

Major accidents and their consequences for risk regulation

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ABSTRACT: The purpose of this paper is to study major accidents in the petroleum industry and their effects on Health, Safety and Environment (HSE) regulatory regimes and industrial actors. Our cases are: Piper Alpha (1988), Texas City refinery (2005), Montara (2009), and Deepwater Horizon (2010) representing accidents of major historical influence or with an assumed high impact on regulatory approaches and industrial actors. In the paper we draw upon theories on HSE regulatory approaches, learning from accidents, safety culture and organizational reliability. Data: Accident investigation reports, other documents and documentaries. The results show changes are being made with regards to regulatory regimes and the organization of safety and energy departments (authority), lessons are tried learnt across industrial sectors and shelves, safety management systems and technological solutions are improved, and higher degree of employee participation and involvement is often called for.

1 INTRODUCTION

Organizational accidents not only cause harm to organizations, humans and environment. They also often imply major structural, regulatory and organizational reforms and change. Re-organizing often manifest itself in the wake of crisis and disasters. Internally, new organizational structures, roles, and management technologies are created. Externally, pressures exist to create or reform regulatory regimes and their programs for risk prevention, reaction, and resilience. In particular, new standards of practice are suggested and new categories such as “operational risk” play a catalytic role in such reform processes. New communities of interest in risk management are created and new mandates for regulatory organizations are proposed (Hutter & Power, 2005).

The purpose of this paper is to study four major accidents in the petroleum industry and their effects on Health Safety and Environment (HSE) regulatory regimes and lessons learnt at an industrial and company level. It describes how four major accidents have consequences for HSE regulation at various levels; for regulators, industrial actors, and with regards to tripartite collaboration and involvement. Our cases are: the Piper Alpha accident (UK shelf), the Texas City refinery accident (USA), the Montara-accident (Australia) and the Deepwater Horizon-accident (Macondo) (USA). They all represent historically important petroleum

related major accidents with large human, material or environmental losses. They have also had or are anticipated to have an assumed high influence on regulatory approaches and consequences at many levels. As such, they hold a high potential of gaining insights into lessons learnt, but also, on the contrary, potential explanation as to why lessons are *not* learnt.

Our focus will mainly be on regulatory and industrial consequences. And even though consequences are our main area of interest, causes, consequences and lessons learnt cannot be properly addressed without having an understanding of the “why’s” of the accidents. So when necessary, underlying causes are to a certain extent addressed.

From a Norwegian petroleum regulator perspective the most crucial concern is to extract lessons learnt on risk regulation in order to prevent similar ones from occurring in the future. Increased knowledge about the consequences related to changes of regulatory practices and principles, re-organizing efforts at a macro level and potential industrial effects in the aftermath of organizational accidents, are crucial to grasp and understand. Our anticipation is also that the influence of major accidents on risk regulation will depend on a combined effect of attention from important stakeholders and the social amplification of risk (e.g. Kasperson et al., 1988; 2003, Pidgeon et al., 2003) exposed in the accidents; such as lost lives, environmental and physical damages. In the wake of Macondo and Montara,

for instance, it has been claimed that lessons can be learnt from regulatory practices across national regimes; for instance learn from the Norwegian and UK regulation of offshore petroleum activities, across industrial sectors; nuclear, aviation etc. (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). This raises, however, important questions regarding the challenge and possibility of both translating and transferring often culturally embedded practices and nationally specific regulatory requirements—even though the industrial sector, technology and operations remain approximately the same.

More specifically the aim of the paper is to study organizational accidents and their impact on: risk regulation and regulatory practices at a macro level; authorities; industrial actors and tripartite collaboration or formal employee-employer cooperation/involvement systems.

2 SHORT SUMMARY OF THE ACCIDENTS

Below follows a very short description of the four accidents, mainly focusing triggering factors. There is a consistent condition that characterizes all the accidents in this paper; lack of control of hydrocarbons (HC) which ignited and an explosion and a fire occurred. In the case of Piper Alpha (1988) there were two condensate injection pumps, A and B. The A pump was not in use because of the removal and re-certification of a safety valve. When pump B tripped, pump A was started and a condensate leak occurred, resulting in an explosion and a fire. This failure was mainly due to lack of communication between shifts. Piper Alpha was also a hub for several other HC production facilities. Feeding from these continued which escalated the fire (The Hon Lord Cullen report, 1990; The Lessons of Piper Alpha, 2008). The accident resulted in 167 deaths and total insured loss was about £1.7 billion.

The Texas City accident (2005) occurred during the startup of an isomerization (ISOM) unit. When a raffinate splitter tower was overfilled, the pressure relief devices opened, resulting in a hydrocarbon liquid leak from a blowdown stack. The release of the hydrocarbons was ignited and led to an explosion and a fire. In the accident 15 people were killed, 180 injured and resulted in a financial loss exceeding \$1.5 Billion.

The last two accidents were caused by an uncontrolled blowout due to poor cementing job and reduced well integrity. The Montara accident (2009) led to an oil and condensate spill that lasted for 74 days, condemnation of a jackup rig and a damaged wellhead platform. Total emissions are estimated to be between 4,000 and 30,000 tons.

Although the Montara accident was severe, it was overshadowed by the Macondo accident (2010). The Macondo accident resulted in 11 fatalities, loss of the rig and an oil spill about 4.9 million barrels. The economic consequences are still uncertain, but it seems to be the most expensive petroleum accident ever.

3 THEORETICAL FRAMEWORK

3.1 Risk regulation

Risk regulation refers to state action to reduce health, safety and environmental risk (Hutter, 2006; Kirwan et al., 2002). Risk regulation is designed to improve the performance of individual and organizational behaviour in ways that reduce risk, by e.g. improving industry's environmental performance, increasing the safety of transportation systems, or reducing workplace risk. The concept of risk regulation regime denotes the overall manner in which the state regulates risk in a particular policy domain. The term regime describes the complex institutional geography, rules, practice, and institution of ideas associated with the regulation of risk (Hood et al., 1999, 2001). In a proposition of risk regulation regime, Hoods et al. (1999) suggest to look at different dimensions that are relevant to characterise concrete state actions on risk management: the regime context (including the type of risk, public preferences and organised interests) and the regime content (size, structure and style of intervention). In these regimes, regulators can direct those they govern to improve their performance in at least two basic ways: a performance-based approach or a prescriptive approach. Regulators can prescribe exactly what actions regulated entities must take to improve their performance. Or they can incorporate the regulation's goal into the language of the rule, specifying the desired level of performance and allowing the targets of regulation to decide how to achieve that level (Coglianese et al., 2004; Hopkins & Hale, 2002; Hutter, 2006; Wilpert, 2008). The performance-based approach to regulation defines objectives in terms of desired outcomes within different types of industries. According to May (2003) performance-based regulation is easy to describe in concept but hard to define in the particulars.

Diverse strategies in enforcing regulation described in the literature usually concern the use of compliance versus deterrence approaches as strategies for applying legal standards (Walshe, 2003; Wiig 2008; Baldwin & Cave, 1999; Hutter & Lloyd-Bostock, 1992; Ayres & Braithwaite, 1992; Reiss, 1984; Wilpert, 2008; Braithwaite et al., 2005). Compliance is an informal style of regulation emphasizing diplomacy, persuasion, and education rather

than the routine application of sanctions to produce a compliance culture within the regulatee. The regime promoting compliance approaches is flexible and tolerant, and its regulators use discretion and pragmatism in their application of the law. The goal is to achieve compliance without invoking the formal legal process. In contrast, deterrence relies on penalties or punishment to discourage the regulated from breaking the rules (Hood et al., 2001; Baldwin & Cave, 1999; Braithwaite et al., 1987). However, some researchers argue for a hybrid approach, referred to as responsive regulation (Ayres & Braithwaite, 1992; Braithwaite et al., 2005). Responsive regulation is pragmatic and replaces the choice between compliance or deterrence approaches with a highly flexible, situationally specific, and adaptable approach. It avoids the “one size fits all” approach in favor of contingency—making the nature of the regulatory regime highly dependent on the behaviour of the individually regulated organizations. Moreover, this approach makes use of a hierarchy of regulatory strategies and sanctions (Walshe, 2003). This is often presented as a set of pyramids—one pyramid of regulatory enforcement strategies corresponding to a second pyramid of regulatory sanctions. The aim is to provide the regulator with a full range of regulatory interventions that can be applied responsively and tailored to the needs and behaviour of each of the regulated organizations. The two other key words: tripartism and empowerment are important for responsive regulation. Advocates of responsive regulation argue for tripartism, meaning that the regulatory process should be designed to include and cooperate with stakeholders beyond the regulator and the regulated for the purpose of regulation (e.g. by using the stakeholders as informants and secure greater regulatory compliance by taking advantage of the stakeholders to pressure the regulated organizations) (Baldwin & Cave, 1999; Ayres & Braithwaite, 1992). In the Norwegian petroleum context tripartite cooperation (Karlsen & Lindøe, 2006) and workforce involvement is a foundation pillar. Trust, dialogue and cooperation between regulator, enterprises and unions in development of a strong safety management regime on the Norwegian Continental Shelf is seen as crucial, and in the development of the general working life conditions in The Nordic Countries as a whole (Tharaldsen, 2011). According to the idea of empowerment, regulation should enable the regulated organizations to perform well rather than impose requirements that may constrain or limit their performance. In sum, proponents of responsive regulation argue that the trick of successful regulation is to establish a synergy between punishment and persuasion (Baldwin & Cave, 1999; Ayres & Braithwaite, 1992; Walshe, 2003).

3.2 *Learning from accidents*

Our approach to learning from accidents is based on a systemic approach. System thinking in relation to accidents and their origin emphasizes the interdependence of people, technology and organizations as opposed to considering these aspects in isolation. System thinking requires considerations of connections both within and outside the organization (Morath & Turnbull, 2005). According to the literature on accident prevention, the ideal approach is to view errors and near misses as symptoms of underlying problems so they become sources of information to understand how systems work. Accidents and near misses should be seen as useful tools that contribute to defining margins of risk and safety and to learning how to prevent accidents (Edmondson, 2004; Johnstone & Kanitsaki, 2005; Morath & Turnbull, 2005; Wiig & Aase, 2007). The system thinking makes the fundamental assumption that accidents are not caused by incompetent humans; accidents are composed of multicausal variables that interact to create the conditions in which the accident may occur (Allsop & Mulcahy, 1996). Viewing accidents in an individual perspective, arguing that the accidents are caused by the “Bad Apples” has demonstrated to hamper organizational learning, counteracting exploration of work processes, and caused a loss of rich information about the interaction of individuals, technology, and organizational processes (Vincent 2006; Leape 1994; Wiig & Lindøe, 2007). With an individual approach, operating personnel often becomes the one pointed at; becoming the non-compliers, in lack of competence, experience, communication skills, risk awareness etc. Such approaches tend to yield quick fixes as worker disciplining, more detailed procedures—sometimes adding more complexity yielding new undesirable effects (Carroll, 1998). Also, individual perspectives on accidents and error in high risk industries seem to delimit information flow (Westrum, 1993) and introduce learning constraints (e.g. Edmondson, 2004).

In order to reveal all relevant factors of organizational, cultural, technological and human character different perspectives are important (Vaughan, 2006; Tjørhom & Aase, 2010;). The different accident perspectives and models make assumptions about how accidents occur and can be prevented. As such they are vital aspects to be aware of in accident investigation processes and in relation to understanding how organizational factors are approached in investigations (Lundberg et al., 2009; Le Coze, 2010; 2008; Hollnagel, 2004) According to Lundberg et al. (2009) the causes found during investigations reflect the assumptions in the accident model following the principle of “What-you-look-for-is-what-you-find”. Moreover,

the identified causes typically become specific problems to be solved during implementation of solutions, which followed the principle of “What-you-find-is-what-you-fix” or “What you find is not always what you fix” (Lundberg et al. 2010).

Another important issue relates to our ability—or often lack thereof—to learn from accidents both within organizations, industries, across sectors and cultures. Even though causes or malfunctions often are the same—and hence possible to account for—failures seem to be repeated indicating that organization tend to suffer from “learning disabilities” (Hopkins, 2009).

3.3 *An industrial sector facing the risk of major accidents*

Organizations situated in the offshore oil and gas industry face huge challenges with regards to safety. As such they share characteristics with other organizations facing the risk of major accidents named High Reliability Organizations (HRO) (Weick, 1987; LaPorte & Consolini, 1991) or characterized as systems in which interactions are complex and couplings tight (Perrow, 1984). Such organizations operate technologies that are highly beneficial, yet costly and hazardous (LaPorte & Consolini, 1991:19). Despite high risk exposure and organizational complexity, the capacity of error free performance in these domains is nevertheless impressive. Daily work tasks on oil and gas facilities and their coordination are highly regulated by procedural systems. The industry is also characterized by complex client-contractor chains, organized as strategic non-equity alliances (Das & Teng, 1998), where the largest portion of employees work in contractor companies within frameworks heavily defined by their customers and authorities (Tharaldsen, 2011).

An often outspoken goal in high risk industries is to build strong “safety cultures” in order to protect the employees, the environment or technology from harm. The concept of safety culture first appeared in the International Nuclear Safety Advisory Group’s (INSAG) report on the Chernobyl accident (INSAG, 1986) and has been defined as: “That assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear installation safety issues receives the attention warranted by their significance” (INSAG 4, 1991, p.1). In accident investigations later on the concept is rather often turned to, and one finds examples of investigations where whole industrial sectors, global companies etc. are characterized as having a bad safety culture (e.g. Baker, 2007). Within the safety culture research field the concepts safety climate and safety culture are often used interchangeably,

and empirical studies have shown that some of the best predictors are related to management commitment to safety (when safety is under pressure) and colleague involvement/participation (Zohar, 1980, 2003, 2011; Flin et al., 2000; Guldenmund, 2000; Rundmo, 2003). Management commitment to safety is supposed to reflect management “true” priorities of safety when safety is under pressure—named “acid-test-indicators” by Zohar (2008). Other important aspects are related to the functioning or malfunctioning of safety systems, procedural compliance, work pressure, competence and risk (Flin et al., 2000). These aspects are also well documented as important buffers against accidents or as an explaining factor in accident investigations (Thunem et al., 2009).

4 METHODS

In our theoretical outlining we emphasized that risk regulation regimes follow different principles, main challenges with regards to learning from accidents, traits of the industrial context, and the role of empowerment and involvement. The Nordic model (Karlsen & Lindøe, 2006) is assumed to facilitate dialogue and agreement between the different parties with regards to the safety and risk level within the industry. In the further analysis we will examine how these aspects are made relevant in the accident investigations, first and foremost as consequences.

Our methods are qualitative and based on document analysis of mainly former accidents investigation reports, but also other available material such as film documentaries, research reports, articles and books dealing with our specifically selected accidents. The selection of documents is not meant to be all embracing. As such, our sources are not primary data, but rather secondary data and even data that have been even further elaborated on by accident investigators or others researchers (Corti & Thompson, 2004).

In their nature, accident investigation reports are produced in order to manufacture facts about a certain event or an accident that have happened—often according to certain qualified or certified methods or tools developed specifically for accidents investigators. As such, accident investigations, like other written or archived data, are not based on primary data, and they involve interpretation processes related to the manufacturing of facts, filling out the puzzle of what have or might have happened (Prior, 2004; Dekker, 2006). That is, the best accessible account of what actually happened, who were involved, the technology in use, direct failures and latent problems, the “why’s” of the accident etc.—often followed by suggestions of

improvements so that one might be able to prevent similar accidents from happening again. So what is seen as relevant information in such reports is not picked randomly, but put together often following a strict pattern.

Our analysis of the accidents follows a descriptive principle along four themes: Regulatory issues, industrial consequences, tripartite collaboration/involvement and organizational incentives/contractual issues. Main results are summed up in the next session.

5 RESULTS

5.1 Regulatory regimes

Results from our document analysis of the accidents shows that it is recommended and implemented regulatory changes at several system levels within each of the risk regulation regimes. Main findings from the accidents are pinpointed in the table below.

At an institutional or regulatory level, the three offshore accidents resulted in a more independent and stronger regulatory regime. The Piper Alpha accident resulted in a new regulatory regime in the UK. This new regime was to a large degree inspired by the Norwegian risk regulation regime within the petroleum industry. The responsibility for safety

on the UK shelf was transferred from the Department of Energy to the Health and Safety Executive. Intention behind this separation is mainly to avoid goal conflicts between safety and production aspects. In the new regulatory regime all offshore facilities needed to conduct a Safety Case, which is based on risk analysis on each facility (Store Norske Leksikon, 2009). The safety case approach is also recommended in the Macondo investigation report. In the safety case the industrial operating actors have to prove that the facilities and operations are sufficiently safe.

Until the Montara accident occurred, the Australian safety authority for offshore activities was regulated by two agencies. Documents show that the Australian authorities have accepted the recommendation of one federal offshore safety regulator after this accident (Government Response to the Report of the Montara Commission of Inquiry, 2010, draft).

In the aftermath of these major accidents, our results show that rules, regulation, and standards are reviewed and changes made to improve safety. In some cases we also found that the philosophy behind the regulation regimes is changing in diverse directions in the different countries. After Piper Alpha, UK incorporated regime changes from a prescriptive to a more performance-regulatory based approach. In the Macondo-case there is a mix of suggested regulatory changes, which to a certain degree might be regarded as contrasting. In the United States preliminary recommendations after the Macondo accident, support is given to a more prescriptive regulation complemented by a performance-based regulation (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). In Australia the Montara Inquiry Commission argues that the pendulum has swung too much towards performance-based regulation. In some areas the Commission wants to have a more prescriptive regulatory approach, for instance developing more detailed standard for drilling operations. This may also be a result after Macondo (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011a). The Australian authorities, however, showed a more reluctant attitude towards this recommendation as it was believed to transfer responsibility from the companies to authorities (Government Response to the Report of the Montara Commission of Inquiry, 2010).

In all our cases we have seen a drift towards more responsibility and liability for the companies. In the oil spill cases it is recommended that the polluter pays. After the Macondo accident, there was a proposal to raise the limit on third party liability from \$ 75 million. Furthermore in the wake of the Texas City—and the Montara accident, it was

Table 1. Results regulatory regimes.

PIPER ALPHA	<ul style="list-style-type: none"> • Independent safety regulator • Introduction of Safety Case • From a prescriptive to a performance based regime
TEXAS CITY	<ul style="list-style-type: none"> • Management of change • Strengthened industrial supervision • Revise API standards
MONTARA	<ul style="list-style-type: none"> • Separate resources and safety responsibilities • Independent safety regulator (NOPSEMA) • Legislation in marine environment • Stop activity criteria • Increased liability • Prohibition powers to NOPSA
MACONDO	<ul style="list-style-type: none"> • Independent safety regulator • Balance prescriptive & performance/risk based regime • Safety case regime • Increased liability • Multilateral collaboration

recommended that corporate management should be held accountable for accidents to a greater extent.

5.2 Industrial consequences

A repeating recommendation after these accidents is to improve procedural systems or compliance, safety management and leadership. Examples are a stronger implementation of the permit to work systems in the UK after Piper Alpha, permit to operate (Macondo), improved process knowledge among senior/corporate management and board members (Texas City), and improved management of change processes (organisational and operational, work processes) as recommended after Macondo.

Further, improvements to emergency response are a repeating recommendation in these accident reports e.g. a rather general recommendation after the Piper Alpha accident, recommendation on improvements on operators emergency assistance (Montara), and several recommendations on oil spill emergency response after the Macondo accident (better funding of oil spill control and oil spill response). As a direct result of the Macondo accident the OGP established a “Global Industry Response Group” in July 2010 (OGP 2011).

Various versions of improvements to risk assessments are recommended after most accidents, e.g. the introduction of safety cases (Piper Alpha),

the use of barriers methodology in risk assessment (Texas City, Montara), lower threshold for conducting risk assessment, independent reviewing, and broader context when performing risk assessments (Montara).

Other technology developments are more linked to the actual causes of the accidents, such as changes to platform design (Piper Alpha), implementation of barriers (Texas City, Montara), and improvements to well integrity and well barrier technology (Macondo, Montara).

Finally, several safety cultural recommendations are mentioned after most accidents, e.g. the introduction of “Step change in safety” and enhanced safety training after Piper Alpha, improved process knowledge among senior/corporate management and board members and personal versus process safety indicators (Texas City), communication and information sharing between stakeholders and broader context when conducting decisions and risk assessments (Montara). Also the Macondo accident investigation reports (National Commission 2011a and 2011b) recommends strengthening of the safety culture, including learning from the nuclear, chemical and aviation industry, and a move towards a more collective responsibility of safety. Somewhat similar to the “Step change to safety”, a safety excellence institute is recommended in the Macondo accident investigation reports (National Commission 2011a and 2011b) for establishment of best practices stand-

Table 2. Industrial initiatives and consequences.

PIPER ALPHA (UK)	<ul style="list-style-type: none"> • Stronger implementation of permit to work system and incident reporting systems • Enhanced emergency response systems • Introduction of “Step Change in safety” • Enhanced safety training • Changes to platform design
TEXAS CITY (US)	<ul style="list-style-type: none"> • Improved process knowledge among senior/corporate management and board members • Increased liability for senior/corporate management and board members • Adequate physical devices and technology (barriers) • Personal versus process safety indicators
MONTARA (AU)	<ul style="list-style-type: none"> • New requirements for barrier, well, risk assessments • More provisions, reviewing, verification, reporting and testing, documentation • Lower threshold for conducting risk assessments and independent reviewing • Operators emergency assistance • Communication and information sharing between stakeholders • Broader context when conducting decisions and risk assessments
MACONDO (US)	<ul style="list-style-type: none"> • Proposed introduction of a Safety excellence institute • Proposed funding of regulators activities by the industry • Increased funding of oil spill control by the operators • Proposed stricter operating permit conditions (well integrity and oil spill response) • Proposed strengthening of Safety culture • Proposed increased system, operation and risk understanding • Proposed various technology enhancements like Capping, BOP, oil-spill recovery

Table 3. Tripartite collaboration and involvement.

PIPER ALPHA	The independence of safety delegates, committees and inspectors are being questioned
TEXAS CITY	(NONE)
MONTARA	Indirect through requirements of broader involvement
MACONDO	Whistle blower protection

ards. This safety excellence institute is proposed to be independent of the industry itself, modelled according to the practice in the nuclear industry.

5.3 Tripartite collaboration and involvement

Within the Nordic model the involvement of safety delegates, committees and unions are considered important sources for ensuring safety. When examining the four accidents, more formal collaboration systems are not being introduced as actions in themselves. However, discussions about the independence of safety delegates, committees and inspectors are questioned for instance in the aftermath of Piper Alpha (New Scientist, 1988). The Offshore Industry Liaison Committee (OILC) was a trade union set up in the United Kingdom in response to Piper Alpha (Wikipedia.org).

The Texas City accident investigation did not mention or come up with actions or suggestions related to improvement of formal employee collaboration and involvement. The Montara investigation does neither suggest any changes with regards to formal employee participation. However, we found that the tripartite issue is covered more indirectly through requirements of more informal involvement and broader workforce participation. In the Macondo report a suggestion of whistle blower anonymity and protection emerges, together with a stopwork authority system (National Commission, 2011a, Deepwater Horizon Study Group, March 2011).

6 DISCUSSION AND FUTURE CHALLENGES

The examined accidents represent one of the major accidents in 1980'ties, two of the major accidents in the first decade of 2000 and finally one major accident in 2010. Despite of this rather large time span, causes, underlying factors and suggested improvements are often similar.

Prior to the first of these accidents (Piper Alpha) all involved regulators (including also Norway) were dominated by one single regulator dealing both

with resource management, national economic interests and safety of the facilities and operations. As a result of these accidents one of the main aims have been to avoid the potential conflicts between safety and economy/resources. In UK, Norway and now also in US after the Macondo accident, a more distinguished regulator role emerges, with a clear split between guidance and control (e.g. White Paper, no. 17, 2002–2003).

Our study showed that regimes were re-organized and their regulator philosophy changed. Some of them from a prescriptive to performance based others to a more hybrid approach (Braithwaite et al., 2005). Main reasons for going from prescriptive to performance based regimes are often in the literature related to the arguments that competence, improvement and innovations relies within in the industry, and hence, it becomes difficult for a regulator to keep track. Another argument is that safety responsibility and commitment should come from and be placed within the industry itself (Kirwan et al., 2002). A more detailed, prescriptive regime is dominated by “checklist” regulation which also is anticipated to have a ceiling effect, meaning that the companies comply with regulation, but do not take safety improvements further.

However, we believe that there are vital challenges to be taken into consideration in the performance based regimes as well. In times of good financial situations innovation and safety improvements are probably easier to foster and promote within the companies and by regulator, than in times of scarce resources. There may also be a potential danger of complacency in the performance based regime, where companies are the holding the competence on how to improve safety level within their organization. Diverse questions can be raised such as: Will the companies work to improve safety level; will they have the right motivation to continuously improve the safety level and set new safety goals; and what about the companies who see themselves as market leaders; will they work to further improve their safety performance? Moreover, we think it is worth considering that a performance based regime also has its limits and might become dysfunctional. What may be the signs of such weaknesses? Is it when the regulator sees a tendency of falling motivation among different companies; when the company and industry lack interest and incentives and ask what's in it for us? We cannot offer the answers to such problems, but limited attention is given to these aspects in the studied accidents when recommendations are given on changing regulations and regimes.

After some of the accidents there were recommendations to “look to Norway” and how Norway had succeeded with the performance-based approach. However limited attention has been paid to contextual, cultural, and structural aspects in which

the Nordic Model has evolved, is being applied and the cultural preconditions that should be in place for it to work. The Nordic Model requires a high degree of trust, dialogue and democratic principles that are present in Norwegian work life. The model is also strongly equality oriented, and we believe that cultural preconditions may complicate translation of a risk regulation regime and practices to completely different contexts.

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