

Carbon copy: The mock bureaucratic setting of colliery explosions in early Twentieth Century Britain and at Pike River, New Zealand

REVELEY, James and SINGLETON, John <<http://orcid.org/0000-0002-9286-5559>>

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3 **Carbon Copy: The Mock Bureaucratic Setting of Colliery Explosions in Early**
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5 **Twentieth Century Britain and at Pike River, New Zealand**
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10 **Abstract**

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13 **Purpose:** By juxtaposing fatal colliery explosions in early twentieth century Britain and in
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15 2010 at Pike River, New Zealand, this paper investigates the generalizability of the mock
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17 bureaucracy concept to underground coal mining disasters.
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21 **Design/methodology/approach:** The main source is published official accident inquiries; a
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23 methodological reflection justifies use of these materials.
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26 **Findings:** Mock bureaucracies existed in British underground coal mining milieu from the
27
28 time when safety rules were first formulated in that industry context. As for Pike River, it is
29
30 an exemplary case. The development in 1970s Britain of a new approach to safety
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32 management (the Robens system), and its subsequent export to New Zealand, means that a
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34 contemporary coal mine under financial duress, such as Pike River, is a prime site for mock
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36 bureaucracy to flourish.
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39 **Originality/value:** Though the concept of mock bureaucracy has been applied to an
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41 explosion in an underground coal mine before, this is the first paper to explore the concept's
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43 historical utility and generalizability in explaining the environing context of such
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45 explosions.
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3 Of all places of work that can fill a worker with fear and anxiety, a mine is among the
4
5 foremost. Its darkness alone is enough to oppress even the staunchest soul; its dim,
6
7 deserted rooms are a gloomy reminder that it is all too possible to get lost there.
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10 (Gouldner, 1964, *Patterns of Industrial Bureaucracy*)
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16 **Introduction**

17 Tracing lines of continuity and discontinuity is the stock-in-trade of the professional
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19 historian (Sewell, 2005). The writing of management and organizational history is no
20
21 exception to this rule. The present paper focuses primarily on the continuity side of the
22
23 coin. It explains how a distinctive bureaucratic pattern – characterized by organizational
24
25 stakeholders routinely acting in concert to ignore safety rule violations – can constitute the
26
27 key context for fatal colliery explosions. Examples from the British coal industry in the
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29 early twentieth century are juxtaposed to the case of the 2010 mining disaster at Pike River,
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31 a remote location on the West Coast of New Zealand's South Isle, where twenty-nine
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33 miners perished. Admittedly, every underground coal mine - situated in a fixed spatial and
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35 geomorphological locale and within a specific regional and social setting - has unique
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37 features. Between the selected past and present disasters there is also substantial technical
38
39 progress due to the development of mechanized methods of coal mining, which Trist and
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41 Bamforth (1951) documented in their famed study into the introduction of underground
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43 longwall mining. Yet a singular thread runs like a leitmotif through the British and
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45 Antipodean cases. The twin objectives of safety on the one hand, and profits and earnings
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47 on the other hand, were juggled by key stakeholders; a process in which safety was let slide
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49 in the hope that a disaster would not happen. In explaining such outcomes, we use aspects of
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51 organizational theory to label this pattern and to explain how it crystallizes.
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3 We take our conceptual cue from work by Hynes and Prasad (1997) who trace the
4 origins of the 1992 explosion at the Westray coal mine, in the Canadian maritime province
5 of Nova Scotia, which resulted in twenty-six miners being killed. The latter authors apply
6 the sociologist Alvin Gouldner's concept of mock bureaucracy, showing that managers and
7 workers were complicit in ignoring an elaborate set of safety rules in a desperate effort to
8 boost revenue and make the mine commercially viable. Mine inspectors knew what was
9 happening, but declined to intervene because Westray was of great political importance to
10 the province. Certainly, Westray and Pike River exhibit commonalities. Though the mines
11 were in essentially the same predicament, struggling to meet financial targets at an early
12 stage of development, this paper's purpose is not to compare the two cases directly. Rather,
13 by bracketing together the Pike River and British mine explosions, we put Hynes and
14 Prasad's findings in historical perspective.
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28 By showing that the phenomenon defined by Gouldner as mock bureaucracy existed
29 in the early twentieth century British milieu, we also inflect the concept with historical
30 nuance. Central to the concept of mock bureaucracy are understandings not of how rules are
31 made in organizations but rather how they are broken. We argue that despite – and in
32 certain respects because of – the development in 1970s Britain of a new approach to safety
33 management (the Robens system), and its subsequent export to New Zealand, a
34 contemporary coal mine under financial duress, such as Pike River, is a prime site for mock
35 bureaucracy to flourish. Our primary theme, though, is mock bureaucracy, and the
36 regulatory regime is discussed not for its own sake but rather for its implications for the
37 growth of mock bureaucracy. This significantly extends our previous work on British
38 mining disasters (reference withheld). The analysis is distinguished from these earlier
39 writings by the adoption of the mock bureaucracy framework, the introduction of additional
40 case studies and, through the discussion of Pike River, the inclusion of an international
41 comparison.
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3 Our paper is organized in the following manner. The first section locates the mock
4 bureaucracy concept within classic industrial sociology and explains how the concept still
5 has relevance. The second section provides a methodological reflection on the official
6 inquiries that are this paper's main source. In the third section, the historical origins of
7 safety rules pertaining to British coal mines are discussed, and comparisons are made to the
8 equivalent New Zealand regulatory regime. The fourth section presents vignettes of three
9 British coal mine explosions – Genwen (1907), Wellington Pit (1910) and Gresford (1934).
10 The mock bureaucratic context of these disaster events is underscored. As a contemporary
11 example of the distinctive type of mock bureaucracy evident at Gresford, Pike River is
12 examined in the fifth section. Reflecting back on the cases, the concluding section explains
13 why underground coalmining today is vulnerable to mock bureaucracy arising within the
14 sphere of safety. The discussion finishes with some future research directions.
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29 **Resituating the Concept of Mock Bureaucracy**

30 How organizational theory and history intersect is a topic of interest both to organizational
31 scholars and to management and business historians (Clark and Rowlinson, 2004). Within
32 the domain of the theory of bureaucracy specifically, sensitivity to the risks of abstracting
33 concepts from history has been present in work by the field's sociological founders since the
34 outset (Albrow, 1970). It was none other than the pioneer of bureaucratic theory, Max
35 Weber, who advanced the methodological notion of the 'ideal type' – which by its very
36 nature is open to context and history (Weber, 1922/1964, p. 110).
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46 The dangers of a 'grand theory' disconnected from history have been highlighted by
47 US-based Weberians such as C.W. Mills (1959/1983). Set against this backdrop, *Patterns of*
48 *Industrial Bureaucracy* by Alvin Gouldner – an American sociologist of Weberian stripes – is
49 a seemingly aberrant case (Gouldner, 1964). Built around a snapshot of a single gypsum
50 mine and processing plant, circa the early 1950s, the study is dated to a particular time and
51 place.¹ It is not replete with historical consciousness, and does not have Weber's wide-
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3 ranging historical scope (cf. Collins, 1986). Nonetheless, we regard Gouldner's work as a
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5 live option with which to inform comparative and historical analysis of underground mining
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7 explosions. This entails reading Gouldner as a theorist of rule breaking rather than of
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9 bureaucracy per se. Even today, mines are not classic sites of bureaucratic organization; in
10
11 terms of one organizational taxonomy, they incline as much to the craft as to the
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13 bureaucratic end of the continuum (Stinchcombe, 1959). No matter, for it is in analysing the
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15 application of rules in particular, rather than the features of bureaucracy in general, that
16
17 Gouldner excels (Martin *et al.*, 2013). Mock bureaucracy occurs when an organization's
18
19 stakeholders collude to break, bend, or ignore rules in a manner that persists over time and
20
21 becomes routinized. To be sure, Gouldner's case study does not portray safety regulations
22
23 as a domain for the operation of mock bureaucracy; the study focuses instead on a tolerant
24
25 managerial regime under which miners were allowed to ignore a smoking ban. Unlike in a
26
27 gaseous or dusty coal mine, smoking is not a genuine safety issue in a gypsum mine. Yet, as
28
29 the sociologist clearly acknowledges, there is no reason why, at other sites, safety rules
30
31 cannot be the object of mock bureaucracy (Gouldner, 1964, p. 205). Simply put, the rule
32
33 violation pattern Gouldner documented is not unique to any particular type of rule.
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38 Gouldnerian insights into routinized rule-breaking are eminently applicable to safety
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40 rules in underground coal mining. At Westray, Hynes and Prasad (1997, p. 611, emphasis
41
42 omitted) conclude, 'the safety rules themselves showed all of the characteristics of a mock
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44 bureaucracy.' The Westray case suggests that mock bureaucracy occurs at two levels:
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46 workplace and institutional. The former is when members of the mine managerial hierarchy
47
48 know about and tolerate the flouting of safety rules underground. This workplace-based
49
50 pattern is consonant with Gouldner's findings, in every respect except rule content. To
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52 understand the institutional level, however, entails going a step beyond his work.
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56 One of the new institutionalism's greatest insights is that organizations operate in
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58 institutional settings where the pressure to conform to social and legal norms varies
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3 (DiMaggio and Powell, 1991). In this vein, Martin et al. (2013) argue that consensual rule
4 violation can occur at the level of the interplay between organization and institutional field.
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7 In a manner Gouldner did not envisage, there is a real 'possibility of organizational-level
8 rule-breaking *permitted* by field-level actors' (Martin et al., 2013, p. 558, emphasis in
9 original). Such actors include, but are not limited to, industry regulators, safety enforcement
10 agencies, and anti-competition watchdogs. If the mock bureaucracy concept can be modified
11 in this way, what would institutional-level mock bureaucracy in underground coal-mining,
12 specifically in relation to safety, look like? Though the paper by Hynes and Prasad (1997)
13 both predates the comprehensive review by Martin et al. (2013) and does not feature in the
14 review, the write-up of the fieldwork on which Hynes and Prasad draw provides an answer.
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25 The characteristics of the institutional-level rule-breaking pattern are as follows:

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27 management and the mining inspectorate may collude in such a way that management
28 is lax in its statutory responsibilities to enforce certain rules and the monitoring body,
29 the mine inspectors, implicitly or explicitly, allow the non-compliance to continue
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33 (Hynes, 1999, p. 117).
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36 As we shall see, evidence can be adduced from the British cases to demonstrate both the
37 workplace-based and institutional-level forms of mock bureaucracy. In the case of Pike
38 River, for reasons we will explain in the fifth section, the evidence points to the institutional
39 level as the locus of mock bureaucracy.
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44 **Methodological Reflection on Sources**

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46 Most of the evidence for our investigation is taken from published official accident inquiries.
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48 In the case of Pike River, the New Zealand government established a Royal Commission
49 which held hearings and published a two volume report on the tragedy. Official inquiries –
50 often very detailed ones – were also conducted into mining disasters in Britain in the early
51 twentieth century.² Clearly, one of the advantages of using such documents is the wealth of
52 fine-grained detail that they contain, which cannot be found elsewhere. British and
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3 Commonwealth accident and disaster investigations tend to be inquisitorial rather than
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5 accusatorial. Their stated goals are to find out what happened and why, and to recommend
6
7 remedial action (Hutter, 1992). They do not seek explicitly to find a culprit, although in
8
9 most cases they cannot avoid making some criticism of management or employees, or of
10
11 both.
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13
14 We acknowledge that disaster reports should be read critically. There is a
15
16 ceremonial element to official inquiries and reports (Hilgartner, 2007). Moreover,
17
18 interpretations could well be twisted to support the status quo. Brown (2000), for example,
19
20 argues that the Allitt Report into the background to the murder of four children by Beverly
21
22 Allitt, a nurse at a Lincolnshire hospital in 1991, was constructed in such a way as to
23
24 exonerate the medical profession from any suggestion of culpability or negligence. More
25
26 generally, it has been argued that official disaster inquiries are designed first and foremost
27
28 to deflect criticism of the authorities and powerful business interests (Birkland, 2009).
29

30
31 If used carefully, however, official disaster reports, including those into mining
32
33 accidents, can be very informative. Let us start with early twentieth century British disaster
34
35 reports. Most investigation reports were written by a member of His Majesty's (H.M.)
36
37 Mines Inspectorate, often with the assistance of a Home Office solicitor. A typical report
38
39 summarized and commented upon the evidence heard at the inquest. Investigators also had
40
41 access to reports on previous inspections of the colliery and plans of the workings. On
42
43 occasions, scientific tests were conducted on behalf of the investigators, and the results
44
45 presented in an appendix. After some of the most serious and complex explosions, however,
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47 separate hearings were held in addition to the inquest. One of the disasters examined below,
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49 Gresford, was the subject of a formal public inquiry: the Chief Inspector of Mines acted as
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51 commissioner, and was assisted by assessors, one representing the industry and the other
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53 the workforce. In so far as the investigators were biased they were most likely to have been
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55 biased in favour of the Inspectorate, but at the Gresford inquiry the competence of
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3 inspectors was deliberately challenged. It should also be pointed out that members of H.M.
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5 Mines Inspectorate were required to have several years' experience of mine management,
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7 and as a result may have been more likely to share the attitudes of management than of the
8
9 miners. Nevertheless, careful reading of the official reports shows that as much, if not more
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11 of the criticism contained therein, was directed at management and the company as it was
12
13 towards the miners. Such reports were neither whitewashes of mine management nor of
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15 mines inspectors.
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18 Moving forward, three commissioners were appointed to the Pike River Royal
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20 Commission: Graham Panckhurst, a High Court judge; Stewart Bell, the Commissioner for
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22 Mine Safety and Health for Queensland, and David Henry, a former Chief
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24 Executive/Commissioner of Inland Revenue. This group was even more independent than
25
26 the British investigators, and had a wider range of outside technical expertise on which to
27
28 call. The commissioners were not beholden to mine inspectors and were deeply critical of
29
30 them. Their findings were remarkably consistent with those of their British predecessors,
31
32 and are particularly revealing on the matter of inspection failures.
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36 **Development of Safety Systems in British and New Zealand Coal Mines**

37 Since this paper compares British mining disasters in the early twentieth century with the
38
39 disaster at Pike River in 2010, it is important to distinguish between the regulatory regimes
40
41 in operation in each period. British coal mine regulation originated in the middle of the
42
43 nineteenth century, as Parliament responded firstly to scandals about women and children
44
45 working underground, and then to a stream of explosions and other disasters. The drivers
46
47 of regulation were humanitarianism and pressure from the miners. Regulation became
48
49 increasingly detailed over time, and the number of government inspectors grew (Bryan,
50
51 1975). Advances in scientific knowledge, and the diffusion of new technologies such as
52
53 electrically-powered machinery and communications systems, prompted a series of
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55 regulatory responses during the early twentieth century (Rockley, 1938).
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3 From a comparative standpoint, the revolution in health and safety regulation that
4 started in Britain in the 1970s, and spread to other countries including New Zealand,
5
6 became perhaps the single most important determinant of safety outcomes. Lord Robens,
7
8 chairman of the National Coal Board, was appointed by the British government in 1970 to
9
10 head a committee to redesign health and safety regulation across all sectors of the economy.
11
12 The Robens Report 1972 underpinned the *Health and Safety at Work Act 1974*. In place of
13
14 separate regulatory regimes and inspectorates for each type of workplace, a generic
15
16 approach was adopted under a single regulator, the Health and Safety Executive. The new
17
18 regime sought to move away from the former emphasis on compliance with a long list of
19
20 rules, and towards a more active approach based on risk management. Robens believed that
21
22 the main threat to health and safety was apathy, and his solution was to engage the interest
23
24 of employers and the workforce in the assessment and management of risk in the workplace
25
26 (Sirrs, 2015; Robens, 1972).
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31 In due time, the Robens model was transposed to New Zealand, albeit not
32
33 immediately and not without modification. The first major reform to New Zealand
34
35 legislation, the *Coal Mines Act 1979*, maintained a rules-based approach to safety issues. It
36
37 was not until the *Health and Safety Act 1992* that New Zealand migrated to a generic risk
38
39 management approach, though the Mining Inspectorate retained a degree of autonomy until
40
41 1998. It should also be noted that the 1992 Act was introduced at a time of radical labour
42
43 market deregulation in New Zealand (Anderson and Quinlan, 2008), and inevitably owed
44
45 something to that context as well as to the Robens doctrine. Achieved in 1991, this
46
47 deregulation dispensed with all remnants of New Zealand's distinctive arbitration system, in
48
49 which union representational rights were enshrined, and replaced it with a system of
50
51 employment contracts. Anecdotal evidence suggests that the comparatively poor health and
52
53 safety outcomes that ensued in New Zealand were due, in part, to the strengthening of
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55 employer prerogative in the health and safety field, and the minimal penalties prescribed for
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3 regulatory breaches (Harris, 2004). **Moreover**, after the Moura mining disaster in
4
5 Queensland in 1994, the authorities in New Zealand began to have second thoughts about
6
7 the appropriate health and safety regime in hazardous industries. In 1996 and 1999 some
8
9 mine safety regulations were reintroduced, but they were expressed in language that, in the
10
11 absence of a proactive and robust inspectorate, potentially offered employers a let-out in
12
13 cases of non-compliance (Royal Commission on the Pike River Coal Mine Tragedy 2012,
14
15 Vol. 2, pp. 266-275, 306-309). The result was a hybrid regime.

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18 To illustrate differences in the ethos of mine safety regulation in early twentieth
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20 century Britain and early twenty-first century New Zealand we focus on the ventilation
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22 question. It is vital to maintain a current of air through the mine, both to enable miners to
23
24 breathe easily and to flush away methane.³ The British *Coal Mines Act 1911* required that
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26 'An adequate amount of ventilation shall be constantly produced in every mine' (*Coal Mines*
27
28 *Act 1911*, Pt II, Section 29). The term 'adequate' was defined in some detail: for example,
29
30 there must be no less than 19 per cent of oxygen in the air. The frequency of checks for gas
31
32 was specified, along with the maximum permissible amount of inflammable gas in certain
33
34 areas of the mine. It was forbidden, furthermore, to place the main ventilation fan below the
35
36 surface where it would be vulnerable to damage (*Coal Mines Act 1911*, Pt II, Section 31). The
37
38 New Zealand *Health and Safety in Employment (Mining - Underground) Regulations 1999* also
39
40 dealt with ventilation. Employers at all mines 'must take all practicable steps to ensure' that
41
42 there was sufficient air circulating through the workings (*Health and Safety in Employment*
43
44 *(Mining - Underground) Regulations 1999*, Section 28). In 'gassy' mines, every employer 'must
45
46 take all practicable steps to ensure' that the quantity of flammable gas in the mine was no
47
48 more than 1.25 per cent of the general body of air by volume (*Health and Safety in*
49
50 *Employment (Mining - Underground) Regulations 1999*, Section 40). Unlike the British
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52 legislation of 1911, the New Zealand regulations of 1999 did not prohibit the installation of
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3 the main fan underground. The phrase 'must take all practicable steps to ensure' recurs
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5 throughout the 1999 regulations.
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7 To reinforce the point just made, we now turn to regulations relating to the
8 withdrawal of workmen after the detection of gas or another danger. The *Coal Mines Act*
9 *1911* was explicit: 'If at any time it is found by the person for the time being in charge of the
10 mine, or any part thereof, that by reason of the prevalence of inflammable or noxious gases,
11 or of any cause whatever, the mine or any place in the mine is dangerous, every workman
12 shall be withdrawn from the mine or place found dangerous' (*Coal Mines Act 1911*, Pt II,
13 Section 67). In the equivalent situation, employers working under the 1999 regulations in
14 New Zealand were expected to take 'all practicable steps to ensure' that miners were
15 withdrawn from the mine or the dangerous district when gas was detected (*Health and*
16 *Safety in Employment (Mining – Underground) Regulations 1999*, Section 21). On the one hand,
17 then, the old British regulations were tighter than those in New Zealand at the time of Pike
18 River. On the other hand, the New Zealand approach was more flexible. If employers and
19 workers were genuinely committed to identifying and combatting risk, such flexibility was
20 advantageous. The essential point is not that one approach was better than the other, but
21 that they were different in important respects, and these differences have implications for
22 the locus of mock bureaucracy. As we will show, compliance was haphazard under both the
23 old British and the modern New Zealand arrangements. As risk and safety-consciousness
24 pervades contemporary work organizations and society at large, the fact that this
25 unevenness persists demands explanation.
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49 **British Coal Mine Explosions in the Early Twentieth Century**

50 Coal mining involves complex work processes. This was so even in the early decades of the
51 twentieth century – prior to the use of heavy machinery. To operate a mine successfully and
52 safely requires expertise in geology, chemistry, and civil and mechanical engineering, as
53 well as the capacity to manage a labour force. As we subsequently demonstrate, worryingly
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3 many of the managerial and organizational defects observed in British coal mines a century
4 ago are evident at Pike River. In this section, we examine three British disasters in which
5 mock bureaucracy was a contributing factor. They have been chosen for their ability to
6 throw into relief continuities with the pattern of mock bureaucracy as it recurred at Pike
7 River. First, however, it is worth getting some idea of the risks run by British miners in the
8 early twentieth century. Explosions accounted for roughly one in ten fatalities in British
9 coal mines. Between 1900 and 1938 a total of 3544 British miners – an average of 91 per
10 year – died in gas and/or coal dust explosions (Chief Inspector of Mines, 1901-1915; Board
11 of Trade, 1928, pp. 240-241; Board of Trade, 1940, pp. 310-311). Employment in the coal
12 industry fluctuated considerably and declined after the early 1920s, but averaged 952,000
13 over the period between 1900 and 1938 (Church et al., 1986, pp. 304-305; Supple, 1987, pp.
14 8-9). Roughly 80 per cent of employees worked underground. Hence we can calculate that
15 an underground coal miner had about a 1 in 8400 chance each year of dying in an explosion.
16 Since a typical miner, if fully employed, worked 250 days per year (Anney, 2013, p. 40), his
17 chance of dying in an explosion on a given shift was about 1 in 2,000,000.

35 Genwen

36 We begin our analysis of mock bureaucracy in early twentieth century British coal mines
37 with the official inquiry into the firedamp (methane gas) and coal dust explosion at Genwen
38 Colliery, South Wales, which occurred on 5 March 1907. Six miners died including two
39 engaged in rescue operations. A more or less forgotten accident at a small mine, Genwen
40 merits attention for two reasons. Firstly, the official report by Atkinson and Lewis, both
41 mines inspectors, was particularly explicit about the failings of management (Atkinson and
42 Lewis, 1907). Secondly, the report suggests that management and workers colluded in lazy
43 and dangerous practices underground, especially in relation to lamps and the reporting of
44 gas. This is the stuff of mock bureaucracy.

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3 At Genwen the under-manager and firemen were aware that the seam was giving off
4 gas freely, but shunned their legal obligation to record the presence of gas in the report
5
6 book, apparently because reporting was not worth the effort if the gas was easily dispersed.
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8 The inquest and inquiry concluded that the explosion was caused by firedamp coming into
9
10 contact with the flame of an open safety lamp, probably carried by a miner returning from
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12 lunch. Although not illegal, the type of easily-opened safety lamp used at Genwen met with
13
14 the strong disapproval of H.M. Inspectors of Mines in the Swansea district. It was
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16 convenient but dangerous for miners to open and perhaps relight lamps that had gone out.
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18 Colliery management was in breach of the law because it did not provide a lamp station,
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20 staffed by a designated lampman, on the surface where lamps could be oiled, cleaned, and
21
22 repaired safely. Miners were also complicit in the lax implementation of safety regulations,
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24 as is shown by the discovery of pipes and matches on or near the four victims of the initial
25
26 blast. It was illegal to take contraband underground, but management condoned the
27
28 practice and did not bother to check.⁴ In a nutshell, miners strove to maximize their
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30 earnings, and assumed that everything would be alright, at least on the current shift, a
31
32 judgement shared by managers, and one that proved correct until the disastrous events of 5
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34 March 1907.
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39 **Wellington Pit**

40 A disastrous explosion and fire at Wellington Pit, on the Cumberland coast, claimed 137
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42 lives on 11 May 1910. A detailed report on the inquest and official investigation was
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44 written by Richard Redmayne, Chief Inspector of Mines (and great-grandfather of Eddie
45
46 Redmayne), and Samuel Pope, a barrister representing the Home Secretary. What
47
48 Redmayne succeeded in showing is that mock bureaucracy – whereby miners and
49
50 underground managers knowingly and together ignored safety rules – was the
51
52 organizational backdrop against which the Wellington Pit explosion occurred.
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3 The most awkward feature of the Wellington Pit was that it extended several miles
4 under the Irish Sea, a circumstance that restricted the number of alternative exit routes
5 during an emergency. Although doubts remained as to the precise cause and location of the
6 initial explosion, it was obvious that both firedamp and coal dust were involved. The official
7 report was candid about the shortcomings of management and the safety regime at the
8 colliery. The ventilation system was inadequate, and most likely in breach of safety
9 legislation. Indeed, there was 'a want of appreciation on the part of management of what
10 constitutes a proper ventilation arrangement' (Redmayne and Pope, 1911, p. 7). Poor
11 ventilation allowed firedamp to linger and accumulate. Record keeping in relation to air
12 quality was sloppy. Under regulations, the miners ought to have been withdrawn from the
13 affected area whenever the amount of gas reached $2\frac{1}{2}$ per cent of the air, and the
14 withdrawal noted in a special book. But miners and officials, including deputies and
15 overmen – the most junior levels of the management hierarchy – were reluctant to report
16 gas, often preferring to clear or waft it away if present in apparently small amounts. Miners
17 at the coal face (hewers) were paid a piece rate and did not want to lose wages for gas
18 stoppages. Some were inclined, in their own words, to 'fettle on' and accept the risk even
19 when there was a potentially dangerous amount of gas, and in the knowledge that they were
20 flouting the regulations (Redmayne and Pope, 1911, p. 10).

21
22 For mock bureaucracy to exist it is not necessary that incumbents within *all* levels of
23 the managerial hierarchy be aware and tolerant of rule-breaking; only some need be. In this
24 case, deputies and overmen colluded with the miners to ignore gas events. The lack of
25 control underground was this pattern's breeding ground. While Robert Steele, the mine
26 manager – and therefore the person legally responsible for safety at the pit – expressed
27 disapproval of his subordinates' inadequate gas reporting, the fact that it was recurring
28 demonstrated that he was not fully in control (Redmayne and Pope, 1911, p. 34).

29 Wellington Pit, concluded the report, presented a sorry example of laxity in the matter of

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2
3 organisation' (Redmayne and Pope, 1911, p. 38, emphasis omitted). The 'absence of strict
4
5 discipline' was noted. Deputies and overmen were given no clear instructions regarding
6
7 what to do when firedamp was discovered, and were allowed too much discretion in the
8
9 reporting of gas. Consequently, management did not have an adequate picture of conditions
10
11 underground (Redmayne and Pope, 1911, p. 38). Prior to the explosion, the pit had given
12
13 the District Inspector of Mines no grounds for concern, and he claimed to have received no
14
15 complaints from the workforce (Redmayne and Pope, 1911, p. 10). If the absence of
16
17 complaints is in one part due to miners' fearfulness of adverse consequences had they
18
19 reported safety breaches, the other part is miners accepting risk. Miners and their
20
21 supervisors flexed and bent rules, a little more or a little less, in essentially a series of
22
23 marginal decisions. Together they hoped an explosion would not occur.
24
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26 **Gresford**

27
28 The Gresford colliery explosion, in North Wales on 22 September 1934, was the worst in
29
30 interwar Britain. Gresford claimed 265 lives including those of several rescuers. With
31
32 respect to compliance with official regulations, Gresford exhibited many of the same
33
34 shortcomings as Genwen and Wellington Pit. The official inquiry into Gresford was more
35
36 politicized than previous mine disaster investigations. To some extent Sir William Walker,
37
38 the Chief Inspector of Mines, lost control of proceedings. Walker was singularly unable to
39
40 prevent criticism of H.M. Mines Inspectorate, a feature largely absent from earlier disaster
41
42 inquiries. Although Walker denied that inspectors were inclined to downplay any
43
44 difficulties in the mines that they visited, even he acknowledged that 'certain Inspectors
45
46 were at fault in their dealings with this colliery [i.e. Gresford] over a period of years'
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48 (Walker, Brass, and Jones, 1937, p. 90).
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51
52 The Gresford inquiry was dominated by Sir Stafford Cripps, the lawyer and left-
53
54 wing Labour MP appointed to represent the North Wales Miners' Federation. The main
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56 reason for including Gresford in this series of case studies is to focus on Cripps's cross-
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3 examination of Percy George Dominy, the Sub-Inspector responsible for Gresford, as it
4 brings to light collusive behaviour between inspectors and mine managers that typifies
5 institutional-level mock bureaucracy. Cripps was able to show that on several occasions
6 Dominy had visited the mine without actually descending the pit. When Dominy had gone
7 underground he had not seen much of the pit. Yet Dominy had known about the haphazard
8 record keeping at Gresford, especially in relation to measurements of air and gas, and had
9 done nothing about it. Despite being cognisant of regulatory breaches, he had been too
10 ready to accept the word of management that everything was nonetheless under control. As
11 Dominy admitted during cross-examination, he had regarded an explosion at Gresford as
12 impossible (Williamson, 1999, pp. 145-149).
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24 In his dissenting report on the inquiry, Joseph Jones, the assessor representing the
25 interests of the workmen, described the performance of the Inspectorate as 'insufficient and
26 ineffective'. He also suggested that the disaster could have been avoided if management had
27 been pressed more firmly to abide by regulations (Walker, Brass, and Jones, 1937, p. 146).
28 The mining inspectorate thus permitted safety rule non-compliance to persist over time.
29 Inspectors were aware of breaches in record keeping, and relied on the reassurances of
30 managers who themselves knew that records were lacking. As such, Gresford exemplifies
31 institutional-level mock bureaucracy.
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42 **The Pike River Disaster**

43 In relation to collusive rule-breaking, Pike River bears similarity to the mining disasters
44 described above in general, and to Gresford in particular. Some situated particularities are
45 worth noting. Pike River was a new mine in remote and difficult terrain. Preparatory
46 geological investigations proved inadequate. Work on development of the mine fell a long
47 way behind schedule and Pike River Coal Company Limited ran into financial difficulties.
48 The directors and managers of Pike River were under severe pressure to start extracting
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3 coal as soon as possible in order to reassure shareholders and creditors. Production began
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5 on a small scale in September 2010, only a few weeks before the fatal disaster.
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7 At 3.45 pm on Friday 19 November 2010 an explosion occurred underground.
8
9 Twenty-nine of the men working below ground died during or shortly after the explosion.
10
11 Two who were working relatively close to the combined entrance and exit – a portal or
12
13 tunnel rather than a vertical shaft – managed to walk out alive. Further explosions occurred
14
15 on 25, 26, and 28 November. The mine was sealed and written off. The victims were
16
17 entombed where they died. Pike River was New Zealand's worst coal mine accident since
18
19 an explosion at Ralph's Mine, Huntly accounted for 43 lives in 1914 (Royal Commission on
20
21 the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 259). Given that the mine was sealed, it
22
23 was impossible for the Royal Commission set up to investigate the disaster to be certain
24
25 about the location or the proximate cause of the fatal initial explosion. Pike River was a
26
27 gassy mine and the evidence pointed to a methane explosion. According to the Royal
28
29 Commission, the most likely (but not the only) scenario involved an accumulation of
30
31 methane in the goaf, the waste area abandoned after the extraction of coal. It was deemed
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33 likely that a spark from electrical apparatus was responsible for ignition, but other sources
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35 of ignition could not be ruled out (Royal Commission on the Pike River Coal Mine Tragedy,
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37 2012, Vol. 2, pp. 179-193).
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41 Though the explosion's proximate cause is indeterminate, institutional-level mock
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43 bureaucracy is a key organizational element in the sociotechnical matrix that increased the
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45 likelihood of an explosion occurring. We begin with a discussion of the mine's numerous
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47 deficiencies and inadequate risk management because they are the forming ground of the
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49 mock bureaucratic pattern, in which inspector inaction featured centrally, that took hold at
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51 the mine. To recapitulate, the risk management failures are, in turn, traceable back to New
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53 Zealand's permissive, Robens-style, safety regime.
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Risk management failures

The report of the Pike River Royal Commission was scathing about the actions and inactions of the company in the years and months leading up to the disaster. Aspects of the mine's design, especially in relation to ventilation, were sloppy in the extreme. The main ventilation fan was situated underground where it could spark an ignition and would thus be vulnerable to the effects of an explosion. Even if not seriously damaged, the fan might be difficult to restart. This was a bizarre arrangement, albeit one that was not illegal in New Zealand. The justification for an underground fan was that it would have been difficult and expensive to put it on the surface, given the remote, inhospitable, and environmentally-sensitive terrain. The hydro mining method adopted at Pike River – the coal was blasted by a jet of water – required skills that its operators may have lacked. Hydro mining began on 19 September without adequate preparation or precautions. The main ventilation fan, in fact, was not fully operational until 22 October (Royal Commission on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 93).

Miners were offered a large bonus for getting coal into production; the amount of the bonus diminished with every week's delay. The recording of gas levels was patchy and reports of high concentrations were sometimes overlooked by management. Some gas sensors were defective, while others were disabled by workmen anxious to get on with the job instead of stopping for alarms (Royal Commission on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 136, pp. 141-143). According to the Royal Commission, 'the hydro bonus at Pike created particular risks' and it was troubling that management did not give careful consideration to the implications of the bonus for health and safety (Royal Commission on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 162).

Methods used for draining methane from the coal face were also inadequate. Notifiable incidents, notably methane outbursts, were not reported to New Zealand's Department of Labour as the law stipulated. Portentously, these included 'high methane

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3 readings of about 5% in October 2010' (Royal Commission on the Pike River Coal Mine
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5 Tragedy, 2012, Vol. 2, p. 74). Pipes carrying gas were fragile and situated in close proximity
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7 to electrical cables. Worker discipline was slack with contraband taken into the mine. There
8
9 were too few supervisors. Those who were present struggled to assert their authority,
10
11 particularly over inexperienced men who did not yet grasp the dangers inherent in mining.
12
13 In September 2010, some of the second intake of trainees had complained that 'the safety
14
15 approach taught in the classroom was not always evident underground' (Royal Commission
16
17 on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 65). Construction of a viable second
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19 form of egress from the mine was also accorded a lower priority than ensuring that coal
20
21 production commenced as soon as possible. As an interim expedient, a ladder was installed
22
23 in a vertical ventilation shaft. Healthy miners would have struggled to climb to the surface
24
25 in normal circumstances, let alone in an emergency (Royal Commission on the Pike River
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27 Coal Mine Tragedy, 2012, Vol. 2, p. 226). Amazingly, at the time of the explosion,
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29 management had no failsafe means of knowing who was actually underground.
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33 The above examples do not exhaust the mine's design and operational defects. There
34
35 are too many to enumerate here, but the point is this: the plethora of deficiencies is due in no
36
37 small measure to the 1970s shift in emphasis within mine safety systems from detailed
38
39 regulation and rule compliance, in combination with strong external enforcement, to
40
41 Robens-style self-managed risk assessments. This is a system premised upon an
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43 organization's senior participants accepting accountability for ensuring the safety and
44
45 wellbeing of all in the workplace. At Pike River, this responsibility simply was not met. The
46
47 Royal Commission found that the mine's top management team and board 'did not properly
48
49 identify and manage the major health and safety risks facing the company' (Royal
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51 Commission on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 72). The internal
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53 organizational reasons for this are clear. Despite efforts to develop detailed health and
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55 safety plans, middle managers were under pressure to give priority to production. The
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3 company's safety and training department, the investigation concluded, 'struggled for
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5 credibility alongside the more production focused departments' (Royal Commission on the
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7 Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 73). Downplaying one department's
8
9 interests while favouring other departments, especially those regarded as being more
10
11 central to achieving paramount organizational goals, is a classic strategic contingencies
12
13 phenomenon (Salancik and Pfeffer, 1977). Senior managers and directors were complacent
14
15 about safety, but deeply concerned about delays in production and the mine's desperate
16
17 financial situation. As a result, risk assessments were perfunctory, where they occurred at
18
19 all. Deemed by the Royal Commission to be woefully inadequate, the ventilation plan is a
20
21 prime example. The plan stipulated there must be a ventilation engineer, but one was not
22
23 appointed. In short, 'the company largely ignored this plan and it was not an effective risk
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25 control' (Royal Commission on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 164).

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Though Pike River possessed a health and safety management system on paper,
clearly it had glaring faults. Further, the Royal Commission concluded that there was a
serious 'gap between the documented system and actual practices underground' (Royal
Commission on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 77). Good practice was
set aside in the interests of production, in the belief (which was borne out until 19
November) that, in New Zealand parlance, 'she'll be right.'

Flexible though the Robens approach may be, financial and production pressures
converted this flexibility into rubbery safety and risk management practices at Pike River.
'Focused on production targets', lamented the Royal Commission, 'the executive
management [at Pike River] pressed ahead when health and safety systems and risk
assessment processes were inadequate' (Royal Commission on the Pike River Coal Mine
Tragedy, 2012, Vol. 2, p. 56). The Robens-inspired regulatory framework's emphasis on
gameable risk assessments enabled managers to shun their legal responsibility for
establishing robust safety arrangements. To be clear, our interest is not in the inadequacies

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3 of the Robens-like safety systems per se, but rather in the fertile soil they provide for
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5 institutional-level mock bureaucracy to take root. For that to happen there must be acts of
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7 omission or commission by the mining inspectorate. As the next part of our paper explains,
8
9 slack enforcement and inspection compounded risk management failures at the company.
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11 The final piece of the mock bureaucratic pattern, therefore, was put into place by the
12
13 inspectorate itself.
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15 16 17 **Mock bureaucracy at Pike River**

18 Present at Pike River are each of the elements of institutional-level mock bureaucracy:
19
20 complicity of mine inspectors in management's failure to observe legal requirements and
21
22 enforce safety rules; and inspectors allowing non-compliance to persist. Interestingly, this
23
24 pattern crystallized around a failing – the location of the extraction fan underground – that,
25
26 although it did not constitute a regulatory breach, did not meet industry norms. Moreover,
27
28 although a spark from the fan was a possible, but not the most likely source of ignition in
29
30 the Pike River disaster, the saga of the fan encapsulates the problems at the mine. Early in
31
32 the piece, in February 2007, mines Inspector Firmin knew of the fan's intended location but
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34 did not question it. In the Royal Commission's view:

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37 [t]his failure not only allowed a highly questionable ventilation system at Pike River,
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39 but also set the tone for subsequent interactions between the company and the
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41 inspectorate (Royal Commission on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p.
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43 197).
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46 To the extent that inspectors did not challenge arrangements that fell below industry
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48 best practice, and in some cases accepted regulatory non-compliance, the tonality was that
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50 of mock bureaucracy. By the same token, frictional ignitions due to inadequate ventilation
51
52 occurred in November 2008. Inspector Poynter was advised by a de facto whistle-blower
53
54 that not all of the ignitions had been reported – a clear breach of the company's legal
55
56 obligations. But after receiving an email from the mine manager (Kobus Louw) to the effect
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3 that he (the manager) did not and could not know of ignitions that his staff did not report,
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5 the inspector closed the file (Royal Commission on the Pike River Coal Mine Tragedy,
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7 2012, Vol. 2, p. 198). The upshot is that the inspectorate did not act on the 'clear indications
8
9 that Pike was not properly investigating and reporting notifiable incidents' (Royal
10
11 Commission on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 199).

12
13 On the issue of ventilation, more broadly, the indefinite (Robens) rubric of an
14
15 employer having to take 'all practicable steps' is prominent. The *Health and Safety in*
16
17 *Employment (Mining – Underground) Regulations 1999* stipulate that an employer must 'take
18
19 all practicable steps to ensure a supply of fresh air in every workplace' (Royal Commission
20
21 on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 199). Coalface ignitions demonstrated
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23 fresh air was lacking and hence that such steps were not being taken. Inspector Poynter
24
25 later asserted, however, that he could do nothing to require proper ventilation in the mine
26
27 due to a grey area in the regulations. The Royal Commission found this to be wrongheaded:
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31 It should have been obvious to an inspector that he had to decide whether the company
32
33 had taken all practicable steps to supply fresh air to the face and, if not, what response
34
35 was appropriate (Royal Commission on the Pike River Coal Mine Tragedy, 2012, Vol.
36
37 2, p. 199).

38
39 The inspectorate's whole approach to compliance was questionable. In the light of the
40
41 inspectorate's knowledge of the mine's deficiencies, the Royal Commission averred that it
42
43 should not have persisted 'with a low-level compliance strategy based on negotiated
44
45 agreements' (Royal Commission on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 199).
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47 Given that inspectors almost literally never specified in the agreements a deadline or
48
49 timeframe within which compliance was required (Royal Commission on the Pike River
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51 Coal Mine Tragedy, 2012, Vol. 2, p. 201), they were empty letters.
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55 The inspectorate's reluctance to take formal action against the company contributed
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57 to the continuance of non-compliance. Two incidents detailed by the Royal Commission are
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3 revealing. The first concerns an accident, on 14 February 2010, which resulted in a miner
4 suffering a crush injury to his foot after he climbed onto an underground roof-bolting
5 machine to assist its operation. Inspector Poynter conducted an investigation and concluded
6 that not only was the miner breaching the mine's rules, the breach was compounded by 'a
7 mine deputy observing a similar action earlier in the shift and doing nothing to prevent a
8 recurrence' (Royal Commission on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 202).
9
10 A vital safety lever on the machine had also been deliberately tied down and therefore
11 disabled, although this did not cause the accident. The Royal Commission found it 'difficult
12 to fathom why there was no prosecution or, at the very least, a written warning issued to
13 Pike', and suggested that the inspector's discovery of 'a disabled safety device on the same
14 machine...should have increased concern about the safety culture at Pike and called into
15 question the need for a much firmer compliance approach from the inspectors' (Royal
16 Commission on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 202).
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31 The second incident centres on the lack of a second practicable means of egress.
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33 After conducting an underground inspection on 8 April 2010, Inspector Poynter concluded
34 that the vertical shaft with the ladder 'was not a suitable emergency escapeway' and
35 requested of the company 'a plan and timeline' for a 'walkout egress' (Royal Commission on
36 the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 199). Four days later the company
37 simply emailed to the inspector a document containing the results of an earlier risk
38 assessment meeting that spoke of the need for yet another risk assessment concerning the
39 vertical shaft's suitability as a mode of egress. Risk assessments took the place of action. A
40 further request from Inspector Poynter, on 31 August, led to a plan for a walkout egress
41 being provided at the inspector's mine site visit on 2 November, but the plan contained an
42 unrealistic timeline (Royal Commission on the Pike River Coal Mine Tragedy, 2012, Vol. 2,
43 p. 200). Given that coal extraction was ramping up, the Royal Commission insisted, '[t]here
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3 was no option but to issue a prohibition notice...’ to enforce compliance (Royal Commission
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5 on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p. 201).
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7 For the inspectorate simply to trust the company to comply with regulations when
8
9 there is clear evidence it consistently and knowingly breached them is to be complicit in the
10
11 non-compliance. Undoubtedly, the inspectorate was understaffed and the inspectors had
12
13 heavy workloads (Royal Commission on the Pike River Coal Mine Tragedy, 2012, Vol. 2, p.
14
15 278). Notwithstanding these constraints, the Royal Commission found that inspectors
16
17 should have been much more assertive. They well knew some of the mine’s most serious
18
19 faults, but under New Zealand’s light-handed, participatory approach to regulatory
20
21 compliance were inclined to accept management’s promises that safety matters were in
22
23 hand. If mine managers in a Robens-influenced safety regime loaded the dice, the mining
24
25 inspectorate did little to stop them from rolling it. To summarize: the hybrid Robens system
26
27 let managers fall back on the muddy waters of risk assessments as a way of evading their
28
29 statutory obligations; inspectors in turn were complicit in allowing risk to go unmanaged
30
31 and in failing to arrest the resulting non-compliance. Following Hynes (1999), this is the
32
33 *sine qua non* of mock bureaucracy’s institutional variant.
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38 **Conclusion**

39 This paper has shown that, despite its origins in an old-fashioned Gouldnerian field study,
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41 the concept of mock bureaucracy is not a sociological curiosity. Building on extant academic
42
43 literature, we redefined the concept to mean a pattern of collusive rule-breaking with two
44
45 sub-types (workplace and institutional). These are not tied to any particular type of rule or,
46
47 for that matter, any wider bureaucratic form that might render the concept susceptible to
48
49 the criticism that we live in a post-bureaucratic age. By juxtaposing the British explosions
50
51 with the Pike River incident, we have been able to demonstrate that the concept has
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53 analytical purchase in relation to contemporary mining disasters, beyond the single case of
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55 Westray that is the focus of Hynes and Prasad’s (1997) attention.
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3 Our historical comparative analysis suggests that, within the domain of
4
5 underground coal mining, cases of mock bureaucracy can be found as far back as when
6
7 safety procedures were first formulated in that domain. Clear examples can be identified in
8
9 British mines of managers and miners, sometimes with the knowledge of mine inspectors,
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11 colluding to ignore or to wilfully break safety rules. At the institutional level, in particular,
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13 there are striking parallels with Pike River. At Gresford, mine inspectors too hastily took
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15 employers at their word regarding safety matters. In this respect Pike River is more
16
17 remarkable than the British disasters because of the intervening improvements in
18
19 knowledge about the causes of explosions and how they may be prevented. Yet, once we
20
21 uncover the mock bureaucratic setting of the explosions, Pike River is not at all surprising.
22
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24 Two developments result in the mock bureaucratic pattern recurring. The first is the
25
26 much higher capital intensity of modern coal mining. Mine operators experiencing
27
28 problems extracting sufficient quantities of coal to defray costs are subject to greater
29
30 business risk than in the days of 'pick and shovel' labour-intensive mining. Our discussion of
31
32 Pike River displays this pressure. Yet it also reveals how light-handed regulation, stressing
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34 Robens-style responsabilized self-assessment, provides wriggle room for managers of
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36 mining companies under financial duress to downplay the safety management side of this
37
38 risk. Not only was inspectional cursoriness and inaction still a problem under the very
39
40 different regulatory environment that obtained in early twenty-first century New Zealand,
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42 the regime invited it. Indeed, the Robens system made it easier for mine managers and mine
43
44 inspectors to fudge the development and review of safety arrangements and procedures.
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46 That fudging, we maintain, exhibits all of the characteristics of institutional-level mock
47
48 bureaucracy.
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52 The directions for further research that emerge from our findings are threefold.
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54 Firstly, there is considerable scope for more comparisons of historical and recent mining
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56 disasters in a range of countries, not only to establish the prevalence of mock bureaucracy
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3 but also to identify other patterns in the interactions between workers, management, and
4
5 regulators on safety matters. Secondly, the unintended consequences of the Robens-style
6
7 approach to industrial safety since the 1970s merit further analysis. Questions can be asked
8
9 about the appropriateness of Robensian self-monitoring to inherently dangerous extractive
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11 industries where the cost of establishing a new site means that safety all too readily takes a
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13 back seat to profitability. In relation to coal mining, in particular, careful examination
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15 should be given to the case for and against industry-specific safety regulation and
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17 monitoring of companies by dedicated government agencies with a clear enforcement
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19 mandate. The role of strong safety legislation in promoting corporate social responsibility
20
21 has recently featured in academic discourse (Hart, 2010). This is a promising avenue of
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23 inquiry to pursue in subsequent studies of how to improve the behaviour of mining company
24
25 participants within the safety domain.
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29 Thirdly, and finally, we believe it is important to move beyond the mining industry
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31 and apply the concept of mock bureaucracy more widely. Historically, underground mining
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33 in Britain was an activity replete with masculinist values (McDowell and Massey, 1984). In
34
35 countries such as the US and India, this gendering process persists (Scott, 2010; Lahiri-
36
37 Dutt, 2007). Mills (2010) has shown, primarily for Cornish tin mining, but also for coal
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39 mining, how masculine attitudes affected risk taking before the First World War, and it
40
41 would be worthwhile exploring this area further. The cultural mediation of sentiments and
42
43 behaviours that contribute to mock bureaucracy warrants greater attention. Mining's
44
45 occupational masculinism provides a reason to transpose the concept of mock bureaucracy
46
47 to risk-laden work settings with a different cultural inflection, including industries like
48
49 textiles and clothing that have high fire risk and a high proportion of women workers.
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51 Though originating in a case study of gypsum mining, from which the extension to coal
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53 mining naturally follows, the concept could be employed by management and business
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55 historians investigating a wide range of other industries. These include banking and
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financial services where mistakes, non-compliance with regulations, and collusion with regulators, while not having fatal consequences, may have a far-reaching impact.

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58 ¹ *Patterns of Industrial Bureaucracy* was first published in 1954.
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4 ² For example, the command paper on the Gresford disaster of 1934 was 170 pages long, comprising the main
5 report by the Commissioner (the Chief Inspector of Mines) and additional reports by two assessors appointed
6 to represent the interests of workmen and employers.
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9 ³ By 1900 most coal mines used a massive extractor fan to suck air through the system of underground
10 roadways and coal faces.
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13 ⁴ Note that the pipes and matches were not believed by Atkinson and Lewis to have caused the explosion
14 (Atkinson and Lewis, 1907, p. 8).
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