochemical plants). The experts, regulators and risk
managers can design and develop models and measures with the potential to prevent accidents (Renn, 2014, pp. 20-21).

Under another scenario, when risk is highly uncertain but of low ambiguity: affected stakeholders can participate in the process of risk assessment and evaluation. In addition, it is important to apply precaution-based risk management (Renn, 2014, p. 21).

When risk is highly ambiguous: it is better if affected stakeholders, the public and civil society participate in assessing and evaluating risk. Further, they can contribute to the development of a collective understanding of risk and design procedures for making decisions on risk acceptability and tolerability (Renn, 2014, p. 21). The types of actors to participate in the process of risk governance must be selected in accordance with their level of knowledge about risk (or understanding of risk characteristics (see more details in Figure 2.6).

![Figure 2.6: Relationship between stakeholder participation and risk categories in risk governance (Renn, 2014, p. 21)](image)

The risk governance approach provides useful insights into when, how and why regulators should involve other stakeholders in risk assessment and management. It acknowledges both the importance, and the limitations of, technical or realist approaches to risk assessment. Some questions, however, remain unanswered. What are the criteria that regulators use to choose participatory groups? Are these criteria valid? What role can these groups play in mitigating technological risks and at what levels can they participate? In addition, the operationalisation of the concept of ‘risk governance’ in practice implies difficulties understanding causation. More particularly, when
accidents have not yet occurred, as in the Australian pipeline case, stakeholders may not perceive the urgent need for regulators to develop a risk governance platform. Furthermore, bringing groups with opposing perspectives onto one platform could prevent the possibility of reasonable outcomes. The latter may not eventuate if opposing groups keep arguing about what may not be compromised in negotiation – by extension creating more gaps among these groups.

This thesis extends the scope of the risk governance approach by investigating the power relationships between regulators and pipeline industries and how their relationships shape regulatory practices and knowledge about public safety. In addition, it explores notions of risk that may fall outside the conventional criteria and scopes of the risk governance framework. The question to be examined is how regulators deal with this new type of risk?

In the next section, I will summarise the limitations of contemporary theories as addressed in Section 2.1 and propose an alternative approach (see Section 2.2) for tackling the two main research questions: (1) how is power-knowledge in relation to risk regulation performed by and around regulators in the case study of pipeline industries in Australia; and (2) how can the process of power-knowledge in relation to risk regulation be improved?

2.1.4 Limitations of contemporary theories

It is apparent that each theory on risk, organisational safety and regulation has its own assumptions and limitations. The uncritical use of such assumptions can lead to design inflexibility which constrains the boundaries of research exploration and analysis. Although one may argue that constructivism seems to be more flexible than realism, the process of constructivist analysis is dominated by a particular pattern of research practice. As Law contends: ‘[c]onstruction usually implies that objects start without fixed identities but that these converge and so gradually become stabilised as singular in the course of practice, negotiation and/or controversy’ (Law, 2004, p. 158). The employment of constructivism could result in the reproduction of similar analyses and narratives. This is evident in most approaches to the theorisation of risk regulation and organisational safety employed within the Australian pipeline contexts. They pay little attention to power-knowledge relationships as indicated by the discourses about risk
that circulate around major accidents when they occur. The limitation of these approaches is that discourses and assemblages implicated in politics and power relations can be overlooked.

In addition, each theory takes a different approach in dealing with risk and may ignore ontological assumptions, in particular, the nature of risk and the nature of power as they relate to empirical grounds and regulatory processes. For example, the theories of responsive regulation and of risk society are involved with the social and political processes in understanding and managing risk, theories of risk governance set premises related to the ontology of risk, and theories of governmentality set premises pertinent to the ontology of power.

Finally, through the evaluation process of reviewing existing theories, I found that theoretical suppositions have a tendency to construct analysis through a series of dichotomies, such as realism vs. constructivism, the macro vs. micro level of studies, expert vs. lay people, dominance vs. powerlessness, and classical versus discursive concepts of studying power relations. This series of dichotomies are indicative of dualist assumptions and may indicate that the regulatory knowledge pertinent to regulating technological risk, enacted based on these contemporary theories, is likely to be incomplete, dissociated and fragmented.

In addition, existing theories of technological risk regulation are framed around either human entities (e.g., regulatory experts, lay people, the public, unions, human factors, and organisational factors) or the non-human entities (e.g., pipelines, risk assessment tools, technical-regulatory pipeline standards) involved in performing knowledge and practices in relation to risk, safety and regulation. The question of how realities (power, knowledge and practices) are co-performed by both non-human and human entities, by contrast, has been relatively under-explored.

In light of the limitations of existing theories, this thesis argues that instead of following assumptions that are uncritically situated within existing theories in tackling research questions, a better option would be to take a critical-empirical approach to viewing what is incomplete, unacknowledged or disassociated on empirical grounds. Such absences or disassociations that emerged from empirical findings in this research are used to challenge existing theories. This thesis’s purpose is to understand and explore the ontology of risk and ontology of power in risk regulation. To this end, I have employed
a theory of governmentality associated with the concept of Foucauldian power-knowledge in cooperating with ANT to tackle the research questions, explained in the following.

2.2 What approach does this thesis take?

To reiterate, in this thesis, a critical-empirical approach is employed to reframe and re-evaluate theoretical ontologies. The assumptions of existing theories are put aside to allow the empirical evidence that emerges from field research free reign to inform. This approach is influenced by Actor-Network Theory (ANT) and the concept of Foucauldian power-knowledge. The following section will review ANT, and explain why it is important to this research. Starting with its background and philosophy, the key features will be investigated as well as limitations.

2.2.1 ANT background and philosophy

2.2.1.1 An overview

ANT, which has its roots in Science, Technology and Society (STS) studies, argues that ‘knowledge is a social product’ (Law, 1992, p. 381). Knowledge cannot be true and accepted only through the operation of the scientific method (ibid). Instead, Law explains that knowledge is the effect of a network of heterogeneous materials (Law, 1992, p. 381). ANT aims to characterise and understand networks of heterogeneous assemblages and to investigate how knowledge has been produced through a system. Knowledge is ‘performed’ as a set of associations. It is, therefore, the effect of a 'doing' from diverse assemblages including people, technologies, textual and symbolic forms assembled within a social context (Latour, 1986; Law & Callon, 1992). The term ‘assemblage’, which is taken from the English translation of Deleuze and Guattari’s *Mille Plateaux* (Deleuze & Guattari, 1988), refers to ‘a process of bundling, of assembling, or better of recursive self-assembling in which the elements put together are not fixed in shape, do not belong to a larger pre-given list but are constructed at least in part as they are entangled together’ (Law, 2004, p. 42).

ANT has evolved from STS over a disagreement about theoretical prepositions. The STS theorists’ strong programme alters the way to explore realities by changing the
mode of research examination from ‘natural’ science to ‘social’ science (Collins & Yearley, 1992, p. 302). The ‘strong’ STS approach attempts to argue that the science status quo takes a scientific and technical approach that is based on their own interests and benefits. The alternative is to develop a reflective-critical analysis of science actors, institutions and applications, as part of shaping and performing societal knowledge. The traditional opposition between nature and society still remains with the utilisation of the strong STS approach. Callon, an ANT theorist, argues against those adopting the strong SST approach:

They acknowledge the existence of a plurality of descriptions of Nature without establishing any priorities and hierarchies between these descriptions. However, and this is where the paradox is revealed, within their proposed analyses, these social scientists act as if this agnosticism towards natural science and technology are not applicable towards society as well (Callon, 1986, p. 197).

ANT has increased its distance from STS by combining the traditional opposites assumed by STS. These include nature and society (or between the philosophy of natural sciences (usually realism)) and the social sciences (usually constructivism), macro- and micro-analysis, agency and structure, objectivity and subjectivity, positivism and interpretativism. ANT aims to renew analysis and explanation of the process of performing knowledge (Callon, 2001, p. 62) by: (a) tracing back how those opposites are assembled in a network of knowledge, and (b) analysing what and how material conditions have influenced the performance of knowledge over time.

### 2.2.1.2 ANT ontology

The terminology of performativity, performing and performance (or enactment) and ‘perform’ in a verb form, employed throughout this thesis, is grounded in the ontological stance of ANT: the ontology emphasises a relational approach. Law argues that: ‘[w]e are no longer dealing with construction, social or otherwise: there is no stable prime mover, social or individual, to construct anything’ (Law, 2009, p. 151). What has been seen ‘is an effect rather than a cause. We are dealing with enactment or performance. In this heterogeneous world everything plays its part, relationally’ (ibid).
In as much as it is framed and analysed as a relational approach, the performativity concept is employed in a similar way to other concepts used throughout this thesis including power-knowledge, power-knowledge practices, discourse and the performativity of power-knowledge relationships. These terms are core theoretical concepts. They are used in a relational way consistent with the ANT approach: a relational approach (see more details in Section 2.2.2.3).

Viewed broadly, ANT is a poststructural approach. Law (2009) states that ANT can be ‘understood as an empirical version of poststructuralism’ (Law, 2009, p. 145). It emphasises insight into otherness (or the others) and absence. Law (2004) asserts that this version of poststructuralism challenges a flaw in the classical metaphysics of presence, which attempts to bring everything to presence in the form of a transparent representation (pp. 162-163). Classical metaphysics presents particular enacted versions of reality which set limits on what is able to be known or created (ibid). Poststructuralism argues that presence demands absence and that the two are constructed and come into being together (ibid). The poststructuralist paradigm challenges such limits and attempts to reveal the otherness, incompleteness, absence, or things that have been repressed but are necessary to presence. For example, social and political issues overlooked by conventional regulatory processes may be revealed through open investigation.

2.2.1.3 Sociology of translation (or sociology of association)

ANT is acknowledged as a sociology of translation, and as a sociology of association in which the notion of translation stresses ‘the continuity of displacements and transformations’ (Callon, 1986, p. 223) of conditions (e.g., goals, interests, human beings, devices, and pipelines). ANT theorists emphasise that no entities are situated in isolation in making and representing realities. Knowledge is performed though networks of nature and the social and that changes through time. Callon and Law (1995) state that:

There isn’t a reality on the one hand, and a re-presentation of that reality on the other. Rather, there are chains of translation. Chains of translation of varying lengths, and varying kinds. Chains which link things to texts, texts to things, and things to people. And so on (p. 501).

The next section will outline the key features of ANT which are employed in this thesis.
2.2.2 Key features of ANT

ANT has three important features: ontological equality (Section 2.2.2.1); semiotic materiality (Section 2.2.2.2); and the study of the effects of power-knowledge processes (Section 2.2.2.3).

2.2.2.1 Ontological equality

The ANT approach dissolves *a priori* distinctions between opposite theoretical propositions: for example, nature and society. ANT emphasises an important role for ‘non-human’ as equal to the role of human actors in order to bring nature and society into being, and to represent realities. Both human and non-human actors play equal roles in performing knowledge as part of the process of their interconnected relationships.

Traditionally, the ontology of non-human entities has been overlooked in social research and theories. ANT theorists offer ‘a radical constructivist semiotic approach’¹⁰ (Ashmore, Wooffitt, & Harding, 1994, p. 735) where it is necessary to treat non-human and human entities equally for the purpose of the analytical process (ibid). ANT theorists argue that ‘agency cannot be dissociated from the relationship with actors’ (Callon, 1991, p. 134). Non-human entities (or non-human actors or actants) are equally able to act upon or negotiate or do things to human entities (or human actors or actants) in the heterogeneous networks, associations and relations (a network of human and non-human actors or an assemblage of them). Actant refers to ‘anything that acts’ and actor refers to ‘what is made the source of action’ (Latour, 1992, p. 256). The terms actant and actor are defined from a semiotics perspective which is not limited to humans; the act in principle is treated symmetrically (ibid) (see further discussion of how an ANT symmetric approach has been undertaken in practice in the methodology chapter: Chapter 3, Section 3.2.2).

ANT theorists argue that rather than debating whether non-humans are equal to humans or whether non-humans have agency, it is better to pay close attention to empirical practices (called ‘empirical metaphysics’) when exploring the agency status of non-human entities (Latour, 2005, p. 51). Callon and Law (1995) further suggest that ‘[a]ll

¹⁰ Material semiotics is explained in Section 2.2.2.2.
we can do is make stories which suggest that if you don’t make such assumptions, then revealing things may happen, theoretically and empirically\textsuperscript{11} (p. 483). In light of this, what are the assemblages that have influenced the power-knowledge relationships that shape knowledge and practices in the processes of risk regulation? Some examples include: pipelines, the effects of chemical compositions of gases, risk assessment methods, pipeline regulations, industrial and government policies, and organisational structures, along with other emerging entities from field research. Do they have to be investigated or unveiled? How do the assemblages, which are all relational, come to be?

The process of revealing the relationships involving the assemblages above relies on empirical findings that may possibly support the evaluation of many other narratives which have yet to be explored. In the main, this thesis has focussed on and revealed discourses and assemblages implicated in the power-knowledge relationships that shape knowledge and practices in relation to regulatory outcomes: those outcomes which appear to have been overlooked in the existing literature. How the relationships involving assemblages are revealed will be discussed in the following section.

\textbf{2.2.2.2 Material-semiotic relationality: treating all actants as network effects}

ANT offers an approach that treats all actants (humans and non-humans that perform in assemblages) within the social and natural worlds as network effects produced and reproduced through webs of heterogeneous relations. Law states that ‘nothing has reality or form outside the enactment of those relations’ (Law, 2009, p. 141). This approach can be described as a ‘semiotics of materiality’, ‘relational materiality’ (Law, 1999, p. 4) or ‘material semiotics’ (Law, 2009). The semiotics of materiality approach attempts to develop insight into the relationality of assemblages, by examining the ways in which materials are produced and shaped in relation to other actors. This applies to all materials, not only to those that are linguistic (ibid). Thus, realities can only be understood as sets of relations, allowing the construction of human and non-humans, nature and society, centres and peripheries, insides and outsides, and so forth (Murdoch, 1995, p. 743). This approach is used throughout this thesis.

\textsuperscript{11} This issue will be expanded upon in the methodology chapter (Chapter 3) by utilising the concepts of method assemblage.
Knowledge about risk regulation is materially constructed not only through technical-regulatory processes, but also together with social, economic and political processes. For example, risk should be socialised in order to practically calculate and manage it (Lockie & Measham, 2012, p. 6). The calculation of physical harm from risk-sources is crucial to producing the best estimation by experts from the natural and technical sciences. But, in order to gain best management practices for risk, an exploration of how relevant actors take action and respond to hazardous risks is necessary (Renn & Klinke, 2012, pp. 65-66).

In this thesis, ANT takes a semiotics of materiality approach as a theoretical-methodological foundation to explore heterogeneous relationships between human actors (e.g., regulators, operators, Australian Pipeline Associations, labour unions et al.) and non-human actors (pipelines, gas, petroleum industries, industrial risk et al.) in performing power-knowledge in relation to risk regulation and regulatory practices. This approach addresses the issue of heterogeneity and considers how different elements and different perspectives are combined in the creation of a socio-technical network (Star, 1991, p. 26).

### 2.2.2.3 Power-knowledge effects

Finally, ANT is employed to study the effects of power-knowledge processes (or power-knowledge practices). ANT re-conceives the concept of power as a performative effect or a relational consequence between humans and non-humans alike performing as assemblages rather than as properties enacted by individuals, collective groups or institutions, or as a cause of their actions (Latour, 1986, p. 264).

The term ‘power-knowledge’ which I use in this thesis is taken from the Foucauldian concept of power-knowledge, as explained in Section 2.1.2.3. The forms and mechanisms of power and knowledge in both ANT and Foucault are similar as they both re-theorise the concept of power and knowledge as interwoven with relational effects (Matthewman, 2010, pp. 3-4). Knowledge is influenced, interpreted and displaced by power relations and competing discourses generated though heterogeneous relationships.

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12 This issue will be extended in the methodology chapter.
ANT emphasises the implications for both non-human and human actors in these relational effects. In addition, it offers principles for studying power and politics that take an agnostic approach: generalising symmetry and freedom from association or abandoning hypotheses with a definite boundary between natural and social events (Callon, 1986, p. 200). Researchers in this tradition attempt to impartially observe scientific, technical and technological arguments without judging them (ibid). Second, the ideal of generalising symmetry means that researchers engage with both sides of an argument from the social and natural sciences, and seek to analyse them equally (ibid). Last, researchers must not impose pre-established assumptions; rather, they investigate issues by following actors and analysing topics for their discussion in order to explain and build their argument (Callon, 1986, pp. 200-201).

Analysts do not directly criticise powerful entities (e.g. states, CEOs, industries) when employing ANT and Foucauldian approaches to study ‘power-knowledge’. They seek to avoid being indirectly tied into the same repertoire that is being required to enunciate the same social explanation (Latour, 2005, p. 260). Critical concepts assist researchers in re-compositing and expanding the contents of power and politics by revealing how these actors have power without speaking politically (ibid) or unveiling how the power of powerful groups comes to be. As one ANT theorist stated: “be sober with power”, that is, abstain as much as possible from using the notion of power in case it backfires and hits your explanations instead of the target you are aiming for. There should be no powerful explanation without checks and balances’ (Latour, 2005, pp. 260-261).

These key features form the methodological framework of this thesis (see Chapter 3). The overall theoretical-methodological thesis framework is presented in Figure 2.7.
Figure 2.7: The overall theoretical-methodological framework.

Advantages
- Risk-based regulation is used to analyse how regulators determine industrial activities according to a degree of risk.
- Responsive regulation is used to analyse how regulators interact with business in order to improve regulatory design and enforcement.
- Theory of organisational safety is used to analyse the performance of safety systems in risk management influenced by human factors, organisational factors and culture.
- Risk society is used to analyse how social and political process influence societal risk.
- Governmentality is used to analyse how power relations shape risk.
- Risk governance is used to analyse how risk should be regulated by integrating with multidisciplinary and deliberative approaches.

Disadvantages
- Each theory has its own limitations (see a summary in Section 2.1.4). For example, risk-based framework and theories of organisational safety are ill-equipped to reveal complex discourses implicated with the power-knowledge of regulatory experts; theories of responsive regulation and risk society are ill-equipped to analyse the ontology of risk related to power in regulation; the theory of inclusive risk governance is ill-equipped to explore power relations among actors in shaping regulatory outcomes.
- When tracing theoretical ontologies, there is a tendency to construct analysis through a series of dichotomies.
- Such limitations influence the disassociation and fragmentation of existing regulatory knowledge in regulating technological risks.

This thesis proposes a combination of ANT and governmentality as an overarching perspective in tackling ontological and epistemological issues, in particular, the nature of risk and power associated with regulation.
2.2.3 ANT Limitations

As previously suggested, ANT emphasises how non-human actants play their parts in producing knowledge. Ontological equality is emphasised to balance both the natural and the social, or to balance both views with the views of those who take a natural-technical approach or a social science approach.

The theoretical and methodological repositioning associated with ontological equality leads numerous authors to claim ANT neglects those issues of power, inequality and injustice which occupy the base of traditional sociology (Murdoch, 1995, p. 748). It is true that ANT does not propose a macro-social theory of capitalist or patriarchal inequality or the skepticism towards ideas such as corporate responsibility and industrial safety macro-social theory is often used to support (see the discussion in Lockie, 2004a; Star, 1991). However, it is important to remember that ANT conceives power and inequality as network effects which researchers ought, in fact, explore through the processes of translation, mobilisation and interessement that produce and reproduce actor-networks (Callon, 1986; Latour, 2005; Law, 1992). In other words, ANT requires researchers to explore both the productive role of power relations in network assembly and the repressive role of inequality, coercion, sanctions etc. through which some actants are enrolled or excluded. The emphasis here on process is highly relevant to a research field in which a diversity of actors including regulators, external auditors, CEOs, engineers, workers, and the general public are all involved in relations of power – the understanding of which is fundamental to this thesis.

The ontological focus of ANT does place it at one step removed, however, from direct engagement with risk regulation. To address this limitation the thesis adopts two approaches. The first is to co-opt a concept of deliberation (see Section 2.1.3). A basic understanding of the importance of both workers’ and the public’s roles in deliberative democracy is crucial in order to take further steps towards examining empirical work that may yield answers to questions such as whether workers, their representatives (unions) and the public, have previously been involved in the regulatory processes and, if so, how; what roles workers, their representatives (unions) and the public play in the regulatory process; and how these respective roles produce risk and knowledge. The second approach employs discourse analysis and ANT material semiotics to reveal inconsistencies in field practices by analysing the following processes: (a) how safety
practices in relation to safety regulations are enacted in pipeline industries; and (b) how safety rules are set to mitigate pipeline risks towards the workers and the public. Unveiling these processes could offer solutions towards articulating with existing discourses that aim to improve regulatory effectiveness and practices.

**Conclusion**

Through a review and evaluation of theories on regulation, the causes of accidents and risk, this chapter argues that regulatory knowledge built from these theories is likely to be incomplete, disassociated and fragmented. This thesis proposes to utilise ANT together with Foucault’s concept of governmentality as an overarching perspective to tackle ontological issues associated with risk and power in regulation. ANT extends its ontology beyond governmentality in order to dissolve the nature and society boundary. It also provides an analytical approach (the semiotics of materiality) to examine both the material character of risks and the construction of risks associated with regulation. ANT further helps with retaining an openness to recursive relationships involving the dualist character of risk through discourses, theories, power, knowledges and practices. How ANT is undertaken in practice will be discussed in the next chapter.
Chapter 3
Methodology: power-knowledge and risk regulation

This chapter describes and discusses the process of developing and operationalising research questions in relation to ANT. It begins with an analysis of the process of research inquiry: what it is; and how it is related to ANT?

This research inquiry contains the following basic interconnected elements: an epistemology-ontology, a theoretical perspective (or philosophical stance), a methodology and methods. An overview of the process of research inquiry articulated using the model of Crotty (1998) is presented in Figure 3.1.

![Figure 3.1: The research inquiry process, articulated using the model of Crotty (1998, p. 4).](image)

3.1 Philosophical stance and reflexivity

This thesis adopts the view that theoretical perspectives (or philosophical stances) are informed by epistemological-ontological views (Crotty, 1998, p. 10). An epistemology refers to a theory of knowledge. Crotty (1998) contends that an epistemology ‘is a way of understanding and explaining how we know what we know’ (p. 3). Ontology is the study of being and existence: it includes the study of assumptions about the nature of what exists (Blaikie, 2007, p. 13). Ontology addresses what the form and nature of reality is and what can be known about reality (Crotty, 1998, p. 10). From this point, ontological issues and epistemological issues are likely to arise together and these issues
inform theoretical perspectives (ibid). By way of explanation, Crotty (1998, p. 10) states that ‘each theoretical perspective embodies a certain way of understanding what is (ontology) as well as a certain way of understanding what it means to know (epistemology)’. For example, according to objectivist epistemology realities exist outside the mind (ibid). Proponents of constructivism, however, argue that the ontological status of realities cannot be divorced from the meaning-making activities with which we make sense of them (Crotty, 1998, p. 10). At its most extreme, this might suggest reality exists only in the consciousness of beings but, for the majority of constructivists, reality is conceived as an outcome of interaction between and among human and non-human entities (Crotty, 1998, p. 43).

The philosophical stance of this thesis is based on ANT and the Foucauldian approach, adopting the view that realities are not fixed as they are enacted in a heterogeneity of process. Realities (or power, knowledge and practices) are performed in diverse and heterogeneous ways. Or, power, knowledge and practices are relational effects, a consequence of interaction between human and non-human actors. Realities are multiple, not singular.

The philosophical stance informs methodology and method. Methodology, the strategy or plan of research action, design or process, is used to guide inquiry (Crotty, 1998, p. 3). The various methods include techniques or procedures to collect and analyse data in relation to the theoretical considerations, problems and the questions of the research. The methodology of this thesis is ‘method assemblage’, using the material semiotics of ANT combined with discourse analysis. How this methodological framework is operationalised will be discussed in the next section. The methods used to collect data involved interviews and documentary sources. A mixture of sampling techniques were used for data collection including theoretical sampling, purposeful sampling, snowball sampling, and opportunistic sampling. This thesis used the principle of a grounded theory together with the symmetrical approach of ANT to select samplings. The sampling justification will be discussed in Section 3.2.2. The findings from interviews and documents were inductively coded into research themes and the coding techniques were guided through grounded theory (discussed in Section 3.4.3).

Throughout the methodological process, this thesis follows a concept of reflexivity. Reflexivity has various foci, including: (a) a researcher’s awareness of their own
relationships with others in field research together with a consideration of how these relationships effect the research process including data analysis and further outcomes (Ashmore, 2015; Clifford & Marcus, 1986; Cunliffe, 2003; Geertz, 1988); (b) the potential influence of theoretical orientations and methodological approaches on research outcomes (Wilson, Ruch, Lymbery, & Cooper, 2008); and (c) consideration of the role of reflexivity in social processes as proposed by theories of ‘reflexive modernity’ (Beck, 1992b).

Reflexive awareness of the researcher’s position in the field is ‘a practical methodological concern’ through sampling, data collection, analysis and communication (Passoth & Rowland, 2013, p. 465). Reflexive awareness is employed when cross-checking the relational assemblages in which various groups of interest are immersed against novel assemblages and recommendations. Reflexivity is employed when determining when sufficient data have been collected. Reflexivity is fundamental to ethical practice in research involving humans.

3.2 Operationalisation of the methodological framework

3.2.1 Method assemblage

This thesis relies on empirical evidence that emerges from field research in order to gain insight into understanding and improving the process of risk regulation that is performed to prevent pipeline accidents. The goal of revealing the process of power-knowledge performativity in the research situation is part of the larger objective to help perform anew how regulators can effectively deal with pipeline risks both practically and theoretically.

How is the process of performing power-knowledge practices in relation to risk regulation revealed? This thesis uses ‘method assemblage’ as a methodology strategy to investigate, craft, and enact in order to make absences manifest (Law, 2004, p. 161). Method assemblage is performative or generative: it crafts the relations of entities (ibid). The material semiotics concept is a key element of method assemblage (see Chapter 2, Section 2.2.2.2), which I employ together with discourse analysis. This thesis argues that the application of ‘semiotics of materiality’ to the methodological strategy of
discourse analysis is an important advance. But, what is discourse analysis and how does discourse analysis work with ANT material semiotics?

Discourse analysis is the analysis of discourse: so what is discourse? The concept of discourse used in this research was developed in the wake of Foucault’s methodology of social science (Law, 2004, p. 159). From a sociological standpoint, discourse includes more than talk or written text (Ruiz Ruiz, 2009). It also refers to ideology and a social product (ibid). More importantly, discourse following the concept of Foucault ‘refers to a long-standing systems of ideas’ (Tracy & Mirivel, 2009, p. 154). The analysis of discourse is the analysis of broad patterns of meaning, representing ways of thinking about the social world (Tracy & Mirivel, 2009, p. 155).

Law summarises the Foucauldian concept of discourse as ‘a set of relations of heterogeneous materiality … recursively produc[ing] objects, subjects, knowledges, powers and distributions of power’ (Law, 2004, p. 159). Adopting this approach, this thesis examines the ways in which power-knowledge relationships are embedded within discourses that circulate through and around elite-expert institutions. Discourse, it is assumed, is indelibly linked to power, knowledge, and the material outcomes of regulatory practice.

It is important to note that ANT and discourse analysis are consistent with the broad concept of power-knowledge as a relational effect in sociological theory. However, ANT extends its focus to non-human actors. The concept of ontological equality is employed here. Non-human actors play roles in social networks broadly equal, albeit different, to the roles of human actors (Callon & Law, 1995). Furthermore, this perspective can be built through both theory and method into notions of discourse analysis. Theoretically speaking, ANT attempts to dissolve dichotomies: for example, the roles of structure and agency that have putatively constituted the world; the concepts of the social and the natural that some believe act independently in reality (Law & Hassard, 1999; Lockie, 2002). ANT offers a resolution involving the dissolving of dualisms which can be described as the ‘semiotics of materiality’ or ‘relational materiality’ (Law, 1999, p. 4). The semiotics of materiality approach attempts to gain insight into the relationality of entities by conceptualising all materials or concepts produced and shaped in relation with other entities in social networks (ibid).
The application of a ‘semiotics of materiality’ with the methodological strategy of discourse analysis is an important advance for the following reasons. Power-knowledge effects that better mitigate risk from hazardous industries are unlikely to develop only through discourse and/or discursive relations but rather through the interactions among people, discourses and non-human entities. The ‘semiotics of materiality’ approach will contribute to the development of a process of research inquiry that designs methodological techniques, builds up research themes, interview themes, interview questions and data analysis.

In addition, it is important to acknowledge that ANT and discourse analysis, which are situated within a poststructural approach (see Chapter 2, Section 2.2.1.2), are used to investigate the process of performing power-knowledge among conventional regulatory processes. Employing a discourse analysis approach can help to reveal how power-knowledge is produced as a network effect or, to put this differently, as outcome of negotiations among entities.

Taking these insights from ANT and discourse analysis, it is evident that consideration of the thesis’s key research questions (see below) requires consideration of how a heterogeneous range of entities, including non-human entities, influence power and knowledge. In asking how power-knowledge is performed in relation to risk regulation we need to take the questions of what is involved in these performances just as seriously as we take the question of who. The process is put forward to investigate key research questions: (a) how is power-knowledge in relation to risk regulation performed by and around regulators in the case study of pipeline industries in Australia?; and (b) how can the process of power-knowledge in relation to risk regulation be improved?

An important question is: what non-human and human actors interact to generate power-knowledge effects that shape the processes of risk regulation? Empirical data emerges from both inside, in between and outside of organisations. Given this abundance of choice, the question is: where to start? On the basis of its research rationale and questions, this thesis emphasises ontological equality: the idea that human actors are equal to non-human actors as a source in performing power-knowledge effects. To this end, this thesis begins by equally investigating both human and non-human actors in forming assemblages. Primary human and non-human actors are regulators and pipelines respectively. They were my first entry points. Empirical
evidence was investigated through interviews and documentary sources (summarised in the following Section 3.2.1.1 and 3.2.1.2).

Some commentators raise the question of how non-humans can exercise agency (see for example: Khong, 2003, pp. 702-703; Riis, 2008, p. 295). I acknowledge that my research focuses, for the most part, on understanding the actors who attempt to speak on behalf of actants (human and non-human) that make up the assemblages I am investigating. Humans use a variety of devices and techniques to understand non-human actants ranging from technical instruments that measure physical parameters to conventions for recording data to concepts that inform regulatory practices. Those humans face the same problem that I do – namely, knowing when non-humans have been enrolled successfully and knowing when failure to enrol them is likely to lead to catastrophic failure. As a social researcher I explore how it is that the regulators and other people in my sample try to access non-humans, and whether there is evidence of failure to do so as indicated by accidents, near misses, disagreement among interviewees, understanding of regulatory documents among interviewees, accident reports, databases, and pipeline maps. In so doing, the principle of symmetry has been put into action. How this principle has been enacted in practice is explained in Section 3.2.2.

### 3.2.1.1 Interview groups

My first entry point was regulators. I started by interviewing a few regulators with assistance from my research team. My formal participants can be divided into two groups: (a) regulators and their associates from Australia and New Zealand; and (b) non-regulators. There were 64 formal and 14 informal interviews. The different interviewee types and their details are detailed in Table 3.1.

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13 My research has been funded by the Energy Pipelines Cooperative Research Centre (EPCRC). The EPCRC is mainly supported by a combination of the Australian Commonwealth under the Cooperative Research Centre (CRC) Programme and the Australian pipeline industry, and partly supported by the Australian university participants in the EPCRC program (Energy Pipelines Cooperative Research Centre (EPCRC), 2015a). The EPCRC program was established in 2010 to provide research and education to benefit the energy pipelines industry in Australia (ibid). The key institutions that lead and support the EPCRC programme are the CRC Programme and a pipeline industry partnership: the Australian Pipelines and Gas Association Research and Standards Committee (APGA-RSC) (ibid). My EPCRC research team is composed of not only my academic supervisors from universities but also of industrial advisors. The industrial advisors are those who have practical knowledge and experience of pipeline regulations and pipeline industries.
Table 3.1: Interviewees and their details.

<table>
<thead>
<tr>
<th>Types of interviewees</th>
<th>Details</th>
<th>Numbers of interviewees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulators and associates</td>
<td>Regulators regulating pipelines and petroleum industries across Australian states and New Zealand.</td>
<td>26</td>
</tr>
<tr>
<td>Non-Regulators</td>
<td>Pipeline industry staff from different divisions including:</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>- technical compliance personnel from both high gas transmission pipelines and distribution pipelines</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- pipeline construction project teams</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- operation and maintenance divisions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- business divisions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- health safety and environment divisions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pipeline consultants, lobbyist groups, unions, planning panels, regulatory experts and the public.</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>78</td>
</tr>
</tbody>
</table>

3.2.1.2 Documentation sources

Apart from conducting interviews, this thesis also investigated documents, both written and non-written. The analysis of documents is not only useful for producing findings; it can also be important for cross-checking empirical data obtained from interviews and other sources. Documents are used as the basis of criticism and for later development of the research argument (Finnegan, 2006, p. 138). Documents were sourced through theoretical sampling and purposeful sampling (discussed in Section 3.2.2).

Examples of documents included: (a) public inquiries, Royal Commission reports and transcriptions of meetings about previous offshore and onshore petroleum accidents in Australia; (b) regulations and legislative frameworks of pipeline industries, onshore and offshore petroleum industries; (c) the Australian pipeline standards (AS2885); (d) regulatory documents including a PMS and a safety case; (e) official and unofficial
reports of government, states, firms and trade unions; (f) pipeline maps; and (g) graphic, pictorial, audio and video.

3.2.2 Sampling justification and the symmetrical approach of ANT

Various sampling techniques were employed to identify potential interviewees: purposeful or selective sampling, theoretical sampling, snowball sampling and opportunistic sampling. These sampling procedures are related to each other. Purposeful and theoretical sampling techniques were used at different levels. The method of grounded theory (Glaser, 1978; Glaser & Strauss, 1967) has a contribution to play here. According to Glaser (1978, p. 37), purposeful sampling refers to:

the calculated decision to sample a specific locale according to a preconceived but reasonable initial set of dimensions (such as time, space, identity or power) which are worked out in advance for a study.

Glaser (1978, p. 36) defines theoretical sampling as:

the process of data collection for generating theory whereby the analyst jointly collects, codes, and analyses his data and decides which data to collect next and where to find them, in order to develop his theory as it emerges.

The data collection process is guided by the emerging theory. Thus, ‘[t]he analyst who uses theoretical sampling cannot know in advance precisely what to sample for and where it will lead him’ (Glaser, 1978, p. 37).

Purposeful sampling and theoretical sampling were employed in the field in a manner consistent with the symmetrical approach of ANT: selecting who (humans) and what (non-humans). The sampling process is a reflexive approach to selecting participants (the definition of ‘reflexive’ is explained in Section 3.1). Purposeful sampling, involving who and what to sample, was enacted from preliminary literature reviews of related literature about the research questions. Theoretical sampling of who and what to sample was enacted by interacting with the empirical ground. I started interviewing regulator participants (my purposeful samples) so as to understand how they performed their knowledge in regulating risk. My research aimed to open the black-box of regulatory discourses pertinent to regulatory responsibility, roles and devices.
The process of theoretical sampling occurred as follows. The narratives and research themes that emerged from interviews allowed me to see gaps in knowledge: thus who and what were selected for interviews so as to explore gaps in knowledge that emerged. Who and what were unknown before I started investigating. After interviewing regulators began, some insight into how they performed their knowledge became apparent, for example, regulators of some states employed external auditors’ reports and inspections from pipeline companies to support their inspection analysis. Once this was observed, I investigated further by identifying the external auditors and interviewing them. The external auditors (who) and auditing documents (what) were unknown before my research investigation.

Another example is that after interviewing regulators the issues of measurement length and who are involved with such issues were raised. I therefore investigated the risk knowledge about measurement length and selected more participants associated with this issue. For example, I interviewed a participant who was dealing with planning and investigated what was happening: what were the problems they faced with ‘measurement length’ and planning processes associated with pipeline encroachment? I also interviewed a pipeline operator who had field experience in dealing with third party encroachment.

After the theme related to measurement length emerged, the what (non-human actants) and documents were investigated. They included: the Australian Pipeline Standard (AS2885), industrial documentation regarding measurement length, planning documents and reports, maps of the areas that had problems with pipeline danger and measurement length. This gap in risk knowledge about pipeline danger was gradually fulfilled or saturated. This is how I selected who and what from my theoretical sampling. The planning participants (who) and measurement length (what) were unknown before my research investigation. They were selected from the empirical ground to fulfil the gap in knowledge. This is how emerging themes drawn from empirical findings became saturated.

Additional interviewees were selected through a snowball process. This occurs when an interviewee, who has been chosen through purposeful sampling, helps the researcher to identify other interviewees through his or her networks (Warren, 2002, p. 87). For my purposes, I interviewed regulators and used snowball sampling which involved asking
regulators to suggest other interviewees. Selecting a sample of interviewees is sometimes opportunistic when advantage is taken of unexpected situations (Creswell, 2013, p. 158). For instance, the interview responses of opportunistically-chosen interviewees were considered relevant to the second key research question: how can the process of power-knowledge in relation to risk regulation be improved?

Despite their general importance, the aforementioned sampling models do not fully explain the research method I used. I had to develop my own strategies articulated with ANT methodological strategies to gain access to my interviewees and to manage issues of trust and confidentiality – issues that were themselves embedded in the network of power relations pertinent to elite-expert institutions that this thesis aimed to explore. These issues are outlined in Section 3.3.

3.3 Difficulties with power-knowledge assemblages

There were difficulties encountered during the process of data collection that were related to the effects of power-knowledge within elite-expert institutions. I started my data collection process by tracing the relationships of regulators with others. The process led me to become part of the power-knowledge assemblages in which regulators were embedded. This process was interactive; it both shaped me, and was shaped by me, to enable accessibility (and inaccessibility) with my interviewees. The issues were associated with trust and confidentiality of access to participants, and reflected on the confidentiality of the power-knowledge network in pipeline industries (discussed in the following section).

3.3.1 Trust and confidentiality

Data collection took 11 months from December 2013 to October 2014. It took more time than I had expected due to the following reasons. I could not use snowball sampling to interview regulators outside of the state where I started the process as it would have infringed with confidentiality requirements. I wanted to keep my interviewees’ names as anonymous as possible. In cases where my interviewees mentioned other regulators’ names during my interview session I did ask for the latter name and contact details. I located them independently and during contact with them I did not mention who provided their names and contact details unless my interviewees
directly contacted them for me. Such cases, however, were relatively rare. Where I had difficulty gaining access to interviewees, I approached potential interviewees at the national rather than at the state level. I searched for interviewees’ names in the regulatory websites of every state. Nevertheless, I still struggled as regulators’ names were usually not included on regulatory websites. Only a few were found.

I initially struggled to get access to interview regulator-interviewees, except in a few cases, despite having the name of my potential regulator-interviewee – either discovered myself or provided by my research team. This difficulty can be analysed in two ways. First, it involved the matter of trust between my professional participants and me – a stranger researcher. I subsequently developed strategies to establish trust with my potential interviewees. I asked the AS2885 committee’s (ME-038) permission to attend their annual meeting in early 2014. I had heard about the meeting from one of my interviewees. I asked if I could attend the AS2885 board meeting and provided the committee with information about my research. The information I provided included: my research background, research aims, my role in the ME-038 meeting, my research methods and my participant involvement. I wanted to introduce myself to potential interviewees, in particular, to regulators who were attending from other states. More importantly, I informed potential interviewees about my intentions with the committee in these words: ‘I will be at the ME-038 meeting as an observer for the purposes of getting background on the standards and their modification process’. I stated that nothing from the meeting would be reported directly in my research. More importantly, I wanted to seize this opportunity to recruit more participants. In addition, I affirmed the involvement of participants was on a voluntary basis. During the meeting I had a chance to introduce myself personally to my potential interviewees and I then provided them with my information sheet.

The process of employing a strategy and presenting myself at the meeting, on one hand, helped me a great deal in establishing trust with regulators, as well as other members of the committees who work for pipeline companies and consultant companies. The personal meetings ensured easier access and interviews were conducted at a later date with less difficulty. In addition, attending the meeting assisted me in developing my understanding of pipeline risks, safety and regulation.
On the other hand, confidentiality constraints in accessing participants reflect power-knowledge relationships. Had I not known about the AS2885 board meeting in early 2014, I may have had limited access to regulators and industry’ interviewees. Being through this process, I have come to terms with what is a power-knowledge effect in the process of risk regulation. Information pertaining to pipeline risks is not openly disclosed.

The relationships that obtain between human entities and non-human entities involved in performing power-knowledge practices through elite-expert institutions were gradually traced and revealed. For example, by attending the meeting, I ascertained that the members of ME-038 were composed of only two main bodies: pipeline industries and regulatory institutions. Members of these two institutions held roles at the higher levels of their organisations or at least in managerial roles. The committee did not include any ‘third’ or independent parties such as unions, workers or the public. In essence, the tripartite and risk governance concepts were either disassociated from or unacknowledged by the prevailing discourse of the Australian pipeline case (see Chapter 2, Section 2.1.1.2 and Section 2.1.3 consecutively). These disassociated relationships will be further analysed in the following section in terms of actor-networks.

### 3.3.2 Difficulties in accessing interviewees

I explored the relational assemblages (or a web of heterogeneity or an actor-web, or an actor-network) of actors, both human and non-human, involved in the pipeline regulatory process. My initial human entities and my initial non-human entities were regulators and pipelines. The pipeline standard (AS2885) subsequently became a non-human entity. From this beginning, I was able to gain access to specific groups of participants: regulators and industries who were the members of AS2885. The advantage of gaining entry to this group was that I had a chance to interview regulators in various Australian states and participants from private sectors who are usually difficult to access. However, once I had enrolled myself in the network of regulators, I struggled to gain access to those who were not part of that network. They included the workforce entities, unions, public, and planning panels. The workforce entities are specifically those who work ‘on the ground’ in pipeline safety operation and maintenance. In this section, I will further discuss the complexity, association and
disassociation of relational assemblages by reference to the difficulties in accessing workforces for interviews.

The web of relations among actors involved in regulating pipeline risks forms a complex of relational assemblages. For example, the human actors are those I interviewed as detailed in Table 3.1. The emergent findings from a web of relations slowly emerged and were subsequently gathered into research themes\textsuperscript{14}. In parallel, more time than expected was exercised in following these human actors and making contact with them for interviews. My strategy of investigating relationships among actors involved following controversial issues and triangulating and cross-checking the data obtained from different parties. Following controversial issues is part of the methodological practice of the process of data collection and analysis. The process, as inspired by the ANT approach, is to trace how controversial issues are enacted by who and what entities (Latour, 2005, p. 23). For example, when I understood that workforce entities and the public were not part of the AS2885 board, I asked questions about the safety practices of workforces in relation to safety practices developed through AS2885 and the safety documentation submitted to regulators. I wanted to find out about the relationships between safety documentation and safety practices at the coalface. What risk is there, and what safety knowledge do workforces utilise to cope with pipeline risks? In addition, I wanted to know about how (and if) the public engaged in the processes of risk regulation in preventing pipeline risks. What knowledge does the public have about pipeline risks? The findings that emerged could assist me in gaining a better understanding and improving of the process of risk regulation. I then started to ask questions about pipeline risks in relation to workforces and public knowledge with regulators and industry staff whom I interviewed.

I tried to gain access to interview workforces by using snowball sampling. First, I asked for the contact details of workforces from industrial staff, my industrial advisors from the EPCRC, regulators, as well as the AS2885 committee members so that I could arrange to interview them. However, I failed to get the contact details of workforce entities in the first instance: the industrial staff told me that they would get back to me about interviewing their workers. After not hearing anything from the staff for three months, I contacted them again and persisted in attempts to gain access to their workforces regarding safety operations and maintenance. I finally acquired the contact

\textsuperscript{14} The research themes that were gathered from emergent findings will be explained more in Section 3.4.3.
details of the field managers but not of the technicians and patrol staff. I subsequently interviewed the field managers in an attempt to use snowball sampling. My aim was to get access to the workers through the field managers. I asked a field manager if I could interview the company’s workers but was unsuccessful in the first instance. The reason provided was that the workers were working under pressure with limited availability of time. The managers insisted that the workers did not have enough time to be interviewed. In their words, the workers were not paid to do both the operation and maintenance and be involved with my research. Notwithstanding, I persisted in trying to interview some workers.

When I asked for the contact details of workforce members from the industry staff, my industrial advisors, and the AS2885 committee members I interviewed, their response invariably came in the form of a question: why did I want to interview the workers? This question gave rise to concern vis-à-vis the workers’ role and the risk knowledge that workers employ in their work.

I developed my own strategies to approach workforce members in two ways, in both cases using different entry points to gain access to the workforces. First, I went to interview the union staff members, who are outside of the regulator-industry pipeline network. My aim was to access workers who were union members and I was eventually successful. But, in the process of attempting to interview union members, I first had to spend some time learning how to access unions as the unions’ systems and categories in Australia were new to me. The different union organisations in Australia include the following: the Australian Workers’ Union (AWU), Australian Council of Trade Unions (ACTU), Australian Manufacturing Workers’ Union (AMWU), and Construction Forestry Mining Energy Union (CFMEU). I commenced by telephoning union organisations directly; but this proved unsuccessful. Then, I visited some union offices at the state level. A receptionist working for a union organisation provided me with an email address of a union staff member. I contacted that person and she provided me with contact details of union members who she thought were close to my research. I was successful in the end after realising that union systems in Australia were scattered. There is no pipeline union as such. Pipeline workers were part of different union organisations. I tried to use snowball sampling from union participants to gain access to interview pipeline workers but was unsuccessful. This experience suggested the relevance of Foucault’s governmentality concept. Ideally, the union philosophy should
support workers against risk. Nevertheless, institutional systems including unions, workers, industries, regulators and the public are all part of a process of governmentality and are part of the discursiveness of governmentality practices (Miller & Rose, 1990, p. 4), which in this case prevented access to participation. Power-knowledge is dispersed everywhere in society and indirectly controlled through various ‘conduct of conduct’ forms of governmentality. This seems to be a norm (Miller & Rose, 1990).

So, I developed a second strategy to approach workers. While I was waiting to gain access to the workers I worked to establish trust with my regulators and industrial participants. I sought permission to attend key regulator-industry meetings so that I could get to know more people and understand how their organisations were structured. By doing this, I continually built trust with industry participants. In addition, I came to understand more about the structure of industry organisations, which in turn allowed me to access potential participants who had strong links to workers’ workplaces. These key participants worked in the Division of Occupational Health and Safety and had empathy for workers’ contributions. I have named these types of actors as ‘interactors’ (see Chapter 6 (Section 6.2.2), and Chapter 8 (Section 8.3.2.1)).

After approximately four months I gained access to workers. After interviewing them I felt ‘saturated’ (Strauss & Corbin, 1998) as the data relevant to safety practices associated with the process of risk regulation in the Australian pipeline case had been triangulated or cross-checked. I had reached the point where I felt satisfied that I had collected enough data to support analysis of my research questions.

3.4 Data analysis processes and strategies

The data analysis process commenced once I started collecting my data. I made journal notes, observed, and analysed what was happening in my field research. The process of performing power-knowledge practices was analysed through relevant documentation and interview transcripts, transcribed both by myself and transcription experts. I traced the relationships of regulators interacting with other human actors, as well as non-human actors, in performing power-knowledge practices implicated in the processes of risk regulation. The methodology framework of ANT material semiotics combined with discourse analysis proved beneficial in providing concepts for revealing the
relationships of actors. But, the strategies involved in how to do it or how to collect and analyse data relevant to issues of power-knowledge relationships were, to say the least, challenging.

3.4.1 Operationalising key research questions

I collected my data beginning with open-ended questions where I put theoretical assumptions about risk, safety and regulation aside as much as possible. My interview questions had been operationalised from my key research questions (see Table 3.2), and were gathered under the interview themes. The strategy of re-configuring key research questions into interview questions involved cause-effect relations and the transformation of relations. I began with questions: ‘how’, ‘what’, ‘who’ rather than ‘why’ as the how, what and who questions allowed me to search further with in-depth investigation and analysis compared to the why questions.

Table 3.2: The operationalisation from ‘modified key research questions’ to ‘interview questions’ and interview themes.

<table>
<thead>
<tr>
<th>My modified key research questions.</th>
<th>The operationalisation of my interview questions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>How has power-knowledge in relation to risk regulation been shaped and performed by what entities and by whom?</td>
<td>Interview theme: regulatory challenges</td>
</tr>
<tr>
<td></td>
<td>What is the most important issue or challenge that regulators encounter these days?</td>
</tr>
<tr>
<td></td>
<td>Are there other issues you would like to mention as well?</td>
</tr>
<tr>
<td></td>
<td>How has this issue had an impact on safety?</td>
</tr>
<tr>
<td></td>
<td>How has this issue had an impact on what you do?</td>
</tr>
<tr>
<td></td>
<td>How well is your agency/department equipped with regulatory frameworks and compliance processes?</td>
</tr>
<tr>
<td></td>
<td>Interview theme: regulatory trends</td>
</tr>
<tr>
<td></td>
<td>What about regulatory approaches? Have</td>
</tr>
</tbody>
</table>
What has worked well and what has not worked well and how can they be improved?

Opportunities for improvement.

What do you think could be changed to improve the knowledge you used and your knowledge-capacity and actions? For example, what could be changed in dealing with uncertain situations?

What about regulators themselves? Where do you see opportunities to improve what you and other regulators do?

What about regulation? What do you think could be done to improve regulations?

Where do you see opportunities to improve the effectiveness of regulations?

The opening interview question was: ‘what is the most important issue or challenge that regulators encounter these days?’ Although the question was open-ended, to a certain degree it was limited to issues in relation to ‘power-knowledge’ practices engaged in by regulators. After asking my opening interview question, I followed up with either specific questions or with operational questions (Kvale, 1996, pp. 133-134). The interview questions that were common across all groups of interviewees are presented in the Appendix.

During the first stage of data collection from December 2013 to April 2014, I interviewed 15 regulators, who were predominantly pipeline regulators (or technical regulators). I also interviewed some who regulate petroleum industries in order to compare practices; but, a comparative study was not the main aim. I wanted to understand the background to regulatory practices from petroleum industries compared
to pipeline industries in light of the changes in the regulatory practices and regulations as a consequence of the Longford Incident in Victoria (Victoria State Government, 2004).

After my initial 15 interviews (of regulators) were conducted, I shifted to interview pipeline company staff and other actors including unions and lobbyist industry groups with the intention of cross-checking data. I subsequently returned to interview regulators again. In the meantime, some among the 15 initial interviews I conducted asked for second interviews to follow up certain issues and for data triangulation. Some responded to the follow-up questions via email. I employed the same follow-up strategies with other groups of interviewees as well.

The most important issues associated with regulation comprise complex assemblages of technical, social, economic and political themes. Having let the research unfold, and letting the data emerge with no assumptions, it took time to follow the web of relations; that is, who had been involved and how and influenced by what entities. Nevertheless, I had to choose what entities to follow. In the next section, the process of data analysis will be explained. I will discuss the entities I chose to follow, and what were the reasons for selecting them and not others.

3.4.2 Four emerging relational assemblages

I explored the non-humans that interact with humans in constituting assemblages by tracing their relationships involved in the processes of risk regulation. To achieve this, I employed the strategic methods associated with a semiotics of materiality combined with discourse analysis in, between and outside of pipeline and regulatory institutions. In addition, grounded theory is employed to draw out emerging themes.

How did I make my decisions to follow which assemblages? I chose to follow and analyse assemblages that were involved in contradictory and controversial issues wherein multiple, complex and relational assemblages were involved. The contradictory and controversial issues were represented in the process of negotiation and re-negotiation among entities.

There are four distinct relational sets of assemblages that emerged in relation to these contradictory and controversial issues, including: (a) regulators and multiple
assemblages across Australian States; (b) three regulatory apparatuses involved in the safety-regulatory apparatus including safety plans, risk-based regulation, and social-regulatory controls; (c) the technical-regulatory specification of measurement length; and (d) neoliberal rationalities, discourses about government (i.e. deregulation and energy privatisation), as well as neoliberal techniques embedded within deregulation and energy privatisation. The four relational assemblages are laid out in the thesis’s four discussion chapters (Chapters 4-7).

Through the process of following these relational assemblages, aspects (or research themes) that have a material impact on regulatory outcomes were gradually revealed. The aspects representing discourses involved knowledge and practices in the process of risk regulation; the knowledge and practices that are shaped through power-knowledge relationships involving elite-expert institutions. Such discourses are unacknowledged in the existing literature. The discourses were subsequently analysed empirically and theoretically with the larger aim of performing new power-knowledge practices in the existing process of risk regulation.

Formally, material semiotics ANT combined with discourse analysis describes the method used in this thesis, but, in practice, the analysis was complex and messy. As Law (2004, p. 2) stresses:

> what happens when social science tries to describe things that are complex, diffuse and messy. The answer, I will argue, is that it tends to make a mess of it. This is because simple clear descriptions don’t work if what they are describing is not itself very coherent. The very attempt to be clear simply increases the mess.

Although Law argues that the ANT approach has attempted ‘to imagine what it might be to remake social science in ways better equipped to deal with mess, confusion and relative disorder’ (ibid), how ANT is done in practice is still complex and messy.

So, how did I deal with such complexity and messiness? There were several ways to ANT in my analysis. I regularly took notes in my journal books, whiteboard, my Ipad, my notebook and office computer. I also used the NVivo textual database and analysis software to help me to code my interview transcripts and draw interview themes. Despite its powerful features, the process of my coding and analysis was more complex
than NVivo could facilitate. My primary means of analysing the complex and messy data was by using sequential mind mapping (see Figure 3.2). In addition, I printed out coding information from NVivo. I then crafted the linkages of interaction between those who and what that emerged from the findings. I also crafted the transitions of these interactions and their effects as they emerged from findings. These linkages were gradually drafted, and drawn into the research themes and narratives of each chapter.

![Figure 3.2 Example of sequential mind mapping of the complex and messy data.](image)

**3.4.3 Emerging research themes**

The second key research question involves the improvement of regulatory practices and effectiveness: how can the process of power-knowledge in relation to risk regulation be improved? The question was modified and operationalised to enable effective interviewing. The research themes about the improvement of regulatory practices and effectiveness that were raised by interviewees were gathered and critically analysed in an attempt to improve the process of risk regulation.
I took a grounded theory approach to coding. I employed an inductive logic (Charmaz, 2011) to develop explanatory concepts through data analysis. Interviews were coded by using the concepts of opening coding, axial coding and theoretical coding. Opening coding involved an interpretative process that helped me conceptualise data into categories or subcategories (Corbin & Strauss, 1990). Axial coding was employed to help me develop relationships between coding categories and subcategories (Charmaz, 2011). Theoretical coding was employed to provide an analysis of new relations which helped me analyse the thematic concepts at the abstract level. One of the key theoretical codes is ‘incoherence of knowledge and practices’. The concept of incoherence (or disassociation or in a verb form as disassociated or incoherent) emerged inductively from the research. It refers to a number of ways in actors’ understanding and performance of safety knowledge, risk regulation etc. were characterised by absences, incompleteness, fragmentation and/or the marginalisation of potentially important actants.

Examples of coding are presented in Table 3.3.

**Table 3.3: Examples of coding**

<table>
<thead>
<tr>
<th>Types of coding</th>
<th>Examples of coding</th>
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</thead>
<tbody>
<tr>
<td>Chapter 4</td>
<td></td>
</tr>
<tr>
<td>Opening coding</td>
<td></td>
</tr>
<tr>
<td>Categories</td>
<td>Technical regulatory specifications</td>
</tr>
<tr>
<td>Subcategories</td>
<td>AS2885</td>
</tr>
<tr>
<td>Categories</td>
<td>Risk metrix</td>
</tr>
<tr>
<td>Categories</td>
<td>Pipelines being physically safe</td>
</tr>
<tr>
<td>Subcategories</td>
<td>Using technical controls</td>
</tr>
<tr>
<td>Axial coding</td>
<td>Relationships among pipeline regulators and pipeline industries, and pipeline regulations that shape regulatory knowledge, power and practice</td>
</tr>
<tr>
<td>Theoretical coding</td>
<td>Five constituents of pipeline regulators’ ontological-epistemological logic: a new form of regulatory capture</td>
</tr>
<tr>
<td>Chapter 4</td>
<td></td>
</tr>
<tr>
<td>Opening coding</td>
<td></td>
</tr>
<tr>
<td>Categories</td>
<td>Regulatory practices in Australian states</td>
</tr>
<tr>
<td>Subcategories</td>
<td>Accidents and their impacts</td>
</tr>
<tr>
<td>Resources</td>
<td></td>
</tr>
<tr>
<td>The salary system</td>
<td></td>
</tr>
<tr>
<td>Industrial policy and activities</td>
<td></td>
</tr>
</tbody>
</table>
Organisational structures within regulatory departments

Styles of auditing process

The approval processes of a safety plan

Disclosure of information about industrial pipeline performance presented as an annual report over the website of regulatory departments

Changes in technical specifications in AS2885

Deregulation

Energy privatisation

Axial coding

Relationships among pipeline regulators and pipeline industries across Australian states

Theoretical coding

Multiplicity (or incoherence) of regulatory practices

Chapter 5

Opening coding

Categories

Developing, understanding and implementing safety plans

Subcategories

Safety plan

Field safety practices

Process safety

Personal safety

Workforce engagement

Union engagement

Categories

Developing, understanding and implementing risk-based regulation

Subcategories

Risk-based regulation

Axial coding

Relationships among pipeline regulators, pipeline industries, pipeline workforce groups and unions that shape regulatory knowledge, power and practice

Theoretical coding

Incoherence of knowledge and practices between safety plans and operational activities

Incoherence in understanding and implementing risk-based regulation

Incoherence of risk assessment practice

Ambiguity of regulator accountability towards workforces

Chapter 6

Opening coding

Categories

The enactment of Measurement Length

Subcategories

Definition

Urban encroachment

Third parties

External interference

Location class
<table>
<thead>
<tr>
<th>Categories</th>
<th>Subcategories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical-technical controls</td>
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<tr>
<td>Procedural controls</td>
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</tr>
<tr>
<td><strong>Categories</strong></td>
<td><strong>Changes in technical-political assemblages</strong></td>
</tr>
<tr>
<td><strong>Subcategories</strong></td>
<td><strong>Public notification</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Safety Management Study (SMS)</strong></td>
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<tr>
<td></td>
<td><strong>Dial Before You Dig program</strong></td>
</tr>
<tr>
<td><strong>Categories</strong></td>
<td><strong>Changes in economic-political assemblages</strong></td>
</tr>
<tr>
<td><strong>Subcategories</strong></td>
<td><strong>Cost</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Who pays?</strong></td>
</tr>
<tr>
<td><strong>Categories</strong></td>
<td><strong>Changes in social-political assemblages</strong></td>
</tr>
<tr>
<td><strong>Subcategories</strong></td>
<td><strong>Planning authorities</strong></td>
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<td><strong>Independent planning panels</strong></td>
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<td><strong>Underground companies</strong></td>
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<td><strong>Developers</strong></td>
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<td></td>
<td><strong>Builders</strong></td>
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<tr>
<td></td>
<td><strong>Contractors and sub-contractors</strong></td>
</tr>
</tbody>
</table>

Axial coding

Relationships between measurement length and others that shape knowledge and practice associated with public safety

Theoretical coding

Distortion of risk accountability and risk assessment

Muddling practice of risk communication

Uncommon knowledge about pipeline risk

Incoherence of knowledge and practice related to pipeline risk and public safety

### Chapter 7

**Opening coding**

- Categories: Neoliberalism concepts
- Subcategories: Deregulation

- Categories: Neoliberal techniques
- Subcategories: Contractual arrangement
- Subcategories: Key Performance Indicators (KPIs)
- Subcategories: Red tape reduction
- Subcategories: External auditors
- Subcategories: Building blocks

**Axial coding**

Relationships between deregulation, energy privatisation and other assemblages that shape knowledge and practice in the process of risk regulation

**Theoretical coding**

Stewardship complexity

Precarious conduct of conduct or uncertainty of governing at a distance

Incoherence of knowledge and practice shaped through neoliberalism
The process and methodological practices of this thesis are presented in Figure 3.3. This process can be applied to explore, undertake and analyse research in risk regulation.

Figure 3.3: The process and practice of the methodological framework used in this thesis.
Conclusion

This chapter has attempted to explore and explain how two key research questions were operationalised and tackled. More importantly, it has attempted to reflect on the concepts of ANT: dissolution of dichotomy, material semiotics and ontological equality, which are articulated with reflexivity. The ANT concepts and reflexivity have been shaped through the process of this research inquiry: the philosophical stances, methodological framework (material semiotics ANT combined with discourse analysis), and the process of data collection and data analysis. Within the rationales of this application of methodology, the webs of relational assemblages were revealed. Following these assemblages, research themes embodying power-knowledge relationships that shaped knowledge and practices in relation to regulatory outcomes were made visible. Such themes were critically analysed with an aim to revise the existing process of risk regulation so as to improve regulatory outcomes. This chapter highlights that this application of methodology not only illuminates alternative processes in research inquiry, research exploration and analysis; but can be extended, developed and made relevant to ethical practices in undertaking research on risk regulation.
Chapter 4
Regulator ontological stances and the multiplicity of regulatory practices

Existing scholarship on risk is largely moulded by either realist or constructivist ontological orientations. The primary ontological approach in dealing with technological risk shaped by regulatory theories is argued to be realism, where technical-regulatory tools and strategies are used in relatively pragmatic ways to objectively regulate technological risks (see Chapter 2, Section 2.1.1.3). The realist approach, however, has been criticised by constructivists arguing that risks are socially constructed through values, experiences, and expert institutions associated with power relations (see Chapter 2, Section 2.1.2).

This chapter argues that this dichotomy of ontological stances has placed limits on the exploration and explanation of ontological diversity in the empirical world, resulting in a constrained set of regulatory solutions to regulating risk. Consequently, this chapter explores the question of how realities (knowledge and practices) out-there are composed, by whom and by what entities within the context of the Australian pipeline industry?

Using a semiotics of materiality, this chapter follows technical regulators (the entry points) and non-human actors that interact with them in performing regulatory practices. Herein, regulatory practices are defined as a performative effect generated from the power-knowledge relationships of multiple assemblages. The first section (4.1) evaluates the discourse that involves the current ontological stances of regulators. The findings indicate that pipeline regulators have a certain kind of logic: a way of thinking and doing safety practices which I describe as an ontological-epistemological logic comprised of, in this case, five constituent assumptions. The questions of what logics are and how such logics have influenced regulatory practices, will be discussed in more detail in Section 4.1.1. A performativity of the logic of pipeline regulators is employed to challenge the existing discourse underlined within theories of regulatory capture (discussed in Section 4.1.2).

The second section (4.2) analyses the findings relevant to the question of how regulatory practices are performed across Australian States. The findings about
emergent multiple assemblages that interact with regulators across Australian states are mapped out. The terms multiplicity and coherence (discussed in Section 4.2.2) are used in this analysis, challenging the ontological-epistemological logic of pipeline regulators and the adoption of a harmonised Australian pipeline standard (AS2885) (discussed in Section 4.2.3). The outline of this chapter is presented in Figure 4.1.
Section 4.1: This section discusses and evaluates the discourse that involves the ontological logics and the regulation of pipeline risks.

- Section 4.1.1: Five constituents of pipeline regulators' ontological-epistemological logic
  - Section 4.1.1.1: Analyses and discusses the first constituent of logic: technical-regulatory specifications, constituted by two independent groups of pipeline experts.
  - Section 4.1.1.2: Analyses and discusses the second constituent of logic: pipelines are physically safe and pipeline risks are regulated with technical-physical controls.
  - Section 4.1.1.3: Analyses and discusses the third constituent of logic: regulators use specific sets of regulatory theories and strategies.
  - Section 4.1.1.4: Analyses and discusses the fourth constituent of logic: regulators inevitably rely on the knowledge and activities of industry.
  - Section 4.1.1.5: Analyses and discusses the fifth constituent of logic: establishing good relationships with industries.

Section 4.1.2: This section retheorises the form of regulatory capture with the findings, suggesting that ontological-epistemological logic is a subtle form of regulatory capture.

Section 4.2: This section reveals discourses implicating the multiplicity of regulatory practices, shaped through power-knowledge relationships of regulators interacting with multiple assemblages at different geographical levels.

- Section 4.2.1: Presents overarching multiple assemblages at different geographical levels.
- Section 4.2.2: Discusses and analyses the multiplicity and differences of regulatory practices across Australian states.
- Section 4.2.2.1: Discusses and analyses differences between regulatory practices associated with accidents and their impacts.
- Section 4.2.2.2: Discusses and analyses differences between regulatory practices associated with resources.
- Section 4.2.2.3: Discusses and analyses differences between regulatory practices associated with the salary system.
- Section 4.2.2.4: Discusses and analyses differences between regulatory practices associated with the industrial policy and activities.
- Section 4.2.2.5: Discusses and analyses differences between regulatory practices associated with organisational structure.
- Section 4.2.2.6: Discusses and analyses differences between regulatory practices associated with the styles of auditing process.
- Section 4.2.2.7: Discusses and analyses differences between regulatory practices associated with the approval processes of a safety plan.
- Section 4.2.2.8: Discusses and analyses differences between regulatory practices associated with the disclosure of industrial pipeline performance.
- Section 4.2.2.9: Other assemblages associated with changes in technical-regulatory specifications in AS2885 and deregulation and energy privatisation will be discussed and analysed in Chapter 6 and 7 respectively.

Section 4.3: Analyses and discusses the incoherence of risk-based practices and the challenges associated with the current ontological stance of Australian pipeline regulators.

These emerging findings are employed to conceptualise the process of performing new power-knowledge practices with an aim to improve the process of risk regulation and achieve positive regulatory outcomes, discussed further in chapter 8.

Figure 4.1: Chapter 4 outline.
4.1 Ontological stance and the regulation of pipeline risks

The main argument of this thesis is that realities (regulatory practices) are relational and not fixed. A fixed categorisation of the existing theories on risk, organisational safety and regulation, either realist or constructivist, tends to contain one singular narrative which may overlook or fail to fully comprehend complex power-knowledge relationships involved in regulation. This chapter, therefore, attempts to investigate how regulatory practices in relation to the ontological stance of regulators are composed, by whom, and by what. It examines and evaluates the current stance of pipeline regulators, and the roots or origins of their thinking and doing in regulatory practice. To my knowledge, this has not previously been examined in contemporary pipeline research. My investigation and evaluation are based on empirical findings in an effort to widen and contextualise the understanding of current practices among technical regulators. The empirical findings are employed to challenge the ontology of realist and constructivist theories so as to assist contemporary scholars to go beyond mainstream thinking and consider different ways of improving the process of risk regulation.

Debates over the ontology and epistemology of risk have been problematized using straightforward technical calculations of probability (see for example: Althaus, 2005; Aven & Renn, 2009; Macgill & Siu, 2004; Merkelsen, 2011; Rosa, 1998; Solberg & Njå, 2012). They have drawn attention to debating and progressing the definition of risk together with advancing new ways for practicing risk analysis in a holistic manner. These debates have several implications for risk regulation including: an articulation of the concept of political risk calculation (Althaus, 2005); a utilisation of asemantic analysis to redefine risk (Merkelsen, 2011); a reconceptualization of risk in relation to the concepts of time, states of affairs and events (Solberg & Njå, 2012); and an employment of the definition of risk at various scales (macro, meso, micro) together with a recognition of the notion of risk as containing both physical and social aspects (Macgill & Siu, 2004). Drawing on these insights, this chapter will tackle the problematic character of the dualist concept of risk in the sciences. In addition, the chapter will explore how risk regulation is framed through hybrid realms.

An analysis of emergent themes was conducted which disclosed that the current ontological stance of pipeline regulators is neither simply realist nor dominated by constructivist perspectives. Instead, the stance of pipeline regulators is composed of a
combination of realism and constructivism. The stance contains a realist element in the sense that pipeline regulators have a tendency to understand and regulate risk objectively by employing technical-regulatory tools that lie in pipeline regulations and AS2885. Nevertheless, the way in which risks are regulated is shaped, interpreted and in a sense, constructed by two interconnected bodies: regulators and the pipeline industries. Both parties are the same groups that originally enacted the technical-regulatory specifications posited within AS2885. The outcome is that risk regulation is controlled and constructed by these interconnected parties. The lesson to be drawn here is that the ontological stance of pipeline regulators is partly created through a constructivist approach.

The findings of this study have informed my notion of the ontological stance of regulators: a stance that leads regulators to think and act in certain ways, referred to as their ontological-epistemological logic. The logic is deeply embedded in taken-for-granted assumptions about the nature of pipeline risks and the practice of pipeline regulation. The logic itself is comprised of five inter-related constituents.

4.1.1 Five constituents of the pipeline regulators’ ontological-epistemological logic

4.1.1.1 The first constituent: the technical-regulatory specifications of pipeline regulations are constituted by two interdependent groups of experts

The first constituent, indicating how regulatory practices influence power-knowledge in regulating pipeline risks, articulates with the technical-regulatory approaches employed in pipeline regulations. Such approaches are shaped through historical processes, from gas discovery until the establishment of pipelines and their implementation. An analysis of historical processes since gas discovery indicates that pipeline regulatory knowledge and practices have been influenced by pipeline regulations that were developed after the inception of pipelines (part of this issue is discussed in Chapter 2, Section 2.1.1.3).

Date indicate that the pipeline regulations were created by specific experts within two larger interdependent groups of experts: pipeline industries and pipeline regulators. Although one may argue the general point that such experts are located in elite-expert
institutions, experts work in different divisions and at different levels within and outside of different kinds of organisations. Experts contributing to pipeline regulation include: (a) professionals working on technical safety assurance, regulatory enforcement and compliance; (b) professionals working in safety assurance in the field; (c) professionals working in organisational management; (d) professionals working on industrial and business policy; (e) professionals working on work, health and safety issues; (f) CEOs of companies; (g) executive directors working in state government bodies; and (h) ministers of state parliaments. Among them, professionals are positioned at different levels within organisations: senior professionals who have manager roles, young professionals who work under the seniors. In summary, different professionals sit within two broader bodies: industry and government. They are connected together, working within relational assemblages in performing power-knowledge relationships that have shaped regulatory logic and practices in regulating pipeline risks.

The industry body played a key role in discovering gas. Gas was discovered in 1900 in Australia and the process of petroleum exploration was expanded in the 1950s (Kimber, 1984, p. 1). The majority of petroleum resources were gas, and a natural gas industry was developed (ibid, p. 2). Gas discovery brought a pipeline industry into being with strong support from Australian governments. Kimber (2009) states:

None of these gas finds was able to be commercialised without the strong support of governments – either directly, with significant amounts of government ownership or supply underwriting, or indirectly through facilitation of land access and support for major gas consumers (p. 1).

Without government support, the industry would not have been able to commercialise the gas and pipeline industry. The interdependence of the two bodies influenced how pipelines were established, commercialised, and managed, and how pipeline risks are regulated. As I state in Chapter 2 (Section 2.1.1.3), both bodies played their important roles in developing, establishing and revising the Australian pipeline standard AS2885.

These two broader bodies have dominated the technical-social approaches employed in pipeline regulations. They chose and made decisions about what technical-pipeline specifications are, and who should be involved in the process of regulating pipeline risks. This longstanding historical relationship between industry and government continues to influence regulatory practices today.
4.1.1.2 The second constituent: pipelines are physically safe and pipeline risks are regulated with technical-physical controls

The second constituent is that pipelines are generally perceived as physically safe by both pipeline regulators and pipeline industries at all levels including senior manager levels and technicians at the ground level. Their viewpoints were supported with technical-scientific evidence and records of pipeline accidents in Australia. For example, pipeline regulators and pipeline industry professionals claimed that pipeline ruptures are very rare events, and that the Australian pipeline industry has operated at high standards with an excellent safety record. In addition, there have been no catastrophic pipeline accidents in Australia, involving the safety of people. One participant, a pipeline manager on the operation and maintenance side, contended that ‘[W]e don’t consider [that] pipelines are major hazardous facilities’ and ‘it is confusing’ to consider them as major hazardous facilities. Such consideration is influenced by technical rationalities, reiterating the way pipelines are technically-physically operated and controlled.

The degree to which pipelines are physically safe is dependent upon the invisibility of pipelines. Some participants, both regulator and industrial participants, indicated that pipelines are acknowledged among the pipeline industry body as fitting in to ‘the silence of supply’ and they are ‘out of sight, out of mind’. An industrial participant highlighted the meaning of these terms:

Pipelines are out of sight out of mind, they are silent. ... They deliver a vast quantity of energy, quietly, nobody knows about it, unless something goes wrong, and we don’t want something to go wrong.

The participant further commented that the pipeline industry likes to keep pipelines this way, out of sight and out of mind so that pipelines remain unopposed by the public. Such perspectives influence how pipelines are regulated and managed. Technical knowledge has become central to regulating pipelines by pipeline regulators and the Australian pipeline industry that focuses on technical knowledge in accordance with cost. For example, the Australian pipeline industry developed the Australian pipeline research program in 1996 to support and develop pipeline technology in a response to a complex set of rules created to design, construct and operate pipelines with an aim to reduce costs and improve the safety of pipeline technical conditions (Kimber, 2001, p.
1). The Research and Standards Committee (RSC) was established in 1996 and has worked closely with the pipeline committees of pipeline Australian standard AS2885 to ensure that the results from pipeline research are applied directly and quickly to AS2885 (Australian Pipelines and Gas Association Ltd, 2015). There are four research programs, that aim for: (a) more efficient use of materials for energy pipelines; (b) the extension of the safe operating life of new and existing energy pipelines; (c) advanced design and construction of energy pipelines; and (d) public safety and security of supply of energy pipelines (Energy Pipelines Cooperative Research Centre (EPCRC), 2015b).

Pipeline regulators and the Australian pipeline industry are concerned about the technical and physical controls that regulate pipeline risks. The industry requires the adoption of AS2885 to protect external interference from third party damage in order to maintain public safety. The physical protection of pipelines includes: (a) using sufficient wall thickness to resist pipeline penetration; (b) using sign posts and other markers as physical warning messages; (c) frequently patrolling of pipelines; (d) using the mechanical-physical method of pipeline inspection; and (e) using a safety management study during the design period and reviews every five years to identify threats including changes in the pipeline environment and, in particular, urban development.

The second form of logic together with the influence of technical-scientific evidence about presenting a good safety record has the potential to lead to a complacency about the management and regulation of technological-hazardous risks (see for example: Carroll, Rudolph, & Hatakenaka, 2002; Hopkins, 2001; Hopkins, 2007a). The issues of becoming complacent are addressed in the following questions: (a) are the technical and physical measures adequate; and (b) how do regulators regulate and evaluate such complacency?

4.1.1.3 The third constituent: regulators use specific sets of regulatory theories and strategies

Regulator participants indicated that most pipeline regulators acknowledge and employ particular regulatory theories in their strategies. Regulators primarily employ enforcement-based regulatory pyramids. The strategy of employing social mechanisms (i.e., tripartite and inclusive risk governance approaches (see Chapter 2, Section 2.1.1.2
and 2.1.3 consecutively) that assist regulators in increasing regulatory effectiveness is not part of pipeline regulatory practice (analysed further in Chapter 5). Engagement with third parties (e.g. the public and trade unions) in the process of regulating pipeline risks has also been partially excluded.

Enforcement pyramids are useful in many ways. Regulatory participants contended that the regulatory guidance concerning compliance and enforcement pyramids is easy to follow and not complicated. Nevertheless, regulators utilise highly negotiation-based strategies and only proceed with prosecution as a last resort. I did ask the question: ‘have you ever prosecuted any company’? A participant regulator stated:

No never had to. I don’t want to be prosecuting companies. It means I’m failing as a regulator too. No. It’s true. When you start prosecuting you’ve failed as such, as I have, and people forget that. It’s not my job ... I am not responsible for their compliance but I am responsible to make sure that I feel comfortable with what their performance is, and when they are not, I need to hit them over the head, but fortunately I haven’t had to prosecute anybody.

Although the enforcement pyramid procedures suggest that prosecution should be the last resort, it needs to happen when necessary (Braithwaite, 2011, p. 504). Nevertheless, when considering reasons for prosecution including the process of shutting down a facility, regulatory participants highlighted the involvement of politics outside and within regulatory organisations. The political reasons are beyond the scopes and procedures of regulators’ enforcement actions; regulators are unlikely to intervene in pipeline operations as the consequences of prosecuting companies by shutting down a pipeline facility will affect energy supplies to industry and domestic sources. Regulators cannot directly decide to shut down pipeline facilities although they may predict that an accident will happen. In addition, the decision process leading to prosecution involves executive directors or a head of regulatory department within regulatory agencies as well as ministers positioned within states. Based on the degree of influence and intervention, regulators tend to take action by choosing the lower levels of the enforcement pyramid instead of prosecuting the company. A regulator participant emphasised that:

We need to do some intelligent thing, you need to do this. We actually told them many times they need to do it but they just ignored it. We predicted but
Pipeline regulators’ activities revealed certain patterns in doing and practicing in relation to guidelines attached to the enforcement pyramids. The findings indicated that regulators would rather use compromising strategies instead of punishment strategies. The reasons also involve their work roles: regulators work as public servants under the Australian government. Regulators have been brought in to regulate pipeline risks after the decision regarding the establishing of pipelines was already made by the Australian government in response to demand by the pipeline industry. Regulators’ roles are to provide information and recommendations to the government authority who makes the decision. Regulators acknowledged that they cannot guarantee accidents involving the public will not happen. One participant regulator contended: ‘I don’t give community guarantee [sic] that nothing will go wrong, I just gave the community guarantee that I am watching their back as best as I could’.

It could be argued that regulators lack power. This, however, ignores the relational character of power-knowledge, and the discourses, enforcement actions, regulatory roles and responsibilities through which power-knowledge in relation to the regulation of pipeline risks is performed. The relational effects of the third constituent of regulators’ ontological-epistemological logic result in the next constituent.

4.1.1.4 The fourth constituent: regulators inevitably rely on the knowledge and activities of industry

The three previous constituents of ontological-epistemological logic have led to and been associated with the fourth: regulators have relied on industrial knowledge and industrial activities in managing pipeline risks. A regulator participant stated:

Well I’m not saying that – nothing’s really wrong. As long as industry does the right thing there’s no problem, because all the industries out there, doing things, and we audit and inspect a sample of all that. That’s fine. Now if something goes wrong and we need to do a lot more things then we’re going to need a lot more bodies. … It’s all good until something goes wrong, something goes wrong people start pointing fingers and saying “who?” and
“what?” Did the company do something wrong by not managing their pipeline properly, or was it the government that was wrong by not making sure the company did the right thing? So if something goes wrong, there’ll be fingers pointed, yes.

Regulators rely on industrial expertise to ensure the safety of pipelines. Regulators tend not to consider how the knowledge of pipeline risks is understood throughout regulatory processes as long as industry can show them how pipeline industries are going to deal with pipeline risks (discussed further in Chapter 5). Regulators are unlikely to check whether pipeline risks are validly assessed by industries throughout regulatory processes. This form of logic is a relational effect of the three previous constituents and all of them are related to the next constituent.

4.1.1.5 The fifth constituent: establishing good relationships with industries

As a consequence of the previous constituents of ontological-epistemological logic, regulatory knowledge and approaches are circumscribed through industrial bodies and the establishment of relationships with industries that are important to them. Regulators emphasised what they saw as the importance of establishing good relationships with industries for the following reasons:

Because what happens is a lot of this comes about regulatory engagement with the stakeholder. If the regulator doesn’t have meetings with the stakeholders regularly telling them that these are what they expect, this is what is required to be done, this is what licensee’s obligations are and you keep telling them again and again and again at the highest level, at the CEO level, things will never change because it will just go on the way it’s always gone on.

The statement above emphasises that an engagement with industries is the way to communicate the required regulatory obligations and actions with the goal of better regulatory outcomes.

The following quote from one regulator highlighted another reason:
We don’t definitely audit as much as we should. Again, that pushes more weight on the relationship we have with the gas entities and that’s why we try extremely hard to maintain the relationship as a ‘no surprise relationship’. If you don’t have the time to audit then hopefully you got that relationship where they tell you that they’ve got a problem before it actually happens.

The implication here is that regulators have limited resources to undertake field audits. In order to negotiate safety knowledge and practices, a strategy of establishing good relationships with industries is crucial. With this strategy, informal dialogue and trust between two parties can occur and this is the way accidents can be prevented. Trusting each other is fundamental, in particular, when a problem happens. Both parties can work and solve problems together before the possibility of an accident arises. Regulators indicated that they ‘need to be on top of everything’, and they have to engage with industries in order to know what industry is doing. In addition, this strategy enables regulators to access technical information and enhance their technical skills. The process of establishing a relationship between the two parties is the basis of the negotiation of their power-knowledge in relation to the process of risk regulation; these relationships have shaped regulatory practices or regulatory outcomes.

The findings of this chapter are consistent with the existing regulatory literature, in particular: regulators’ dependence on industry to access information and other resources necessary to enact regulatory practices; regulators’ reliance on industrial expertise to ensure safety; regulators’ need to create and maintain good relationships with industries; and regulators’ reluctance to use punishments (Friedrichs, 2007; Hawkins, 1983; 1984; Kringen, 2014; Wiig & Tharaldsen, 2012). This chapter has extended the analysis of existing literature to power-knowledge relationships that shape ontological practices as a new form of regulatory capture.

4.1.2 Ontological-epistemological logic: a form of regulatory capture

The constituent assumptions of regulators’ logic indicate that regulators are closely connected to industry, and reliant on industry knowledge and activities to carry out their regulatory work. The closeness of this relationship, however, has a detraction. The notion of regulatory capture has been raised by regulatory theorists when two parties, in this case, regulators and industry, share a cooperative relationship and where their
regulatory actions are not transparent to others outside of their network (Ayres & Braithwaite, 1991; Levine & Forrence, 1990; Makkai & Braithwaite, 1992).

Regulatory capture has been analysed in various situations. First, regulators become captured when they fail to enforce the law against powerful business offenders (Makkai & Braithwaite, 1992). This occurs for three main reasons. First, regulators who once worked for industry are loyal to industries rather than to the goals of regulatory institutions (ibid, p. 67). Second, regulators sympathise with industries in correlation with time; the longer regulators are involved with industries, the more likely they can be captured (ibid). Last, regulators can become weak because they aim for future careers in the industries they regulate (ibid).

There are further explanations of regulatory capture. Baldwin et al. (1998) contend that regulators are distorted by their responsibilities, and have conflicts of interest whereby they serve their interests rather than the public interest (pp. 9-10). Furthermore, Bó (2006) theorises that regulators can be captured through state interventions at policy levels including the setting of taxes and regulations and the restructuring of regulated monopolies that allows regulated corporations to manipulate and control regulatory institutions (p. 203).

I argue that these theories on regulatory capture are framed with a classical theorisation of power relations in which power is assigned to dominant states or industries. A more relational theorisation of power suggests more attention should be paid to the relationships between regulators and industry without assuming these to be negative or unproductive. The ontological-epistemological logic explored in this chapter helps to expose the ways in which such relationships are understood and ordered in the Australian pipeline industry.

I have employed the findings that emerged around ontological-epistemological logic to re-theorise and interpret how regulators are captured. I argue that pipeline regulators have not only been captured in the ways analysed and theorised by the extant theories. Rather, regulators have been subtly captured through their own logic and practices in regulating industry. More importantly, regulators themselves do not realise this new type of regulatory capture in which they are immersed. Regulator participants acknowledged the conventional forms, based on the contemporary literature. They insisted that they have not been captured by industry. They asserted that they were
aware of the issue and have developed organisational criteria and rules to avoid regulatory capture.

4.2. Multiplicity of regulatory practices

This section continues to explore regulatory practices shaped through power relations pertinent to elite-expert institutions. The findings demonstrate that the knowledge and practices of regulators are influenced by multiple assemblages – collections of human and non-human entities – that interact with regulators across Australian states. These findings are employed to challenge existing theories in relation to regulatory practices.

The existing literature shows that regulators in many countries including Australian pipeline regulators increasingly use and develop risk-based strategies to allocate their resources (discussed in Chapter 2, Section 2.1.1.1). Despite their salience, regulatory scholars acknowledge that risk-based regulatory regimes have faced difficulties in analysing the complex problems and dynamics of regulatory practices concerning risk-related issues (Baldwin, Cave, & Lodge, 2012a, p. 283; Black & Baldwin, 2010, p. 181). Uncritical application of risk-based frameworks may, therefore, promote an equally uncritical application of other regulatory standards and practices. Black and Baldwin (2010) evaluate the issue as follows:

In a risk-based regime, the inherent danger is that of "model myopia" — that regulatory officials become committed to an historically captured set of risk indicators and assessment criteria. Such commitment inhibits the regulator from responding to an unpredicted future. If the safest thing to do is to follow the risk framework, the way of least resistance is not to respond to any circumstances or events that are not anticipated by that framework. The irony is that risk-based frameworks are in danger of becoming institutionalized in a way that negates their capacity to deal with the very predictive challenges that they are intended to meet. … a further aspect of this danger of institutionalization is that regulators may become committed to a risk model that is technically or intellectually deficient in a manner that prevents adaptation to developing threats (Black & Baldwin, 2010, pp. 205-206).
As an antidote, Black and Baldwin (2010) propose a ‘really responsive risk-based regulation’ model (ibid), arguing that regulators should be required to regulate risk in a responsive way to five elements including: (a) regulated firms’ behaviour, attitudes and cultures; (b) regulations’ institutional environments; (c) interactions of regulatory controls; (d) regulatory performance; and (e) change. The response to the last element, change, suggests that regulators should be adaptive to the changes that may impact regulation including shifts in objectives and emergent risks. What are ‘changes’ and how can they be explored?

Despite the comparative flexibility of a ‘really responsive risk-based regulation’ model, I am concerned that these scholars do not adequately explain how to monitor and comprehend relevant ‘changes’. This thesis develops a theoretical-methodological approach to explore such changes. The method of assemblage (material semiotics of ANT combined with discourse analysis, presented in Figure 3.3) is used to investigate assemblages interacting with regulators that have influenced regulatory practices. The investigation is based on the analysis of grounded empirical findings. The findings open more opportunities to analyse and challenge the existing risk-based regulations, as well as providing a more flexible-analytical framework for dealing with complex risk issues.

### 4.2.1 Overarching multiple assemblages at different geographical levels

Multiple assemblages were evident in the performance of regulatory practices, several of which are not documented in extant regulatory theories. Specifically, assemblages included: (a) accidents and their impacts; (b) resources; (c) the salary system; (d) industrial policy and activities; (e) organisational structures within regulatory departments; (f) styles of auditing process; (g) the approval processes of a safety plan; (h) disclosure of information about industrial pipeline performance presented as an annual report over the website of regulatory departments; (i) changes in technical specifications in AS2885; (j) deregulation; and (k) energy privatisation. The assemblages were located within, between and beyond the boundary of organisations.

The assemblages are organised in four geographical levels in Table 4.1. Despite being enrolled in different geographical levels, each assemblage was mobilised, dynamic and interrelated.
Table 4.1: Assemblages at different geographical levels.

<table>
<thead>
<tr>
<th>Assemblages</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>International</td>
</tr>
<tr>
<td>1 Accidents and their impacts</td>
<td>X</td>
</tr>
<tr>
<td>2 Resources</td>
<td></td>
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<tr>
<td>3 Salary systems</td>
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<tr>
<td>4 Industrial policy and industrial activities</td>
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<td>5 Organisational structures within regulatory departments</td>
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<tr>
<td>6 Styles of auditing process</td>
<td></td>
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<tr>
<td>7 Approval processes of a safety plan</td>
<td></td>
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<tr>
<td>8 Disclosure of information about industrial pipeline performances presented as an annual report on the website of regulatory departments</td>
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<tr>
<td>9 Changes in technical-regulatory specifications in AS2885</td>
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<td>10 Deregulation</td>
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<td>11 Energy privatisation</td>
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</table>

Note: X refers to the presence of data related to the assemblages at different geographical levels.

4.2.2 Multiplicity: differences among regulatory practices across Australian states

The data drawn from the interviews were reorganised and grouped into seven states and territories variously labelled State A, B, C, D, E, F, and G. Although each assemblage was enrolled at different levels, they were dynamic and related to each other. Each state or territory had multiple and different assemblages as presented in Table 4.2. Nevertheless, it is important to note that this chapter is of a qualitative nature and no attempt is made to draw out statistical differences between states. The purpose here is to demonstrate variability and to explore the range of ways in which regulatory practices are and might be enacted. Each state has been influenced by different assemblages which emerged from interviews and documentation. Some states have not been discussed because their regulatory performance has not been shaped by those particular assemblages. For example, in Section 4.2.2.6, only three states (State A, E and F) employed external auditors in their regulatory process (Table 4.2 and 4.7).
influences of different assemblages associated with each state were analysed to indicate the different or multiple power-knowledge practices of states across Australia.

This section aims to present the multiplicity of regulatory practices across Australian states (discussed in the following paragraphs), challenging the existing regulatory literature and the existing regulatory practices (discussed throughout this chapter).
<table>
<thead>
<tr>
<th>Assemblages</th>
<th>State</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
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</thead>
<tbody>
<tr>
<td>1  Accidents and their impacts</td>
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<tr>
<td>1.1 Accidents at the international level</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>1.2 Accidents at the state level</td>
<td></td>
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<td></td>
<td></td>
<td>x</td>
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<td>x</td>
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<tr>
<td>2  Resources</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>3  Salary system</td>
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<td>3.1 Paid directly by state governments</td>
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<td></td>
<td></td>
<td>x</td>
<td>x</td>
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<tr>
<td>3.2 Cost recovery levies: charging licenses’ fees from licensees (pipeline companies)</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
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<tr>
<td>4  Industrial policy and industrial activities</td>
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<td></td>
<td>x</td>
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<tr>
<td>4.1 Crude oil production and reserve</td>
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<td></td>
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<td>x</td>
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<td>4.2 Refinery</td>
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<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
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<td>x</td>
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<td>4.3 Production of conventional natural gas</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
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<td>4.4 Coal Seam Gas</td>
<td></td>
<td>x</td>
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<td>4.5 Shale Gas</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
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<tr>
<td>4.6 Liquefied Natural Gas (LNG)</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<td></td>
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<td>4.7 Mining</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>4.8 Pipeline industry</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>5  Organisational structure</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td>6  Style of auditing process</td>
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<td></td>
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<tr>
<td>6.1 Field audits</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>6.2 External audits</td>
<td></td>
<td>x</td>
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<td>x</td>
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<tr>
<td>7  Approval processes of a safety plan</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>7.1 A safety plan approved by regulators</td>
<td></td>
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<td>x</td>
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<td></td>
<td>x</td>
<td>x</td>
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<tr>
<td>7.2 A safety plan not approved by regulators</td>
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<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td>8  Disclosure of industrial pipeline performances on the website of regulatory department</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>9  Changes in technical-regulatory specifications in AS2885</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>10 Deregulation</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>11 Energy privatisation</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Note: X refers to the presence of data related to the assemblages across states.

As Table 4.2 shows, a multiplicity of regulatory practices was evident across states and territories, as performed through the interactions between multiple assemblages and
regulators across jurisdictions. What is the ‘multiplicity’ concept used in this thesis? According to Law (2004), ‘multiplicity: like difference’ (p. 162), represents:

> the simultaneous enactment of objects in different practices, when those objects that are said to be the same. Hence the claim that there are many realities rather than one. … The additional claim that practices overlap in many and unpredictable ways, so there are always interferences between different realities (Law, 2004, p. 162).

Following multiple assemblages that interact with regulators highlights several themes relevant to knowledge and power (discussed in the following Sections: 4.2.2.1 to 4.2.2.8). Themes neglected in the existing literature on risk regulation but shown to be important here point to differences in the regulatory practices of each state. The practices of each state are different because they are performed through different assemblages. The differences in regulatory practices are evaluated throughout the discussion in this section. The differences indicate changes between assemblages, shaping multiple forms of regulatory practice across Australian states.

**4.2.2.1 Differences between regulatory practices associated with accidents and their impacts.**

Similar to other cases in relation to technological-hazardous risk, accidents have influenced changes in regulatory approaches to regulating pipeline risks. Such accidents are not only limited to pipelines, but include accidents that occur from petroleum and energy industries at the international and local levels. The Piper Alpha incident (see Chapter 2, Section 2.1.1.1 (b)) was mentioned regularly by research participants. As a result of the Piper Alpha accident, regulation shifted from a prescriptive approach to a risk-based approach.

The Australian pipeline sector adopted a risk-based approach to their regulatory operation, embedded in the Australian standard pipelines (AS2885) and the pipeline regulations across Australian States. Nevertheless, the structure and implementation of risk-based frameworks in each state are different depending on the type of safety system employed. The documented safety system must be approved by pipeline regulators. For states where catastrophic accidents have occurred (States B and E), a ‘safety case’ system is used whereas the other states employ a ‘pipeline management system’ (PMS),
following the safety prerogatives outlined under the AS2885 framework. The impacts from accidents in each state are presented in Table 4.3.

**Table 4.3: Differences between regulatory practices associated with accidents and their impacts**

<table>
<thead>
<tr>
<th>Impacts of accidents and types of safety systems across states</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Accident</td>
<td></td>
</tr>
<tr>
<td>Accidents at the international level</td>
<td>X</td>
</tr>
<tr>
<td>Accidents at the state level</td>
<td>X</td>
</tr>
<tr>
<td>Types of safety systems</td>
<td></td>
</tr>
<tr>
<td>A ‘pipeline management system’ (PMS)</td>
<td>X</td>
</tr>
<tr>
<td>A ‘safety case’ system</td>
<td></td>
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</tbody>
</table>

Note: X refers to the presence of data related to impacts across states.

Here I pose an important question: what do the participants know about the differences between a safety case and a PMS? Most of the participants, both regulators and non-regulators, knew little about the differences between these two regulatory models (further discussed in Chapter 5, Section 5.1.2). Only a few knew about the differences between the two types of safety system.

**4.2.2.2 Differences between regulatory practices associated with resources**

Resource inadequacy is one of the issues most mentioned as a hindrance to regulatory effectiveness. Regulators in every state have raised issues about the inadequacy of resources (as presented in Table 4.2). Participants including regulators, union officers and consultants indicated that the majority of regulators across states do not have adequate resources either in terms of financial resources or human resources (i.e., regulatory skills, capacities and competency). Regulator participants from a few states suggested that they actually had enough financial resources. But, the regulators of these states expressed a contrary view, claiming that they do not have enough human resources. The issues surrounding inadequate competency and the skills of regulators were raised by research participants – not only regulators but also industrial and consultant participants.
One of the emerging research themes revealed that regulators are required to develop their strategies with limited resources. The most common strategy of regulators is to adjust their resources and time in accordance with their assessment of the amount of risk. Many of the participant regulators mentioned that: (a) they spent more of their resources where there is a high population density; (b) where the pipelines are old and have thinner walls; and (c) practice less regulation of companies that are involved with pipeline activities in remote areas. Regulators adapt their assessment to mitigate pipeline risks by ensuring physical controls are established for pipeline risks. These strategies are limited by other assemblages associated with salary systems, organisational structures, industrial policies and activities within each state. More generally, the assemblages are associated in complex relations, forcing differences (or incoherencies) in regulatory practices in each state (see the definition of incoherence in Section 3.4.3).

4.2.2.3 Differences between regulatory practices associated with the salary system

The salary system supporting pipeline regulators is of two types: salaries paid directly by state governments and salaries funded by licensees or pipeline companies through state governments (see Table 4.4).

Table 4.4: Differences between regulatory practices associated with salary systems.

<table>
<thead>
<tr>
<th>Salary systems across states</th>
<th>State</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary system</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td>Paid directly by state governments</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost recovery levies: charging licensees’ fees against licensees (pipeline companies)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

Note: X refers to the presence of data related to salary systems across states.

This section does not attempt to evaluate which of the two systems is better but, rather, addresses differences and issues concerning the two systems. The findings indicate that, in most states and territories, regulators’ salaries were paid through cost recovery levies by charging a licensees’ fee against licensees (pipeline companies) although the structure of fee collections is different in terms of the rate of licensees’ fees.
The relationship between the salary system and the regulation system was ambiguous. A regulator participant stated that ‘[r]egulation is a private good, not a public good’. This phrase was explained as follows:

Regulation is not for the public. Regulation might protect the public but regulation is only there because some private interest has decided to do something which is imposing in cost, potential risk or cost to the community. That’s the private goods. So me as a regulator. I am there to deal with the private goods so I have to get that money to pay for my time from the person who incurs the cost and that is the company. So my license fees have to be set at the right level to fund the resources I need to satisfy the community and the industry safety. The best way to do [this] is through license fees. That is why regulation people have licensee fees to pay for the cost of regulation. That is in theory but some governments don’t charge enough so they don’t have enough money to pay for the right resources.

The key message inherent in this statement is that the fee collected from the pipeline industry is part of regulatory practice. Regulations are created to manage the industry. Regulators who are assigned to regulate the industry should be paid by the industry. This regulator and some others were satisfied with how their salaries were arranged through cost recovery levies.

Despite the advantages, there were some contradictions in the salary system. A few regulator participants and one union officer were concerned with how the salary system influenced regulatory practices. For example, one regulator participant addressed a concern about being fully funded by industries, indicating that the cost recovery levies have made some regulators feel uncomfortable because ‘who pays’ the salary of regulators, or ‘where the salary comes from’ is relatively controversial. The issues of transparency, accountability, and the conflict of interests were raised by this regulator participant:

From my point of view, I have a lot of discussion with my colleagues and a lot of debate about this issue. I do not feel comfortable. Some of us don't feel comfortable with this but it's not our choice. We don't have a choice. We'd rather be impartial which means that we are independent from the operators. We'd rather be government servants in the true respect of the word, which means our salaries are not being funded by the industry.
Another issue surrounds industrial intervention. This regulator participant further opined that the salary system, whereby regulators are paid through cost recovery levies from the licensee’s fee collection, could allow industries to intervene in the regulators’ actions on compliance and enforcement as well as in the prosecution process:

That's a bit of a challenge here because the industry is basically … yeah, the first thing is nobody likes to come up with money. Basically the … I mean, from the point of view of the operator nobody likes to come with money, out of pocket. If they come up with money they want something in return. It's only natural, okay? It's like anybody else. At the meeting they try to influence … they want to have a lot of say and influence in how money is spent. Basically they are not too concerned on how money is spent, I think. They like to have a lot of … we find that again a problem with the issues with prosecution and all that. You can imagine: how are you going to prosecute somebody who pays your salary if somebody commits offence, there's a big accident or something happens. Under regulations, the penalties of breach of compliance of regulations, we're supposed to prosecute them. The question is how motivated are we to prosecute them if they actually pay our salary? This is a big challenge. It's one of the challenges we face. Our track record, history, of successful prosecutions is pretty poor, very poor. There's only one in the history of how many years … successfully prosecuted.

Conversely, some of the regulators claimed that they have a transparent system and follow rigorous checks within an independent reporting system to prevent industrial intervention. Even so, I argue that there is no room for third party intervention in checking such a transparent system and in monitoring the closed relationship between the two interdependent parties: pipeline industries and regulators. In summary, different types of salary systems have different impacts on regulatory practices with deferential outcomes that may lead to subtle forms of ‘regulatory capture’.

4.2.2.4 Differences between regulatory practices associated with the industrial policy and activities

States have different types of industrial policy and activities (as presented in Table 4.5), that influence regulatory practices differently.
Table 4.5: Differences between regulatory practices associated with industrial policy and activities.

<table>
<thead>
<tr>
<th>Industrial policy and activities</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Crude oil production and reserves</td>
<td>x</td>
</tr>
<tr>
<td>Refinery</td>
<td>x</td>
</tr>
<tr>
<td>Production of conventional natural gas</td>
<td>x</td>
</tr>
<tr>
<td>Coal Seam Gas</td>
<td>x</td>
</tr>
<tr>
<td>Shale Gas</td>
<td>x</td>
</tr>
<tr>
<td>Liquefied Natural Gas (LNG)</td>
<td>x</td>
</tr>
<tr>
<td>Mining</td>
<td>x</td>
</tr>
</tbody>
</table>

Sources: The information in this table is drawn from the research findings and following source: Minter Ellison Legal Group (2013).

Note: X refers to the presence of data related to industrial policy and activities

Pipelines are a fundamental infrastructural activity in every state of Australia. They carry energy products to and between industries and domestic households. Although some states (States D and F) have a minimum of heavy industry compared to other states (see Table 4.5), pipelines pass through to deliver products to domestic residents and local businesses.

The location of pipelines has an impact on regulatory practices and knowledge. For example, there are pipeline licensees who own pipelines passing through State F that are based in other states. The pipelines are operated by other companies. A regulator participant indicated that because pipeline licensees are located in different states, pipeline regulators have difficulty accessing the safety documentation particulars of pipeline licensees. The issues involve the process of deregulation (the emerging assemblage number 10) and energy privatisation (the emerging assemblage number 11), which will be discussed further in Chapter 7.

Unlike others, State A does not have an upstream petroleum industry. The petroleum resources that are currently supplied to State A have nearly run out. For this reason, State A has proposed coal seam gas as an alternative energy resource, in the main to support downstream industrial sectors. A special divisional institution has been set up for managing and regulating the new coal seam industry, leading to changes in organisational structure. Such changes have had an effect on pipeline regulatory practices within State A. The number of pipeline regulators was reduced as they were
rearranged to share their roles and expertise. Some were moved to support the coal seam gas division.

The states B, C, E and G have considerable industrial activity. Nevertheless, among them, the regulatory departments responsible for industrial activities are arranged differently. States B and C have more than one department managing different types of industries whereas states E and F have only one department regulating different types of industries including regulating the whole gas industry from petroleum exploration to BBQ bottles.

The regulatory practices of State E are relatively distinct: there is only one department accountable for heavy industry activities within the state; and the numbers of regulators, as well as their technical knowledge and skills, are limited. State E has developed and rapidly expanded LNG industrial activities and the total production capacity of LNG will be increased more than 50% by 2017. In the meantime, State E passed through an organisational restructuring phase in 2014, recruiting new technical regulators and new team leaders as part of a political mechanism associated with the state government. The previous technical regulators of State E, employed through a contractual arrangement under the previous political regime, were dismissed and their agreement cancelled. This was not because they did not have knowledge and skills, but due to a political situation within the organisation, impacting on the restructuring of regulatory institutions.

Participants, both regulators and industrial employees, indicated that the consequences of the resulting regulatory-institutional restructuring were substantial. Regulatory knowledge and skills take time to build. Not only technical knowledge and skills, but new regulators need time to learn to establish new relationships and develop trust with the industry as part of regulatory practices. Such restructuring of regulatory agencies has broken the continuity of regulatory practices and knowledge, in the process impacting on the effectiveness of regulating pipeline risks.

In summary, the differences between industrial policy and activities shape regulatory practices differently. The regulatory practices of State E have been massively influenced by industrial policy and activities compared to others. The reason is that the relational effects of industrial policy and activities are entangled with complex and multiple assemblages (i.e., the assemblages related to resources, the salary system and, in
particular, the stability of the political regulatory-institutional structure), much more than other states.

4.2.2.5 Differences between regulatory practices associated with organisational structure

The interview evidence of regulatory and industrial participants about the role of organisational structure strongly suggested an impact on regulatory practices in nearly every state (see Table 4.6). Some states (States A and E) were discussed in the previous Section (4.2.2.4). This section will discuss States B, C, and D.

Table 4.6: Differences between regulatory practices associated with the organisational structure.

<table>
<thead>
<tr>
<th>Organisational structure across states</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisational structure</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: X refers to the presence of data related to organisational structure across states.

The organisational structure of State B was influenced by catastrophic accidents and the process of energy privatisation. A new organisation was set up in relation to part of these two material entities. Due to these reasons, State B was able to gain greater resources, both human and monetary. A regulatory team was recruited and obtained support from the executive team located within the new organisational structure.

Regardless of catastrophic accidents, findings indicate that State C regulators initially restructured their organisation and regulatory framework beginning with the reframing of their own regulatory framework, regulatory philosophy and regulatory roles. The restructure process was supported by the director and the chief engineer of the organisation. Rather than following previous regulations, State C started designing and rewriting its own regulations, beginning with a principle of regulation.

Despite such positive outcomes, there were negative impacts from influence exerted by executive directors of organisations. For example, an executive director intervened in regulators’ actions against a petroleum company. Regulators wanted to adopt a punitive approach, following the sanction enforcement pyramid. Regulators wanted the company to make immediate changes to mitigate risks. Regulators intended to send an urgent letter to the company, and if the company did not make any change within four weeks,
regulators would proceed with a plant shut-down. But, the regulatory processes and actions were obstructed by the executive director, who employed a compromising strategy to deal with the company instead.

Considering the overall organisational structure of states, State D is different. Pipeline regulators are required to be part of a WorkSafe organisation (the government statutory agency dealing with general worker safety issues) within State D, whereas pipeline regulators of other states are positioned within a petroleum department (or an energy or a petroleum and mine department). The WorkSafe organisations of other states are managed separately and associated with other different types of work and industries. The separation of organisations and legislative systems has set and limited the boundaries of who should be involved in regulatory processes and how (further discussed in Chapter 5). This has resulted in an incoherence of practices and knowledge in relation to pipeline risks and danger.

4.2.2.6 Differences between regulatory practices associated with the styles of auditing process

The styles of auditing process are addressed comparatively by research participants as presented (see Table 4.7). There are two main styles of auditing process, either audit by pipeline regulators, or by others. The latter is undertaken by external auditors, independent auditors (or third party auditors). Criticism arises over ‘who pays’ for external auditors: either pipeline companies or regulatory bodies. The question of ‘who pays’ involves a conflict of interest in audits which I will discuss later in this section.

<table>
<thead>
<tr>
<th>Style of auditing process across states</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Field audits</td>
<td>x</td>
</tr>
<tr>
<td>External audits</td>
<td>x</td>
</tr>
</tbody>
</table>

Note: X refers to the presence of data related to styles of auditing process across states.

Nearly all of the participant regulators preferred to do their own field audits for the following reasons. First, the gap between what is expressed in the safety documentation, submitted to pipeline regulators, and what happens in field safety practices is disclosed
through field auditing. Because this is a key piece of regulatory knowledge and practice, most of the regulatory agencies see this as a core task to be done by their in-house staff. Second, the problems in field safety practices are passed on to pipeline regulators from pipeline field staff. Again, this is a key source of knowledge other than that passed on in writing by company management. Pipeline regulators can subsequently raise these problems with licensees or CEOs of pipeline companies so that the resources are being provided to enable field staff to work in safer conditions. Regulator participants indicated that licensees or CEOs are willing to fix the problems to prevent deaths. One regulator participant stated: ‘that is very cheap investment, for licensees to make it. When they start to understand this, these issues that have been raised by the regulator from a field perspective, are not big issues at all.’ Nevertheless, industrial participants (in particular, those who work at the sites such as operation and maintenance managers, occupational health, safety and environment (OHSE) managers, field managers and field technicians) indicated that in some areas the field staff have neither met regulators nor raised their concerns with regulators. The areas concerned are located in states that have limited resources for undertaking field audits.

Some states that had suffered major accidents took on the assignment to make major changes in the organisational structures, regulatory devices and strategies, increasing regulatory effectiveness. The states that had suffered accidents gained more resources than others, both monetary and human resources. Due to the increased supply of resources as a result of accidents, they tended to be ‘more stringent’ or ‘more at arm’s length’ than others. And, there has been a change towards increased regularity of field audits. In addition, senior regulators have had more time to train young regulators to enhance the competency and skills of young regulators, compared to others. This is against a background wherein the competency and skills of regulators are inadequate in all states, an observation made by the majority of participants (see Section 4.2.2.2.).

Those states that have not had accidents had less resources to do field audits. Regulators develop their regulatory strategies in accordance with the amount of resources they have, both technical knowledge and skills, as part of their negotiating process when dealing with pipeline risks. The use of ‘external auditors’ or ‘third party auditors’ is one of the regulatory strategies employed to prioritise regulatory resources and skills.
Despite such advantages, the implications of ‘external audits’ are controversial, as emphasised by a regulator participant:

There is no independence. This individual has been conducting the audits for ten plus years and sees no fault in their system. However, us as technical inspectors/regulators are finding faults within their system which the auditor is not recognising, so there is no independence. I believe it’s a very flawed system where the auditor and the utility are too close and too interrelated, the auditor is paid by the utility to conduct that audit; they will never, ever give negative results of the utility’s activities because they’re paid by the utility. If they give negative results the utility will find another auditor to pay to get the right result and I think it’s a very dangerous practice.

In addition, an industrial participant said:

That’s very difficult. That’s very difficult. Some companies will bring in a friend of a friend and they’ll write a soft audit. Other companies will bring in a very good auditor and they’ll find a list of things like that, that need to be improved. It’s tough. It’s tough. Even though they’re external, sometimes they’re kind of not. It should be in the report. So in the report there should be a scope and a criteria, objectives, there should be the competencies of the auditor, the professional competencies of the auditor, the methodology that was used to do the audit and then the results.

The roles and the independence of external auditors are implicated by conflicts of interest and accountability, in particular involving states A and E. Although an external audit is required by regulators, some external auditors have been paid by pipeline companies, not by regulatory departments, the exception with State F.

Despite such shortcomings, a process of intervention to check external audits has not been developed. In addition, there is a lack of rigid guidelines for external auditors in their field audits: external auditors have to develop their own guidelines. The process of evaluating the work of companies has been left to auditors, who again develop their own guidelines. Even though external auditors exercise integrity and competency when undertaking the audits, there is no trustee or institution responsible for checking their protocol. This can be described as a subtle form of regulatory capture. Regulators have
been captured by their own practices. In this case, regulators are captured through the process and practices of employing external auditors.

4.2.2.7 Differences between regulatory practices associated with the approval processes of a safety plan

This section discusses the differences among approval processes of safety plans. Pipeline companies need to obtain an approval for their safety plans before they can start operations. The approval process of a safety plan is different in each state (see Table 4.8) but can be divided into two subcategories: one is a safety document that is set up to be approved by regulators and the other is not.

Table 4.8: Differences between regulatory practices associated with the approval process of a safety plan

<table>
<thead>
<tr>
<th>Approval processes of a safety plan across states</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approval processes of a safety plan</td>
<td>A</td>
</tr>
<tr>
<td>A safety plan approved by regulators</td>
<td>x</td>
</tr>
<tr>
<td>A safety plan not approved by regulators</td>
<td>x</td>
</tr>
</tbody>
</table>

Note: X refers to the presence of data related to approval processes of a safety plan across states.

Under AS2885 requirements, a safety plan is required to be approved either by pipeline licensees or their delegates. The safety plan is designed to prove to regulators that their infrastructure is being maintained, operated and serviced correctly. Nevertheless, the document is not necessarily approved by regulators although some regulatory agencies, in particular those having had catastrophic accidents within states (States B and E), have practiced a rigorous scrutiny and adopted an onerous approach to approving and checking the safety document and auditing the operation of pipeline companies. Some criticism has been levelled against regulatory agencies that do not approve the safety plan. As one industrial participant commented:

In some states, they have an attitude of … they won’t approve because if something goes wrong and you have a safety plan in place and the regulator has approved that. You can say, well you guys approved it, you knew about it, you’re liable too … If you kill someone or damage property or something like that. So, in some states they have that attitude that ‘we don’t want to
know about it’, ‘we’re not gonna approve any … but [the problem is that] they don’t go into as much depth, thinking that they don’t have the liability then if something goes wrong.

This criticism involves issues concerning the liability of regulators and the process of thoroughly checking and assessing pipeline risks, undertaken by industries.

The approval process is part of the regulatory strategies utilised in risk-based regulation. The strategies are associated with regulatory resources. For example, State A has a limited number of regulators who neither have the time nor the resources to assess the safety and operating plan. State A has developed a strategy to negotiate their regulatory power-knowledge in accordance with the limited resources of regulators.

Regardless of the strategies used in risk-based regulation, State G has an approval process associated with the structure of regulatory frameworks, industrial practices and industrial implementation. As part of the legislative frameworks, industrial sectors in State G do not need to get an approval prior to undertaking industrial activities. According to the Gas Act enacted in State G in 1967, industrial sectors need to get a franchise to proceed. The franchise is a system that allows a company to get authorisation for a petroleum lease in an area that has attracted their interest. Once having obtained franchise authorisation, a company can proceed with any of their industrial activities (e.g. drilling petroleum wells, building processing plants, building pipelines) in that area. And, when the area belongs to the company, others including regulators cannot intervene.

Regulators in State G have no authority to intervene in industrial activities. Within the state’s franchise system, there is no regulatory requirement to seek legislation authority before a pipeline is constructed. The pipeline regulators become involved at the commissioning and operating phases, after the pipeline construction phase has finished. The legislation involved in a construction phase comes under the Workplace Health and Safety legislation, similar to other states. Nevertheless, recently, regulators in State G began a review of their regulatory framework in order to gain more influence in negotiating with the industrial sector. The review is in progress and has not yet been finalised.
4.2.2.8 Differences between regulatory practices associated with the disclosure of industrial pipeline performance

Disclosure of industrial pipeline performance is part of the regulatory strategies *vis-à-vis* negotiating regulatory knowledge and practices with pipeline industries. The states taking this approach are presented in Table 4.9.

Table 4.9: Differences between regulatory practices associated with the disclosure of industrial pipeline performance

<table>
<thead>
<tr>
<th>The regulatory strategy: the disclosure of industrial pipeline performance across states</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disclosure of industrial pipeline performance on the website of regulatory departments</td>
<td>A</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Note: X refers to the presence of data related to the regulatory strategy: the disclosure of industrial pipeline performance across states.

Strategies regarding information disclosure are considered as another form of regulation (see for example: Cohen & Santhakumar, 2007; Stephan, 2002). Pipeline regulators have used this strategy as part of their political-legal mechanisms in an attempt to foster positive changes in industrial performances.

Regulator participants indicated that there are three states taking this approach. A pipeline company is required to report their performance annually in an annual report. Nevertheless, each state presents the performance of its companies differently. Among the three states, State A re-writes and re-arranges the annual reports of companies. Similar to State B, the information, which is compiled and written by state regulators, is posted on the internet. The information about industrial performance that is presented via the websites of regulatory agencies is negotiated between regulators and pipeline companies. Among the three states, State C is different. State C presents the annual report of companies direct via the regulatory website without rewriting it. Controversial issues, including non-compliance, are not made public. One regulator participant indicated that the interest groups that show interest in reading an annual report are generally pipeline companies or pipeline operators, not the general public. The intention of pipeline operators in reading annual reports was addressed by this regulator. He
inferred that pipeline operators read the annual report because they want to compare their performance with similar others.

In summary, each state presents the performance of its companies differently. There are only three states that have taken the strategy of information disclosure by presenting an annual report of a pipeline company on the departments’ website. Nevertheless, to a certain degree, the issues around the transparency of industrial performance are cloudy. More importantly, the impact assessment of using this political-legal mechanism in fostering positive change in regulatory outcomes has not yet been analysed by pipeline regulators.

4.2.2.9 Other assemblages

The remaining assemblages associated with changes in technical-regulatory specifications in AS2885, deregulation and energy privatisation, will be discussed in different chapters as they have influenced regulatory practices and knowledge in every state (see Table 4.2). These assemblages involve different interest groups of human actors outside of the two interrelated actors: industrial actors and regulatory actors. In other words, power-knowledge practices associated with changes in technical-regulatory specifications in AS2885, deregulation and energy privatisation have a wider effect across Australian states. A non-human actor: measurement length, which is a technical-regulatory specification, has shaped power-knowledge practices in the process of risk regulation, discussed in Chapter 6. A discussion of how power-knowledge practices have been shaped through the relational assemblages pertinent to deregulation and energy privatisation will be discussed in Chapter 7.

4.2.3 The incoherence of risk-based practices and the challenges

Although the risk-based regulatory regime has been employed to regulate Australian pipeline industries in every Australian state, the findings showed that the risk-based regime has been practised differently across states and territories. The differences in regulatory practices between jurisdictions have been shaped by differences among the multiple assemblages. The regulatory practices of each state are diverse: each is shaped by a different series of assemblages. Different sets of assemblages are located at different social-political levels: international, national, state and local.
The findings about different sets of assemblages across states, in one sense, strongly suggest that the regulatory practices of pipeline regulators are multiple. But, in another sense, they show that the practices of pipeline regulators are incoherent throughout Australian states.

The multiplicity and the incoherence of regulatory practices revealed here not only challenge the ontological-epistemological logic of regulators, that is, a logic reflected in set patterns of thinking and practicing in relation to pipeline regulation. They also challenge adoption of the Australian pipeline standard (AS2885). This gives rise to the question: can Australian states harmonise regulation in the face of such multiplicity and incoherence?

**Conclusion**

The use of material semiotics and ANT combined with discourse analysis has revealed discourses and practices implicated in power-knowledge relationships around elite-expert institutions which are not evident in the existing literature pertinent to the Australian pipeline contexts. First, the discourses revealed certain ways of thinking and doing among regulators which I have theorised as ‘ontological-epistemological logics’. In effect, they are embodied in and taken for granted when regulating and controlling pipeline risks. Such logics inform the ontological stance of pipeline regulators which assembles two elements: realism and constructivism.

The ontological stance of regulators is composed of five related constituents: risk knowledge and regulatory practices as influenced by two interdependent parties (government and industry bodies, or pipeline regulators and pipeline industries); pipelines being perceived as physically safe; and pipeline regulators employing specific sets of regulatory theories and strategies. These constituent assumptions led to subsequent assumptions: (a) that it is inevitable pipeline regulators will rely upon the knowledge and activities of industries; and (b) that regulation depends on the establishment of good relationships with industries.

Ontological-epistemological logics provide a more comprehensive conceptualisation of regulatory capture than that found in existing regulatory theory. This thesis argues that regulators have been subtly captured by industries through their own logics and
practices. The regulators themselves do not even realise such a form of capture. The logics have shaped and constrained the way regulators regulate risks and how regulatory outcomes could be. The logics are a fundamental influence which guides and limits particular parties to be and not be involved in regulating risks. The logics guide and limit particular regulatory specifications and approaches that regulators want and can use, and direct the way to use them. These strategies produce effects that may limit alternative positive regulatory outcomes associated with a wide range of stakeholders and social-technical types of regulatory approaches.

Finally, this thesis reframes the discourse of risk-based practices. Interviews of regulators and non-regulator participants indicated that multiple assemblages influence regulatory practices across Australian states. Each state contains different assemblages that influence each other and perform a multiplicity of regulatory practices. After considering as many of the assemblages as I could conceive, the assemblage associated with accidents and their impacts appears to have massively shaped positive changes in regulatory reform. The assemblage associated with resources was found to have influenced regulatory practices in every state. Even so, the practices of each state have manifested differently because of moulding by other assemblages. For example, one state has enough financial resources. But, regulators have faced difficulties in practice as a result of political interventions within both the state and the department. In states that do not have enough financial resources, regulators have developed strategies to leverage their power relationships. For example, some states employ a strategy involving the setting up of a process involving external auditors to inspect the industry. However, the process appears compromised due to a conflict of interest because external auditors are paid by pipeline companies. Regardless of the strategies that regulators have developed, the majority of regulatory participants emphasised the importance of field inspection.

The multiplicity of realities present difference and incoherence, and indicate that regulatory practices are multiple instead of being unified. The relational effects of multiplicity and incoherence reflect the contradiction of mono-ontological patterns of thinking and practicing in regulating pipeline risks. In addition, the effects of multiplicity and incoherence challenge concerns about the establishment of consistency and harmony among pipeline regulations across Australian states.
Chapter 5
The incoherence of knowledge and practices within regulatory apparatus

The previous chapter focused on regulator power-knowledge relationships with industries and multiple assemblages across Australian states and territories. The interaction of these assemblages has both produced and further influenced incoherence of regulatory practices across states. This chapter extends the focus of power-knowledge relationships to other human entities – in particular, collective workforce groups – interacting with the assemblages associated with three regulatory apparatuses: (a) safety plans, or safety systems (i.e., the Pipeline Management System (PMS) and safety cases); (b) risk-based regulation (a type of safety regime); and (c) social-regulatory controls (i.e., tripartite engagement or union engagement, and workforce engagement).

I have traced and retraced how knowledge and practices involving these apparatuses are made, understood and implemented. When unfolding the process of power-knowledge performativity associated with these apparatuses, the research themes that implicate the incoherence of safety knowledge and practices associated with these apparatuses were revealed. Figure 5.1 presents the process of analysis and discussion of this chapter.
Section 5.1: Unfolding the process of power-knowledge performativity around safety plans or safety systems (PMS and safety cases) interacting with human entities

Emerging findings (research themes): incoherence of safety knowledge and safety practices; what has been written on a safety plan is disassociated from field safety practices

Tracing reasons behind the incoherence

Section 5.2: Such incoherence leads to further analysis of an understanding and implementation of risk-based regulation

Emerging findings (research themes): incoherence in understanding and implementing risk-based regulation (e.g., industries are reluctant to take initiatives in progressing risk knowledge by following principles of risk-based regulation)

Tracing reasons behind the incoherence

Section 5.3: Such incoherence lead to further analysis of an understanding and implementing the regulatory concepts associated with social—regulatory control (i.e., workforce engagement and tripartite engagement)

Emerging findings (research themes): the pipeline professionals are unfamiliar with union engagement; workforce is engaged in assessing risks at their personal safety, low risk level, not involved with assessing major hazardous risks, high risk level

Tracing reasons and assemblages that shape the process of workforce engagement in assessing pipeline risks

Emerging findings (research themes): incoherence of safety concepts between process safety and personal safety, laws and regulatory arrangements, have shaped: first, the workforce collective groups in becoming the silent actors in assessing major hazardous risks, and second, regulatory accountability towards workforces becoming ambiguous.

These emerging findings are employed to conceptualise the process of performing new power-knowledge practices with an aim to improve the process of risk regulation and achieve positive regulatory outcomes, discussed further in chapter 8

Figure 5.1: The process of analysis and discussion of Chapter 5.
5.1 The incoherence of safety knowledge and safety practices in safety plans

The regulatory apparatus most mentioned by participants was safety plans. Before moving on to the findings, I will briefly re-introduce the safety plan process used among Australian pipeline regulators and the reasons for revealing the process of power-knowledge performativity through safety plans.

5.1.1 A safety plan and the reasons for investigation

Regulators require pipeline industries to submit safety plans (or safety systems) to ensure pipeline risks are safely managed. As discussed in Chapter 2 (Section 2.1.1.1 (b)) there are two types of pipeline safety plans. They include the Pipeline Management System (PMS, previously called Safety and Operation Plan (SAOP)); and the Safety Case. These two systems, which are regulated according to risk-based regulation, require pipeline companies to identify major hazards and to put controls in place. Risk-based regulation has replaced the former prescriptive regulation model because prescriptive regulation was believed to have led to catastrophic events in hazardous industries (see for example: Hopkins, 2012b, p. 3; Hopkins & Wilkinson, 2005, pp. 4-5; National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011, pp. 251-252). Safety plans are considered to be proactive and ‘living’ documents (Tuft, Nessim, & Venton, 2007, p. 7). One of the requirements is that risk assessment must be reviewed every five years or sooner if and when changes occur in pipelines (e.g., changes in land use) (ibid).

To date, research into safety regulation of hazardous industries tends to focus on how the safety plans and a safety regime (e.g., prescriptive regulation, goal-based regulation or risk-based regulation) can effectively regulate hazardous risks (see for example: Baram, 2014; Braithwaite, 2011; Hopkins, 2012b; Wilkinson, 2002). Hopkins (2012b, p. 3), for example, emphasises that in order to make mature safety case regimes, the following five necessary features are required: (a) a risk or hazard management framework; (b) a requirement to make ‘a safety case’ to the regulator (what a safety case is was discussed in Chapter 2, Section 2.1.1.1 (b)); (c) a competent and independent regulator; (d) workforce involvement; and (e) a general duty of care imposed on the operator.
This thesis argues that the existing literature constructs regulatory theories with specified features and strategies (as analysed in Chapter 2) that may directly and indirectly influence the process of research exploration and analysis. Thus, some accounts of the making, understanding, communication, and implementation of safety knowledge in relation to power-knowledge may be underexplored (see also Le Coze, 2013; Vaughan, 1999).

This chapter argues that safety knowledge and safety practices are effects of interactive relations between safety plans and human entities. An exploration of how they are constituted through relations is necessary in order to gain insight into safety knowledge and practices shaped through power mechanisms involving elite-expert institutions, pipeline risks and risk regulation. Based on this reasoning, in this section I investigate: how safety plans are made, understood, communicated and implemented, and what and who has influenced them.

5.1.2 Safety plans in the making

Safety plans (PMS or safety cases) were described by participants as ‘a bible’ or a vital manual or handbook for managing pipeline risks. After investigating the relationships between safety plans (PMS or safety cases) and other entities, the emerging theme that stood out from the interviews were that the safety knowledge written in safety plans is not communicated throughout pipeline organisations.

Safety plans were described by a regulator participant as something that ‘[industries] write for approval and put it in a drawer’. Safety plans have been written by different groups of people including in-house and consultant companies. However, the contents in safety plans tend to be diverse. People who write safely plans can be located in different departments in pipeline companies including a regulatory compliance division, or health, safety and environment division, or by consultant companies. Safety cases can be written by engineers. One industrial participant criticised the work of engineers as follows:

they’ll read regulations and they’ll get a checklist and they’ll put something together that really works brilliantly for them. It works perfectly for what the engineers want because the engineers have to tick all these boxes.
Nevertheless, safety cases can be written by staff who work in the health and safety and document control departments. A regulator participant commented that their focus for safety cases is the ‘concept of health and safety, sticking to occupational health and safety, with slips and trips and not covering the process safety side as well’. More importantly, interviews of regulator participants indicated that people who wrote safety plans rarely communicated with others – in particular, frontline workers and technicians working in the field. A regulator participant, when commenting on a safety plan, stressed that ‘it’s good enough to get approval’, but:

you can see it’s almost like a disjoint. It doesn’t feel like it flows down and then feeds other systems. The technicians on the ground probably never read it. It’s not really written in a way they could read it but they should be involved and they should read it and they should understand what’s in it.

I asked the technicians whether any among them had seen or written a safety plan. A technician participant, after indicating that he has never seen one, commented: ‘the people that write this, they wouldn’t even know what a compressor station looks like.’

This comment exemplifies an incoherence between safety plans and operational activities. Participants from various groups identified incoherence in the process of making and communicating safety plans. Not only regulators but non-regulators working in pipeline companies (i.e., technical compliance managers, operation and maintenance mangers, occupational health, safety and environment (OHSE) managers, field managers and field technicians) along with external auditors and unions have identified a process of incoherence around safety plans.

Such incoherence suggests that workforces are relatively disengaged from analysing pipeline risks in a safety plan. The empirical evidence has opened up more questions including: what safety knowledge does the workforce employ in their day-to-day work; and how do they deal with catastrophic accidents when they occur? How can regulators be assured that workforce groups are competent, have the skills and capacity to deal with catastrophic accidents when they occur? This chapter will discuss these questions.
A review of historical events associated with major accidents in the petroleum energy industry\(^\text{15}\) indicated that workforces who work at the ‘coal face’ are the ones affected the most by catastrophic accidents (Lindøe, Baram, & Kringen, 2015, p. 127). Nevertheless, when compared to other petroleum energy industries, workforce groups in energy pipeline industries have received little attention – as ‘affected groups’ – from pipeline scholars and practitioners. The key affected actors in pipeline industries are the public and public sector emergency responders or firefighters, not the workforce groups working in the pipeline industries; these affected actors have had more potential to be affected by pipeline accidents compared to workforces. The loss of members of the public and firefighters is apparent in the world’s major pipeline catastrophic events including the San Bruno case in 2010 and the Ghislenghien (Belgium) incident in 2004 (see Chapter 1, Section 1.2.1), the Taiwan pipeline incident, in Kaohsiung in 2014 (The Guardian, 2014, para. 5), and the China pipeline incident in Qingdao city, Shandong province, in 2013 (Makenin & Kaiman, 2015, para. 5). It became manifest that the workforce collective groups are relatively disassociated from – or largely ignored by – pipeline scholars and practitioners who appear to regard them as of little importance and with little potential to be affected by catastrophic accidents.

Lindøe, Baram & Kringen (2015, p. 127) classify workforce collective groups into the following three categories: (a) company on-site employees; (b) contractor on-site employees; and (c) public sector emergency responders. The collective workforce groups of this thesis are primarily from groups (a) and (b). However, workforce group (c) is also important and needs attention in future research. Emergency services workers accounted for most of the victims during the catastrophic events in the Ghislenghien pipeline case in Belgium (COWI, 2011, p. 28).

The process of ‘workforce engagement’ or ‘workforce involvement’\(^\text{16}\) in assessing risks in a safety plan has been repeatedly emphasised as a key element in the majority of safety literature about preventing accidents (Hopkins, 2012b, p. 2; Lindøe et al., 2015, pp. 129-130). The importance of ‘workforce engagement’ in assessing major hazardous

\(^{15}\) Examples in petrochemical plants are the BP-Texas City Refinery explosion in 2005 (Hopkins, 2008) and the Australian Longford gas plant explosion in 1998 (Hopkins, 2000). Examples in offshore operations are the Piper Alpha accident (UK) in 1988 (National Offshore Petroleum Safety and Environmental Management Authority, 2015) and the Macondo oil rig incident in 2010 in the Gulf of Mexico, USA (Hopkins, 2012a).

\(^{16}\) The emerging themes from interviews indicate that the terms ‘workforce engagement’ or ‘workforce involvement’ are problematic. An analysis of the terms is undertaken in section 5.3 and discussion is extended later in Chapter 8.
risks and co-producing risk knowledge on a safety plan is congruent with the empirical findings of this thesis despite the fact that only a few participants, including union participants and workforce collective groups, actually emphasised the issue.

The reason for involving workforces is not only about fairness and equality but more importantly because workforces often know what the risks are and how risks should be managed in their safety practices. The alternative is an uncritical ‘safety imagination’ by experts with overly fixed-prescribed patterns of thinking (Pidgeon & O'Leary, 2000, p. 22). A frontline manager commented:

I think it’s difficult to put a safety system in place without understanding what the risks are on the frontline as well. That’s a gap and I think that’s been a gap for a long time, not here but everywhere. Instead of coming and telling people ‘This is what you’re doing’ and including them in this process and understanding what the risks they see every day and then put something together to try and minimise that risk as well. But we’ve got this in folders in the office, it’s on the intranet but none of my guys walk up and get the folder and sit down and read through this.

How risks are analysed and managed between uncritical safety imagination and field safety practices is an ongoing problem illustrated by theories surrounding organisational safety (Pidgeon, 1998, pp. 203, 211; Pidgeon & O'Leary, 2000, p. 22). Without the input of an engaged workforce collective group, the process of risk management may become ill-equipped in the face of an incubation period of unanticipated and poorly understood hazards.

The emphasis on ‘workforce engagement’ in co-producing a safety plan has been enacted in safety regulations in many countries. Examples are in the UK legislation (Trbojevic, 2008), the Norwegian legislation (Lindoe et al., 2015), the Australian offshore oil and gas legislation (National Offshore Petroleum Safety and Environmental Management Authority, 2015), the Australian onshore major hazard facility (MHF) legislation (Safe Work Australia, 2012) as well as in pipeline regulations in Australia (Department of Mines and Petroleum, 2011a).

Australia has followed the UK regulatory system, which is known as a safety case regime (ibid). The safety case regime was introduced into Australia to regulate pipeline industries in two states: Victoria and Western Australia. The regime was introduced
after the Longford incident in Victoria State in 1998 (Jaguar Consulting Pty Ltd, 2008, pp. 12-13) whereas the safety case regime in Western Australia was required in 1992 before the Varanus incident in 2008 (Bills & Agostini, 2009, p. 12). Pipeline industries situated in both states are required to submit a safety case as a safety plan to regulators. Other states have been employing a PMS, following the AS2885 requirement. The PMS system and the safety case regime are different in terms of their emphasis on ‘workforce engagement’. Under the AS2885 requirement, workforce engagement has not been underscored as a key element in co-producing the PMS. Despite the different emphases, the interview findings highlight an inadequacy of workforce engagement in assessing major hazardous risks among pipelines across Australian states irrespective of the type of safety system.

5.1.3 Tracing the reasons for incoherence between safety plans and field safety practices

I further traced reasons for the incoherence of safety knowledge between safety plans and field safety practices. The reasons elicited from interviews involve complex assemblages of interacting entities within and beyond organisational structure and factors, which I summarise in Table 5.1.

Table 5.1: Reasons for the incoherence of safety knowledge between a safety plan and safety field practices.

<table>
<thead>
<tr>
<th>Reasons</th>
</tr>
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<tbody>
<tr>
<td>(1) Preparing safety plans to get pipeline licenses, focusing on preparing piles of documents rather than on making sure that people who work on sites are safe.</td>
</tr>
<tr>
<td>(2) Safety plans are prepared by technical professions and remote from field experience.</td>
</tr>
<tr>
<td>(3) Different views of safety between business managerial managers (driven by market-benefits and cost-cutting) and senior engineers or technical professions (driven by technical-engineering safety issues).</td>
</tr>
<tr>
<td>(4) Some business managers and senior engineers misunderstand the management of technical safety. The reason is related to inadequacies in the ability of workforces to understand safety plans (written with high-technical engineering knowledge).</td>
</tr>
<tr>
<td>(5) Safety plans are viewed as strategic plans. Some operation and maintenance managers and business managers within pipeline companies see safety plans as remote from their knowledge and accountability.</td>
</tr>
</tbody>
</table>
First, the incoherence between safety plans and field safety practices has been shaped by perceptions of safety plans as a formality of regulatory requirements. Regulator participants made criticisms that the PMS or safety cases have become mere bureaucratic red-tape in order to get license approval. The regulatory requirements are seen by some as office-bound and remote from field experience. In addition, regulator participants emphasised that the professionals who wrote PMS or safety cases appeared to have done little cross-checking with frontline staff. The focus is on preparing piles of documents rather than making sure that people who work on sites are safe.

One of the reasons for the incoherence of safety knowledge is the influence of organisational factors which are key elements in causing catastrophic accidents. Organisational factors are important in existing theories on organisational safety (see for example: Hayes, 2012; Hopkins, 2000; Hopkins, 2012a; Reason, 1997; Vaughan, 1996). Organisational causes of accidents are related to decision making within organisations, where business safety is prioritised over technical safety, based on budget-cutting policies around technical safety. Decision makers within organisations trade-off increasing production with reductions in technical safety cost. The business-side view of safety among management line managers is driven by cost, reductions and maximising profits with the outcome that technical safety budgets are cut. On the other hand, technical safety is promoted by technical professionals, both pipeline engineers and pipeline field technicians. In other words the existing safety knowledge, influenced by the extant theories on organisational safety, is constructed around a dichotomy between business management teams versus senior engineers where each group has different perceptions, goals and actions involving technical safety.

Such knowledge was uncovered in my field work. Both regulators and industrial participants stressed that business managers who take control of the costs and benefits of pipeline businesses have influential views of and actions towards technical safety. For example, business managers focus on the Key Performance Indicators (KPIs) which indicate a successful business. When KPIs are related to safety, and when handled by business managers, the message about safety may become distorted. Business risk has been prioritised over technical safety. A frontline manager commented:

These days safety is a huge part of KPIs but other than KPIs tailored right, you know, not just support corporate HSE rollout or 365 good days and
things like that. Are the KPIs tailored to the correct safety message not just a compliance safety KPI? If you know what I mean. Are we really contributing and making improvements out in the field where the highest risk is? Are we implementing things, not just saying ‘Corporate has rolled this out, have you told your team about it?’ tacking the box. To me these risks have been raised through the year from field staff, what have you done to mitigate them, what have you put in place to get rid of them? Them sort of things and that way you’re really minimising risks in the field.

Another frontline manager commented on issues related to organisational factors and shaping the incoherence of safety knowledge which is associated with cost-cutting, by extension, to the lack of onsite engineers. The frontline manager commented that business managers do not arrange and provide engineers who have highly skilled knowledge on technical safety at field sites. Instead, workforces rely on field managers for safety knowledge and safety practices.

A range of complex influences that has shaped the misunderstanding and mismanagement of technical safety was gradually explicated during research – beyond the dichotomy frame (the perception and action of business managers versus those of senior technical engineers), constructed by theories on organisational safety. Such complexity was traced and captured through the semiotics of materiality ANT. The findings indicated that not only have business managers’ perceptions and actions influenced the level of misunderstanding of technical safety, but technical professions’ perceptions and actions have influenced the level of misunderstanding and mismanagement of technical safety as well. Some misunderstandings in managing technical safety are related to an inadequate understanding of the intentions of safety plans and workforce roles. For example, some senior technical engineers on the operation and maintenance side commented that a safety plan is a strategic document written with highly technical engineering knowledge. They stressed that workers do not need to understand a safety plan although they need to understand what they are responsible for. Even some within the senior technical engineers themselves admitted that they do not read safety plans either. In other words, a safety plan is seen as remote from the knowledge of senior engineers. An operation and maintenance manager asserted that:
I think the regulators view the safety case as a reference document. But it’s not like that at all. It’s written for them to see what we do. Most of the documents that our people would refer to actively are underneath the safety case. So for the workforce the work permit system, job hazard analysis, and the general work procedures that they use to carry out their day-to-day work are the ones that they look at. The safety case is way up here, describes the fact that they’ll exist but they don’t read the safety cases. They would never have seen it. And from our point of view, we don’t think they need to because they just need to understand what they’re responsible for. … I’ve never read our whole safety case. I’ve written parts of it but I’ve never read the whole thing and no one does, except for the risk and assurance people who have to put it up to be accepted.

The narrative discussed above is absent from the contemporary perspective constructed from the theories addressing organisational safety.

Other absences in the narrative were revealed through findings. The misapprehension of risk management by business managers stems not only from incentives for cost-cutting but from a complex mix of regulations and issues around accountability. An OHSE manager highlighted that business managers do not understand technical safety and how technical safety is important. The reason is associated with a complexity of regulations:

So HSE [health, safety and environment division] can be quite complicated. The legislation is high volume. There’s a lot of the legislation. There’s a lot of prescriptive requirements. The Australian standard, 2885, which relates to high pressure pipelines is a very, very big standard. There’s five different standards. Quite often management haven’t had the time to read and understand everything. So one of the challenges is to take a document that’s this thick and in an hour explain to a manager what they have to do, and then to help them understand the relationship between responsibility and accountability.

The emerging theme indicated that the OSHE managers have become interactors (see Chapter 6 (Section 6.2.2), and Chapter 8 (Section 8.3.2.1)) as they communicate safety issues with business managers, in particular, in relation to how safety and accountability are related.
In sum, the findings not only emphasised the incoherence of safety knowledge and practices between safety plans and field safety practices, but also highlighted how safety knowledge becomes disassociated throughout the regulatory process from regulators to managerial managers, also involving operation and maintenance managers, and workforce groups. Safety knowledge and practices are the effect of a complex assemblage inherent within and outside organisations, moulded by: (a) regulatory complexity in relation to understanding responsibility and accountability; (b) inadequate acknowledgement of the roles of workforce groups and workforce day-to-day experience in safety field knowledge; and (c) inadequacies of acknowledging the importance of risk-based regulation underlined in a safety plan.

Despite such deficiencies, the findings have also opened up some space for further analysis including: (a) understanding and implementing risk-based regulation (see Section 5.2); and (b) understanding the concept of safety and complexity of regulation in relation to accountability and responsibility towards workforce groups (discussed more in Section 5.3.2). The analysis aims to challenge the existing literature that addresses the concepts of ‘tripartite engagement’ and ‘workforce engagement’.

5.2 Incoherence in understanding and implementing risk-based regulation in the Australian pipeline context

Safety plans, both PMS and safety cases, are regulated under risk-based regulation. This section argues that although risk-based regulation has become a norm replacing prescriptive regulation in regulating energy industries, the process of how risk-based regulation is understood and implemented has received little attention in the safety literature on pipeline industries. This section investigates this absence.

5.2.1 How is risk-based regulation understood and implemented in Australian pipeline industries?

Issues of risk and the experiencing of catastrophic accidents have been substantially addressed by theories of knowledge and expertise development, in particular those drawn from theories of learning processes. These theories on knowledge and learning are based on various kinds of experiences including on-the-job experience, hearing stories, and working with colleagues and senior colleagues (see for example: Duguid,
2005; Lam, 2000; Maslen, 2014; Wenger, 1999). However, this literature does not investigate how knowledge and practices in relation to risk regulation have changed over time; how experience in encountering catastrophic events has shaped the understanding and implementation of risk knowledge in association with regulation. In addition, the literature has limited its scope to within organisations. It does not attempt to articulate aspects of power-knowledge relations.

In contrast to the above, the knowledge and practices in relation to risk regulation described in this thesis are proposed as relational effects, partly shaped by industries who have previously encountered major hazardous risk from catastrophic accidents and who have had a long history of using and implementing risk-based regulation. The issues were addressed by both a regulator participant and a union member. A regulator participant contended that:

The risk comes about with how well the companies understand that and how well they implement it. … [Offshore industries] have certainly had it longer. Especially if you go back and start looking at - like one of the big kick starters for the current system is the Piper Alpha incident and how that happened. … So I think it’s newer to pipelines.

This participant regulator pinpointed the fact that the understanding and implementation of risk-based regulations among pipeline industries has been shaped through the history of ‘risk experience’ by catastrophic accidents. The regulator participant compared pipeline industries with offshore petroleum industries, stating that offshore industries have longer experience in implementing and understanding risk-based regulation as a result of catastrophic accidents. The offshore industries are more advanced in progressing risk-based regulation. The regulator asserted that the Piper Alpha incident was a big kick starter, influencing safety knowledge and safety practices in offshore industries by co-utilising the risk-based approach.

The offshore industries in Australia have followed the UK regulatory system. The risk-based regulation employed, which is called a safety case regime, follows risk-based regulatory principles whereby safety knowledge is produced by a risk-maker (or regulatees or companies) articulating with collective workforce groups (Hale, 2014, pp. 415-417). The experience of dealing with catastrophic accidents helps offshore
industries to gain a better understanding of the concept and the relative usefulness of risk-based regulation.

The Australian pipeline industries, in contrast, have never experienced catastrophic accidents. Although the industries may feel alarmed by overseas catastrophic accidents, they have not been put under pressure to make any regulatory changes, for example, through social controls by unions (see Section 5.3) or through public scrutiny (see Chapter 6). In addition, the Australian pipeline industries are newer in terms of implementing and experiencing the utility of risk-based regulation compared to offshore petroleum industries. Risk-based regulation was introduced into the Australian pipeline industry after the major revision of the Australian pipeline standard, AS2885, in 1997 (Tuft, 2009) when offshore industries started using the risk-based regime soon after the 1988 Piper Alpha incident. In addition, although the application of pipeline regulations is flexible following risk-based approaches, findings indicate that pipeline regulatory systems contain numerous prescriptive design rules in their regulatory safety systems.

A regulator participant emphasised:

The issue with pipelines I see is that they don’t fully understand their requirements under the Act, so where you’ve got an offshore operator they know all about safety cases and how they’re supposed to work and performance standards and fire explosion analysis. Onshore pipeline companies are very good at reading 2885 and good at reading prescriptive requirements, so you must have signs this far apart in these areas and apply where there’s defined rules. They need improvement around trying to understand non-prescriptive rules.

The interviewee is saying here that onshore pipeline systems in Australia tend to follow a prescriptive rather than a risk-based approach. The technical knowledge embedded in AS2885 is based on prescriptive rules and these prescriptive technical knowledge-based rules have continued to change as a result of negotiating processes involving cost, technical safety and regulations interacting with pipeline owners and their contractors, AS2885 committees, and regulators.

Experience in encountering major hazardous risk from catastrophic accidents can assist industrial actors to immerse themselves in understanding, utilising and implementing risk-based regulation. I subsequently raised the following question during interview
sessions: ‘do we have to wait until accidents happen before making a change for better safety outcomes?’ The primary answers from both regulator and non-regulator participants was ‘yes’. They supported their arguments with their own observations of historical events: regulatory change and reform has usually happened after catastrophic accidents.

In summary, the findings indicate that pipeline industries have a tendency to follow prescriptive rules rather than the risk-based approach to advancing safety knowledge and practices that is favoured in other petroleum-based hazardous industries. The absence of experience with catastrophic pipeline accidents was a key factor in the application of this approach to safety-regulatory systems.

The industries are reluctant to take initiatives in progressing risk knowledge by following principles of risk-based regulation. The reasons for this were traced and will be discussed in the next section.

5.2.2 Incoherence in advancing the implementation of risk-based regulation: a relational power-knowledge effect

According to the principles of risk-based regulation, industries must convince regulators that they have good safety plans and safety knowledge when dealing with pipeline risks. The platform of risk-based regulation allows both industries and regulators to leverage their resources, both technical skills and finances. Nevertheless, the findings indicate that industries are reluctant to take any initiative in progressing risk knowledge according to risk-based regulation, due to time and cost factors in association with issues of power-knowledge. As an industrial participant observed:

Now what they’re saying is that we need to continuously demonstrate our compliance which means we have to continuously prove we’re doing things the way we’ve always done them. So it’s much more engaged and much more on the onus for us to continually provide something. … So they’re talking about us proving our compliance. It’s like proving your innocence rather than your guilt. In some ways, when previously it was up to them to come and prosecute us for doing something wrong. Now we have to continuously prove that we’re innocent and that’s different. So we can just do our business with the threat that they could come in and look at us. Or
they continually ask us for evidence all the time. Continuously asking for evidence just creates work for us and all it does is it enables them to say they’re actively regulating us but it doesn’t make any differences to what we do. It just creates a whole layer of document exchange for the sake of it.

At the same time, regulators rely on industry knowledge and activities as part of their ontological-epistemological logics. In addition, regulators face limited resources, both human capacity and finance; consequently, they only partially assess risk (discussed in Chapter 4, Section 4.2.2.2 and 4.2.2.6). Their focus is on what is in safety plans, and their checks against what has been undertaken in field safety practices is only partial. Regulators do not inspect throughout the process of risk assessment. For example, they do not thoroughly check how pipeline risks are identified and assessed, who has been involved throughout the process, how the industries get these data, and whether the data from the risk assessment is valid.

Regulators use strategies that involve asking questions, asking industries to provide information that the regulators request together with developing their own requirements to regulate pipeline risks. Nevertheless, pipeline professionals, including those working within pipeline companies – together with AS2885 committees, pipeline consultancies and external auditors – all claim that regulators across states have developed additional requirements that supplement AS2885. These include different styles of auditing processes and approval processes (see Chapter 4). However, pipeline industries claimed that the additional requirements have become unnecessary burdens for pipeline industries.

The recurring complaint from industries was that pipeline regulations and requirements differ across Australian states although each state has adopted AS2885 as part of their pipeline legislation. Regulators can impose additional requirements to those of AS2885. In addition, industries made the comment that regulators do not have adequate knowledge: they do not know which information is important and what they should request. During one interview session, I asked a question about whether industries shared their knowledge with regulators; for example, what documents should regulators ask for and what should they not? The response from an engineering manager was:

And if they were to ask you what documents they should be reviewing, well
I would give them advice on what I thought was important, but that might be
in conflict with what they… I might steer them away from documents that I thought were dodgy, onto ones that I thought were great, without them knowing. They could miss a whole bunch of mistakes that I’ve made and I might have a self-interest in doing that.

The above statement confirms that (at least some) pipeline industries assume risk-based regulation to be self-regulation, and manage it to serve their company interests. Pipeline industries hesitate to share risk-safety knowledge with regulators in order to prevent regulatory intervention in their activities. Furthermore, the statement can be interpreted to show that pipeline companies do not continually improve their safety plans according to the ideal as living documents. This issue was raised by other participants as well including industrial compliance officers, technical regulators and external auditors. Under regulatory requirements, industries have to re-visit a safety plan every five years or anytime when there is a change in their management and operational systems. Industries have to continually update their hazard identification and hazard controls using a ‘safety management study’ instrument. Nevertheless, the evidence showed that risk-safety knowledge in pipeline industries as written into safety plans is not kept up-to-date.

Starting in this section (5.2.2), similar themes emerge and are regularly repeated. The accounts indicate that industries and regulators are the controlling powers at the interstice of regulatory relationships. Both parties use risk-based regulation as a platform to negotiate their power-knowledge relationships rather than improving safety knowledge and safety practices according to the principles of risk-based regulation. In other words, the negotiating process in risk-based regulation is part of their regulatory practices. Negotiation introduces the issue of power-knowledge in relation to risk-based regulation, made opaque in the regulation literature.

The dominant interrelationships must be understood in more depth to improve transparency and regulatory effectiveness. The concept of ‘risk governance’ was promoted to fill a conceptual gap in relation to the broad networks of power relations in which risk regulation is practiced (Lindøe et al., 2014; Renn, 2008c). Risk governance is thus open to more forms of social control or influence in relation to risk. Self-regulation (or risk-based regulation), the role of values and norms, and engaging with different stakeholders (e.g., investors, consumers, the public, workers, unions et al.) in decision-making processes are addressed most often by the literature on organisational
safety and regulations. In the main, the concern is with balancing power relations among interdependent industries and regulators. The principle of risk-governance attempts to balance power relations for transparency in risk regulation by co-operative engagement with stakeholders.

In the organisational safety and regulation literature, workers, unions and the public are the primary concerns. The workers and the public can potentially be injured or killed. For these reasons, unions collaborate as they are the representatives of the workers. The terms ‘tripartite collaboration’, ‘workforce engagement’, and ‘public engagement’ are regularly mentioned in the literature on improving risk regulation. In the next section, the process of tracing these two concepts will be addressed.

**5.3 Power-knowledge in relation to tripartite collaboration and workforce engagement in the Australian pipeline context**

The process of tracing the two regulatory concepts: ‘tripartite engagement and workforce engagement’ began with an analysis of data drawn from participants’ answers to my opening interview questions (see Table 5.2).

**Table 5.2: The interview-questions of this thesis**

<table>
<thead>
<tr>
<th>Type of participants</th>
<th>The opening question</th>
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<tbody>
<tr>
<td>Regulators</td>
<td>What is the most important issue or challenge that regulators encounter these days?</td>
</tr>
<tr>
<td>Non-regulator</td>
<td>What is the most important issue or challenge that you encounter with safety issues and regulations these days?</td>
</tr>
</tbody>
</table>

As delineated in Section 5.1.2, the literature suggests that workforce involvement is important; and the research data suggests that workforce involvement is low, so one might have expected that this issue would be raised by some participants in response to this question. In fact, few participants raised issues about the inadequacy of workforce and union engagement in response to my opening question (with the exception of union participants). The responses indicated that the issues of workforce and union engagement in relation to safety and regulations are not the primary concern of pipeline experts, both regulators and non-regulators. Consequently, I investigated further with the following questions: how are the two concepts, workforce engagement and tripartite
engagement, understood, and what assemblages shaped such understandings in the Australian pipeline case?

5.3.1 Understanding of tripartite and workforce engagement

The literature emphasises that the representation of and consultation with workforces (supported by unions) is a crucial strategy for strengthening the effectiveness of regulatory regimes (see for example: Hart, 2002; Rosness & Forseth, 2014). Participatory mechanisms for workforce engagement supported by trade unions are a fundamental precondition for the improvement of workforce health and safety. This process of tripartite collaboration among employers, employees and regulatory authorities is vital (Rosness & Forseth, 2014, p. 310). Nevertheless, in regulatory and safety practices, the roles and functions of workforce participation vary among countries. For example, in the Scandinavian countries, the union influence supporting workforces is stronger than in other countries (Hovden, Lie, Karlsen, & Alteren, 2008) including Australia. In Australia, the roles and functions of workforce engagement are stated in a mandatory-legislative form (Saksvik & Quinlan, 2003, p. 42). Industrial companies including pipeline industries in Australia are required by the occupational health and safety (OHS) legislations to elect workforce health and safety representatives (HSRs) to promote health and safety issues. They may or may not involve unions. The OHS legislative requirements were put aside as I studied how these two concepts: workforce engagement and tripartite engagement, enacted with and were understood in my field research.

The process of how knowledge about these two concepts is enacted was investigated with follow-up interview questions. I asked participants their opinions about ‘workforce engagement’ and ‘tripartite engagement’. The responses from professional participants indicated that the two terms are associated with their own professional values. They were familiar with the term ‘workforce engagement’ but not with ‘tripartite engagement’. They neither knew what ‘tripartite collaboration’ was nor how important it was. Workforce engagement will be discussed in Section 5.3.1.2.
5.3.1.1 Understanding of tripartite engagement

When I introduced the meaning of the term ‘tripartite engagement’, two opinions became clear. First, participants including regulators, industrial employees and external auditors, felt uncomfortable with engaging unions in the pipeline regulatory process. They disputed that bringing tripartite engagement could offer benefits such as increasing regulatory effectiveness. Their reasons included issues of conflict of interest and the goals of unions who primarily assist their workforce members to obtain improved working conditions. For example, an integrity engineer asserted that:

Do the unions have a role in promoting safety? I don’t know if you can tell, I’m very cynical of unions. I think that in most cases the unions abuse safety in order to push their terms. So they will try and pick a very small safety hazard, and then close the site down to manipulate the employer, but I don’t think their primary interest is safety, I think their primary interest is money.

On the other hand, there were some who appreciated the contribution of unions, in particular those who work around a pipeline compressor station complex including field managers and pipeline technicians. Nevertheless, they had mixed feelings about unions. A field manager maintained the following:

I do think that unions could support work better, in regards to safety I think they could. … Unions aren’t just there for purely enterprise agreements and getting pay rises and things like that, … I think in a controlled environment you should be able to have that communication channel to the union who could then have regular meetings with the company and say ‘So and so has bought this up, they find that we’re not getting much traction in regards to a safety matter’ or whatever. But unions, it depends what their agenda is for me. Some unions are good, [some] are terrible.

A field technician participant offered similar emphasis. He described himself as ‘… politically to the right so I don’t really like [it]. I came here thinking I'll join it because it seemed like a bit of a closed shop’. Nevertheless, he has appreciated the union contribution, in particular, the unions’ roles in assisting their members to negotiate better pay rates and conditions. He said:
but you have to acknowledge that we wouldn’t be on as good a pay and conditions that we’re on if it wasn’t for the union because they’ve been really driving hard to get better pay and wages. We’re on good pay and wages and I think the union is the main reason for that.

Apart from the finding relevant to the contribution of unions, interviews also indicated that the unions have been disengaged in assessing major hazardous risks from pipeline industries in Australia, as well as from other offshore and onshore petroleum industries in Australia. This evidence was drawn from interviews with union participants and from my observations during meetings with regulators who regulate onshore and offshore petroleum industries.

Because there are two contrasting perspectives on unions, it is not straightforward to directly engage unions in assessing pipeline risks along pipeline regulatory processes. The current parties: industries and regulators, have a stable, inter-connected relationship. Adding unions to the bipartite industrial-regulator network will take time, commitment and a new regulatory mechanism that supports this new strategy. In addition, successful cases of union collaboration in assessing risks and balancing power-knowledge between inter-connected regulator-industry parties are rare. There are only a few successful examples. One, ‘the Norwegian model’ of regulatory regime has proven successful in collaborating with unions in their offshore petroleum industries. Nevertheless, Norway has a long history of commitment and supporting social-regulatory mechanisms that facilitate union collaboration (Rosness & Forseth, 2014; Saksvik & Quinlan, 2003, p. 40).

In addition, the invisibility of pipelines is salient. According to research conducted by Lindøe, Engen, & Olsen (2011), industries with visible risks and relatively immediate shows of interest by the public allow easier implementation of regulation with engaged social actors. Such implementation of regulation with engaged social actors could prove difficult in pipeline situations as pipeline risks and pipelines’ physical characteristics are invisible to the public. As a consequence, the public’s interest is not immediately aroused. Therefore, involving unions in assessing pipeline risks requires the re-evaluation and revised performativity of new concepts in accordance with new ontological and regulatory-instrumental premises.
5.3.1.2 Understanding of workforce engagement

The practice of workforce engagement is different to union engagement. The findings showed that unions have been disengaged in assessing major hazardous risk from pipelines, whereas the workforce engagement in assessing ‘risk’ was obfuscated and ambiguous.

Many participants, both regulators and non-regulators, stated that workforces are engaged in assessing risks but, more precisely, that workforces are engaged in assessing risks to their personal safety. Personal safety was interpreted by participants as ‘workplace health and safety’ or ‘occupational health and safety’. Participants emphasised that safety at the personal safety level is much less important than at the ‘process safety’ level. Another dichotomous entity emerged: personal safety versus process safety. The difference between the two safety concepts was traced.

I asked participants about the difference between these two safety concepts. A pipeline practitioner participant offered the following strong criticism:

the workplace health and safety...[is] very low level...It is about ‘OH&S slips, trips and falls, and just personal protection which is normally cuts, Band-Aids, maybe broken bone, rolling your ankle, right up to fatality, if someone obviously falls and hits their head or something, so someone can still die.

The participant further commented that risk assessment at the personal safety level is ‘very different to’ process safety17, which is about:

the pipeline blowing up ... that’s not workplace health and safety, that’s society risk from having a high pressure gas or liquid petroleum being transported in a pipe where things can go wrong like external interference, corrosion, it can ignite, and we could ... many tens and dozens of people could be killed as has happened around the world.

The participants’ arguments seem to be congruent with literature about personal safety and process safety. The literature indicates that risks at the personal safety level (workplace accidents) are considered to have low societal consequences: they happen to

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17 The process safety terms used in relation to energy pipelines include 'asset integrity' or 'technical integrity' or 'technical pipeline integrity'.
individual workers. Experts make the criticism that while avoidance of slips, trips and falls is an example of personal safety, taken together it does not represent the management of major hazardous risks (Øien, Utne, & Herrera, 2011, p. 158). Risks at this level are categorised in the safety literature as a ‘personal safety’ concept (or ‘workplace health and safety’).

But, what about major hazardous risks? The safety literature indicates that major hazardous risks are considered to be of high societal consequence causing multiple fatalities and injuries in catastrophic accidents. The concept of process safety began to be widely used and implemented after the 1984 Bhopal accident in India where a catastrophic release of methyl isocyanate caused at least 4,000 fatalities and over 200,000 injuries (Gupta, 2005, p. 195).

The two safety concepts are made distinct in the safety literature (Hopkins, 2009, p. 460). Safety scholars argue that each concept assesses different types of hazards that need different indicators to measure. Without making a specific distinction, indicators in relation to safety concepts can be misinterpreted, miscommunicated and misused, causing catastrophic accidents. Such misuse was consistently found in evaluations of the catastrophic accidents including the Esso gas plant accident, Australia (Hopkins, 2000), the Texas City refinery accident, USA (Hopkins, 2008), and BP in the Gulf of Mexico (Hopkins, 2012a). For example, the Esso gas plant at Longford in Australia has an excellent lost-time injury rate (for personal safety) but a catastrophe occurred because the organisation had managed process safety hazards poorly (Hopkins, 2000).

As a result of the accident investigation, safety scholars emphasised that the process safety model must be prioritised to prevent accidents, in particular the developing and using of process safety indicators including technical, human and organisational factors (see for example: Heath and Safety Executive & Chemical Industries Association, 2006; Hopkins, 2009; Moura, Beer, Patelli, Lewis, & Knoll, 2016; Øien et al., 2011; Skogdalen, Utne, & Vinnem, 2011).

My view is that the differences and distinctions between the two safety concepts, as emphasised by the existing literature, are relatively appropriate and necessary. Nevertheless, what I have found about the use of the two safety concepts in the Australian pipeline case is that the pipeline practitioners largely follow the ideal of separating the two safety concepts but follow it in an uncritical-routine way.
Workforces that have been assigned to assess risk for their personal safety level have disengaged from assessing major hazardous risks. Despite the necessity of prioritising two safety concepts, the distinction increased the incoherence of relational effects in the process of assessing risk in the Australian pipeline context. I further traced and mapped the assemblages that have shaped the uncritical-routine risk assessment practices of pipeline practitioners (discussed in the following section).

5.3.2 Shaping the incoherence of risk assessment practice

The finding emphasised that the incoherence of risk assessment practice in disengaged workforces is shaped by: (a) different safety concepts in relation to level and scale risks, types of risk assessments and requirements of safety skills, and (b) different and complex legislative frameworks and institutional arrangements (see Table 5.3 and Section 5.3.2.1 - 5.3.2.2). The finding was analysed to highlight the way the two different series of assemblages are interrelated.
Table 5.3: The incoherence of risk assessment practice between process safety and personal safety.

<table>
<thead>
<tr>
<th>Incoherence of risk assessment practice is shaped by?</th>
<th>Process safety (or asset integrity or technical integrity)</th>
<th>Personal safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Differences between process safety and personal safety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Focus on safety</td>
<td>Critical controls(^1)</td>
<td>Personal safety – slips, trips and falls</td>
</tr>
<tr>
<td>1.2 Level of risks</td>
<td>High level (called major hazardous risks) – caused catastrophic accidents</td>
<td>Low level (called personal risks) – caused workers’ injuries</td>
</tr>
<tr>
<td>1.3 Different scales of risks</td>
<td>Major hazardous risks – cause catastrophic accidents, many people will die</td>
<td>Risk to a person – causes workers’ injuries</td>
</tr>
<tr>
<td>1.4 Types of risk assessment</td>
<td>HAZOP(^2)</td>
<td>Permit to work or a work permit system(^3), JHA(^3)</td>
</tr>
<tr>
<td>1.5 Requirements of safety skills: who assesses risks and at what levels?</td>
<td>Technical-engineer professionals, consultants</td>
<td>OHSE managers, workforce groups – field technicians</td>
</tr>
<tr>
<td>2. Differing legislative frameworks and institutionalisation arrangements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Regulations</td>
<td>AS2885, Pipeline Acts</td>
<td>Occupational Health and Safety (OHS) Act</td>
</tr>
<tr>
<td>2.2 Regulations above are in line with what regulatory organisations?</td>
<td>Departments that are in charge of pipeline licensees (e.g., Department of Petroleum and Mines, Department of Natural Resources and Mines).</td>
<td>WorkSafe and WorkCover</td>
</tr>
<tr>
<td>2.3 Roles of regulators: who are involved in managing risks?</td>
<td>Technical regulators (or pipeline regulators)</td>
<td>Worksafe and Workcover regulators</td>
</tr>
</tbody>
</table>

References: The findings in this Table and the notes are drawn from participant interviews.

Notes:  
(1) The concepts of Critical controls or Critical elements are used to prevent major accident events. Examples include having cathodic protection, having overpressure protection systems, reviewing the integrity of the pipe every five years, setting a thickness requirement for piping, having an orifice plate in piping so it does not flow too fast. The critical controls are the design components that companies put in place so that they can prevent catastrophic accidents, which could cause multiple fatalities and injuries. Each one of those critical elements will have a required performance that companies need to adhere to.

(2) Hazard and Operability Studies are abbreviated as HAZOP. It is a formal engineering assessment technique: the process of HAZOP is to identify major hazardous risks and put the right critical controls in place to prevent catastrophic accidents. HAZOP has been employed in assessing major hazardous risks of pipelines since the early 1990s (Tuft, 2011).

(3) A work permit system is a safety system used among pipeline workforces. Pipeline technicians are required to submit a work permit system before starting working on sites. A job hazard analysis (JHA) is a risk assessment technique employed to assess personal safety, as part of the work permit system. Pipeline technicians are required to assess risks and hazards on sites and put controls in place before they start working: they must ring a control room so as to get a work permit number before starting working on sites.
5.3.2.1 Process safety, personal safety and the incoherence of risk assessment practice in disengaging workforces

Interviews indicated that the majority of participants, both regulators and non-regulators, make an uncritically clear-cut distinction between the focus of process safety (or asset integrity or technical integrity or pipeline technical integrity) and personal safety in relation to the level of risks, scales of risks, types of risk assessment, and requirements for safety skills in assigning who should be assessed such risks (see Table 5.3). A risk assessment approach (HAZOP) is employed to evaluate major hazardous pipeline risks whereas JHA is employed to assess personal safety. HAZOP requires expert engineering knowledge to assess major hazardous risks whereas JHA is part of a work permit system that does not require expert technical skills. The JHA tool is used for helping workforces to identify, analyse and manage the hazards associated with the work they are about to undertake.

The uncritical-routine practice of risk assessment is shaped by differing safety concepts that have been set and accepted as normal practice among pipeline professionals (with the exception of collective workforce groups). The findings indicated that collective workforce groups including field managers and field technicians did not appreciate the risk assessment practices that were assigned to them to assess risks at their personal safety level. A representative of the collective workforce groups stated:

So they’ve over-documented things. They’ve taken away the practicality of safety. They’ve turned it into a chore and such a paper, time-consuming thing that it's lost its importance. It's just a process that you go through, … Now, we’re doing a job and we're going to talk about the particular risks in that job. We're not going to talk about tripping over and we’re not going to talk about wearing these clothes because we're all – that’s just ticking their box. If you're inducted, you’ve already gone through all that. Let's just talk about what we’re doing, not sign away that says we've read every possible risk so that if anything at all possibly happens, you’ve said that that shouldn’t happen. … It's a cover arse signature. It’s not a practicality signature.

The collective workforce groups expressed the criticism that the risk assessment they experience and assess at the personal safety level was merely bureaucratic red tape.
They made the comment that such practices have taken away the core of the safety concept by turning safety into a chore. As a result, the important concept of process safety they used in relation to catastrophic risk in their operation and maintenance job was lost.

The workforce collective groups have been forced to become silent actors in the assessment of major hazardous risks, with the consequence of having limited and unequal risk-safety knowledge of dealing with the potential for catastrophic accidents. Interviews indicated that while workforce collective groups do follow instructions associated with routine maintenance to keep a pipeline operation running smoothly, they are not adequately informed with regard to major risks – for example, the necessity to do regular checking of pipeline equipment or how to notice warning signs near critical control equipment that can result in catastrophic failures. The findings stressed that the field safety practices are relatively disengaged from the risk assessment process, assessed and developed within and throughout a safety plan. Risk and safety knowledge is incoherent throughout pipeline institutions. The question becomes: how do pipeline professionals keep reviewing and up-dating risk and safety knowledge on a PMS and a safety case as prescribed for a live document?

The incoherence of risk assessment practice in engaging workforces reflects the first constituent assumption of the ontological-epistemological logic of Australian pipeline practitioners – the assumption that the primary regulatory actors are regulatory agencies and industry (see Chapter 4, Section 4.1) The scopes, types and processes of risk assessment undertaken by industry employees were constrained such that field staff were excluded in much the same way as members of the public. At the process safety level (HAZOP), risk assessment was assigned to technical-engineer professionals and consultants, while workforce collective groups were restricted to assessment at the personal safety level (permit to work, JHA). Such practices fell into the domain of mundane practices and were seldom questioned. Such mundane practices mould the limitations of risk-knowledge understanding, implementing, improving and preventing with regard to pipeline catastrophic accidents.
5.3.2.2 Legislative frameworks, institutionalisation arrangements, and the incoherence of risk assessment practice in disengaging workforces

Using the semiotics of materiality of ANT together with discourse analysis allowed me to explicate further the process of power-knowledge performativity through safety concepts in relation to workforce disengagement. I investigated how safety concepts including process safety and personal safety have been implemented and what has influenced such implementation that involves a disengaged workforce in assessing risk. As workforce groups in the pipeline case are not involved in assessing major hazardous risks, I asked both regulators and non-regulators who was responsible for the workforce? The answers were diverse and recorded from licensees (see Chapter 7), pipeline operators (ibid) to regulators. In this section, I will focus on regulators. The roles of regulators are in line with legislative frameworks and institutional arrangements. The findings suggest the existence of two broader sets of regulatory frameworks and institutional arrangements that are involved with workforces in pipeline industries (presented in Table 5.3).

There were four sets of answers from participants. First, some technical regulators\(^\text{18}\) stated that they were not responsible for the workforces. Those technical regulator-participants indicated that the WorkSafe or WorkCover regulators (called by participants ‘safety regulators’) will be responsible for the workforce, contingent to the Occupational Health and Safety Regulations. A similar answer was provided by some of my non-regulator participants. Nevertheless, I cross-checked the issue of responsibility towards workforces by asking some of the ‘safety regulators’. The safety regulators emphasised that they were not involved with pipeline industries. Their involvement was limited to within a plant or factory (e.g., onshore petroleum industries, chemical factories). Pipelines lie outside the boundaries of plants and, by extension, outside of their scope of work.

The second set of answers showed that some technical-regulator participants indicated their responsibility for workforces by making sure that procedures were in place. The third set of answers indicated that both types of regulators: technical regulators

\(^{18}\) Technical regulators or pipeline regulators made up the majority of my regulator participants. They were in charge of compliance and the licensing of pipelines. They worked within government departments, following the pipeline acts and AS2885 as a call-up regulation. The departments and the acts were named differently across Australian States.
(participants also used the term: ‘gas regulators’ and ‘energy regulators’) and safety regulators will be responsible for workforces when there are catastrophic accidents. The third set of answers were provided by both regulator and non-regulator interviewees.

The last set of answers stressed the presence of some loopholes in the regulations, leading to ambiguities of accountability. Due to the complexity of the regulations, even pipeline industries themselves do not know which regulatory organisations will be responsible for their workforces. In addition, an OHS participant stressed that even among industries, some of them have misunderstood that industries should comply with the pipeline Act and not the OHS Act. Nevertheless, an OHS participant indicated to me that pipeline industries comply with both types of regulations.

The four sets of answers from the interviews reflected that the accountability of regulators towards workforces and the public is ambiguous. This ambiguity is partly an outcome of negotiations of power-knowledge in relation to safety concepts. Interviews indicated that differences among safety concepts have been shaped through differences in the legislative frameworks and regulatory institutions of the Australian pipeline case, leading to an incoherence of risk-knowledge understanding, assessment and implementation in regulating hazardous-pipeline risk. The accountability of regulators to workforces has been negotiated contingent to regulators’ roles, regulations, institutions, safety concepts, and safety procedures. I will summarise these issues in the next Section 5.3.3.

5.3.3 Power-knowledge in relation to safety knowledge and safety practices in pipeline industries

In the Australian pipeline case, findings indicated that power is relational and not limited only to business managers. In addition, power is not limited to regulatory government but is associated with the following associations: safety concepts, types of risk assessment, regulatory strategies (i.e., risk-based regulation), legislative frameworks, regulatory-instructional arrangements and similar relations (hereafter: these associations). The power-knowledge practices among technical regulators, industrial interests (e.g., management line managers, compliance mangers, OHSE managers, field managers and field technicians), external auditors, unions, et al. are negotiated through these associations.
As a consequence of the negotiating process through these associations, there are at least three emerging themes that need emphasising. First, the accountability of regulators has become ambiguous. In other words, the ambiguity of accountability is part of regulatory practices. Second, the unions’ roles in co-assessing pipeline risks do not sit comfortably with pipeline professions. Unions are not welcome to be part of assessing pipeline risks. They are interpreted as potentially disturbing to the ontological norm of negotiating practices between pipeline regulators and pipeline industries. Therefore, although unions make useful contributions to safety practices, bringing unions into the assessment of pipeline risks cannot be undertaken through traditional power structures.

Lastly, the roles, safety knowledge and safety practices of workforces have been shaped through the ontological-epistemological logic informing these associations. The workforces are moulded into becoming silent actors restricted to assessing risks at the personal safety level. They are forced into a regime marked by limited and unequal safety knowledge of understanding and coping with major hazardous risks. In addition, they have not been properly informed of safety knowledge concerning major risks that may dramatically impact on their lives. These three themes exemplify aspects of what Foucault called ‘power-knowledge’.

**Conclusion**

This chapter has further traced and re-traced power-knowledge relationships involving elite-expert institutions. Its focus has been on the interaction of three relational apparatuses: (a) a safety system (or a safety plan) (i.e. PMS and safety cases); (b) risk-based regulation; and (c) concepts related to social-regulatory controls in improving safety knowledge and safety practices among the regulatory processes in regulating pipeline risks (i.e., risk governance including tripartite engagement and workforce engagement). Human entities are those who are involved with the following three regulatory apparatuses including: (a) people who work within pipeline industries ranging from managerial managers, operation and maintenance managers, OHSE managers to field managers and field technicians; as well as (b) those who are associated with them including regulators and unions.
Safety knowledge and practices are disconnected throughout the regulatory process; what has been written in a safety plan is not coherent with what happens in field safety practices. The reasons behind the incoherence were traced: organisational factors around cost-cutting and other complex issues are involved and captured, including: (a) a safety case that is seen by some as bureaucratic red-tape to get pipeline licenses; (b) business managerial managers who do not understand technical safety knowledge in relation to their responsibility as a result of the complexity of regulation; and (c) the intention and principles of workforce engagement in a safety plan are misunderstood.

The failings reveal various weaknesses of risk-based practices. For example, regulators only partially inspect during risk assessment as they have limited resources. In addition, as part of the ontological-epistemological logic underlying pipeline regulatory risk-based practices, regulators rely on industry knowledge and activities to manage pipeline risks. At the same time, however, industries do not share their risk-safety knowledge with regulators as part of self-regulation and risk-based practices that serve their own self-interest.

The thesis further traces the regulatory apparatus related social-regulatory controls (i.e., tripartite or union engagement, and workforce engagement). Analysis of interviews indicated that pipeline professionals are neither familiar nor comfortable with the union engagement. The workforce is engaged in assessing pipeline risks; but at the personal safety level, where it is disconnected from major hazardous risks at the ‘process safety’ level. The incoherence of risk assessment practices in engaging workforces is shaped by the uncritical-routine practices of elite-expert and industrial entities, illustrating again the ontological-epistemological logics of risk regulators. Workforces have become silent actors in the assessment of major risks, resulting in their having limited and unequal risk-safety knowledge to deal with catastrophic accidents. In addition, regulatory accountability towards workforces has become ambiguous due to the complexity of regulatory frameworks and regulatory-institutional arrangements.
Chapter 6
The incoherence of knowledge and practices in relation to pipeline risks and public safety

Coherence between knowledge and practice is a crucial requirement in dealing with risk and safety throughout the regulatory process. The previous chapter discussed how knowledge and practices have been shaped by power-knowledge relationships involving elite-expert institutions and their regulatory apparatus: safety plans, risk-based regulation and social-regulatory controls. This chapter will explore how knowledge and practices have been shaped through an emerging non-human actant (or actor or entity): measurement length, created by elite-expert institutions (see the definition of actant in Chapter 2, Section 2.2.2.1). Risk regulation through technical-regulatory specifications, especially measurement length, was one of the key concerns raised by research participants. Measurement length as a technical-regulatory specification is used with reference to the prevention of pipeline accidents involving the public.

Technical-regulatory knowledge is central for both the Australian pipeline industry and the technical regulators who manage pipeline risks. The emphasis on technical knowledge about risk and safety is part of their ontological stance (as discussed in Chapter 4). The Australian pipeline industry has invested much effort in engineering research to improve technical knowledge. Such knowledge is not only used to reduce costs, but also use to maintain safety. The results of engineering research have informed the technical-regulatory specifications in AS2885.

The focus on technical evaluation, in particular, enquiries based on technical-realist perspectives that analyse and regulate technological risk, have been widely criticised by critical social science approaches (some of the arguments and solutions have been discussed in Chapter 2 and 5). For example, analysis of risk based only on technical premises cannot capture the entire complexity of human activities and consequences. Social science scholars have typically urged a reference to value, experience, culture and other social dimensions when managing risks (see for example: Beck, 1992a; Dietz et al., 2002; Douglas & Wildavsky, 1982; Luhmann, 1993; Zinn, 2008a). Some scholars have emphasised the concept of lay or public knowledge as a counterpoint to expert knowledge (Wynne, 1992; Wynne, 1996). Others have promoted social controls as a
means of engaging opposite and different stakeholders in analysing risk including the tripartite engagement framework and the risk governance framework (discussed in Chapter 2, Section 2.1.1.2 and 2.1.3 consecutively). Among the pipeline safety literature, organisational models including Reason’s Swiss Cheese Model and safety models (e.g., safety culture) offer preventive strategies for avoiding accidents (see Chapter 2, Section 2.1.2.1). The safety culture model was viewed by participants, both regulators and non-regulators, as a very important practice. Safety culture is a crucial concept for the effective operation of High Reliability Organisations (HROs), which include energy pipeline industries.

The existing social science theoretical perspectives, either arraying against the technical-realist perspectives or proposing alternative frameworks by using social controls, have drawbacks, however. These perspectives are limited in how they capture discourses associated with technical-scientific specifications that have been performed through time, and the consequent analyses are limited to questions about social and political effects. Discourses involving knowledge and practices shaped by non-human actants created by elite-expert institutions, therefore, have been overlooked in the existing literature. Actor Network Theory (ANT) scholars who emphasise the importance of non-human actants argue that artefacts are part of the negotiating process in performing knowledge, a process normally dismissed by ‘social’ scholars (Latour, 1992). The organisational safety models that are used among pipeline regulators and pipeline industries also have limits in capturing the interwoven issues of power relations, technical meaning, and values (LaPorte & Consolini, 1991, p. 42).

In this chapter, the focus will be upon how changes in technical-regulatory specifications that are enacted by elite-expert institutions have shaped knowledge and practices in the process of risk regulation. Measurement length, as a relatively new technical-regulatory specification, is the primary ‘non-human’ actant (or performing as a part-human actant) and the entry point for investigation in this chapter. Measurement length was enacted to regulate pipeline risks in 2007, more than four decades after the first Australian pipeline was established in 1964. The enactment of measurement length at a late stage in the history of Australian pipelines has become problematized because it contradicts the emphasis that pipeline regulatory institutions and pipeline industries put on the integrity of pipelines in the face of catastrophic accidents and public safety.
A number of assemblages emerged concomitant with the process of tracing this measurement length actant (see Figure 6.5). An investigation of these assemblages revealed research themes specific to the incoherence of knowledge and practices concerning pipeline dangers (or pipeline risks) and public safety. Such knowledge and practices will be discussed throughout this chapter (summarised in Figure 6.5).

The research themes were revealed in response to guiding questions. The latter were created by employing the method assemblage of this thesis (presented in Figure 3.3) to explore the process of performing power-knowledge relationships through measurement length and its series of assemblages that shape regulatory practices. The first Section (6.1) explored: what is measurement length and how is it important to the regulating of pipeline risks? In addition, I investigated how measurement length was enacted, and who had been involved? What were the influences that led to the enactment of measurement length? In the second Section (6.2), I explore the transitions of knowledge appertaining to pipeline dangers. What has changed after the introduction of measurement length, who has been involved and how? In the last Section (6.3), I explore how knowledge of pipeline dangers has been understood among third parties subsequent to the enactment of measurement length. How have protective devices been used, who has been involved, and how have they functioned? What are the inconsistencies (or incoherence, see Section 6.2) associated with the employment of these devices to regulate pipeline risks? An outline of this chapter is presented in Figure 6.1.
6.1 The enactment of technical-regulatory knowledge of pipeline risks

Much of the existing literature on pipeline dangers pays primary attention to external interference which is claimed to be the dominant cause of pipeline failures in many areas, including Europe, USA, the USSR (before disintegration), and Australia (see for example: Papadakis, 1999; Papadakis et al., 1999; Tuft & Bonar, 2009). Tuft and Bonar (2009) highlight the fact that more than 80 per cent of pipeline incidents in Australia are caused by external interference rather than by corrosion and other factors.

Australian pipeline industries and regulatory institutions focus their attention on third parties (Standards Australia, 2012a, p. 72), who are considered to be the major cause of external interference. A broader typology of third parties includes groups of people who work and live along the pipeline, including the public. Specifically, the groups that pipeline institutions are most concerned about are those who have tendencies to cause harm to pipeline assets. External interferers include local governments, underground
utility companies (e.g., electricity companies, communications companies, water companies), developers, builders, their contractors and sub-contractors, excavators, as well as landowners who have pipelines located on their land. Within the typology of third parties, the general public are peripheral.

The issue of external interference has increased among Australian pipeline industries and regulatory institutions because of an increase in the volume of urban encroachment near to and on pipelines. This increased activity nearby renders pipeline failures more likely. Increased urban density is also likely to lead to greater consequences if such a failure were to occur. The number of people in Australia has almost doubled in the last 40 years (Australian Pipelines and Gas Association Ltd, 2011).

The expansion of urban encroachment and increased level of external interference are becoming more manifest as two interrelated causes of increased risk around pipelines. Land use and development adjacent to pipelines, in particular in capital cities, has increased dramatically (ibid). For example, there are now sensitive areas including schools, kindergartens, hospitals and rest homes that have been located either on top of or nearby to high pressure gas transmission pipelines that were originally constructed under the rubric of different planning zones (e.g., rural zones that have become urban). Since the engineering requirements for pipelines vary according to surrounding land use, the pipeline risk of multiple facilities and injuries has escalated around these sensitive zones.

Such core concerns have led to Australian pipeline industries co-opting with regulatory institutions. Rather than attempting to change and comprehend how pipeline dangers are understood by third parties and planning authorities, Australian pipeline industries and regulatory institutions have centred on setting up and implementing physical and procedural controls to manage and regulate pipeline risks. The development of the concept of measurement length and the enactment of measurement length (Australian Pipelines and Gas Association Ltd, 2014b) have accompanied these changes. Physical-technical approaches are a standard part of the ontological practices of Australian regulatory institutions and Australian pipeline industries’ management of pipeline risks.

Physical controls and procedural controls are now mandatory regulatory requirements (Tuft, 2009, p. 7). Physical preventive controls are used to both prevent accidental contact with pipelines, and to increase the number of physical barriers to prevent
pipeline penetration (Standards Australia, 2012a, pp. 72-73). Procedural controls are protective devices used to minimise the likelihood of human activities with the potential to damage pipelines (ibid). Both preventive controls are summarised in Table 6.1.

**Table 6.1: Physical and procedural controls employed by pipeline institutions to prevent external interferences.**

<table>
<thead>
<tr>
<th>Types of controls</th>
<th>Type of technical tools used</th>
<th>Technical tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical-technical controls</td>
<td>1.1. Separation</td>
<td>1.1.1. Considerations of pipeline burial depth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1.2. Restriction of access, via bollards and fencing.</td>
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<tr>
<td></td>
<td></td>
<td>1.1.3. Relocated pipelines</td>
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<tr>
<td></td>
<td>1.2. Resistance to penetration</td>
<td>1.2.1. Increased pipeline wall thickness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2.2. Increased penetration barriers (e.g., buried concrete or other hard cover above or adjacent to pipelines)</td>
</tr>
<tr>
<td></td>
<td>1.3. Changes in technicality</td>
<td>1.3.1. Reduced pipeline Maximum Allowable Operating Pressure (MAOP)</td>
</tr>
<tr>
<td>2. Procedural controls</td>
<td>2.1. Public awareness</td>
<td>2.1.1. Liaison with landowners and third parties (e.g., local government, utilities, et al.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.1.2. Community awareness program</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.1.3. One-call service known as ‘Dial Before You Dig’</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.1.4. Pipeline marking (warning signs and buried marker tape)</td>
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<td></td>
<td></td>
<td>2.1.5. Agreements with other users of shared corridors</td>
</tr>
<tr>
<td></td>
<td>2.2. External interference detection</td>
<td>2.2.1. Patrolling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.2.2. Planning notification zones</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.2.3. Remote intrusion detection</td>
</tr>
</tbody>
</table>

Sources: Sea Gas Ltd. and Epic Energy Ltd. (circa 2014); Standard Australia Limited (2012a, p. 8); Tuft (2009).

Notes:  
(1) The relocation of pipelines is unlikely because of cost and impact on gas supplies (Sea Gas Ltd. & Epic Energy Ltd., circa 2014, p. 21).

(2) Reduction of MAOP is assumed to be generally impracticable due to reduction in pipeline capacity and the reduced availability of gas supplies (ibid).

For any given pipeline, the question for engineers is whether and/or how each of the above controls should be implemented. A parameter in making this decision is how the land around the pipeline is used. That is, where the concept of measurement length first arises. The question of what measurement length is and how it is enacted in the power-knowledge assemblage will be explicated in more detail in the next section.
6.1.1 Measurement length and its enactment in a power-knowledge assemblage

The definition of measurement length was invested in the AS2885 Australian pipeline standard committee on the revision of AS2885 during 2007. The committee members are composed of pipeline industrial professionals (two-thirds), and pipeline regulators (one-third). The committee has formulated a hard science, technical-engineering definition, which excludes social dimensions. According to AS2885, measurement length is ‘the radius of the 4.7 kW/m² [and 12.6 kW/m²] radiation contour19 for a full bore rupture, calculated in accordance with Clause 4.10’ (Standards Australia, 2012a, p. 64). Technically, it is used to identify the distance from pipelines, and the effect of a person’s exposure to radiated and intensified heat from an ignited full-bore rupture.

There are two types of radiation levels addressed in AS2885: 4.7 kW/m² and 12.6 kW/m².

The distance, calculated relative to 4.7 kW/m², is several hundred metres for a full bore pipeline rupture. The effect of exposure to heat at this level will directly cause pain in unprotected people within 15-20 seconds (O’Neil, Hunichen, & Walters, 2013, p. 27) and will cause injury after 30 seconds exposure, at least second degree burns (Standards Australia, 2012a, p. 173). The simplified meaning of the technical definition is that unprotected people who stay, work or live within the calculated distance will suffer severe burns in less than a minute; and in general, their severe burns will demand a long recovery time (Peter Tuft & Associates Pipeline Engineering Consultant, 2015, p. 5).

In addition, the distance, calculated relative to 12.6 kW/m² is several hundred metres for a full bore pipeline rupture which will bring a significant risk of fatality after extended exposure and a high risk of injury (O’Neil et al., 2013, p. 28) after 30 seconds exposure for third degree burns (Standards Australia, 2012a, p. 173). The simplified meaning of the technical definition is that unprotected people are likely to receive fatal burns following a short exposure (Peter Tuft & Associates Pipeline Engineering Consultant, 2015, p. 5).

This concept was introduced in order to codify the link between engineering and procedural controls for pipelines and the expected activities in areas surrounding the

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19 Radiation contours depend on various pipe sizes and types of gases (Standards Australia, 2012a, p. 64).
said pipelines. The more people are potentially exposed to pipeline failure the more controls are required by the standard. But, this technical concept clearly has non-technical implications for land use planning and for those who live and work within the measurement length of a pipeline.

What is the measurement length in non-technical understanding? The measurement length can be simplified as a technical concept related to adverse, devastating impacts of pipeline catastrophic events caused by full bore ruptures of high pressure gas pipelines. The impacts from full bore ruptures have a certain length of heat radiation, a round shape. The impacts can potentially cause catastrophic harm to both humans and environment within less than a minute.

The findings suggest that the technical meaning as defined by AS2885 committees is too technical and obfuscates the understanding of catastrophic risk from pipelines. This was addressed by both regulator and non-regulator participants (i.e. industrial, planning and consultant participants). It has been criticised as ‘not a very descriptive term’ (Geelong Council, 2013, p. 18). In lay terms, participants described measurement length as ‘a blast zone’, ‘a kill zone’ or ‘a danger zone’. Some either interpreted it as an incineration zone and blast radius (NH Pipeline Awareness, n.d.) or as a ‘heat flux zone’ (Geelong Council, 2013, p. 18). This measurement length terminology is, however, only used within Australian pipeline institutions. In other pipeline literature it is described differently, using terms including ‘safety distances’ (Fateen, 2012; Sklavounos & Rigas, 2006) or ‘buffer zones’ (Fateen, 2012).

The technical specification of pipeline risks under AS2885 is narrow. A ‘blast zone’ is contingent upon the sizes of and pressures within pipelines. But, the Australian pipelines and regulators have largely emphasised only two zones at a radiation level of 4.7 and 12.6 kW/m² from an explosion of high pressure gas transmission pipelines. A blast zone can occur in gas distribution pipelines, which are used to transfer gas through residential areas. In addition, people living, working or studying outside the measurement length when a full bore rupture occurs can be burned, injured or die if they have not been evacuated before heat radiation transfers to them.

Before moving on to the next section, I will illustrate the effects of a blast zone or ‘measurement length’ by providing some visual figures from the catastrophic event of a pipeline rupture in San Bruno city in California, USA. I would have preferred to use
examples from the Australian pipeline literature; however, I could not find clear photos carrying an explanation. This may indicate that the technical knowledge of a blast zone itself is not transparent in Australia. The description of a ‘blast zone’ is more open in countries such as the USA wherein a catastrophic pipeline explosion has already occurred. Figure 6.2 shows the blast zone of the San Bruno pipeline explosion and the consequence. Figure 6.3 presents an overview of the fire. Figure 6.4 presents the burned houses around the San Bruno pipeline explosion.

Figure 6.2: An illustration of a blast zone (600 feet or 183 meters) of the San Bruno pipeline explosion and the consequence. The San Bruno gas transmission pipeline was 30 inches in diameter, had a 0.375 inch wall thickness, and a pressure of 375 pounds per square inch (psi) (National Transportation Safety Board, 2010b, p. 19).
Figure 6.3: An overview of the fire at San Bruno (National Transportation Safety Board, 2010b, p. 3).

Figure 6.4: Burned houses around the site of the San Bruno pipeline explosion (National Transportation Safety Board, 2010b, p. 20).
6.1.2 Incoherence of knowledge about pipeline dangers among actors

The zone of pipeline danger was unregulated before 2007, or more than 40 years after the first Australian Pipeline was built in 1964. Pipeline regulators and the Australian pipeline industries have claimed that they have no control over the changes in planning. Is this claim valid? What are the reasons behind such a late establishment of a blast zone related to a full bore rupture of pipelines? The research themes involving knowledge vis-à-vis the dangers of pipelines were gradually exposed.

The enactment of ‘measurement length’ was my entry point to tracing how risk knowledge of pipeline danger is performed and changes over time. After I asked participants how measurement length was established, the AS2885 committee participants and pipeline industrial participants revealed that the intention was to use measurement length as a regulatory specification only by pipeline designers and operators. This group had to be assured that the design and operation were appropriate for acceptable risk, and not likely to cause catastrophic pipeline failures. There were no specific intentions to distribute knowledge about the danger zones of pipelines to others.

After the measurement length was enacted, pipeline regulators and the Australian pipeline industries were forced to involve other parties in measurement length, especially those outside of pipeline industries and regulatory institutions. These other parties included those associated with land use planning and those contiguous with pipeline assets. They included the developer, local council and planning authority. These parties are required to know about measurement length because, to quote a pipeline consultant: ‘the consequences of failure are part of the argument necessary to persuade the developer to maximise separation from the pipeline’.

Some interviewees, including regulators, industrial and consultant participants, observed that a number of groups are not required to know about the dangers of pipelines. Such groups included the potential buyers of land within and around a blast zone, as well as members of the public living within and near the blast zone. A pipeline consultant put forward a reason for this exclusion:

[t]he industry is very concerned about scaring the public and do not wish to create alarm by informing too many people about the consequences of a
On the surface, the perspective concerning the public’s fear of technological risks have become a normative assumption. As I have suggested earlier in this chapter, some social science scholars have concluded that the experts’ normative assumptions indicate that experts have misunderstood how lay people understand science (see for example: Wynne, 1992; Wynne, 1996). Lay people are unwitting victims who rarely participate in debates and decision-making about the appropriateness and usefulness of the technosciences. As a consequence, the structure of the counterpoint between lay people and experts, nevertheless, has become problematised. Callon and Rabearisoa (2008) urge the avoidance of dichotomy traps because the structural assumptions of lay-expert counterpoints have a tendency to omit other assemblages and discourses embedded in power-knowledge in relation to the development of technosciences and their impacts (Callon & Rabearisoa, 2008, p. 231).

The assemblages and their effects as they relate to knowledge and practice about pipeline risk were exposed when investigating the enactment of measurement length. Pipeline regulators and pipeline industries have chosen which groups they want to keep informed about pipeline danger in relation to a blast zone (within measurement length), and which groups they do not want to keep informed. In other words, the elite-expert institutions and the industry pipeline institutions have shaped the incoherence of knowledge about pipeline danger.

6.2 Enacting measurement length and the distortion of risk accountability, assessment, and communication

This section aims to discuss the research themes that emerge from the negotiating process (or the translation process) of measurement length. The translation process of assemblages is defined as ‘the continuity of displacements and transformations’ of assemblages and their relations in the process (Callon, 1986, p. 223) (the translation process is discussed in Chapter 2, Section 2.2.1.3).
ANT scholars prefer to begin at a different entry point from that of conventional dichotomous models (e.g., lay people and experts) in order to establish a process of revealing assemblages and their effects (Callon & Rabeharisoa, 2008). Researchers can begin their research with non-human entities, and follow how they interact with other entities in enacting realities. Or, researchers can start with controversial issues, by tracing connections among such issues. They can trace how controversies are enacted rather than attempting to extract solutions to cure controversies (Latour, 2005, p. 23). By following the enactment of measurement length herein, an attempt was made to reveal the assemblages and their effects.

This chapter explored the controversial issues pertinent to measurement length, and the elite-expert and industrial entities that created this non-human entity (measurement length). In the Australian pipeline case, the controversial issues involved the concerns of pipeline institutions (both industries and regulators) about the public’s apprehension of and fear towards pipeline catastrophic accidents. Such concerns contradict the roles and accountability of pipeline institutions in and towards public safety. Investigation of these controversial issues through the transitional changes of measurement length led to a number of assemblages emerging beyond the public, laypeople and dominant institutions. They were categorised into three groups (see Figure 6.5): technical-political assemblages; social-political assemblages, and economic-political assemblages.

Following the interactions of these assemblages and their effects, research themes involving incoherence among knowledge and practices in the process of risk regulation were further revealed. Such knowledge and practices have been generated though the power-knowledge effects involving these assemblages. These research themes are included: (a) the distortion of risk accountability and risk assessment; (b) the muddle of risk communication; and (c) the uncommon knowledge of pipeline risks. These themes will be discussed throughout the rest of this chapter. The process of performing power-knowledge in relation to measurement length before and after its enactment, and the assemblages that have been involved are explicated in Figure 6.5 together with a summary of the themes revealed throughout this process.
Before enacting measurement length

Two primary interconnected elite-expert entities:
Australian pipeline industries and regulatory institutions

Primary relational assemblages
- Australian Pipeline industries
- Contractors
- Subcontractors
- Pipeline regulatory institutions
- Location class

After enacting measurement length

Changes in technical-political assemblages
- Public notification
- Pipeline maps
- Safety Management Studies (SMSs)
- (Process of risk assessment)
- Dial Before You Dig (DBYD) program
- Location classes (T1, T2, R1, R2)
- Maximum Allowance Operating Pressure (MAOP)
- Design Factor
- Wall thickness
- Depth of cover
- Signpost

Changes in social-political assemblages
- Planning authorities
- Independent planning panels
- Underground companies
  (e.g. electricity companies, communication companies, water companies)
- Developers
- Builders
- Contractors and sub-contractors
- Excavators
- Transportation Department
- Safety regulators (regulators of Major Hazardous Facilities (MHF))
- State Planning Minister
- State Resource Minister
- Buyers
- Land owners
- The public

Changes in economic-political assemblages
- Cost of changes in technical acts
  Who is going to pay for these?

New emergence of relational assemblages of power-knowledge relationships around elite-expert entities

Research themes involving incoherence of knowledge and practices in the process of risk regulation were revealed. The incoherence of knowledge and practices is generated through the power-knowledge effects of these relational assemblages.
- Knowledge about pipeline dangers and pipeline risks are incoherent among actors
- The practice of risk accountability and risk assessment towards pipeline risks is distorted
- The practice of risk communication is muddled
- Knowledge of pipeline risks is uncommon and made uncommon

Figure 6.5: A summary of the assemblages and the research themes.
6.2.1 The incoherent practice of accountability and risk assessment

Subsequent to the enactment of measurement length, Australian pipeline industries have co-operated with regulatory institutions to negotiate with planning authorities over the control of pipeline assets. The two interconnected bodies; the pipeline industry and the pipeline regulatory body, have formed a Pipeline Corridor Committee – facilitated by the Australian Pipelines & Gas Association Ltd. (APGA). APGA is the representative body of the Australian pipeline industries (Australian Pipelines and Gas Association Ltd, 2013). The Pipeline Corridor Committee is composed of senior state regulators, pipeline company representatives, industry consultants, representatives of the AS2885 Committee and the APGA (Australian Pipelines and Gas Association Ltd, 2014b). The Pipeline Corridor Committee aims to develop a ‘notification zone’ to be implemented nationally which is acceptable to pipeline licensees, planning authorities and developers (Tuft & Davies, April 2011).

The practice of risk accountability is distorted by obscurities in the meaning of measurement length, enacted by pipeline regulators and the pipeline industry. The meaning of measurement length is obscured in its description as a ‘notification zone’, a term used by Australian pipeline industries and regulators to refer to a danger zone. The obscuring of ‘measurement length’ has resulted in a misrepresentation of how measurement length should be regulated, and by whom? Regulators and the pipeline industry have made planning authorities accountable for the notification of development and land use changes to pipeline licensees, or pipeline owners (Cronin, 2015, p. 3; DePrinse, 2015, p. 1). As a pipeline regulator has claimed:

Planning schemes largely fail to recognise and address the planning constraints posed by existing pipelines licensed under the Pipelines Act (2005) (licensed Pipelines). This means that pipeline licensees are often not notified of development and land use changes within a pipeline’s measurement length early in the planning process, if at all, and prospective purchasers of land located within the measurement length of the pipeline are not aware of the existence of the pipeline or the risks associated with it (Cronin, 2015, p. 3).

The obfuscation of the meaning of measurement length and the misrepresentation of accountability has resulted in messiness in practicing risk assessments around the
measurement length zone. A research theme involving the distorted practice of risk assessment was revealed when following the technical-political assemblage: Safety Management Studies (SMSs). The findings indicated that the key principle of assessing pipeline risk in accordance with the SMSs had been distorted. The actors involved with, living and working within the measurement length had been excluded from the practice of the risk assessment process.

The distortion of SMS is evident in the narrow and technical definition of SMS, defined within AS2885:

> the process that identifies threats to the pipeline system and applies controls to them, and (if necessary) undertakes assessment and treatment of any risks to ensure that residual risk is reduced to an acceptable level (Standards Australia, 2012a, p. 16).

The regulatory institutions have primarily centred their assessment of pipeline risk on the construction phase. A pipeline licensee or representatives of pipeline licensees must conduct an SMS at the design and construction stage to consider pipeline risk. Their design plan must incorporate physical and procedural controls to prevent pipeline explosions (Australian Pipelines and Gas Association Ltd, 2014a, p. 4). The physical-technical controls that emerged from the interviews include: changing design factors, Maximum Allowance Operating Pressure (MAOP), and depth of cover.

Pipeline licensees are required to act on SMSs in order to protect vulnerable groups. The latter are classified as those living in and attending sensitive use zones including schools, hospitals, aged care facilities and prisons (ibid, p. 9). If there is a change in a pipeline location class in the vicinity of a pipeline corridor or a pipeline easement, an additional SMS must be taken (ibid). The fundamental element of location class is established as technical specification to classify vulnerable groups of people who are unable to protect themselves and subject to the possibility of adverse impacts. The presence of such groups would normally lead to a new pipeline being routed elsewhere. Or, if it remains in the vicinity, then pipeline licensees are required by AS2885 to essentially design-out the full bore rupture case for the pipeline by using physical and procedural controls (Table 6.1). The SMSs should be composed of a location class review, pipeline risk assessment and a review of the possible mitigation measurements (ibid).
The practice of risk assessment is made messier when one pipeline is handled by complex ownerships involving several companies under contractual arrangements. One example is when the pipeline owner, the pipeline facilitator, and the pipeline operator are located in different states but handle the same pipeline. The complexity of ownership has been amplified by neoliberal government programs, a topic I discuss in Chapter 7. An illustrative structure of the complexity of ownerships is presented in Figure 7.2 (Chapter 7, Section 7.2.2).

The research theme involving the distorted practice of risk assessment was further exposed. I had no prior knowledge of who would be included and excluded from the process of SMSs. During an interview with a field manager, working for the pipeline operator (the subcontractor), I asked if I could observe the SMSs process conducted within the company in order to gain background knowledge about SMSs. The participant field manager mentioned the case of a kindergarten near to where the company needed to assess risks. The participant field manager emphasised that the kindergarten was located within a danger zone, a problem discovered by his pipeline patrol staff. Because the pipeline did not belong to the pipeline operator (the company he worked with), he reported the situation about the kindergarten to the pipeline facilitator who then reported to the pipeline owner. The SMS was subsequently conducted but took time due to the complexity of ownership.

I was invited to observe the SMSs process in assessing pipeline risks around the kindergarten located within the danger zone. I imagined that representatives of those affected people had been invited and were coming to co-assess risks with the pipeline operator. I planned to use snowball sampling to interview them later, but my assumption was wrong. The SMS was conducted by a consultant company, hired by the pipeline owner. The initial outcome was to construct physical and procedural controls for managing pipeline risks from a full bore rupture of a high pressure gas transmission pipeline. The stakeholders in the SMS workshop were representatives of pipeline owners, the patrol staff and the field manager of the pipeline operator (or the pipeline subcontractor). The kindergarten school developer, the affected groups of people working and studying at the kindergarten school, the pipeline regulators, and the planning authorities were not present.
The case epitomises how the practice of risk assessment has been negotiated among actors around changes to the technical-regulatory specifications involving measurement length. The process of risk assessment can be straightforward and serve the principle of protecting public safety. Nevertheless, the process was twisted as a result of the obscured meaning of measurement length. The obscured meaning was enacted contingent to the ontological practices of regulators and pipeline industries (these ontological practices are discussed in Chapter 4).

**6.2.2 The practice of risk communication is muddled**

This section will briefly introduce and problematise the contemporary concepts associated with risk communication required to analyse their interaction with the incoherencies associated with measurement length discussed above. Risk theorists have proposed the concept of integrative risk governance to enhance the communication of risk in order to manage the effects of technological risk. The risk governance approach is underpinned by the deliberative concept of Habermasian discourse theory (Habermas, 1984; 1987) (discussed in Chapter 2, Section 2.1.3). This concept advocates a deliberative democracy of public participation in communicating and integrating with different stakeholders. The deliberative concept is ideal for creating democratic processes to solve conflicts of risk in the public space (Wardman, 2008, pp. 1623, 1628). Conversely, the deliberative approach has been criticised by ANT theorists for reducing the role and identity of the public in the public space. The democratic process, utilising communicative rationality and reasoning, can omit accounts of difference and the roles and identities of other groups, who are impacted by technological risk (Barry & Slater, 2005b, p. 118). In addition, the ideal of the deliberative approach in offering ‘what should be done’ (Wardman, 2008, p. 1629) leads to neglect of investigations into how practice in the process of risk communication has been shaped in this case, by the measurement length entity and those who enacted it.

Pipeline regulators and pipeline industries are forced by the material entity: measurement length, to communicate with others but the practice of risk communication has become muddled as a result of the obscured meaning of pipeline risks. The research theme involving the muddled practice of risk communication was revealed by following the controversial issues around measurement length in relation to
an emerging social-political entity: the independent planning panels who I refer as ‘interactors’.

The term ‘emerging concerned groups’ (Callon, Lascoumes, & Barthe, 2009, p. 29) was coined by ANT scholars investigating controversial and contradictory discourses over uncertainty and risk in relation to technologies. The emerging concerned groups are unacknowledged actors who are under-explored within the existing contemporary literature. As suggested earlier, the authors of the existing literature either develop their arguments vis-à-vis the counterpoint between laypeople and experts, or propose solutions by engaging them together to assess risks. Both ways, researchers can fall into a dichotomy trap, a dilemma that ANT scholars prefer to avoid.

The ‘emergent concerned groups’ are groups of people who have received adverse impacts from technologies. More importantly, these groups have taken action to conduct research using themselves as objects of their own study (ibid, p. 147). The process is called objectification (ibid). The ‘emergent concerned groups’ are not stereotypical victimised groups such as laypeople, the public, communities, workers; nor non-governmental organisations that represent these groups. The ‘emergent concerned groups’ can be patients suffering from new forms of diseases, or those affected by technologies.

In the Australian pipeline case, instead of alluding to them as emergent concerned groups, I would rather call them ‘interactors’ (or ‘inter-emergent groups’) because their roles and actions are different from the emergent concerned groups. In this case, the interactors are the independent planning panels. They do not suffer direct impacts from pipeline risks and conduct the process of objectifying research in a similar way to the emergent concerned groups. Interactors play their roles in re-identifying public safety and accountability in the pipeline case. They are independent, separate from the interconnected bodies, regulators and pipeline industries, but share relevant knowledge. Those interactors have sympathised with the affected groups and have willingly set up a model to help inform affected groups about pipeline risks.

The muddled practice of risk communication was exposed by following the interactors’ approach to controversial issues of measurement length. A case occurred in a local council, located in one of the Australian States. In this case there was conflict associated with a planning scheme developed by the local council. This particular conflict was
brought into being because a pipeline licensee and pipeline regulators had submitted a submission objecting to a particular planning scheme because there was a high pressure gas transmission pipeline buried under the area. It had been there for more than 30 years and its existence was poorly known. Nevertheless, pipeline regulators and the pipeline licensee were forced to communicate with the local council. Their decision was prompted by measurement length because sensitive facilities under the planning scheme including schools, kindergartens and a community centre were to be constructed within measurement length.

The independent planning panel took the initiative to rearrange the new practice of risk communication in relation to measurement length. The panel wanted to set up public notification to notify the danger zone to potential buyers who were planning to buy land within the measurement length. Public notification changes the current practice of risk communication in relation to how pipeline risks should be communicated, who needs to know about pipeline risks and how? The public notification is contingent to the principles of public right to know, openness and transparency. Before development commenced, the panel wanted to devise a mechanism to advise the purchasers of the property near the danger zone by notification of agreements over land titles. The panel insisted that land purchasers should be informed of the existence of the pipeline so that they would be free to make their decision to invest and live with full knowledge of the hazardous nature of the pipeline and its accompanying risks.

The research practice of following interactors and observing their actions revealed the power-knowledge dynamics implicated in the muddling of the practice of risk communication. In response to advice from the independent planning panel on public notification, the interview data showed that the pipeline licensee and an Executive Director of one of the institutes for urban development in Australia wrote a letter to the Planning Minister expressing their disapproval of public notification. I asked to see the letter but I was refused due to the issue of confidentiality.

The reasons given for opposing public notification were influenced by the ontological-epistemological logic underlying the current knowledge and practice of elite-expert institutions: (a) pipeline ruptures are very rare events; and (b) the Australian pipeline industry operates with high standards together with an excellent safety record. In

20 The data was gathered from interviews and secondary resources
addition, the pipeline had co-existed with communities since 1999 without an incident affecting residents and other land users. Moreover, physical controls must be adopted according to AS2885 to protect external interference including: (a) resistance to penetration by virtue of wall thickness; and (b) using sign posts and marking. The putative lack of technical competency among the public in relation to their lack of understanding of ‘measurement length’ and the potential for public anxiety and fear was another reason. The Planning Minister disapproved the submission due to these reasons:

this requirement is unnecessary as gas supply infrastructure is common to the majority of urban areas … and the pipeline that runs through the … site has been designed and constructed in accordance with the relevant Australian Standard (AS 2885.1-2012) for a Residential (T1) environment (Geelong Council, 2014, p. 6).

This case illustrates the power-knowledge dynamics implicit in risk communication. The new way of risk communication, arranged by the interactors, has forced pipeline regulators, the pipeline industry, and developers to renegotiate their current power-knowledge practice. Nevertheless, in this case, the arrangement proved unsuccessful. The reasons were investigated and are discussed in the next section.

6.2.3 The incoherent practice of risk communication

Interviews involving a pipeline regulator and a planning participant indicated that an attempt to rearrange the current process of risk communication initiated by the interactors failed because of cost and accountability issues associated with the existing power-knowledge practice of the elite-expert and industrial entities. In terms of cost, the public can use awareness and knowledge of pipeline risks to negotiate the price of land within, nearby and around measurement length. The price of land may be reduced and this could raise questions of compensation. In addition, pipeline licensees will be required to prevent pipeline risks by using physical and procedural controls to prevent pipeline explosions. Potential changes in technical-physical controls, emerging from interviews, include MAOP, design factor, wall thickness, and depth of cover (see other controls in Table 6.1). The cost of construction of physical and procedural controls can be very expensive.
Public notification can create new forms of power-knowledge relationships across the Australian states and territories, potentially impacting on and dismantling the existing form of power-knowledge practice of the two interconnected entities: pipeline regulators and the pipeline industry. If a public notification mechanism had been set up as advised by the independent planning panel, other local governments across Australian states may well have done the same. As a consequence of the requirement for public notification, pipeline licensees may face difficulties when constructing new pipelines. In addition, pipeline regulators and the pipeline industry will be forced to rearrange their current ontological practices in regulating pipeline risks despite a reluctance to change in the face of a lack of regulatory support mechanisms.

The rearrangement of the current ontological practices is associated with accountability. The question of ‘who will pay for this’ has become a key concern among participants including pipeline regulator participants and pipeline industrial participants. ‘Who will pay for this’ in this context is not only associated with who will pay the costs, but more especially who will be accountable for the consequences of implementing measurement length?

The research theme on the muddling of the practice of risk communication concerning measurement length reflects ambiguous accountability in relation to pipeline risks. I asked the pipeline regulators: who will be responsible if there is a pipeline failure associated with unregulated measurement length? A number of pipeline regulators replied that pipeline licensees are accountable for pipeline failures, based on law. Regulations require pipeline companies to reassess risk, and to demonstrate how they are going to control such risks in order to get or extend their licenses in accordance with SMSs. If licensees can demonstrate how they are going to establish control, regulators are relatively satisfied. In addition, some pipeline regulators in some states said that under their pipeline act, regulators have neither the right nor the obligation to regulate a danger zone.

Some regulators emphasised that ‘I don’t know’ who will be accountable because issues of accountability are rather complex involving a complexity of actors and laws:

We have a sort of a regulatory responsibility as far as pipeliners complying with the standard that has this process for doing a safety assessment if land use changes. But that standard has no power over developers or planners,
there's no requirement on them to comply with it, and we have no power over those people at all. So there's a sort of an expectation that something's going to happen that a standard can't force to happen, the licensees can't force to happen, and we can't force to happen.

Findings suggest that pipeline licensees and regulators are forced to become involved with unregulated measurement length. For example, there are approximately 400 pipeline licensees across Australian states that are required to identify changes of land use, re-assess risks around pipelines, and even to rearrange pipeline routes which is an expensive option. With such large numbers of pipeline licensees across Australian states, a regulator reflected that ‘is way beyond what a pipeline, licensed pipeliner could really be expected to sort of monitor’. Additionally, in cases involving accidents ‘the regulator will be investigated and found potentially to have been ineffective’, and ‘in this case there’ll be evidence around the planning functions that aren’t helpful’.

The above findings indicated that pipeline regulators and pipeline industries are at an interstice of negotiations with regards to their accountability. Pipeline regulators and pipeline industries have claimed that they have been working with developers and pipeline industries together with government bodies – to set up a planning process. One regulator asserted that:

> to come to an outcome where no single person is responsible, so it means that all parties need to meet their obligations, and we need a framework in place so that that can happen.

The question is how to regulate against pipeline dangers (or pipeline risks) when knowledge about pipeline risks is available but the elite-expert and industrial entities are in a transitional process of negotiation about their roles, power-knowledge, and accountability? Instead of making no single person accountable for the unregulated measurement length, should every single person be made accountable with reference to improving knowledge and practices around the pipeline blast zone? And, if so, how?
6.3 Knowledge about pipeline risks is uncommon and made uncommon

Measurement length was enacted in 2007. This means that pipeline licensees and pipeline regulators are in a transitional period of regulating the zone of pipeline danger. A question arises as to what pipeline licensees and pipeline regulators can do to regulate existing pipeline risk *vis-à-vis* situations where pipeline licensees lack information about the past (and therefore cannot go back to re-assess risks), and furthermore, in cases where licensees cannot meet their new obligations?

Both interconnected parities have tried to control third parties, many of whom have high potential to spoil and disturb pipeline assets. Pipeline industries are highly concerned about third parties. As a measure of approachment, the pipeline industries have established ‘Dial Before You Dig’ (DBYD) together with physical and procedural controls including signposts (warning signs) notifying third parties of the existence of pipelines (see Figure 6.6).
Figure 6.6: Illustrations of a sign post near a residential area.

Note: The photo on the top was taken on the 10th September 2014. The photos on the middle and bottom were taken on the 25th May 2014. Photos by Dolruedee Kramnaimuang King.
Studies have been conducted in an attempt to understand the levels of awareness about pipelines among third parties in Australia. Pipeline industries express concern about their pipeline assets and want to protect their pipelines from interference by external parties (McDermott & Hayes, 2014). However, pipeline industries do not have control over all activities near pipelines that pose a risk to the public (McDermott & Hayes, 2014, p. 15). Working around this claim, McDermott and Hayes set up their study to investigate the organisational structure of third party groups, with specific reference to local councils and underground companies with their contractual chains, and their responsibility for public safety. In their view, some questions remained underexplored, such as: how do pipeline industries view their responsibility for public safety? How have pipeline industries enacted and transferred risk-safety knowledge to third parties? And, how do third parties (both within the researchers’ focus (local councils and underground companies with contractual chains) and beyond the researchers’ focus (landowners and the public in general)) understand risk-safety knowledge?

McDermott and Hayes’ analysis indicates that the third-party groups are primarily concerned with their own business risk. They want to protect their assets and have a tendency to shift their responsibility to frontline personnel who work around their assets (Hayes, McDermott, & Lingard, 2015, p. 105). In conclusion, Hayes et al. (2015) commented that third-party groups prefer to protect their businesses rather than prevent catastrophic accidents that might impact on public safety (ibid, p. 113). On the other hand, pipeline regulators have become ‘toothless tigers’ (McDermott & Hayes, 2014, p. 52). They do not take any action to assist third parties, to sanction the pipeline sector, or to share regulatory responsibility to prevent repercussions from third parties (ibid, p. 50-51).

The usefulness of the research is that it points out some of the limitations of dominant regulatory institutions; but, there are drawbacks. An unintended outcome has been a series of dichotomies. In this case, the dichotomies are not between experts and laypeople but between pipeline industries and third parties, between third parties and their frontline workers, between business safety and public safety, between pipeline industries and pipeline regulators, and between the roles of pipeline regulators and public safety. Such an analysis, to a certain degree, has provided insight into issues of power but framed within traditional arrangements of power.
I have taken a different entry point from McDermott & Hayes’ research. In order to provide new insights by employing a different approach to regulating pipeline risk, I have rearranged and dismantled the series of dichotomies and the ontological identity of ‘dominant’ institutions and actors by emphasising non-human entities in a more equal way compared to human entities in performing knowledge and practices.

In the next section I will discuss how pipeline risks have come to be understood by third parties since the measurement length was enacted in 2007. I have followed the process of performing power-knowledge practices through two non-human actants: the ‘Dial Before You Dig’ (DBYD) and the ‘signposts’ actant. As discussed in the beginning of this section as well as in the beginning of this chapter (Section 6.1), these two actants are procedural controls. They are mandatory requirements under AS2885. The pipeline industry and regulators use them to communicate information about pipeline dangers to third party groups. I explored how knowledge of pipeline risks was shaped through these two regulatory requirements; how they were used, and how they have functioned. Furthermore, I discussed the inconsistencies of using these requirements to regulate pipeline risks.

6.3.1 Knowledge of pipeline risks is uncommon among third parties

Through the process of investigating these two regulatory requirements, interviews indicated that knowledge of pipeline risks is uncommon among third parties. As outlined in Section 6.1, the third party group includes the public in general, landowners, contractors and subcontractors of local councils and underground utility companies. Third parties are not being made aware of pipeline risks from full bore ruptures. This section will discuss how each type of third party (i.e. the public, landowners, contractors and subcontractors) understand pipeline risks, consecutively.

Regulator participants and industrial participants highlighted that the public in general either does know about nor understand pipeline risks from full bore ruptures in relation to a danger zone or measurement length. One of the regulator participants stressed that:

> At the moment no one in the public would understand about measurement lengths on pipelines. You might be well enough informed to, you know, like you do before you buy a house you might check whether there's any planning for new freeways, or you might know that you can get an easement
look at their pipelines, you know, like overhead power lines, pipelines, I'm not sure if people know but they think oh it's just a gas pipeline. But on the other hand, and then I guess the backdrop to all this is obviously pipelines and community have to be together, because they're bringing essential energy to the community. And of course the other thing is that pipelines are very, very safe. When you think about how many millions of kilometres of pipelines are around the world, and how many incidents there are, the safety record is very, very good, and then Australia it's even better than anywhere else in the world. So you say, well how much though do you tell people? Now telling the public and then having to explain all this it's very complicated, it takes people even in the industry six months to get their head around what all this means. So how do you explain this to the public in simple terms?

The above narrative shows that the information about pipeline risks from full bore ruptures has not been directly communicated to the public. There are many reasons for this. First, part of the reasoning is related to ontological-epistemological logics: pipeline risks are perceived as very safe by the pipeline industry and the pipeline regulatory authorities (see Section 4.1.1.2). In addition, industry and regulators tend to form their own assumptions about the public’s fear of technological risk. Industry is particularly concerned that the public may intervene and obstruct the pipeline industry’s activities (see Section 6.1.2). Furthermore, the public has never been informed about pipeline risks: the regulator participant claims that it is too complicated to explain and inform people about pipeline risks in simple terms.

Second, the findings indicated that there has been communication between landowners, pipeline technicians and pipeline patrol staff. However, when I asked about what information the industry communicated with landowners, or what information had been passed to landowners, an industrial participant said:

it generally says, you know, this is your annual mail-out confirming to make contact with you, you know, basically reminding them that the pipeline’s there and using them as a mechanism to make sure that their contact details are correct, and reminding them that at any time if they’re digging near the pipeline or have any questions that they can ring the 1-800 number, dial before you dig, etcetera. So it’s normally to reinforce those processes and procedures are there once again to protect the pipeline.
The quote above refers to the fact that in the main, landowners are ill-informed about pipeline risks from full bore ruptures associated with measurement length. The information offered to landowners is in the form of a regular-routine check so that the pipeline industry can ascertain whether there are any changes in landowners, and also remind landowners to follow a mechanism of DBYD if they are going to dig near pipelines. The information about what landowners have to do if a pipeline accident were to occur was not properly communicated. In other words, the communication made with landowners is done with an intention to protect pipeline assets and not to protect landowners’ and the public’s safety.

Third, not only is knowledge of pipeline risk uncommon among landowners and the public, interviews with regulators and industrial participants showed that some of the sub-contractors and contractors of third-party groups (local councils and underground companies) (hereafter called the contractual chains of third-party groups) who sometimes work near high pressure pipelines, have little understanding about pipeline risks. The issue was exposed in the context of dealing with low pressure gas pipelines. According to a pipeline field manager, the rate of accidentally hitting low pressure gas pipelines was high. For this reason, the danger may seem to be less than that incurred when hitting a high pressure pipeline. Nevertheless, there is still risk of an explosion from low pressure gas pipelines in certain circumstances, an eventuation that the contractual chains of third-party groups may not properly understand.

Apart from the issue of uncommon knowledge, recent research conducted by Hayes et al. (2015, p. 113) (described early in Section 6.3) discovered another problem occurring through contractual chains of third-party groups. Hayes et al. (2015, p. 109) emphasise that frontline workforces of contractual chains of third-party groups work within time and cost constraints so as to meet incentives for timely project completion. The frontline workforces are not remunerated for the extra effort to work safely and they trade off this risk against their own economic survival regardless of having, or not having, knowledge of pipeline risks.

There is a further reason why there is an inadequate knowledge of pipeline risks among the contractual chains of third party groups. The reason that emerged from an interview with a field manager is related to, quote: ‘no-one else is telling them’. There are no technical and regulatory mechanisms for informing and empowering the contractual
chains of third party groups about pipeline risks. In addition, they lack pipeline trade training: they are not raised and educated in the pipeline trades. As the field manager suggested:

we’re talking about excavator operators and that sort of stuff that don’t have much education anyway in the first place, so how are they ever going to find out.

The warning signs indicating DBYD and the location signposts are the only controls in place to protect against pipeline accidents. Despite these efforts aimed at protection, some participants highlighted that the DBYD and warning signs do not function well because the reason behind dialling a DBYD number is not well explained. As the field manager asserted:

that’s the only industry awareness that is officially put out there and doesn’t tell anyone anything, it just tells people that you’ve got to dial 1100 before you dig, which is helpful but doesn’t tell anyone why they’ve got to do it.

Some contractual chains of third party groups may have been aware of the possibility of getting a fine if they hit a pipeline, quote: ‘but no-one tells you that you’ll lose your life if you hit that’.

The field manager participant emphasised that it is crucial to inform contractual chains of third party groups about knowledge surrounding pipeline risks, in particular, about pipeline failures that may eventually result from damage to a pipe coating (pipelines are coated to prevent external corrosion). The participant further commented that contractual chains of the third-party group do not understand how a pipeline could fail in time after it has been hit. There is danger if someone digs near a pipeline, damages the protective coating and then covers it up without telling pipeline companies.

The delayed risk of failure from damage to a pipeline coating is invisible to contractual chains of the third-party groups because they do not usually receive the direct and immediate impact of pipeline strikes or explosions. As, one industrial participant suggested, quote: ‘that’s a ticking time bomb’. Sooner or later, after the pipeline has been hit, the pipeline may fail. Concern about this kind of damage is described by an industrial interviewee:
I’m not concerned about [directly hitting a pipe] because we know about the damage and know it’s there, I’m more concerned about the people that hit the pipe, cover it back over and we don’t know what’s there, that’s a ticking time bomb, you don’t know when that will fail because you don’t even know that there’s damage there until you do some of your survey stuff later on, that’s the scary stuff. So that’s what we try to tell people as well, it’s very important you tell us about any damage that you do, doesn’t matter how insignificant you need to tell us, yes, you know what, you shouldn’t be hitting it but if you do make sure you tell us.

The knowledge about pipeline failures as a consequence of hitting a pipeline is uncertain and unmanaged. Pipeline operators must rely on contractual chains of third-party groups to inform them about any invisible risks. However, contractual chains of third-party groups do not have knowledge about how to detect invisible risks. Although it is important for contractual chains of third-party groups to be informed about unacknowledged pipeline risks, the question is: who will inform them and who will pay for their training?

A pipeline failure that occurred in Belgium is a good example (see Chapter 1, Section 1.2.1). In this case, the pipeline ruptured not because of direct penetration from hitting and digging into a pipe; instead, it was indirectly caused by a previous disturbance associated with an earth moving machine. The pipeline was gouged and had a big dent put in it. The disturbance led to an increase in the internal pressure of the pipeline, and two weeks later the pipeline failed. The pipeline company was not aware of the damage done to the pipeline. In addition, knowledge about how a pipeline could potentially fail was inadequately transferred from the sub-contracting chain to their workforce groups (AFESAC, 2014b). One consequence of this accident has been an unofficial change in policy with the outcomes that workers now get informed about pipeline risk and how to react and behave when things go wrong. This information is placed on action cards.

The pipeline industries and pipeline regulators primarily emphasise the procedural and physical protections in managing, assessing and communicating pipeline risks (see for example: Australian Pipelines and Gas Association Ltd, 2016) (some of them discussed in Section 6.2), but the empirical evidence indicates that these controls are insufficient to protect pipeline catastrophic incidents. As an adjunct to my main research, I informally interviewed twelve people who live in a residential area near a high pressure
gas pipeline, and pass by a ‘high pressure gas main’ sign regularly. Ten of the twelve had not previously noticed the sign despite its location near the footpath they were currently using. This suggests that their awareness of pipeline risks is low. Nevertheless, eleven participants out of the twelve were aware that digging near pipelines can lead to pipeline ruptures. The concern is that if the pipeline leaks without obvious digging damage, how will the public know about the risk?

6.3.2 The incoherent knowledge of pipeline risks within pipeline industries, regulatory institutions, and other authorities

The findings indicate that not only is knowledge about pipeline risks uncommon among third parties, but knowledge of pipeline risks may also be inadequate among pipeline industries, pipeline regulators and other industries and authorities including planning authorities, transportation and resource departments, planning ministers, energy resource ministers, safety MHF regulators, independent planning panels, and developers. One of the issues raised by regulator participants is that the existence of pipelines is not well documented. The inadequacy of the pipeline database indicates an inadequacy of risk knowledge within pipeline institutions.

A pipeline patrol participant reported that along some pipeline routes, there are no signposts that normally indicate pipeline locations. The pipeline patrol had to mark where the routes were and put a new signpost in place. In addition, regulator participants said that signposts were not positioned correctly, causing incidents and creating uncertainty about pipeline management among field pipeline staff and the DBYD team. In addition, one regulator participant said that the database showing pipeline locations is not well documented, in particular with reference to those pipelines outside of the mainlines. Reflecting on insufficient knowledge of pipeline routes, the regulator was concerned that, even themselves, they do not fully comprehend a complete picture of pipeline routes. Therefore, regulators cannot inform the public about pipeline risks.

Recent information from the Australian Pipelines and Gas Association (APGA) states that the APGA has developed an Australian Pipeline Database (APD). Subsequently, APGA has offered it for use by planning authorities and other planning stakeholders (Australian Pipelines and Gas Association Ltd, 2016, p. 1). The APGA has passed
information about APD on to the Major Hazard Facilities (MHF) Advisory Committee. The MHF have been appointed to improve land use buffers around the MHF. Pipelines are being brought into consideration by the MHF Advisory Committee for developing buffer requirements (Victoria State Government & Planning Panel Victoria, 2015, p. 1). The information has been reported as being composed of the pipeline centreline and measurement length (Australian Pipelines and Gas Association Ltd, 2016, p. 1), in which pipelines outside of the mainlines may not be included. The database needs further development and improvement in order to create a complete map including pipelines outside of mainlines. Co-operation between pipeline owners and their contractual arrangements will be essential.

Similar databases are available to people outside pipelines in other countries including the USA (NH Pipeline Awareness, n.d.; No NEXUS Pipeline, n.d.; Pipeline Safety Trust, n.d.-b). The availability of databases has been influenced by catastrophic pipeline incidents, non-profit organisations, communities and families where members have died from accidents (Pipeline and Hazardous Materials Safety Administration, n.d.; Pipeline Safety Trust, n.d.-a). In addition, there are non-governmental organisations working with communities to provide information about pipeline risks to the public. Pipeline regulators in the USA have regulatory mechanisms in place that allow them to engage with and listen to the public, lobbyists, and workers, the aim being to reduce catastrophic incidents (Pipeline and Hazardous Materials Safety Administration, n.d.).

In Australia, these ‘initiatives’ have little presence as yet. The pipeline industries and pipeline regulators have not been forced to take further action to protect the public safety and provide information about pipeline risks to the public. In Australia, the pipeline industries and pipeline regulators have insisted that the knowledge of pipeline risks must not be released to the public because of the likely emotional impacts, cost and accountability.

Some commentators have asserted that there are serious pipeline failures in the USA despite the knowledge of pipeline safety available to the public. In addition, public interest groups and environmentalists do not lobby pipeline regulators. The regulator institution in the USA is the Pipeline and Hazardous Materials Safety Administration (PHMSA) (Leven, 2016).
The Australian pipeline case is different from the USA for the following reasons: the issues are not so much about lack of impact from accidents and the public in influencing regulatory initiatives; instead, authorities themselves do not fully comprehend pipeline risks. Only a few of my research participants, specifically: certain regulatory, planning and industrial participants emphasised the importance of providing information to the public. But, one regulator participant insisted, before informing the public: ‘involved authorities have to work out what risks are and understand them and know what they have to do, then you start informing people. Otherwise, when passing information, the people will ask you what the authorities are going to do about it’. Another regulator participant raised a concern about security risk if knowledge of pipeline risks is made transparent. My empirical evidence indicates that there has been a lack of regulatory mechanisms to support the roles and activities of pipeline regulators and involved authorities in taking regulatory action to protect the public. The Australian pipeline regulators and involved authorities are in a deadlock, each group playing their independent regulatory roles and actions to engage with the public and lobbyist groups.

Because of the above reasons, pipeline risks have become more complex and difficult to regulate. What has occurred is that specific knowledge about pipeline risks has become uncommon to nearly every group; not only the public, but also to the safety MHF regulators, third parties, planning authorities, independent planning panels, developers, planning ministers, and energy resource ministers. Even the pipeline industries themselves do not fully comprehend pipeline risks in terms of technical knowledge about pipeline existence. The pipeline regulators themselves have been inactive in ensuring public safety due to lack of support for regulatory mechanisms.

I argue that instead of blaming public and lobbyist inefficiency, a new regulatory mechanism platform for regulating pipeline risks must be developed. The new platform needs to establish a regulatory mechanism that offers independent support and co-operation with others to maintain public safety. In addition, it is necessary to set up new ontological stances and new accountability systems of all interested parties in order to understand and manage pipeline risks.
Conclusion

This chapter has presented how measurement length – a regulatory concept and a non-human actor has been created by human actors but has had an effect in shaping and changing knowledge and practice among human actors in an incoherent way. First, although measurement length was developed by experts (i.e. pipeline regulators and pipeline industry representatives) with good intention to prevent accidents for the sake of public safety, these experts expressed no intention to communicate knowledge about pipeline danger related to measurement length with the public. The rationales are associated with cost and accountability. The term measurement length itself is a misguided one, resulting in the obfuscation of knowledge about pipeline risk, the distortion of risk assessment, and ambiguous accountability among actors.

The effect of enacted measurement length has put pipeline regulators and industry in a deadlocked state concerning the management of pipeline risks. They have faced difficulties with efficacy in managing their physical-technical controls in attempts to regulate pipeline risks with third parties. They have also faced difficulties transferring knowledge of pipeline risk to third parties. In addition, they have faced difficulties pertinent to the limited availability of databases showing pipeline locations, in particular those outside of mainlines which are not well documented.

In the next chapter, I will discuss how knowledge and practices relevant to risk regulation have been shaped through the last relational assemblage – deregulation and energy pipeline privatisation.
Chapter 7
The influence of deregulation and energy pipeline privatisation on the coherence of power-knowledge practices

Knowledge and practices involved in the regulation of pipeline risks are produced through a web of heterogeneous relationships and assemblages created by and associated with elite-expert institutions (see Chapters 4-6). This chapter will explore how knowledge and practices in relation to risk regulation have been shaped through assemblages associated with neoliberalism, a subject that remains largely unexplored in the contemporary literature. By contrast, conventional types of risk agents are described in the integrative risk governance framework (Renn, 2008c). The risk governance framework is largely silent on how features of the institutional and regulatory environment have shaped knowledge and practices in relation to risk regulation. This chapter will explore this gap by tracing neoliberalism through empirical analysis.

Here, neoliberalism is described as a process and, following Foucault, as a rationality of governance: a way of thinking that informs the practice of governance. Neoliberalism has produced a range of discourses about government that are operationalised through specific techniques and entities (see for example: Foucault, 1991; Miller & Rose, 1990; Rose, O'Malley, & Valverde, 2006). A range of neoliberal rationalities and discourses about government including specific techniques and entities that emerged from empirical findings were explored during the research. The question of how they were enacted into a power-knowledge network that performs knowledge and practices in relation to risk regulation was put to analysis. This was done against the historical background of Australia’s energy pipeline industry.

In most cases, Australian pipeline industries were initially developed as publicly owned infrastructure prior to being privatised in the 1990s. Various discourses about government, including specific techniques and entities, emerged from the findings. They included: (a) discourses about government including deregulation and energy privatisation; (b) specific techniques including contractual arrangements, Key Performance Indicators (KPIs), red tape reduction, external auditors, and building blocks; and (c) other entities including: regulators, pipeline licensees, pipeline engineers, pipeline technicians, and the public.
This chapter begins with the introduction of existing concepts associated with neoliberalism and the discursiveness of power-knowledge, which is a primary concern of this thesis (Section 7.1). The question of what neoliberalism is, and how it is related to deregulation and energy pipeline privatisation, will be examined in Sections 7.1.1-7.1.2. Concepts of governmentality, technologies of government, conduct of conduct, and governing at a distance (or action at a distance) will be discussed in Section 7.1.3 in the context of the underlying rationality of governmentality approach.

In Section 7.2, I will analyse how deregulation and energy privatisation have been enacted into a power-knowledge network to produce risk-safety knowledge and regulatory practices in energy pipeline industries. I will ask who has been involved and how? In the last Section (7.3), the effects of the heterogeneous and interactive assemblages implicated in neoliberalism will be revealed. The following four effects that were revealed from findings egress in an unpredictable and uncontrolled way: (a) deficits of accountability; (b) the limitations of regulatory actions in mitigating pipeline risks; (c) the unavailability of knowledge of services and knowledge of risk-safety to the public; and (d) the discontinuity of knowledge transfers among pipeline companies. The effects highlight some difficulties faced by regulatory institutions that challenge existing concepts including inclusive risk governance.

In the last section, the question of how neoliberalism has created unpredictable and uncontrolled effects will be discussed. Analysis has revealed discourses involving the incoherence of knowledge and practices in the process of risk regulation, influenced by deregulation and energy privatisation. An outline of this chapter is drawn and presented in Figure 7.1.
Figure 7.1: The process of analysis and discussion of Chapter 7.

Section 7.1: This section introduces the concepts associated with neoliberalism and the discursiveness of power knowledge

Section 7.1.1 and 7.1.2 Introduces what neoliberalism is and how it is related to deregulation and energy pipeline privatisation

Section 7.1.3 Introduces the concepts of governmentality, technologies of government, conduct of conduct, and governing at a distance (or action at a distance)

Section 7.2: This section aims to tackle: how deregulation, energy privatisation and neoliberalism have been enacted into a power-knowledge network in performing risk-safety knowledge and regulatory practices in energy pipeline industries, who has been involved and how?

Section 7.2.1 Unfolding power-knowledge performativity around deregulation
Section 7.2.2 Unfolding power-knowledge performativity around energy privatisation
Section 7.2.3 Unfolding power-knowledge performativity around five forms of neoliberal techniques used in association with deregulation and energy privatisation. The five forms include:
    7.2.3.1 Contractual arrangements
    7.2.3.2 Key Performance Indicators (KPIs)
    7.2.3.3 Red tape reduction
    7.2.3.4 External auditors
    7.2.3.5 Building blocks

Section 7.3: This section aims to reveal the unpredictable effects from interactive assemblages among deregulation, energy privatisation and human entities

Four unpredictable and uncontrolled effects that emerged from findings including:
Section 7.3.1 Deficits of accountability
Section 7.3.2 The limitations of regulatory actions in mitigating regulatory risks
Section 7.3.3 The unavailability of knowledge of services and knowledge of risk-safety to the public
Section 7.3.4. Discontinuity of knowledge transferal among pipeline companies

The findings revealed will be employed to find an alternative way to improve the process of risk regulation so as to improve regulatory practice and effectiveness (regulatory outcomes) (discussed in Chapter 8)
7.1 Existing concepts of deregulation and energy pipeline privatisation associated with power-knowledge

This section starts by tracing existing concepts used in contemporary research to explore energy in relation to deregulation and energy privatisation, and its association with power-knowledge. Castree (2010) states that deregulation and energy privatisation are embodied within the neoliberalism concept (p. 1728). The question of what neoliberalism is – and how it is related to deregulation and energy privatisation in energy research – will be introduced in the following section.

7.1.1 Neoliberalism

Neoliberal theory proposes that the well-being of humans can be advanced though an institutional-regulatory system that supports free markets, free trade and private property rights (Harvey, 2007, pp. 1-2). In its bit to serve neoliberal strategies, the state has played its role in creating supportive institutional-regulatory institutions and frameworks (ibid). By contrast, state intervention in markets is avoided (ibid). Neoliberalism, as well as being perceived as the most powerful ideology in the global economy (McCarthy & Prudham, 2004; Peck & Tickell, 2002), has acted to promulgate reforms to enhance a free economy under market rules (Peck & Tickell, 2002).

The dominant criticism of neoliberalism is that it is structured around capitalist power relations that exacerbate economic inequalities. For example, neoliberal ideology serves market-fundamentalist policy and institutions (Williamson, 2000, p. 251). According to Harvey, the policy has been transformed into a system of economic rationality and management (Harvey, 2007, p. 2). Economic rationality has been used by macro-scale institutions, including the International Monetary Fund (IMF), the World Bank (WB) and the World Trade Organisation (WTO), to open up national economics to multinational corporations and global institutions (Larner, 2003, p. 509). Such a process is called neoliberal globalisation (ibid) or globalisation (Harvey, 2007, p. 2).

The dominance of neoliberalism has been widely criticised (see for example: Barry & Slater, 2005b; Gibson-Graham, 2006; Harvey, 2000; Jessop, Bonnett, & Bromley, 1990; Larner, 2006; McCarthy & Prudham, 2004; Peck, 2001; Rose, 1996a; 1999). The perspectives of neoliberal globalisation have been challenged as globalisation scripts...
(Gibson-Graham, 2006, p. 145) which need to be reconsidered in order to open up space for alternative narratives and exploration. Neoliberalism can be interpreted in the following three ways: (a) neoliberalism understood as a policy framework; (b) neoliberalism construed as ideology; and (c) neoliberalism as a rationality of governance (Larner, 2006, p. 200). Among these interpretations, the conceptualisation of neoliberalism as a rationality or way of thinking informing the practice of government – a conceptualisation drawn from Foucault’s lectures on ‘governmentality’ – is most relevant to understanding the discursive and material relations embedded in power-knowledge (ibid, p. 206) (see Chapter 2 (Section 2.1.2.3) and further discussion in Section 7.1.3). Although neoliberalism is associated with the idea of minimal government intervention, government has never really been absent but, rather, re-shapes the ways in which it seeks to govern economic arrangements (Barry, Osborne, & Rose, 1996).

7.1.2 Neoliberalism in the energy sectors

So, how does neoliberalism emerge in the energy sectors of Australia? The narratives about neoliberalism in the energy sector are similar to the dominant critique of neoliberal globalisation. To date, the research has in the main been undertaken in Australia’s energy electricity sector, not in its energy pipeline sector. The dominant criticism emerging from the energy electricity sector is that neoliberalism is negative. This critique is made, however, with \textit{a priori} assumptions, for example, the assumption that neoliberal programmes support elite institutions taking control of energy services and setting prices, detrimental to the public interest (Peters, 2012; Quiggin, 2002; 2014; Walker & Walker, 2000). Law and Singleton (2014) argue that by utilising \textit{a priori} suppositions, researchers tend to produce one singular narrative, called an ontological singularity (p. 387), that may omit unexamined and crucial discourses.

The dominant critique as discussed above regarding the Australian energy electricity industry needs to be contextualised. Chester (2015) contends that there are misleading claims about what happens after electricity privatisation regarding impacts on prices by both the pro-privatisation side and the anti-privatisation side. Such claims are based on ideological positions (Chester, 2015, p. 219). The Liberal Party, business groups and others claim that private electricity companies will be more efficient and prices will be
lower. Conversely, those against privatisation including the Labor Party and the unions, claim that prices will be higher and jobs will be lost.

In response, Chester (2015) argues that electricity prices are driven by a complex web of regulations involving human actors who are involved with regulation (e.g., the national regulator (the Australian Energy Regulator (AER)), the market operator (the Australian Energy Market Operator (AEMO)), and networks of electricity businesses including the distribution sector and the transmission sector.

Apropos of energy industries, research into pipeline industries has been limited, partly due to the invisibility of pipelines which are primarily buried under the ground. Nevertheless, some research has been undertaken, in particular, where pipelines have become more visible, including: (a) when the pipelines have exploded (Hayes, 2014; Hayes & Hopkins, 2014a); (b) when pipelines pass through more than one country (Barry, 2013; Stulberg, 2012); and (c) when pipeline construction has impacted on indigenous communities (Barry, 2013). Pipeline risks in Australia lack visibility; therefore, pipeline risks in relation to power-knowledge practices and elite-expert institutions are likely to remain undiscovered, an issue that needs to be explored. In the next section, I will discuss the existing concept of governmentality and its associated concepts.

7.1.3 Governmentality in governing pipeline risks at a distance

Traditional concepts involving hierarchies and structures of power envisage government as a monolithic state, exercising a linear and singular source of power to control the conduct of citizens. Such concepts fail, however, to capture the diversity of political rationalities, powers and actions or the complex assemblages of economics, politics, society, laws and individuals implicated in governing (Rose & Miller, 1992). Traditional concepts are misleading because political power is exercised not by a state as such but through various ‘technologies of government’ (ibid, p. 183) and different institutional arrangements to indirectly govern economics, society and individuals (ibid, p. 174). Governance needs to be understood more broadly, as the ‘conduct of conduct’, rather than being seen as the sole province of the state (Foucault, 1982, pp. 789-790; Lemke, 2002, pp. 50-51). Conduct of conduct involves authorities, rationalities, and
strategies which governments and others use in their attempts to exercise power (Rose et al., 2006, p. 101).

The form of control is diverted: control has become indirect through subtle forms of technologies of government. The terminology for this process is ‘governing at a distance’ (Rose et al., 2006, p. 89) or ‘government at a distance’ (Miller & Rose, 1990, p. 9). The government has developed technologies of government embedded in regulatory mechanisms so that they can govern ‘at a distance’ to fulfil their economic-political strategies to conduct individuals and organisations (Miller & Rose, 1990, p. 1).

The term ‘governing at a distance’ or ‘government at a distance’ has been drawn from the concept of ‘action at a distance’ (Latour, 1987, p. 219), a part of Actor Network Theory (ANT) in which science and technologies are used by scientific experts to act on spatial entities without direct contact (Rose et al., 2006, p. 89). The government (or state, or political institutions) use technologies to exercise authority, negotiate, intrigue, calculate and persuade persons, places and activities in specific practices (Rose, 1996b, p. 43).

The concepts of governmentality and governing at a distance provide a framework to explore political rationalities which underlie neoliberal programmes (see for example: Burchell, 1996; Higgins & Lockie, 2002; Lemke, 2007; Lockie, 1999; 2002; O'Malley, 1996; Ruhl, 1999). The rationality of the governmentality approach is consistent with the approach of this thesis albeit I argue that the above concepts can be overgeneralised when investigating the power-knowledge struggles of government or the public institutions themselves. I have articulated ANT, together with the concept of Foucauldian power-knowledge, to expand the understanding of power-knowledge mechanisms as influenced by neoliberalism.

This chapter investigates and maps out how neoliberal rationalities, discourses of government (i.e., deregulation and energy privatisation) and neoliberal techniques are brought into power-knowledge assemblages, and how they have performed with and shaped risk-safety knowledge and regulatory practices in the Australian energy pipeline industry. This requires questions vis-à-vis who has been involved and how. The enactment (or performing) process of deregulation and energy privatisation will be discussed in the next section (7.2).
The performativity of deregulation, energy privatisation, and neoliberalism

Deregulation and privatisation are commonly involved in debate over the restructuring of the welfare state (Larner, 2006, p. 199). What are the differences between these two discourses about government? Larner (2003) argues that the differences and relations involving deregulation and energy privatisation have been rarely discussed and explored. Not only have they been inadequately explored, but the techniques of neoliberalism used and embedded within them have also been insufficiently investigated (ibid).

Despite these criticisms, there has been no offer of an alternative theoretical-methodological approach to explore the differences or relationships between these two discourses about government. The underlying reason for this omission may be related to how neoliberalism is understood (ibid). In the main, neoliberalism is understood as a unified set of policies or a political ideology (Larner, 2006, p. 200). The relational process of power-knowledge, deregulation, energy privatisation, and the techniques of neoliberalism are absent from such understandings.

This section aims to bring an alternative explanation of power-knowledge performance (or enactment) among regulatory practices, as a performative effect of deregulation, energy privatisation, and the techniques of neoliberalism. The concepts of semiotics of materiality, ANT and power-knowledge are explored so as to investigate and map out how neoliberal characteristics and neoliberal techniques used in energy sectors are performed, and who has been involved and how?

The term performativity is explained in Chapter 2 (Section 2.2.1.2): a concise reiteration introduces this section. Law (2009, p. 150) proposes that: ‘crucial to the new material semiotics is performativity’. The term ‘performativity’ refers to: ‘the claim that enactments produce realities’ (Law, 2004, p. 162). The ongoing enactment of practices, depending on who and what crafts them, produces realities, which is what there is in the world (ontology).

The ontological perspective of ANT is performativity. Following the importance that ANT places on non-human entities as equal to human entities (Latour, 1992), subtle economic-technological assemblages used in association with deregulation and energy were revealed through empirical investigation. I have formulated a new approach that
follows both non-human and human in performing risk-safety power-knowledge and regulatory practices, also revealing other assemblages in the process.

Here I call the process of performativity of assemblages in the power-knowledge network the translation process of neoliberalism. The translation process is defined as ‘the continuity of displacements and transformations’ of entities and their relations in the process (Callon, 1986, p. 223) (see Chapter 2, Section 2.2.1.3). The translation process is a political process (Barry & Slater, 2005a, p. 9) by which ‘we understand all the negotiations, intrigues, calculations, acts of persuasion and violence thanks to which an actor or force takes, or causes to be conferred on itself, [the] authority to speak or act on behalf of another actor or force’ (Callon & Latour, 1981, p. 279).

The translation process involves the method of following and analysing assemblages to the extent that effects are revealed. As a consequence of using this method, I was able to conceptualise how power-knowledge relationships associated with neoliberalism and the shaping of regulatory knowledge and practices were performing.

### 7.2.1 Deregulation

Deregulation is considered as one of the characteristics of neoliberalism. The majority of arguments centring on neoliberalism involve the impacts of energy privatisation. Little attention is given to deregulation. So, what is deregulation? According to Castree (2010, p. 1728), deregulation is the process of removing or reducing regulatory intervention to increase the ‘freedom of choice’ for energy firms and consumers. The findings herein indicate that deregulation contains diverse forms irrespective of the ‘freedom of choice’ (discussed further in Section 7.2.3). Different forms have continually been initiated over time to leverage the financial and human resources of pipeline regulators (or technical regulators). Analysis of interviews indicated that some forms of deregulation were employed as part of government-industry functions even before the energy reforms in the 1990s. For example, some participants (regulators and pipeline consultants) stressed that contractual arrangements, as one of the forms of deregulation, have been employed by the government since pipelines were first introduced in Australia, as well as during the processes of gas discovery and exploration. Gas was not able to be commercialised or serviced without strong support from government. This policy extended to owning and managing gas pipelines, as well as
facilitating land access and supporting gas consumers (Kimber, 2009, p. 1). Nevertheless, deregulation has continued until the present throughout the neoliberal process.

7.2.2 Energy privatisation

Energy pipelines in Australia were involved at the start of the privatisation process in the early 1990s (Productivity Commission, 2009, p. 185), promoted by the Organisation for Economic Cooperation and Development (OECD) (Organisation for Economic Cooperation and Development, 2003). Privatisation was a key component of economic reform among the OECD countries (ibid, p. 3) and Australia was one of the leading countries that advanced privatisation among the OECD countries (Kain, 1996).

The process of energy privatisation involved legal and forced changes in energy institutions, both public and private organisations, and in managing energy sectors (Productivity Commission, 2009, pp. 185-186). The process has transferred the management and assets of the energy sector from public hands to privately owned firms (Organisation for Economic Cooperation and Development, 2003, p. 19). Privatisation policies aim to increase energy competition, promote efficiency through private ownerships, and decrease government’s burdens in regulating-managing energy sectors (ibid).

The contemporary literature emphasises that the pressure for neoliberal reform in energy privatisation was influenced by active external institutional forces at the macro structural level. In the 1990s, these included the OECD, development banks and international trade agreements. Interviews conducted during this research indicated that energy pipeline privatisation was enacted as part of a network effect with no boundaries among macro, meso and micro structures. Energy pipeline privatisation did not occur in isolation through macro structural reform but was concomitant with a need from the Australia states and federal government to gain additional revenue to balance budgets and reduce debt (Kimber, 1996, p. 3; Organisation for Economic Cooperation and Development, 2003, p. 8).

The findings revealed that the neoliberal concept in relation to energy pipeline privatisation was performed as part of government-industry functions before and
throughout the neoliberal reforms of the 1990s. A regulator participant emphasised that pipelines have never been the interest of governments alone. While pipelines may have been owned by the public sector, they have been outsourced and managed by private companies through a form of sub-contracting of construction, operation and maintenance. The form of contractual arrangements is embedded in the neoliberal concept of deregulation and privatisation. In addition, state governments and pipeline industries have been dependent on each other since gas was discovered, reliant on licensing and contractual arrangements with the state governments (Asher, 1999, p. 2).

The process of investigating the performativity of energy privatisation has revealed complex relations between the public actors and economic institutions. Energy privatisation has been associated with changes in pipeline ownership, the restructuring of institutional arrangements, and legislative action at national, state and local levels. These processes drive reforms in relation to selling, buying and regulating energy pipelines (see example in Figure 7.2).

Pipeline consultants contended that the process of transferring pipeline ownership had been confusing and messy. The process of transferral involved heterogeneous actors, aspects and arrangements including commercial, financial, regulatory, technical safety and institutional arrangements. The Council of Australia Government (COAG) – mandated to drive economic reform across all sectors of the Australian economy given a lack of national or state codes of practice or legislation to regulate the pricing of services such as energy – has played a major role in the reform process. In addition, the Australian Energy Market Agreement (AEMA) was set up to establish a legislative and regulatory framework for Australia’s energy markets. The AEMA established two institutions to oversee the Australia’s energy market including the national Australian Energy Regulator (AER) and the Australian Energy Market Commission (AEMC). The AER’s role is to monitor and enforce national energy legislation. The AEMC undertakes energy market development. The summary of economic-national regulation and national market institutions, established to drive energy privatisation, appears in Table 7.1 and Table 7.2.
Table 7.1: Summary of national regulation.

<table>
<thead>
<tr>
<th>Regulations</th>
<th>Details of regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Energy Market Agreement (AEMA) (2004)</td>
<td>An agreement between the Australian, state and territory governments to set the agenda for a transition to national energy regulation as part of the National Energy Market (NEM)</td>
</tr>
<tr>
<td>National Gas Law (NGL) (2008)</td>
<td>The NGL replaces the Gas Pipelines Access Law and the National Gas Code. The NGL established the enforcement framework and obligations surrounding access to gas pipelines and the gas market bulletin board. The gas market bulletin board is a website that facilitates trade in gas and pipelines by providing information on the state of the gas market, system constraints and market opportunities. The NGL is applied by state and territory legislation in New South Wales (NSW), Victoria (VIC), Queensland (QLD), South Australia (SA), Tasmania (TAS), Australian Capital Territory (ACT) and Northern Territory (NT). Western Australia (WA) is not covered under NGL.</td>
</tr>
<tr>
<td>National Gas Rules (NGR) (2008)</td>
<td>The NGR are enacted under the NGL, dealing with the details of the access regime and bulletin board.</td>
</tr>
</tbody>
</table>

Table 7.2: Summary of market institutions of key relevance to the national energy market.

<table>
<thead>
<tr>
<th>Institutions</th>
<th>Details of institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Policy</strong></td>
<td></td>
</tr>
<tr>
<td>Council of Australia Government (COAG) (established in 1992)</td>
<td>The COAG was established to drive economic reform across all sectors including energy.</td>
</tr>
<tr>
<td>Ministerial Council on Energy (MCE) (established in 2001)</td>
<td>The sole government institution for initiating and developing Australia’s energy market policy reform for consideration by the COAG. In addition, the MCE’s role is to monitor and oversee the implementation of energy policy reform, agreed to by the COAG.</td>
</tr>
<tr>
<td><strong>Rules development</strong></td>
<td></td>
</tr>
<tr>
<td>Australian Energy Market Commission (AEMC) (established in 2005)</td>
<td>The AEMC is responsible for the rule-making process under the National Gas Law and making determinations on proposed rules and market development in the National Energy Market (NEM). The AEMC is funded by the states and territories that are party to the AEMA.</td>
</tr>
<tr>
<td><strong>Regulator and market operator</strong></td>
<td></td>
</tr>
<tr>
<td>Australian Energy Regulator (AER) (established in 2005)</td>
<td>The AER enforces the National Gas Law and Rules and regulates covered gas transmission and distribution pipelines (except in Western Australia state). The AER is fully funded by the Australian Government.</td>
</tr>
<tr>
<td>Australian Energy Market Operator (AEMO) (established in 2009)</td>
<td>The AEMO merged the roles of the National Electricity Market Management Company (NEMMCO) with the gas market operators in NSW, ACT, QLD, Vic, and SA to form a single, industry-funded national energy market operator for both gas and electricity including pipelines. In addition, AEMO is responsible for the operation of the gas bulletin board.</td>
</tr>
</tbody>
</table>


This thesis emphasises the grounded empirical context where human and non-human assemblages enact through networks and change over time. This section draws upon an
example of a complex assemblage involving contractual arrangements (see Figure 7.2 and 7.4). For example, one pipeline can be owned by different entities across different geographical levels: either by an international corporation, a national or local company, a bank, a state or a combination of them.

The primary concern of this chapter is to explore how changes in the transferral of pipeline ownerships and restructured institutions have influenced risk-safety knowledge and regulatory practices in energy pipeline industries. It is important to note that due to time constraints and the nature of my research, I did not explore all of the entities, in particular, the international entities and some of the national entities. Nevertheless, I explored the flow of key actors from international to national and local entities through the contractual arrangements of pipeline owners, operators, facilitators and subcontractors of pipelines.

![Diagram of contractual arrangements](image)

**Figure 7.2: An example of the complex assemblage through contractual arrangement**

Note: The Figure is drawn from interviews.

### 7.2.3 Other neoliberal forms or techniques

Some of the neoliberal techniques were revealed in earlier sections. In this section, I will identify the specific techniques and instruments through which deregulation and privatisation were operationalised.

#### 7.2.3.1 Contractual arrangements

Participants (i.e. regulators, industrial employees and a regulatory expert) identified that the contractual arrangements have created stewardship complexity among owners,
operators and their contractual chains. The contractual arrangement has resulted in a deficit of accountability in regulating-managing pipeline risks (discussed further in Section 7.3). For example, pipelines could be owned by an international company, an Australian company, a bank, a state, or a combination of these. The owners of pipelines and the pipeline operators (the companies that operate pipeline facilities), can be different. The owners of pipelines can subcontract their operation and maintenance work to operators. The operators can subcontract their work to the facilitator, who carries out some administrative work. The facilitator then employs other companies as subcontractors to do the operation and maintenance work. The pipeline companies outsource their work to contractual chains. This situation is typical because pipeline owners cannot manage all their work due to inadequacies of technical skill and competency. Nevertheless, risk still intrudes and the question of who will be responsible when pipeline failures occur may be difficult to answer.

The contractual arrangement of pipelines across Australian states can be very sophisticated. There are approximately 400 onshore pipeline licenses in Australia (Australian Pipeline Industry Association Ltd, 2014). Each pipeline license has a different structural arrangement. However, the information, about who owns what and how is not readily available to the public. Only regulators and pipeline industries can easily access that information. I was not given access to it, despite requesting access during an interview session. Nevertheless, based on the available evidence, an illustration of stewardship complexity is drawn in Figure 7.2.

### 7.2.3.2 Key Performance Indicators (KPIs)

With the burgeoning of contracts defining relationships between organisations, business has turned attention to how to define the success of various undertakings in order to be able to link success to economic reward. A common way to address this is to define the required outcomes in the form of Key Performance Indicators (KPIs). KPIs are largely employed among hazardous industries, articulated within the safety literature (see for example: Hayes & Hopkins, 2014b; Hopkins, 2008; Hopkins & Maslen, 2015) including pipelines. Nevertheless, the KPI practice, as a neoliberal technique, has rarely been addressed (Larner, 2003, p. 511). The pipeline companies and their contractual chains use KPIs to measure performance in relation to cost, incentives, productivity and efficiency. The KPIs are enacted in the contractual agreement and so reflect what is
important. The temptation, therefore, is to assume that KPIs represent everything that must be attended to, including safety.

A regulator participant commented that contracts were likely written for high productivity, not for regulatory-technical competency. KPIs are not about doing quality work but about cost efficiency using indicators such as number of jobs, volume of work, number of calls answered, and the number of things responded to. In addition, interviews indicated that the use of KPIs is primarily related to financial repercussions and the level of incident failures. In the case where a subcontracted company has a lower level of incident failures (not about the partial loss of pipeline containment or loss of containment), subcontractor companies will not report to the company that contracted them or to the regulators because they are concerned about losing their contracts. As a regulator participant said: ‘this is synonymous in safety everywhere’ under the contractual arrangements. KPIs have been employed to obscure the comprehension of incident failures and safety accountability. For example, from a regulator participant’s perspective, the lower number of incident failures are important in order to show there is monitoring and effective management of controls over incidents.

Due to the KPI rationales among pipeline owners and their contractual chains, the findings suggested that the quality of maintenance and operations on pipelines was being compromised. The deficiency of KPIs in relation to contractual arrangements has been acknowledged by both regulator participants and industrial participants. Some pipeline companies have rethought and attempted to take some work back from their contractual chains so that they can have more control and keep improving their in-house skills and knowledge.

The contractual arrangement has become a loophole in the technical regulations pertaining to pipelines. The regulators primarily deal with licensees or pipeline owners. Regulators do not have adequate time, financial resources, technical skills, or technical capacity to check through the actions of pipeline contractual chains.

7.2.3.3 Red tape reduction

The term ‘red tape’ refers to excess bureaucracy and regulation that increases the cost of business activities (Mazzarol, 2012). Red tape reduction has been used globally to ease
the practice of business (The World Bank, 2016). Red tape reduction was an important neoliberal technique emerging from interviews. Red tape reduction has been used to alleviate the regulatory burden on business from Australian regulations (Productivity Commission, 2009). Although the policy on red tape reduction was a particular focus on the Australian government for the period September 2013 to September 2015, a review of the literature indicates that the red tape reduction was employed earlier than 2013-2015. It was used in the 1990s as part of the process of energy reform (Productivity Commission, 2009), initiated irrespective of political affiliation. Its purpose was to enhance regulatory consistency across Australian states and the Commonwealth (ibid, p. iv-v). For example, a risk-based approach was proposed to assist regulators to reduce compliance costs for firms (Commonwealth of Australia, 2014, p. 13). The findings suggested that a risk-based approach is used to leverage resources and negotiate power-knowledge between pipeline regulators and pipeline companies (see Chapter 5, Section 5.2).

Red-tape reduction is commonly understood as a neoliberal term for one way to reduce the regulatory burden. This attitude to regulation, that it is a ‘burden’ on industry, impacts regulatory practice in other ways. Nevertheless, the question of what techniques are used in relation to red-tape reduction within pipeline regulatory agencies has been under-addressed. Examples include reduced resourcing levels within regulatory agencies and increased use of external auditors (discussed in Chapter 4, Section 4.2.2.6 and later in this chapter, in the next section).

One OHSE manager indicated that the number of regulators was reduced as a result of red tape reduction during the 2013-2015 period. Resource limitations are a typical problem for regulators; but, the red tape reduction renders the inspection process more risky. Regulators have indicated that they would like to obtain more resources. But, the following question is raised: who is going to pay for that?

Some regulators appreciate the red-tape reduction approach. They agree with the red tape regime’s scope because it helps them to target outcomes more than the process. Some regulators felt that red tape reduction has allowed them to engage and negotiate more with industries instead of using penalties or the force of sanctions. The question is: how do regulators know whether pipeline risks have been properly regulated if they
have not maintained a sufficient level of inspections as part of the process of risk assessment throughout the regulatory system?

7.2.3.4 External auditors

The utilisation of external auditors is another neoliberal technique, embedded within the risk-based regulatory practice of AS2885. It has been described as part of a light-handed approach to regulation, favoured by both regulator and industrial participants. Regulators have employed the light-handed approach to leverage their resources, capacity and accountability. In light-handed regulation, firms are pursued with less action and intervention from regulators. Regulators are unlikely to go out to inspect pipeline companies’ activities and they avoid approving pipeline companies’ safety documents. The approval process is associated with accountability. Without approval, regulators do not share accountability when something goes wrong, leaving pipeline licensees accountable. The onus is then on pipeline companies to do the right thing and convince regulators that pipeline companies have got safety systems in place that work reliably and safely.

External auditors are employed in some Australian states. Despite the benefits of light-handed regulatory practices, there are some drawbacks according to participants both regulators and industrial participants. Some concerns regarding external auditors are related to conflicts of interest because external auditors have been paid by pipeline companies, as required by regulators in some states. For this reason, one regulator and a minority of pipeline industry staff have commented that external auditors and pipeline companies may misrepresent risk by manipulating the inspection report. More importantly, there has been no process of intervention from third parties to monitor the relationship among regulators, external auditors, and pipeline industries. Some external auditors commented that the quality of external auditors can vary and their suggestion is that it may be best for regulators to employ their own auditors but paid by the pipeline companies.

7.2.3.5 Building blocks

A building block is one of the neoliberal-economic techniques employed to forecast the cost of services over a regulatory period (Asher, 1999, p. 18). How the technique is
associated with safety practice in pipelines is underexplored in the existing literature on risk, safety and regulation. This section will begin by defining building blocks before analysing their relationship with safety-regulatory practice.

Generally, a building block is a technique used to calculate the maximum allowable revenues (MAR) of pipeline companies. The MAR are the prices or revenues that pipeline companies are allowed to collect. Should they collect more than the specified amount of revenue each year, they are obliged to call in economic regulators.

MAR is the sum of the return on capital, the return of capital, and operating and maintenance expenditure. The depreciation and returns are calculated over the life of the pipeline assets. The building block is presented as the following equation:

\[
MAR = \text{return on capital} + \text{return of capital} + \text{operating and maintenance expenditure (O&M)}
\]

\[
MAR = (WACC \times WDV) + D + O&M
\]

where

- \( WACC \) = weighted average cost of capital
- \( WDV \) = written down (depreciated) value of the asset base
- \( D \) = depreciation allowance
- \( O&M \) = operating and maintenance expenditure (including administrative costs)

Considering the definition and the economic equation, as described above, the discourse of safety-regulatory practice in relation to the building block is relatively absent. Evidence from interviews indicated that the majority of technical regulators, with few exceptions, do not acknowledge the influence of the building block and its calculative practices on safety-regulatory practice.

The building block was sarcastically explained by a technical regulator participant, who had a background in economics, as ‘very simple accounting’. It is ‘depreciation, return and your operating costs’, but it is misused. The cost that has been negotiated among economic regulators, technical regulators and regulatees is the cost based on operating and maintenance costs. Some commentators have pointed out that economic regulators are not interested in setting the operating and maintenance expenditure forecasts (Asher, 1999, p. 19). Economic regulators can introduce the operation and maintenance costs as an unnecessary regulatory risk (ibid, Fletcher, Kimber, & Venton, 2004, p. 2). In
circumstances where the cost of operation and maintenance is necessary, according to economic legislation under privatisation reform, economic regulators can pass the cost on to users, consumers or the public.

The interviews with pipeline regulators showed that economic regulators and technical regulators work independently in regulating pipeline industries – rarely cross-checking each other’s work. The majority of technical regulator participants pointed out that they have never suffered intervention by economic regulators.

An issue around cost-cutting in pipeline maintenance work manipulated by economic-regulatory practice was alluded to by an integrity engineer, who said that some assets may be sold because of unprofitability. In these cases, the new owner may try to make an asset more profitable by deliberately cutting costs on maintenance of the asset.

A number of participants insisted that cost-cutting on safety management could occur in both direct and more subtle ways, and at least one regulator participant stressed that it did not necessarily occur through deliberate manipulation of the building block framework. In other words, the relational assemblages in which building blocks, cost-cutting and safety are enmeshed can go unacknowledged by regulatory institutions.

The safety cost was explained by a manager of a sub-contractor company as a ‘hidden’ cost with no money allocated to it:

> Safety is something that’s always absorbed into people’s businesses, no-one quotes for a job and says it’s going to cost you $20,000 to build this and I’m going charge you another $5,000 for safety stuff, it’s not written anywhere, no-one ever sees it, it’s very hidden, so it’s hard to justify it and everyone fits it into their business somehow, they cost it out in their budgets and it all gets fitted in.

The question is: how do regulatory inspections assess safety and the potential for cost cutting when these are treated as ‘hidden costs’ in contractual arrangements and how is this practice of treating them as ‘hidden costs’ related to the building block framework managed by economic regulators? There is no process of intervention to check either the hidden costs or the interventions of economic regulators in technical regulators. Thus, the knowledge and practices in regulating pipeline risks and maintaining public safety could be incoherent between economic regulators and technical regulators.
More importantly, the analysis above has shown economic regulation to be its own black box. While the full impact of this black boxing cannot be determined from this research, it can be suggested that the process hides the cost of safety and provides incentives to keep this cost as low as possible. This does not mean, however, that pipeline companies will necessarily underinvest in safety. Rather, what it does mean is that the regulatory system does not have a clear process in place to ensure safety expenditure is adequate.

7.3 Complex stewardship structures: the unpredictable and uncontrolled effects of neoliberalism

On the surface, the concepts of governmentality, conduct of conduct and governing at a distance might be used to comprehend the empirical findings of this chapter. For example, deregulation, energy privatisation and neoliberal techniques can be summarised as ‘technologies of government’ (Miller & Rose, 1990, p. 1). Technologies of government are an aspect of economic-political rationality relevant to the concept of governmentality. They are a diverse set of regulatory mechanisms employed by government to indirectly conduct individuals and organisations (ibid). Regulatory mechanisms are employed by governments so that they can attempt to govern at a distance to fulfil their political-economic strategies aimed at controlling individuals or organisations (Miller & Rose, 1990, p. 1).

This pipeline case, nevertheless, is different. Interviews of regulators and industrial participants have revealed effects from assemblages associated with neoliberalism. The effects indicated the difficulties that regulators and pipeline companies face when managing pipeline risks. The effects have shaped knowledge and practices in the process of risk regulation. Four of the effects that emerged from the interviews are performed as consequences of the complexity of stewardship structure including: (a) deficits in accountability (discussed in Section 7.3.1); (b) regulatory actions in mitigating pipeline risks (discussed in Section 7.3.2); (c) the process of knowledge distribution and services to the public (discussed in Section 7.3.3); and, (d) the process of knowledge transferral among pipeline engineers and pipe line technicians (discussed in Section 7.3.4). These issues were identified by both regulators and industrial participants.
My research indicates that the effects of neoliberalism are performed in an unpredictable and uncontrolled way. Unpredictable outcomes affect not only individuals and the public but especially public institutions and pipeline companies. Where regulators have become inactive in dealing with the effects of neoliberalism, public institutions are in a situation of uncertainty in relation to the adequacy of regulatory strategies that rely on ‘action at a distance’ (or ‘governing at a distance’). Public institutions now face higher levels of unpredictability in relation to the control of risk due to the precarious regulatory regimes they have built around the rationality of neoliberalism.

7.3.1 Deficits of accountability

So, are the deficits of accountability a consequence of contractual arrangements? Analysis of interviews as part of this research revealed that these consequences can lead to situations where nobody is accountable if pipeline failures occur. However, according to law, some parties are always legally accountable including technical regulators and pipeline licensees. This is because contractual arrangements involve a complexity of stewardship structures of pipelines among owners, operators and their contractual chains (referred to in Section 7.2.3.1, and Figure 7.2). Some technical regulators acknowledged such complexity: others did not.

I asked the question: who will be responsible if there are pipeline failures? Both regulators and industrial participants insisted that the ‘licensee’ will be responsible based on the extant laws. I subsequently traced, analysed and then asked the questions: what is a licensee and does the definition by law refer to the complexity of pipeline stewardship structures? The findings indicate that the term ‘licensee’ is incoherent among regulations across Australian states and the 2007 AS2885 revision. For example, according to the AS2885 revision definition, a licensee is:

1.6.27 Licensee

The organization responsible for the design, construction, testing, inspection, operation and maintenance of pipelines and facilities within the scope of this Standard. The Licensee is generally the organization named in the pipeline licence issued by the Regulatory Authority (Standards Australia, 2012a, p. 14).
According to the definition above, the licensee is an organisation under the regulatory authority within each state. The definition of licensees has been widely debated by regulators and pipeline companies, in particular, by those who have been involved in the Australian Pipeline Standard AS2885. The question of who the licensees are can become ambiguous when the ownership structure is made more complex through contractual arrangements. The companies who own the pipelines are not always the companies who operate the pipelines. The debate has resulted in changes to the definition of licensee during the AS2885 revision in 2013. The term has been amended in 2015 to:

1.5.4 Licensee

The entity that the regulatory authority holds accountable for the pipeline.

NOTES:

1. The Licensee may or may not be the pipeline owner and may or may not be a licence holder under legislation.

2. The Licensee may be a different entity at different points in the pipeline life cycle from design through construction to operation and abandonment (Standards Australia, 2015, pp. 1-2).

While the new definition is more flexible than the earlier version, it is also more open to opportunity for debate or change. Although regulator participants emphasised that licensees will be responsible if a pipeline explodes due to their duties as defined in legislation, the new definition can become ineffective under a realm of stewardship complexity, for example, where deregulation and energy privatisation hold sway. Licensees can become muddled as a result of the complex structure of pipeline ownerships where the owners of pipelines can be an international corporation, a bank, a local company, a state, or a combination of these.

The increasingly complex structure of pipeline ownerships leads to a strategy of ‘risk shifting’. This concept describes a situation where the responsibility of employers is shifted to those at the bottom of contractual chains: subcontractors and workers who are assumed to carry out actions to ensure safety because of concern about their own safety (Gray, 2009, p. 327). Regulators have failed to proceed with legal prosecution to mandate employer responsibility because regulatory frameworks and enforcement are
not sufficient for multi-tiered contracting arrangements (Quinlan, Hampson, & Gregson, 2013, p. 285). The concept in one sense can describe the case that has emerged from this thesis. For example, based on the empirical findings of this thesis, interviews indicate that international corporations and banks can exercise attitudes and strategies when doing business and considering issues of risk and safety that are different from what authorities expect. They may not respect local laws and authorities. More importantly, technical regulators cannot prosecute international companies who own pipelines but technical regulators can prosecute anyone within their own state.

Apart from the inability to prosecute international companies, some of the regulator participants insisted that if anything goes wrong, they will be unable to deal with any of the contractual chains of licensees as some of the contracts are not enforceable by law. Based on participants’ (regulators, industrial staff and a regulatory expert) observations, when catastrophic incidents involving hazardous industries have occurred, the owners usually pass the responsibility on to contractors and subcontractors, even though by law safety responsibility cannot be contracted out. It may be that the deficits and complexity of accountability and legislation will only be revealed in public when a catastrophic incident occurs.

The technical regulators are unable to govern effectively at a distance when regulating pipeline risks due to the complexity of pipeline stewardship structures. A regulator expert stated: ‘this is going to be a whole new thing in terms of risk’. This whole new thing in terms of risk has a cause. The deficits of accountability are more complex, uncertain and ambiguous beyond what Renn (2008c, pp. 74-78, 165) delineates in terms of risk characteristics in his concept of integrative risk governance. Risk characterisation is classified on the basis of technical types of risk agents. The types of risk agents include technologies, nature, and environment (including nuclear energy, dams, large-scale chemical facilities, earthquakes, Genetic Modified Organisms (GMO), nanotechnology, volcanic eruptions, new infectious diseases, and climate change) (ibid). Risks instigated by neoliberalism in relation to energy are beyond the scope and cannot be applied in the direct approach of risk governance. Risk governance, therefore, needs to take account not only of the types of risks involved, but also of the institutional and regulatory environment in which governance is enacted.
The consequences of stewardship complexity lead not only to deficits in accountability, but to intervention in risk-safety knowledge and practices throughout regulatory processes, discussed in the following sections (Section 7.3.2 to 7.3.4).

### 7.3.2 The limitations of regulatory action in mitigating pipeline risks

The findings showed that regulators have faced difficulties in mitigating risks as indicated by unpredictable effects and influenced by neoliberalism. In particular, difficulties have occurred between interconnected pipelines where two state authorities are involved in managing one interconnected pipeline under a complex stewardship structure. For example, a pipeline is owned, operated, and maintained by companies located in different geographical locations. The owners of pipelines are in one state and the operators, as well as contractors and subcontractors are in another state (Figure 7.3).

![Figure 7.3: Illustration of one interconnected pipeline located between two state authorities under a complex stewardship structure.](image)

The difficulty is that regulators in each state have different requirements; nevertheless, the operator only wants to follow one state, not the other. The reason is relevant to cost and conflict of interest. As one participant regulator stated:

> probably because it is cheaper…that would be one of the reasons why they wouldn’t want to comply, if it’s more expensive, when I say more expensive, it depends on the size of the operation or what would be required to upgrade say the pipeline to meet the requirements. If they change the technical specifications, how do you upgrade a pipeline? Do you replace it? I mean it might be something literally as the pipeline’s got to be replaced every x years or something. I don’t know about gas pipelines, how long they last for. I imagine they last for quite some time. But presumably you’ve got
to do constant checks to make sure you haven’t got leaks and all that sort of thing. Now if the requirements of [one state] are more rigorous than [the other] they’d be more expensive to implement. It’s a conflict of interest.

The discussion of this issue is illustrated by using a diagram, illustrating a contractual chain (Figure 7.4).

![Figure 7.4: Illustration of a contractual chain.](image)

Regulators have faced difficulties in accessing information about operation and maintenance work when the pipeline crosses the border between states. Regulators face less difficulties when the owner, the operator and their contractual chains are located in one state; or, when the owner, the operator and their contractual chains are in a different state but owned by the same company. When the structure of ownerships is complex and where a pipeline is owned, operated and maintained by different companies and located differently in two states or more, the situation becomes what I term ‘precarious conduct of conduct’.

When regulators have to deal with the mess of stewardship complexity in a pipeline, regulators have difficulties accessing information about operation and maintenance due to manipulative strategies employed by companies under the complex structure. Companies can make the information unavailable, uneasy to access, or it may take a long time. Although the information may be finally presented, that can be too late to prevent pipeline accidents or explosions. This is an example of a precarious regulatory
regime. The government has become ineffective in using their own technologies of government, shaped through neoliberalism.

7.3.3 Knowledge about services is unavailable to the public

A regulator participant commented on the monetary charge for providing the information (requested by regulators) about the operation and maintenance of pipeline companies:

If I apply to [Company E] they don't own the information, they have to apply to [Company D] who then have to apply to [Company F] to supply that information. Every time that you apply for something that contractor will put a charge on that cost of retrieving that information. Company F, they will charge [Company D] and then [Company D] will put a charge back to [Company E]. So every step there’s an 18% charge.

The above interview emphasises that the complexity of contractual arrangements leads to a ‘gouging’ process where each company within that complex structure takes advantage of the other (Figure 7.4). The charge is usually debited to customers as indicated by a regulator participant:

It’s called the deregulation of the energy industry and what they’re saying is consumer pays, but the way the companies are being structured, they’re paying a far higher cost in price for the consumable goods or the services they’re receiving through indirect management structure.

A regulator participant indicated that each company demands profit rather than delivering best services to consumers, the public or users. Such ‘gouging’ has been a normal practice since well before the neoliberal reform of the 1990s and has continued until the present throughout the neoliberal process. A regulator participant stated:

Yeah, it’s quite commonly referred to in the industry as gouging. What it does is an entity such as ... any entity, it’s like the old pyramiding system which was outlawed in the 80s where you pay a certain amount of money to one person, they pay a certain amount to another person and instead of a service costing $100 it ends up costing $350 for a very simple service. So the consumer is getting ripped off.
The public, consumers or users are those who pay for the additional cost. For example, a regulator participant said that when customers face problems related to cost or maintenance issues (for example, when the gas has been cut off or needs to be fixed) they lack information about which institutions can provide a solution. The customers do not know who to talk to. In addition, the company can charge for the service provided without telling the customers what they are paying for. At the same time, the customers do not ask about those costs because the additional cost has been made a normal practice by the technologies of government.

The problem is that there is no regulatory mechanism available to intervene in the gouging process (see Section 7.2.3.5). The regulators and the government are in a situation involving a precarious regulatory regime or a situation of precarious conduct of conduct wherein they cannot control the effects of stewardship complexity. In addition, together with limited financial resources, limited human resources and time constraints, regulators do not inspect throughout the contractual arrangements. In sum, the regulatory knowledge and practices are shaped by an effect of stewardship complexity which is performed through the process of neoliberalisation.

7.3.4 Discontinuities of knowledge transferral among pipeline companies

In addition to the public and public institutions, pipeline engineers and pipeline technicians also face difficulties in accessing and knowing about risk-safety knowledge. The complexity of stewardship structure through contractual arrangements has shaped a series of deficits of safety knowledge transference.

7.3.4.1 Risk-safety knowledge has been lost during the hand-over to new owners

Although in minority, a number of experienced regulators and industrial participants reported that knowledge in relation to risk and safety was lost when a change of ownership occurred. This occurred prior to the pipeline reforms in the 1990s, and happened after the pipeline system was built by a contractor company and handed over to government. In addition, there have been cases where pipeline ownership has changed through several owners over time. A technician working in that pipeline contended that procedures and documents have been left by the wayside and old safety
procedures were not saved. The technician was assigned to re-write the procedures as the relevant documents had been lost. Thus, he was tasked with the job of finding who had used that equipment and writing it up from scratch.

**7.3.4.2 Discontinuities in transferring safety knowledge between pipeline engineers and pipeline technicians**

Gas pipelines cover long distances. The companies and the structural divisions are diverse and located in different locations. For example, one pipeline may have several pipeline stations and control office centres (see Figure 7.5). Certain industrial participants, who manage the operation and maintenance on-sites, emphasised that they did not have engineers they can consult on-site. The pipeline technicians rely on the on-site manager’s knowledge (not engineers with educational training). A manager who works in a subcontracted company revealed that previously there were engineers on-site with whom they could share knowledge. The situation has changed towards one of higher risk.
In association with the discontinuation of the transfer of knowledge between pipeline engineers and pipeline technicians, another problem was raised during an interview with a technician participant. He said that apart from having good engineers on site, he would prefer to have another technician who could co-work and double check his job and co-make decisions with him. The technician worked on-call; and on one occasion had to fix a compressor station by himself in the middle of the night. He personally considered a compressor station a complex piece of equipment, dangerous and expensive. The case not only involved a discontinuity of knowledge transfer between engineers and technicians, but also involved a lack of sharing of risk-safety knowledge and responsibility in relation to costs and management.
7.3.4.3 Knowledge is not shared among pipeline technicians and training systems lack structure

Analysis of the interviews in this research indicated that the training system became less structured after energy privatisation. Because of the complexity of the stewardship structure, new technicians and potential managers of operations and maintenance have been assigned to learn through an online system, as a result of resource constraints related to the geographical landscapes of companies. There has been little interaction with trainers and others. In addition, when technicians, who work on a field site have a problem, they rely on the knowledge of their senior peers. The industrial participants suggested that some of the ‘senior staff’ did not have much experience due to a high turnover within pipeline companies. Thus, some of the ‘senior staff’ who had been assigned to train the new staff had been working for the company for only a few years. One technician participant admitted that he had not mastered pipeline knowledge and that he himself was still learning. In addition, one field manager indicated that technical-pipeline knowledge was not shared between different sites in the same company. The reason was that the company had been in a transitional period of handing over pipeline assets and was restructuring pipeline management.

In sum, the structure of contractual arrangements (as an effect of the neoliberal process of deregulation and energy privatisation) has led to deficits in the transferral of safety knowledge between pipeline engineers and pipeline technicians and between pipeline technicians themselves. Such deficits, together with the limitations of online training systems and cost constraints, may lead to greater risk and catastrophic pipeline accidents.

A question is that we do not know how many companies have faced this kind of situation. In addition, with limited resources and capacity, regulators have become incapable of checking through the entire process. This is another situation of precarious conduct of conduct, or uncertainty of governing at a distance: regulators are bound to precarious regulatory regimes. In the process, both technologies of government and regulators have been made less capable of regulating pipeline risks.
Conclusion

Neoliberal reforms that have proliferated since the late 20th century have had major impacts on the regulation of energy pipelines. The projects of privatisation and deregulation have been operationalized via a number of techniques and entities including contractual arrangements, KPIs, red tape reduction, external auditors, and building blocks, technical regulators, economic regulators, pipeline licensees, engineers, operators, technicians, contractors, and subcontractors. However, while the broad thrust of these reforms is to encourage government ‘at a distance’, several factors hamper the ability of regulators to regulate effectively. As part of neoliberal reforms, deregulation and energy privatisation have been aggravating factors, creating new types of risks. The new types of risks are less predictable and controllable by regulators, including: (a) deficits of accountability; (b) limitations of regulatory action in regulating pipelines; (c) limitations in public knowledge about additional costs charged for consumable goods or services, about which institutions they can approach for advice, and about the appropriate steps to take for repairs when the gas has been cut off or requires fixing; and (d) discontinuities in risk-safety knowledge transfer between pipeline engineers, pipeline field managers and pipeline technicians.

Accountability has been made ambiguous as a result of stewardship complexity from contractual arrangements through deregulation and energy privatisation. As a consequence of contractual arrangements, knowledge of risk and safety has been made unavailable to different groups of actors. Technical regulators have faced difficulties in mitigating pipeline risks, in particular when pipelines pass through interconnected states. The regulators have become less effective in accessing knowledge about risk and safety of both the operation and maintenance of pipeline companies. The public lack information about an additional charge for services and they do not know where they can seek solutions. Furthermore, contractual arrangements have impacted negatively on the continuity in transferring safety knowledge among pipeline engineers and pipeline technicians.

The above unpredictable and uncontrollable effects reflect the precarious situations of regulatory regimes, in which regulators have been made less capable through the use of their neoliberal techniques and strategies to shape the conduct of pipeline companies, their own authorities, and individuals. They have become less able to govern at a
distance through their technologies of government. Neoliberalism has negatively moulded the precarious ‘conduct of conduct’ and uncertainty of ‘action at a distance’ (or uncertainty of governing at a distance).

The new risks associated with neoliberalism have led to an increase in the incoherence of knowledge and practices throughout the process of risk regulation. The incoherence of knowledge vis-à-vis risk and safety and regulatory practices can result in an increase in pipeline risk that variously pose a threat to workforces, the public and those who work and live around pipelines.
Chapter 8
Performing new power-knowledge practices in a precarious regulatory regime

This chapter discusses how to improve processes of risk regulation with the goal of achieving better regulatory outcomes. It will begin by addressing the challenges emanating from the empirical findings (see Section 8.1). The first challenge concerns incoherence of knowledge and practices in the process of risk regulation, shaped by the series of assemblages described in Chapters 4-7. Another challenge, associated with the key argument of this chapter, emerges from the suggestions of interviewees about how to improve regulatory practices and effectiveness. The implications of these interviews will be analysed to assist in remediating the incoherence of knowledge and practices pertinent to risk regulation.

In an attempt to overcome limitations stemming from incoherence, the findings will re-theorise the ontology of risk (discussed in Section 8.2). The process involving the re-theorisation of the ontology of risk not only concerns ‘what is’ but also ‘who has been involved’, and ‘how’? In other words, the ontology of risk is viewed as a relational process. The ontology of risk proposed here realises the power relations in regulation. The method of re-theorisation is inspired by ANT and the concept of Foucauldian power-knowledge, exploring and following whoever and whatever are associated and disassociated in producing knowledge and practices that are related to regulatory outcomes in the process of risk regulation (referred to as power-knowledge practices). The ontology of risk will be used as a starting point to discuss and analyse potential improvements in the process of risk regulation which may lead to improvements in regulatory outcomes (see Section 8.3).

In the last Section (8.3), I argued that in order to improve the process of risk regulation, the process of power-knowledge in relation to risk regulation must be performed differently. Here, I offer a process of new performativity in three stages. The first stage (Section 8.3.1) is to re-arrange the ontology of risk. I discuss the first stage by using examples from the findings to re-arrange: (a) ontological-epistemological logics; (b) process safety; (c) public safety; and (d) unacknowledged assemblages associated with invisible risk. The second stage involves co-performing power-knowledge practices
with other actants outside of the traditional form of power relations so as to strengthen
the process of co-regulation involving regulators and industries. In order to co-perform
power-knowledge practices with others outside of the conventional ones, the following
three concepts are proposed: (a) rearranging the ontological identity of actors; (b)
developing the concept of deliberative democracy; and (c) developing the concept of
hybrid regulatory forum. The last stage involves the process of co-accountability,
discussed in Section 8.3.3.

The outline of this chapter is drawn and presented in Figure 8.1.

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Figure 8.1: The process of analysis and discussion of Chapter 8.
8.1 Proposals for the improvement of regulatory practices and effectiveness

This thesis challenges mainstream criticism that targets regulatory experts (or ‘elite-expert institutions’) and technical-regulatory approaches to regulating risk (discussed in Chapters 1 and Chapter 2). Such criticisms have black boxed the exploration of assemblages behind power mechanisms employed by regulatory institutions, the mechanisms that have shaped the knowledge and practices of regulators and their impact on regulatory outcomes.

The failure to explore these assemblages, knowledge and practices leads this author to propose a key research question: who and what entities are involved as regulators perform their power-knowledge practices and how have these relationships shaped knowledge and practices in relation to regulatory outcomes? In the process of investigating these questions, the research themes involving an incoherence of knowledge and practices in the process of risk regulation were revealed (as summarised in the conclusion section of Chapter 4-7 and in Table 8.1). Knowledge and practices have been performed by a precarious web of assemblages associated with elite-expert institutions, grouped into four sets of relational assemblages (see Table 8.1, discussed in Chapters 4 to 7).

Table 8.1: Four sets of relational assemblages that shape knowledge and practices in the process of risk regulation.

<table>
<thead>
<tr>
<th>Sets of relational assemblages (non-human and human)</th>
<th>Research themes involving incoherence of knowledge and practices</th>
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</thead>
<tbody>
<tr>
<td>The first set (Chapter 4)</td>
<td></td>
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<tr>
<td>Different assemblages, emerging from geographical space and social-political levels (i.e., international, national, state and local councils), that have influenced power-knowledge and practices of each Australian state across Australia. The</td>
<td>Regulators and industries, interacting as interconnected bodies. Pipeline regulators have certain ways of thinking and doing, theorised as their ontological-epistemological logic. The logic is embodied in taken-for-granted assumptions about the control and regulation of risk. These constituent assumptions are</td>
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<tr>
<td>The second set (Chapter 5)</td>
<td>Regulatory apparatuses (i.e., safety plans (PMS and a safety case) and risk-based frameworks), and contemporary concepts of social control (i.e., risk governance, including tripartite engagement and workforce engagement).</td>
</tr>
<tr>
<td>The third set (Chapter 6)</td>
<td>Measurement length as a technical-regulatory AS2885 specification in regulating pipeline risks.</td>
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</tbody>
</table>
planning authorities, groups doing activities near a pipeline easement (e.g. local councils, underground utility companies (e.g. electricity companies, communications companies, water companies), developers, builders, their contractors and subcontractors, landowners and the public) (see Figure 6.5).

- The practice of risk communication is muddled.
- Knowledge of pipeline risks is uncommon and made uncommon.

| The fourth set (Chapter 7) | Neoliberal rationalities, discourses about government (i.e., deregulation and energy privatisation), and neoliberal techniques (i.e., contractual arrangements, KPIs, red tape reduction, external auditors, and building blocks). | Multiplication of human actors, including pipeline licensees, pipeline owners and their subcontractors, technical regulators, and economic regulators. | Inequality among actors in knowing and accessing risk-safety knowledge: not only affecting regulators but also pipeline engineers, pipeline field managers, pipeline technicians and the public. |

Such knowledge and practices were revealed to be even more challenging than those raised by conventional critiques, in particular, when seeking concrete and practical solutions for regulators to improve the process of risk regulation so as to mitigate pipeline risks and improve regulatory outcomes.

This section focuses on challenges for the improvement of regulatory practices and effectiveness. The second key question of this thesis: how can the process of power-knowledge in relation to risk regulation be improved, is the subject of examination here. Participants suggested ways to improve regulatory practices and effectiveness, based on their knowledge. The themes to emerge were based on empirical data, in accordance with ‘what’ needed to be improved; how regulators can improve it and who needs to be involved (see Table 8.2).
<table>
<thead>
<tr>
<th>Areas for improvement raised by participants</th>
<th>Proposed methods of improvement raised by participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical aspects</td>
<td></td>
</tr>
<tr>
<td>1. Technical competency</td>
<td>Training</td>
</tr>
<tr>
<td></td>
<td>Training arrangements through law enforcement</td>
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<tr>
<td></td>
<td>Establishing relationships with industry</td>
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<td></td>
<td>Learning by attending industrial conferences</td>
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<tr>
<td></td>
<td>Employing consultants who are approved by regulators to conduct third party reviews</td>
</tr>
<tr>
<td>2. Database of regulatory knowledge</td>
<td>Documenting what has been undertaken through communication with regulatory teams</td>
</tr>
<tr>
<td>3. Learning from incidents</td>
<td>Sharing with industries information about root causes</td>
</tr>
<tr>
<td>4. Improving management of change</td>
<td>Undertaking a process of risk assessment</td>
</tr>
<tr>
<td>5. Learning from process plants</td>
<td>Focussing on Major Accident Events (MAE), focussing on safety critical elements</td>
</tr>
<tr>
<td>6. Improving the quality of HSE professionals who work with workforces and managers</td>
<td>HSR professionals need to have qualifications and skills</td>
</tr>
<tr>
<td>7. Improving workforce knowledge of safety systems</td>
<td>7.1 Informing workforces about safety cases with specific information, rules and reasons as to why the rules are important rather than writing generic motherhood statements</td>
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<tr>
<td></td>
<td>7.2 Making the process of safety systems easier for workforces to use</td>
</tr>
<tr>
<td>8 Improving the risk assessment process with workforces</td>
<td>Assessing risk by involving with workforces using workforce terms and processes, for example, participating with them in the field rather than doing risk assessment by bringing in the workforces for demonstrations in offices.</td>
</tr>
<tr>
<td>9. Improving knowledge of pipeline dangers, especially around pipeline easements and measurement length</td>
<td>9.1 Facilitating and cooperating by governments to set up regulatory enforcement</td>
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<td></td>
<td>9.2 The co-production of a safety management study between pipeline companies and third parties, in particular, the underground services.</td>
</tr>
<tr>
<td></td>
<td>9.3 Using and understanding a safe work method statement that explains the</td>
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<tr>
<td>Regulatory aspects</td>
<td></td>
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<tr>
<td>-----------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------</td>
</tr>
<tr>
<td>1. Changing the external auditing process</td>
<td>Regulators need to hire their own auditors and approve auditors’ work by themselves</td>
</tr>
<tr>
<td>2. Doing more field audits</td>
<td>N/A</td>
</tr>
<tr>
<td>3. Harmonised pipeline regulations</td>
<td>Involving third parties to oversee and mandate the review of regulation</td>
</tr>
<tr>
<td>4. Understanding the roles of regulators by ethical considerations</td>
<td>N/A</td>
</tr>
<tr>
<td>5. Cooperation between two acts of law: Pipeline Acts and Work Health and Safety Act</td>
<td>N/A</td>
</tr>
<tr>
<td>6. Learning from other countries, in particular, those in the North Sea (UK, Norway)</td>
<td>N/A</td>
</tr>
<tr>
<td>7. Changing the process of submitting and reviewing a safety plan</td>
<td>N/A</td>
</tr>
<tr>
<td>8. Emphasis on using a more prescriptive approach and adopting a stringent approach in the wake of deregulation and privatisation</td>
<td>N/A</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Organisational aspects</th>
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</thead>
<tbody>
<tr>
<td>1. Changing organisational structures</td>
<td>Re-arranging organisational structures</td>
</tr>
<tr>
<td>2. Having leadership roles and cultures</td>
<td>N/A</td>
</tr>
<tr>
<td>3. Increasing salary of regulators</td>
<td>Collecting a fee from industries</td>
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</tbody>
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<table>
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<tr>
<th>Social-regulatory aspects: tripartite engagement (or union engagement) and workforce engagement</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1. Union engagement</td>
<td>1.1 Engaging unions as part of the workforce groups, not just treating unions as a third party</td>
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<tr>
<td></td>
<td>1.2 Rearranging the definition of unions: unions are more than just union officers: they include all of the workers who are union members and work in the workplace</td>
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<table>
<thead>
<tr>
<th>Social-regulatory aspects on workforce engagement</th>
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</thead>
<tbody>
<tr>
<td>2 Workforce engagement</td>
<td>2.1 Involving workforces in decision-making processes so that they take some ownership of safety operations</td>
</tr>
<tr>
<td></td>
<td>2.2 Setting up conditions in respect of health and safety by including Enterprise Agreements</td>
</tr>
</tbody>
</table>
2.3 Empowering ‘health and safety representatives’ (HSRs) to be *de facto* inspectors, assisting regulators to monitor and regulate risk. This needs to be supported by the federal government.

Note: N/A refers to not-applicable. No proposed solutions were raised for these items.

The research themes concerning regulatory improvement in accordance with participants’ views were broadly organised into four categories: technical; regulatory; organisational and social-regulatory aspects with reference to tripartite engagement (or union engagement) and workforce engagement. The majority of suggestions, nevertheless, were relatively limited within the first three aspects although they were associated with each other. The interviews indicated that participants are rarely focussed on the last category (social-regulatory aspects).

The overall recommendations concerning technical aspects include: improving the database of regulatory knowledge; learning from accidents; learning from process plants; and improving the management of changes. The primary suggestions were shared as expert knowledge between regulators and the pipeline industry, for example, a regulator participant stressed:

> I think the biggest thing we can do to improve [the knowledge of regulators], is exposure to industry. Spend more time actually out there with the people learning about it. … To learn how their plant works, to understand the intricacies of it. So we’re not just coming in as someone to stand back and point at things so we understand what’s happening as part of the process. That’s probably where the biggest knowledge improvements can occur.

Some participants including regulators, industrial participants and external auditors, additionally, suggested further improvement of knowledge already held by workforces about safety systems and risk assessment, and knowledge of pipeline dangers and measurement length associated with third parties. Nevertheless, these suggestions are focussed on technical aspects. Workforces need specific information, rules and guidance about the gist of operating in a safe manner. The suggestion *vis-à-vis* the social aspects of engaging workforce in co-producing safety plans was rarely addressed by participants. A regulator participant highlighted:
The gap is a safety case which is implemented that actually has an impact, their awareness that it has an impact and writing it in such a way that it’s actually useful to the guys on the tools, so it is to the point and, you know, ‘These are the rules that you need to comply with and this is why it’s important.’ So, give them something specific rather than generic motherhood statements. ‘We will operate in a safe manner,’ doesn’t mean much, or ‘PPE’. You need some specifics. ‘Don’t drive your car into the hazardous areas,’ you know, ‘Make sure your gas tester is tested every day to do this and this and this and this and this.’ The actual useful stuff.

Similar to the process of improving the knowledge of actors in relation to pipeline easements and measurement length, in the main the participants’ suggestions were focussed on technical-regulatory aspects, and not on involving actors in co-performing knowledge and practices. Various technical tools were suggested including: (a) facilitation and cooperation by governments to set up regulatory enforcement; (b) employing a safety management study and a safe work method statement; and (c) providing information about DBYD to every household. The process of co-opting stakeholders into the decision-making process pertinent to risk identification, risk assessment, and risk regulation has been given little attention by the majority of participants. This reflects the ontological-epistemological logic articulated by pipeline regulators (as discussed in Chapter 4, Section 4.1.1, summarised in this chapter in Table 8.1, and the subject of further discussion in the next two paragraphs). The knowledge of risk, safety and regulatory practices is shared and influenced by two interconnected bodies: pipeline regulators and pipeline industries. Pipeline regulators rely on the knowledge, skills and activities of pipeline industries.

The suggestions regarding regulatory aspects and organisational aspects were narrowly focussed. The regulatory aspects include: the auditing process; doing more field audits; harmonising pipeline regulators; emphasising the use of a prescriptive approach; and increasing the level of regulatory stringency. The last recommendation was emphasised most strongly when dealing with deregulation and energy privatisation. The organisational aspects include change in organisational structures, leadership roles and cultures, and salary increases for regulators.

As indicated at the beginning of this section, it was uncommon for regulators and industrial participants to focus on improving social-regulatory aspects: tripartite
engagement (or union engagement) and workforce engagement. These improvements were only recommended by a few participants who are union officers. In one case, a union officer advised that it was necessary to re-define what a ‘union’ is and what it does. He contended that the union is not a third party, confined to union officers who work in union offices, but the term ‘union’ refers to all of workers who are union members working in the workplace. Companies need to be involved with workforces in the decision-making process so that workforces can feel like part of the decision-making and that they have ownership of safety matters. In addition, conditions concerning health and safety can be included in an Enterprise Agreement.

Another union participant urged improvement through empowering the roles and capacities of health and safety representatives (HSRs), becoming ‘…de facto inspector[s]’, assisting regulators to monitor and regulate risks so as to enhance the implementation of safety systems and outcomes of health and safety without ‘having to provide the resources in-house’. The union member said:

But if you’ve got an embedded HSR, that is a sponsored agent of the regulator, they should have under law … And they can work with the other HSRs and management and they can have the right, if they see anything wrong with these contractor companies, in the way that they manage health and safety, they can trigger an inspection, investigation or review from the regulator. … and if they find anything that they think needs addressing, immediately they can notify the regulator and say come here. Because what that does is it gives the regulator tentacles. It gives them greater coverage.

The union emphasised that the process of being ‘a de facto inspector’ requires support from a ‘courageous federal government’. The alternative is that it could be triggered by ‘a horrible major event, where not only is there loss of life, but there will be serious damage to [the] economy’.

Although engaging unions and workforces is useful and regulators can gain benefit, regulators and industries feel uncomfortable about engaging with them. The overall suggestion about how regulators can improve technical knowledge falls into the realm of ontological-epistemological logics (discussed in Chapter 4). Regulators are focused on improvements that utilise specific technical-regulatory aspects and specific groups within the tradition of a regulatory network. They rely on industry knowledge with an
emphasis on establishing relationships with industries. Among participant regulators’ suggestions, engagement with non-conventional actors (discussed in Section 8.3.2.1) was largely not mentioned. Participant regulators neither address nor note issues associated with their own power-knowledge practices; in particular, where regulators have been subtly and indirectly captured by industry using regulatory logics and practices (as a new form of regulatory capture (see Chapter 4, Section 4.1.2)).

Although there was advice suggesting that regulators can learn from other countries, especially the UK and Norway, none of the participants provided concrete advice on how to learn from these countries and in what way. The question of what is so unique about the regulatory regimes in UK and Norway that leads to successful outcomes was not addressed. Instead, participants merely asserted that the UK and Norway regimes are progressive because both countries have longer experience. A regulator pointed out that: ‘[t]he UK and Norway have been doing this sort of stuff in the North Sea for 60/70 years. They are usually considered the best’.

In one way, perhaps suggestions regarding the methods proposed by participants can be applied directly as policy amendments. Nevertheless, the challenge is that they may not be in line with – and be insufficient to cope with – the incoherence of knowledge and practices that persist throughout the regulatory processes. Such incoherence is defined as the sense of becoming disassociated through fragmentation and obfuscation around the processes of risk identification, risk assessment, risk communication and risk accountability (summarised in Table 8.1). This definition emerged during the analysis of my findings (discussed in Chapter 3, Section 3.4.3). Pipeline risks are the performatve effect of negotiating processes of multiple interactive assemblages, and the trend, although subtle, is towards greater risk. Risks are associated with issues of power-knowledge. On this basis, the question of how can the process of power-knowledge in relation to risk regulation be improved (or, how regulators can improve their regulatory practices and effectiveness) requires an in-depth analysis and exploration, in particular concerning the issues of ontology of risk in relation to power-knowledge practices.
8.2 Ontology of risk in association with power-knowledge practices

The extensive literature on improving regulatory practices and effectiveness in the process of risk regulation has focussed on a paradigm shift and regulatory reform through conditional strategies (or pre-requisites) attached to regulatory regimes (see for example: Lindøe et al., 2014). The well-known risk governance framework exemplifies the paradigm shift from government to governance. Risk governance provides a series of stages (i.e. pre-estimation, interdisciplinary risk estimation, risk characterisation, risk management, and risk communication and participation) (Renn, 2014, pp. 11-29) for setting up a communicative dialogue with main actors and other stakeholders, in particular, the interested public, about being adversely impacted by technological risks (ibid, p. 30). But, none of the regulatory literature focuses on changes in the ontology of risk or on subsequent changes in the performance of power-knowledge practices. Despite risk governance underlining the issues of power relations in regulating technological risk, risk governance theorists do not trace and re-trace the ontology of risk in relation to power relations. This thesis argues that, in cases where risk is not well understood, risk governance has been limited in improving regulatory practices and effectiveness, resulting in ineffectiveness in improving the process of risk regulation.

The existing forms of regulatory practices and effectiveness (regulatory outcomes) used by pipeline regulators and pipeline industries need to be performed anew. As discussed throughout this thesis, the existing forms of regulatory outcomes are shaped by four relational assemblages (summarised in Table 8.1). The existing concept of regulatory effectiveness primarily refers to the good safety records of pipeline industries (discussed in Chapter 1, Section 1.2.2.1), embedded within the extant ontological stance (discussed in Chapter 4, Section 4.1.1.2).

The process of performing a new form of power-knowledge process in relation to risk regulation so as to improve regulatory outcomes, justified earlier in this chapter, will be discussed throughout the remainder of this chapter. In brief, the process is to re-arrange the ontology of risk, co-perform power-knowledge practices with non-conventional actors so as to enhance co-accountability in regulating risks. The process is articulated with Actor Network Theory (ANT) rationalities, a concept of discursive power-knowledge, deliberative democracy and six criteria of a hybrid regulatory forum (i.e.,
equality, transparency, clarity, intensity of collaboration, openness, and quality of arguments).

The findings of this thesis illuminate an alternative strategy related to the ontology of risk with contributions and inspiration from Actor Network Theory (ANT). ANT offers an analytical approach that can tackle ontological issues pertinent to regulation which are relatively unproblematised in the current theoretical literature on risk. The process of tracing the ontologies of risk implicit in various regulatory strategies has been a goal of this thesis. Without tracing the ontologies of risk related to power relations, what is being black boxed and what is assumed are not open to question. Therefore, a strategy of tracing the ontology of risk is fundamental as it questions what regulators do to treat risk in order to regulate it. Or, it asks not only what is the object of regulation, but also who has been involved in the process of risk regulation and how?

The ontology of risk is dynamic; performed as a variable and relational effect in association with power-knowledge practices. The new strategy of the ontology of risk proposed in this thesis is built on both realist and constructivist perspectives that emerge through the process of unpacking the dualist character of risk in regulatory practice. Such an ontology of risk recognises the active role of risk regulation in producing risk both materially and discursively. Further, such an ontology of risk articulates how greater recognition of the dual character of risk might improve risk regulation in general and in relation to the pipeline industry more specifically.

Zinn (2016) incorporates ontology into risk theory, surmising that the relationship between risk calculation and accident prevention is paradoxical. The concept of risk itself, the techniques through which risk is calculated and managed, and associated ideas such as the precautionary principle do not stop people from undertaking potentially hazardous activities. On the contrary, they enable and encourage us to undertake activities that may seem otherwise to be unknowably and unmanageably dangerous. Risks may be deemed acceptable in light of the material gains they offer and risks may also be considered as ends in their own right – signifiers of identity, power and control (Zinn, 2017).

Risk regulation thus plays a key productive role in the construction and operation of hazardous facilities including gas pipelines. Further, as the findings of this thesis show,
risk regulation is performed through the interaction of myriad actors involved materially and discursively in shaping the notion of risk in practice.

To regulate risk more effectively, this thesis proposes a reconfiguration of risk ontology. Drawing from the findings, risk characteristics are claimed to include incoherence, multiplicity and negotiation arising from the interactive effects of relational-heterogeneous assemblages in regulatory networks (discussed further in Section 8.2.1-8.2.3). The ontology of risk involves multiplicity and negotiation due to its production from incoherences within regulatory knowledge and practice both material and constructed. This thesis argues that by recognising risk regulation has these characteristics it becomes possible to develop a more inclusive concept of risk that can enable better ways to deal efficiently with risk. Such an ontology of risk is open for discussion, and for negotiation. Finally, examples of how the ontology of risk can be reconfigured in practice are in Section 8.3.1.

8.2.1 Multiplicity

The ontological multiplicity of risk was discussed in Chapters 4 and 5. For example, in Chapter 4, the findings revealed multiple and interactive non-human and human assemblages influencing power-knowledge practices. The dynamic assemblages are located at different social-political levels including international, national, state and local levels.

The findings emphasise that each Australian state has different interactive assemblages performing power-knowledge practices, reflecting the ontological multiplicity of risk (see Table 4.2). Other examples of the ontological multiplicity of risk are discussed in Chapter 5. The findings reveal that the field safety practices employed to manage pipeline risks are different from those written in safety plans and submitted to regulators (discussed in Chapter 5). The field safety practices articulate with knowledge held by collective workforce groups. On the other hand, a safety plan is used by regulators and some external auditors to inspect pipeline industries. The different forms of safety practices reflect the multiple forms of managing and regulating pipeline risks employed and acknowledged by regulators and industrial actors within pipeline organisations.
8.2.2 Negotiation

The ontology of risk involves negotiation. The ontology of risk emerges from a negotiating process of risk identification, risk assessment, risk communication and risk accountability. How risk is identified, assessed, communicated and made accountable is the result of the transactions of interactive entities throughout the negotiating process (or process of translation) (discussed throughout Chapter 4-7, summarised in Table 8.1). Pipeline risks are negotiated among actors through multiple entities across Australian states, through the establishment and implementation of safety plans, safety regimes and safety concepts, and through the implementation of measurement length, deregulation and energy privatisation.

8.2.3 Incoherence (or disassociation)

The nature of risk as multiplicity and negotiation is an effect of incoherence in regulatory knowledge and practice. In other words, the background characteristic of risk is incoherence. Such a characteristic was exposed throughout Chapters 4-7, summarised in Table 8.1. First, the multiplicity of the ontology of risk, described in Chapter 4, reflects a situation whereby regulatory practices are incoherent across Australian states. The ontology of risk is incoherent not only among pipeline regulators across Australian states, but also among actors within the pipeline industry (e.g., pipeline owners, pipeline contractors, pipeline subcontractors, pipeline engineers, field pipeline managers and field pipeline technicians), and among actors outside of pipeline industries and regulators (e.g., unions, the public, planning authorities, planning ministers, and developers). For example, Chapter 5 presented evidence for the incoherence of safety knowledge and practice among actors. Chapter 6 presented an incoherence of knowledge and practice about pipeline dangers among actors in risk accountability, risk assessment and risk communication. Last, Chapter 7 presented how knowledge and practice among these actors has become incoherent as shaped by neoliberalism. Such incoherence suggests that regulatory effectiveness is compromised because actors who should participate in decision making resist enrolment in regulatory networks. Reasons for this resistance include: (a) the current ontological stance of regulators; (b) unfamiliarity with union engagement; (c) mundane use of safety concepts between process safety and personal safety; (d) different sets of safety legislative frameworks
and institutions; (e) the obfuscated meaning of the blast zone through the use of ‘measurement length’; (f) fear of public alarm if the public know about a danger zone of pipelines; and (g) insufficient knowledge about pipeline routes. To conclude, this incoherence of knowledge and practice are regulatory problems in the Australian energy pipeline industry and undermine regulatory effectiveness.

8.3 Performing new power-knowledge practices in relation to risk regulation

The extant ontology of risk, as it emerges from empirical findings in association with power-knowledge practices employed when regulating pipeline risks, is composed of three dynamic elements: multiplicity, negotiation and incoherence. The three ontological elements of risk contradict the ontological-epistemological logics of interconnected bodies, regulators and industries as discussed in Chapter 4 and summarised in Table 8.1.

The ontological-epistemological logic identified in Chapter 4 is static and unable to cope with the multiplicity, negotiation and incoherence of the ontology of risk. Regulators have been captured by their own ontological-epistemological logic, a logic build around their understanding and regulating of pipeline risks, as a subtle and new form of regulatory capture. However, regulators are rarely aware of this new form of regulatory capture. In the Australian pipeline case, although scholars have highlighted the independence of regulators’ roles and actions as a crucial element in improving regulatory practices and effectiveness, the findings imply less independence and more dependence among regulators. The challenge is: how can regulators increase their independence and at the same time maintain their close relationships with industries? The constraints, in turn, can be the subject of research intending to improve the processes of power-knowledge practices that by extension will improve regulatory outcomes. I suggest three stages of improvement, discussed in Section 8.3.1-8.3.3.

8.3.1 Re-arranging the ontology of risk regulation

The first step is to re-arrange how risk is conceived within regulatory practice. Accepting that risk is characterised by multiplicity, negotiation and incoherence can facilitate a different way of regulating risk. A different way of understanding risk can
shape alternative approaches to regulating risk. One may ask: how can such a term as the ‘ontology of risk’ be interpreted by the regulatory community? I propose that the questions of who has been involved, what concepts have been used, and how power-knowledge practices have been performed must be considered and investigated through the process of inspection. The ontology of risk is, therefore, dependent on the enactment of those ‘what’ and those ‘who’ questions in performing power-knowledge practices. In other words:

- What are the regulatory tools used to identify, assess and communicate risk?
- What are the rationales of using such tools?
- What are the objectives of using such rationales and tools?
- Who has been involved in the process of identifying, assessing and communicating risks through those tools?
- What might alternative tools be? How are they different from the existing tools? How can such alternative tools help regulators to achieve positive outcomes compared to the tools that regulators currently use?

The process of how to re-arrange the ‘ontology of risk’ in practice will be discussed drawing upon examples that have emerged from this thesis.

**8.3.1.1 Example 1 (Chapter 4): ontological-epistemological logics in regulating pipeline risks**

As suggested earlier, regulators are unlikely to improve regulatory practices and effectiveness without reconsidering their ontological-epistemological logic. Rearrangement of the ontology of risk as multiplicity, negotiation and incoherence will assist regulators to investigate pipeline risks differently. For example, regulators will ask questions in a different way with those whom they inspect and communicate with (e.g., industries, consultant companies, external auditors). Regulators may focus their questions around what, who and how, for example:

Multiplicity: How do you assess risks and in what ways?
How many ways do you have to access risk?

What tools and strategies have been using in assessing risk in your own practices?

What are the rationales behind the tools and processes of assessing risk?

What has influenced your field safety practices, apart from the tools and rationales you have been using?

What are the other tools and strategies that have been suggested in the safety plans?

Negotiation: Who has been involved in the process of risk identification, risk assessment and risk communication?

Who has not been involved in the process of risk identification, risk assessment and risk communication?

Incoherence: What are the similarities and differences between field safety practices and the practices written in the safety plans?

What tools and strategies do you think are needed in assessing risks?

Such questions will assist regulators to go beyond their objective technical perspective, mapping out their in-depth analyses with other dimensions including social, economic and political dimensions. This example shows how the ontology of risk in relation to power relations may be rearranged in practice: the power relationships among and between regulators, industries, consultant companies, external auditors etc. throughout regulatory processes being emphasised.

Regulators must triangulate with those who have not been formerly involved, but have nonetheless been affected by, pipeline risks. Regulators can begin by communicating with others (e.g., those who write safety plans, field pipeline staff, managers of the operation and maintenance division, as well as the OHSE division and unions). These others will become enrolled in what become new assemblages. This will allow regulators to re-arrange the existing power-knowledge practices throughout the processes of risk identification, risk assessment, risk communication and risk accountability. Regulators will not only be able to expand and rearrange their own knowledge and practices in regulating risks and build trust with others, but regulators can use this alternative knowledge and new practices to negotiate their resource and technical skills.
8.3.1.2 Example 2 (Chapter 5): ontology of risk around process safety

This example presents how the ontology of risk may be rearranged in practice by focussing on the power relationships involving regulators and the use of process safety. This is different from the existing process safety literature where indicators are the main focus.

The empirical evidence indicates that regulators have focused on process safety indicators, not on personal safety indicators (as discussed in Chapter 5). Although a distinction between the two safety concepts has been helpful in that it emphasises the prioritisation of appropriate indicators to assess major hazardous risks (see for example: Hopkins, 2009), this distinction has increased the incoherence of knowledge and practices in the process of assessing pipeline risks. Collective pipeline workforces have contributed little towards identifying and assessing pipeline risks. On the other hand, pipeline risks, at the process safety level, have not been properly communicated to collective workforces. Therefore, the disassociation reflected in the distinction between the two safety concepts can interfere with changes in the ontology of risk regulation.

This thesis contends that restructuring the ontology of risk in a way that addresses the incoherence of process and personal safety may help regulators to re-organise safety concepts in relation to safety procedures. However, questions remain concerning which indicators need to be included and who needs to be involved in identifying and assessing risks and re-analysing the safety concepts. The reorganisation of the process of risk identification and risk assessment will improve the way risk is communicated, which should result in the reduction of pipeline risks. The processes of re-analysing safety concepts and the distinction between process safety and personal safety may subsequently be dismantled in favour of shifting the focus to the questions of what major hazardous risk is and how to prevent it.

This shift in focus will result in changes in how risk is assessed. There will be exploration, expansion and inclusion of new actors (previously excluded) involved with major hazardous risk in the process of risk assessment; and controls already put in place will be revisited. The shifting focus and exploration will allow a shift of power-knowledge practices critical to assessing risk. It is likely that inequalities in knowing and accessing knowledge of risk and safety will be reduced among actors. Nevertheless,
one may argue that according to the existing legislative framework, technical regulators do not have responsibility for worker safety, only process safety. How can they be held accountable for this? The argument is framed under traditional forms of power-knowledge practices with a routine and uncritical approach to the existing regulatory knowledge and practices (see Chapter 5, Section 5.3). I argue that the routine and uncritical approach of technical regulators needs to be re-arranged. This will involve co-performing their power-knowledge practices with non-conventional actors and articulating with alternative concepts (see Section 8.3.2.).

**8.3.1.3 Example 3 (Chapter 6): ontology of risk in regulating the incoherence of pipeline risks around public safety**

This third example explains how the ontology of risk can be rearranged to recognise relationships between regulators and practical knowledge that are pertinent to pipeline risk and public safety. As evidenced in Chapter 6, knowledge about pipeline risks relevant to public safety is incoherent among associated parties. One of the reasons for this incoherence is the obfuscation of what a ‘measurement length’ is, established primarily by pipeline experts enacting the measurement length in AS2885, and pipeline licensees with whom regulators are closely associated. By rearranging a new form of ontology, regulators may find a new way to communicate risk and cooperate with others outside of the regulator-industry binary. Examples of other actors that emerged from interviews include independent planning panels who act in a way that suggests their role as ‘interactors’, and actors who practice in the regulatory institutions including safety regulators, economic regulators, and even pipeline regulators across states. Unless they can engage in a process of co-performing power-knowledge practices with other actors, regulators will remain ensconced in traditional forms of power-knowledge relationships, limiting their capacity to identify, assess and regulate risk. The co-performance of power-knowledge practices with others will be elaborated later (in Section 8.3.2).

**8.3.1.4 Example 4 (Chapter 7): ontology of risk in regulating unacknowledged assemblages associated with invisible risk**

This example emphasises the rearrangement of risk ontology through relationships between regulators and broader trends in governance such as deregulation and
privatisation – assemblages that are positioned outside of conventional safety knowledge and practices and which may lead to increased risk. These assemblages are reflected in specific techniques and practices including contractual arrangements, KPIs, red tape reduction, external auditors, building blocks and other entities. The interaction of these assemblages with pipeline industries has created a new form of risk, which has not been empirically documented in contemporary research.

In the process of re-arranging the ontology of risk, regulators will be aware of new types of risks which may emerge in any situation with the potential to precipitate energy pipeline accidents. For example, one of the emergent findings of this thesis is that at least a few regulators are aware that their regulatory practices are shaped and constrained by contractual arrangements, a practice that can result in a complex form of stewardship complexity among pipeline actors (discussed in Chapter 7, Section 7.3.2). A technical regulator revealed that he was unable to access information about operation and maintenance from pipeline licensees who own pipelines that cross more than one state. To overcome this difficulty, regulators need to answer further questions about the influences that obstruct them when accessing information, and about who else has been impacted by such influences. For example, a few regulators raised their concerns in relation to consequential outcomes from highly a complex pipeline ownership structure. They indicated that: (a) members of the public face difficulties when seeking information about the additional charges for their consumable goods or services, or where to seek advice about relevant gas repairs; and (b) pipeline engineers and workforce collective groups face difficulties with the continuity of knowledge transferral on risk-safety among them.

To conclude, new types of risks which are unacknowledged and unimagined can emerge when regulators rearrange their ontology of risk. Rearrangement will assist regulators in being aware of new types of risks. New types of risk can emerge during the process of asking questions during regulatory inspection. For example, questions can be asked of who has been involved in and who has not been involved in the regulatory process of risk identification, risk assessment and risk communication, and what are the influences of obstructing them from the process?

Those who have not been involved in the regulatory process are considered non-conventional actors (examples of non-conventional actors are presented in Table 8.3).
Regulators need to include non-conventional actors in a co-performance of power-knowledge practices to rearrange the existing form of power-knowledge practices in risk regulation both formally and informally (discussed further in Section 8.3.2), with the goal of improving regulatory practices and effectiveness.

**8.3.2 Co-performing power-knowledge practices in co-regulating risk**

The second step in improving the process of risk regulation is to employ the concept of co-performativity (or co-production) of power-knowledge practices in regulating technological risk. The process of co-performing knowledge with others outside of the dominant groups has been emphasised extensively in the existing literature that deals with risk problems (see for example: Chilvers & Kearnes, 2016; Lindøe et al., 2014; Mansbridge, 2003; Niemeyer, 2004; Renn & Schweizer, 2009; Wong, 2015). However, I argue that without further development in the ontology of risk, the mechanisms of conventional power-knowledge practices may repeat in the same cycle involving the same political actors. And, it may negate the possibility of better outcomes in regulating risk.

This thesis provides new insights into gaps in the existing knowledge by expanding on, from empirical evidence, alternative concepts in the ontology of risk related to power relationships – known as multiplicity, negotiation and incoherence. Based on this alternative view, risk can be performed anew through an ongoing and negotiated process among interactive assemblages. When re-enacting both human and non-human actors, the process of re-arranging the ontological identity of actors in a way that eschews conventional and hierarchical forms of power-knowledge in favour of discursive power-knowledge assemblages is a pivotal step (discussed in Section 8.3.2.1).

**8.3.2.1 Ontological identity of actors: from conventional and hierarchical power-knowledge forms to discursive power-knowledge assemblages**

In the process of re-arranging the ontological identity of actors, I propose that the concept of power-knowledge is defined as a performative effect rather than as an existing property, as articulated in this thesis – by utilising ANT together with Foucauldian power-knowledge. The transition of power-knowledge as a performative effect can assist regulators in dismantling and re-arranging the conventional and
hierarchical notions of power relations towards discursive power-knowledge assemblages. The new form of discursiveness of power-knowledge assemblages can assist regulators to connect and communicate with those who have been excluded from conventional power relationships.

Actors who are omitted can be diverse and are not limited to the public or affected groups – as generally suggested in the literature on risk from science and technology (Callon, 1999; Callon et al., 2009; Callon & Rabeharisoa, 2008; Chilvers & Kearnes, 2016; Wong, 2015). The tendency to address only public and affected groups at the expense of others can become problematic because it can limit the exploration of actors outside of conventional actors. Some non-conventional actors were discovered in this thesis. They are either those who are involved with and attempt to voice the position of affected groups, or those who are part of regulatory and industrial institutions. An example of a non-conventional actor is the independent planning panel, referred to as an interactor (discussed in Chapter 6 (Section 6.2.2)).

The concept of the discursiveness of power-knowledge assemblage can assist regulators to recognise the diversity of actors who are outside of the conventional network with whom regulators are familiar. The multiplicity of actors has been captured by semiotic materiality ANT (see Chapter 4-7). I have categorised these actors into two groups: conventional actors and non-conventional actors (presented in the Table 8.3). Besides co-producing knowledge and practices in risk regulation with conventional actors, regulators need to re-enact non-conventional actors in the process of co-performing knowledge and practices in regulation. This way, regulators can assist in the distribution of power-knowledge relationships, which should lead to improvement in how technological risks are identified, assessed, communicated and made accountable.

Table 8.3: Examples of conventional and non-conventional actors.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Types of actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional actors</td>
<td>Some members of pipeline companies (e.g., managers who are at the higher levels of pipeline organisations involved with the process of developing, writing, and submitting safety systems and the process of managerial arrangements and safety)</td>
</tr>
<tr>
<td></td>
<td>AS2885 committee</td>
</tr>
<tr>
<td></td>
<td>External auditors</td>
</tr>
</tbody>
</table>
Consulting companies undertaking pipeline design, writing safety plans, and conducting Safety Management Studies (SMS)

Pipeline lobbyist groups

Developers, local councils, land use planners and planning authorities, who have been in association and communication with conventional actors (e.g., pipeline companies, AS2885 committee) so as to be persuaded to maximise separation from pipeline assets

<table>
<thead>
<tr>
<th>Non-conventional actors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Interactors</td>
<td>OHSE industrial team connected with workforce groups</td>
</tr>
<tr>
<td></td>
<td>Independent planning panels connected with the public</td>
</tr>
<tr>
<td></td>
<td>Pipeline patrol operators and pipeline technicians</td>
</tr>
<tr>
<td></td>
<td>Workforce health and safety representatives</td>
</tr>
<tr>
<td></td>
<td>Researchers who have undertaken research into Australian pipeline industries</td>
</tr>
<tr>
<td>Silent actors</td>
<td>Workforce collective groups who work for pipeline industries</td>
</tr>
<tr>
<td></td>
<td>(e.g. pipeline field managers, pipeline patrol officers, pipeline technicians)</td>
</tr>
<tr>
<td>Affected actors</td>
<td>The public who live and work within and close to the measurement length zone</td>
</tr>
<tr>
<td></td>
<td>The vulnerable groups whom live, study and work within or close to the measurement length zone; including schools, hospitals, aged care facilities and prisons (described in Chapter 6, Section 6.1, 6.2.1)</td>
</tr>
<tr>
<td></td>
<td>Workforce collective groups who work under contractors and sub-contractors for ‘third party groups’ (described in Chapter 6, Section 6.1)</td>
</tr>
<tr>
<td>Unwelcome actors</td>
<td>Unions</td>
</tr>
<tr>
<td>Other regulators</td>
<td>Safety regulators regulating major hazardous facilities</td>
</tr>
<tr>
<td></td>
<td>Economic regulators</td>
</tr>
<tr>
<td>Other actors managing</td>
<td>Emergency response actors</td>
</tr>
<tr>
<td>catastrophic accidents, or</td>
<td>Media</td>
</tr>
<tr>
<td>with an interest in them</td>
<td></td>
</tr>
</tbody>
</table>

So, who are these non-conventional actors? I have sub-categorised non-conventional actors into six categories, including interactors, silent actors, affected actors, unwelcome actors, other regulators, and other actors managing catastrophic accidents or expressing interest in them such as emergency response teams and media. They are a diverse cohort: some of them work in the pipeline industry; some are independent; and some have changed their identity. I have arranged them into diverse categories to avoid a dichotomy trap (e.g., laypeople and experts, as discussed in Chapter 6, Section 6.1.2), and actors who have been categorised as stereotypical victimised groups by the existing
literature (e.g., laypeople, the public, communities, workers, non-governmental organisations) (see Chapter 6, Section 6.2.2).

The interactors, who are defined in Chapter 6 (Section 6.2.2), are crucial because they sympathise with affected actors and silent actors, and they attempt to make changes to reduce the technological risk towards these actors. Some interactors work within pipeline companies such as the OHSE team. Another group of interactors comprises the independent planning panels. They are independent parties who have taken the initiative to re-arrange the ontology of power-knowledge, by setting up a model to inform about the dangers of pipelines to the public. The panel aims to re-affirm the right of the public to know about pipeline danger by integrating with the concept of public right to knowledge, openness and transparency.

On reflection, researchers such as myself and those who undertake research in association with the Australian pipeline industries may be considered as another group of interactors, with whom regulators can connect and communicate. Although researchers may be seen as part of the pipeline actor network, their research work is relatively independent as it is aligned with the ethos of tertiary educational institutions and is not directly controlled by pipeline companies. In addition, researchers play their roles in contributing knowledge to prevent pipeline catastrophes.

The groups of silent actors and affected actors are relatively interchangeable. A distinction between the two groups is made when a mismatch of safety concepts developed and used by pipeline practitioners isolates an enforced silent group. The affected groups, on the other hand, have been minimally engaged in the assessment process. The reasons are complex and related to power-knowledge, cost, complexity of regulations, and industries having concerns about public emotion and public action. Industries fear that the public may obstruct them when developing and constructing new pipelines, may force them to change pipeline routes, and may force the implementation of more physical controls in vulnerable places, which could interfere with their investment and profits.

Here, it is important to note that the actors I have categorised are those that emerged from interviews. There might be other types of actors in other contexts, that have not been unveiled. Diversity requires openness to different types of actor. Regulators;
therefore, need to open up to any opportunity to meet, connect, and re-connect with alternative, non-conventional actors in the process of co-producing knowledge.

The emphasis on co-performing power-knowledge practices with other groups (e.g., workforce collective groups, unions, the public) outside of the dominant actors is extensively discussed by the existing literature on risk (as discussed in the beginning of Section 8.3.2). Nevertheless, the Australian pipeline case is different in terms of its engagement with unions, the workforce groups (discussed in Chapter 5, Section 5.3), and the public (discussed in Chapter 6). Regulators have omitted engaging with workforce groups regarding safety cases; instead, the pipeline industry workforce groups are restricted to discussions regarding personal safety. Regulators are additionally reluctant to engage with the public in co-producing knowledge. The reasons involve the invisibility of pipeline risks, costs, accountability and power-knowledge (see Chapter 6). Interaction with these actors, as well as other non-conventional actors and other concepts, must emerge to inform constructive rationales.

How can regulators co-perform power-knowledge practices with non-conventional actors? Regulators need alternative rationales to support regulatory action. This means replacing the existing rationales with those having greater efficacy than the routine and bureaucratic-regulatory requirements around the ideals of ‘engagement’, ‘collaboration’ and ‘participation’ posited in the regulations. Two strategies: the deliberative democracy concept and the hybrid regulatory forum, may advance regulatory rationales in co-opting with others in the process of co-performativity (Section 8.3.2.2-8.3.2.3).

8.3.2.2 Developing the concept of deliberative democracy

To overcome the problems pertinent to incoherence of knowledge and practice in regulation, new regulatory concepts need to be identified and shared. This thesis deploys the concept of deliberative democracy in the process of co-performing power-knowledge as the most plausible strategy and the foundation to improve regulatory practices and effectiveness. The integration of deliberative theory with relational concepts of power-knowledge promises practical ways of managing, governing and assessing risk in relation to science, technology and the environment (see for example: Callon et al., 2009; Chilvers & Kearnes, 2016; Lockie, 2004b; 2007; Lockie, Sonnenfeld, & Fisher, 2013; Wong, 2015; 2016). In addition, deliberation is a
component of the responsive regulation and risk governance frameworks, both of which draw on Habermasian discourse theory and its focus on public participation in the communication process (Habermas, 1984; 1987); in an attempt to manage conflict in the public sphere (Wardman, 2008, pp. 1623, 1628) (discussed in Chapter 6, Section 6.2.2).

The deliberative concept of this thesis is based on Dryzek’s theoretical framework (Dryzek, 2000; Dryzek & Niemeyer, 2010). The concept of deliberative democracy, which is extended beyond communicative rationality, aims to promote collective choice mechanisms so that actors in the democratic process can achieve fair and reasonable outcomes from decision making (Lockie, 2007, p. 790). The notion of a deliberative concept is supported by the concept of intersubjectivity as a discursive representation (Dryzek & Niemeyer, 2008). The intersubjective discursive representation underlies the rationales of ontological entities, in which actors are equally and mutually justified and treated in the democratisation of making decisions (ibid, p. 483).

The integration of a deliberative concept into the process of co-performativity remakes the notion of engagement and participation, used in the concepts of tripartite engagement and risk governance. The integrative concept of deliberation can assist regulatory practitioners to re-configure their focus onto a dialogic democratisation process of deliberative engagement, rather than on the routine process of engaging with bureaucratic stakeholders.

A further step in co-performing power-knowledge practices utilising the deliberative concept involves actors being an integrative part of producing risk-safety knowledge and practices in safety cases, initiating, discovering and using safety procedures and safety concepts as well as setting up institutional and regulatory frameworks. Being part of the co-production of knowledge and practices, actors utilise their power relationships to maintain safety, reduce risk and increase resilience.

Despite its salience, the concept of deliberation has been criticised as not practical and easily ignored by regulatory practitioners (Little, 2000). Deliberation is used to establish fairness as part of regulatory requirements and norms. But, it has become challenging. The challenge emerges as part of risk-based regimes whereby self-regulating industrial companies are unwilling to engage with – and share their safety information with – the public (Baram & Lindøe, 2014, p. 51).
To overcome these constraints, it is necessary to develop clear guidance for regulators regarding how they should involve the various stakeholders. The deliberative concept cannot be floated as just an ideology: it needs to be promoted and enacted in a regulatory framework (e.g., responsive regulation, risk-based regulation or co-regulation) so as to assist regulators and other actors in renegotiating their roles, ideology and their existing power-knowledge practices in technological-pipeline risks. To remedy the democratic deficits, Baram and Lindøe (2014) emphasise that regulators must ensure that the self-regulatory activities of companies are consistent with their implementation of other laws including the law that protects workers’ rights (p. 51), as well as public rights in the case of Australian pipelines. The possibility of enacting the deliberative concept can be discussed among regulators at the hybrid regulatory forum. The concept of a hybrid forum will be discussed in the next section (8.3.2.3).

### 8.3.2.3 Developing the concept of hybrid forum

A hybrid regulatory forum is an elaboration of the concept of hybrid forum (Callon et al., 2009). Hybrid forums are theorised as open spaces of direct engagement with actors which assume importance when controversies about science and technologies take place. Callon et al. (2009) stress that:

> the controversies take place in public spaces that we propose to call *hybrid forums* … forums because they are open spaces where groups can come together to discuss technical options involving the collective, hybrid because the groups involved and the spokespersons claiming to represent them are heterogeneous, including experts, politicians, technicians, and laypersons who consider themselves involved (p. 18).

The hybrid forum may be seen as a theoretical trend (see for example: Irwin & Horst, 2016; Wong, 2015) on offer for practical applications, ideally employed as an alternative platform to manage emergent risk from science and technologies. Hybrid forums emphasise two factors. First, the forum democratically facilitates the process of co-performing power-knowledge among actors, in particular, with non-conventional actors (Callon et al., 2009, p. 30). Second, it re-poses identity and differences among groups affected by science and technology (ibid, p. 33-34). The rationale of a hybrid forum contains two types of criteria: one is about procedure and the other is about involving actors (presented in Table 8.4). These criteria are employed to strengthen a
hybrid regulatory forum, in particular to facilitate dialogic and non-hierarchical democracy.

Table 8.4: Rationales to strengthen a hybrid regulatory forum, containing six criteria.

<table>
<thead>
<tr>
<th>Criteria about procedures(^1)</th>
<th>Purposes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Equality</td>
<td>Providing necessary resources for non-conventional actors to co-produce knowledge</td>
</tr>
<tr>
<td>2. Transparency</td>
<td>Setting up transparency of debates</td>
</tr>
<tr>
<td>3. Clarity</td>
<td>Setting up clear rules of debate and the goal of process</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria about how to involve actors(^2)</th>
<th>Purposes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Intensity</td>
<td>Emphasising the intensity of collaboration among actors</td>
</tr>
<tr>
<td>5. Openness</td>
<td>Openness of a forum to a variety of groups</td>
</tr>
<tr>
<td>6. Quality</td>
<td>Emphasising quality of arguments among actors and the continuity of deliberation</td>
</tr>
</tbody>
</table>


Some of the findings that were revealed in thesis interviews indicate a need for setting-up forums where regulators can learn, share their knowledge, and network with industries, as suggested by a regulator participant here:

We have our liaison meetings and all that sort of thing but we should have more like a yearly forum with industry, all representatives from industry so … I think that’s somewhere where that could be an improvement. … If there was a forum where we can all go and representatives from each operation can go, and they can discuss it openly, what any issues that they’ve had just to ensure that there’s consistency but we’re doing the right job.

The forums, as recommended by the participants, can be either formal or informal. Irrespective of form, participants have limited scope in their roles as actors within the boundary between regulators and industries. The participants’ recommendation above, however, confirms that the existing regulatory practices have fallen into an ontological-epistemological logic that is unable to cope with pipeline risks.

The notion of a hybrid forum can be employed to assist regulators in setting up a hybrid regulatory forum that will enhance the ongoing process of collective exploration and collective learning in mitigating risk (Callon et al., 2009, pp. 34-35). The core aim of the hybrid regulatory forum is to establish a learning system among actors which requires the regulatory system to be open for criticism and to be self-critical itself.
regarding regulatory performance, structure and function (Hale, 2014, p. 422). In addition, the forum may be structured in a way that enables discussion, and encourages the mandate of regulatory instruments and regulatory indicators in response to change and learning processes so as to reduce risk and prevent catastrophic accidents (ibid).

A new form of deliberative democracy can be established in the form of collective alliances and assemblages that will improve mutual understanding among actors (Callon et al., 2009, p. 34) about pipeline risks. Regulators can use this concept of hybrid forum to set up a regulatory forum, which can be either a formal or informal platform for discussing and developing solutions to any concerns about pipeline risks. Regulators can use the six criteria (see Table 8.4) to evaluate whether the regulatory processes in identifying, assessing and communicating pipeline risks have been democratically achieved among actors. Similar criteria, for example, have been used to assess the processes of setting a radiation standard by three actors (government, private sector, and a consumer cooperative) in response to Fukushima-related food contamination (Kimura, 2013). Kimura’s article shows that both the government and the private sector standard-setting processes failed to engage with meaningful opportunities for democratic debate compared with the standard-setting process set up by a consumer cooperative (ibid). The article argues that democratic dialogue can be used as an important part of evaluating the standard.

The notion of a hybrid forum is an alternative to increase the independent roles of regulators by co-performing power-knowledge practices with diverse actors. The anticipated outcome is that traditional power relations will be partially dismantled and repositioned. Regulators may start the process of co-performing knowledge and practices with actors involving issues with which the actors are concerned, and to which they are closely related. The forum will allow actors to discuss, negotiate and find new safety procedures, new safety indicators, new safety concepts as well as new institutional arrangements that will enhance regulatory practices and effectiveness. This is what I refer to as the hybrid regulatory forum.

It is important to note that there is a large amount of existing literature on preventing risk through studies of technological disasters. To a certain degree, the existing literature and the hybrid forum share similar elements, in particular their emphasis on integrating the views of various stakeholders. Specifically, the existing literature tends
to set up tools or concepts for aiding decision making processes for risk prevention, risk assessment and risk management (see for example: Merad, Dechy, Llory, Marcel, & Tsoukias, 2014; Merad, Rodrigues, & Salvi, 2008) or for aiding experts to set up a critical system of thinking and a rationale to promote equality and mutual communication with ordinary citizens (see for example: Midgley, 1997; Ulrich, 1987). In contrast to the extant literature, this thesis foregrounds the concept of co-producing or co-performing power-knowledge practices to re-arrange the existing power assemblages among actors. Despite the differences, the tools and concepts developed by the existing literature about aiding decision-making processes and aiding experts can be useful for pipeline regulators to employ in their practices, in particular, with those who attempt to develop an integrated framework, based on expertise analytics and ethics pertinent to safety, security and the environment (see for example: Merad et al., 2014).

8.3.3 Co-accountability

The third element of performing new power-knowledge practices is co-accountability. Who will be accountable for what? In the risk-based approach and in co-regulation, conventional actors: regulators and industries, are required to substantially share their accountability (Baram & Lindøe, 2014, p. 53). The accountability of both actors is substantively ambiguous and negotiated, as indicated by the emerging discourses in this thesis.

To ensure accountability, not only the establishment of essential features is required, but accountability needs to be contested in a political sense by both conventional actors and non-conventional actors (Baram & Lindøe, 2014, pp. 50-51). The essential features, which are framed in the process of regulatory function, include: (a) criteria and standards for regulators to apply when evaluating companies’ performance; (b) authorisation of regulators to evaluate companies’ performance; (c) setting up goals that need to be met by companies; (d) authority for regulators to inspect and have access to information needed for evaluation; (e) authority for regulators to take actions against deficiencies in a companies’ performance; and (f) documentation and reporting requirements for regulators and companies (Baram & Lindøe, 2014, pp. 49-50). The essential features were developed and are used in the UK, USA, and Norwegian regimes (Baram & Lindøe, 2014, p. 49), as well as in Australia. They can be produced through the process of co-performing knowledge. The challenge for Australian pipeline
regulators is to set up a platform where the accountability of industries and regulators in the Australian pipeline case can be contested. The process of contestation will occur when regulators start to communicate with non-conventional actors. Such a process is contingent to and enhanced by the current push for transparency by the Australian Commonwealth government, emphasising that ‘people who will be affected by a proposed decision must be given an opportunity to express their views to the decision maker’ (Administrative Review Council, 2007, p. 1).

The process of co-accountability can be integrated with the concept of discursive accountability (Dryzek & Niemeyer, 2008, p. 490); and also with responsive regulation which argues for a link between deliberation, accountability and regulation (Braithwaite, 2006). Actors need to be accountable for the knowledge they co-produce (e.g., safety plans, emergency response plans, et al.). Although the accountability among conventional actors in the Australian pipeline case can be negotiated, the accountability of conventional actors will become less ambiguous and strengthen as a result of the ongoing process of co-performativity of knowledge among actors.

An ongoing process of co-performativity is expected to increase transparency and establish more trust. Actors will be more aware of what knowledge they produce. In addition, any issues concerning the inequality of knowledge, skill and financial constraints may be discussed and solutions found. For example, one solution is for regulators to be able to collect an increased amount of royalty fees from industries to facilitate the process of co-producing knowledge (a strategy suggested by regulator participants in this research). The process of co-performativity can assist regulators to be more efficacious, which could by extension lead to the mitigation of technological pipeline risks, improved regulatory practices and effectiveness, improving the process of risk regulation as well as reducing the inequalities of knowledge and power among actors. The process of performing new power-knowledge practices and the potential outcomes are presented in Figure 8.2.
Figure 8.2: The process and potential outcomes of performing new power-knowledge practices in the process of risk regulation.
Conclusion

This chapter has offered an alternative approach to improving the process of risk regulation with a goal to improve regulatory practices and effectiveness. The approach attempts to remedy empirical challenges arising from the performativity of incoherent power-knowledge practices throughout the process of risk regulation (i.e., risk identification, risk assessment, risk communication and risk accountability). These practices generate from power-knowledge relationships that shape knowledge and practices associated with regulatory outcomes. The three stages of the process proposed for performing new power-knowledge practices include: (a) re-arranging the ontology of risk; (b) co-performing power-knowledge practices with diverse groups of actors; and (c) strengthening the co-accountability of conventional actors by integrating with the concept of discursive accountability.

First, the ontology of risk must be re-arranged and extended. The new ontology of risk involves a dynamic, relational approach – not a fixed model. The ontology of risk that I propose is an open approach with questions to be discussed and negotiated (I am not proposing a new form of ontology but a re-arrangement and extension). The ontology of risk involves questions not only about what is but also about who has been involved and how? These have become the key questions in re-theorising the ontology of risk. As influenced by empirical findings and ANT rationalities, the current ontology of risk exhibits multiplicity, negotiation and incoherence (becoming disassociated by obfuscation and fragmentation). This ensemble can be modified in a revised form of ontology that re-arranges the ontological-epistemological logic of regulators, re-arranges mismatched safety concepts and extends to developing an awareness of unacknowledged assemblages.

Second, the process of co-performativity of power-knowledge practices with others outside of conventional entities needs to be organised. In order to co-perform power-knowledge practices, regulators need alternative rationales to change their normative practices. First, the power relations of conventional institutions need to be re-arranged to reflect the discursiveness of power. Regulators need to co-perform their knowledge and practices in relation to risk regulation with diverse groups of non-conventional actors (e.g., silent actors, affected actors, unwelcome actors, other regulators and emergency response actors). The process of co-performing power-knowledge practices
with these actors can be co-opted with interactors who sympathise with and are willing to work to reduce the risks that threaten affected actors in non-conventional ways. Interactors can be posited both within and outside industry pipeline institutions.

To strengthen the co-performativity of power-knowledge practices with non-conventional actors, two concepts are required: the concept of deliberative democracy and the concept of a hybrid regulatory forum. Both of these concepts should be enrolled in the regulatory network. Deliberative democracy, which is employed to re-make the concept of engagement and participation, is widely alluded to in the contemporary literature along with the concepts of tripartite engagement and risk governance. The ideal of engagement and participation in the Australia pipeline case is muddled because it is variously involved with traditional forms of power relations, the cost of implementation, and the complexity of the regulatory framework. The concept of deliberative democracy is underlined with intersubjectivity whereby actors are equally treated in order to achieve fair and reasonable decision-making from the collective choice mechanisms. The concept of deliberative democracy will assist regulators to mutually engage with others to co-produce knowledge and practices appertaining to the process of risk regulation.

The last rationale is the concept of a hybrid regulatory forum. This concept comprises six criteria designed to assist regulators in facilitating dialogic and non-conventional democracy. The process of co-performing knowledge and practices with diverse actors, both conventional and non-conventional, using these three alternative rationales will assist regulators to remedy the challenge of being subtly trapped by their own deleterious practices during engagement in bilateral relationships with industry.

Last, a process of strengthening co-accountability between conventional actors is required, and can be achieved through integration with discursive accountability. Conventional actors need to be accountable for knowledge and practices that they produce in safety plans, emergency plans, et al. Conventional actors who use discursive accountability will be aware of and accountable for any and all of the knowledge and practices they produce to prevent catastrophic accidents.

Performing new power-knowledge practices within three stages is an on-going process of collective exploration and collective learning in mitigating technological risk. The on-going process of performing new power-knowledge practices may lead to lessened
ambiguity in accountability, increased transparency of power-knowledge practices, increased independency of regulators, and improved processes of risk identification, risk assessment and risk communication. These will putatively lead to a reduction of risk and improvements in the process of risk regulation, resulting in the improvement of regulatory practices and effectiveness.
Chapter 9
Conclusions and the future

Questions of regulatory effectiveness arise in the wake of catastrophes and associated risks associated with science and technology. The mainstream is critical of the failures of regulators and their objectivist-realist approach in regulating and controlling risk. The criticism reproduces certain discourses of responsibility. This thesis challenges mainstream criticism. It argues that such discourses of responsibility black box the roles, actions, and inactions of regulatory experts (or ‘elite-expert institutions’), obstructing exploration of how power-knowledge and the practices of regulators are performed. These issues were put forward for questioning in this research.

This thesis has taken a critical and empirical approach, inspired by ANT and the concept of Foucauldian power-knowledge as a theoretical and methodological framework. It has aimed to improve the process of risk regulation by investigating: (1) how power-knowledge in relation to risk regulation is performed by and around regulators in the case study of pipeline industries in Australia; and (2) how the process of power-knowledge in relation to risk regulation can be improved? The inquiry into these research questions has led to a re-configuration of the understandings of scholars, regulators and practitioners about how realities (power, knowledge, and practices) are formed in relational effect, leading to an improvement in risk regulation (i.e. risk identification, risk assessment, risk communication, and risk accountability).

The findings indicated that the actions and inactions of regulators are the effect of multiple complex relational assemblages, situated within, between and outside of organisations. The technical-regulatory actants (e.g., safety plans, risk-based regulations, and technical-regulatory specifications of the Australian pipeline standard) are part of the heterogeneous assemblages that influence the actions of regulators. Perhaps unsurprisingly, the objectivism-realism of regulatory practice was found to limit its effectiveness in a number of ways. Further, the thesis provides insight into: how regulatory knowledge and practices (or actions), in specific instances, are performed; and who and what material entities are involved. Various research themes and assemblages, which have been disassociated from and remain unacknowledged in the existing literature, were gradually revealed throughout the investigation of a series of material-social assemblages (discussed in Chapters 4-7 and summarised in Table 8.1).
The assemblages that shaped regulators’ action and inaction were beyond organisationally-based factors and the politics of what scholars, regulators, and practitioners understand and imagine through the reproduction of discourses in relation to regulatory responsibility in the contemporary literature. Regulatory actions, roles and accountability have been shaped not only by the technical-regulatory entities, the regulatory-organisational structure, the decision-making processes within their organisation, and the resource insufficiency of skills, capacities and finance as key organisational factors; but also shaped through regulatory dependency on industrial knowledge and activities. Such dependency is embedded within their risk-based regulatory regime despite the usefulness of risk-based regulations and advances in replacing prescriptive regulations.

The assemblages that influence regulatory action and inaction also include the complexity of pipeline regulations and regulatory arrangements across Australian states. The intention of regulation is misunderstood and misused by the industry, an intention most pronounced when a pipeline crosses the boundary between two states. Pipeline industries choose to follow the regulation of one state and not the other due to the cost involved and the complexity of regulations that allow industries to obfuscate their obligations.

Other influences affecting regulatory actions, roles and accountability are associated with regulatory interpretations of the technical concepts they have created, such as measurement length, as well as with their own interpretation of public engagement and their discomfit when engaging with unions. The findings further indicate that regulators largely omit to acknowledge the outside influences that drive their inaction, derived from their own technologies of government, such as deregulation and energy privatisation which constitute part of neoliberalisation. Regulators struggle with the technical-regulatory approaches they have created to leverage their power-knowledge relationships and their existing power-knowledge practices.

In the main, the findings show that the knowledge and practices appertaining to risk, safety and regulation that actors hold are incoherent throughout the regulatory process from regulators through to pipeline managers, pipeline engineers, pipeline technicians, their contractors and sub-contractors, planning authorities, as well as the public. The reasons for this incoherence of knowledge and practice are multiplex. They include
obfuscation through the concept of measurement length and its late enactment in 2007; misused and misunderstood concepts of safety in the literature, especially the distinction between process safety and personal safety, and the re-structuring of pipeline companies as a result of pipeline energy privatisation.

The disassociated knowledge and practices related to risk, safety and regulation in elite-expert institutions are reframed to improve the process of risk regulation. The empirical findings (e.g., limitations of regulatory skills and regulatory capacities, limitations of regulatory resources, complexities of regulations) can be put forward as straight policy amendments in the decision making process of regulatory institutions. The enhancement of technical skills and regulatory capacities can be strengthened by a training system. The financial resources can be increased though the development of the pipeline licensee’s fee process. The decision makers can alter the complexities of pipeline regulations by involving third parties to oversee and mandate the review of regulation.

The policy amendments are not the only way to improve the process of risk regulation. This thesis has proposed more in-depth exploration of changes concerning the root or origin of risk (described here as ‘what is’ risk), drawn from the empirical and theoretical implications of this thesis. These implications are composed of three dynamically-related stages: (a) re-arranging the ontology of risk in association with power-knowledge practices; (b) co-performing power-knowledge practices with diverse actors; and (c) co-accountability.

These three steps, involving a new performance orientation, offer an alternative approach to improve the process of risk regulation. The rationales of performing new power-knowledge practices revolve around rearranging the ontology of risk, re-identifying actors, and re-positioning the form of power-knowledge traditions and hierarchies to discursiveness. The reconfigured ontology of risk is not merely focussed on technical-regulatory aspects in regulating risks, as part of the existing Australian regulatory practices, but the ontology of risk is related to power relations that are incoherent, multiple and negotiable.

The process of co-performing power-knowledge practices with diverse actors is supported by the concepts of discursive power-knowledge assemblages, deliberative democracy and the hybrid regulatory forum to re-make the concepts of risk governance, engagement, collaboration and participation. Diverse actors will be mutually treated so
as to gain fair and reasonable outcomes from decision-making processes. Through the process of co-performing power-knowledge practices, diverse actors will be able to negotiate and re-negotiate how risk is identified, assessed, communicated and made accountable. The re-negotiating process among actors will perform new, diverse and different forms of power-knowledge practices and strengthen the co-accountability of conventional actors, playing their roles to regulate and mitigate technological risk.

The on-going co-performance of power-knowledge practices may lead to these following positive outcomes: assisting regulators to lessen the ambiguity of accountability; increase the transparency of power-knowledge practices; increase the role-independence of regulators; and improve the process of risk regulation. These processes should lead to a reduction in technological risk. The new approach will assist regulators in improving the process of risk regulation (i.e., risk identification, risk assessment, risk communication and risk accountability), resulting in positive changes in regulatory outcomes. Such an approach can be employed to regulate risk that involves science and technologies at large, or at least to regulate the Australian Pipeline energy industry for the sake of balancing power-knowledge practices. It cannot merely be used to optimise regulatory effectiveness and practices for industrial benefit, but more importantly, to reduce inequality and the inaccessibility of knowledge on risk, safety, and regulation for affected, marginalised and silent actors within, in between and outside organisations.

Before concluding, this thesis suggests that in order to better improve the process of risk regulation, mitigate pipeline risks and prevent catastrophic pipeline accidents, further research is needed. Potential research could study relationships among these following assemblages: (a) relationships of assemblages among the collective workforces of pipeline industries; (b) relationships of assemblages within and connected to emergency response organisations; (c) relationships of assemblages associated with regulatory regimes used successfully in other countries (e.g. UK and Norway) that serve as ideal cases by participants; (d) relationships of assemblages associated with economic regulators; and (e) relationships of assemblages connected to process safety and personal safety.

The research can be explored both theoretically-methodologically and empirically with the following research questions.
First, how can workforce collective groups contribute their roles and knowledge to the improvement of processes of risk identification, risk assessment, risk communication and risk accountability in reducing technological risk?

Second, how can emergency response actors perform their safety knowledge to prevent and manage energy pipeline accidents? What concepts have they used and how can such concepts be improved to reduce technological risk and improve resilience?

Third, what are the UK and Norway regulatory strategies and how they have been performed in negotiating-regulating energy industries in these places to enhance their regulatory practices and effectiveness?

Fourth, what can be improved to enhance regulatory practices and effectiveness to limit risk associated with neoliberal structures and processes relevant to energy industries?

Fifth, how can the mismatch, misunderstandings, and misuse of safety concepts in the division between process safety and personal safety be improved?

Research into these disassociated relationships can potentially reveal new knowledge, practices, and assemblages from the existing literature. This type of research can assist scholars and practitioners in widening the ways of coping with pipeline risk and improving the process of risk regulation. It is hoped that the outcomes from the present and future research will lead to the better prevention of pipeline-related risk that affects humans, society, environment, and their associations.
Appendix. Interview Protocol (sample)

Interviews of regulators: potential interview questions, themes, and subthemes.

1. Icebreaker questions.
   1.1. Regulatory background.
       • What is your background (e.g. science, policy, management)?
       • What is your role?
       • How does your role fit into the overall role of your agency/department?
       • How many years have you been working in this position?

2. Introduction, main themes and follow-up questions.
   2.1. Regulatory challenges.
       • What is the most important issue or challenge that regulators encounter these days?
       • How do you see your role in dealing with this issue?
       • Are there other issues you would like to mention as well?
       • How well equipped do you think regulatory frameworks and agencies are to deal with new industries or policy settings?

   2.2. Regulatory trends.
       • What about regulatory approaches? Have you seen any major changes in approaches to regulation? If you have, what are they? What has worked well and how? What has not worked and why?
       • In your opinion, what are the main reasons behind the changes?
       • Who has been involved in those changes (governments/ regulators/industries/the public or workers)? Who are the key actors among them who create change and how?

   2.3. Knowledge construction and regulatory actions.
       • Based on your own role, what knowledge do you use to cope with the problems you have mentioned (e.g. assessing submissions, inspecting, or (x))? 
         o (or asking a more practical version) You’ve said that your main job is (assessing submissions, inspecting, or (x)). Can you talk me through a recent (assessment, inspection or (x)) and describe how you decided what to do?
         o Can you explain why you chose to do that? What else might you have done? How did you know?
       • How do you obtain such knowledge?
       • Who is involved?
       • What do you read (or hear, or watch)?
       • What might have shaped or influenced the knowledge you used, your knowledge-capacity and actions?
         o These influences may include the following:
           ▪ (a) regulatory apparatus (e.g. changes in regulatory approaches, development of new regulatory standards or new regulatory devices)
           ▪ (b) policy changes (e.g. cutbacks, new industrial policies introduced (e.g. for coal seam gas fracking, carbon dioxide pipelines)
           ▪ (c) firms (e.g. roles and actions of firms, interaction with corporations, subtle forms of regulatory capture, regulatory enforcement, different perspectives from firms)
           ▪ (d) risk characteristics; embedded in uncertainty, ambiguity and complexity
(e) non-governmental bodies (e.g. roles and actions of non-governmental bodies, participatory actions, different views)

- How have these influences shaped the knowledge you used, your knowledge-capacity and actions? Who was involved?

2.4. The influence of risk characteristics; embedded in uncertainty, ambiguity and complexity.

- When there is potential for accidents in hazardous industries (including the pipeline industry), what knowledge do you use to cope with uncertain situations that may occur?
- When you have a problem, who do you ask for advice?

2.5. Opportunities for improvement.

2.5.1. Improvements in the knowledge that regulators used and their knowledge-capacity.

- What do you think could be changed to improve the knowledge you used and your knowledge-capacity and actions? For example, what could be changed in dealing with uncertain situations?

2.5.2. The improvement in regulatory actions.

- What about regulators themselves? Where do you see opportunities to improve what you and other regulators do?

2.5.3. The improvement in regulations.

- What about regulation? What do you think could be done to improve regulations?
- Where do you see opportunities to improve the effectiveness of regulations?

3. Finishing-up question.

- Are there any important issues that have not been addressed through this interview session? If there are, what are they and would you like to discuss them?

4. Potential probing questions. What influences knowledge, knowledge-capacity and regulatory action?

4.1. How have changes in regulatory approaches influenced the knowledge you used, your knowledge capacity and regulatory action?

- What was your experience when there was some change in regulatory approach?
- Have these changes affected your roles, knowledge and actions? If they have, how?
- Who was involved?

4.2. The influence of policy changes.

4.2.1. Cutbacks.

- Were there any cutbacks that affected your knowledge and capacity to deal with regulatory problems? If there were, what were they and how have these affected your knowledge and actions?

4.2.2. Industrial policy changes.

- When new industrial policies are introduced (e.g. for coal seam gas fracking, carbon dioxide pipelines), have they affected regulations? If they have, how?
- Has the introduction of new industrial policies affected your role, knowledge and responsibility? If they have, how?
- Who was involved? When did it occur?

4.3. The influence of firms.

4.3.1. Influence of the roles and actions of firms.

- How do you see the role of firms?
• Has their role and actions affected your roles, your knowledge and actions? If they have, how have they been affected and in what way?

4.3.2. The influence of interaction with corporations
• How many firms do you need to inspect?
• How many regulators do you have in your team?
• Would you like to share some of the difficulties around your regulatory task in dealing with firms? If so, what are they? Have these difficulties affected your knowledge and actions in enforcing the firms? If they have, how can these be improved?

4.3.3. The influence of subtle forms of regulatory capture.
• When you first started your job, and needed to deal with big corporations, how did you feel about it?
• What about now - how have you considered your position in dealing with them?
• Has this interaction affected your knowledge and action in dealing with the firms?
• Have you ever come across firms that use loopholes in the legislation to take advantage over workers or communities? If you have, what are they and how did you cope with this problem? How could it be improved?

4.3.4. The influence of regulatory enforcement.
• What are the best knowledge-strategies you have used to enforce noncompliant firms?
• How did you use them to enforce the compliance of firms?
• Have you revised them at any point?
• What kind of support do you need to improve your knowledge-capacity in helping you deal with firms?
• Do the firms require support from you to improve their knowledge-capacity? If they do, what kind of support do they need from you?

4.3.5. The influence of different perspectives from firms.
• Have the firms’ views affected your knowledge production and actions? If they have, how have they been affected, and in what way?

4.4. The influence of non-governmental bodies.
4.4.1. The influence of roles and actions of non-governmental bodies.
• How do you see the role and action of non-governmental bodies?
• Has their role and actions affected your role, your knowledge and actions? If they have, how?

4.4.2. Influence by the participatory actions of non-governmental bodies.
• Have you been involved with non-governmental bodies in enforcing and monitoring regulations? If you have, who are they and how did the involvement take place?

4.4.3. The influence of different perspectives from non-governmental bodies.
• Have the views of non-governmental bodies affected the knowledge you used, knowledge-capacity and actions? If they have, how have they been affected, and in what way?
Interviews of operating company staff: potential interview questions, themes and subthemes

1. Icebreaker questions.
   1.1. The background of operating company staff.
   • What is your background (e.g. science, policy, management)?
   • What is your role?
   • How does your role fit into the overall role of your agency/department?
   • How many years have you been working in this position?

2. Introduction, main themes and follow-up questions.
   2.1. Regulatory challenge.
   • What is the most important issue or challenge that you encounter with regulations these days?
   • How do you see your role in dealing with this issue?
   • Are there other issues you would like to mention as well?
   • How well is your agency/department equipped with regulatory frameworks and compliance processes/policies?

   2.2. Regulatory trends.
   • What about regulatory approaches? Have you seen any major changes in approaches to regulation? If you have, what are they? What has worked well and how? What has not worked and why?
   • In your opinion, what are the main reasons behind the changes?
   • Has the industrial sector been involved in those changes? If it has, how? If it has not, why? Who else has been involved with those changes? What are their roles? Who are the key actors among them, who create change and how?

   2.3. Regulatory actions towards risk characteristics; embedded in uncertainty, ambiguity and complexity.
   • Do you feel that regulators have the same view of key risk issues in your workplace as you do? Do you think they focus on the right thing?

   2.4. Regulatory engagement.
   • How do you see the roles of regulation?
   • What about the regulators? How do you see their roles?
   • Have you discussed contentious issues with them? If you have, what were the issues you raised? What were their responses or actions?
   • Have you shared any difficulties you have encountered with regulators? If you have, what were their responses or actions?

   2.5. Third parties engagement (e.g. workforce unions and communities)
   • What about third parties? How do you see their roles?
   • Have you involved them in maintaining your safety system? If you have, who were they and how did you engage them? What contentious issues have been raised and resolved?

   2.6. Opportunities for improvement
   2.6.1. Improvement in the operating staff’s actions.
   • Where do you see opportunities to improve what you and other operating staff do?

   2.6.2. Improvement in regulations.
   • What about regulation? What do you think could be done to improve regulations?
• Where do you see opportunities to improve the effectiveness of regulations?

3. Finishing-up questions.
• Are there any important issues that have not been addressed through this interview session? If there are, what are they, and would you like to discuss them?

Interviews of workforce health and safety representatives: potential interview questions, themes and subthemes

1. Icebreaker questions.
1.1. Background of workforce health and safety representatives
• What is your background?
• What is your role?
• How many years have you been working in this position?
• How does your role fit into the overall role of your agency/department?

2. Introduction, main themes and follow-up questions.
2.1. Workforce challenge.
• What is the most important issue or challenge that you encounter with the firm these days?
• How do you see your role in dealing with this issue?
• Are there other issues you would like to mention as well?

2.2. Regulatory challenge.
• How do you see your regulatory role in protecting the workforce?
• How well is the firm you have worked for equipped with regulatory frameworks and compliance policies and processes?

2.3. Regulatory trends.
• Have you see any major changes in approaches to regulation? If you have, what are they? What has worked well and how? What has not worked and why?
• In your opinion, what are the main reasons behind the changes?
• Have you been involved in those changes? If you have, how? If you have not why? Who else has been involved in those changes? What are their roles? Who are the key actors among them, who create change and how?

2.4. Regulatory actions towards risk characteristics, embedded in uncertainty, ambiguity and complexity
• Can you give me some examples of when regulators have made a difference to safety in your workplace? Are there other things they might have done?

2.5. Interaction with regulators and firms (workforce engagement).
• Have you discussed contentious issues with the regulators or the firms? If you have, what were the issues you raised? What were their responses or actions?
• Have you ever been consulted by the regulators or the firms? If you have been, what were the issues they raised? If you have not, why?
• Have you ever been involved in the regulatory process? If you have, what did you do? If you have not been involved, what do you think about it? Do you want to be involved? If you do, can you please give me your reasons? If you do not, can you please give me your reasons as well?
• Have you ever been involved in maintaining the safety system of the firm? If you were, how were you involved and what did you do? If you were not, what
did you think about it? Do you want to be involved? If you do, can you please give me your reasons? If you do not, can you please give me your reasons as well?

2.6. Opportunities for improvement
   2.6.1. Improvement in workforce actions.
   • Where do you see opportunities to improve what you and other workers do?
   2.6.2. Improvement in regulations.
   • What about regulation? What do you think could be done to improve regulations?
   • Where do you see opportunities to improve the effectiveness of regulations?

3. Finishing-up question.
   • Are there any important issues that have not been addressed through this interview session? If there are, what are they, and would you like to discuss them?
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