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Review

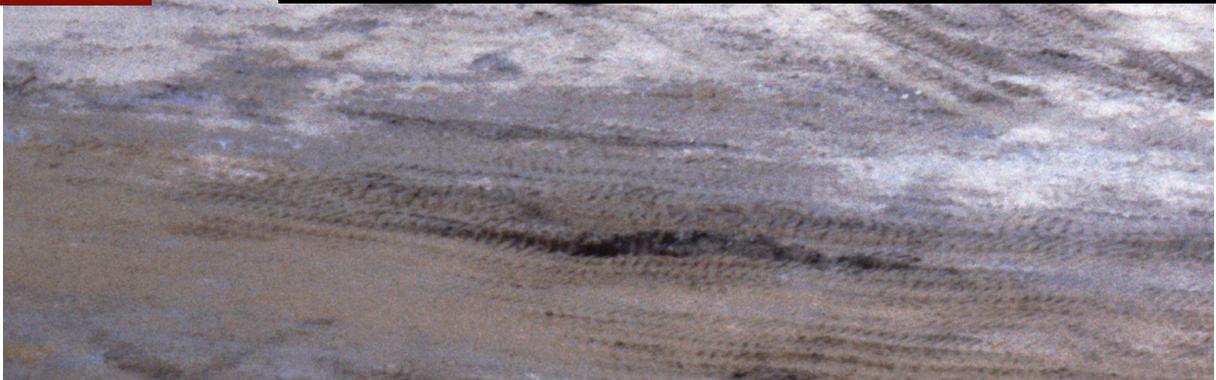
of all fatal accidents in
Queensland mines and quarries
from 2000 to 2019

By

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for the Department of Natural Resources, Mines and Energy

December 2019



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EXECUTIVE SUMMARY

Recommendation 1: The industry should recognise that it has a fatality cycle. Unless it makes significant changes to how it operates, the rate of fatalities is likely to continue at current levels. This pattern has been evident over the past 19½ years and is characterised by periods where a significant number of fatalities occur, followed by periods where there are few to none. This suggests that the industry goes through periods of increasing and decreasing vigilance. Past behaviour suggests that in the order of 12 fatalities are likely to occur over any 5 year period.

If the industry continues to take a similar approach to safety, using the same philosophies and methodologies adopted over the past 19½ years, then similar safety outcomes are to be expected.

The cycle further suggests that the periods with few to no fatalities should be viewed as simply part of the fatality cycle – they are not evidence of the industry becoming safer over the long term. Instead, further fatalities should be expected as the cycle continues. This may appear a bleak prediction, but this cycle has proven surprisingly resilient over the past 19½ years.

The 6 fatalities that occurred between July 2018 and July 2019 have been described by some in the industry, media and politics as evidence of an industry in crisis, but a bleaker assessment is that this is an industry resetting itself to its *normal* fatality rate.

Perhaps one of the biggest stumbling blocks to reducing the number of fatalities is how the mining industry views itself. Mining *is* a hazardous industry, but that doesn't mean that workers and their families must continue to suffer the consequences of these hazards. An illustrative comparison can be made with the airline industry – the general public *expect* air travel to be safe, despite it having to cope with significant hazards. By contrast, both the mining industry and the general public appear to *expect* mining to be dangerous. This fatalism may be the biggest stumbling block to preventing the industry taking the next step.

Recommendation 2: The industry should recognise that the causes of fatalities are typically a combination of banal, everyday, straightforward factors, such as a failure of controls, a lack of training, and/or absent or inadequate supervision. Internal incident investigations in mining companies must strive to capture these combinations of causal factors, and avoid simplifying them to a single cause, such as human error, bad luck or freak accidents, which has the potential to mask the underlying system failures. Recommendations 3 to 5 cover the key causal factors identified in this review.

A superficial examination of the causes of the 47 fatalities analysed as part of this review gives the impression that many were freak accidents, that events transpired in such a way that could never have been anticipated. This impression can inspire fatalism: *how can we possibly protect workers against such freak accidents?* It can reinforce the notion that mining *is* a hazardous industry and fatalities simply cannot be avoided.

However, the majority of fatalities were not freak accidents. Many were preventable, and there was rarely a single significant cause. This is likely to be an uncomfortable finding for many: there is a tendency to assume that bad outcomes must have equally bad causes – when a fatality occurs, it must have a particularly sinister cause. This is not the case – there were few smoking guns.

At a practical level, a large number of the fatalities involved a mine worker in a situation that they were inadequately trained for, with the controls meant to prevent harm being ineffective, unenforced or absent, with no or inadequate supervision to identify and remedy these shortfalls. It then took an initiating event, e.g., in the form of a freak incident or bad luck, to result in a fatality.

Almost all of the fatalities were the result of systemic, organisational, supervision or training failures, either with or without the presence of human error. Human error alone would not have caused these fatalities. 17 involved no human error *at all* on the part of the deceased.

There were 10 incidents involving known faults, where individuals were aware of them, but no action was taken. 9 fatalities had known near misses occur prior to the fatality. In some cases, prior fatalities had occurred in a similar manner.

Recommendation 3: The industry needs to focus on ensuring workers are appropriately trained for the specific tasks they are undertaking.

A total of 17 of the 47 fatalities involved a lack of task specific training and/or competencies for the tasks being undertaken. A further 9 had inadequate training. These tasks were often undertaken at the direction of supervisors or others who were aware of these deficiencies.

In many cases this lack of training resulted in the worker being unaware of the hazards involved in completing the task or the worker operating equipment in a manner that exposed them to hazards.

Recommendation 4: The industry needs to focus on ensuring workers are appropriately supervised for the tasks they are undertaking.

In 32 of the 47 fatalities, the worker was required to be supervised when undertaking the task, i.e., the 32 did not include routine tasks, such as driving. 25 of these 32 fatalities involved inadequate or absent supervision.

17 of the fatalities involved a lack of training or inadequate training for the specific task being undertaken and inadequate or absent supervision.

Not only does absent or inadequate supervision allow tasks to be approached in an unsafe manner, but it also greatly amplifies the consequences of a lack of training or ineffective or unenforced controls.

Recommendation 5: The industry needs to focus on ensuring the effectiveness and enforcement of controls to manage hazards. Given the increasing Serious Accident Frequency Rate, industry should implement more effective controls (such as elimination, substitution, isolation, or engineering controls). A significant number of the controls reported put in place in the aftermath of an incident were administrative in nature.

The majority of the 47 fatalities involved at least one failed or absent control that could have prevented the fatality. The underlying factors for these absent controls often stemmed from decisions made at a supervisory and/or organisational level in organisations.

In recent years, the role played by ineffective controls in incidents, including Serious Accidents, is increasing.

In addition, the reported corrective actions put in place in the aftermath of Serious Accidents – incidents with a demonstrated capability to require hospital admission for treatment – were in 62% of the cases administrative controls only. Administrative controls, despite having their place in the industry, are some of the least effective controls available.

Recommendation 6: The industry should adopt the principles of High Reliability Organisational theory in order to reduce the rate of Serious Accidents and fatalities. At its most fundamental level, High Reliability Organisational theory focuses on identifying the incidents that are the precursors to larger failures and uses this information to prevent these failures occurring. Adopting a High Reliability Organisation approach will require the refinement or addition of specific competencies to both the mining industry and the Regulator.

Drift into failure, where the industry exhibits a greater acceptance of risk over time, is potentially evident in the Queensland mining industry at both a macro and micro level.

While the 1999 legislation has made significant progress in making the industry safer, despite this progress, the current approach has not been sufficient to reduce the fatality rate to zero in the long term.

No single change to the mining industry will reduce this rate, what is instead required is a change in approach to how the industry identifies and controls hazards, as well as how it recognises and addresses them when these controls are eroding or ineffective.

A High Reliability Organisation, or HRO, understands that periods of success breed complacency, which can lead to failures and fatalities. Periods where there are few to no fatalities are typically periods where a drift into failure occurs. Safety is compromised for a variety of reasons, often benign, over time. These compromises typically result in a series of minor near-miss incidents.

HROs actively seek out these near-miss signals, which are typically the precursors to failure. HROs believe that these signals provide an opportunity to identify and act on existing hazards in order to remove them from the workplace. This is the key step that helps prevent the drift into failure.

Many of the recommendations that follow flow directly from HRO theory.

This will require the industry to develop a dedicated group with the appropriate competencies whose role it is to collate, categorise, actively search and identify concerning trends in incident data.

Recommendation 7: In order to proactively assist the mining industry to operate more like High Reliability Organisations, the Regulator should play a key role in collating, analysing, identifying, and proactively disseminating the lessons learned from the incident and fatality data it collects from the industry.

Central to the concept of a HRO is that incident information can be actively used as a preventative tool to educate the wider industry. The Regulator is in a critical position to fulfil this role due to its centralised access to industry wide incident data.

The identification of developing incident trends and the timely dissemination of this information to industry, coupled with inspections and audits aimed at ensuring the wider industry is engaging and responding to this information will be critical in fatality prevention.

This will require the Regulator to develop a dedicated group with the appropriate competencies whose role it is to collate, categorise, actively search and identify concerning trends in incident data for the industry.

Recommendation 8: The Regulator should develop a new and greatly simplified incident reporting system that is easy to use by those in the field, that is unambiguous, and that aims to encourage open reporting, rather than be an administrative burden to reporting.

The current reporting system is a product of evolution over the past 19½ years, rather than a system designed to take advantage of current technology. Due to its evolutionary nature, it is cumbersome, ambiguous, and difficult for the industry to use.

In order for the Regulator to play a central role in collating and analysing data, it must develop a system that maximises the probability of incident reporting. In HROs there is no such thing as a safety culture, rather there is a reporting culture. Currently, the data suggests under-reporting of incidents is occurring, and steps to address this issue are required.

The Regulator should develop a new system to address these shortcomings. While this review does not intend to set out the specific details of such a system, it should be in line with modern mobile technology, preferably app based, and the Regulator should ensure that the administrative burden of reporting is minimised, e.g., consider allowing the industry to report the incident in text based form, which reduces the need to fill in fields and categories pertaining to the incident.

The Regulator should also consider the development of a dual reporting system to discourage potential under-reporting of incidents. The role of this dual system is to ensure that two reports, by separate individuals/companies/institutions, are submitted to the Regulator. For example, if a person is admitted to a hospital for treatment, i.e., a Serious Accident, then the hospital can make an independent report, which should be cross-checked to ensure the mine site also provided a report of the incident.

It should also be accepted that there will be an inevitable tension between the need to capture comprehensive information on an incident, while at the same time avoiding the discouragement of reporting due to the volume of information required.

Recommendation 9: The industry should shift its focus from Lost Time Injuries (LTIs) and the Lost Time Injury Frequency Rate (LTIFR) as a safety indicator.

LTIs as a safety indicator are problematic. LTIs are prone to manipulation, are a measure of how the industry manages injuries after they have occurred, as opposed to a measure of industry safety. It is possible, therefore, to reduce the LTIFR without making the industry safer.

Further, an analysis of the fatalities shows that many of the causal factors would not have caused injuries prior to the fatality. Therefore, they would not be recorded as LTIs, with them remaining unidentified as issues. At best the LTI Frequency Rate is a distraction that focuses industry on the wrong safety measure, at worst it results in early warning signs being missed.

Recommendation 10: The Regulator should adopt the Serious Accident Frequency Rate as a measure of safety in the industry.

Selecting a metric for determining if the mining industry is getting more or less safe is challenging. This metric must be both a true reflection of safety in the industry, as well as a metric that is not easily manipulated.

Therefore, it is recommended that the Serious Accident Frequency Rate be selected as the appropriate metric. There are a number of reasons for this selection:

- Apart from the fatality rate, the Serious Accident Frequency Rate is a genuine reflection of how many people are getting seriously injured to require admission to hospital for treatment,
- The Serious Accident Frequency Rate is least likely to be susceptible to both conscious and subconscious manipulation. To qualify as a Serious Accident, determination of a 3rd party from the medical profession is required.

Recommendation 11: The Regulator should adopt the High Potential Incident Frequency Rate as a measure of reporting culture in the industry.

Rather than viewing the High Potential Incident Frequency Rate as a measure of the level of safety in the industry, it should be viewed as a measure of the reporting culture.

High Potential Incident reporting should be encouraged in order to better ensure early warning signals of impending incidents and fatalities are captured and disseminated to the wider industry. This provides the best opportunity to identify hazards before they cause harm and ensure they are effectively controlled.

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1. INTRODUCTION

1.1 Background to the Review

On the 8th of July 2019 the Honourable Dr Anthony Lynham, Minister for Natural Resources, Mines and Energy, announced an expert review would be undertaken to identify changes needed to improve health and safety in Queensland mines and quarries.

The announcement was made following a fatality on the 7th of July 2019, which followed a total of 5 fatalities in the 2018/19 financial year.

1.2 Purpose of the Review

The Minister's requirements were to examine all fatal incidents in Queensland mines and quarries from 2000 to 2019, and based on this examination look at¹:

- a) Why mine workers have died over the past 20 years²,
- b) How industry can improve, and,
- c) How the mines inspectorate can work better.

1.3 Conduct of the Review

The review was led by Dr Sean Brady based on information provided by the Queensland Government Department of Natural Resources, Mines and Energy (DNRME).

In this report the terms Queensland mining industry or the mining industry shall be taken to include both mines and quarries.

1.4 Review Methodology

The review adopted a multi-prong approach to investigate the underlying causes of fatalities, namely:

1. **Causes of Individual Fatalities:** Over the course of the review period, when a fatality occurred, the regulator investigated and compiled the findings into what are known as Nature and Cause Reports.³ These reports were analysed, both to understand the causes of each individual fatality, and to identify if patterns and common causes existed across the 47 fatalities that occurred between the 1st of January 2000 and the 31st of July 2019 – hereafter referred to as the review period.
2. **Incident Data:** To provide context to the individual fatalities, an analysis of the incidents that occurred throughout the mining industry was conducted. The details of these incidents were provided by the regulator, which receives reports on a range of incident types, many of which involve mandatory reporting. In the order of 40,000 incident details were available for the review period.
3. **Hours Worked Data:** In order to provide context to these 40,000 incidents, the hours worked for each mine, per month, from 2000 to 2019 were analysed.

¹ Prior to the announcement of this review, an investigation into mining fatalities was underway with a more limited scope that covered coal mine incidents from 2000 to the end of 2018. The Minister subsequently expanded this scope on 8 July 2019 to include mineral mine and quarry incidents, and all fatal incidents up until 31 July 2019.

² The review considers all fatal incidents from 1 January 2000 to 31 July 2019.

³ This review assumed that the Nature and Cause reports accurately describe the causes and circumstances surrounding each fatality. This was considered a reasonable assumption. The focus of the review was not to confirm the accuracy of these reports.

4. **Discussion:** Discussions were held with individuals from both industry and the regulator. The findings from this review were presented to, and feedback was received from, the Coal Mining Safety and Health Advisory Committee⁴ and the Mining Safety and Health Advisory Committee⁵ - two mining advisory committees that advise the Minister for Natural Resources, Mine and Energy on the safety and health of coal mine, mineral mine and quarry workers.
5. **Call for Submissions:** On the 28th of October 2019 a call for submissions was released to the industry. Responses were considered as part of this review.
6. **Analysis and Reporting:** The analysis findings of the individual fatalities, the wider incidents in the industry, and the hours worked in the industry were collated to identify the overall industry trends that drive increases and decreases in fatality and incident rates. These findings, combined with research into various approaches to safety, form the basis for the recommendations for how industry and the regulator can attempt to reduce incident and fatality rates.

1.5 Report layout

The report is laid out as follows:

1. A brief overview of the Queensland mining industry is presented in Section 2. Some industry statistics are introduced, and the role of the regulator and industry, along with the various roles of site senior executives and others, are discussed.
2. Section 3 discusses the fatalities that occurred from 2000 to 2019. The cyclical behaviour evident in fatalities, along with general statistics are presented. Causal diagrams are introduced, which provide a visual representation of the key aspects of each individual fatality. The conclusions and patterns evident from these analyses are presented in this report.
3. Section 4 provides a detailed examination of the incidents and injuries occurring in the industry from 2000 to 2019. This section introduces the available data, as well as the purpose and method of its collection.
4. Section 5 examines the behaviour of the industry as a whole. An analysis of the frequency of different incident types, with respect to the hours worked provides an opportunity to develop a deeper understanding of how the Queensland mining industry operates in practice.
5. Sections 6 and 7 introduce the concepts of complexity, drift into failure and High Reliability Organisations (HROs). These concepts provide a basis for how the Queensland mining industry and the regulator can reduce the rate of fatalities.
6. Section 8 provides the review's conclusions and recommendations.
7. Appendices are included that provide additional material and discussion to the main report.

⁴ <https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/commissioner/advisory-committees/cmshac>

⁵ <https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/commissioner/advisory-committees/mshac>

2. INDUSTRY OVERVIEW

2.1 Introduction

This section provides an overview of the Queensland mining industry. It discusses industry statistics, as well as the role of the regulator and various statutory positions within the industry.

2.2 General Data and Statistics on Queensland Mining

Over the past decade, the overall value of Queensland Resources Exports has almost doubled from \$36 billion in 2009 to \$71.5 billion⁶. Metallurgical coal represents the largest share at \$38.72 billion, Minerals at \$10.23 billion and Thermal Coal at \$6.53 billion⁷.

At the end of June 2019 there were a total of 53,084 people employed in the resources industry, split across each subsector as follows⁸:

- (a) 37,290 in Coal Mining,
- (b) 14,034 in Minerals Mines,
- (c) 1,760 in Quarries.

The year-on-year percentage change in employment in each subsector for the 12 months up to the end of June 2019, is:

- (a) 9.4% increase in Coal Mining,
- (b) 0.5% increase in Mineral Mines,
- (c) 3.3% increase in Quarries.

The number of mining operations, by sector, operating in Queensland as of December 2019 is:

- (a) Coal–Exploration – 321,
- (b) Coal–Open-Cut – 62,
- (c) Coal–Underground – 13,
- (d) Metalliferous–Exploration – 304,
- (e) Metalliferous–Open-Cut – 292,
- (f) Metalliferous–Other – 1,137,
- (g) Metalliferous–Quarry – 341,
- (h) Metalliferous–Underground – 93.

⁶ As of January 2020. DNRME Strategic Economics Unit - Queensland Resources Exports.

⁷ The total of \$71.5 billion also includes LNG at \$16.02 billion.
DNRME Strategic Economics Unit - Queensland Resources Exports.

⁸ Provided by the DNRME.

2.3 Hours Worked in Industry (2000–2019)

The regulator records the number of hours worked per mine per month as part of the monthly incident summary report⁹. Between January 2000 and the end of July 2019, 1,635,566,224 hours were worked in the industry.

These hours have been worked by both employees and contractors. While the definition of an employee is obvious - they are employed by the mine site as an employee - the definition of a contractor, as used in this report, is more complex. The term contractor includes:

- **Employees of contracting companies:** the mining industry engages contracting companies to undertake various tasks at the mine to support mining operations¹⁰. The individuals who perform the work are known in the industry as contractors (they are employed by the contracting company). As will be discussed and examined later in this report, there is an industry view that this contracted workforce does not perform at a similar level of safety to mine employees. The expression *wearing the shirt* is used to describe mine employees, as opposed to contractors.
- **Specialist contractors:** the mining industry engages specialist contractors to perform very specific tasks. This often occurs during a shutdown, when specific maintenance activities are undertaken. There is an industry view and expectation that these contractors will be highly skilled and competent from a safety perspective.
- **Contractors operating mines:** some mines are operated by a contracting company on behalf of a mining company. In this case the entire mine site is operated by contractors, with few employees.

Figure 1 illustrates the distribution of hours worked per sector per contractor and employee.

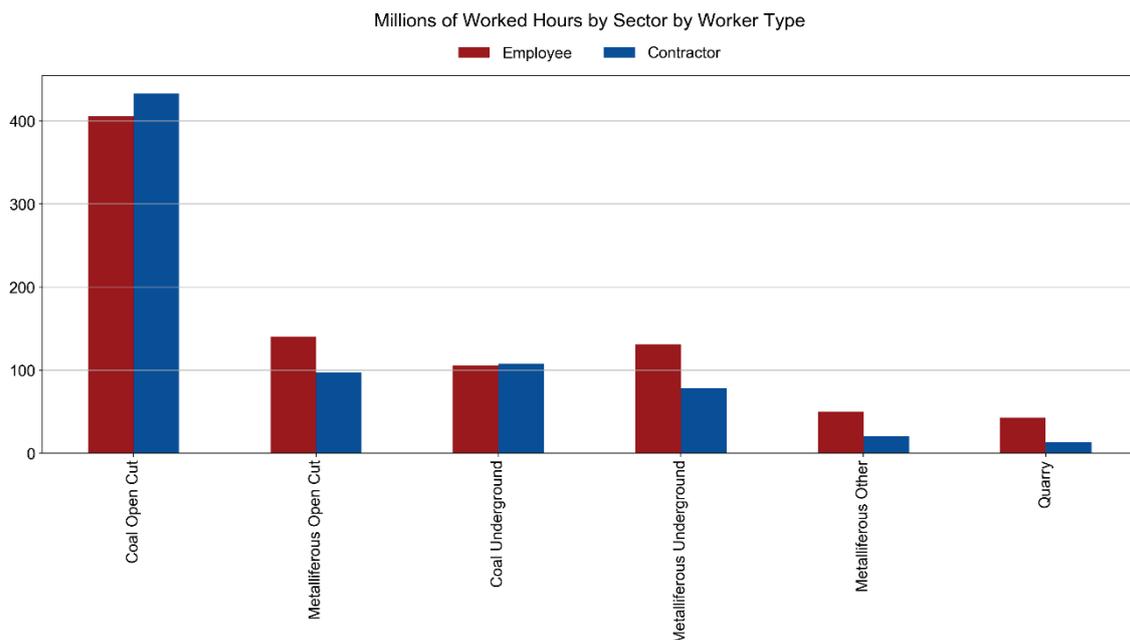


Figure 1 Distribution of hours worked per sector per worker type¹¹

Figure 2 shows the distribution of hours worked, per contractor and employee, for each financial year¹².

⁹ <https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/accidents-incidents-reports/report-notify>

¹⁰ Sometimes this is in the form of labour hire.

¹¹ Coal and metalliferous exploration are not shown in this graph as they have minimal worked hours.

¹² The Australian financial year runs from 1 July to 30 June, e.g., the 2012/13 financial year runs from 1 July 2012 to 30 June 2013.

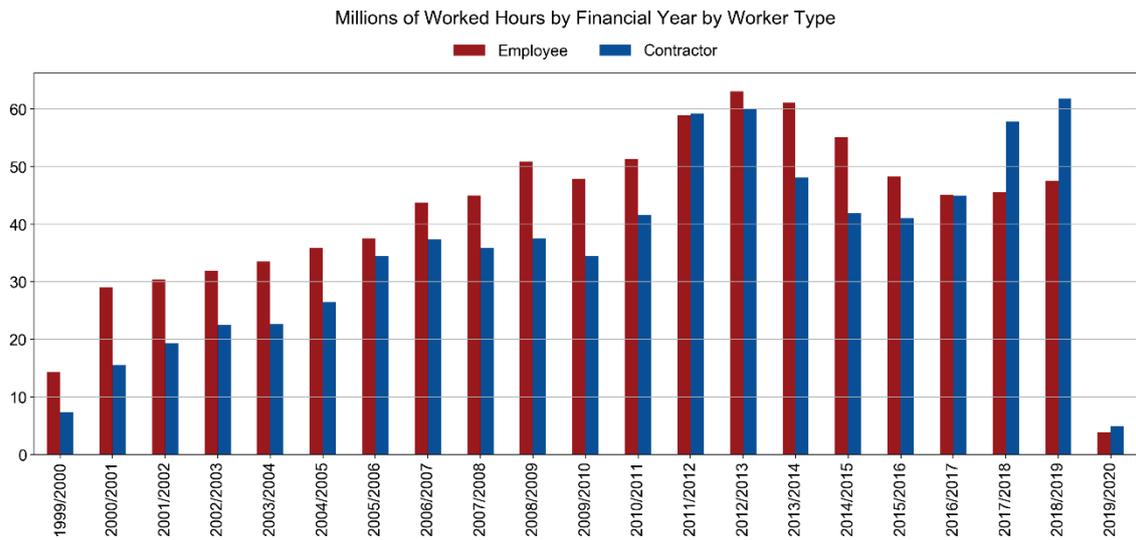


Figure 2 Distribution of hours worked, per contractor and employee, per financial year

Between 2000 and 2012/13, the hours worked gradually increased, typically with more employee hours worked than contractor. Between 2012/13 and 2015/16 the overall hours decreased, then from 2016/17 onwards, the hours steadily increased. Since 2017/18, contractor hours have exceeded employee hours, which is almost unique across the last 19½ years.

Figure 3 shows the split of hours worked per sector for the period of the review – the largest increases over time have been in open cut coal.

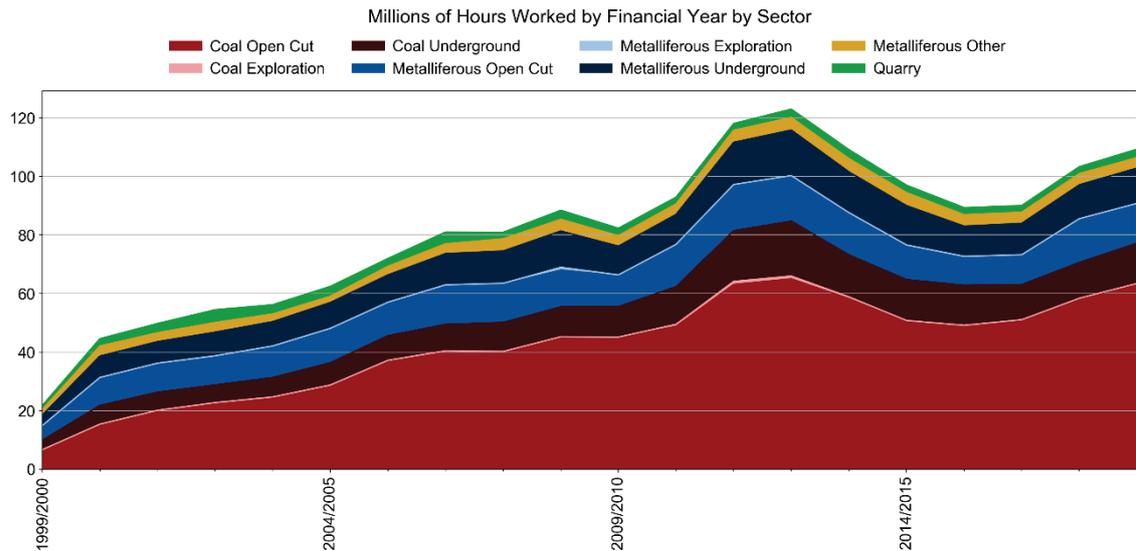


Figure 3 Hours worked per financial year per sector

2.4 Discussions with the Industry

A significant number of discussions took place with those in the industry as part of this review – on occasions as a result of visits to mine sites¹³. From these discussions a number of common themes emerged, which are discussed below.

Too Much Paperwork: a significant proportion of people spoken to expressed the view that the large amount of paperwork (relating to safety) that they are required to produce and manage is a major challenge. While all accept *some* paperwork is required – at least to establish compliance – they were of the view that the sheer amount of it resulted in them spending more time at their desk than actively in the field talking to and observing the workers.

In their view, the importance of spending time on the mine site or underground was critical in both identifying hazards and ensuring work was being carried out in line with procedures. This, they felt, was a very high price to pay in order to keep on top of their paperwork - at what point was it making the site *less* safe. Throughout the discussions it was unclear whether this large amount of paperwork was a result of having to comply with the legislation or if it was driven by the mining companies themselves.

To many, this ever increasing paperwork load was in the form of more and more procedures. Many felt this was the default approach to managing risk. And as both the number of and quantity of detail in procedures grew, they questioned the workers' ability to retain all this information. They have the view that miners learn on the job, working with experienced individuals. (A number of people spoke about this issue with respect to inductions, where individuals are expected to understand and retain more and more information during their inductions.)

New People in the Industry: Many expressed the view that more new and inexperienced individuals were entering the industry. While new and inexperienced individuals have always been entering the mining industry, there is a view that they are now doing so in higher numbers than before. Combine this with the situation where many experienced individuals are leaving the industry and some significant challenges present themselves.

Firstly, as inexperienced people enter the industry they are being trained by people who are also reasonably inexperienced. Given, as mentioned above, that miners learn on the job, this means that the deep learning from someone who has spent a career in the industry is not being passed on.

Secondly, because of the need to hire and retain people, there is a drive to promote individuals quicker than would have been in the past. One of the reasons why this is taking place is that if a person gains experience, there is pressure to promote them in that mine *before* another mine offers them a position and they leave.

Mental Health: While an examination of mental health is outside the scope of this review, many individuals – when asked about mine safety and fatalities - raised it. Two broad areas were discussed. The first related to the pressures of *fly in fly out* work, and the pressure that puts on both the miners and their families. The second area relates to the management of the mental health of both a miner who has been injured, as well as the other individuals on that site when an incident or a fatality has occurred.

Quarries: Quarries stress that they are different to mines. They are smaller, have considerably tighter budgets, have smaller teams and because they rely on receiving orders each month, they argue that this makes long term planning difficult. One individual stressed that the health and safety approach that may work for the large mines does not scale down well for quarries. He also stressed that there should be inspectors in the Regulator who came from a quarrying background.

Employee/Contractor Debate: At the onset of this review, many expressed a strong view that the increasing number of contractors in the industry was leading to a reduction in safety. There was an openly expressed view that, as was discussed above, contractors do not work in as safe a manner as employees.

Some of these factors will be discussed as the report progresses.

¹³ A response to the call for submissions was received from the Mine Managers' Association of Australia and is included in Appendix E.

2.5 Safety and Health Acts 1999 ¹⁴

The mining industry operates under a legislative framework that commenced in March 2001. *The Coal Mining Safety and Health Act 1999* and *Mining and Quarrying Safety and Health Act 1999* were the outcomes of an extensive tripartite process between government, industry and unions over the six years that followed the 1994 Moura No. 2 mining disaster¹⁵.

The new framework introduced a risk-based safety and health management system for each mining operation. These systems are central to the Queensland safety and health framework and incorporate risk management practices to ensure the safety and health of coal mine workers and persons who may be affected by mining operations.

Under the framework, mine operators are required to proactively review their safety and health management system to ensure it is effective and adapts to the changing environment and interdependencies of complex mining operations.

The Queensland framework enables statutory officers (such as the mine's Site Senior Executive (SSE)), worker representatives (such as Industry Safety and Health Representatives (ISHR) and district worker representatives), mines inspectors, and mine workers to play a proactive role in reviewing, inspecting or auditing the safety and health management system. This proactive review by a wide range of people, with differing expertise and perspectives, is intended to strengthen the integrity of the safety management system and safeguard against potential risk exposure not being addressed.

2.6 The Role of the Regulator ¹⁶

The regulator's responsibility is for administering and enforcing the risk-based regulatory framework for worker safety and health in Queensland's resources sector. The regulator, which currently sits within the Department of Natural Resources, Mines and Energy (DNRME)¹⁷, includes the Coal Mines Inspectorate, the Mineral Mines and Quarries Inspectorate, as well as the Petroleum and Gas Inspectorate and the Explosives Inspectorate (hereafter referred to as the Regulator)¹⁸.

The Regulator's statutory responsibilities for mining and quarry safety and health are set out in the following legislation and regulations:

- (a) The *Coal Mining Safety and Health Act 1999* (CMSHA) and Coal Mining Safety and Health Regulation 2017, which is administered by the Coal Mines Inspectorate,
- (b) The *Mining and Quarrying Safety and Health Act 1999* (MQSHA) and Mining and Quarrying Safety and Health Regulation 2017, which is administered by the Mineral Mines and Quarries Inspectorate.

This review focuses on the regulatory functions of the Coal Mines Inspectorate and Mineral Mines and Quarries Inspectorate, which together constitute the Queensland Mines Inspectorate (QMI).

¹⁴ Details provided by the DNRME.

¹⁵ The Moura No. 2 underground coal mine disaster took place on Sunday 7 August 1994, when an explosion occurred in the mine. There were twenty-one persons working underground at the time. Ten men from the Northern area of the mine escaped within thirty minutes of the explosion, but eleven from the Southern area failed to return to the surface. A second and more violent explosion occurred on Tuesday 9 August 1994. Rescue and recovery attempts were thereafter abandoned, and the mine sealed at the surface. (Wardens Inquiry, Report on an Accident at Moura No 2 Underground Mine, <https://www.publications.qld.gov.au/dataset/moura-mining-disaster-inquiry-reports/resource/a8e96409-52a3-4075-b4a6-b1224ecc8e63>)

¹⁶ Details provided by the DNRME.

¹⁷ Draft legislation is before the parliament at the time of publication, which would see the Regulator established as a standalone statutory body.

¹⁸ <https://www.dnrme.qld.gov.au/>

The QMI's compliance approach is to protect the safety and health of resource industry workers and the Queensland community at large, by ensuring that:

- (a) The risk of injury or illness resulting from regulated activities is at an acceptable level,
- (b) Obligation-holders receive the support, guidance, and information necessary to discharge their safety and health obligations,
- (c) Industry, workers and the broader community have confidence in Queensland's resources safety and health framework.

To this end, QMI applies its resources to the areas of greatest risk and to the activities that will achieve the best safety and health outcomes.

QMI uses compliance and enforcement tools which are:

- (a) **Educational:** including engagement activities, safety alerts and bulletins, substandard condition and practice advice, inspection and audit activities,
- (b) **Corrective:** including directives, inspections, audits, substandard condition or practice advice,
- (c) **Deterrent:** including prosecutions, directives, investigations, random inspections and audits,
- (d) **Punitive:** prosecutions and civil penalties.

QMI applies all of the available compliance and enforcement tools available to it and considers which actions are most appropriate, with regard to the relevant circumstances, on a case-by-case basis.

2.7 The Role of the Industry in Safety¹⁹

The Legislation places obligations on mining operators and other individuals to protect the safety and health of workers and others at mines and ensure the risk of injury or illness to any person resulting from operations is at an acceptable level. The DNRME considers that industry's ability to protect workers is dependent upon a wide range of activities, including:

- (a) The accurate, timely reporting of safety and health data to allow identification and adequate assessment and management of risk,
- (b) Participating, along with workers' representatives²⁰ and government, in the development of strategies for improving safety and health through the tripartite statutory advisory committees (the Coal Mining Safety and Health Advisory Committee and the Mining and Quarrying Advisory Committee),
- (c) Discharging obligations in respect of health assessments and health surveillance,
- (d) Proactively reviewing the safety and health management system to ensure it is effective and adapts to the changing environment of complex mining operations.

¹⁹ Details provided by the DNRME.

²⁰ Refer Appendix A for further explanation of this role.

2.8 Further Roles

Further statutory roles exist in the industry, such as the site senior executive, the underground mine manager for coal, the Industry Safety and Health Representatives (ISHR), and the District Workers' Representatives. Further details on these roles are presented in Appendix A.

2.9 Summary

The purpose of this section is to provide an overview of the industry, with the key takeaway being the number of hours worked. This information will be used to calculate incident frequency rates later in the report, e.g., number of incidents per million hours worked. In general, these hours have risen since 2000, reaching a peak in 2012/13. Since then they decreased to a low around 2015/16, before increasing again.

3. FATALITIES (2000–2019)

3.1 Introduction

Prior to January 2000, a total of 1,451 workers had lost their lives in the Queensland mining and quarrying industry since records began in 1877²¹.

A total of 47 mining industry fatalities occurred between January 2000 and the end of July 2019²².

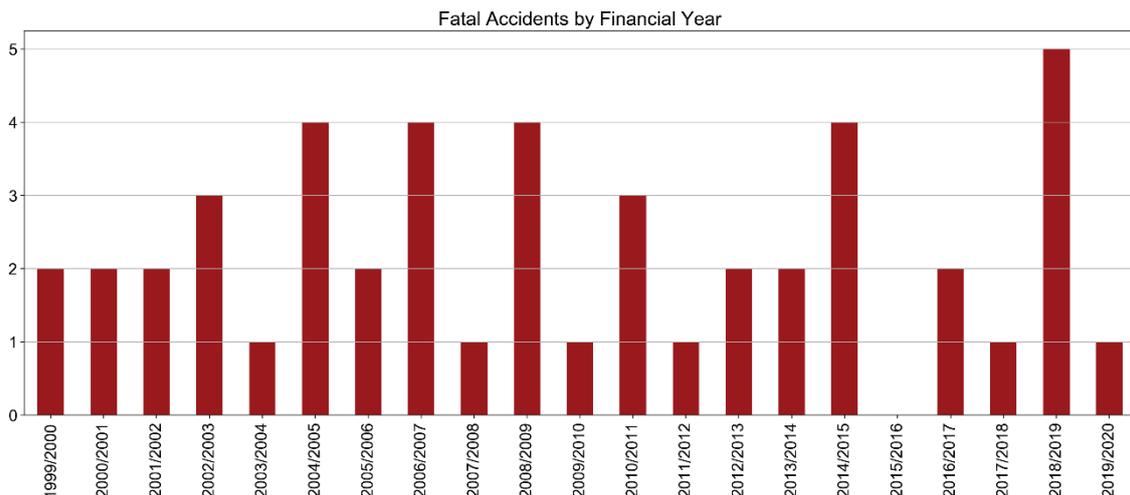
This section provides a brief overview of the 47 fatalities, examines the industry’s fatality cycle, introduces the causal diagrams used to analyse the factors involved in each fatality, and discusses the causal factors common across the fatalities.

3.2 Overview of Fatalities from 2000 to July 2019

The physical causes of the 47 fatalities can be grouped as follows:

- Vehicle accident (15), including:
 - Worker was driver or passenger,
 - Collision with pedestrian,
- Contact with machinery (12), including:
 - Struck by moving/falling object,
 - Entangled/crushed in machinery,
- Rib/roof/rock fall (10),
- Fall from height (4),
- Tyre failures (4),
- Fire (1),
- Irrespirable atmosphere (1).

Figure 4 illustrates the number of fatalities that occurred in each financial year for the review period.



²¹ <https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/accidents-idents-reports/investigations-inquiries>

²² Other mine worker fatalities occurred during this period, for example due to natural causes as opposed to a workplace incident, and they are not included in this review. This review also does not include one fatality that occurred post July 2019 – Mr Bradley Duxbury at Carborough Downs, 25 November 2019.

Figure 4 Number of fatalities per financial year

The only financial year where no fatality occurred was 2015/16. In the 2018/19 year there were 5, with a further occurring on the 7th of July 2019 – culminating in 6 fatalities for the 13 month period.

Figure 5 illustrates the worker type for each of the fatalities split across each sector, excluding those where the deceased was not a worker²³

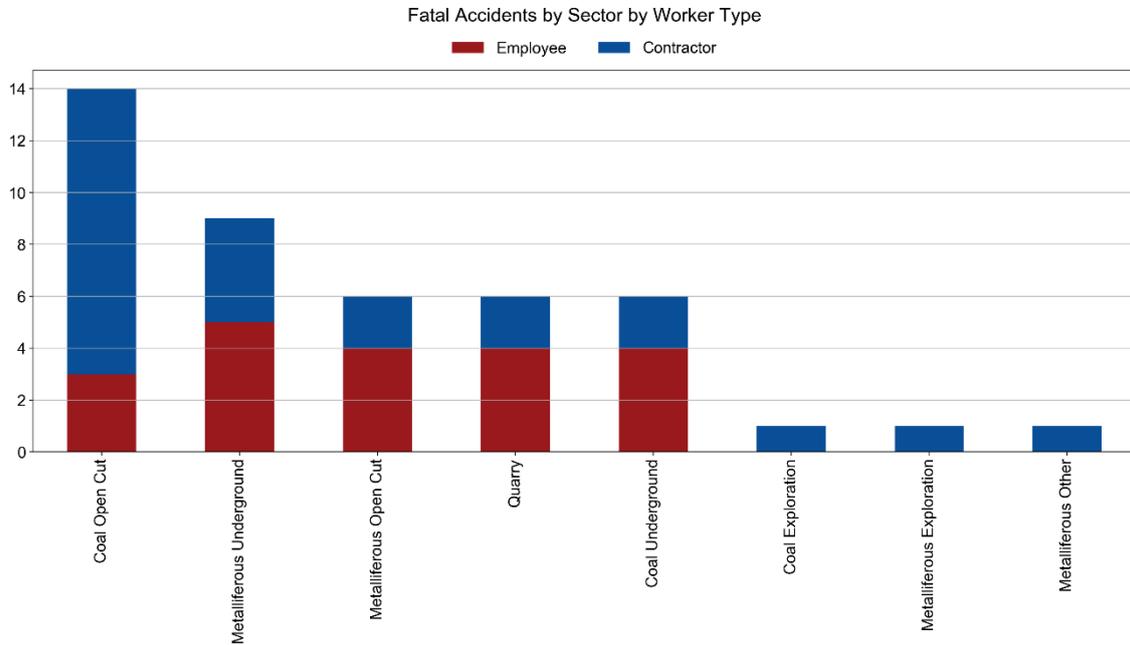


Figure 5 Distribution of fatalities for employees and contractors per industry sector

The fatality rates per worker type per industry sector are presented in Figure 6. For example, the employee fatality rate is the number of employee fatalities per 1 million hours worked by employees for that sector. The highest fatality rate is in quarries, followed by underground minerals.

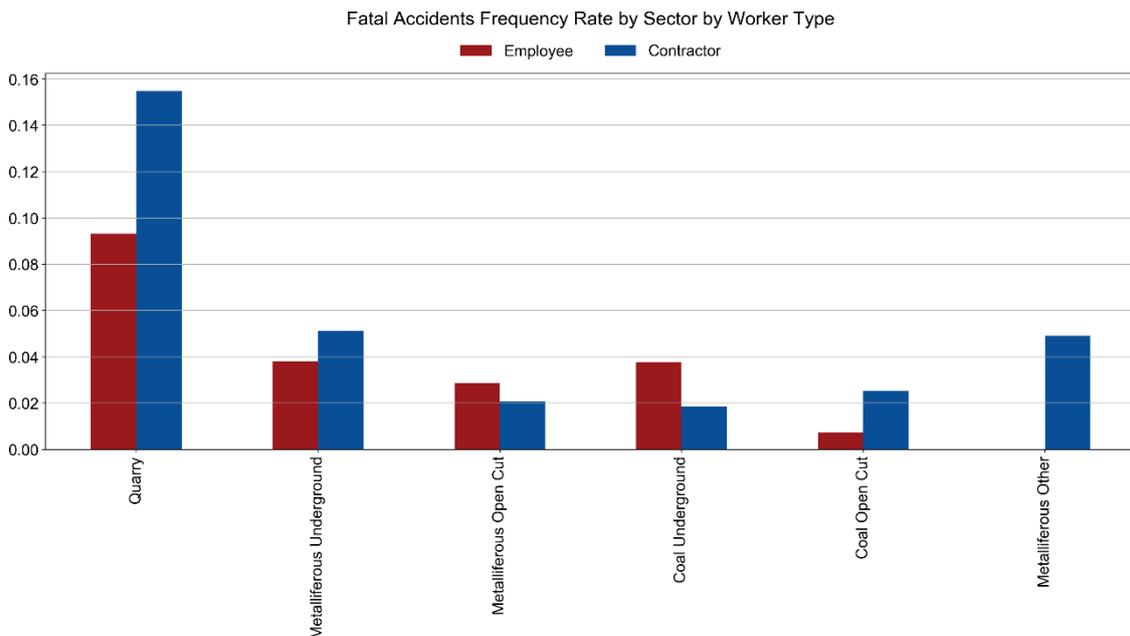


Figure 6 Fatality rates for both employees and contractors per sector

²³ Two children and one mine site visitor were excluded.

3.3 The Cyclical Nature of Fatalities

Figure 7 shows the number of fatalities that occurred per financial year since 1900. The review period is highlighted in yellow.

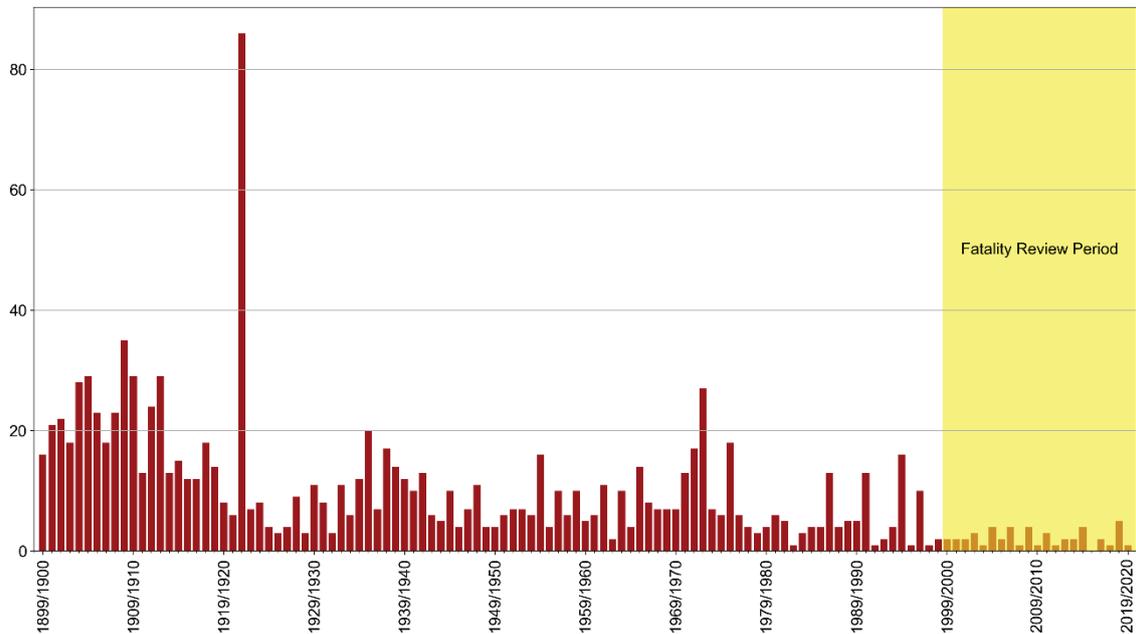


Figure 7 Number of fatalities per financial year from 1900 to July 2019

A considerably higher number of fatalities occurred per financial year between 1900 and 2000 than occurred in the review period. Figure 8 presents the 12 month rolling sum for the past 119 years. Each point in the chart represents the number of fatalities that occurred in the previous 12 months.

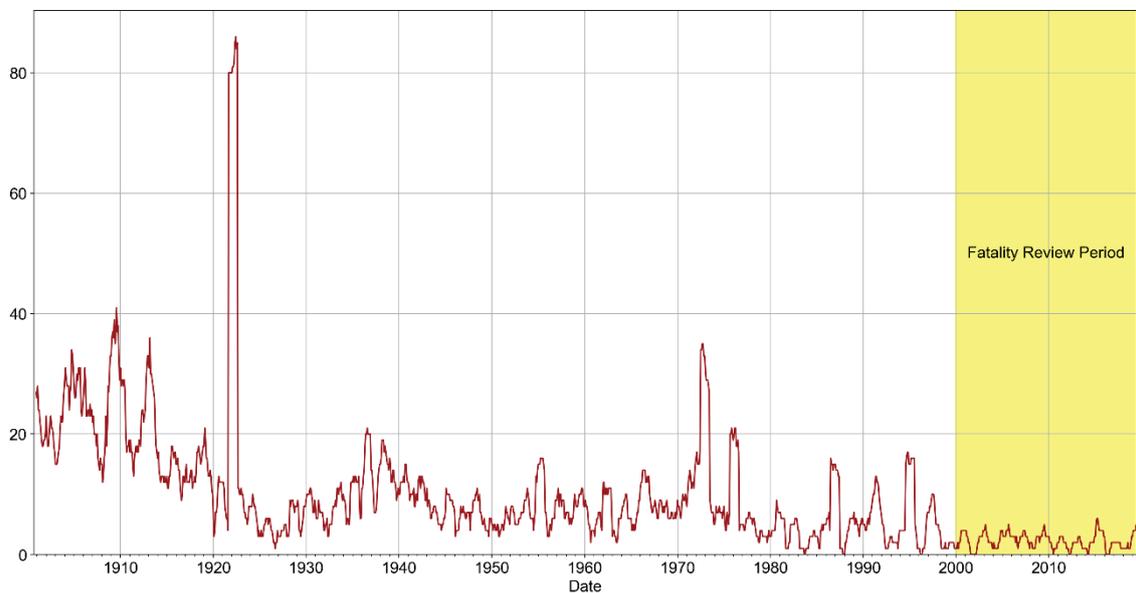


Figure 8 12 month rolling sum of fatalities from 1900 to 2019²⁴

²⁴ The large spikes in the plot represent multiple fatalities from well-known mining disasters:

- Moura No. 2 Underground Coal Mine in 1994 (11 fatalities),
- Moura No. 4 Underground Coal Mine in 1986 (12 fatalities),
- Kianga No. 1 Mine in 1975 (13 fatalities),
- Box Flat No. 7 Colliery in 1972 (17 fatalities),
- Mount Mulligan Colliery in 1921 (75 fatalities).

As discussed in Section 2, following the Moura No. 2 disaster a process was initiated that resulted in new legislation²⁵. The improvement due to this legislation, combined with any additional safety initiatives undertaken over the same period, is evident in the figure above. Since its introduction there have been no multiple-fatality disasters and the overall number of fatalities for any 12 month period has reduced. However, while the 1999 legislation has made significant progress, it has been insufficient to reduce fatalities to zero in the long term. What is now required is a new approach to reduce the number of fatalities further.

Considering the review period alone, the 47 fatalities that occurred are equivalent to an average yearly fatality rate of 2.4 per year. Figure 9 shows the cumulative sum of the fatalities, with each represented as a vertical step, e.g., the 4 fatalities that occurred in quick succession during 2000 are evident in the left-hand side of the chart.

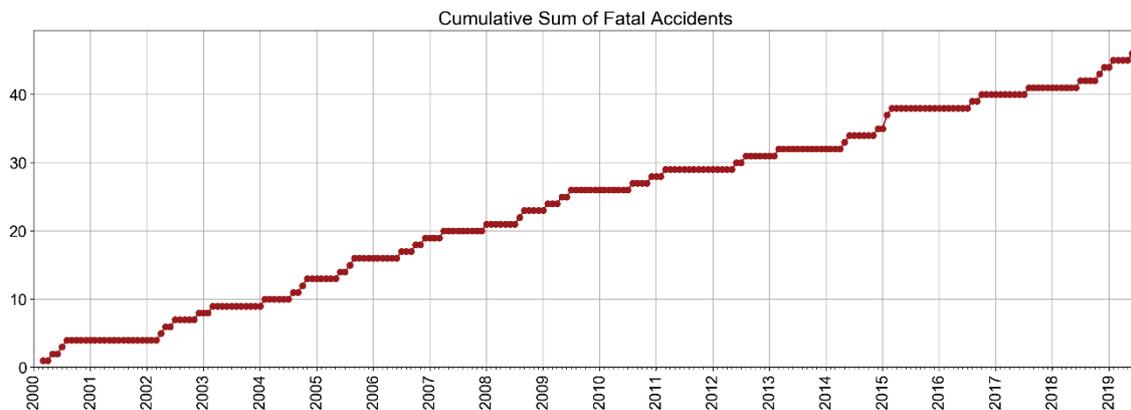


Figure 9 Cumulative sum of fatalities for the review period

The chart illustrates that the industry has periods where a significant number of fatalities occur over a short period of time, as illustrated by steps in quick succession, followed by periods where few to no fatalities occur, as illustrated by the flat horizontal sections in the chart. Figure 10 shows the same chart with the blue line representing an indicative average yearly fatality rate of 2.4 per year.

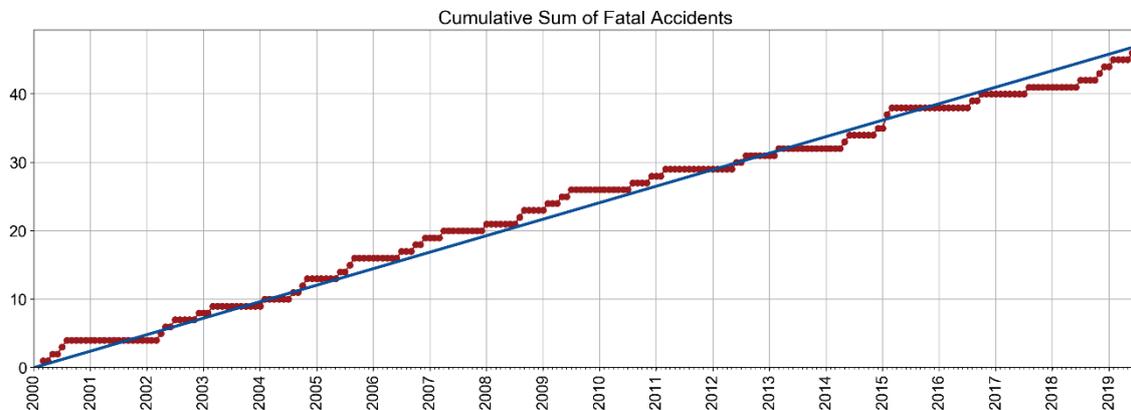


Figure 10 Cumulative sum of fatalities for the review period

This chart shows that while there are time periods with few or no fatalities, fatalities will occur, given time, in quick succession, which will have the effect of returning the overall average yearly fatality rate to approximately 2.4 per year. In other words, this chart suggests that in these periods of few or no fatalities, the industry is essentially *banking* fatalities for some point in the future. The 6 fatalities that occurred between July 2018 and July 2019 have been described by some in the industry, media and politics as evidence of an industry in crisis, but a bleaker assessment is that this is an industry resetting itself to its *normal* fatality rate.

²⁵ The Coal Mining Safety and Health Act 1999 and Mining and Quarrying Safety and Health Act 1999.

The same information can also be presented, as in Figure 11, as a 12 month rolling sum - each point on the graph represents the total number of fatalities that occurred in the previous 12 months. For example, in early 2015, 6 fatalities occurred in the previous 12 month period.

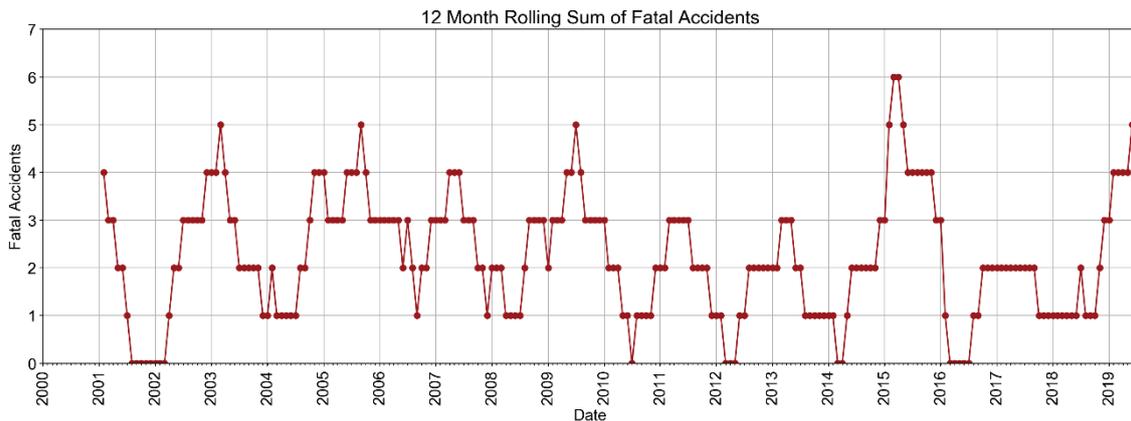


Figure 11 12 month rolling sum of fatalities

A fatality cycle is evident in this figure. The industry has periods when fatalities occur, followed by periods where there are few to none. For example, in early 2014, no fatalities occurred in the previous 12 months. Then over the course of the next 12 months, 6 occurred. This was then followed by period - from early 2015 – where there were no fatalities. The cycle then repeats itself.

From 2000 onwards the industry has continued to cycle between 0 and 6 fatalities. The cycle further suggests that periods with few to no fatalities should be viewed as simply part of the fatality cycle - they are not evidence of the industry becoming safer over the long term. Instead, further fatalities should be expected as the cycle continues.

While it is possible that this cycle is coincidental – the dataset is relatively small – it has proven surprisingly resilient over the past 19½ years²⁶. If the industry continues to take a similar approach to safety, using the same philosophy and methodologies as have been adopted over the past 19½ years, then similar safety outcomes should be expected. There will be periods where a significant number of fatalities occur, followed by periods where there are few to none. Past behaviour suggests that in the order of 12 fatalities are likely to occur over any 5 year period.

3.4 Nature and Cause Reports²⁷

The Mines Inspectorate conducts investigations into complaints, fatalities and, where appropriate, other incidents, such as Serious Accidents and High Potential Incidents²⁸.

A core purpose of an incident investigation is to establish the incident's nature and cause – put simply, what happened and what caused it to happen. The inspectorate conducts nature and cause investigations using the Incident Cause Analysis Method or ICAM, a commonly used model in safety investigations that incorporates human factors and risk management principles. The findings of these investigations are presented in Nature and Cause reports prepared by the Regulator (hereafter referred to as Nature and Cause Reports). The other purpose of incident investigations is to identify potential contraventions of statutory obligations, which may give rise to enforcement action.

While these Nature and Cause Reports analyse and document each fatality in detail, they are not traditionally released by the Regulator. Reports have only been published for 3 of the 47 fatalities: Goonyella Riverside (2017), Newlands Open Cut Mine (2016) and Grasstree Mine (2014).

²⁶ Mining fatalities in Western Australia also exhibits a cycle, although it is different to Queensland and the cycle appears to change from 2013 onwards.

²⁷ Details of the Nature and Cause Reports were provided by the Regulator.

²⁸ Details of each of these incident types are discussed in Section 4.

3.5 Introduction to Fatality Causal Diagrams

As part of this review it was necessary to condense the details of each fatality into a format that allowed their causal factors to be readily compared. The method chosen was to use *fatality causal diagrams*²⁹.

These causal diagrams allowed the various contributing factors of each fatality to be represented on an A4 sized page. A total of 47 fatality causal diagrams were produced in this review, and a significant number are reproduced in Appendix B³⁰. These causal diagrams, as well as being central to this review, were also produced as a resource for the mining industry. They are intended to be read and discussed.

These diagrams do, however, provide confronting details regarding each fatality, which some readers may find distressing. While these diagrams have attempted to avoid insensitivity, there were, however, many instances where direct language was required in order to provide a clear and concise description of how the fatality occurred.

In the preparation of these causal diagrams, it was assumed that the Nature and Cause reports prepared by the DNRME were factually accurate descriptions of the fatalities. There were a number of reasons for this assumption: typically the reports were comprehensive and of good quality; in many cases they would have been difficult to independently substantiate; and, finally, the focus of this review was not to re-investigate each fatality, but rather to use the information available to identify trends across the 47 fatalities. The fatality causal diagrams presented in this report, therefore, are a visual representation of facts already determined by the DNRME and presented in the Nature and Cause reports.

Each fatality causal diagram was produced as follows:

1. The key factors for each fatality were identified from the Nature and Cause report and reproduced in visual form,
2. Each fatality causal diagram was then reviewed by an inspector of mines to ensure its accuracy,
3. Where no Nature and Cause reports existed, as was the case for some of the recent fatalities, these causal diagrams were prepared directly by an inspector of mines.

²⁹ Other visual methods, such as the bowties or fault tree analysis, could have been selected, but causal diagrams were chosen for their simplicity.

³⁰ However, it was determined by the DNRME that the diagrams from June 2018 onwards would not be reproduced out of sensitivity to the families and friends of the deceased and/or because of the potential for enforcement action.

3.6 Causal Diagram Example

Figure 12 shows an example of a causal diagram. The remainder of this section will step through the various elements of the diagram. Each diagram has four headings, separated into *physical, individual, supervision, and organisational* categories³¹.

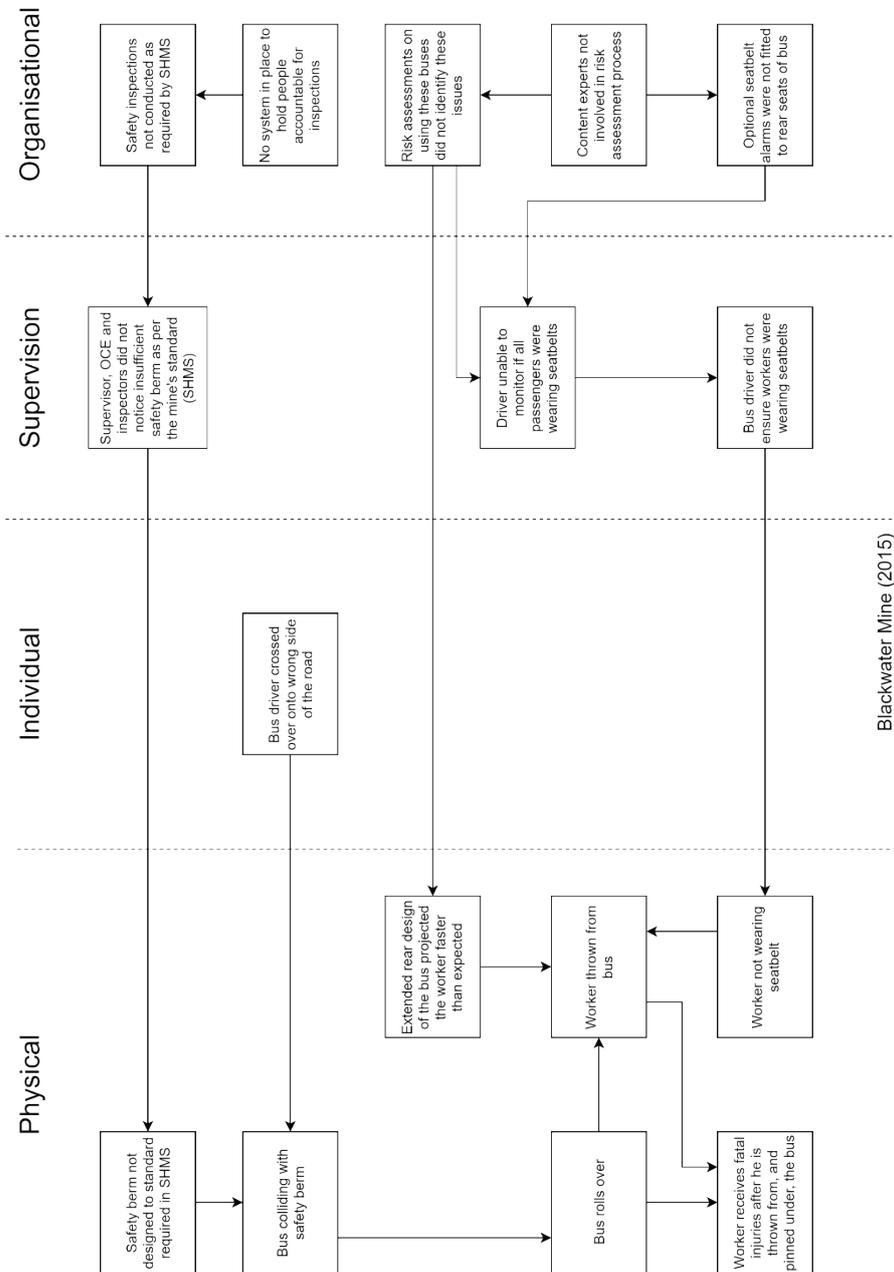


Figure 12 Example Casual Diagram

³¹ There exists some subjectivity with respect to the placement of some causal factors under the various categories. Some readers may disagree with the placement, but such disagreement is unlikely to change the conclusions with respect to causal factors for the individual fatalities.

Figure 13 presents the nodes under the physical heading.

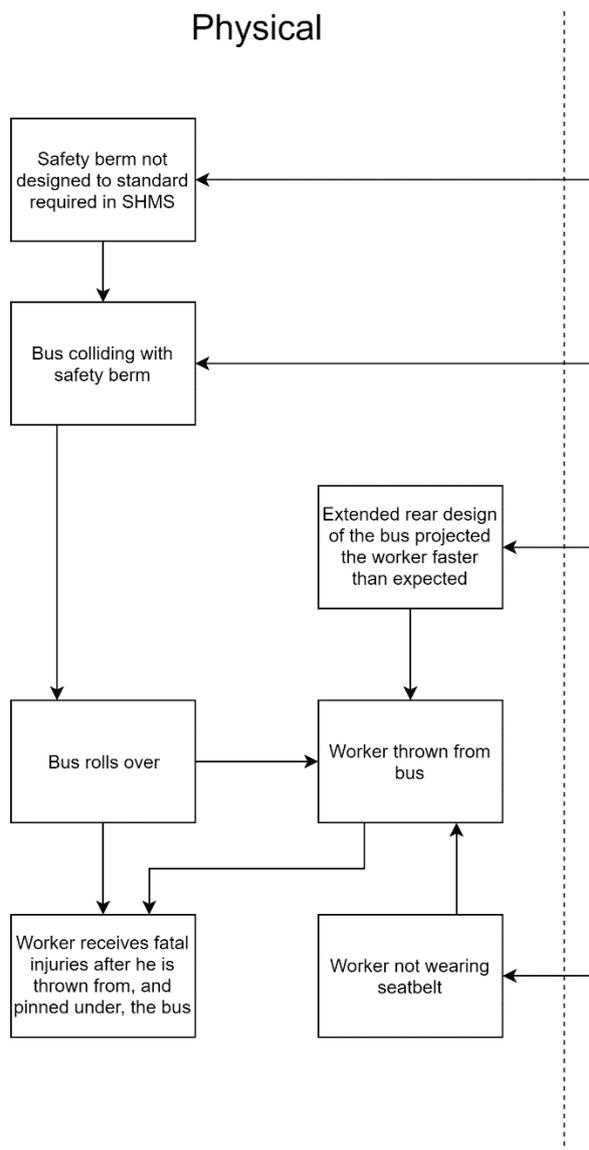


Figure 13 Physical factors in the fatality

Causal diagrams are typically read by starting in the bottom left-hand node. This node describes how the fatality occurred. In this case a worker received fatal injuries from being thrown from, and pinned under, a bus.

Two factors contributed to the worker being pinned under the bus:

- The bus rolled over,
- The worker, a passenger, was thrown from the bus.

A solid line connecting nodes indicates that the factor played a direct causative role in the fatality. The removal of one of these nodes would have likely resulted in the fatality being avoided. In the example above, both the bus rolling over and the worker being thrown from it were necessary for the fatality to occur.

Causal diagrams can also include dashed lines. Dashed lines indicate that a particular factor may have contributed to the fatality, but may not be directly causative. In other words, the fatality may still have occurred even in the absence of this factor.

The passenger was thrown from the bus because of two factors:

- The passenger was not wearing a seatbelt,
- The extended rear design of the bus had the effect of throwing the passenger faster than was expected.

The bus rolled over because:

- It collided with a safety berm, which was not designed to the appropriate standard³².

Figure 14 shows the addition of the *individual* heading to the diagram, which describes the role of individual actions in the fatality.

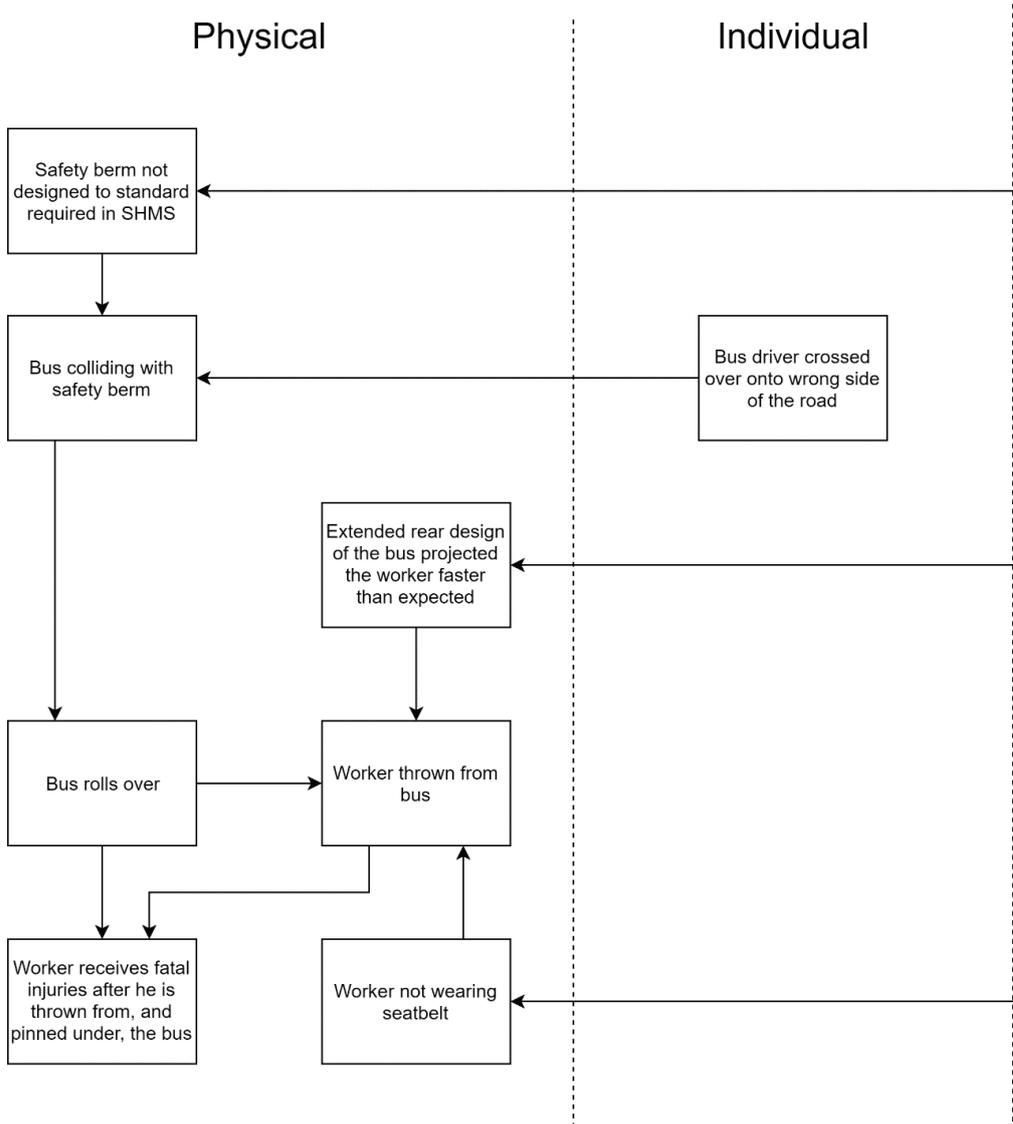


Figure 14 Physical and Individual factors in the fatality

The bus collided with the safety berm because:

- The bus driver crossed over onto the wrong side of the road.

Figure 15 shows the causal diagram with the *supervision* heading added. This heading examines the role supervision, or a lack of supervision, played in the fatality.

³² A safety berm is a raised barrier made of dirt and rock along the side of the roadway.

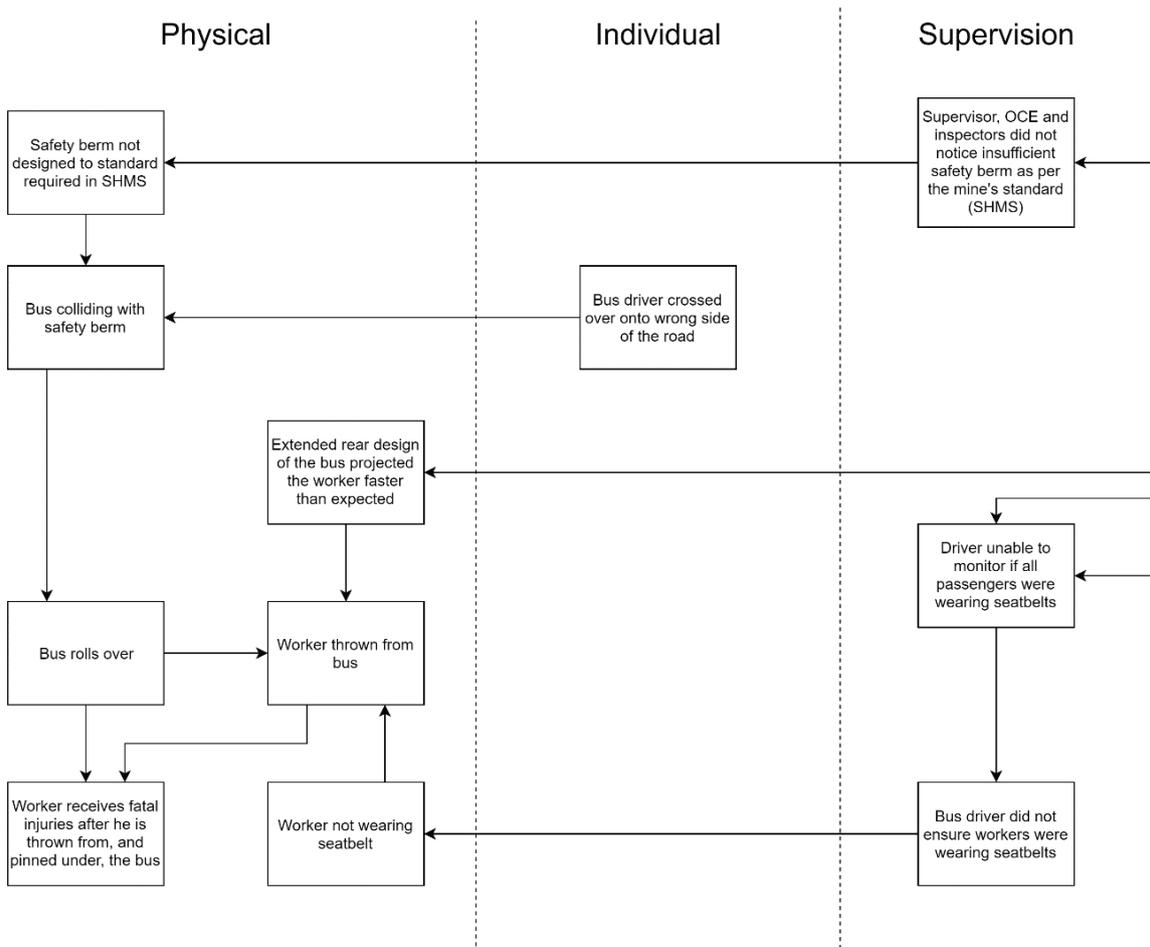


Figure 15 Physical, Individual, and Supervision factors for the fatality

The safety berm had not been designed in accordance with the required standard and this hazard was not identified because:

- The supervisor, Open Cut Examiner (OCE) and inspectors did not notice that the safety berm did not meet the required standard.

While the deceased was required to be wearing a seatbelt, the bus driver did not ensure all passengers were wearing them. However, while this may have been a requirement from a supervisory perspective, the driver was unable to easily confirm passengers were wearing seat belts in practice because he could not visually check from his position in the driver's seat. (Checking would have required the driver to exit the vehicle and visually check by looking in the door used by the passengers.)

Figure 16 includes the *organisational* aspects of the fatality. This heading captures all the remaining relevant factors involved.

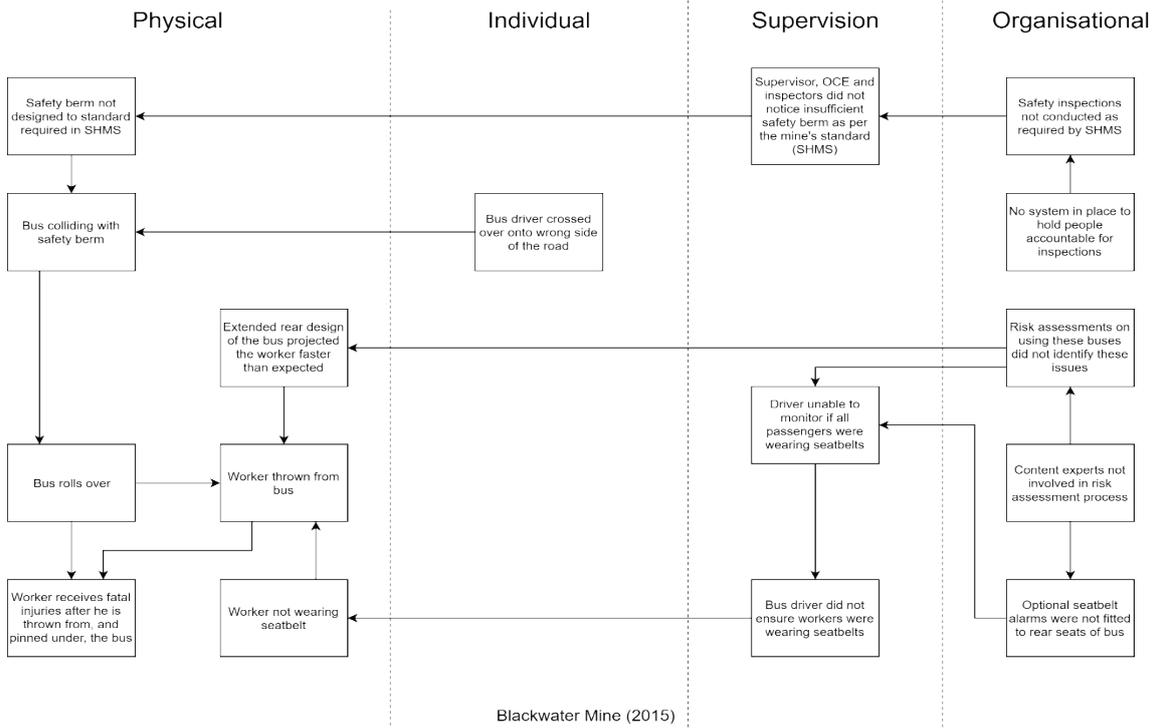


Figure 16 Physical, Individual, Supervision and Organisational factors for the fatality

The diagram illustrates how the physical and supervision aspects of the fatality relate to factors at a higher level in the organisation:

- The substandard safety berm was not identified because inspections were not conducted as required. Further, there was no system in place to hold people accountable for a lack of adequate inspections,
- The extended rear design of the bus was not identified in the risk assessment due to a lack of content experts involved in the assessment process,
- The risk assessment did not identify that the driver was unable to visually monitor if passengers were wearing seatbelts from the driver's seat,
- Optional seatbelt alarms were not fitted to the rear seats of the bus. The lack of content experts involved in the risk assessment process contributed to this situation.

The sections that follow discuss some of the key findings from an analysis of the causal diagrams. The reader is encouraged to briefly review these diagrams, presented in Appendix B, prior to proceeding.

The sections that follow summarise some of the key findings from the causal diagram analysis³³. They do not specifically focus on the technical details of each fatality, e.g., why did a tyre burst, why did a piece of machinery fall? While these details are, of course, important in terms of stopping reoccurrence of similar incidents, the purpose of this discussion was to highlight the macro trends evident across the 47 fatalities. Therefore, there is a focus on the role played by non-technical aspects, such as the wider human and organisational factors, including supervision, training, and human error.

It is the identification of these wider aspects that provides an opportunity to identify the systemic failures that are occurring in the Queensland mining industry.

³³ This report does not specifically discuss the various incident models, such as the bird safety triangle or the swiss cheese model. Hopkins (2013) does provide an excellent description of both, and the findings of the causal diagrams are certainly consistent with such models, particularly the swiss cheese model.

3.7 Role of Age in Fatalities

Figure 17 shows the significant spread in the ages of the deceased. This chart challenges the oft repeated view that fatalities typically occur to younger workers behaving in a reckless manner. While there are a number of fatalities in the 18 to 25 year old range, a significant number were older. Age does not, however, equate to experience, but data was unavailable with respect to worker experience or time in the role³⁴.

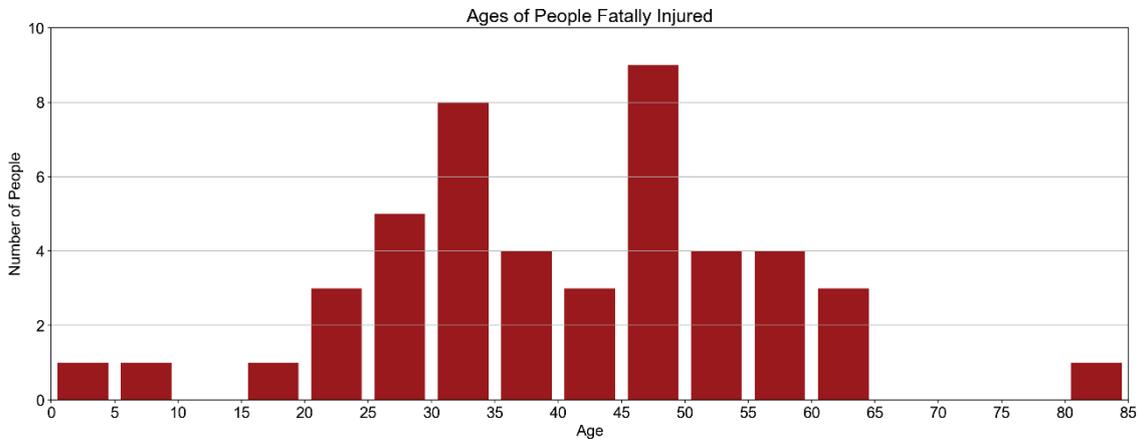


Figure 17 Ages of fatalities³⁵

3.8 Role of Human Error in Fatalities

A common view in the mining industry is that human error plays a substantial role in fatalities. This includes accidental error, as well as errors due to workers deliberately ignoring safety procedures and conducting activities in an unsafe manner. A common risk management term in the industry is *lapses in concentration*. Anecdotally, while a number of people in the mining industry have described the detailed investigations that occur in the aftermath of an incident, which includes the consideration of organisational factors, many have also expressed a view that industry investigations often stop at the point where human error is identified as playing a causative role in an incident.

Based on discussions with those in the industry there is no doubt that human error, both accidental and deliberate, occurs. However, human error alone did not cause the majority of the 47 fatalities examined in this review. Almost all were the result of systemic, organisational, supervision, and/or training causes - either with or without the presence of human error.

Of the 47 fatalities, 17 involved no human error *at all* on the part of the deceased.

3.9 Role of Training in Fatalities

A total of 17 of the 47 fatalities involved a lack of task specific training and/or competencies for the tasks being undertaken. A further 9 had inadequate training. These tasks were often undertaken at the direction of supervisors or others who were aware of these deficiencies.

An example of a fatality demonstrating a lack of training occurred at Foxleigh in 2005. A worker, who was not trained or assessed as competent, did not deflate a tyre prior to removal, which is a requirement of the national standards. The mine site also did not communicate changes in its tyre fitting procedure to the contracting company. These failures led to a sudden release of pressure that propelled components of the rim assembly, which struck the worker and caused fatal injuries.

This finding is consistent with a fatality review undertaken in Western Australia in 2014 (hereafter referred to as the WA Fatality Review), which found that a lack of compliance with

³⁴ The regulatory framework does not require worker experience in the industry nor time in role to be reported.

³⁵ The extreme ages are 2, 7 and 82. The 2 and 7 year olds were children that died on mine sites, the 82 year old was an opal miner.

safe work procedures were major contributing factors to fatalities, as well as the worker's short duration at the mine site³⁶. The WA Fatality Review regarded these two factors as reflecting a lack of training and familiarisation on behalf of the deceased worker³⁷.

3.10 Role of Supervision in Fatalities

In 32 of the 47 fatalities, supervision was required for the tasks being undertaken, i.e. the 32 did not include routine tasks, such as driving.

25 of the 32 fatalities involved inadequate or absent supervision.

There were a variety of supervision issues, such as absent supervision, supervisors with inadequate knowledge of the hazards and level of risk, and supervisors who watched as workers undertook unsafe acts. An example of absent supervision occurred at Castle Creek Quarry in 2008, where supervision was absent for much of the time when the work was being performed. An example of inadequate supervision occurred at Wongabel Quarry in 2006, when the supervisor observed a worker driving a loader with the bucket too high, but did not intervene. A fatality occurred when the loader struck another worker.

Regarding supervision, the Queensland legislation is clear with respect to coal mines: 'A **supervisor** at a coal mine is a coal mine worker who is **authorised** by the site senior executive **to give directions to other coal mine workers** in accordance with the safety and health management system'³⁸. The legislation is also clear regarding a supervisor's competency. A site senior executive must not assign the tasks of a supervisor to a person unless the person 'is competent to perform the task assigned'³⁹. The site senior executive must ensure 'adequate supervision and control of coal mining operations on each shift at the mine'⁴⁰ and 'adequate supervision and monitoring of contractors and service providers at the mine'⁴¹. The Queensland legislation also includes similar provisions for Mineral Mines and Quarries⁴².

The WA Fatality Review also highlighted major deficiencies in supervision. From analysis of the 52 fatalities which occurred during this time period, it was found that '44 per cent of fatal accidents occur under the supervision of a person in their first year in the role, with 6 per cent in the first month'⁴³.

The WA Fatality Review further found that almost 'a quarter of fatalities involved a supervisor in their second and third year in the role' and overall '68 per cent of fatalities occurred during the supervisor's first three years in the role'⁴⁴. The WA Fatality Review recommended in its Areas for Improvement that the 'training of supervisors is regarded as a key issue in accident prevention'⁴⁵.

The WA Fatality Review concluded that this data 'shows that new and inexperienced workers are at particular risk' and required 'close supervision' and adequate safety training⁴⁶.

³⁶ Government of Western Australia, Department of Mines and Petroleum, (2014), Fatal accidents in the Western Australian mining industry 2000–2012

³⁷ Data in the form of number of years as a supervisor or number of years worked in the industry was unavailable for Queensland mines.

³⁸ Section 26 of the *Coal Mining Safety and Health Act 1999* (Qld). Emphasis on 'supervisor', 'authorised' and 'to give directions to other coal mine workers' added.

³⁹ Section 56(a) of the *Coal Mining Safety and Health Act 1999* (Qld).

⁴⁰ Section 42(f)(iii) of the *Coal Mining Safety and Health Act 1999* (Qld).

⁴¹ Section 42(i)(vi) of the *Coal Mining Safety and Health Act 1999* (Qld).

⁴² Section 23 of the *Mining and Quarrying Safety and Health Act 1999* (Qld); Section 51(a) of the *Mining and Quarrying Safety and Health Act 1999* (Qld); Section 39(1)(i)(iii) of the *Mining and Quarrying Safety and Health Act 1999* (Qld); and Section 39(1)(i)(vi) of the *Mining and Quarrying Safety and Health Act 1999* (Qld).

⁴³ WA Review, Section 4.5.

⁴⁴ WA Review, Section 4.5.

⁴⁵ WA Review, Section 6.6.

⁴⁶ The WA Mining Review considered the duration of the deceased in their professional role and their duration of work at the particular mine site where the fatality occurred. In the former, the review found that in 48% of the fatalities, the deceased/worker had been in their role for two years or less. (WA Review, Section 4.3)

3.11 Role of Training and Supervision in Fatalities

17 of the fatalities involved a lack of training for the specific task they were undertaking *and* inadequate or absent supervision.

For example, a fatality occurred at Grasstree Mine in 2014 where a worker, who was not assessed as competent, was sent to calibrate a gas detector. The worker was unsupervised and not familiar with the area of the mine. These factors led to the worker being unaware of the presence of an irrespirable atmosphere, which led to his death.

3.12 Role of Controls in Fatalities

The majority of the 47 fatalities involved at least one failed or absent control that could have prevented the fatality. This absence of effective control often was a result of decisions both related and unrelated to the deceased, e.g., wearing a seatbelt or the substandard design of a berm. The underlying factors for these absent controls often stemmed from decisions made at a supervisory and organisational level in organisations. This is evident in the bus roll-over fatality discussed earlier, where there is a clear link between the substandard safety berm and the absence of safety inspections conducted by the mine-site.

In one case effective controls were removed and replaced by redundant ones. An edge protection safety bund was removed and replaced with an administrative control. A worker fell from the 11 metre high bench, while operating machinery, and was fatally injured.

Evident in the failure of controls is a failure of administrative controls. Administrative controls are typically in the form of procedures or directives. An example is a sticker on a vehicle's dashboard directing passengers to wear seat belts. Other examples are signs prohibiting people from entering certain areas, or procedures relating to how to complete a task. These examples, however, are more easily bypassed than other forms of control (e.g., removal or isolation of the hazard) and require worker awareness and adherence. As will be discussed in a later section, the majority of the reported industry responses to incidents are in the form of administrative or other less effective controls, as opposed to elimination, substitution or isolation. Given this finding, the role of a failure of controls in fatalities is not unexpected.

3.13 Role of Known Faults

There were 10 fatalities involving known faults, where individuals were aware of them, but no action was taken.

For example, in the Hyde Park Station incident of 2008, individuals at multiple levels in the mine were aware that a vehicle had faulty brakes. The company had no defect reporting process, had no Safety and Health Management System (SHMS) and relied on the contractor's SHMS. The day before the fatality occurred, there was a near miss with the very same truck, but no action was taken.

At Mt Norma Mine (2004) a track-mounted pneumatic drill with known faults was involved in a fatality. It had a range of mechanical faults, including faulty brakes, a faulty tramming control lever⁴⁷ and fractured track axles. It hadn't been repaired because the site had a reactive approach to maintenance, rather than a preventative maintenance approach⁴⁸.

⁴⁷ The tramming control lever controls the movement of the drill's tracks, allowing the operator to drive and steer the machine.

⁴⁸ In other words, maintenance was typically undertaken when a breakdown occurred, rather than being undertaken to prevent a breakdown.

3.14 Role of Near Misses

9 fatalities had known near misses occur prior to the fatality. In some cases, prior fatalities had occurred in a similar manner.

For example, at George Fisher Mine there had been 3 fatalities involving workers driving into open voids prior to the 2009 fatality. The worker who died in 2009 was recorded as a witness to one of the previous fatalities.

Two of the fatalities occurred where either the worker, or the equipment, was involved in a near-miss incident the day before the fatality. This is evident in the Hyde Park Station fatality of 2008: a truck rolled backwards into a tree due to faulty brakes. The site did not report or act on this incident and the next day the same truck rolled backwards into a gate, causing fatal injuries to the worker.

3.15 Role of Pre-existing Medical Conditions in Fatalities

A worker's physical condition played a role in a small number of fatalities. There are two cases where the worker's pre-existing medical condition may have compromised their ability to survive the incident. There were also two cases where a worker's poor eyesight and/or poor hearing may have led to a lack of awareness of potential hazards.

3.16 Role of Drugs and Alcohol in Fatalities

3 of the 47 fatalities involved the use of alcohol or drugs, but in two cases played no causative role in the fatality⁴⁹.

For example, in the Mt Isa Mines Copper Smelter fatality in 2013, a worker had methamphetamine in their system. The fatality occurred when the worker was struck by a pump that fell as it was being lifted by a crane⁵⁰. In addition, a lack of supervision and training led to the workers performing the task against the Original Equipment Manufacturer's (OEM) requirements. A lack of controls, such as a barricade around the drop zone, also played a role in the fatality.

⁴⁹ Based on the findings of the Nature and Cause Reports.

⁵⁰ Based on the findings of the Nature and Cause Report.

3.17 Summary

While the 1999 legislation has made significant progress in reducing the number of fatalities, it has been insufficient to reduce them to zero in the long term. The 47 fatalities that have occurred during the review period are equivalent to an average yearly fatality rate of 2.4 per year. Further, a fatality cycle is evident in the industry – there are periods when fatalities occur, followed by periods where there are few to none. If the industry continues to take a similar approach to safety, using the same philosophies and methodologies adopted over the past 19½ years, then similar safety outcomes are to be expected. Past behaviour suggests that in the order of 12 fatalities are likely to occur over any 5-year period.

For the 47 fatalities, a superficial examination of their causes gives the impression that many were freak accidents, that events transpired in such a way that could never have been anticipated. This impression can inspire fatalism: *how can workers be protected against such freak accidents?* It can reinforce the notion that mining is a hazardous industry and fatalities simply cannot be avoided.

The majority of fatalities, however, were not freak accidents. Many showed significant (and often unintended) interactions between factors across various levels in the mine site, e.g., individual, supervisory and organisational. Many were preventable, and there was rarely a single cause. They were typically the result of a combination of banal, everyday, straightforward factors, such as a failure or absence of controls, a lack of training, and/or absent or inadequate supervision. This is likely to be an uncomfortable finding for many: there is a tendency to assume that bad outcomes must have equally bad causes, especially when a fatality occurs. This was not the case – there were few smoking guns.

4. INCIDENTS AND INJURIES (2000–2019)

4.1 Introduction

A detailed analysis of the reported incidents in the Queensland mining industry was undertaken as part of this review.

This section introduces the various types of incident data collected by the Regulator, sets out the reasons for doing so, and provides an analysis of the key findings and trends in this data. This section will not examine or discuss all the available incident data, rather it will provide an overview of the key trends. A history of the manner in which the Regulator has collected data over the review period is included in Appendix C, and a complete presentation of the data is available in Appendix D. This analysis focuses on the industry as a whole, although some sector specific findings are presented in Appendix D.

4.2 The Regulator and Incident Data⁵¹

The Regulator is required to keep a database of hazards associated with mining operations, methods of controlling hazards, lost time injuries and high potential incidents under Section 280 and Section 260 of the *Coal Mining Safety and Health Act 1999* and *Mining and Quarrying Safety and Health Act 1999*, respectively.

However, while the Regulator puts considerable effort into the collection of this data, it has been of limited value to the industry⁵². This limitation exists for the following reasons:

- While there have been improvements within the Regulator's approach to data collection and scrutiny in recent years, there are historical issues regarding the integrity of the data⁵³,
- While the Regulator does provide some data to industry, typically in the form of Safety Alerts, Safety Bulletins, workshops and presentations, it does not make the data available in a manner that would enable industry to perform analysis to identify emerging trends,
- The Regulator does not typically publish in-depth analysis of the data in a manner that would assist industry to identify emerging trends.

⁵¹ Information provided by the DNRME.

⁵² The site senior executives of mines and quarries have obligations to notify the Regulator of fatalities, Serious Accidents and high potential incidents, as well as various statistics, including lost time injuries and hours worked. This information is collected to perform analysis and provide stakeholders with details on industry safety and health, to focus industry attention on emerging areas of risk and to encourage implementation of strategies to improve safety and health performance. This database also informs regulatory priorities.

⁵³ These significant data integrity issues had to be addressed as part of this review. That process is discussed in the Appendix D.

4.3 Incident Data Types

The following incident types were analysed in this review⁵⁴:

- **Serious Accidents**⁵⁵: are accidents that result in a) the death of a person or b) a person admitted to hospital as an in-patient for treatment of their injury⁵⁶. The Serious Accidents considered in this review are those specifically reported to the Regulator as Serious Accidents. Systematic reporting of this incident type commenced in 2012. A total of 589 Serious Accidents are considered in this review,
- **Lost-Time Injuries (LTI)**: is an injury resulting in the injured person being unable to work the next day or a longer period, whether they are rostered to work or not⁵⁷. A total of 9,202 LTIs are considered in this review,
- **High Potential Incidents (HPI)**: is an event, or a series of events, that causes or has the potential to cause a significant adverse effect on the safety or health of a person⁵⁸. A total of 34,690 HPIs are considered in this review⁵⁹.

Based on these definitions it is possible for an event or accident to be one or more of these categories. For example, a fatality is a Serious Accident, and also a HPI. Fatalities are also classed as LTIs, with the lost time reported as equivalent to 220 days⁶⁰. LTIs can also be HPIs, but in some cases they are not HPIs, e.g., a slip and fall could result in a LTI, but not be a HPI. As HPIs include events that may or may not injure a person, the HPIs that result in no injuries provide valuable information with respect to where potential hazards exist in the industry.

4.4 Serious Accident Analysis

As discussed above, a Serious Accident is an accident that resulted in a) a fatality or b) the worker being admitted to hospital for treatment.

Figure 18 shows the number of Serious Accidents reported to the Regulator per sector. The data is separated by worker type, e.g., employee or contractor.

⁵⁴ These definitions will be adopted throughout this report.

⁵⁵ Note that the Regulator records Serious Accidents on an event basis, as opposed to a person basis. For example, if a Serious Accident injures 2 people who are admitted to hospital for treatment, then this is recorded as 1 Serious Accident. This method of recording differs from LTI reporting, which counts LTIs on a per person basis. For example, if a single event occurs and two people are hurt, this is counted as 2 LTIs. However, the Regulator does keep a record of each person involved in the Serious Accident. While the Regulator records Serious Accidents on an event basis, this report considers them on a person basis – i.e. if three people were involved in a single event, and two of them are admitted to hospital for treatment, then this is counted as two Serious Accidents in this report.

⁵⁶ Section 16 of the *Coal Mining Safety and Health Act 1999* (Qld); Section 17 of the *Mining and Quarrying Safety and Health Act 1999* (Qld)

⁵⁷ Section 16 of the *Coal Mining Safety and Health Act 1999* (Qld); Section 260 of the *Mining and Quarrying Safety and Health Act 1999* (Qld)

⁵⁸ Section 280 of the *Coal Mining Safety and Health Act 1999* (Qld); Section 18 of the *Mining and Quarrying Safety and Health Act 1999* (Qld)

⁵⁹ Note that the Regulator records HPIs on an event basis, as opposed to a person basis. For example, if a HPI involves 2 people, then this is classed as 1 HPI. This method of recording differs from LTI reporting, which counts LTIs on a per person basis. For example, if a single event occurs and two people are hurt, this is counted as 2 LTIs.

⁶⁰ Equivalent to 52 5-day work weeks, less 10 sick days, 10 public holidays and 20 days recreational leave.

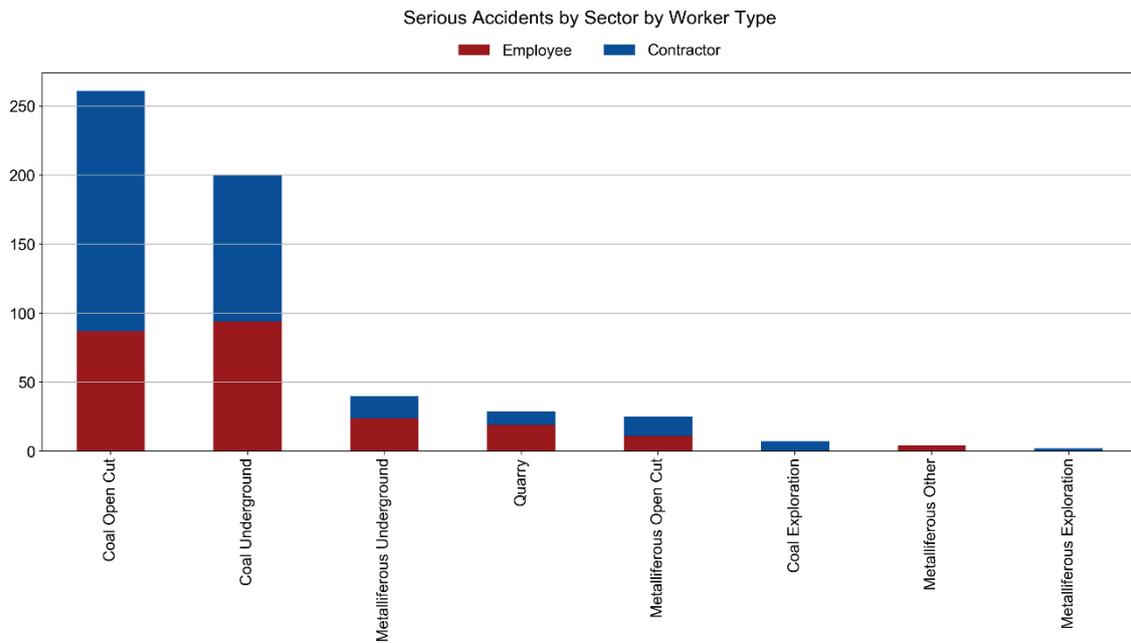


Figure 18 Distribution of Serious Accidents per sector

Figure 19 shows a comparison of the Serious Accidents per sector compared to the fatalities per sector. In general, the distributions of Serious Accidents and fatalities are similar - the sectors with the highest number of Serious Accidents typically have the highest number of fatalities – with the exception of coal underground.

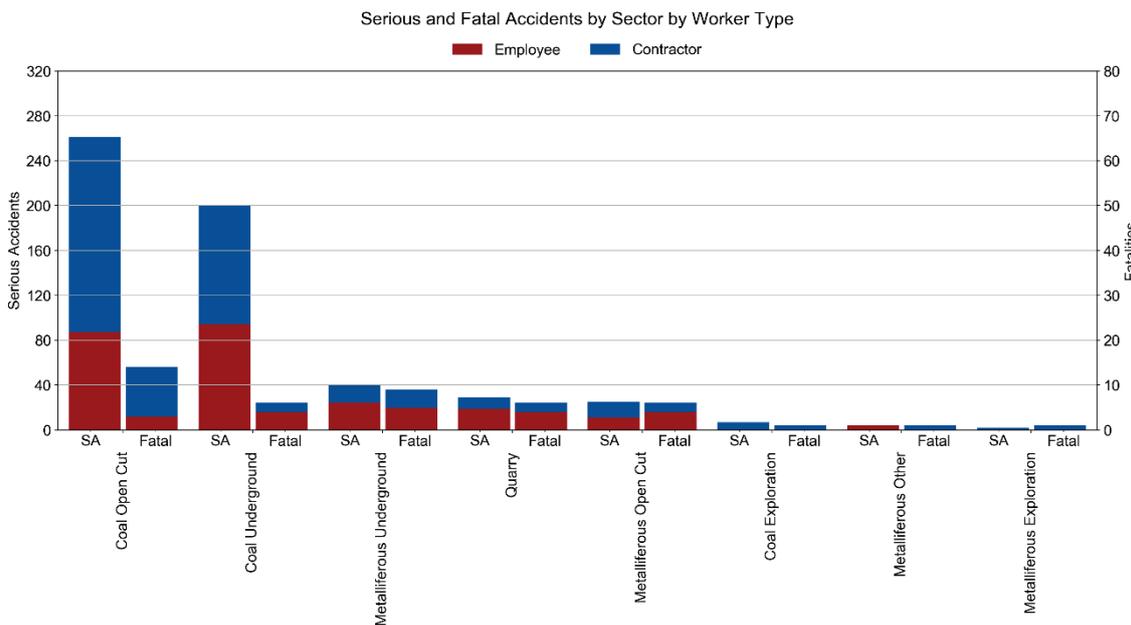


Figure 19 Distribution of Serious Accidents and Fatalities per industry sector for employees and contractors

Figure 20 illustrates the distribution of Serious Accidents per financial year. The number of Serious Accidents has generally trended upwards over the past 5 years, however, so too has the hours worked over the past 4 years⁶¹.

⁶¹ Serious Accident Frequency Rates, in terms of the number of Serious Accidents per 1 million hours worked, are presented in later sections

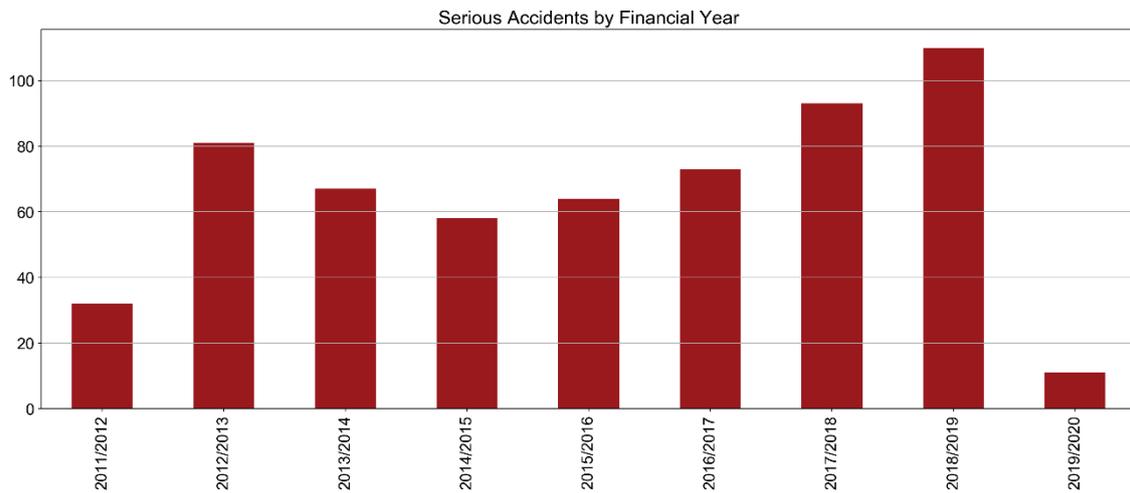


Figure 20 Distribution of Serious Accidents per financial year

The remainder of this section focuses on the key findings of the analysis, but general details of the nature and causes of Serious Accidents are presented in Appendix D.

Firstly, the corrective actions put in place after an incident, typically to prevent reoccurrence, are examined. Corrective actions can be grouped into a commonly accepted hierarchy of control categories. Figure 21 shows an example of this hierarchy, from most effective (eliminate the hazard or substitute it), to least effective (administrative controls and personal protective equipment).

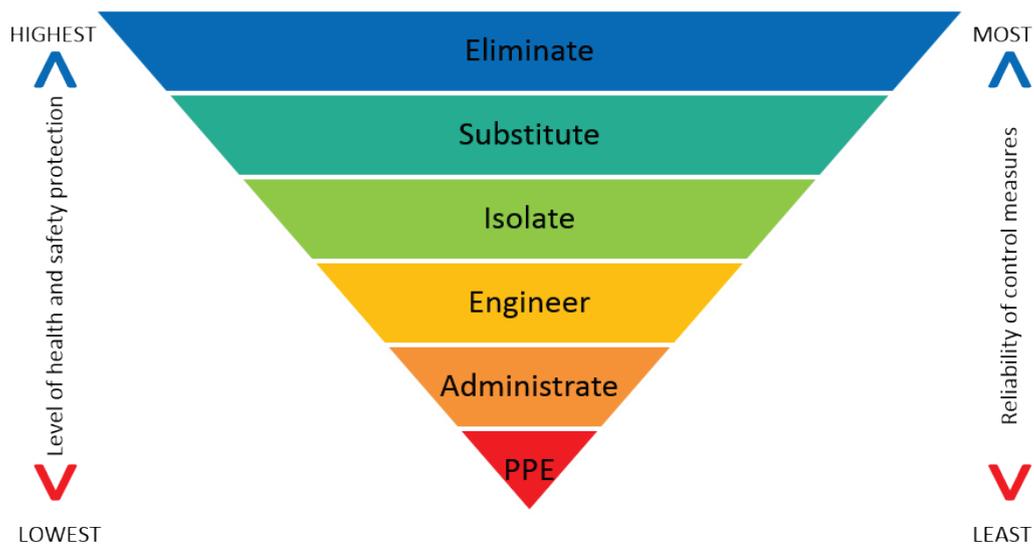


Figure 21 Typical hierarchy of controls⁶²

In the hierarchy, elimination, substitution, isolation and engineering controls are typically referred to as *hard controls*, whereas administrative and Personal Protective Equipment (PEE) controls are referred to as *soft controls*.

Figure 22 shows the corrective actions reported to the Regulator in the aftermath of a Serious Accident. Note that for some incidents multiple corrective actions were applied, but in the charts that follow only the most effective controls are presented, e.g., if an incident is responded to with an engineering control and an administrative control, then the higher level engineering control is presented.

⁶² <https://ppl.app.uq.edu.au/content/2.30.01-occupational-health-and-safety-risk-management>.

Highest Level of Corrective Action Applied after Serious Accidents for All Mines

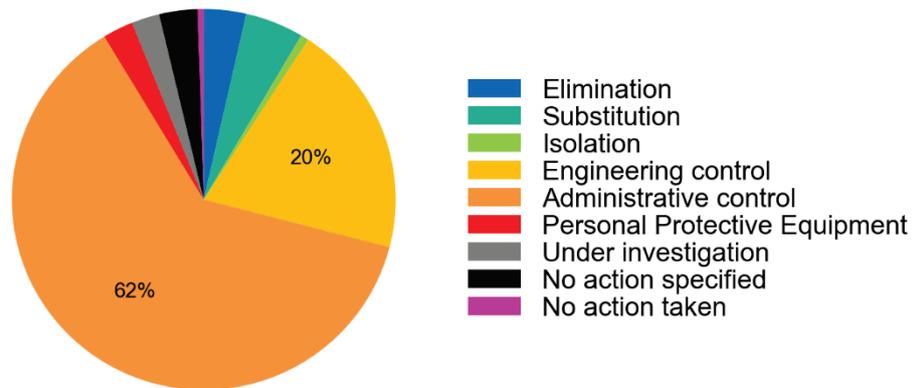


Figure 22 Controls actions in the aftermath of a Serious Accident

This chart shows that less than 30% of the controls applied in the aftermath of Serious Accidents were hard controls. The single largest category of control was administrative controls at 62%. Figure 23 shows how the application of the various control types has changed over the years.

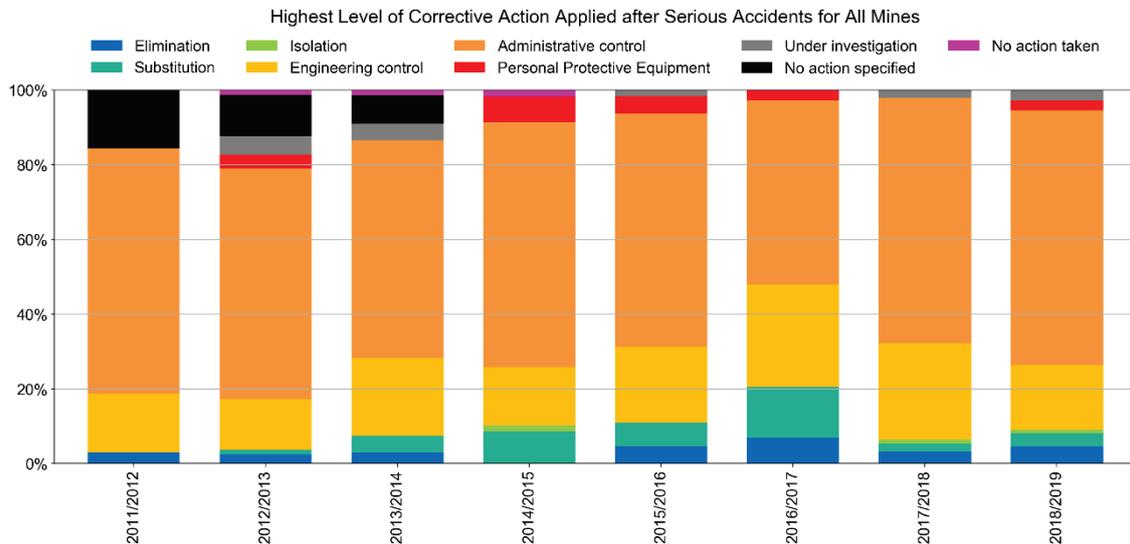


Figure 23 Controls put in place in the aftermath of a Serious Accident per financial year (normalised)

Administrative controls are the single largest category of controls applied⁶³. Hard controls peaked in the 2016/17 year at approximately 50%.

If this reporting is representative of how the industry actually responded to Serious Accidents in practice, then it is concerning. It means that a hazard, which had the demonstrated capacity to kill or require a person be admitted to hospital for treatment, was responded to with a control that was among the least effective in the hierarchy.

Also reported for Serious Accidents was an assessment of a) whether or not a hazard was identified, and b) if so, was it adequately controlled. Table 1 shows the various definitions adopted, and Figure 24 shows the results for the review period.

⁶³ Examples of some of the administrative controls reported include: 'No contract work is to commence on site unless authorised by the SSE and SWI's and Risk Assessments in place and signed off by all involved.' 'Reinforce the reporting process for all minor injuries received during work resulting in treatment by an external agencies.' 'We will be reviewing the procedure to do the work and ensure that the sequence of tasks are clearly defined.' 'Housekeeping standards to improve Accountability of Supervisor inspections.' 'Importance of Reporting all incidents has been stressed and communicated to workforce to prevent any further incident.' 'Education around lifting techniques.' 'Training of correct operations of Plant, maintenance & knowledge of guarding requirements for the plant.' 'Review SWP with work group' 'Raise awareness of risk in toolbox meeting.'

Table 1 Hazard Identified/Effective Controls

Hazard Identified - No Control	There was no control for the hazard even though the hazard was identified.
Hazard Not Identified - No Control	There was no control for the hazard because the hazard had not been identified.
Hazard Identified - Control Ineffective	A control to manage the hazard had been implemented, but it was inadequate to manage the hazard.
Hazard Identified - Control Bypassed	A control to manage the hazard had been implemented, but someone bypassed that control, contributing to the incident.
Hazard Identified - Control Unenforced	A control to manage the hazard was theoretically in place, but it was not enforced.

Absent or Failed Controls found in Serious Accidents for All Mines

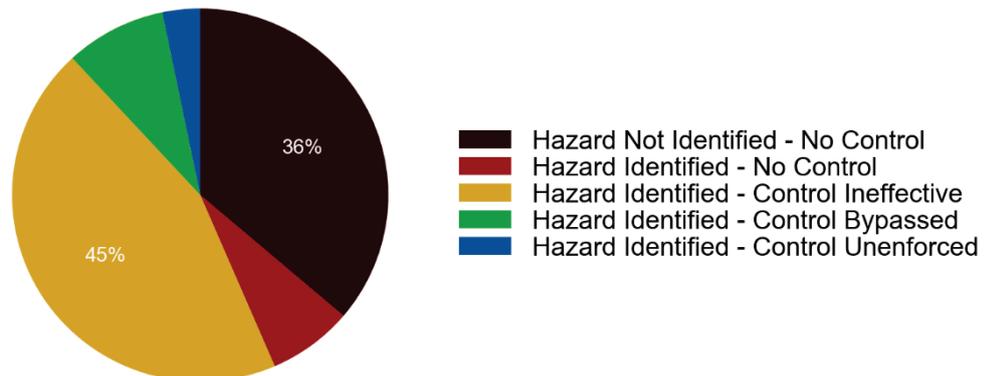


Figure 24 Absent or failed controls for Serious Accidents

The largest category, at 45%, was ineffective controls – the hazard was identified, controls were in place, but they were ineffective, and a Serious Accident resulted. The second largest category, at 36%, was an unidentified hazard – the hazard that caused the Serious Accident had not been identified in the past. These two categories show that approximately 81% of Serious Accidents occurred because of a failure to identify a hazard or control it. Bypassed or unenforced controls were less likely to play a role in Serious Accidents.

Figure 25 shows how the occurrences of these categories have changed over time.

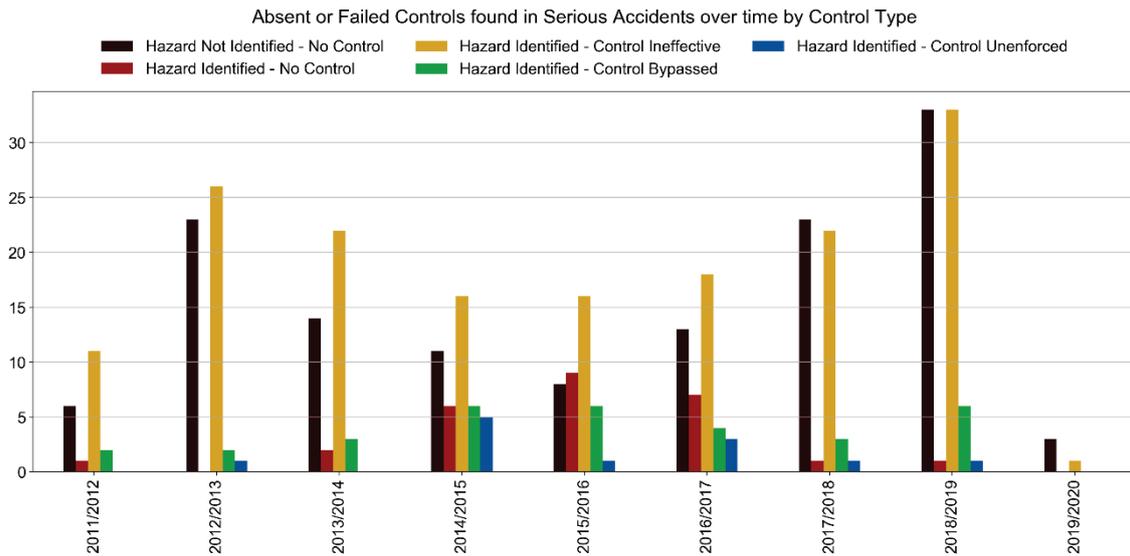


Figure 25 Absent/Failed controls for Serious Accidents over time

The chart illustrates that in recent years the number of Serious Accidents occurring is rising, with both ineffective controls and a failure to identify the hazard also increasing.

As the number of Serious Accidents varies from year to year, Figure 26 shows how the percentages of these categories have changed over time.

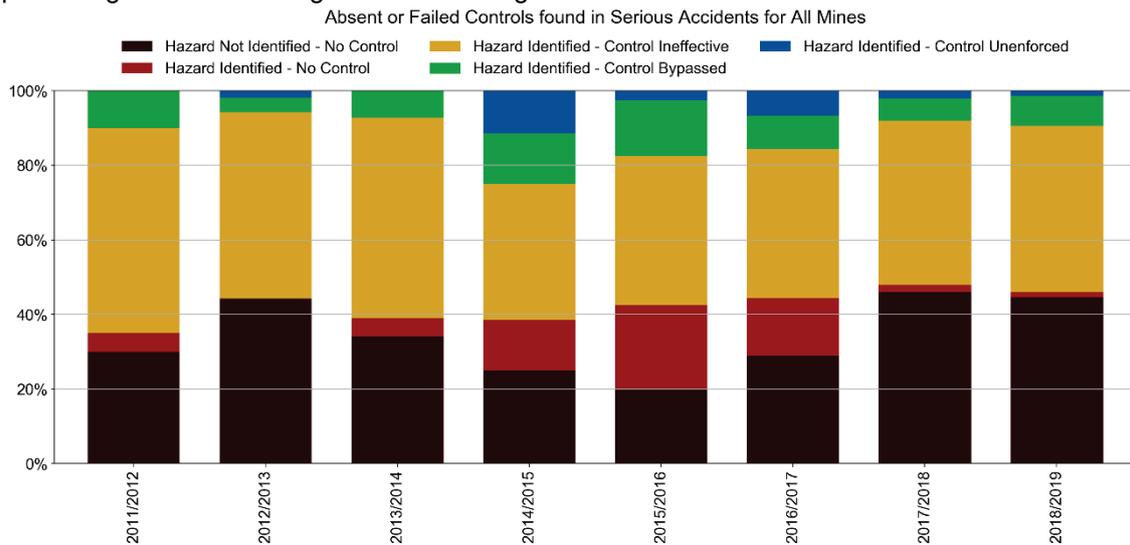


Figure 26 Absent/Failed defences for Serious Accidents over time (normalised)

From 2011/12 onwards the Serious Accidents have been predominantly caused by a failure to identify hazards or application of ineffective controls.

4.5 High Potential Incident Analysis

A High Potential Incident (HPI) is an event, or a series of events, that causes or has the potential to cause a significant adverse effect on the safety or health of a person.

Figure 28 shows the distribution of these HPIs across the sectors. Significantly more HPIs were reported in open cut coal than in any other industry, however, as discussed above, significantly more hours were also worked in this sector.

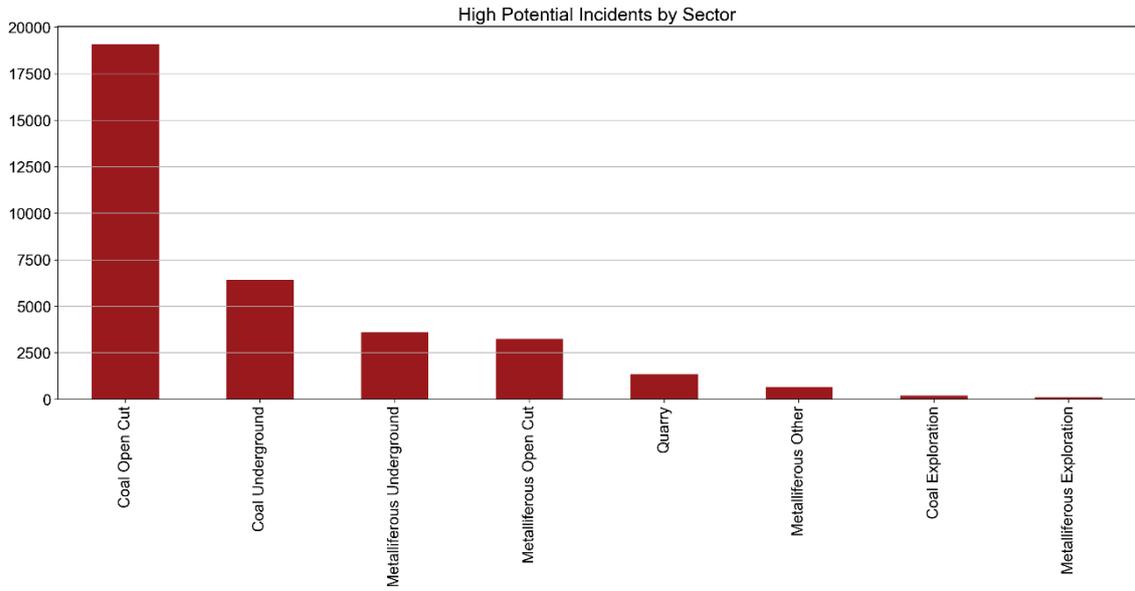


Figure 27 HPIs per sector

Figure 28 and Figure 29 show a comparison between the HPIs and fatalities per sector and the HPIs and Serious Accidents per sector.

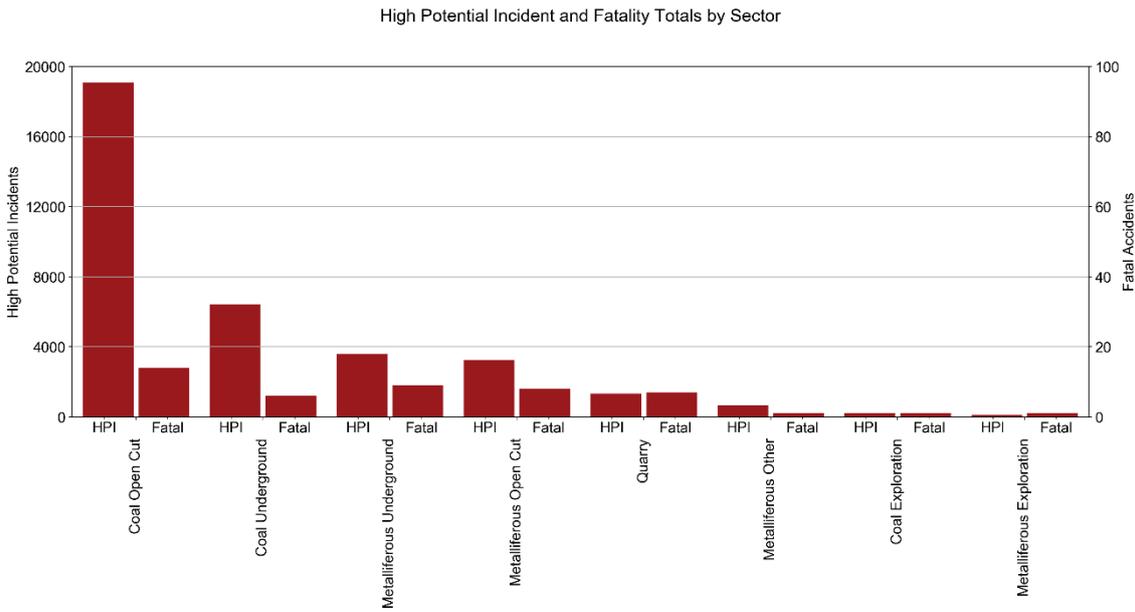


Figure 28 Distribution of HPIs and fatal accidents across sectors

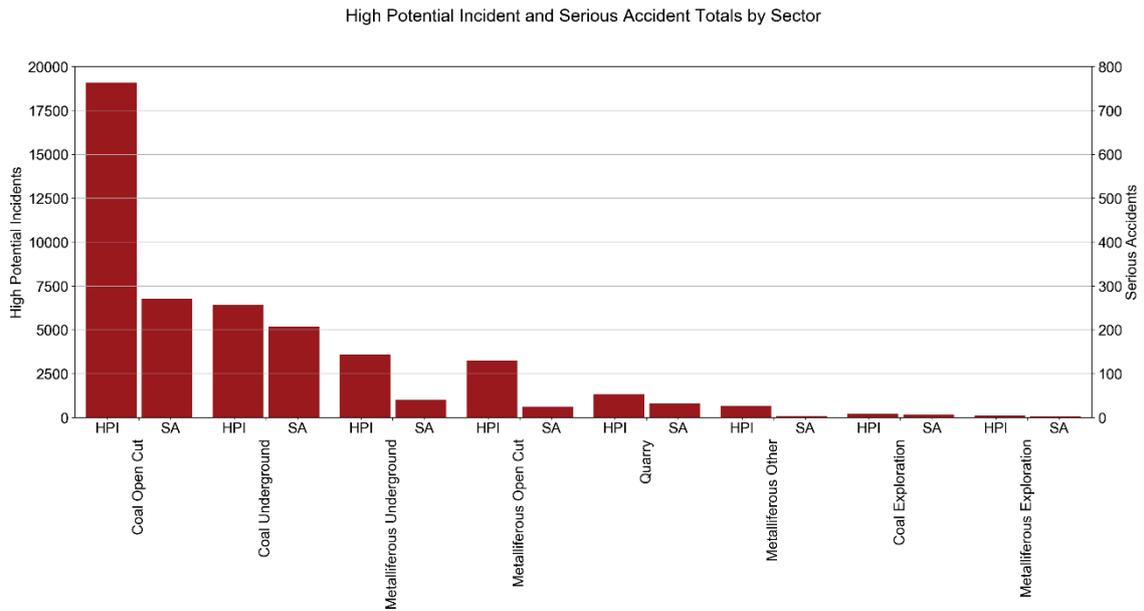


Figure 29 Distribution of HPIs and Serious Accidents across sectors

Figure 30 shows the distribution of HPIs, per financial year, for the review period.

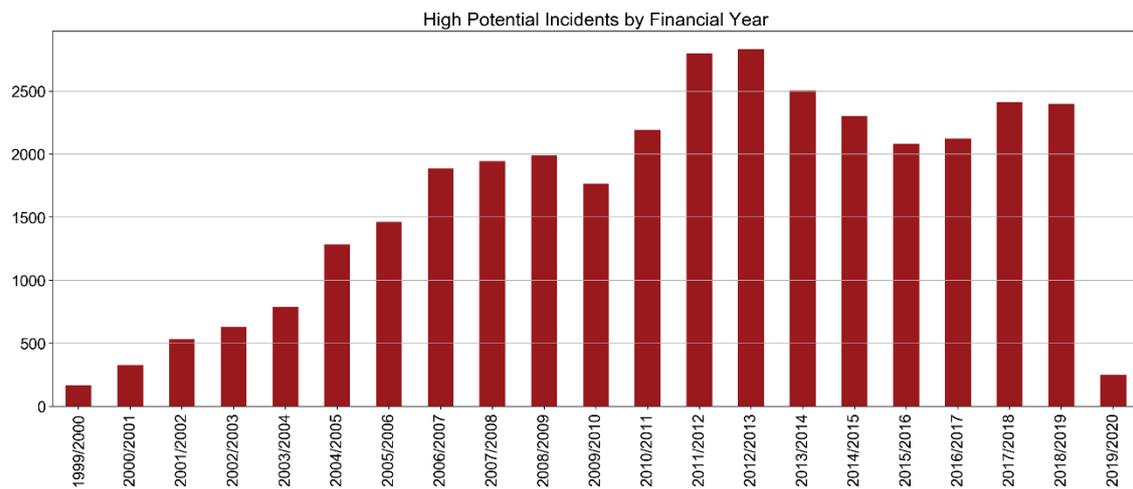


Figure 30 Distribution of HPIs per financial year for the review period

Between 2000 and 2009 there was a steady increase in the number of HPIs reported per year to the Regulator. Figure 31 shows a distribution of HPIs per financial year per sector.

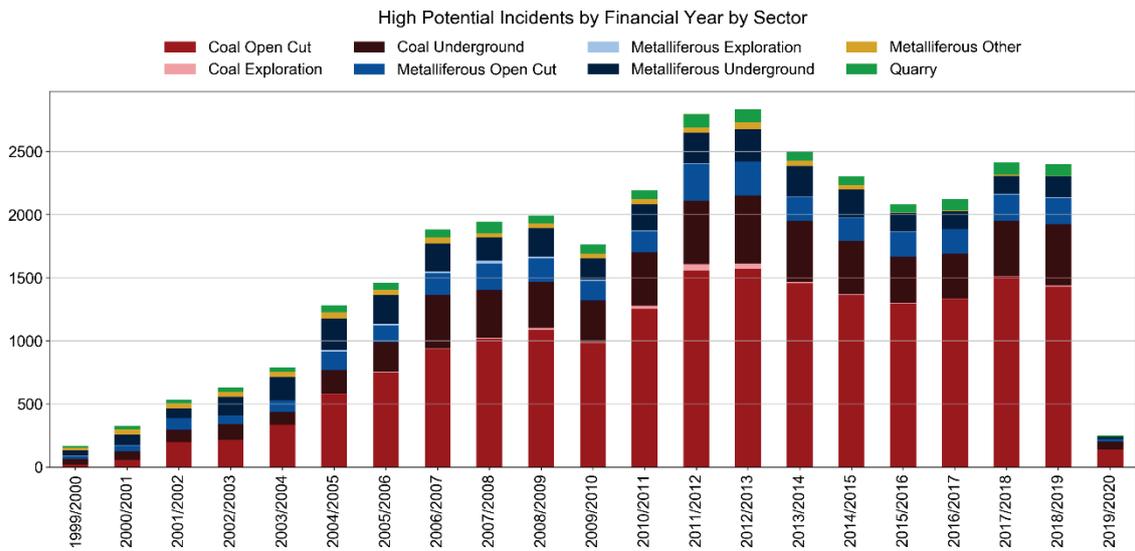


Figure 31 Distribution of HPIs per financial year per sector

The significant increases in HPIs reported over time are largely a consequence of increases in HPI reporting in the open cut coal sector.

Figure 32 shows the portion of HPIs that resulted in injuries. While HPIs include fatalities, Serious Accidents, and in some cases LTIs, the majority of HPIs did not result in an injury.

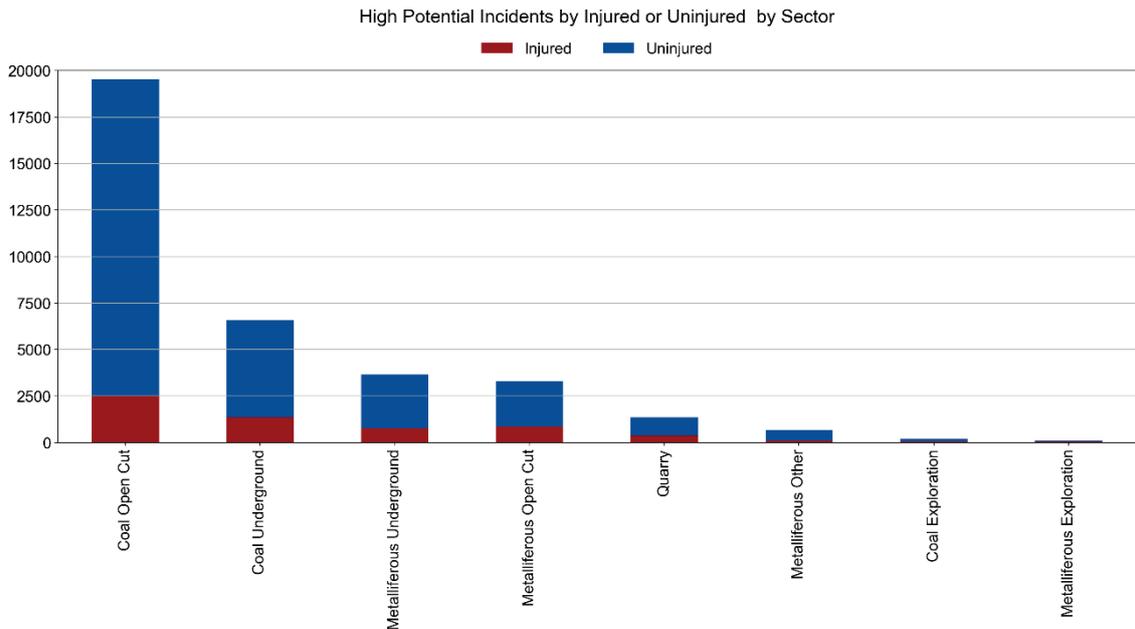


Figure 32 Portion of HPIs resulting in injuries per sector

Figure 33 shows the percentage of HPIs per sector that resulted in an injury. Except for Coal and Mineral exploration, approximately 75-85% of HPIs do not result in injuries. These HPIs are near misses, which offer genuine opportunities for the industry to identify hazards and remove them before they can cause harm.

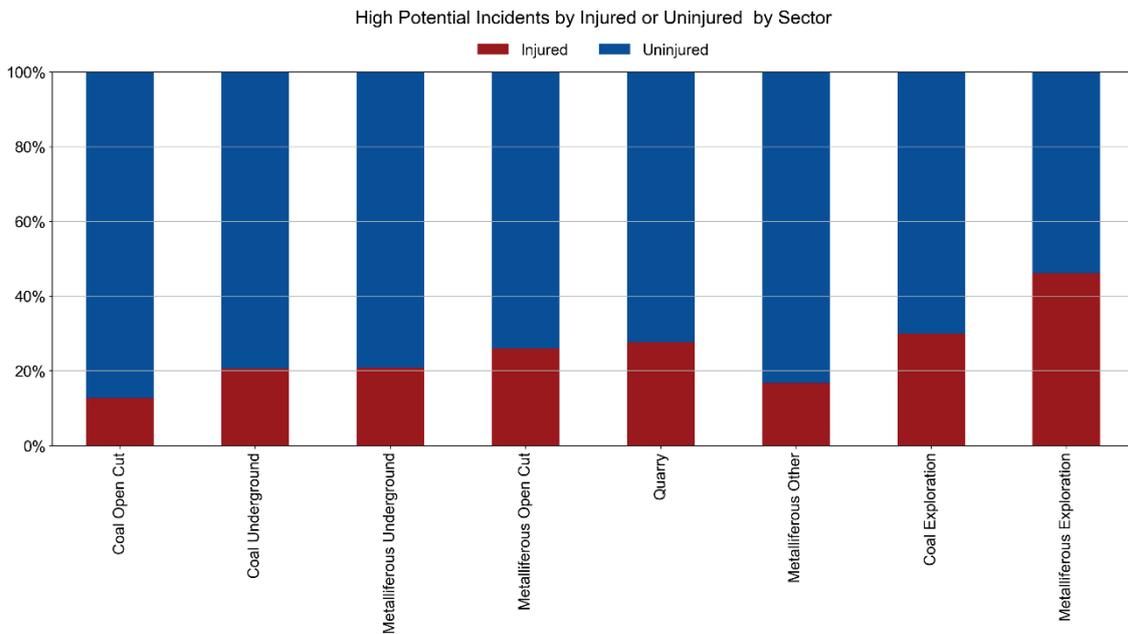


Figure 33 Percentage of HPIs resulting in injuries per sector

Figure 34 shows the corrective actions reported in the aftermath of a HPIs.

Highest Level of Corrective Action Applied after High Potential Incidents for All Mines

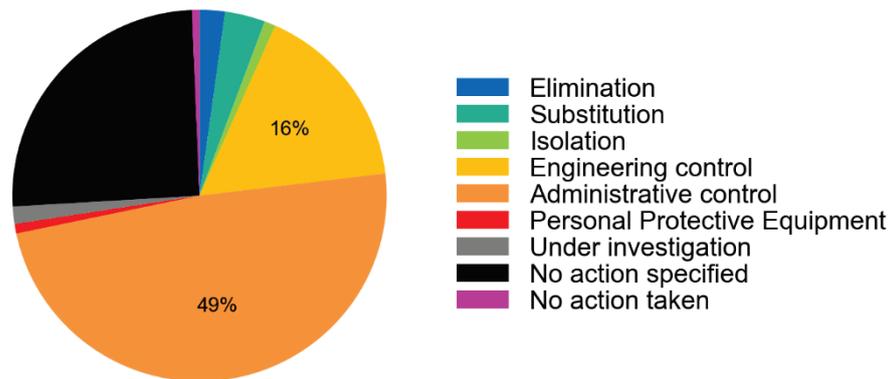


Figure 34 Controls put in place in the aftermath of a HPI

The percentage of hard controls reported is in the order of 25%, with the largest category being administrative controls at 49%. (Note that the percentage of *no action specified* is larger for HPIs than Serious Accidents.) Figure 36 shows how the application of controls has changed over the years.

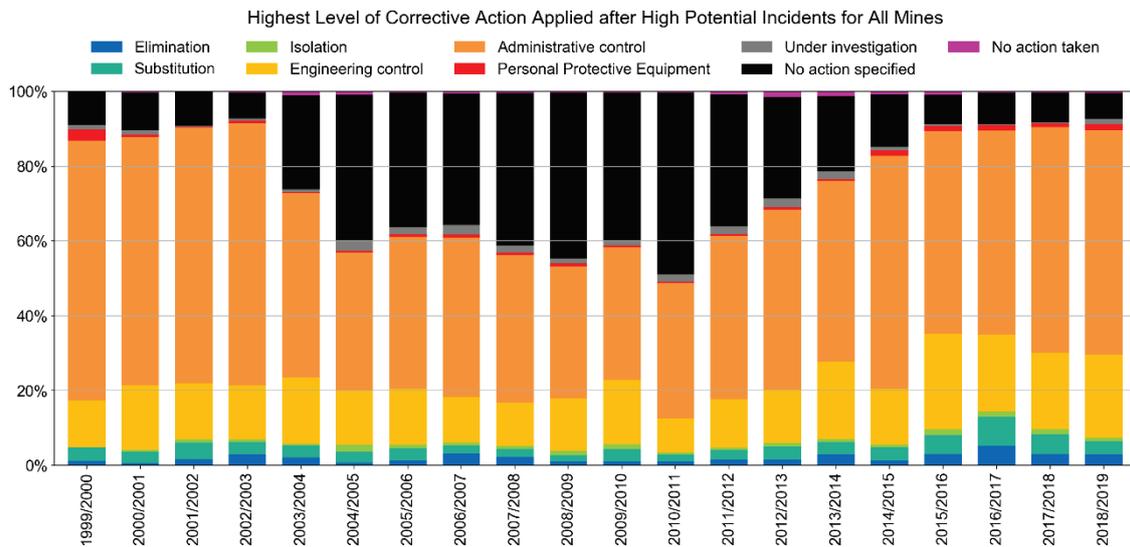


Figure 35 Controls put in place in the aftermath of a HPI (normalised)

In recent years the percentage of hard controls has dropped a little and administrative controls have grown. In the 2018/19 year the percentage of hard controls was 30% and administrative controls were 60%. As for Serious Accidents, if these reported controls are representative of the controls applied in practice, it is concerning. A key benefit of identifying HPIs, particularly those involving no injury, is that they highlight hazards that exist in the system and provide an opportunity for the industry to eliminate or control them.

If the industry is not responding with more effective controls - like elimination, substitution, or engineering controls - then it is likely missing opportunities to effectively control hazards. Instead of these effective controls there is a significant percentage of administrative controls being applied, some of the least effective available. In a discussion with one senior person in the mining industry they said that the high percentage of administrative controls was not surprising. Their view was that because the industry places significant emphasis on the use of procedures, it is only natural for it to automatically default to the use of *more* procedures, which are administrative controls, in order to control hazards. In other words, stepping through the hierarchy of controls in a deliberate fashion may not be occurring, rather the default may be to simply apply administrative controls.

It was not possible to categorically determine the reason for this willingness to accept less effective controls, but there are many potential reasons why:

- It may be that mining companies do not see the benefits provided by HPIs in identifying hazards before they cause harm, and the opportunity for their subsequent control. This is considered unlikely,
- It may be that mining companies are not provided with the right support and funding from higher up in the organisation in order to deal with these hazards in a more effective way - higher order controls can be costly to implement during operations and may not be attractive to management at site or corporate head office,
- There may be a lack of Regulator engagement in the process of selecting and following up on the implementation of corrective actions in the industry.

Regardless of the reason for the low percentage of hard controls applied, it does suggest that these hazards are not being removed from the system or effectively controlled. This means they will likely remain in the industry, lying in wait for another individual to become exposed to them. This point will be explored further in a later section.

Figure 36 shows the role played by absent or failed defences for HPIs.

Absent or Failed Controls found in High Potential Incidents for All Mines

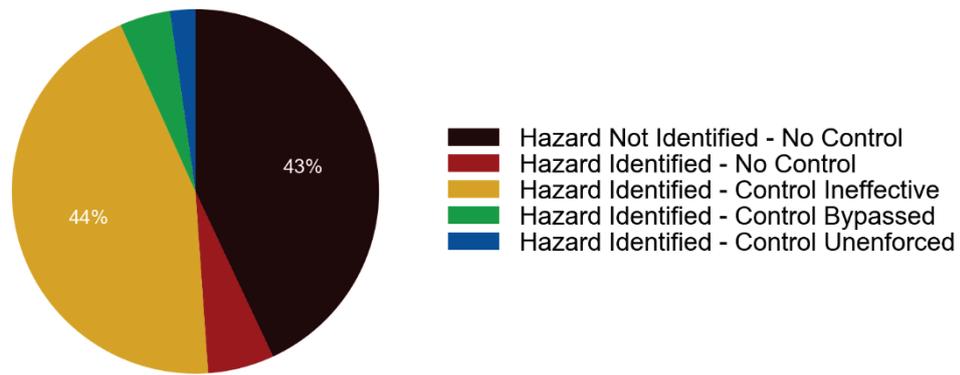


Figure 36 Absent or Failed defences for HPis

As in the case of Serious Accidents, a significant number of HPis are the result of the hazard being identified, but the controls ineffective, or the hazard being unidentified. Figure 37 shows how these absent and failed defences have changed over time.

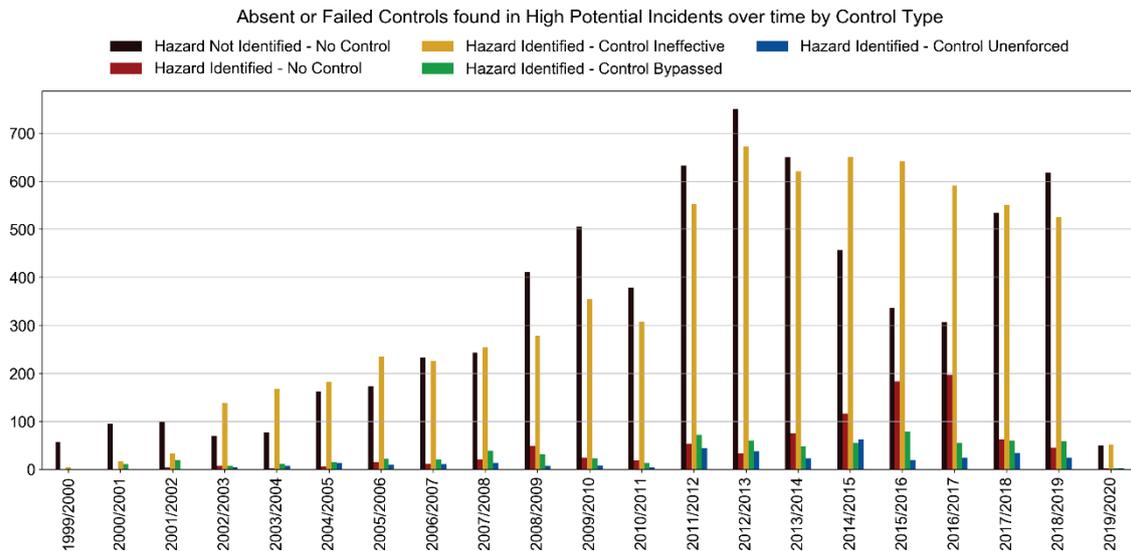


Figure 37 Absent/Failed defences for HPis over time

From July 2016 onwards, the number of HPis in which the hazard was not identified has increased, while the role of ineffective controls has decreased. Figure 41 shows how the percentage of each of these factors have changed over time.

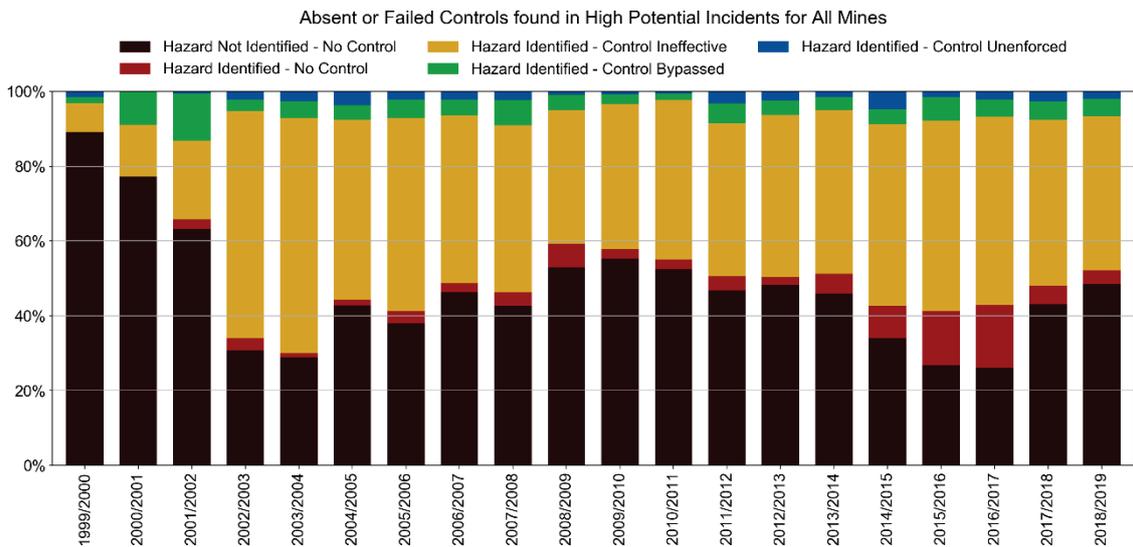


Figure 38 Absent/Failed defences for HPIs over time (normalised)

This chart suggests that, similar to Serious Accidents, the HPIs are predominantly the result of a failure to apply effective controls or a failure to identify the hazard. Over recent years, the percentage of HPIs as a result of a failure to identify the hazard is growing. One potential hypothesis for why this may be the case is that, from discussions with numerous individuals in the mining industry, the number of relatively inexperienced workers entering the industry is growing. It is likely that these individuals will not have the experience necessary to recognise and avoid exposure to hazards.

4.6 Lost-Time Injury Analysis

Lost-Time Injuries (LTIs) are injuries resulting in the injured person being unable to work the next day or a longer period, whether they are rostered to work or not.

Figure 39 shows the distribution of LTIs by worker type per sector.

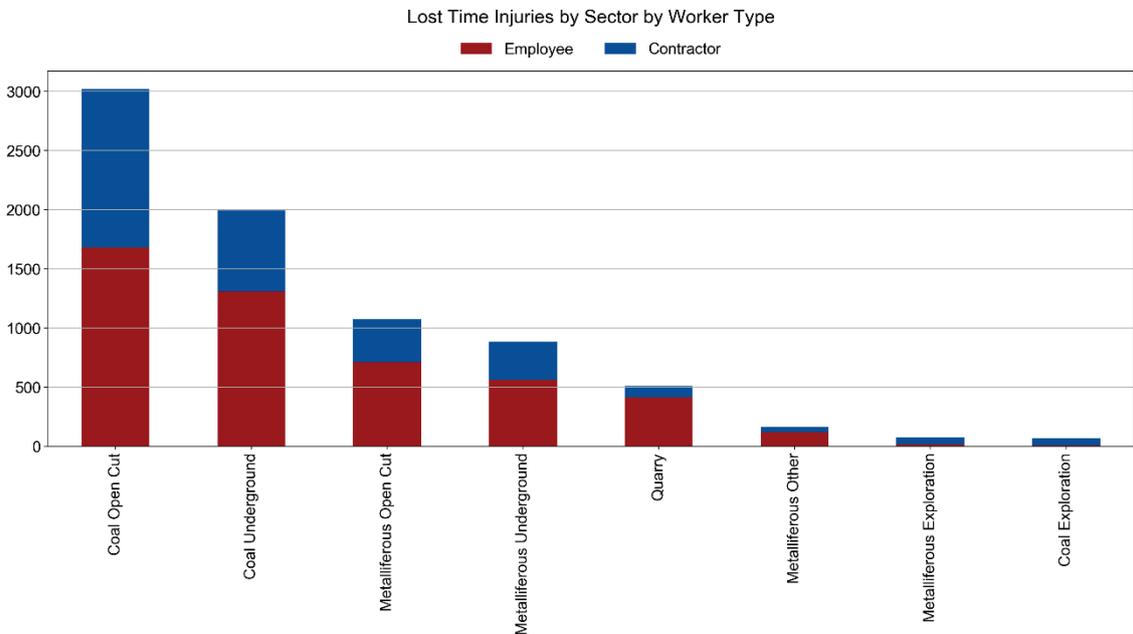


Figure 39 Distribution of LTIs per worker type per sector

Figure 40 shows the distribution of LTIs reported per financial year.

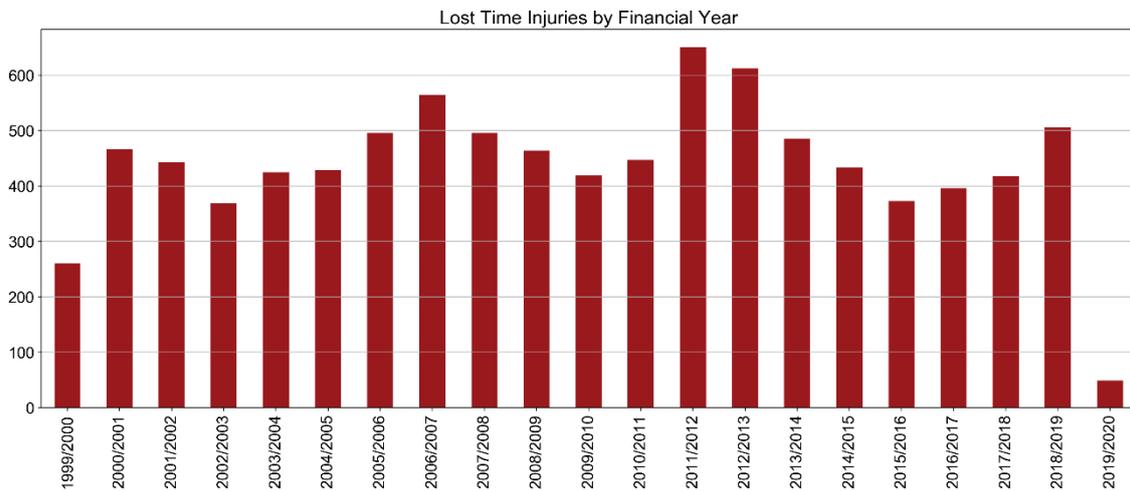


Figure 40 Distribution of LTIs per financial year

Figure 41 shows the corrective actions taken following an LTI. Of the 9,202 LTIs reported over the review period, 61% were responded to with *administrative controls only*. Again, as with Serious Accidents and HPIs, the industry response to LTIs is overwhelmingly administrative in nature.

Highest Level of Corrective Action Applied after Lost Time Injuries for All Mines

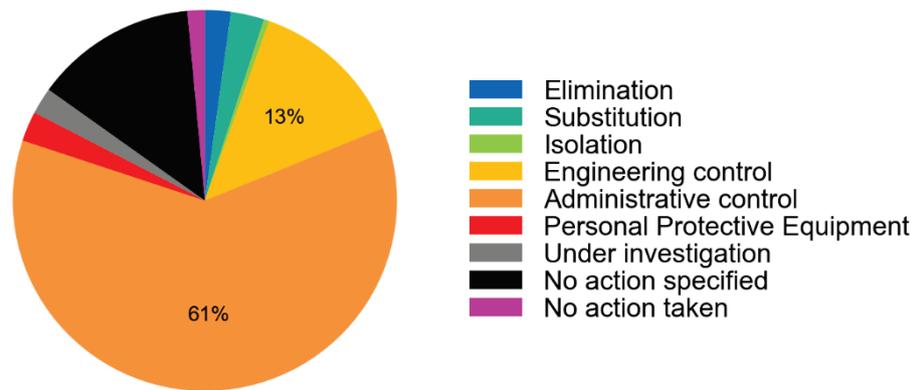


Figure 41 Corrective action in response to LTIs

Figure 42 shows how the application of these corrective actions have changed over time.

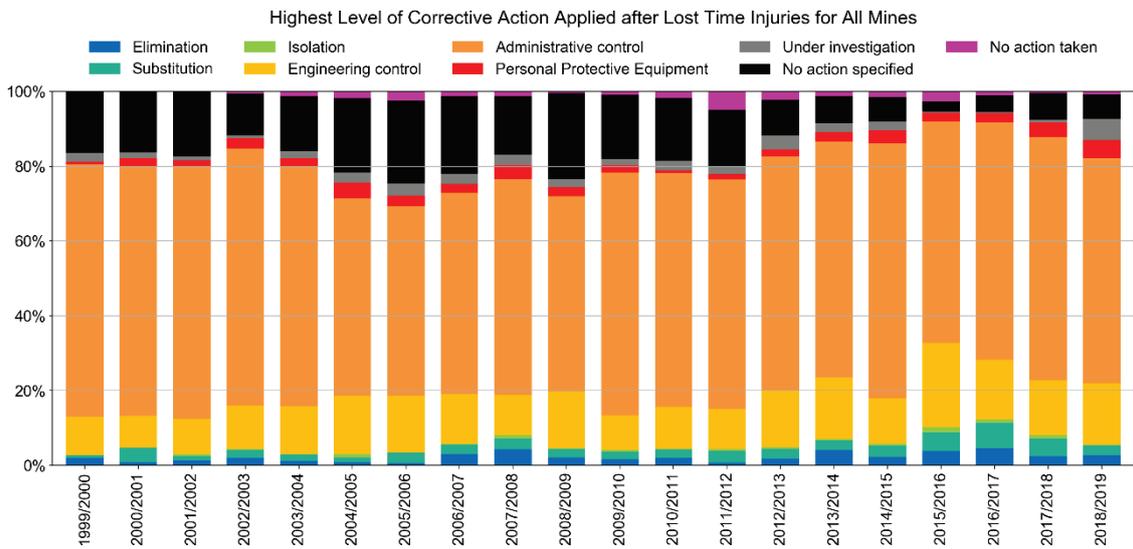


Figure 42 Corrective action in response to LTIs (normalised)

Figure 43 shows the role of hazard identification and failed controls in LTIs. As with both Serious Accidents and HPIs, the key causes of LTIs are a failure to identify the hazard or the application of ineffective controls.

Absent or Failed Controls found in Lost Time Injuries for All Mines

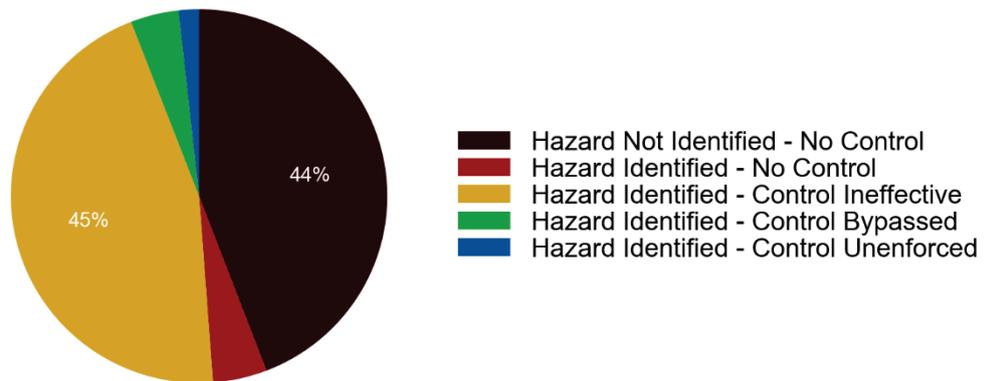


Figure 43 Absent/Failed Controls in LTIs

Figure 44 shows how these factors have changed over time. The role of both a failure to identify the hazard and ineffective controls have been increasing in recent years.

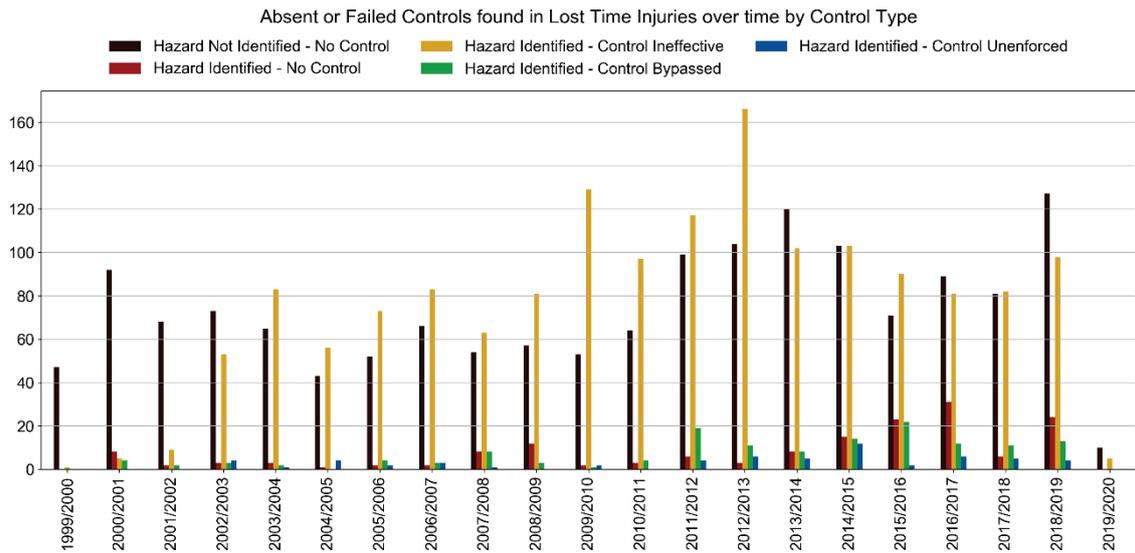


Figure 44 Absent/Failed defences for LTIs over time

Figure 45 shows the role of each percentage of these categories have changed over time.

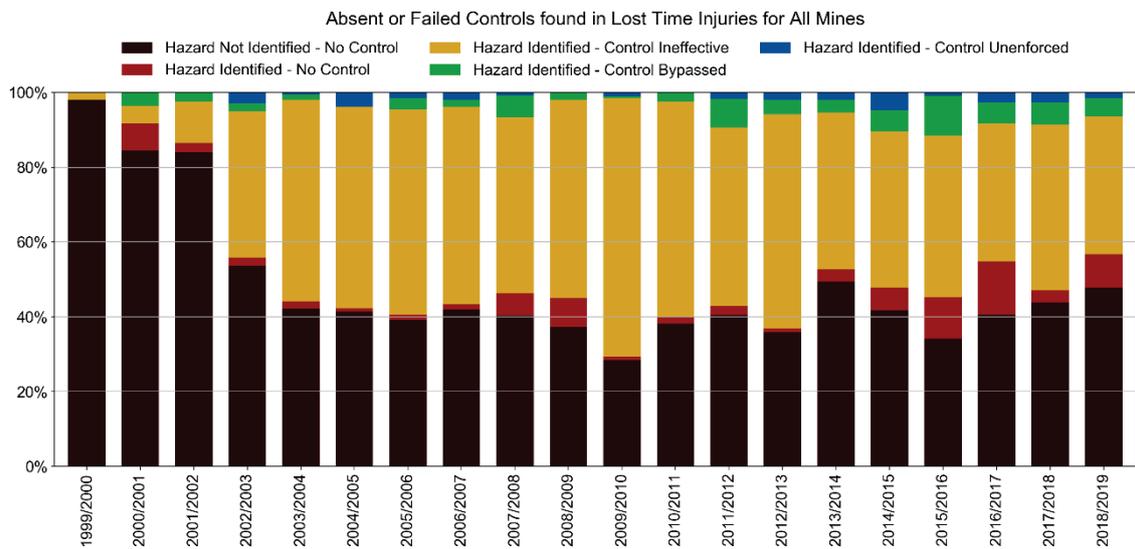


Figure 45 Absent/Failed defences for LTIs over time (normalised)

4.7 Summary

Administrative controls are applied in the majority of cases in the aftermath of an incident. For example, in the 2018/19 year, administrative controls were applied in 60% of HPIs, 68% for Serious Accidents, and 60% for LTIs. By contrast, the total hard controls never exceeded 30% for the same year.

An analysis of the causes of these incidents shows that the majority are caused by either a failure to identify the hazard or ineffective controls being in place.

5. OVERALL INDUSTRY BEHAVIOUR

5.1 Introduction

This section examines the relationship between the hours worked in the industry with respect to fatalities, Serious Accidents, HPIs and LTIs.

While some may be of the view that incidents are random and unpredictable events, this review found that there are several underlying relationships that suggest incidents are reasonably predictable. These relationships provide valuable insight into the overarching behaviour of the industry.

5.2 Incident Frequency Rates

Frequency Rates for each incident type are defined as the number of incidents per month or year divided by the number of hours worked for the same period. For example, the yearly Fatality Frequency Rate is the number of fatalities that occurs in a certain year divided by the number of hours worked for that year.

Figure 46 shows the Fatality Frequency Rate for each financial year⁶⁴. The rate was higher for the earlier part of the review period and was trending downwards, but it has increased again in the 2018/19 year.

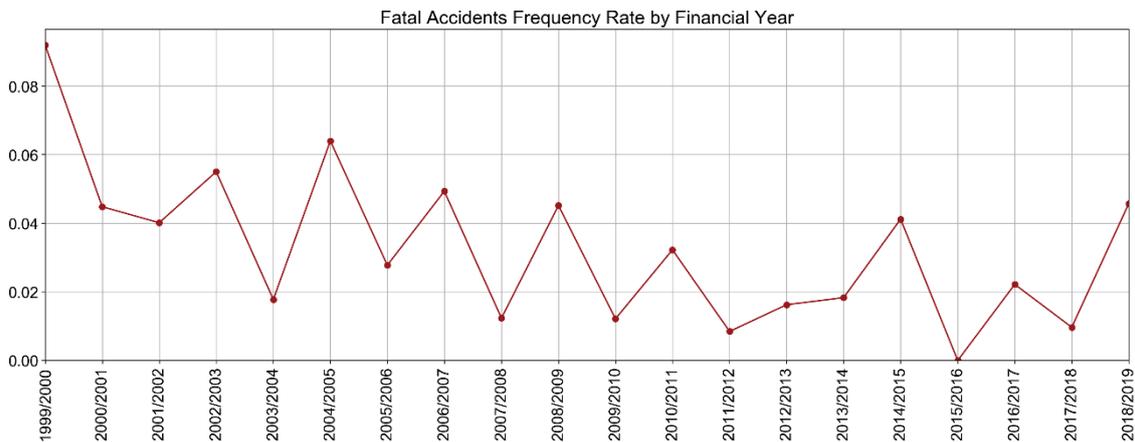


Figure 46 Fatality Frequency Rate per year

Figure 47 shows the Fatality Frequency Rate split for employees and contractors. The spike in the employee rate is evident and associated with the significant number of employee fatalities in the 2018/19 year. This significant increase in the employee Fatality Frequency Rate does not support the view that employees work in a safer manner than contractors, as has been expressed by many in the course of this review.

⁶⁴ The Fatality Frequency Rate should not be confused with the average yearly fatality rate of 2.4 per year discussed in Section 3. The average yearly fatality rate was the average number of fatalities that occurred per year irrespective of number of hours worked.

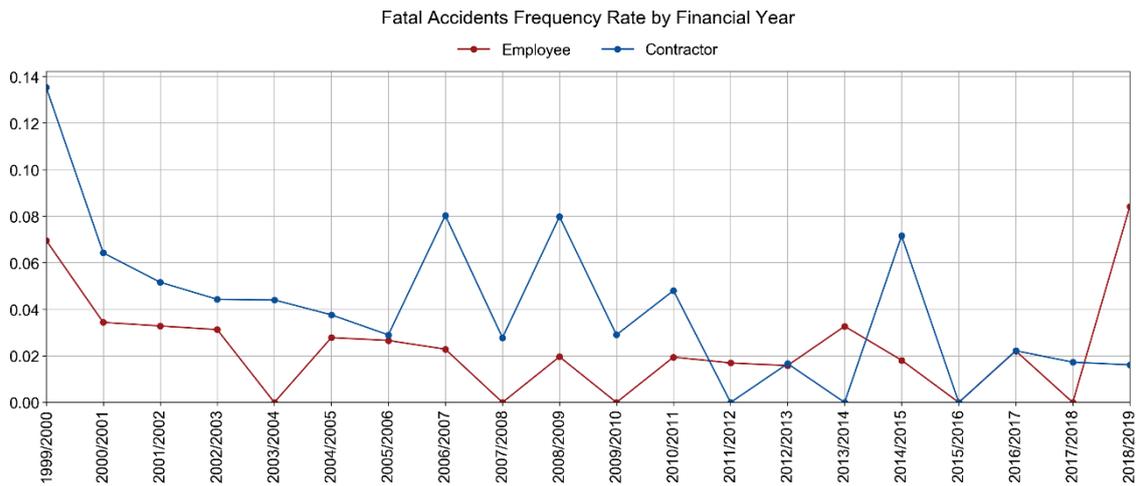


Figure 47 Fatality Frequency Rate for Employees and Contractors

Figure 48 shows the Serious Accident Frequency Rate per year, which is continuing to trend upwards.

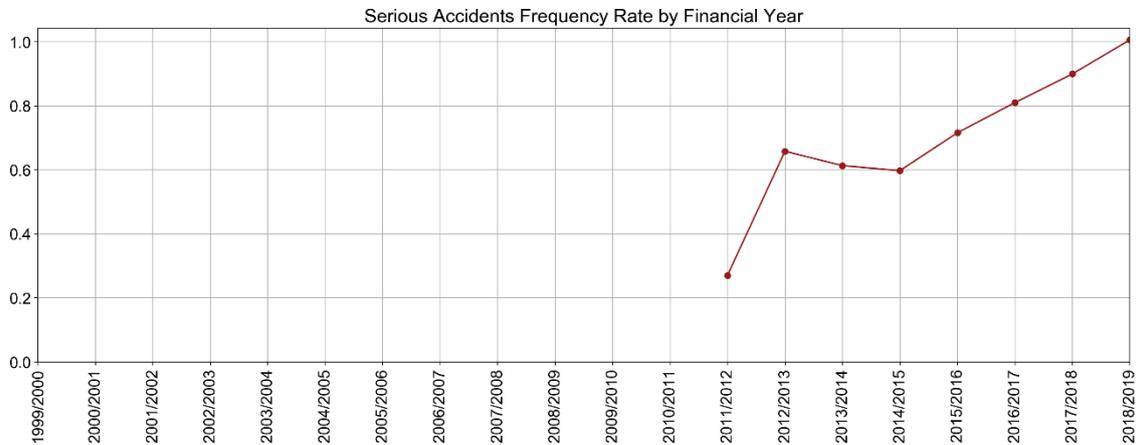


Figure 48 Serious Accident Frequency Rate per year⁶⁵

Figure 49 shows the Serious Accident Frequency Rate for both Employees and Contractors. While the contractor rate is higher, the rates are reasonably comparable.

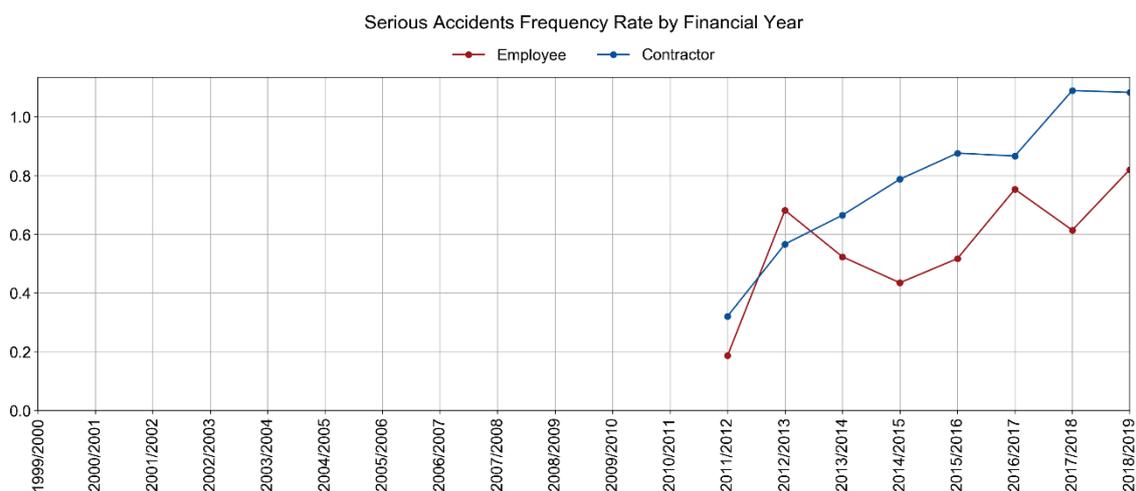


Figure 49 Serious Accident Frequency Rate for employees and contractors

⁶⁵ As discussed earlier in this report, the Serious Accidents were introduced in 2012.

This increasing trend in the Serious Accident Frequency Rate is concerning. This rate, as will be discussed later in the report, is a real indicator of the level of safety in the industry. It is less susceptible to manipulation - to qualify as a Serious Accident the individual is required to be admitted to hospital for treatment - so it is a genuine measure of the number of people being seriously hurt in the industry. An increasing Serious Accident Frequency Rate indicates that a higher percentage of the workforce require hospitalisation for injuries than in the past.

Further, as was discussed with respect to the Fatality Frequency Rate, many have expressed the view that contractors work in a less safe manner than employees. While the Serious Accident Frequency Rate for contractors is higher than that of employees, they still are reasonably comparable - a contractor is more likely to suffer a Serious Accident than an employee, but both are generally trending upwards. Conversely, this data does not support the view that employees work in a considerably safer manner than contractors.

5.3 HPI and Hours Worked Relationship

Figure 50 shows both the number of HPIs reported per month and the number of hours worked per month. The number of HPIs reported follows a similar overall trend to hours worked.

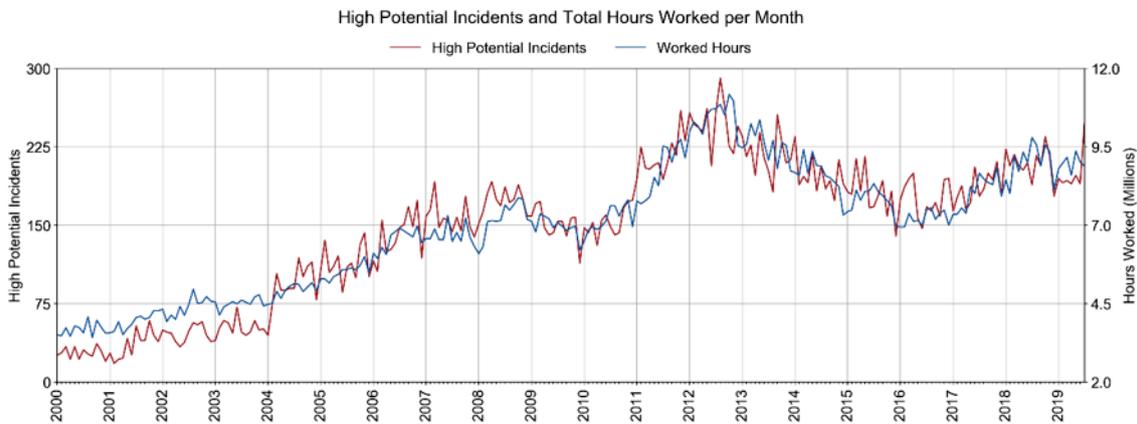


Figure 50 Relationship between number of HPIs reported and hours worked

The HPI Frequency Rate is defined as number of HPIs reported per million hours worked. Figure shows the HPI Frequency Rate on the y-axis, plotted against total hours worked per month on the x-axis. The objective of this chart is to determine if the HPI Frequency Rate varies with total hours worked per month.

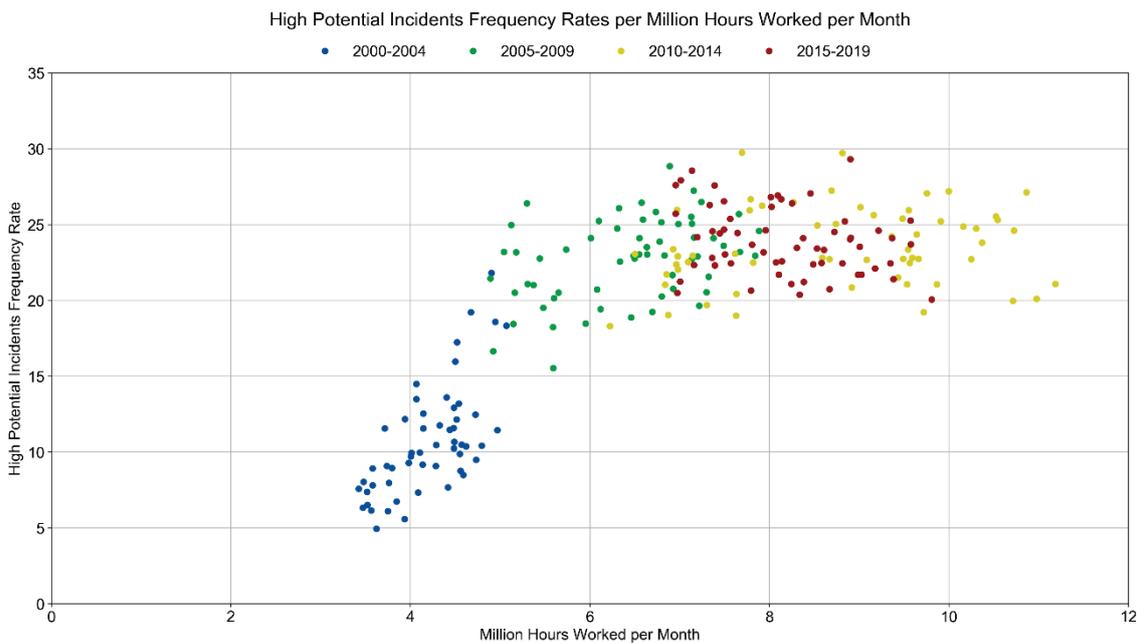


Figure 50 HPI Frequency Rate versus hours worked per month

The HPI Frequency Rate increases from approximately 3 million to 6 million hours per month, then has a relatively constant rate of approximately 23 HPIs per million hours worked. For example, if there are 8 million hours worked in a month, then an average of 184 HPIs will be reported (8 multiplied by 23). Similarly, if 10 million hours are worked, then an average of 230 HPIs will be reported for that month (10 multiplied by 23).

The low HPI Frequency Rate corresponds to the period from 2000 to the 2003/04 financial year. Therefore, leaving aside this period, the chart shows that for the past 15 years the industry has had a constant HPI Frequency Rate of an average of 23 HPIs per million hours worked.

It is useful to examine this Frequency Rate from a practical perspective. Assume a worker works, say 2,000 hours per year. For a HPI Frequency Rate of 23, each year 500 workers (equal to 1 million hours) will report 23 HPIs⁶⁶. Put another way, taking a sample of 500 workers, only 23 of them in any given year are likely to find themselves in a situation that causes or has the potential to cause a significant adverse effect on their safety or health⁶⁷.

Alternatively, consider what this frequency rate suggests for a single person. If a person works, say, 2,000 hours per year, then in a 30 year career they will report 1.4 HPIs⁶⁸. This suggests a person is, on average, only likely to report between 1 and 2 HPIs in their career.

If it is assumed that no underreporting of HPIs is occurring, this means that only once or twice in a career is a person likely to find themselves in a situation that causes or has the potential to cause a significant adverse effect on their safety or health.

However, based on discussions with people involved in the mining industry, this statement appears inconsistent with their experience – people find themselves in situations that could have an adverse effect on their health many more times than once or twice in their careers. In other words, 1.4 situations per 30 year career appears unrepresentative of the actual number of hazardous situations in the industry. If this is the case, it suggests a significant level of under-reporting of HPIs.

A further point to consider is *why there is a constant frequency rate of HPIs?*

One hypothesis is the more people that enter the industry, the more people are exposed to hazards⁶⁹. Thus the number of HPIs reported increases, as does the hours worked, which gives a reasonably constant HPI Frequency Rate. But this suggests a troubling explanation: the hazards are present in the industry waiting for additional people to become exposed to them, which in turn suggests that the hazards are not being removed or effectively controlled.

This hypothesis is also consistent with the low percentages of hard controls (elimination, substitution, isolation and engineering controls) being applied in the industry. As discussed in the previous section, in the order of only 25% to 30% of incidents of all types are responded to with hard controls, with 49% to 62% being administrative in nature, some of the most ineffective controls available.

Exploring the converse argument, if hazards are being effectively removed and controlled, why would the HPI rate increase with hours worked? Are there new hazards emerging to replace the old?

Put another way, while the number of HPIs reported may or may not be directly related to the actual number of hazards or hazardous situations in the industry, it is certainly correlated with the number of hours people spend exposed to those hazards.

⁶⁶ 1,000,000 hours divided by 2000 is 500 workers. Therefore 23 HPIs for 500 workers for one year.

⁶⁷ Limiting the calculation to one HPI per person per year.

⁶⁸ 2,000 hours by 30 years is 60,000 hours. Based on a HPI rate of 23 HPI/million hours worked, this equates to 1.38 HPIs per career.

⁶⁹ Another hypothesis is that for every HPI genuinely identified and removed, a new and different HPI occurs.

5.4 Serious Accidents and Hours Worked Relationship

Figure 51 shows a plot of the number of Serious Accidents reported per month, along with number of hours worked in the industry per month.

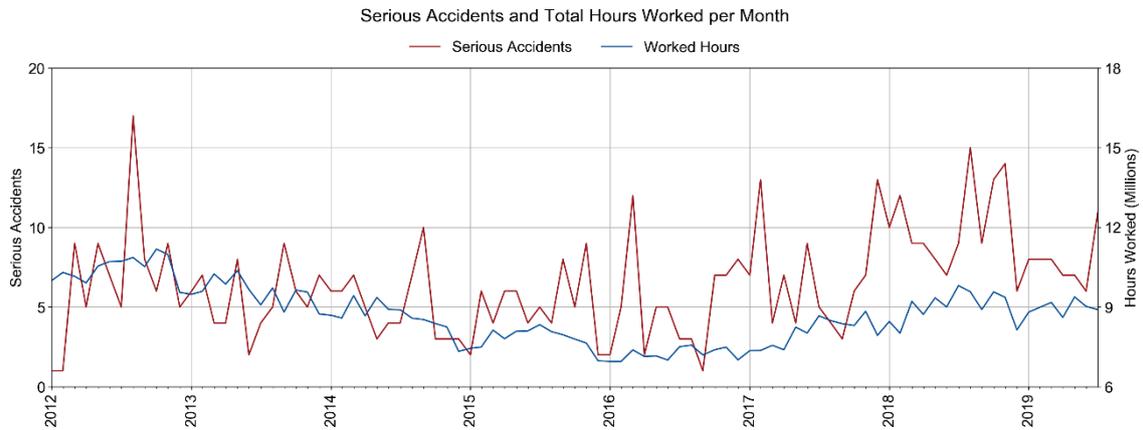


Figure 51 Relationship between number of Serious Accidents and Hours Worked

While there appears to be some broad correlation between the number of Serious Accidents and hours worked per month, the number of Serious Accidents is greater from 2016 onwards.

Figure 52 shows the relationship between the Serious Accident Frequency Rate - the number of Serious Accidents per million hours worked – and the number of hours worked per month.

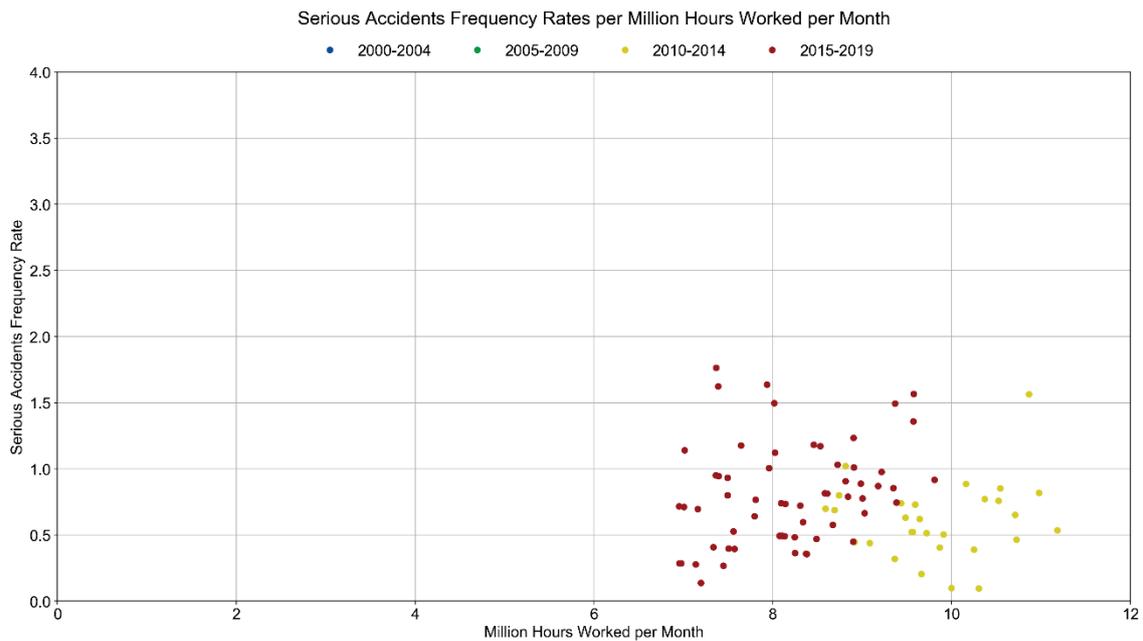


Figure 52 Serious Accident Frequency Rate and total hours per month

Similar to the HPI Frequency Rate, the Serious Accident Frequency Rate appears reasonably constant at 0.75 Serious Accidents per million hours worked. For example, if 10 million hours are worked in a month, this equates to an average Serious Accident Frequency Rate of approximately 0.75, suggesting there will be an average of 7.5 Serious Accidents for that month⁷⁰.

⁷⁰ A Serious Accident Frequency Rate of 0.75 per 1 million hours worked, means a total of 7.5 serious accidents for 10 million hours worked. While the estimated number of serious accidents is 7.5, there is a wide spread in the data.

5.5 LTIs and Hours Worked Relationship

Figure 53 shows both the number of LTIs reported and hours worked per month.



Figure 53 Relationship between number of LTIs and hours worked

From 2011 onwards the number of LTIs reported broadly follows the number of hours worked in the industry. Prior to 2011, however, a different overall trend is evident. While the number of LTIs is remaining relatively constant, the number of hours worked are increasing significantly over time.

Figure 54 shows the LTI Frequency Rate and the total number of hours worked per month.

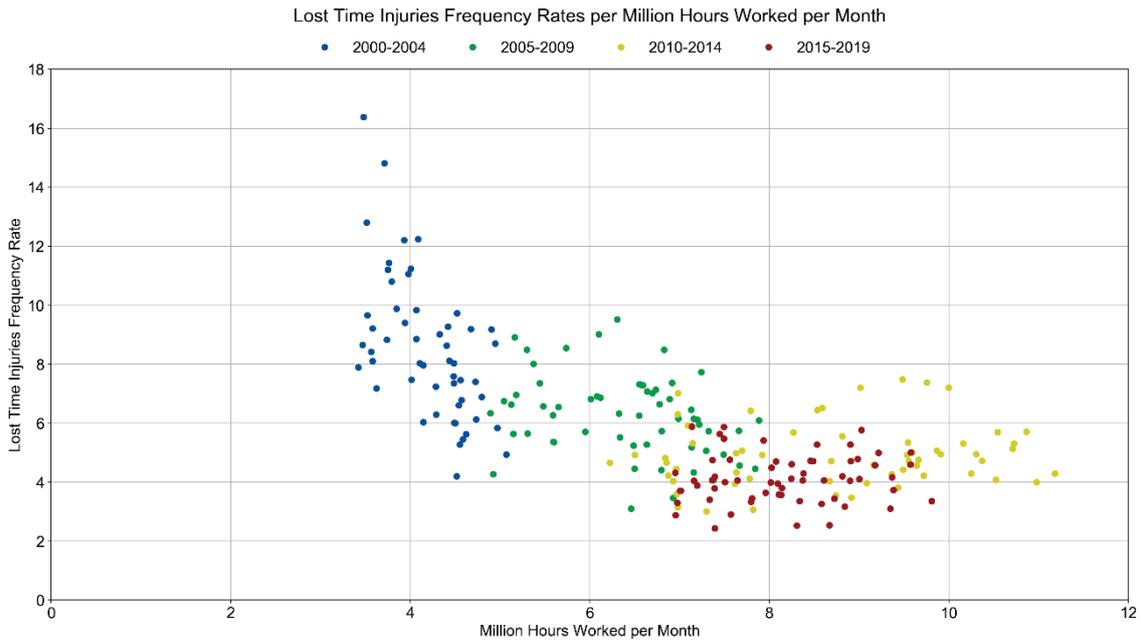


Figure 54 LTIs per million hours vs total hours per month

The LTI Frequency Rate initially decreases, before becoming reasonably constant at an average of approximately 5 LTIs per million hours worked. The points representing less than 5 million total hours worked per month correspond to the period 2000 to 2004. Therefore, a constant average LTI Frequency Rate of approximately 5 has been reasonably consistent for the past 15 years.

The LTI Frequency Rate can be separated for employees and contractors ⁷¹. Figure 55 shows the ratio of the LTI Frequency Rate for contractors to employees, by month, for the review period.

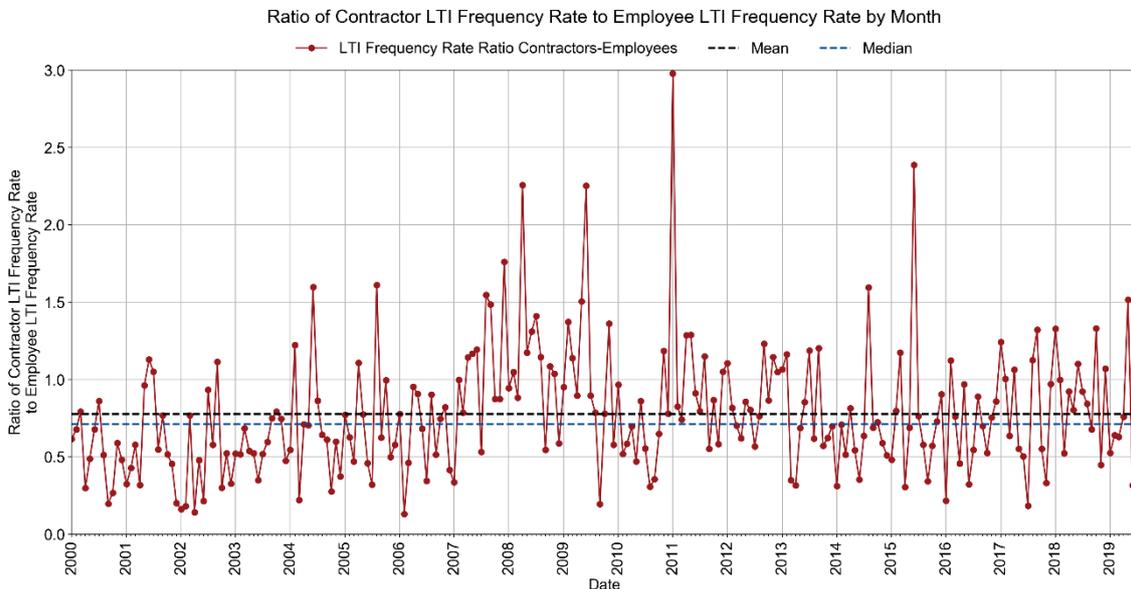


Figure 55 Ratio of LTI Frequency Rates for contractors and employees

While this rate varies, this chart shows that the LTI Frequency Rate for contractors is on average approximately 0.7 times that of employees. For the same number of hours worked, employees typically report 1 LTI for every 0.7 reported by contractors.

Why would contractors have a lower LTI rate than employees? There are a number of potential hypotheses why this may be the case:

- Hypothesis 1: contractors undertake less hazardous work than employees,
- Hypothesis 2: contractors have a *safer* approach to their work than employees, which may indeed be the case for contractors operating mines or specialist contractors,
- Hypothesis 3: contractors are not reporting all the LTIs that occur.

Based on discussions with those in the mining industry the first 2 hypotheses seem less likely, with many suggesting the most likely reason is contractors are reporting less LTIs than employees. Discussions suggest that contractors are incentivised to do so – they are rewarded for having a low LTI Frequency Rate⁷².

Figure 56 illustrates the injured body location due to LTIs. While both employees and contractors broadly follow the same distribution, employees have a considerably higher number, relatively speaking, of back, knee, shoulder, neck, and other back complaints. These are *hidden injuries*, which if go unreported are unlikely to be noticed by others, as opposed to, for example, hand and face injuries, which are obvious injuries.

⁷¹ It was not possible to separate the HPIs associated with contractors and employees because this data was not reported.

⁷² For example, if mining companies award contracts to contracting companies, based on criteria that includes consideration of the LTI Frequency Rate, then this has the potential to incentivise under-reporting among contractors.

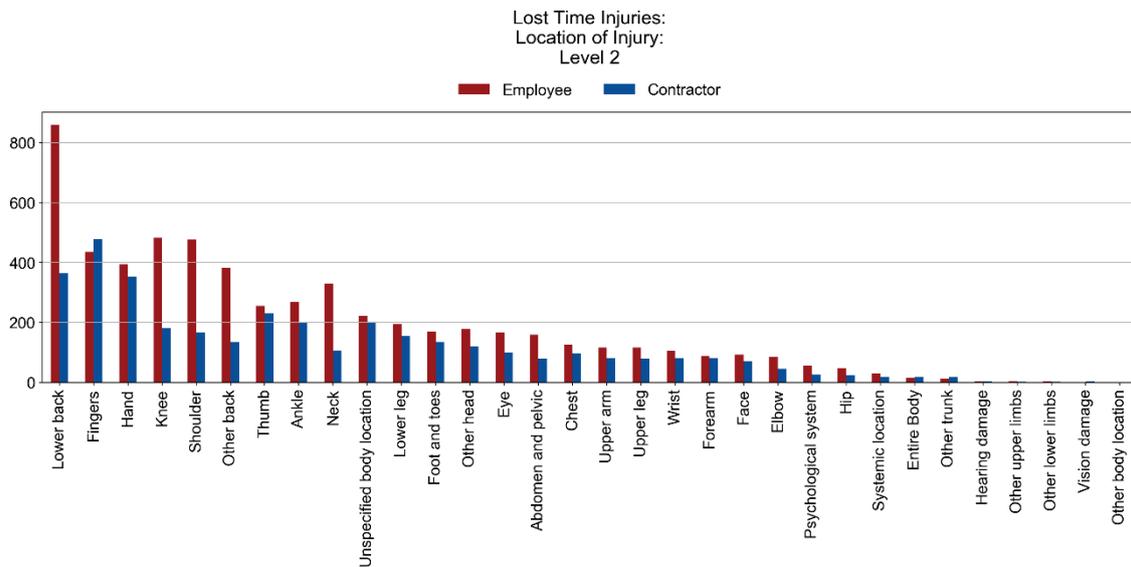


Figure 56 Location of Injury for Lost Time Injuries for Employees and Contractors

5.6 Summary

The mining industry may have the view that incidents are random and unpredictable events. However, the analysis of this data shows that this is not the case. The number of incidents is broadly related to the number of hours worked in the industry. This means that every month the industry will hurt or place in hazardous situations a predictable percentage of its workforce. In an average month, this equates to 23 HPIS, 5 LTIs and 0.75 Serious Accidents per million hours worked.

This is consistent with the number of hazards in the industry remaining constant, waiting for more workers to become exposed to them. In turn, this is also consistent with the industry typically selecting some of the least effective controls available to manage these hazards. Thus, the hazards are remaining in play, continuing to affect the same percentage of workers.

Any other interpretation of the data is a hard argument to mount. And this situation is getting worse, as evidenced by the increasing Serious Accident Frequency Rate. Unless hazards are effectively identified and effectively controlled, it is unlikely that the Serious Accident Frequency Rate will decrease.

Further, the significant increase in the employee Fatality Frequency Rate, combined with the employee Serious Accident Frequency Rate being reasonably comparable to that of contractors, does not support the view that employees work in a considerably safer manner than contractors.

6. DRIFT INTO FAILURE – A HYPOTHESIS FOR INDUSTRY BEHAVIOUR

6.1 Introduction

Based on this review's analysis of incidents and fatalities, unless the mining industry makes significant changes to how it operates, the Fatality and Serious Accident Frequency Rates are likely to continue at, or exceed, current levels.

As discussed in Section 3, fatalities occur in what appears to be a cycle. This pattern has been evident over the past 19½ years, and is characterised by periods where fatalities occur, followed by periods where there are few to none.

If the industry continues to take a similar approach to safety, using the same philosophies and methodologies adopted over the past 19½ years, then similar safety outcomes are to be expected. There will be periods where a significant number of fatalities occur, followed by periods where there are few to none. Past behaviour suggests that in the order of 12 fatalities are likely to occur over any 5 year period.

The cycle further suggests that the periods with few to no fatalities should be viewed as simply part of the fatality cycle - they are not evidence of the industry becoming safer over the long term. Instead, further fatalities should be expected as the cycle continues. This may appear a bleak prediction, but this cycle has proven surprisingly resilient over the past 19½ years.

In addition to the fatality cycle, the Serious Accident Frequency Rate is trending upwards. This increasing rate suggests the industry is more likely to cause serious injury to a person than in the past.

Of concern, also, has been the industry's reported response to incidents. For the 2018/19 year, the reported corrective actions put in place for HPIs and Serious Accidents show that the application of hard controls never exceeded 30% of the total corrective actions. Further, for HPIs and Serious Accidents in that same period, a significant percentage of corrective actions put in place were administrative in nature (in the order of 60% and 70%, respectively) – one of the least effective controls available. Put another way, in the case of Serious Accidents, a hazard that had the capacity to hospitalise a person was responded to with a control that essentially directed workers to ensure it didn't happen again.

Finally, a review of the incident numbers shows broad relationships between the number of incidents per month and the number of hours worked per month. One hypothesis for this behaviour is that hazards are remaining in the industry, being either unidentified or with ineffective controls, with the result being that the more people that are exposed to these hazards, the more HPIs and Serious Accidents will occur. These incidents are not particularly random and unpredictable.

How should the industry respond to these challenges?

This section provides a hypothesis for why fatalities are occurring, both at a macro and micro level. This section will focus on the concept of a *drift into failure*, but first the concept of blame will be examined.

Some readers may feel these discussions a little too philosophical or impractical, but these concepts underpin and drive the practical changes that are needed in the industry. These concepts also form the basis for this review's recommendations.

6.2 Blame

Anecdotal discussions suggest that while many organisations strive to identify the broader causes of an incident, a number still identify human error on the part of the injured worker as a primary cause. A detailed examination, however, of the fatality causal diagrams discussed in Section 3, shows that human error, in and of itself, is not a major causal factor. While it is often involved, typically many other factors are required to cause fatalities.

While it is important to hold people accountable for their actions, it is also important to ensure that the drive for accountability does not overshadow the importance of learning the lessons from the incident⁷³. Hopkins points out that blame is often the enemy of understanding: 'Most but not all major accidents are triggered by operator errors, and the initial response of the companies is to blame the operators. However, operator error is better seen as a starting point for inquiry [into accident causes], rather than an explanation in its own right. As soon as we ask *why* operators made the mistakes they did, a whole range of factors come into view that are far more important from an accident prevention point of view'⁷⁴.

Put another way, asking *why* operators made mistakes helps to expose the *system* errors that led to, or allowed, the human error⁷⁵. A failure to identify these system errors means that another operator or worker can make a similar error in the future, with the potential for the incident to reoccur. The mining industry should ensure that internal incident investigations go considerably deeper than simply identifying human error alone as being causative - these investigations should capture the system factors that caused the incident. Conversely, if internal mining company investigations are largely identifying human error as the cause, they are likely missing valuable learning opportunities.

6.3 Complexity

Useful in the discussion that follows is the concept of complexity. Before examining complexity, however, it is helpful to discuss its opposite, namely Newtonian thinking. Newtonian thinking assumes that if the behaviour of the individual components of a system is understood, and the system's initial conditions are known, then the behaviour of the overall system can be both understood and predicted.

This form of thinking underpins science, appears common sense, and for many systems – namely, simple systems – adequately describes their behaviour⁷⁶. This thinking also underpins the investigation of why systems fail: in order to understand why the system failed, all that is required is to identify the component or components that individually failed.

A number of Newtonian thinking assumptions are worthy of discussion.

One assumption is that there is a direct link between cause and effect. Dekker says in 'the Newtonian vision of the world, everything that happens has a definitive, identifiable cause and a definitive effect. There is symmetry between cause and effect (they are equal but opposite). The determination of the "cause" or "causes" is of course seen as the most important function of accident investigation, but assumes that physical effects can be traced back to physical causes (or a chain of causes-effects) (Leveson, 2002)'.⁷⁷ So not only can a link between cause and effect be clearly drawn, but the seriousness of the effect is related to the seriousness of the cause - big failures are due to big causes, small failures to small ones.

Another assumption is that Newtonian thinking is reductionist, an assumption already introduced above – the system can be broken down into its component parts, including technological and

⁷³ Dekker proposes the concept of a 'Just Culture' where demands for accountability (by society and government) are satisfied; but this accountability must be balanced with the organisational learning necessary to prevent future incidents. (Dekker, S 2012, *Just Culture: Balancing Safety and Accountability*, Ashgate, Farnham, UK.)

⁷⁴ Hopkins, A, 2008, *Failure to learn: the BP Texas City Refinery disaster*, Sydney, CCH Australia Limited.

⁷⁵ Hopkins considers that from 'a prevention point of view it is better to focus on factors further back along causal chains which put operators in a position where it is possible for them to make critical errors.' Hopkins, 1999, *Lessons from Longford: The Esso Gas Plant Explosion*, Sydney, CCH Australia Limited.

⁷⁶ Newtonian thinking also describes complicated (as opposed to complex) systems, which will be discussed in more detail later in this report.

⁷⁷ Dekker, S & Cilliers, P & Hofmeyr J-H 2011 "The complexity of failure: Implications of complexity theory for safety investigations" *Safety Science* 49.

human, and once the behaviour of each component is understood, the behaviour of the whole system can also be understood. The system is the sum of its parts. Dekker succinctly articulates the issue as the 'functioning or non-functioning of the whole can be explained by the functioning or non-functioning of constituent components.'⁷⁸

The Queensland mining industry is characterised by Newtonian thinking. A clear link between cause and effect, as well as a focus on the components as opposed to the interactions of the system, is apparent in both the Regulator and the mining industry. This Newtonian thinking not only drives how safety is approached by the industry, how it is regulated by the Regulator, but also how the aftermath of incidents are managed from both an investigation and corrective action perspective.

The industry approach to safety appears to be characterised by treating safety as a component in the system. Once this component is in place, there seems to be a view that safety is assured, with negative outcomes being treated as simply a function of someone failing to comply with the component.

A similar Newtonian approach appears evident with respect to investigations by the Regulator—they have a focus on identifying the broken components, and they do not, despite using ICAM, attempt to understand the circumstances that *led to the decisions to compromise safety*. Anecdotal discussions suggest that some mining companies terminate investigations when human error is identified, which reduces the *cause* of the incident to the one component – the human – and prevents an opportunity to identify the system errors that contributed to the failure, as discussed earlier.

In contrast to Newtonian thinking, complex system thinking is very different. Dekker describes how complex behaviour 'arises because of the interaction between the components of a system. It asks us to focus not on individual components but on their relationships. The properties of the system emerge as a result of these interactions; they are not contained within individual components.'⁷⁹ Dekker goes on to say that complex systems 'generate new structures internally, they are not reliant on an external designer. In reaction to changing conditions in the environment, the system has to adjust some of its internal structure. Complexity is a feature of the system, not of components inside of it.'^{80,81}

The system interactions, therefore, are not only critical in complex systems, they define them. Further the 'knowledge of each component is limited and local, and there is no component that possesses enough capacity to represent the complexity of the entire system in that component itself. The behaviour of the system cannot be reduced to the behaviour of the constituent components. If we wish to study such systems, we have to investigate the system as such. It is at this point that reductionist methods fail.'⁸²

⁷⁸ Dekker et al., 2011, *The complexity of failure: Implications of complexity theory for safety investigations*.

⁷⁹ Dekker et al., 2011, *The complexity of failure: Implications of complexity theory for safety investigations*.

⁸⁰ Dekker et al., 2011, *The complexity of failure: Implications of complexity theory for safety investigations*.

⁸¹ At this point it is useful to highlight that a complex system is different to a complicated system. Dekker explains that certain systems 'may be quite intricate and consist of a huge number of parts, e.g. a jet airliner. Nevertheless, it can be taken apart and put together again. Even if such a system cannot practically be understood completely by a single person, it is understandable and describable in principle. This makes them complicated.' In other words, a complicated system is reductionist, it can be reduced to, and understood by, understanding its individual components. And while this system may have a large number of components, the manner in which they interact is well understood and predictable – and they do so because they were designed to do so. A complicated system, however, can *become* a complex system. A jet liner is a complicated system that becomes a complex system when it is placed in service. It is now subject to interaction with outside influences, such as air traffic control, schedule pressures, maintenance issues, human interaction, etc. (Dekker et al., 2011, *The complexity of failure: Implications of complexity theory for safety investigations*).

⁸² Dekker et al., 2011, *The complexity of failure: Implications of complexity theory for safety investigations*.

Exploring this further, it must first be recognised that the interfaces and interactions between components of the system are critical. When it comes to the investigation of failure in complex systems, the reductionist assumption in Newtonian thinking has significant limitations. It typically aims to identify only the individual components that failed, not the interactions that caused the failure. Such investigations will not identify the interface and relational causes⁸³.

Secondly, some properties of the system are classed as *emergent*. In other words, they are not *designed* into the system, but they naturally occur (and emerge) as the system behaves. Research has shown that one such emergent property is safety⁸⁴. For example, take workers on a mine site. The level of actual safety - how safe the mine site is in practice - will *emerge* as a result of the interaction between many components, such as the safety system used on the mine site, production pressures, workplace culture, and outside influences, such as commodity price. Safety procedures will certainly have been *designed* into the system (as components), but the actual practical safety on site cannot be evaluated by examining this safety component in isolation. It can only be ascertained by observing the interaction that emerges between the safety component and the other components of the system.

Take for example how safety can be compromised by a singular focus on production, which is another component of the system. (This production focus can come from both a company or individual worker level.) The safety component itself has not necessarily changed – but its interactions with the production component almost certainly has. Dekker says we ‘used to say that the whole is more than the sum of its parts. Today we would say that the whole has emergent properties.’⁸⁵

While there is no single definition for what makes a system complex, these systems typically exhibit the following characteristics:

- **Emergence:** as discussed above, because of interactions the whole of the system can be more than the sum of its parts. Unanticipated behaviour can *emerge* as part of these interactions,
- **Non-Linearity:** complex systems exhibit non-linear behaviour. There is not always a linear relationship between cause and effect – small causes can produce big effects and combinations of causes can do the same, in some cases because of direct and indirect feedback loops,
- **Open Systems:** they are open systems and they interact with their environment, which means they do not tend towards equilibrium. For example, the mining industry is open: it responds to outside influences, such as the commodity price or actions of the Regulator,
- **Adaptation and Drift:** They are adaptive. They can reorganise themselves naturally. One aspect of adaptation is drift, which will be the subject of the following section.

The mining industry is therefore a complex system. The system is an open system that responds to commodity prices, it has non-linearity and feedback loops, its interactions and internal relationships between components are complex and critical to understanding the system, it displays emergent behaviour, particularly with respect to safety, and it displays drift. It is also driven by organisational complexity, with decentralised and fragmented corporate structures devolving key responsibilities (in practice, but not necessarily from a legislative perspective) to subsidiaries, contractors and subcontractors. Such decentralisation can result in siloed independent businesses with different incentives, procedures and specialties appropriate to their function within the complex system.

While the section that follows will examine how complex systems fail, it is useful to discuss some aspects here. Firstly, a complex system can fail without any of its components failing –

⁸³ ‘Yet simplicity and linearity remain the defining characteristics of the theories we use to explain bad events that emerge from this complexity.’ Dekker, S, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*, Ashgate, Farnham, UK.

⁸⁴ Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.

⁸⁵ Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.

instead the relationships and interfaces between the components can fail⁸⁶. These interactions mean that complexity 'opens up a way for a particular kind of brittleness'⁸⁷. As a result of the interactions, one error or mistake can shatter the system: big effects do not require big causes. Small causes, given the right combinations and interfaces, have the potential to generate big effects because of non-linear behaviour⁸⁸.

Secondly, there are a myriad of unintended behaviours that result from the interactions in the system. For example, research has shown that safety Key Performance Indicators (KPIs) can result in unintended behaviour if not carefully selected. A management focus on reducing LTIs can have the effect of encouraging under-reporting of incidents. Or consider how commodity prices not only drive the hours worked in the industry, but also the contractor/employee mix of hours, which in turn drives the number of HPIs and LTIs reported to the Regulator. Further, many of the fatalities showed significant (and often unintended) interactions between factors across various levels in the mine site, e.g., individual, supervisory and organisational.

The theory of complex systems illustrates that safety cannot simply be *designed* into a system as a standalone and discrete component. It needs to be viewed as a component that interacts with the other components in the system, and not always in a rational or predictable manner. Dekker reminds us that the 'commitment that is called for here is to see safety-critical organizations as complex adaptive systems.'⁸⁹ The section that follows examines how such systems drift into failure.

6.4 Drift into Failure

The concept of *drift into failure* has many features according to Dekker, but for the purposes of this review the following two will be focused on:

1. 'Complex systems can exhibit tendencies to drift into failure because of uncertainty and competition in their environment,'
2. 'Drift occurs in small steps'.⁹⁰

Despite the best of intentions, complex systems can 'gravitate back to a certain level of risk acceptance, even after interventions make it safer.'⁹¹ If applied to the mining industry, this suggests the industry will gravitate towards higher levels of risk acceptance over time, even after intervention by, for example, the Regulator, shareholders or public opinion.

The second point is that drift does not occur in large, easily noticeable steps, but rather small ones, none of which are necessarily undertaken to explicitly accept higher risk. Dekker says that 'each next step is only a small deviation from the previously accepted norm, and continued operational success is relied upon as a guarantee of future safety.'⁹² Central to a drift into failure is that the system is not necessarily making a deliberate decision to accept more risk, rather the acceptance of more risk is simply a natural tendency of systems that are complex⁹³. Drift into failure is not - using a physical example - analogous to someone deliberately loosening a single large bolt that holds the system together, rather it is more akin to numerous individuals

⁸⁶ 'The [system] accident results from the relationships between components (or software and people running them), not from the workings or dysfunction of any component part.' (Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.)

⁸⁷ Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.

⁸⁸ This is often referred to as the butterfly effect, which was a term introduced by Edward Lorenz and his research into weather modelling. Very small changes to initial conditions, can produce very large consequences – just like a butterfly flapping its wings in Brazil and ruffling the air can cause a tornado in Texas.

⁸⁹ Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.

⁹⁰ Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.

⁹¹ Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.

⁹² Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.

⁹³ Near-miss research shows that when human beings become familiar and comfortable with a risk (or deviation) it becomes normalised, i.e., what was once a concern becomes acceptable. Further, rather than this risk or deviation being treated as evidence that the potential for catastrophic failure existed, the near-misses were viewed as supporting the position that catastrophic failure is unlikely. Once deviations are normalised, the opportunity to learn from them is generally lost. This phenomenon is known as Normalisation of Deviance. Tinsley C. H., Dillon R. L. and Madsen P. M. (2011) 'How to Avoid Catastrophe', *Harvard Business Review*, 89 (4).

loosening numerous smaller bolts over time, which eventually results in system failure. Importantly, the loosening of a single bolt would not, in and of itself, cause the system failure, it's the combination that is the issue. To use the language of complexity, this loosening results in the system becoming more *brittle*.

Why take small steps that result in the acceptance of more risk?

One aspect that drives this drift is the inherent tension between safety and a focus on production and efficiency⁹⁴. Dekker summarises the problem as although 'safety is a (stated) priority, operational systems do not exist to be safe. They exist to provide a service or product, to achieve economic gain, to maximize capacity utilization. But still they have to be safe (in some sense, safety, or at least an image of safety, is a precondition for achieving any of the other goals).'

With respect to this tension, it often falls to the individuals to make a practical choice between safety and efficiency⁹⁵. But while it may appear like a simple choice to always prioritise safety, the choice is never quite that explicit⁹⁶. As Dekker says, these 'conflicts are to be negotiated and resolved in the form of thousands of little and larger daily decisions and tradeoffs. These are no longer decisions and trade-offs made by the organization, but by individual operators or crews.'⁹⁷

Take an example of a worker undertaking a routine task. Assume the worker is protected while undertaking this task by a safety system, for example, controls or physical barriers. Imagine the worker identifies a more efficient way to undertake the task at hand. Now imagine the worker, or supervisor, decides to prioritise safety. They examine if the proposed change to the task will compromise safety, but this examination will be usually only be conducted taking into account *local* considerations⁹⁸.

In other words, rather than examining the global repercussions of the change, human nature is to evaluate the appropriateness of the change based on the local information available to the decision maker. Dekker states that 'It is these normal day-to-day processes where we can find the seeds for drifting into failure.'⁹⁹

While discussions with those in the mining industry suggest there are certainly occasions when an individual deliberately acts in a manner that compromises safety, a key point about the above process is that individuals do not necessarily have to wilfully make decisions that result in less safe environments, rather they are making decisions based on improving efficiency, while ensuring safety is maintained relative to local considerations. And the reason these decisions are being made in the first place is because of production drives and/or the normal drive for people to get on with their job¹⁰⁰. Adapted procedures are either formally or informally developed, and as Dekker reminds us 'operational success with such adapted procedures is one of the strongest motivators for doing it again, and again.'¹⁰¹

Once, however, these decisions are made, an organisation begins to drift. And, in typical organisations, this is not just one individual making one decision about one process. A similar

⁹⁴ 'One of the ingredients in almost all stories of drift is a focus on production and efficiency.' (Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.)

⁹⁵ Dekker states that if we want to understand drift into failure 'we have to be particularly interested in how people themselves view these conflicts from inside their operational reality, and how this contrasts with management (and regulator) views of the same activities.' (Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.)

⁹⁶ 'Most important goal conflicts, however, are never made so explicit. Rather, they are left to emerge from multiple irreconcilable directives from different levels and sources, from subtle and tacit pressures, from management or customer reactions to particular trade-offs. Organizations often resort to "conceptual integration, or plainly put, doublespeak.'" [Footnote 33: Dörner, D. (1989). *The logic of failure: Recognizing and avoiding error in complex situations*. Cambridge, MA: Perseus Books.]

⁹⁷ Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.

⁹⁸ "Behavior that is locally efficient, acquired through practice, anchored in the logic of the task, and legitimized through unremarkable repetition." [Footnote 45: Snook, S.A. (2000). *Friendly fire: The accidental shutdown of US Black Hawks over Northern Iraq*. Princeton, NJ: Princeton University Press.]

⁹⁹ Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.

¹⁰⁰ This 'is sustained because of feedback asymmetry: there are immediate and acute productive gains, and little or no feedback about any gathering danger, particularly if the procedure was successful' (Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.)

¹⁰¹ Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.

decision-making process is occurring throughout the organisation¹⁰². This is analogous to all the little bolts gradually being loosened in the system. It is these decisions that cause the drift of the entire organisation.

And if a failure or a fatality occurs, it is these decisions, with the benefit of hindsight, that look like poor decisions and are often blamed for the failure. But these decisions often only look poor with the benefit of hindsight because they resulted in a poor outcome. Dekker says a 'challenge is to understand why assessments and actions that from the outside look like really bad ideas appeared, from the inside, unremarkable, routine, normal, or systematically connected to features of the work environment we have put people in.'¹⁰³

Indeed, not only do these decisions seem unremarkable to the individuals making them, but they are often rewarded for the outcomes because these individuals *got the job done*. And because these decisions result in efficiencies, with no obvious downsides in the short term, this is interpreted as supporting their appropriateness. This is known as the Outcome Bias, which is a tendency for individuals and organisations to observe a successful outcome and assume that the process that led to it was fundamentally sound, even when it wasn't¹⁰⁴. Further, to the individuals involved, these decisions are often viewed as proof of their expertise - resulting in professional pride¹⁰⁵.

Summing up the problem of drift, Dekker says that local decisions 'that made sense at the time given the goals, knowledge and mindset of decision-makers, can cumulatively become a set of socially organized circumstances that make the system more likely to produce a harmful outcome. Locally sensible decisions about balancing safety and productivity – once made and successfully repeated – can eventually grow into unreflective, routine, taken-for-granted-scripts that become part of the worldview that people all over the organization or system bring to their decision problems. Thus, the harmful outcome is not reducible to the acts or decisions by individuals in the system, but a routine by-product of the characteristics of the system itself.'¹⁰⁶,
¹⁰⁷

6.5 Queensland Mining Industry: Drifting into Failure

As discussed earlier, the Queensland mining industry is not a Newtonian System, it is a complex system where interactions between components are important. And it's a system where safety is an emergent property. The safety of a mine site cannot simply be reduced to the attributes of its safety component. Understanding how the safety component interacts with other components is key to understanding how effective safety will be in practice. Production pressures, budget constraints, culture and unions will all interact to govern the safety on site. Drift into failure theory shows that these competing goals, regardless of how often a company stresses that they are committed to safety, will ultimately govern safety on site.

¹⁰² Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.

¹⁰³ Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.

¹⁰⁴ Brady, S 2013 "Near-misses and failure (part 1)" *The Structural Engineer*. London, UK: The Institution of Structural Engineers.

¹⁰⁵ 'In fact, practitioners take their ability to reconcile the irreconcilable as a source of considerable professional pride. In many worlds, it is seen as a strong sign of their expertise and competence.' (Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.)

¹⁰⁶ 'This is the phase, if you will, where "drift" happens. It is characterized by the "accumulation of an unnoticed set of events which are at odds with the accepted beliefs about hazards and the norms for their avoidance.' [footnote 3: Turner B.A, (1978). *Man-made disasters*. London: Wykeham.] (Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.)

¹⁰⁷ Where does this drift end? Just prior to failure it ends at what is known as the edge of chaos. In complexity language the term critical state is often used. At this point the organisation is running at maximum efficiency – the drive for efficiency has brought it to this point – but it is also running at maximum brittleness. All the bolts holding the system together have been loosened sufficiently – all that is now required is something to go wrong. This could be as simple as a lack of good luck, and when it happens all the vulnerabilities that have been built into the system, as a consequence of the drift, become apparent. Once a system is at the edge of chaos a little nudge is all that is required to shatter it. This is known as a phase shift – 'a bit more (or less) of the same leads to something very different.' The consequences are put succinctly by Dekker: 'Drift into failure, in these terms, is about optimizing the system until it is perched on the edge of chaos. There, in that critical state, big, devastating responses to small perturbations become possible. Large events are within the space of possibilities. Drift doesn't necessarily lead to failure. At least not until it does.' (Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.)

Drift into Failure is evident in the Queensland mining industry, at both a macro and micro level. At a macro level, the fatality cycle, as shown in Figure 57, is potentially consistent with a drift into failure.

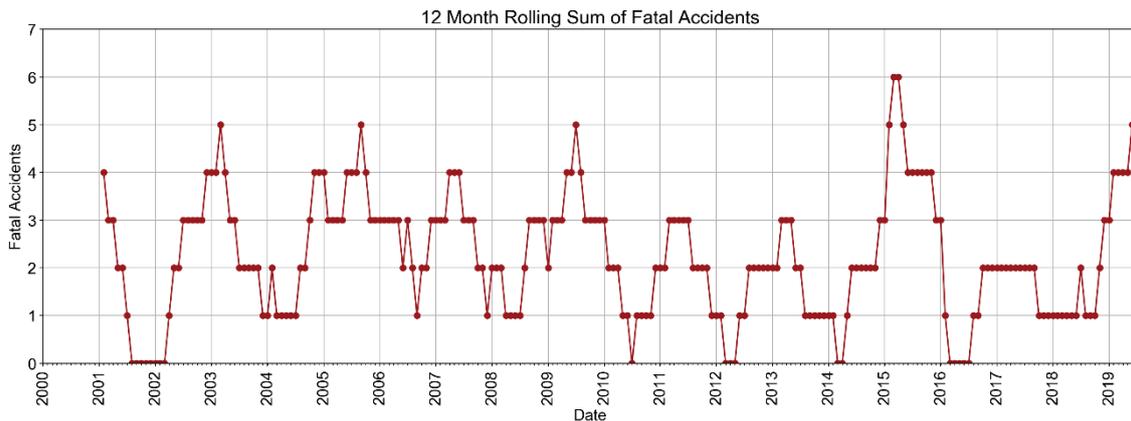


Figure 57 12 month rolling sum of fatalities

When 3 to 6 fatalities occur over a relatively short time period, approximately a year, this prompts the industry to take action, to become more vigilant, to genuinely place safety ahead of production. This increased vigilance is likely to result in more hazard identification, more enforcement of effective controls, ensuring quality supervision, and ensuring workers are well-trained. This period of increased vigilance has the effect of arresting the drift, of making the system less brittle. These measures create a period where few or no fatalities occur, which lasts approximately one year.

Over the course of this year, however, as time elapses since the last group of fatalities, the vigilance gradually decreases because of the tension between safety and production, and the industry, as a whole, begins to drift again. And as this drift reaches a certain point, there occurs not just a single fatality at one mine site, but a number of fatalities across a number of mines over time.

Drift into failure is also evident at a micro level. An analysis of the causal diagrams for individual fatalities show that many of these fatalities are characterised by banal, every-day and straightforward factors, such as a lack of supervision, a lack of training, or a loss of protection. The causative circumstances surrounding many of these failures are consistent with drift, such as the gradual erosion of controls, the adoption of modified procedures to deal with local productivity pressures. Many of these issues would not individually cause a fatality in and of itself, it was the combination of factors that was required.

This is drift, the gradual loosening of individual bolts. It took the combination of these events to expose the brittleness that had drifted into the system. In the words of Dekker 'big, devastating responses to small perturbations become possible.'¹⁰⁸ A number of the fatalities did not involve any form of human error on the part of the deceased, rather were a consequence of a combination of mundane factors that introduced enough brittleness into the system, that when something went wrong, the protections and controls the system should have had in place were eroded to the point that a fatality occurred.

¹⁰⁸ Dekker, 2011, *Drift into Failure: From Hunting Broken Components to Understanding Complex Systems*.

7. MOVING TOWARDS HIGH RELIABILITY ORGANISATIONAL STATUS

7.1 Introduction

The 1999 legislation has made significant progress in making the industry safer. Since its introduction there have been no multiple fatality disasters and the overall rate of fatalities per year has reduced. Whether or not these improvements are due solely to the introduction of the legislation, or involve other factors, such as advances in technology, is difficult to say, but despite this progress, the current approach has not been sufficient to reduce the fatality rate to zero.

One hypothesis consistent with a failure to reduce this rate is that the industry is experiencing cycles of drifting into failure. In other words, while the 1999 legislation has the potential to reduce the rate to zero, drift occurs and it rises again. Then a significant number of fatalities occur and the drift appears to be arrested, potentially because the industry tightens up all the small bolts that have loosened over time.

The challenge now facing the industry is to prevent this drift to failure over the long term. Further steps will be required - the industry is ill equipped to meet the challenge using only the philosophies and methodologies utilised over the past 19 ½ years. These further steps should, however, build upon the practices introduced by the 1999 legislation, which resulted in gains that must not be lost.

These next steps should, therefore, focus on *arresting* the drift and maintaining vigilance. But they will be challenging. They will come at a financial cost and will require both industry and the Regulator to ensure it has teams with the appropriate competency to identify the signs of drift before they occur.

But perhaps one of the biggest stumbling blocks is how the mining industry views itself. Mining *is* a hazardous industry, but that doesn't mean that workers and their families must continue to suffer the consequences of these hazards. An illustrative comparison can be made with the airline industry – the general public *expect* air travel to be safe, despite it having to cope with significant hazards¹⁰⁹. By contrast, both the mining industry and the general public appear to *expect* mining to be dangerous¹¹⁰. This fatalism may be the biggest stumbling block to preventing the industry taking the next step.

And the next step is for the mining industry, as a whole, to adopt the practices of High Reliability Organisations. This section introduces the principles of High Reliability Organisations, illustrates how the Queensland mining industry falls short of achieving High Reliability Organisational status, and discusses the practical steps that need to occur in order to move towards it.

¹⁰⁹ There have been 2 fatalities in Australian regular public transport (commercial air transport) since the 2008/09 financial year, and in the same period these flights have carried over 600 million passengers (https://www.bitre.gov.au/publications/ongoing/domestic_airline_activity-time_series & https://www.atsb.gov.au/media/5776642/ar-2018-030_final.pdf).

¹¹⁰ Put another way, it could be argued that the risk tolerance for fatalities and Serious Accidents is too high.

7.2 What is a High Reliability Organisation?

Professor Andrew Hopkins introduces the theory of High Reliability Organisations (HROs) in *Learning from High Reliability Organisations*¹¹¹. The concept of HROs was first developed in the 1980s at the University of California. Three organisations were of interest to the researchers because they experienced very few disasters or failures, despite conducting activities that were considered complex and hazardous¹¹². Hopkins points out that, in terms of accident record, the major Australian airlines can claim to be HROs.

One of the core aspects of HRO theory is that it considers a safety culture to be a reporting culture. And this safety culture is based upon the organisation's practices, not the attitudes or mindsets of individuals working for the organisation. HRO theory does not isolate human error as the sole cause, and it acknowledges that human error is both inevitable and is the *least controllable* aspect of managing safety hazards.

Hopkins discusses how difficult it is to provide a concise and singular definition for a HRO. For example, what is the best way to statistically define 'near accident-free performance'? Hopkins also points out that attempting to use an organisation's performance record is problematic – operations can have high performance, but also be unsafe.

Hopkins considers that the most useful way to define a HRO is to assess whether or not it exhibits five key characteristics¹¹³. These key characteristics were developed by Karl Weick and Kathleen Sutcliffe and are defined as:

1. Preoccupation with failures rather than successes,
2. Reluctance to simplify interpretations,
3. Sensitivity to operations,
4. Commitment to resilience, and
5. Deference to expertise.

Weick argues that, taken together, these processes 'produce a collective state of mindfulness'.¹¹⁴ The first two will be discussed in detail because they are key to the observations of this review, but further details on the remaining characteristics can be found in Hopkins's text¹¹⁵.

7.3 Preoccupation with Failures Rather than Successes

Hopkins points out that HROs understand that long periods of success breed complacency¹¹⁶. Consequently, they are wary of success because they understand that their system will drift over time towards higher levels of risk acceptance in the absence of incidents. The same drift is evident in the Queensland mining industry's fatality cycle, periods where few to no fatalities occur should not be viewed as evidence of the system getting safer in the long term.

Hopkins, and many other authors, describe a HRO's preoccupation with failure as *chronic unease*.

¹¹¹ Hopkins, 2009, *Learning from high reliability organisations*, Sydney, CCH Australia Limited.

¹¹² Three separate organisations were examined as part of this research: the United States Federal Aviation Administration's air traffic control (ATC) system; a company operating a nuclear power plant and electricity distribution system; and the US Navy's nuclear aircraft carrier operations.

¹¹³ Hopkins, 2009, *Learning from high reliability organisations*, Sydney, CCH Australia Limited.

¹¹⁴ Hopkins, 2009, *Learning from high reliability organisations*, Sydney, CCH Australia Limited.

¹¹⁵ Sensitivity to Operations, Commitment to Resilience & Deference to Expertise are not discussed further in any more detail in this review.

¹¹⁶ Hopkins, 2009, *Learning from high reliability organisations*, Sydney, CCH Australia Limited.

It is this chronic unease that actively prevents drift by striving to identify the early warning signs of disasters. HROs have an obsession with the reporting of minor incidents and near misses, there is a focus on their analysis, and an active use of this information to remove the hazards before they do harm. As Hopkins puts it, HROs believe 'errors and other small failures amount to warnings of danger, indicators of how things might be about to go disastrously wrong. HROs are alert to the warnings of danger and operate on the basis that if warnings are identified and acted upon, disaster can be averted.'¹¹⁷

While there is a theoretical focus in the Queensland mining industry on the identification and controlling of hazards, the findings of this review suggest that the industry, in general, falls short in practice. Chronic unease is not evident.

Firstly, the HPI Frequency Rate of 1.4 HPIs per person per 30-year career appears inconsistent with the experiences described by those in the industry. This is not to suggest that a higher number of HPI type incidents occurring is a good thing, rather it is suggesting that the number of incidents that have the characteristics of HPIs are probably occurring more frequently in practice *anyway* - but they are simply going unreported. Every unreported HPI should be considered both a learning opportunity wasted and a hazard left in play, waiting to cause an incident at some point in the future. HPI reporting must be encouraged, it is one of the most useful and practical early warning systems available to the industry. This is further supported by the finding that a failure to identify the hazard was present in a very significant number of both HPIs and Serious Accidents.

Secondly, the low percentage of hard controls, combined with a large percentage of administrative controls, put in place after an incident is concerning. If it is representative of how the industry responds to incidents in practice, it suggests the industry is not proactively engaged in controlling hazards. Many may question the basis for making this statement, but it is difficult to sustain the argument that the industry *is* actively engaged in effective hazard control when in the order of only 25% of HPIs are responded to with elimination, substitution, isolation and engineering controls – the most effective controls available. This leaves in the order of 50% of the remaining HPIs being managed with administrative controls alone, which, while having their place in the industry, are among some of the least effective controls¹¹⁸.

Industry may attempt to mount an argument that these administrative controls, despite being among the least effective controls available, are *effective enough*. An assessment on their effectiveness, however, suggests this is not the case. The Serious Accident Frequency Rate has risen over the last 5 years. This rising rate is confirmation that the industry is becoming more harmful – a worker is more likely to require admission to hospital for treatment of an injury than they were 5 years ago¹¹⁹. Further, an analysis of the incident data looking at absent or ineffective controls (see Section 4), shows that the role of ineffective controls in Serious Accidents has risen. These factors are the basis for arguing that the industry must begin to move towards the use of more effective controls.

This review suggests that the Queensland mining industry, as a whole, has an unenviable position when it comes to identifying and responding to hazards and issues:

- HROs are *proactive* in seeking out the hazards before they occur, and controlling them,
- Some industries are *reactive* with respect to identifying hazards, and when these hazards become apparent, they implement effective controls,
- Then there is the Queensland mining industry, which, as a whole, is reactive with respect to identifying hazards. Even when hazards are identified, a significant percentage of them are addressed with the least effective controls available.

In order to move towards becoming a HRO, the Queensland mining industry will need to develop, as Hopkins says, a preoccupation with failure. A key step moving forward will be to focus on the identification of hazards and their effective control.

¹¹⁷ Hopkins, 2009, *Learning from high reliability organisations*, Sydney, CCH Australia Limited.

¹¹⁸ One can argue that the apparent default use of administrative controls in and of itself is a form of drift. While their use gives the impression that the risk is managed, they are the easiest controls for workers ignore.

¹¹⁹ The Serious Accident Rate as a safety indicator is discussed in a later section.

7.4 Reluctance to Simplify Interpretations

In all industries there is a tendency to simplify – in part because of a Newtonian drive to break a system into components.

As discussed earlier, a superficial examination of the fatalities would suggest that many were freak accidents – accidents both difficult to anticipate and protect from. This is not only a simplistic interpretation, but it also fails to highlight the system failures that took place to cause these fatalities. It also drives fatalism: it suggests that fatalities are simply a normal part of the mining industry, and nothing more can be done to prevent them.

An analysis of the causal diagrams, however, illustrated a much more nuanced picture. Many fatalities were caused by a combination of banal, commonplace, everyday factors, that combined in such a way to cause a fatality. The majority were not caused by human error alone - a large number involved failures of controls, training and supervision. These were the system causes. They were the natural loosening of many small bolts, none of which in and of themselves would have been likely to cause a fatality. Counterintuitively, fatalities do not require big causes.

This is the essence of drift, and it is these factors that the industry must strive to identify and interpret before they cause harm. And this will be challenging. Many of these early warnings, particularly in the cases of fatalities, do not necessarily result in injuries or indeed have any apparent negative outcomes. For example, a failure to wear a seatbelt may not cause an injury, unless an incident occurs, in which case that incident may be serious or fatal. If an organisation focuses on LTI reporting to identify these precursors to fatalities, they may not identify them.

A key message is that the findings of incident investigations, particularly internal investigations, should not be oversimplified and miss the real lessons from the incident. Internal investigations by mining companies should ensure that they avoid the tendency to blame the incident solely on human error, and not investigate the other (system) causes. If this is widespread practice, then the key lessons from each incident are being lost. Humans are fallible, and if the system failure is not identified and the hazard removed or effectively controlled, then there is the potential for another person to trigger a similar incident in the future.

The key to identifying early warning signs and avoiding simplification is, as Hopkins states, to 'employ more people whose job it is to explore complexity and to double-check on claims of competency and success.'¹²⁰ In other words, the industry and the Regulator needs to ensure they have teams with the appropriate competency whose sole job it is to actively explore what is leading to incidents. This will come at both a financial and intellectual cost.

For industry this means ensuring that internal incident investigations are not reduced to simple causes, such as human error. There must also be a focus on the active identification of hazards, combined with careful monitoring of early warning signs, particularly when the system appears to be working well.

For the Regulator, it should play a key role in collating, analysing, identifying, and proactively disseminating the lessons learned from the incident and fatality data it collects from industry. The Regulator is ideally placed for such a role – they have access to industrywide information in the form of incidents, as well as significant detail pertaining to each fatality. They should play a key role in trend identification, analysis and the dissemination of best practice. This, however, has been a role that the Regulator has not been entirely comfortable with to date. While it is changing, there appears to have been a reluctance to publish detailed incident and fatality information to the industry in the past. Typically information has been released in the form of bulletins and statistics in the annual report.

In order to move towards HRO status, the industry will have to strive to understand the causes of incidents and fatalities. The review of the causal diagrams indicates this is not necessarily a simple task. The majority of fatalities are due to the slow unbolting of the organisation as it drifts towards failure.

¹²⁰ Hopkins, 2009, *Learning from high reliability organisations*, Sydney, CCH Australia Limited.

7.5 Reporting in HROs

Hopkins stresses that when an industry or an organisation is focused on identifying the early warnings signs of future catastrophes, the encouragement of incident reporting is critical. He stresses that the objective is not necessarily to drive up the reporting of injuries, but to drive up the reporting of events that highlight when certain hazards are not adequately under control. In other words, to identify ineffective controls. He also emphasises the importance of the quality of reports, not the quantity, and the fact that it is a real challenge to ensure people report.

Central to this objective is a good reporting culture. Hopkins cites James Reason: 'a safety culture is a reporting culture in which people are prepared to report errors, near misses, unsafe conditions, inappropriate procedures, and any other concerns they may have about safety.'¹²¹

The remainder of this section explores how the Queensland mining industry can develop an appropriate reporting culture. It will focus on the existing measures of LTIs, Serious Accidents, and HPIs.

7.6 The Problem with LTIs

The LTI Frequency Rate (or LTIFR) is one of the key safety indicators used in the mining industry. The industry is considered safer the lower the rate. This measure, however, has significant limitations, despite its widespread use. Fundamentally, this rate 'becomes a measure of how well injuries are being managed, not how safely the organisation is performing'¹²². For example, 'claims and injury management can reduce the LTIFR substantially without any corresponding improvement in safety.'¹²³ Hopkins goes on to say that LTI reporting may be distorted by factors such as individuals being brought back to work before they fully recover or individuals placed on lighter duties.¹²⁴

Unlike Serious Accidents, which will be discussed in the following sections, LTIs can be prone to manipulation. One of the reasons they are manipulated is because they are often incentivised. As Hopkins argues 'LTI's are so heavily relied on as they form part of the annual performance targets for management and organisations as a whole, incentivising individuals and the organisation to drive LTI rates down to secure bonuses and as an arbitrary metric to promote company safety reputation. In converse, continuously monitoring systems and procedures for early warning signs of future adverse consequences, which do not cause LTIs, cannot be measured on an annual basis.'¹²⁵

Based on the overarching view of the literature, as well as discussions with those in the mining industry, the LTI Frequency Rate is considered a poor measure for monitoring safety. This view is further supported by the analysis of the fatality causal diagrams, which illustrate that many of the causal factors would not have caused injuries prior to the fatality. Therefore, they would not be recorded as LTIs, with them remaining unidentified as issues. At best the LTI Frequency Rate is a distraction that focuses industry on the wrong safety measure, at worst it results in early warning signs being missed.

¹²¹ Hopkins, 2009, *Learning from high reliability organisations*, Sydney, CCH Australia Limited.

¹²² Hopkins, A 2000, *Managing Major Hazards: the Lessons of the Moura Mine Disaster*, Sydney, CCH Australia Limited.

¹²³ Hopkins, A 2000, *Managing Major Hazards: the Lessons of the Moura Mine Disaster*, Sydney, CCH Australia Limited.

¹²⁴ Hopkins, A 2000, *Managing Major Hazards: the Lessons of the Moura Mine Disaster*, Sydney, CCH Australia Limited.

¹²⁵ Hopkins, A & Maslen S 2015, *Risky Rewards: How Company Bonuses Affect Safety*, Ashgate, Farnham, UK.

7.7 Selection of a Safety Indicator

As the LTI Frequency Rate is a poor measure of the level of safety in the industry, it is important that a more representative safety indicator be selected. The selection of a safety indicator is important because it provides an objective measure, both for the Regulator and industry, for whether the industry is getting more or less harmful. Excluding LTIs, a safety indicator could be selected from HPIs, Serious Accidents and fatalities.

Selection of the appropriate indicator, however, is not as straightforward as it would appear. To illustrate why this is the case, Hopkins relates the story of how Airservices Australia resolved the issue in their industry. Initially, they selected the number of air traffic control-attributable incidents per 100,000 aircraft movements as their safety indicator. They took the view that if this number was increasing, then the industry was becoming less safe. They also set a 2.5% annual reduction target for this indicator for each air traffic controller subgroup. In other words, they wanted to drive this indicator downwards.

But this approach created a problem: their indicator numbers sometimes dramatically increased. For example, their 2005/2006 annual report showed the incidents reported by tower controllers increasing by 300% over the previous 5 years. Airservices then realised that this safety indicator was not a true measure of the level of safety in the industry, instead it was a measure of the level of reporting¹²⁶. And they recognised this as a good thing because it provided an opportunity to remove hazards before they could cause harm. But it also presented a problem: as Hopkins puts it, 'an organisation that seeks to encourage reporting cannot at the same time treat the number of such reports as a performance indicator to be driven downwards.'¹²⁷

This is the core challenge that the Regulator faces¹²⁸. How does it encourage incident reporting, while at the same time identifying a meaningful safety indicator?

While it is tempting to select the Fatality Frequency Rate as the safety indicator, this is problematic for a number of reasons. Firstly, it is not a lead indicator – the negative outcome has just occurred. Secondly the fatality cycle evident suggests that while the number of fatalities can decrease in the short term, they are also likely to increase in the medium term.

Serious Accidents can be selected as the safety indicator. As discussed, Serious Accidents are defined as incidents that result in a fatality or incidents where an individual requires admission to hospital for treatment of their injury, and is a frontline indicator of the general level of safety in the industry. An increase in the Serious Accident Frequency Rate indicates that the industry has become less safe.

The selection of the Serious Accident Frequency Rate as a safety indicator has a critical attribute. It is considerably less susceptible to the quality of the industry's reporting culture, and is therefore a better measure of level of safety in the industry. The Serious Accident Frequency Rate is less susceptible to manipulation in reporting for the following reasons:

- a) **Unambiguous:** it is an unambiguous measure and not open to multiple or conflicting interpretations. A person is either admitted to hospital or they are not. It is not a matter of opinion, nor is the context in which the incident happens relevant,
- b) **Transparent:** the decision of whether or not an incident is a Serious Accident is typically made by a medical practitioner based on their expertise and experience. Therefore, the decision lies with an individual who is unconnected with either the injured party or the company they work for,
- c) **Target for Reduction:** the selection of Serious Accidents as the safety indicator also provides the Regulator with an indicator that can be targeted for reduction without the risk of compromising a culture of reporting in the industry. This is only possible because Serious Accident reporting is largely unrelated to the prevailing reporting culture.

¹²⁶ Hopkins says that Airservices viewed these increases 'as a reflection of an organisational culture which recognises that submission of information about the smallest deviations can assist in identifying strategies to prevent high risk occurrences. We therefore see the positive cultural driver as a major factor in two traffic segments failing to meet the target for the 2005/2006 financial year.' (Hopkins, 2009, *Learning from high reliability organisations*, Sydney, CCH Australia Limited)

¹²⁷ Hopkins, A 2009, *Learning from High Reliability Organisations*, Sydney, CCH Australia Limited.

¹²⁸ It is the Regulator that should select the appropriate safety indicator.

The fact that a third-party, i.e., a medical practitioner, makes the decision on what constitutes a Serious Accident also provides an opportunity to further improve the accuracy of the Serious Accident reporting. Work by Hopkins and others recognises that, despite the high level of awareness of the importance of incident reporting in some industries, the tendency to under-report is still an issue. To address this Hopkins highlights the importance of dual, but independent, reporting systems. As an example, he highlights the systems used by air traffic controllers and pilots. If an incident occurs, both the air traffic controller and the pilot are required to report the incident, and they are required to report it in two independent systems. This means that if, for example, an air traffic controller is the cause of an incident and is reluctant to report it, they know that the pilot *will* report it in a separate system. This will highlight a lack of reporting on the part of the air traffic controller.

Based on this approach there is the potential opportunity for the Regulator to consider a redundant reporting system. For example, can hospitals that admit mining industry incident victims also report the admission in an entirely separate system to the mine? If such a system were to exist, and it was automatically cross-referenced with the Regulator's Serious Accident reporting system, then this may provide further confidence in the integrity of the data received¹²⁹. Hopkins stresses the importance of multiple watchers to ensure effective reporting.

Therefore, the Serious Accident Frequency Rate provides what is perhaps the best measure of the true level of safety in the industry. It captures the serious injuries sustained by individuals, its definition is unambiguous, and it provides a measure to be driven downwards.

7.8 The Role of HPIs

If the Regulator selects the Serious Accident Frequent Rate, a rate that can be driven downwards, then what is the role of HPIs?

The Regulator should adopt the view expressed by Hopkins that a safety culture is first and foremost a reporting culture. Therefore, the honest and accurate reporting of HPIs by the wider industry, and the encouragement to do so, should be of paramount importance. As has been discussed many times in this report, hazards (incidents) that are identified, reported and controlled/removed are no longer present to cause harm at a later date¹³⁰.

This benefit alone is why the Regulator should not consider HPIs to be a safety indicator. A safety indicator exists to be driven downwards, and the Regulator should not do anything that encourages driving down HPI reporting.

7.9 Summary

In order to reduce the fatalities in the Queensland mining industry it will be necessary to build on the progress that resulted from the introduction of the 1999 legislation. The way forward is for the industry to move towards becoming a HRO, particularly with respect to identifying and controlling hazards, two areas identified in this review as causing incidents.

Moving towards HRO status is not a trivial exercise – it will come at both a financial and intellectual cost, and it will likely require the addition of new competencies to both the industry and the Regulator. Hopkins stresses this is a matter of organisational design. Industry needs to ensure that it identifies all of the precursors to Serious Accidents and fatalities before they occur, and then apply more effective controls to prevent these hazards causing harm. The Regulator needs to encourage the reporting of HPIs, followed by the analysis of these incidents and the dissemination of the findings to the industry at large.

¹²⁹ This does not, of course, address the issue of potential under-reporting due to individuals actively trying to avoid hospital admissions - anecdotally a number of these types of scenarios have been brought to the Regulator's attention.

¹³⁰ With this in mind, the Regulator should identify HPIs that they consider of critical importance for safety in the industry and consider defining them specifically. For example, Hopkins discussed how Airservices Australia has a reporting system that specifies 18 immediately reportable matters – these include, for example, breakdown of separation incidents for aircraft or if a pilot experiences difficulties in controlling an aircraft.

8. CONCLUSIONS & RECOMMENDATIONS¹³¹

Recommendation 1: The industry should recognise that it has a fatality cycle. Unless it makes significant changes to how it operates, the rate of fatalities is likely to continue at current levels. This pattern has been evident over the past 19½ years and is characterised by periods where a significant number of fatalities occur, followed by periods where there are few to none. This suggests that the industry goes through periods of increasing and decreasing vigilance. Past behaviour suggests that in the order of 12 fatalities are likely to occur over any 5 year period.

If the industry continues to take a similar approach to safety, using the same philosophies and methodologies adopted over the past 19½ years, then similar safety outcomes are to be expected.

The cycle further suggests that the periods with few to no fatalities should be viewed as simply part of the fatality cycle – they are not evidence of the industry becoming safer over the long term. Instead, further fatalities should be expected as the cycle continues. This may appear a bleak prediction, but this cycle has proven surprisingly resilient over the past 19½ years.

The 6 fatalities that occurred between July 2018 and July 2019 have been described by some in the industry, media and politics as evidence of an industry in crisis, but a bleaker assessment is that this is an industry resetting itself to its *normal* fatality rate.

Perhaps one of the biggest stumbling blocks to reducing the number of fatalities is how the mining industry views itself. Mining *is* a hazardous industry, but that doesn't mean that workers and their families must continue to suffer the consequences of these hazards. An illustrative comparison can be made with the airline industry – the general public *expect* air travel to be safe, despite it having to cope with significant hazards. By contrast, both the mining industry and the general public appear to *expect* mining to be dangerous. This fatalism may be the biggest stumbling block to preventing the industry taking the next step.

Recommendation 2: The industry should recognise that the causes of fatalities are typically a combination of banal, everyday, straightforward factors, such as a failure of controls, a lack of training, and/or absent or inadequate supervision. Internal incident investigations in mining companies must strive to capture these combinations of causal factors, and avoid simplifying them to a single cause, such as human error, bad luck or freak accidents, which has the potential to mask the underlying system failures. Recommendations 3 to 5 cover the key causal factors identified in this review.

A superficial examination of the causes of the 47 fatalities analysed as part of this review gives the impression that many were freak accidents, that events transpired in such a way that could never have been anticipated. This impression can inspire fatalism: *how can we possibly protect workers against such freak accidents?* It can reinforce the notion that mining *is* a hazardous industry and fatalities simply cannot be avoided.

However, the majority of fatalities were not freak accidents. Many were preventable, and there was rarely a single significant cause. This is likely to be an uncomfortable finding for many: there is a tendency to assume that bad outcomes must have equally bad causes – when a fatality occurs, it must have a particularly sinister cause. This is not the case – there were few smoking guns.

At a practical level, a large number of the fatalities involved a mine worker in a situation that they were inadequately trained for, with the controls meant to prevent harm being ineffective, unenforced or absent, with no or inadequate supervision to identify and remedy these shortfalls. It then took an initiating event, e.g., in the form of a freak incident or bad luck, to result in a fatality.

Almost all of the fatalities were the result of systemic, organisational, supervision or training failures, either with or without the presence of human error. Human error alone would not have caused these fatalities. 17 involved no human error *at all* on the part of the deceased.

¹³¹ The Conclusions and Recommendations are identical to that presented in the Executive Summary.

There were 10 incidents involving known faults, where individuals were aware of them, but no action was taken. 9 fatalities had known near misses occur prior to the fatality. In some cases, prior fatalities had occurred in a similar manner.

Recommendation 3: The industry needs to focus on ensuring workers are appropriately trained for the specific tasks they are undertaking.

A total of 17 of the 47 fatalities involved a lack of task specific training and/or competencies for the tasks being undertaken. A further 9 had inadequate training. These tasks were often undertaken at the direction of supervisors or others who were aware of these deficiencies.

In many cases this lack of training resulted in the worker being unaware of the hazards involved in completing the task or the worker operating equipment in a manner that exposed them to hazards.

Recommendation 4: The industry needs to focus on ensuring workers are appropriately supervised for the tasks they are undertaking.

In 32 of the 47 fatalities, the worker was required to be supervised when undertaking the task, i.e., the 32 did not include routine tasks, such as driving. 25 of these 32 fatalities involved inadequate or absent supervision.

17 of the fatalities involved a lack of training or inadequate training for the specific task being undertaken and inadequate or absent supervision.

Not only does absent or inadequate supervision allow tasks to be approached in an unsafe manner, but it also greatly amplifies the consequences of a lack of training or ineffective or unenforced controls.

Recommendation 5: The industry needs to focus on ensuring the effectiveness and enforcement of controls to manage hazards. Given the increasing Serious Accident Frequency Rate, industry should implement more effective controls (such as elimination, substitution, isolation, or engineering controls). A significant number of the controls reported put in place in the aftermath of an incident were administrative in nature.

The majority of the 47 fatalities involved at least one failed or absent control that could have prevented the fatality. The underlying factors for these absent controls often stemmed from decisions made at a supervisory and/or organisational level in organisations.

In recent years, the role played by ineffective controls in incidents, including Serious Accidents, is increasing.

In addition, the reported corrective actions put in place in the aftermath of Serious Accidents – incidents with a demonstrated capability to require hospital admission for treatment – were in 62% of the cases administrative controls only. Administrative controls, despite having their place in the industry, are some of the least effective controls available.

Recommendation 6: The industry should adopt the principles of High Reliability Organisational theory in order to reduce the rate of Serious Accidents and fatalities. At its most fundamental level, High Reliability Organisational theory focuses on identifying the incidents that are the precursors to larger failures and uses this information to prevent these failures occurring. Adopting a High Reliability Organisation approach will require the refinement or addition of specific competencies to both the mining industry and the Regulator.

Drift into failure, where the industry exhibits a greater acceptance of risk over time, is potentially evident in the Queensland mining industry at both a macro and micro level.

While the 1999 legislation has made significant progress in making the industry safer, despite this progress, the current approach has not been sufficient to reduce the fatality rate to zero in the long term.

No single change to the mining industry will reduce this rate, what is instead required is a change in approach to how the industry identifies and controls hazards, as well as how it recognises and addresses them when these controls are eroding or ineffective.

A High Reliability Organisation, or HRO, understands that periods of success breed complacency, which can lead to failures and fatalities. Periods where there are few to no

fatalities are typically periods where a drift into failure occurs. Safety is compromised for a variety of reasons, often benign, over time. These compromises typically result in a series of minor near-miss incidents.

HROs actively seek out these near-miss signals, which are typically the precursors to failure. HROs believe that these signals provide an opportunity to identify and act on existing hazards in order to remove them from the workplace. This is the key step that helps prevent the drift into failure.

Many of the recommendations that follow flow directly from HRO theory.

This will require the industry to develop a dedicated group with the appropriate competencies whose role it is to collate, categorise, actively search and identify concerning trends in incident data.

Recommendation 7: In order to proactively assist the mining industry to operate more like High Reliability Organisations, the Regulator should play a key role in collating, analysing, identifying, and proactively disseminating the lessons learned from the incident and fatality data it collects from the industry.

Central to the concept of a HRO is that incident information can be actively used as a preventative tool to educate the wider industry. The Regulator is in a critical position to fulfil this role due to its centralised access to industry wide incident data.

The identification of developing incident trends and the timely dissemination of this information to industry, coupled with inspections and audits aimed at ensuring the wider industry is engaging and responding to this information will be critical in fatality prevention.

This will require the Regulator to develop a dedicated group with the appropriate competencies whose role it is to collate, categorise, actively search and identify concerning trends in incident data for the industry.

Recommendation 8: The Regulator should develop a new and greatly simplified incident reporting system that is easy to use by those in the field, that is unambiguous, and that aims to encourage open reporting, rather than be an administrative burden to reporting.

The current reporting system is a product of evolution over the past 19½ years, rather than a system designed to take advantage of current technology. Due to its evolutionary nature, it is cumbersome, ambiguous, and difficult for the industry to use.

In order for the Regulator to play a central role in collating and analysing data, they must develop a system that maximises the probability of incident reporting. In HROs there is no such thing as a safety culture, rather there is a reporting culture. Currently, the data suggests under-reporting of incidents is occurring, and steps to address this issue are required.

The Regulator should develop a new system to address these shortcomings. While this review does not intend to set out the specific details of such a system, it should be in line with modern mobile technology, preferably app based, and the Regulator should ensure that the administrative burden of reporting is minimised, e.g., consider allowing the industry to report the incident in text based form, which reduces the need to fill in fields and categories pertaining to the incident.

The Regulator should also consider the development of a dual reporting system to discourage potential under-reporting of incidents. The role of this dual system is to ensure that two reports, by separate individuals/companies/institutions, are submitted to the Regulator. For example, if a person is admitted to a hospital for treatment, i.e., a Serious Accident, then the hospital can make an independent report, which should be cross-checked to ensure the mine site also provided a report of the incident.

It should also be accepted that there will be an inevitable tension between the need to capture comprehensive information on an incident, while at the same time avoiding the discouragement of reporting due to the volume of information required.

Recommendation 9: The industry should shift its focus from Lost Time Injuries (LTIs) and the Lost Time Injury Frequency Rate (LTIFR) as a safety indicator.

LTIs as a safety indicator are problematic. LTIs are prone to manipulation, are a measure of how the industry manages injuries after they have occurred, as opposed to a measure of industry safety. It is possible, therefore, to reduce the LTIFR without making the industry safer.

Further, an analysis of the fatalities shows that many of the causal factors would not have caused injuries prior to the fatality. Therefore, they would not be recorded as LTIs, with them remaining unidentified as issues. At best the LTI Frequency Rate is a distraction that focuses industry on the wrong safety measure, at worst it results in early warning signs being missed.

Recommendation 10: The Regulator should adopt the Serious Accident Frequency Rate as a measure of safety in the industry.

Selecting a metric for determining if the mining industry is getting more or less safe is challenging. This metric must be both a true reflection of safety in the industry, as well as a metric that is not easily manipulated.

Therefore, it is recommended that the Serious Accident Frequency Rate be selected as the appropriate metric. There are a number of reasons for this selection:

- Apart from the fatality rate, the Serious Accident Frequency Rate is a genuine reflection of how many people are getting seriously injured to require admission to hospital for treatment,
- The Serious Accident Frequency Rate is least likely to be susceptible to both conscious and subconscious manipulation. To qualify as a Serious Accident, determination of a 3rd party from the medical profession is required.

Recommendation 11: The Regulator should adopt the High Potential Incident Frequency Rate as a measure of reporting culture in the industry.

Rather than viewing the High Potential Incident Frequency Rate as a measure of the level of safety in the industry, it should be viewed as a measure of the reporting culture.

High Potential Incident reporting should be encouraged in order to better ensure early warning signals of impending incidents and fatalities are captured and disseminated to the wider industry. This provides the best opportunity to identify hazards before they cause harm and ensure they are effectively controlled.

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APPENDIX A

Explanation of Industry Roles

Introduction

This appendix sets out the various roles and obligations of those roles for the Queensland Mining Industry¹.

The Role of the Mine Operator

An operator for a mine has legislated obligations, which are broadly similar for coal mines² and mineral mines and quarries³. These include obligations to:

- Ensure risk to mine workers is at an acceptable level,
- Ensure their method of operating does not affect their own and others' safety and health,
- Appoint a site senior executive (SSE) for the mine and ensure the SSE,
 - i. Develops and implements a safety and health management system for the mine,
 - ii. Develops, implements and maintains a management structure for the mine that helps ensure the safety and health of persons at the mine,
- Audit and review the effectiveness and implementation of the safety and health management system to ensure the risks to persons from coal mining operations are at an acceptable level,
- Provide adequate resources to ensure the implementation and effectiveness of the safety and health management system.

The mine operator has an obligation not to operate the mine without a safety and health management system for that mine (unless it is an opal or gem mine with 4 or fewer workers).

The Role of the Site Senior Executive

The site senior executive (SSE) for a mine is the most senior officer employed by the mine operator, who is located at or near the mine, and has responsibility for the mine.

An SSE for a mine has obligations in relation to the safety and health of persons who may be affected by mining operations. Obligations for SSEs are broadly the same across coal mines⁴ and mineral mines and quarries⁵. They include obligations to:

- Ensure the risk to persons from mining operations is at an acceptable level,
- Ensure the risk to persons from any plant or substance provided by the site senior executive for the performance of work is at an acceptable level,
- Develop and implement a safety and health management system (SHMS) for all persons at the mine, including contractors and service providers,
- Give a contractor or service provider at the mine information in the SSE's possession about all relevant components of the mine's SHMS, so that the contractor or service provider may comply with their obligations to:
 - i. Identify risks arising in relation to any work to be undertaken by the contractor at the mine, and

¹ Details provided by the DNRME.

² Section 41 of the *Coal Mining Safety and Health Act 1999* (Qld).

³ Section 38 of the *Mining and Quarrying Safety and Health Act 1999* (Qld).

⁴ Section 42 of the *Coal Mining Safety and Health Act 1999* (Qld).

⁵ Section 39 of the *Mining and Quarrying Safety and Health Act 1999* (Qld).

- ii. Ensure no work is undertaken by the contractor until the contractor has given the SSE a safety and health management plan and has made all changes required by the SSE to enable the plan to be integrated into the SHMS for the mine,
- Review safety and health management plans of contractors and service providers and, if necessary, require changes to be made to those plans to enable them to be integrated with the mine's SHMS,
- Develop, implement and maintain a management structure for the mine that helps ensure the safety and health of persons at the mine,
- Ensure no work is undertaken by a mine worker at the mine until the worker:
 - i. Has been inducted in the mine's SHMS to the extent it relates to the work to be undertaken by the worker,
 - ii. Has received training about hazards and risks at the mine to the extent they relate to the work to be undertaken by the worker, and
 - iii. Has received training so the worker is competent to perform the worker's duties.
- Provide for:
 - i. Adequate planning, organisation, leadership and control of mining operations,
 - ii. The carrying out of critical work at the mine that requires particular technical competencies,
 - iii. Adequate supervision and control of mining operations on each shift at the mine,
 - iv. Regular monitoring and assessment of the working environment, work procedures, equipment, and installations at the mine,
 - v. Appropriate inspection of each workplace at the mine including, where necessary, pre-shift inspections,
 - vi. Adequate supervision and monitoring of contractors and service providers at the mine.

The SSE also has additional obligations particular to the management of surface and underground mines in relation to appointing persons who possess required qualifications. This includes appointing an underground mine manager to control and manage the mine who possesses a first class certificate of competency for an underground coal mine or mine (except for MMQ where fewer than 20 people work in the mine).

The Role of the Underground Mine Manager (in Coal Mining)⁶

The Underground Mine Manager is responsible for controlling and managing the mine, and must hold a first-class certificate of competency for an underground coal mine.

The Underground Mine Manager must appoint a person holding a first or second class certificate of competency or a deputy's certificate of competency to:

- Be responsible for the control and management of underground activities when the manager is not in attendance at the mine,
- Have control of activities in one or more explosion risk zones.

The Underground Mine Manager must also appoint a person(s) with appropriate competencies to control and manage the mechanical and electrical engineering activities of the mine.

A coal mine operator or site senior executive may appoint a person as underground mine manager for more than one mine at the same time only with the written approval of the chief inspector.

⁶ Section 60 of the *Coal Mining Safety and Health Act 1999* (Qld).

The Role of Site Safety and Health Representatives

The workers at a mine may elect up to 2 of their number to be the site safety and health representatives (SSHRs) for the mine for the term decided by the workers. The role and functions of SSHRs are broadly similar across coal mines and mineral mines and quarries.

An SSHR for a coal mine has the following functions⁷:

- To inspect the coal mine and review procedures in place at the mine to assess whether the level of risk to coal mine workers is at an acceptable level
- To detect unsafe practices and conditions at the coal mine and to take action to ensure the risk to coal mine workers is at an acceptable level
- To investigate complaints from coal mine workers at the mine regarding safety or health.

An SSHR for a mineral mine or quarry has the following functions⁸:

- To inspect parts of the operations and participate in inspections and investigations conducted by the SSE or a supervisor, inspector, inspection officer or authorised officer,
- To review the circumstances of injuries, illnesses and high potential incidents,
- To consult with supervisors about corrective and preventive action, and about other safety and health matters,
- To consult with district workers' representatives, inspectors, advisers and independent experts,
- To help in the resolution of safety and health issues,
- To investigate complaints from coal mine workers at the mine regarding safety or health,
- To refer safety and health matters to the site safety and health committee as appropriate.

If an inspection report indicates the existence or possible existence of danger, the SSHR must immediately notify the SSE or responsible supervisor, and provide a copy of same to an inspector⁹.

If an SSHR believes an SHMS is inadequate or ineffective¹⁰:

- The representative must inform the SSE, and,
- If the SSHR is not satisfied the SSE is remedying these deficiencies, the SSHR must advise an inspector.

The inspector must investigate the matter and report the results of the investigation in the mine record.

An SSHR has powers to enter any area of the mine within their area of representation to execute their functions (upon reasonable notice to the SSE or SSE representative), and to examine any documents held by the SSE under the Act required by the SSHR to assess whether mine procedures achieve an acceptable level of risk to mine workers¹¹.

⁷ Section 99 of the *Coal Mining Safety and Health Act 1999* (Qld).

⁸ Section 92 of the *Mining and Quarrying Safety and Health Act 1999* (Qld).

⁹ Section 99(4) of the *Coal Mining Safety and Health Act 1999* (Qld) and section 92(4) of the *Mining and Quarrying Safety and Health Act 1999* (Qld).

¹⁰ Section 99(5) of the *Coal Mining Safety and Health Act 1999* (Qld) and section 92(5) of the *Mining and Quarrying Safety and Health Act 1999* (Qld).

¹¹ Section 100 of the *Coal Mining Safety and Health Act 1999* (Qld) and section 93 of the *Mining and Quarrying Safety and Health Act 1999* (Qld).

If an SSHR reasonably believes a danger to the safety or health of workers exists because of mining operations, the SSHR may, subject to certain legislative conditions¹², order the suspension of mining operations.

If the SSHR reasonably believes there is immediate danger to the safety and health of mine workers from mining operations, the representative may stop the operations immediately¹³. The SSHR must give a written report to the SSE about the action taken to stop the mine and the reasons for taking that action.

The SSE must ensure that mining operations stopped on this basis are not restarted until the risk to mine workers from the operations is at an acceptable level.

An SSHR must not unnecessarily impede production at a mine when exercising the representative's powers or performing the representative's functions.

An SSE for a coal mine must tell an SSHR at the mine about the following things:

- An injury or illness to a person from coal mining operations that causes an absence from work of the person,
- A high potential incident happening at the coal mine,
- Any proposed changes to the coal mine, or plant or substances used at the coal mine, that affect, or may affect, the safety and health of persons at the mine,
- The presence of an inspector or inspection officer at the coal mine if the representative is at the mine,
- A directive given by an inspector, inspection officer or industry safety and health representative about a matter.

The role of Industry Safety and Health Representatives¹⁴

The union may, after a ballot of its members, appoint up to 3 persons to be industry safety and health representatives (ISHR) for a period of up to 4 years. To be eligible for appointment as an ISHR, a person must hold a first or second class certificate of competency or a deputy's certificate of competency¹⁵.

ISHRs' functions are set out at section 118 of the *Coal Mining Safety and Health Act 1999*:

- To inspect the coal mine and review procedures in place at the mine to assess whether the level of risk to the safety and health of coal mine workers is at an acceptable level,
- To review procedures in place at coal mines to control the risk to safety and health of coal mine workers so that it is at an acceptable level,
- To detect unsafe practices and conditions at coal mines and to take action to ensure the risk to the safety and health of coal mine workers is at an acceptable level,
- To participate in investigations into serious accidents and high potential incidents and other matters related to safety or health at coal mines,
- To investigate complaints from coal mine workers regarding safety or health at coal mines and
- To help in relation to initiatives to improve safety or health at coal mines.

¹² See section 101 of the *Coal Mining Safety and Health Act 1999* (Qld) and section 94 of the *Mining and Quarrying Safety and Health Act 1999* (Qld).

¹³ Section 101(3) of the *Coal Mining Safety and Health Act 1999* (Qld) and section 94(3) of the *Mining and Quarrying Safety and Health Act 1999* (Qld).

¹⁴ Coal mines only.

¹⁵ Section 109 of the *Coal Mining Safety and Health Act 1999* (Qld).

ISHRs have powers¹⁶ to:

- Make inquiries about the operations of coal mines relevant to the safety or health of coal mine workers;
- Enter any part of a coal mine at any time to carry out the representative's functions, if reasonable notice of the proposed entry is given to the site senior executive or the site senior executive's representative;
- Examine any documents relevant to safety and health held by persons with obligations under this Act, if the representative has reason to believe the documents contain information required to assess whether procedures are in place at a coal mine to achieve an acceptable level of risk to coal mine workers;
- Copy safety and health management system documents, including principal hazard management plans, standard operating procedures and training records;
- Require the person in control or temporarily in control of a coal mine to give the representative reasonable help in the exercise of their powers;
- Issue a directive to suspend operations for unacceptable level of risk.

An ISHR has obligations¹⁷ to:

- Advise the SSE if they believe an SHMS is inadequate or ineffective with supporting reasons, and
- Advise an inspector if the SSHR is not satisfied the SSE is taking necessary action to remedy these deficiencies (which must then be investigated and reported by the inspector).

An ISHR also must not exercise their powers or perform their functions in a manner which unnecessarily impedes production at a coal mine¹⁸.

¹⁶ Section 119 of the *Coal Mining Safety and Health Act 1999* (Qld).

¹⁷ Section 121 of the *Coal Mining Safety and Health Act 1999* (Qld).

¹⁸ Section 120 of the *Coal Mining Safety and Health Act 1999* (Qld).

The Role of District Workers' Representatives¹⁹

The Minister may appoint up to 4 persons with appropriate competencies and experience to be district workers' representatives (DWRs) for a period of up to 4 years²⁰.

A DWR has the following functions²¹:

- To help, represent and advise workers on matters relating to safety and health,
- To inspect mines to assess whether the level of risk to the safety and health of workers is at an acceptable level,
- To participate in inspections by inspectors and inspection officers,
- To participate in investigations into serious accidents and high potential incidents and other matters related to safety or health at mines,
- To investigate complaints from workers regarding safety or health at mines,
- To help in relation to initiatives to improve safety or health at mines.

A DWR's powers are set out at section 116 of the *Mining and Quarrying Safety and Health Act 1999* and are equivalent to the powers of an ISHR (see above).

¹⁹ Mineral mines and quarries only.

²⁰ Section 108 of the *Mining and Quarrying Safety and Health Act 1999* (Qld).

²¹ Section 115 of the *Mining and Quarrying Safety and Health Act 1999* (Qld).

APPENDIX B

Fatalities (2000–2019)

Breakdown of the 47 Fatalities.

Vehicle accidents resulted in 15 fatalities, and consisted of:

- 3 fatalities where the vehicle drove over an edge with an insufficient safety berm/bund,
- 5 fatalities where the deceased was a pedestrian,
- 2 fatalities caused by an uncontrolled runaway vehicle with faulty brakes,
- 5 other vehicle collisions, of which:
 - 2 involved the deceased not wearing a seatbelt,
 - 1 involved faulty brakes,
 - 1 involved both faulty brakes and the driver not wearing a seatbelt,
 - 1 caused by possible worker fatigue.

12 of the fatalities involved the worker being caught in, or struck by, machinery:

- Two quarry workers were pulled into conveyor belts that did not have guards attached,
- Two workers were crushed after being caught in moving parts of their vehicle,
- Two workers were struck by metal plates they were removing from machinery while conducting maintenance activities,
- Two workers were struck by objects that fell from cranes during maintenance activities,
- One worker was struck by a hopper door while conducting maintenance activities²²,
- One worker was crushed between the arm and control panel of a crane while loading a vehicle,
- One worker was struck by a pressurised air line,
- One worker was crushed by the tray of a haul truck, which fell while undergoing maintenance.

Rib falls, roof falls and rock falls resulted in 10 fatalities:

- Two rock falls involved opal miners, each working alone, who died from asphyxiation after a rock roof collapsed on them,
- Two fatalities involved the deceased worker being struck by slabs of coal falling off the wall in underground coal mines,
- A roof fall occurred due to weak roof strata, causing a section of roof to fall, striking a worker,
- Five fatalities occurred after the deceased was struck by falling rocks.

4 workers, none of whom were wearing fall arrest equipment, died after falling from a height:

- 2 workers fell from a highwall or bench at an open cut mine,
- 1 worker fell through an open ore pass in an underground mine,
- 1 worker fell as result of a man basket detaching from a forklift²³. The worker was in the man basket.

²² A hopper forms part of a crushing plant at a quarry and feeds rocks into the crushing mechanism.

²³ A man basket is a small platform that can be attached to a crane or similar vehicle, allowing the worker to work at heights.

Tyre failures resulted in 4 fatalities, all occurring during wheel/tyre handling activities:

- Two fatalities involved tyres exploding after having been driven while underinflated²⁴:
 - A worker replaced a tyre with a repaired tyre, which had been damaged while driven underinflated. The tyre had a *zipper failure* and burst when the vehicle was lowered to the ground, releasing a shockwave of air and fatally injuring the worker,
 - Another involved a worker changing a flat truck tyre. The truck had carried a full load with a flat tyre, which had caused the lock ring to dislocate and violently strike the adjacent tyre's lock ring. This resulted in a sudden expulsion of air, propelling the flat tyre 13 metres, killing one worker and seriously injuring another.
- One fatality involved a tyre locking ring, which was from a different manufacturer to the rest of the assembly, that was also fitted incorrectly²⁵. In this case, the deceased worker's colleague was not assessed as competent in tyre fitting and the tyre may have been inflating at the time of the accident²⁶. Consequently, the tyre and rim components were propelled off the wheel, striking and killing the worker.
- One fatality occurred when the worker was struck by components of a wheel rim assembly while disassembling the wheel. The rim had exceeded its design life and was cracked, and the tyre had not been deflated prior to removal, allowing an uncontrolled release of energy.

Fire resulted in 1 fatality, with the deceased being the child of a mine caretaker²⁷. A fire started in a front room of a caretaker's residence – the cause was unknown.

Irrespirable atmospheres resulted in 1 fatality²⁸. A worker opened a hatch to a longwall goaf (a section of mine that had already been mined), which contained an atmosphere that had been purged of oxygen. The atmosphere flowed out of the goaf and asphyxiated the worker.

For further information on these fatalities, see the following tables and causal diagrams.

Fatality Summary and Causal Diagrams

The information in tables 1 and 2 was provided by the Regulator and lists the 47 fatalities that were examined in this review²⁹. Causal diagrams are also provided for the fatalities, except for those that occurred after 30 June 2018, namely:

- Baralaba Coal Mine, 7/07/2019,
- Middlemount Coal Mine, 26/6/2019,
- Moranbah North Mine, 20/02/2019,
- Saraji, 31/12/2018,
- Fairfield Quarry, 15/11/2018,
- Jack's Quarry, 29/07/2018.

These fatalities weren't included in the causal diagrams out of sensitivity to the families and friends of the deceased and/or because of the potential for enforcement action.

The causal diagrams are displayed in the order shown in tables 1 and 2.

²⁴ The (2010) Foxleigh and the (2004) Century Mine fatalities.

²⁵ The (2015) Dawson Mine fatality.

²⁶ The Nature and Cause report was inconclusive on this issue as there was some conflicting evidence.

²⁷ The 2005 Bracalba Quarry fatality.

²⁸ The 2014 Grasstree Mine fatality.

²⁹ <https://www.business.qld.gov.au/industries/mining-energy-water/resources/safety-health/mining/accidents-incident-reports/investigations-inquiries>

Table 1: Summary of Mineral Mines and Quarry fatalities 2000–2019

Date	Mine	Occupation	Accident Location	Incident description
15/11/2018	Fairfield Quarry	Operator	Surface	An operator was fatally injured at a quarry when he became entangled in the rotating tail drum of a conveyor belt.
29/07/2018	Jacks Quarry	Operator	Surface	A worker operating a Volvo 25c articulated dump truck lost control of the vehicle while descending to a lower level area of the quarry. The vehicle rolled over and fatally injured the worker.
22/10/2016	Opalton Mining Claim 95305	Opal Miner	Surface	Fatally injured when the wall of a shallow trench that the deceased was undercutting to recover opal collapsed and engulfed him.
13/02/2015	Ernest Henry Mine	Grader Operator	Underground	On 1 February 2015 a worker sustained hip and vertebrae injuries when he was struck by a rock which rolled down the sub level cave drawpoint rill which he was standing on. He died in hospital while recovering from his injuries on 13 February 2015.
18/06/2014	Mount Isa Mines - Enterprise Mine	Timberman	Underground	Fatally injured when he fell into an ore pass.
6/03/2013	Mount Isa Mines - Copper Smelter	Labourer	Surface	Fatally injured when he was struck by a pump being lifted out of a sump by a mobile crane.
26/08/2012	Mt Moss Mine	Mining Supervisor	Surface	Fatally injured when he was run over by a front-end loader.
5/06/2012	Moranbah South Quarry	Plant Operator	Surface	Fatally injured after becoming entangled in a conveyor.
6/03/2011	Yowah Mining Claim 4042	Opal Miner	Underground	An opal miner, working alone in old shallow underground workings, was fatally injured while removing mullock used to backfill a surface excavation that intersected the underground workings. The material flowed and engulfed him.
4/07/2009	Roseneath Quarry	Truck Driver	Surface	Worker truck tipped over and crashed when coming down haul road
19/05/2009	Mount Isa Mines - George Fisher Mine	Loader Operator	Underground	Fatally injured when loader he was operating fell into open stope.
18/08/2008	Castle Creek Quarry	Maintenance Worker	Surface	Fatally injured when struck by falling hopper door of a mobile crusher when he was preparing to remove the door from the crusher.
17/01/2008	Cannington Mine	Miner	Underground	Fatally injured when crushed between a light vehicle and a man basket attached to a loader.

Table 1: Summary of Mineral Mines and Quarry fatalities 2000–2019 Cont.

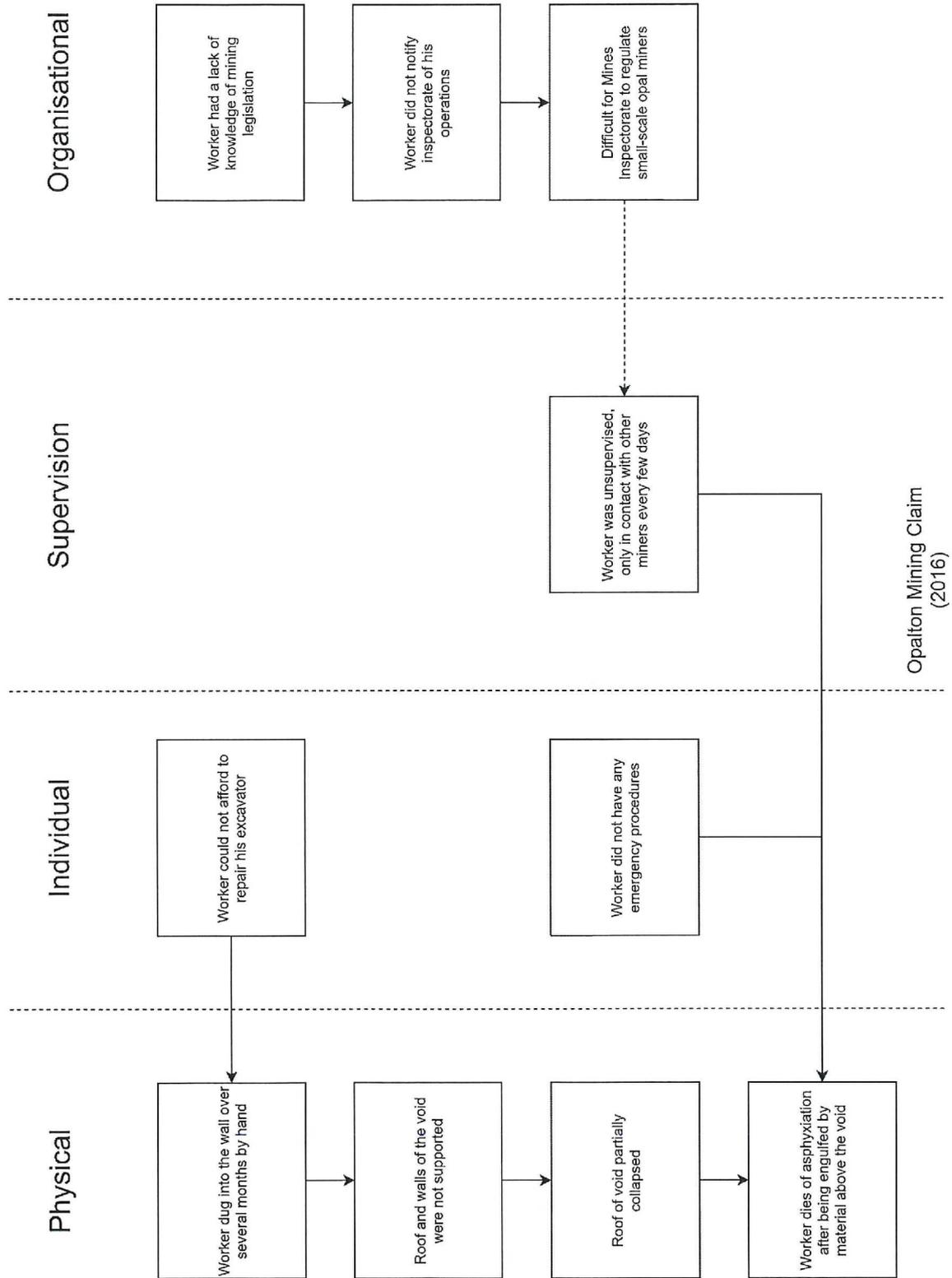
Date	Mine	Occupation	Accident Location	Incident description
15/12/2006	Cannington Mine	Trainee Diamond Driller	Underground	Fatally injured when the main basket detached from the tool carrier and fell to the ground.
27/10/2006	Watershed Exploration Project	Plant Operator	Surface	Fatally injured when loader toppled on and crushed him.
27/07/2006	Wongabel Quarry	Plant Operator	Surface	Fatally injured when run over by loader
27/06/2005	Bracalba Quarry	Child	Surface	Died in fire in caretaker's residence
24/11/2004	Mount Norma Mine	Driller	Surface	Fatally injured when he fell over face with his trac drill.
22/10/2004	Mount Windsor Station	Visitor	Surface	Fatally injured when she was struck by a front-end loader.
17/08/2004	Highway Reward Mine	Miner	Underground	Fatally injured when he was struck by a rock which fell from open stope into the drawpoint.
9/02/2004	Century Mine	Fitter	Surface	Fatally injured when trying to remove a deflated outer rear tyre assembly from the truck when there was a sudden expulsion of air from the inner wheel. This expulsion of air projected the outer assembly 13 metres, striking the deceased.
7/03/2003	Pajingo Gold Mine	Miner	Underground	Fatally injured when he was struck on the head by a compressed air line or fittings from the air line while extending the line underground at the mine.
13/12/2002	Highway Reward Mine	Loader Operator	Surface	Fatally injured when he became caught in the articulation point, between the cab and the front mudguard of an Elphinstone 2900 loader.
2/07/2002	Mount Hay Tourist Mine	Child	Surface	Fatally injured when he was struck by a rock which fell from the face of an excavation where he was fossicking.
3/05/2002	Hadleigh Castle Mine	Miner	Underground	Fatally injured when struck by a fall of rock at the face of the development heading while charging the face.
14/07/2000	Mount Isa Mines - Lead Smelter	Rigger	Surface	Fatally injured when struck by a heavy load which fell from an overhead crane while being lifted.

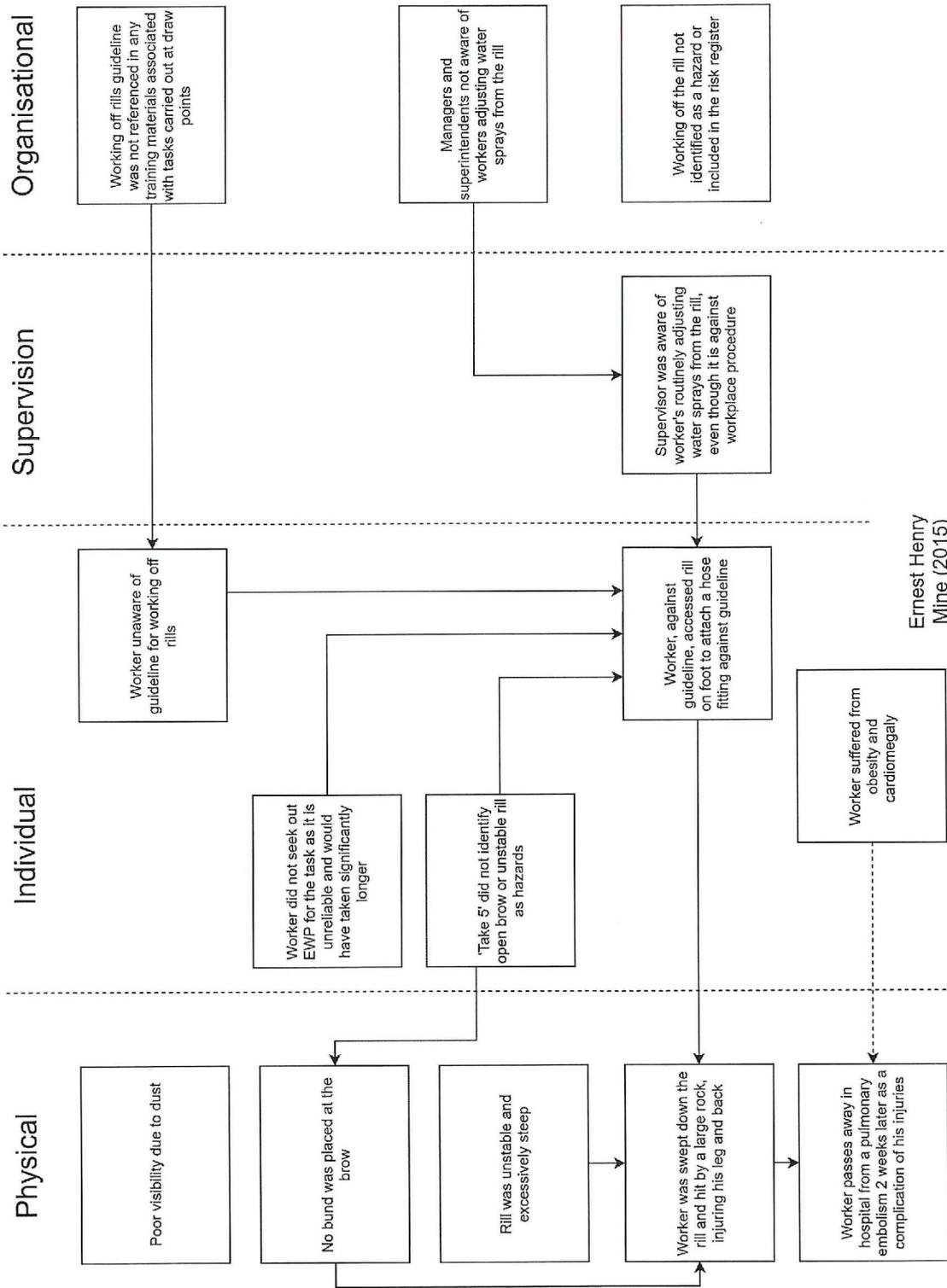
Table 2: Summary of Coal mine fatalities 2000–2019

Date	Mine	Occupation	Accident Location	Incident Description
7/07/2019	Baralaba Coal Mine	Operator	Surface	A coal mine worker was found entangled in an excavator access ladder. The coal mine worker was recovered by emergency responders and was unable to be resuscitated.
26/06/2019	Middlemount Mine	Dozer Operator	Surface	A coal mine worker was fatally injured while he was operating an excavator at an open cut coal mine when an adjacent pit wall 40 metres high suddenly failed. This resulted in fallen material engulfing the excavator and partially crushing the excavator's cabin
20/02/2019	Moranbah North Mine	Grader Operator	Underground	A grader operator received fatal injuries when a grader exiting an underground coal mine rolled down the drift and collided with a man transporter.
31/12/2018	Saraji Mine	Dozer Operator	Surface	An experienced coal mine worker was fatally injured while traversing a bulldozer along a bench. The bulldozer went over the bench's crest and rolled downwards approximately 20 metres, coming to rest on its roof in an area of mud and water approximately two metres deep.
5/08/2017	Goonyella Riverside	Contractor Boilermaker	Surface	Two contractor coal mine workers were refurbishing an excavator bucket in the bucket repair shop near the main surface workshop. One worker was engaged in air gouging the wear plate when he was struck in the head by the plate as this suddenly released resulting in a fatal injury.
30/08/2016	Newlands Open Cut Mine	Contractor Rigger	Surface	Contractor coal mine workers were working on a primary crusher return feeder pan. When the feeder return pan was un-bolted, it swung and struck one of the coal mine workers, resulting in a fatality.
12/03/2015	Blackwater Mine	Contractor miner	Surface	A 4WD bus veered from the left hand side to the right hand side of a haul road, collided with a bund and overturned. A mineworker in the bus was thrown out and crushed under the overturning bus.
16/02/2015	Dawson Mine	Contractor fitter	Surface	While conducting tyre fitting operations on the position 1 wheel of a Cat 777 water cart, a tyre fitting failure occurred resulting in one worker sustaining fatal injuries and the other sustaining significant injuries.
11/12/2014	Grasree Mine	Contractor	Underground	A mineworker was installing secondary support and was fatally injured by a piece of "rib" which broke away and struck him.

Table 2: Summary of Coal mine fatalities 2000–2019 Cont.

Date	Mine	Occupation	Accident Location	Incident Description
6/05/2014	Grasstree Mine	Electrician	Surface	A worker entered an irrespirable atmosphere.
18/12/2010	Foxleigh Open-Cut Mine	Contract Truck Driver	Surface	The truck driver had replaced a tyre on an unloaded road train trailer and was removing the jack when the tyre burst without warning, fatally injuring him.
31/08/2010	Curragh Mine	Contractor	Surface	A light vehicle containing four persons was involved in a single vehicle rollover on a haul road near the top of a ramp. The driver of the vehicle had lost control on a recently watered section of road.
20/02/2009	Blackwater Mine	Service Technician (Contract)	Surface	Fatally injured when light vehicle collided with rear of low loader.
29/09/2008	Hyde Park Station – Exploration Site	Contract Truck Driver	Surface	Water truck driver crushed between water diffuser outlet pipe on rear of truck and the gate. Truck possibly rolled back while deceased was closing the gate.
9/04/2007	Moranbah North	Miner (Contractor)	Underground	Deceased was caught between shuttle car and rib at the face of 1st workings
19/09/2005	Dawson Open Cut Mine	Senior Mining Engineer	Surface	Found deceased on the edge of a body of water at the bottom of the highwall.
7/08/2005	Foxleigh Open Cut Mine	Truck Operator	Surface	Fatally injured while removing tyre from coal haulage truck which forcibly ejected.
12/04/2002	Blackwater Open-cut Coal Mine	Contract Employee	Surface	Fatally injured by crush injuries from the jib of a truck rear mounted crane.
30/08/2000	Cook Colliery	Miner	Underground	Fatally injured by a rib fall in 12 East Panel.
26/05/2000	Oaky Creek No. 1 Coal Mine	Miner	Underground	Fatally injured by a roof fall.
15/03/2000	Jellinbah Open-cut Coal Mine	Fitter	Surface	Fatally injured by falling truck tray body (approximately 20 tonnes weight) that was being repaired. The tray fell on him whilst he was attempting to insert a pin into the under side of the tray body to attach a support structure required to facilitate the movement of the tray whilst it was detached from the truck.





Organisational

Supervision

Individual

Physical

Possible low visibility due to dust, visibility may have been as low as 2 metres

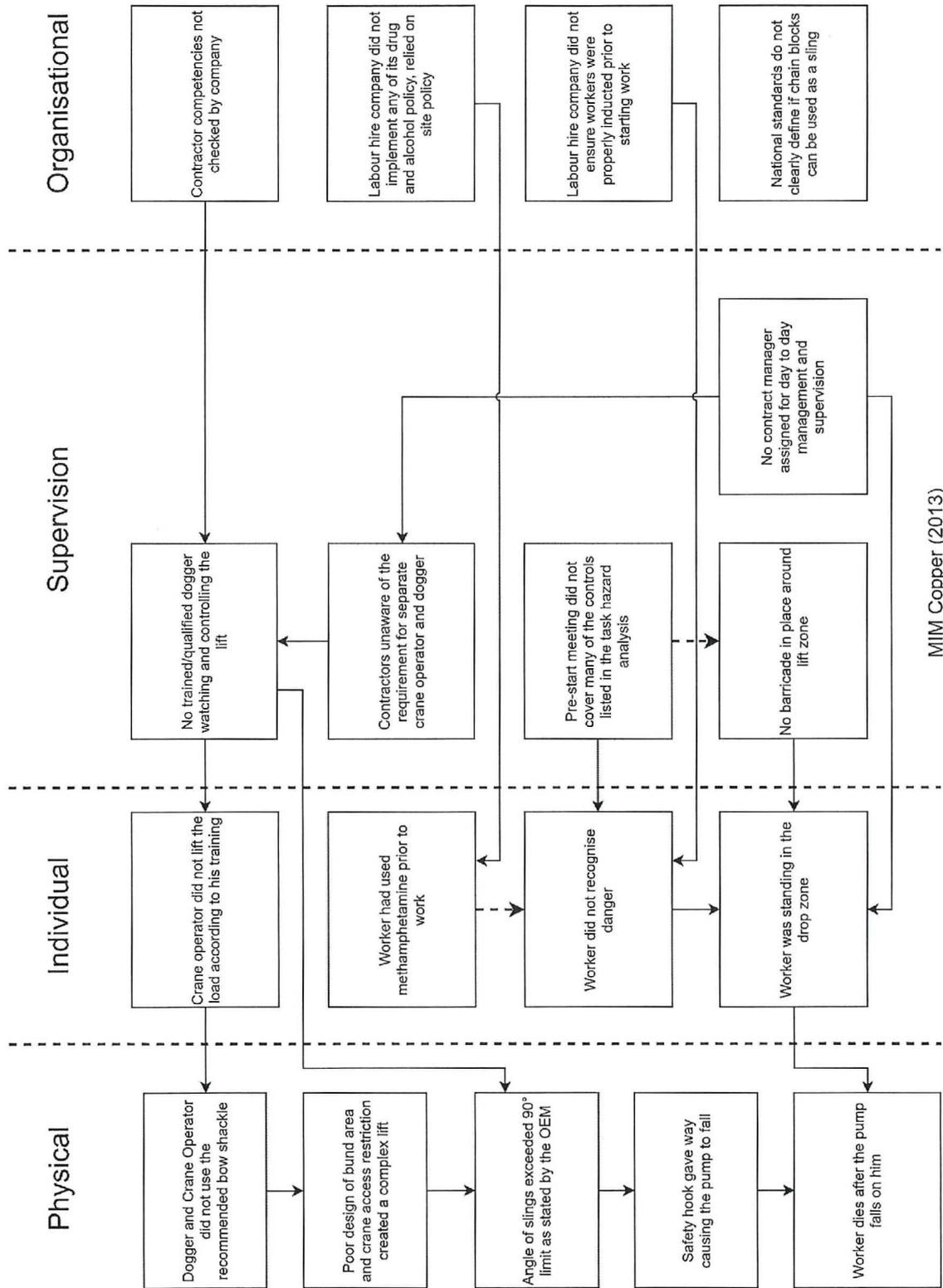
No physical barrier to prevent a person falling down the opening

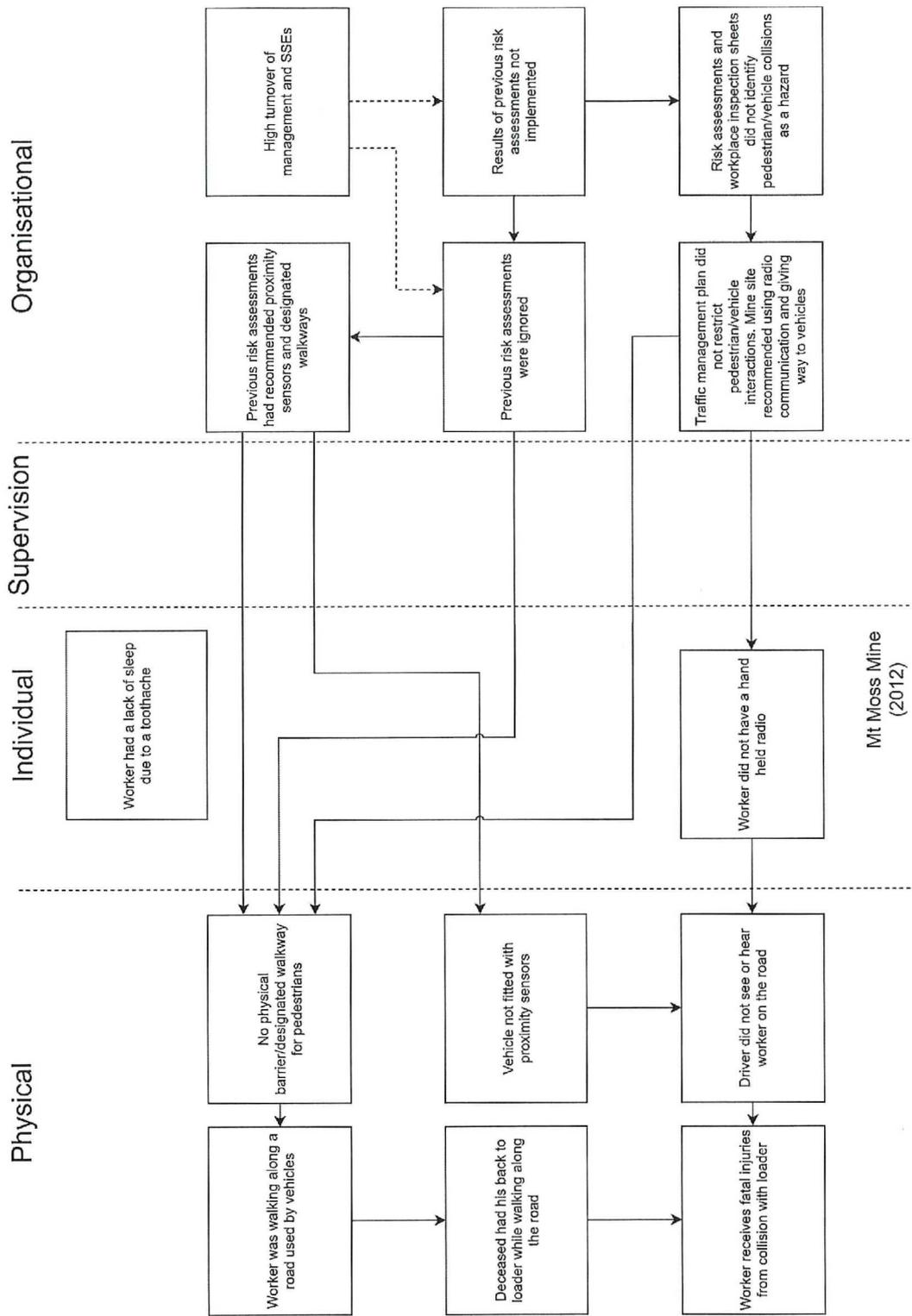
Worker dies after falling down a vertical opening, body is not found for 3 weeks

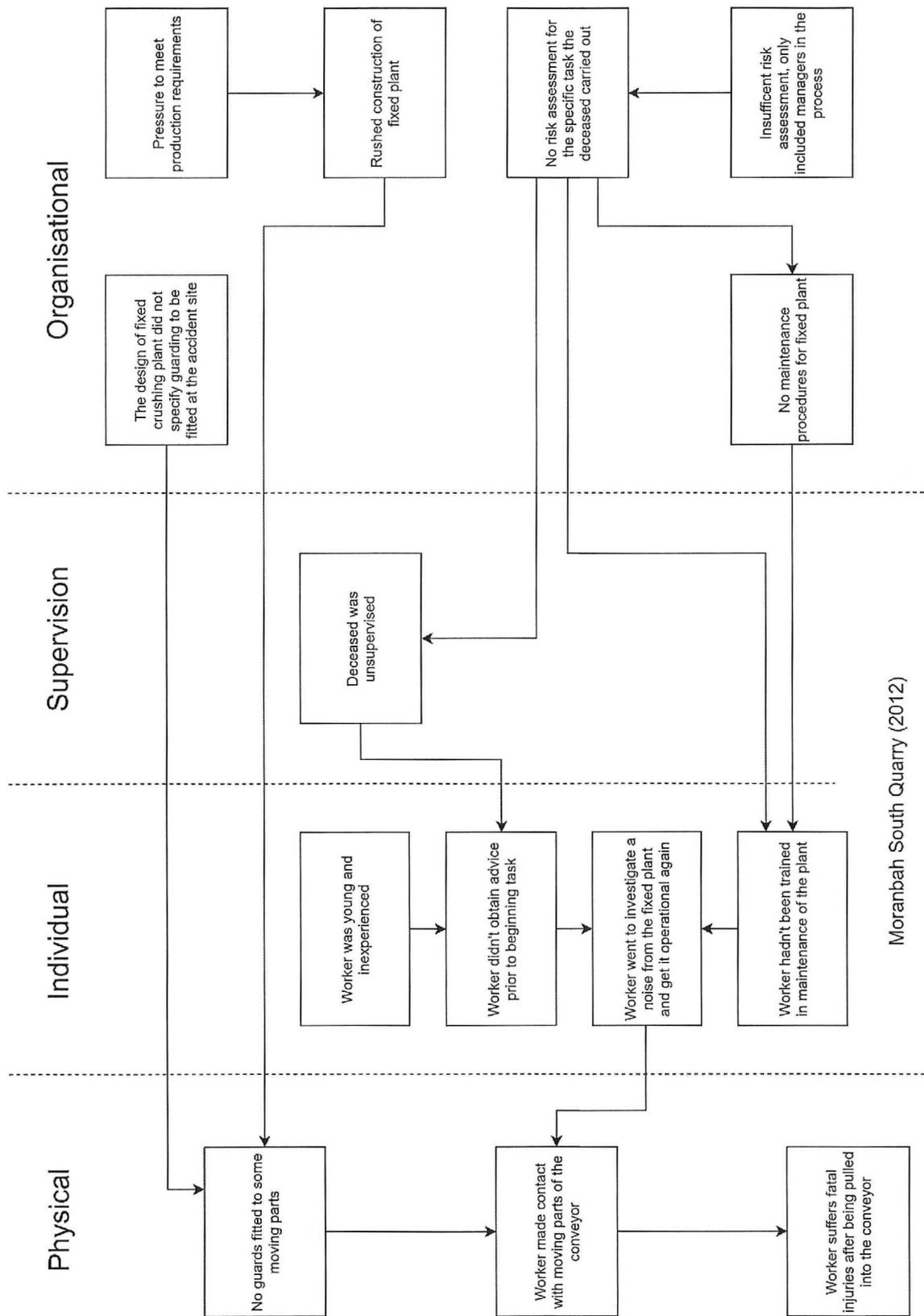
Worker was prescribed antidepressants and referred for counselling in the week prior, didn't advise supervisor he was taking prescribed medication

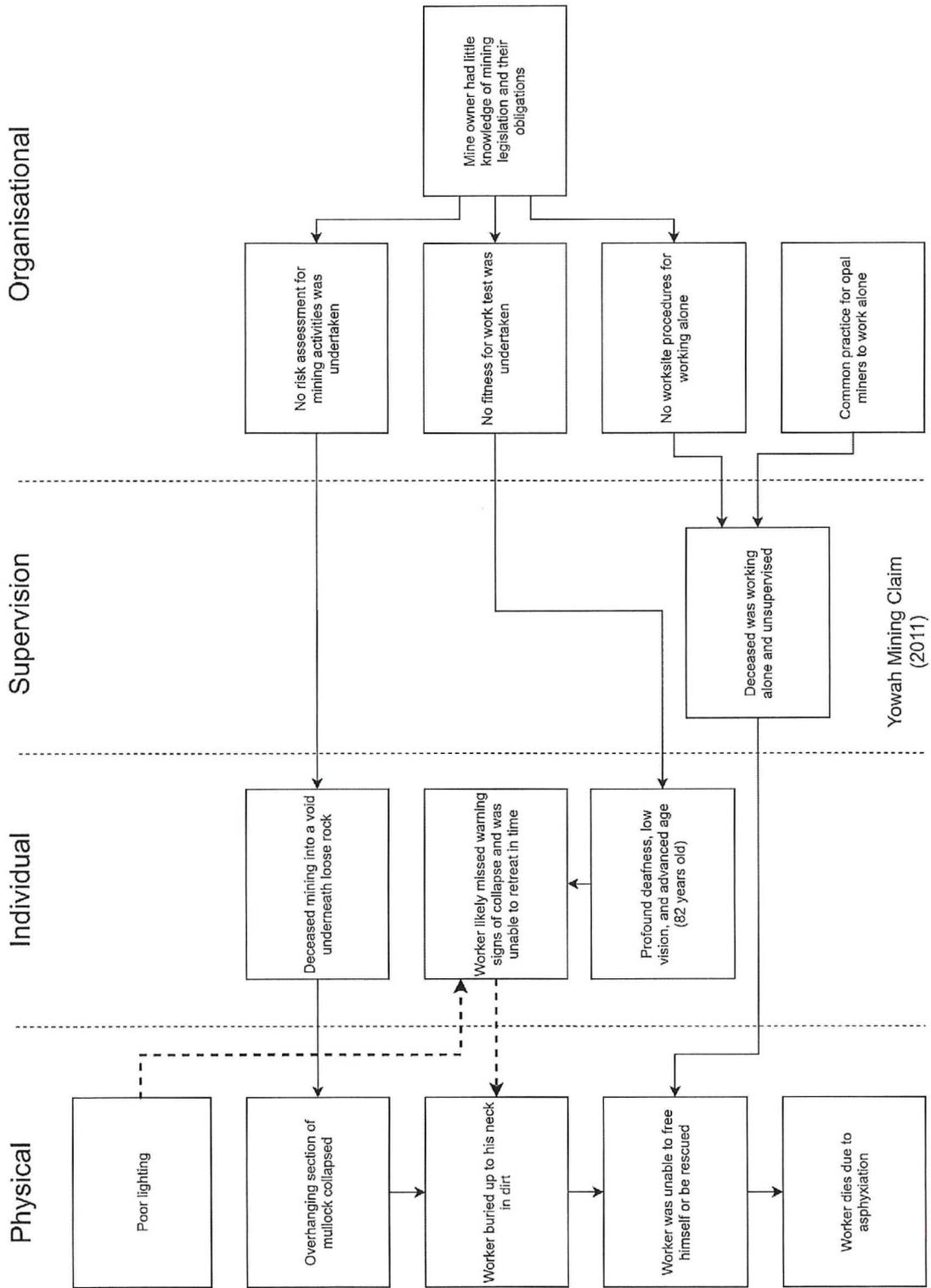
Worker went within 3 metres of a vertical opening without fall arrest equipment as required in the work procedure

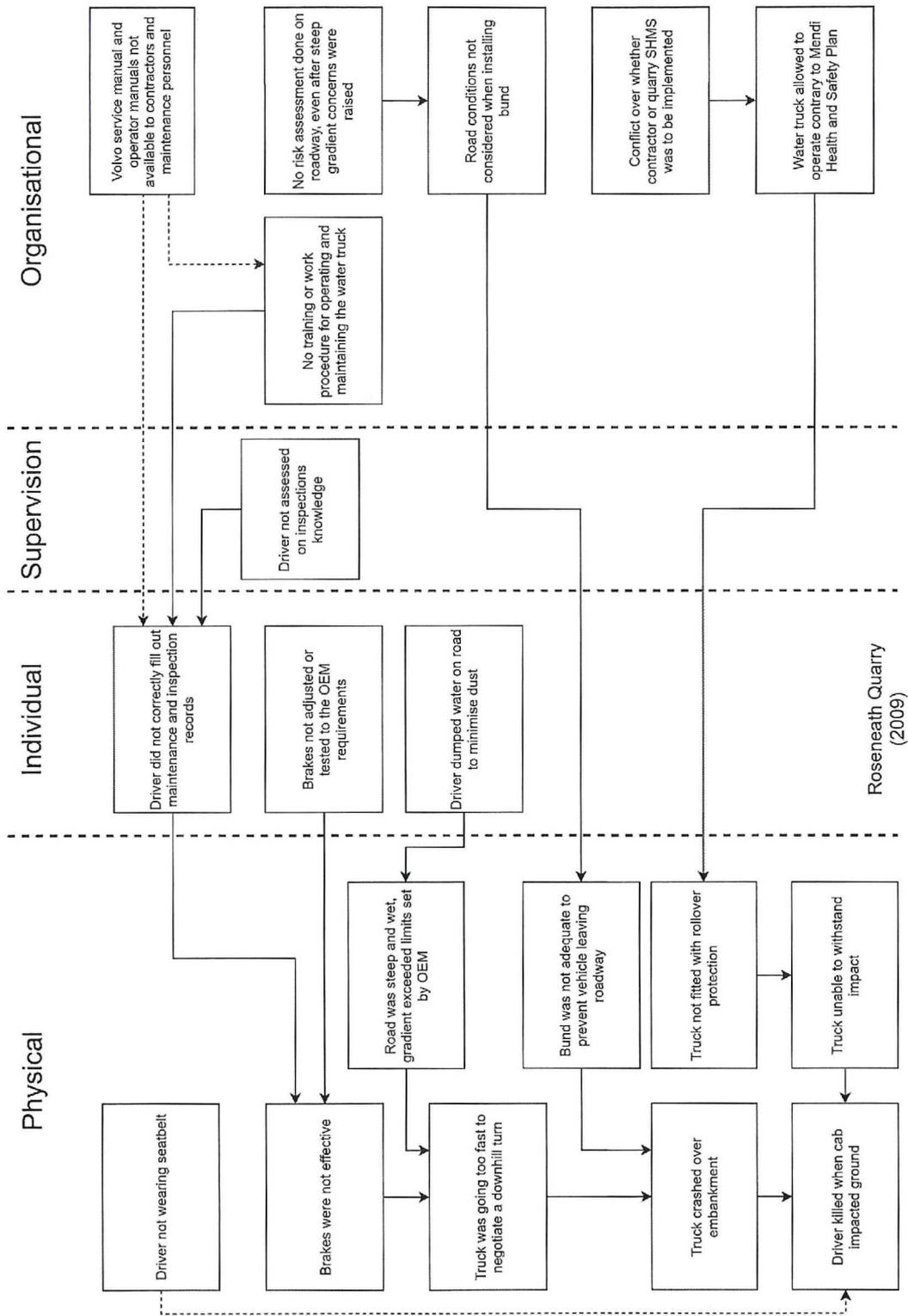
Enterprise Mine (2014)

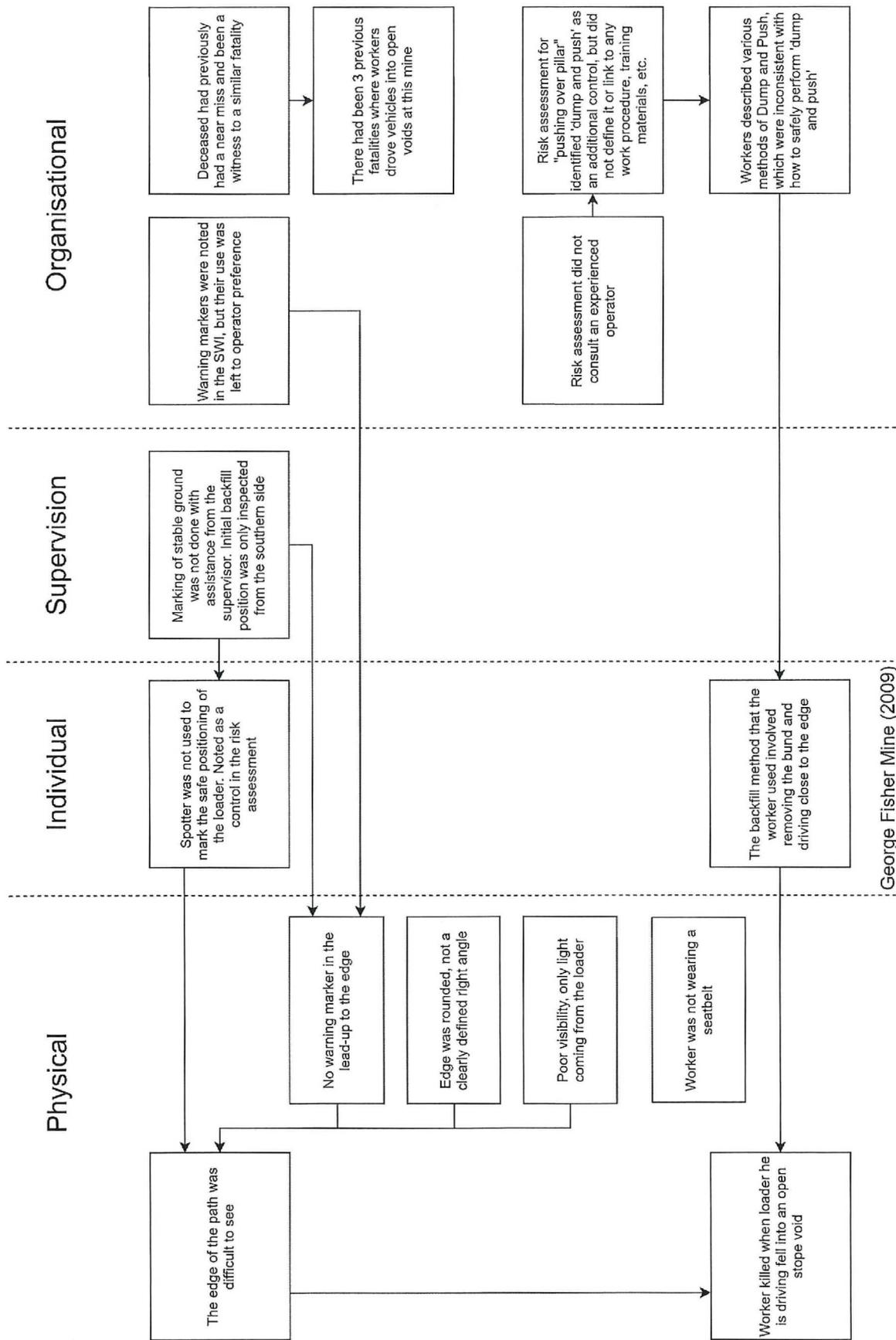


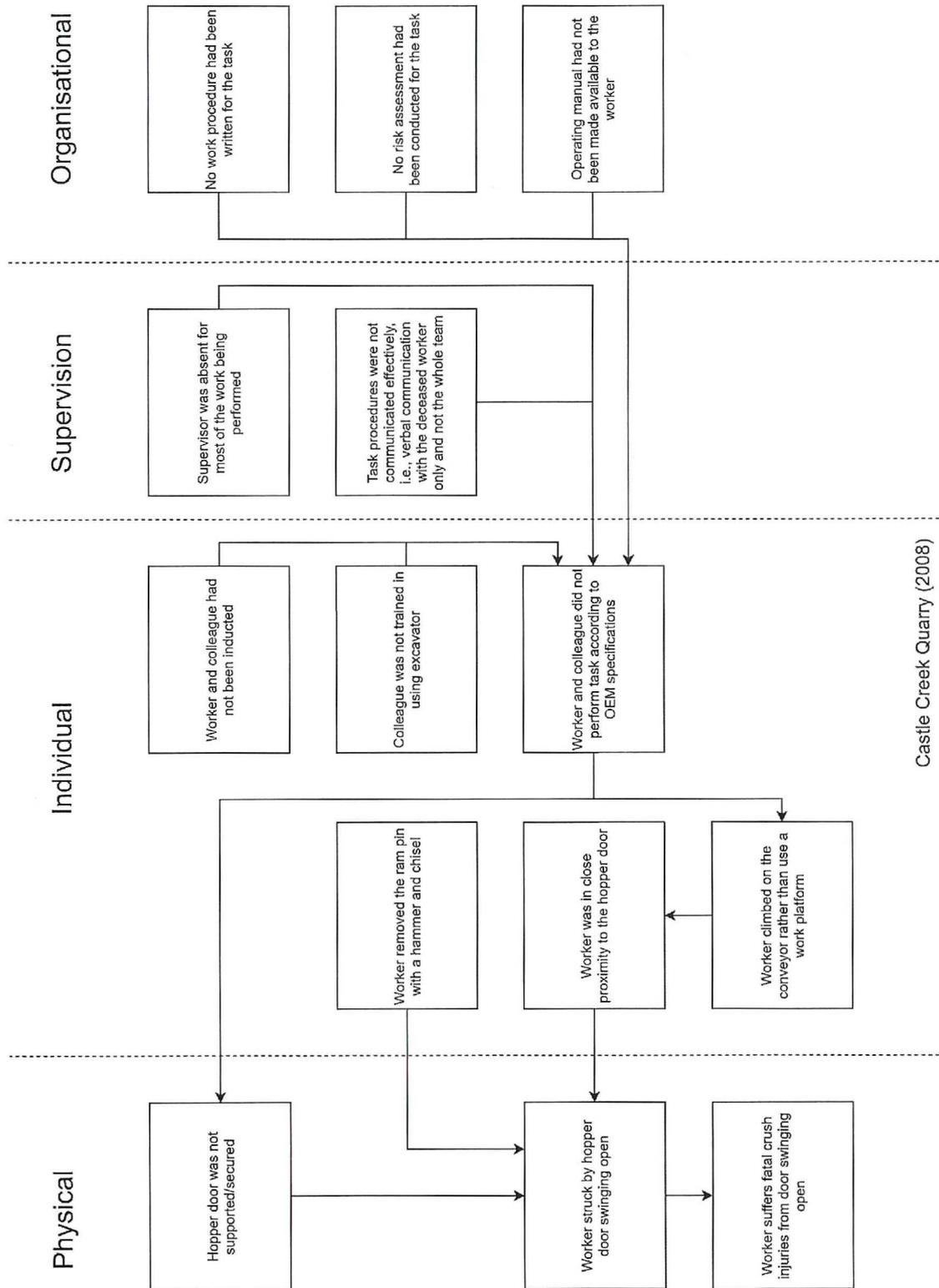


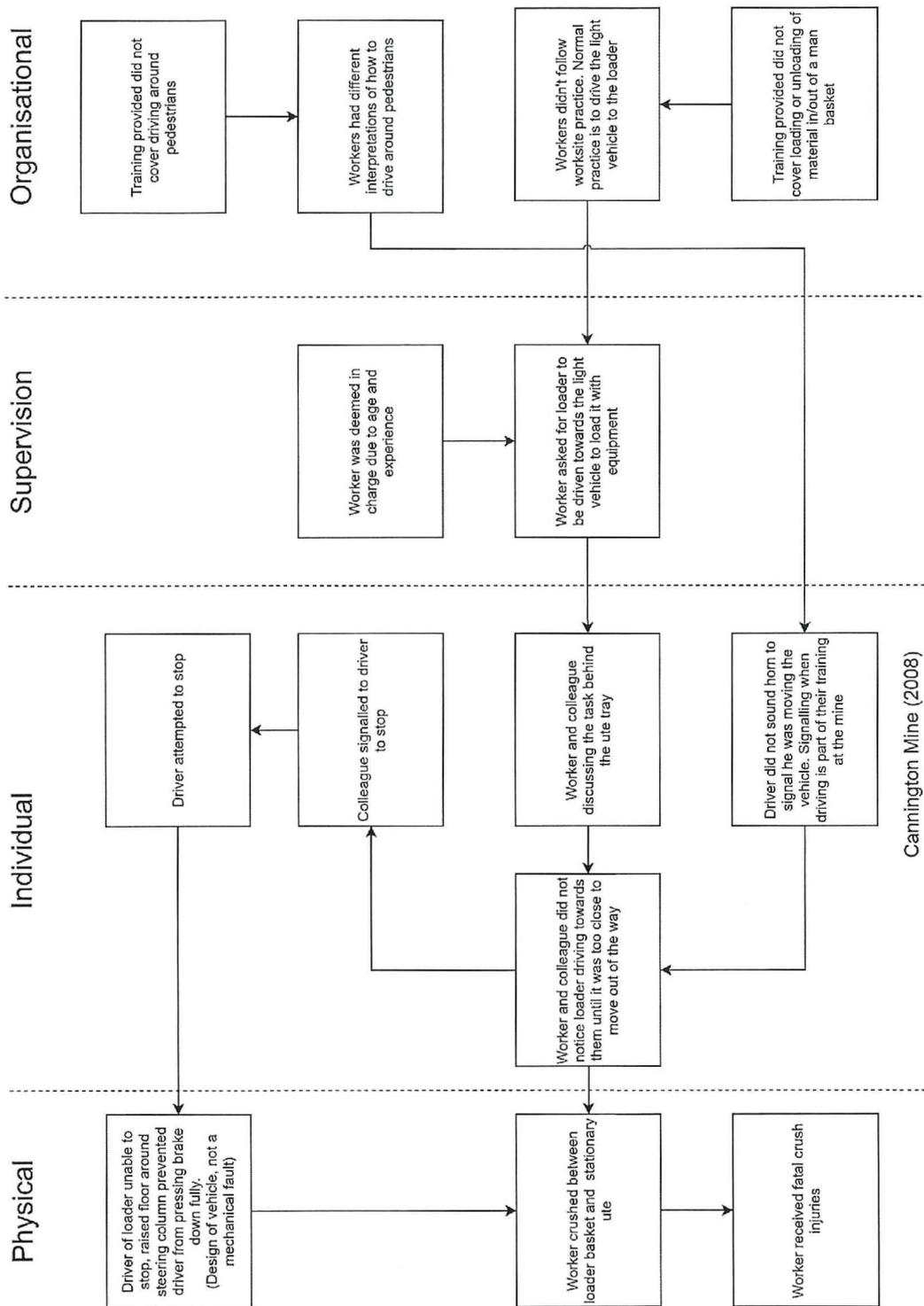




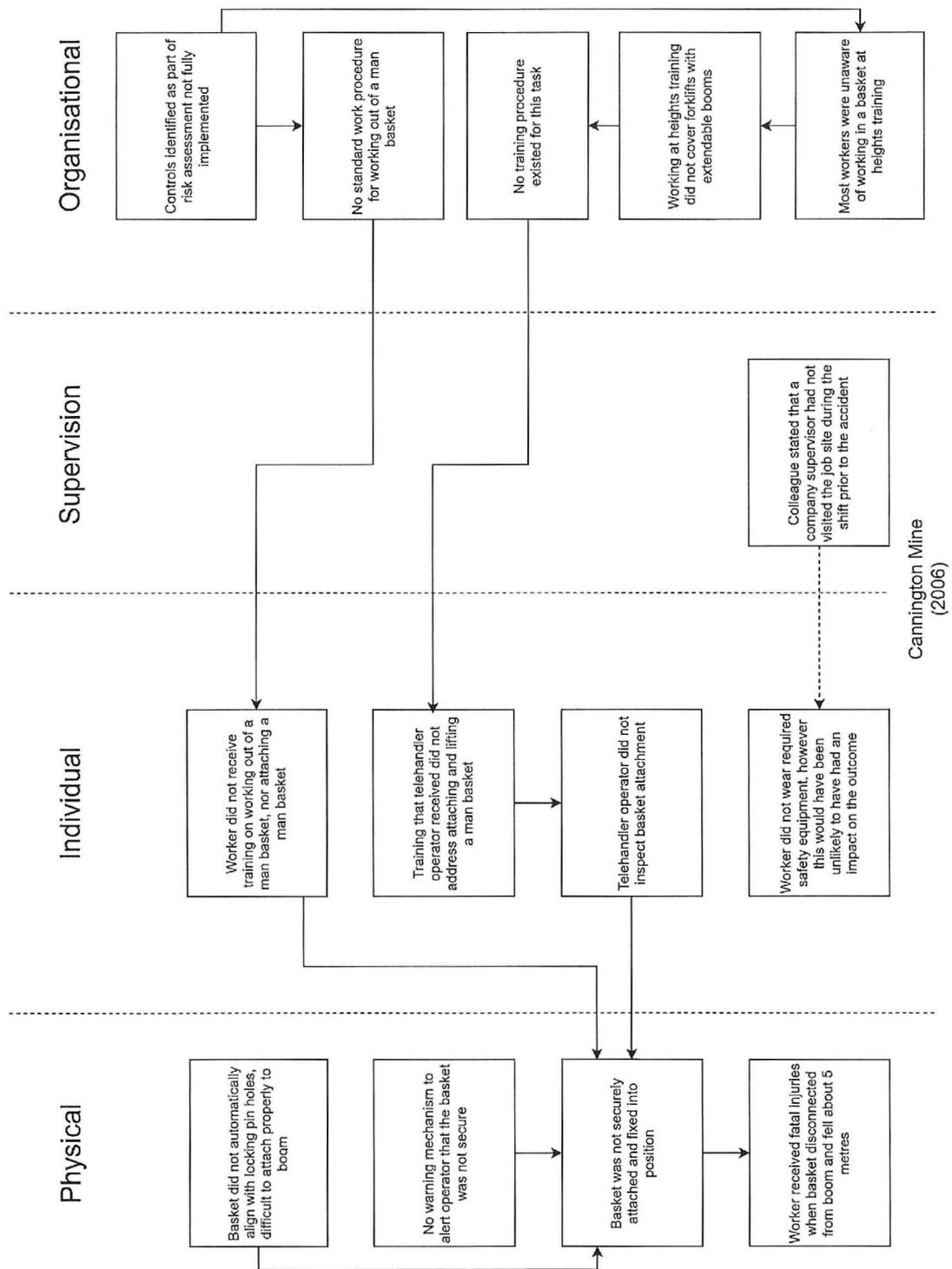




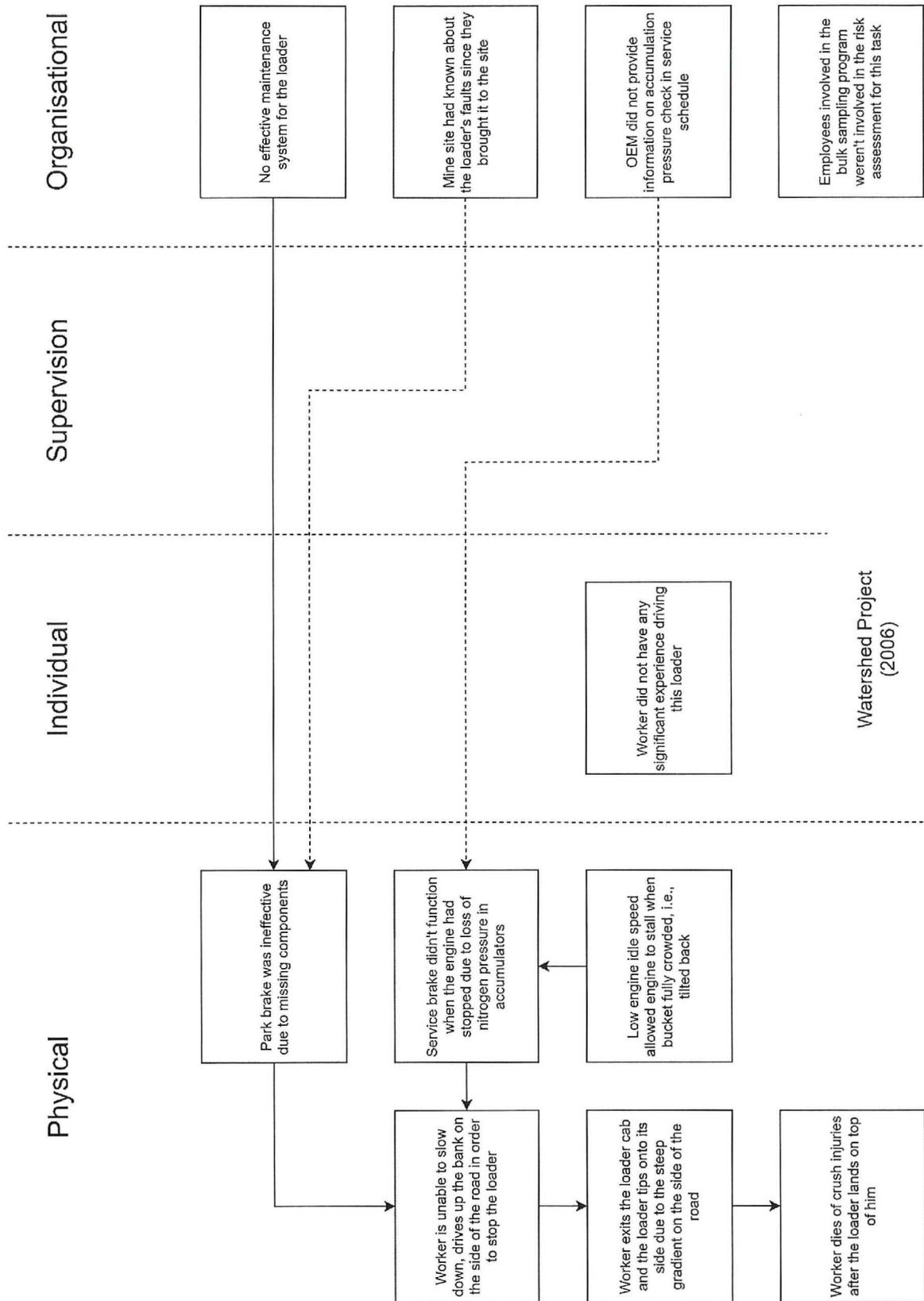


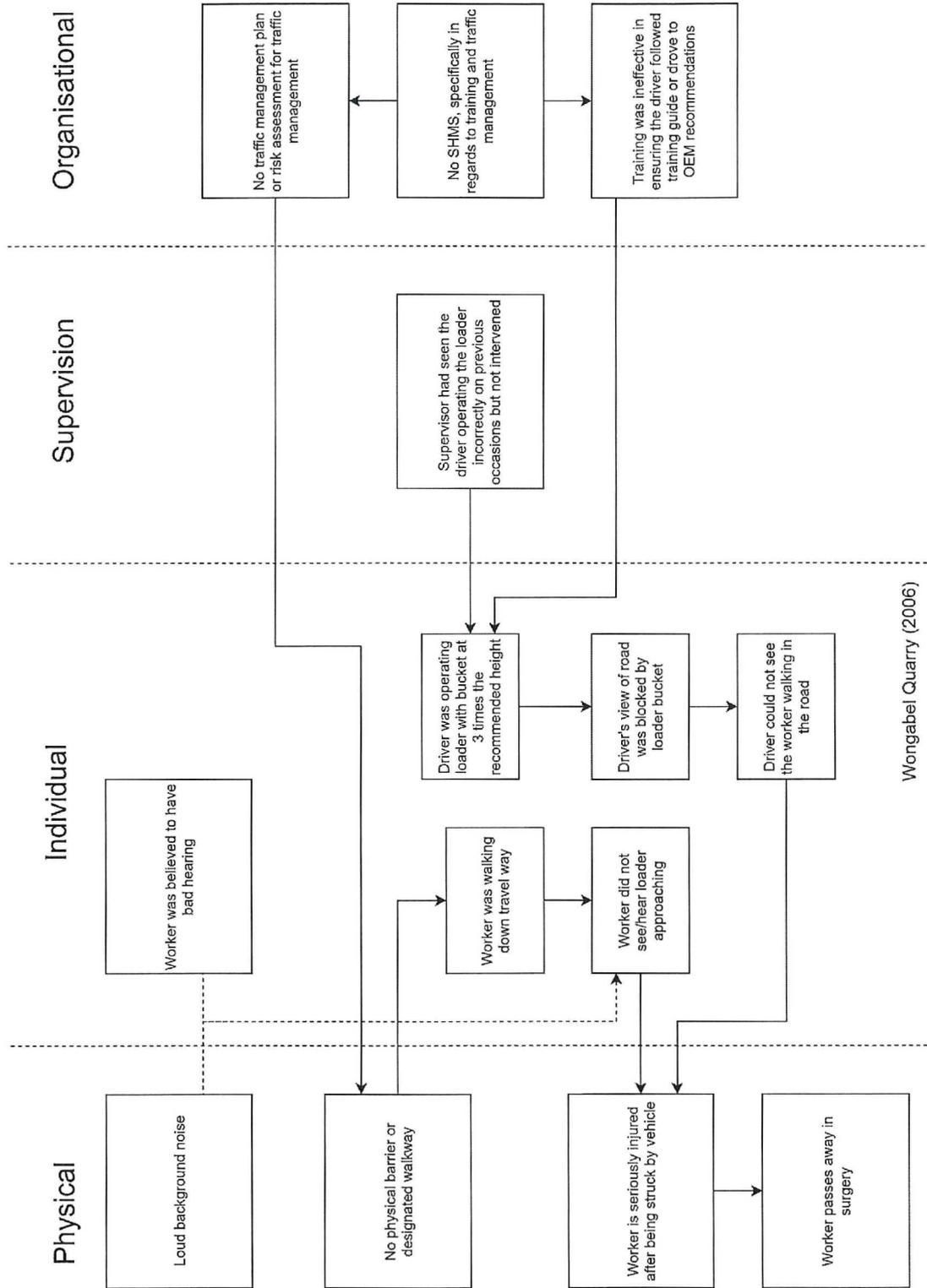


Cannington Mine (2008)



Cannington Mine
(2006)



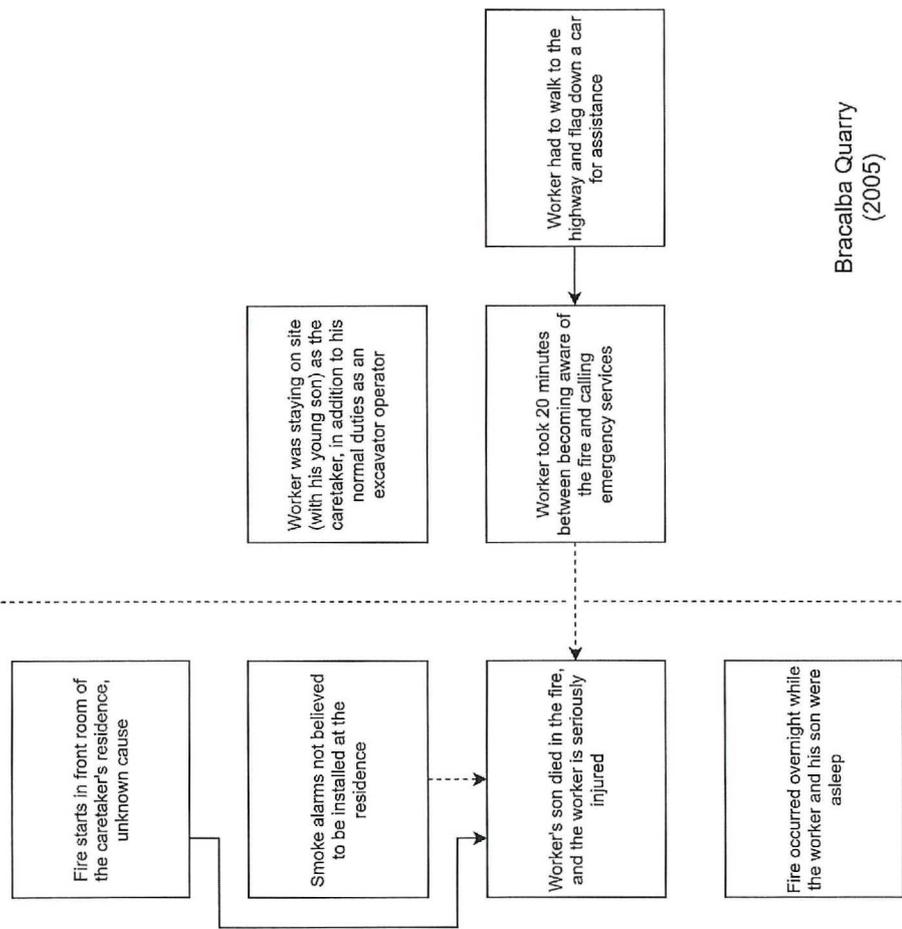


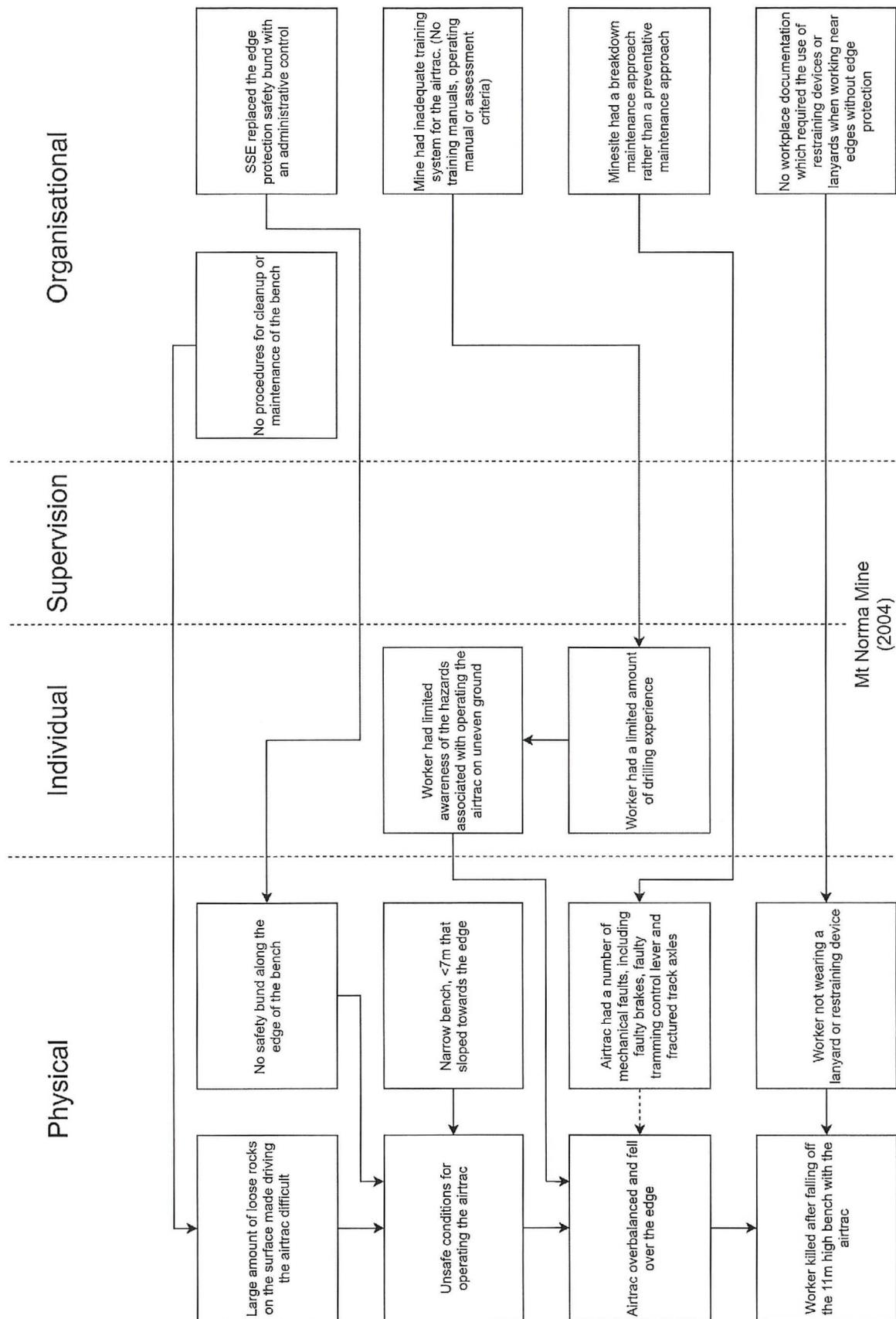
Organisational

Supervision

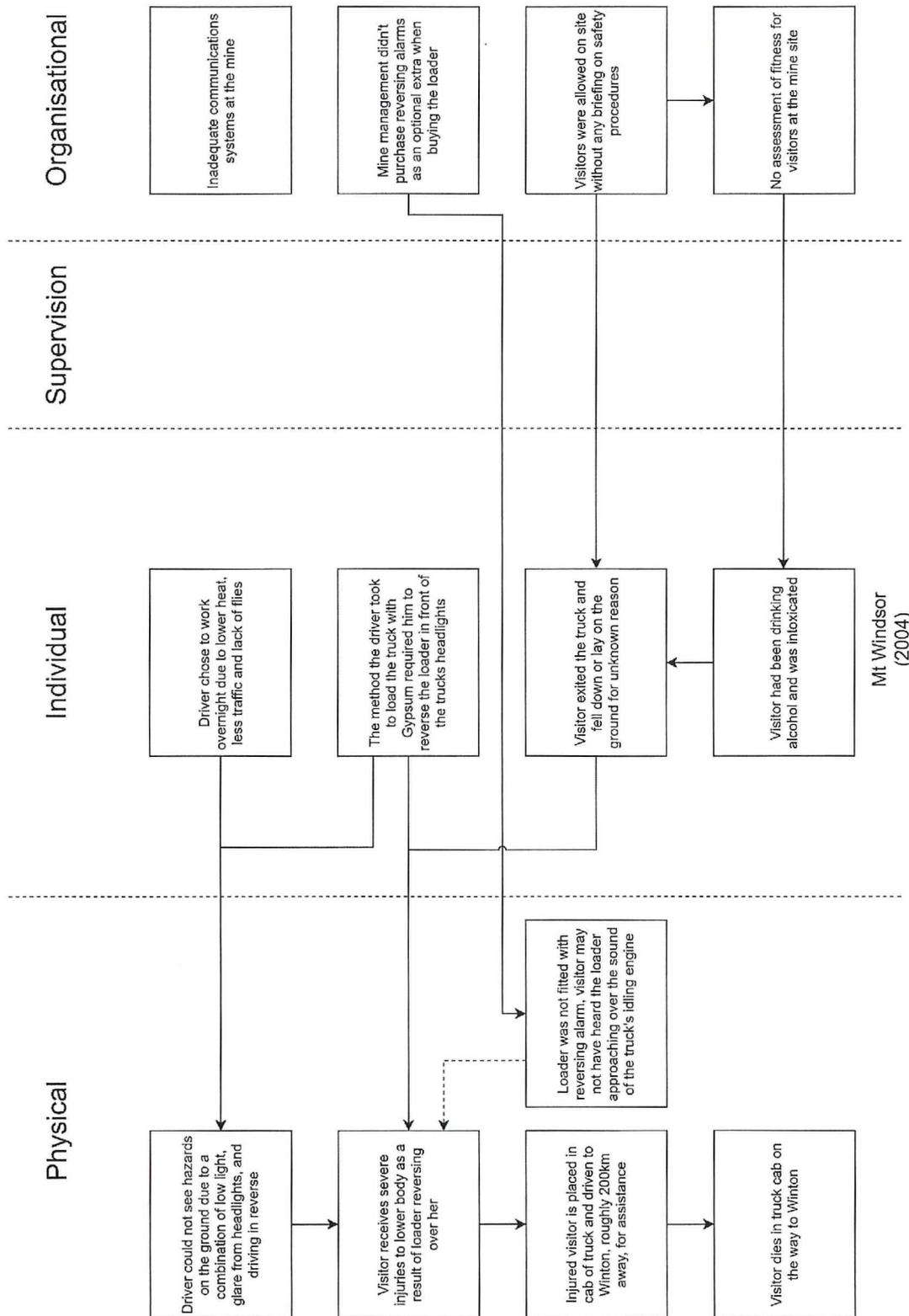
Individual

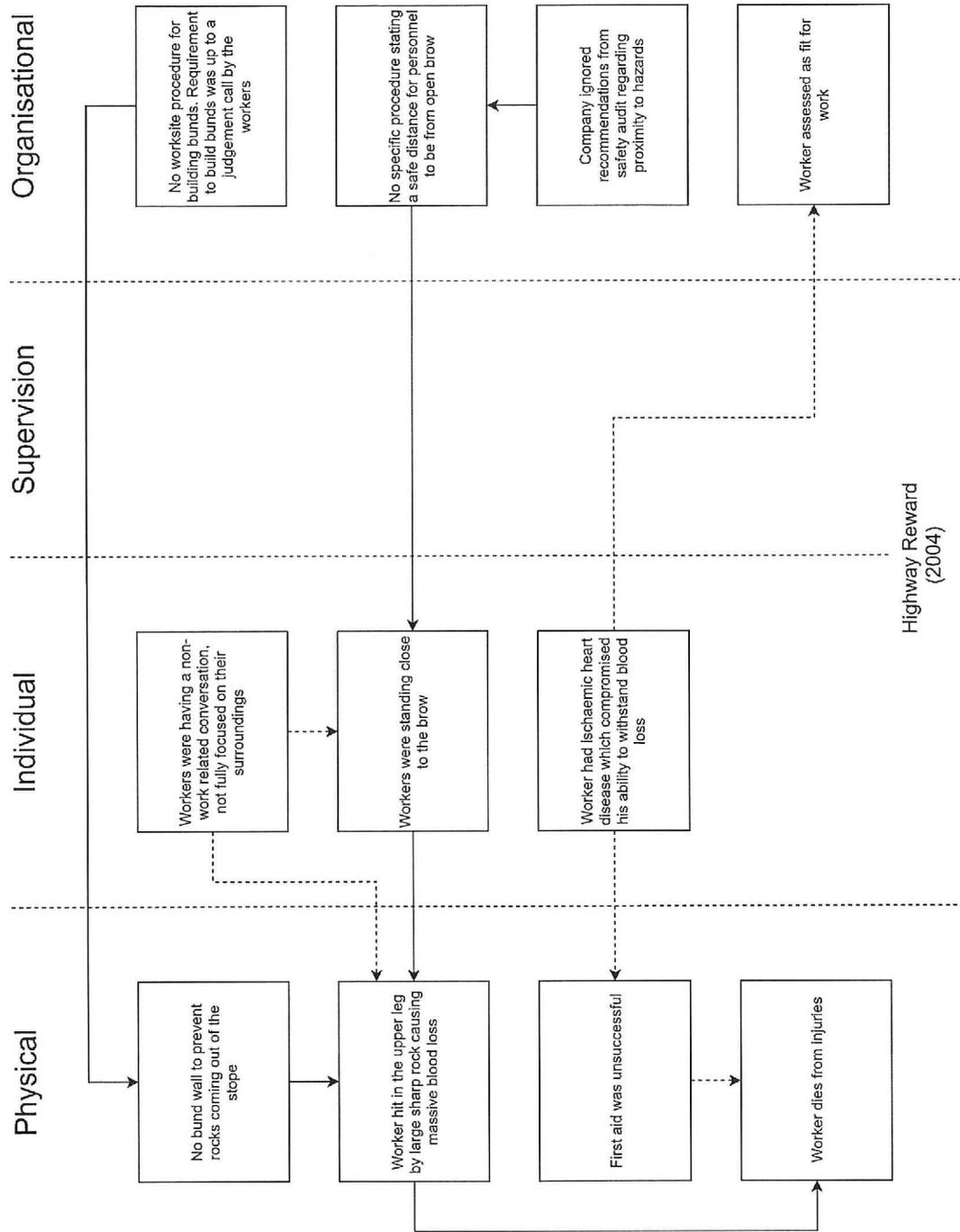
Physical

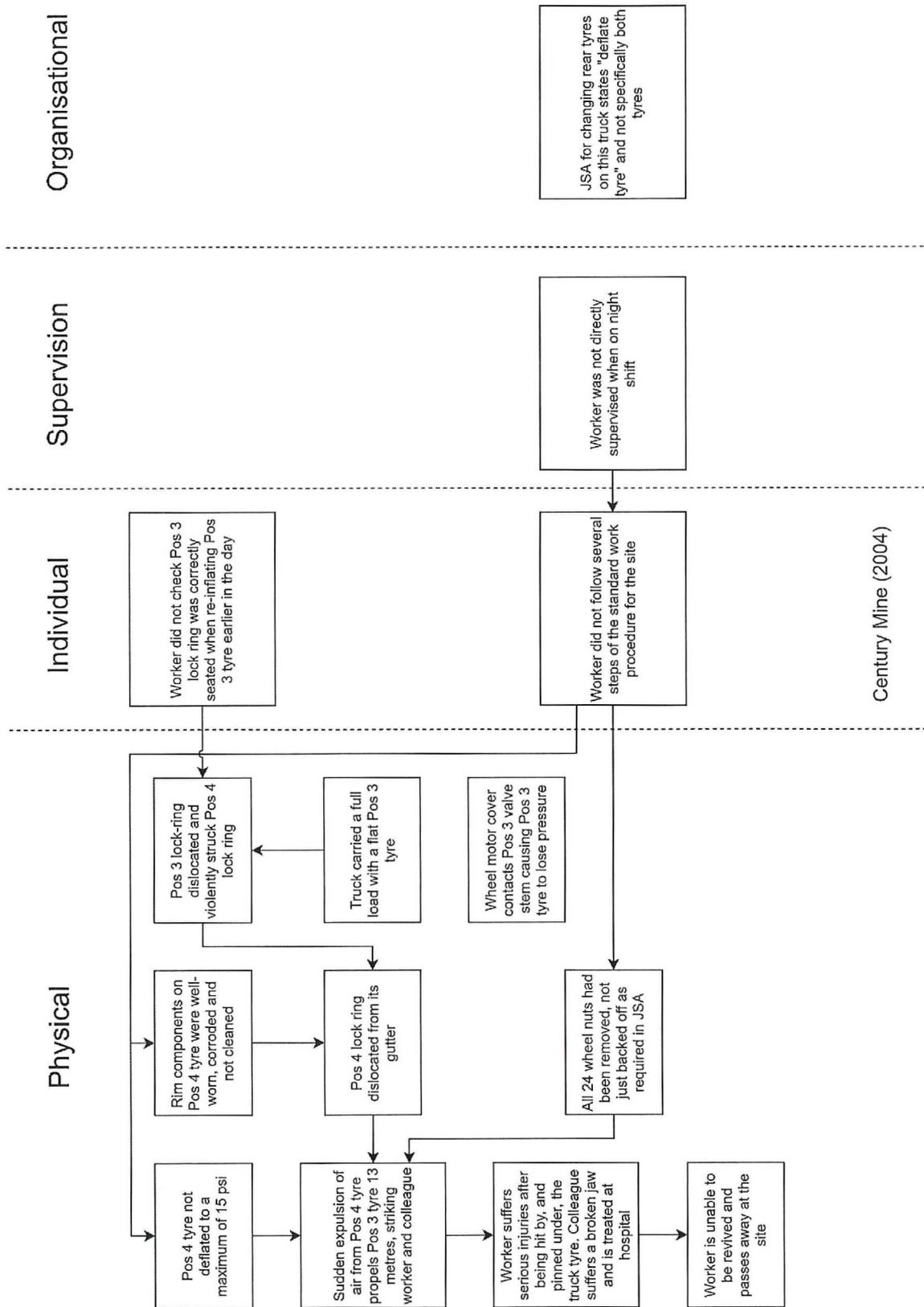


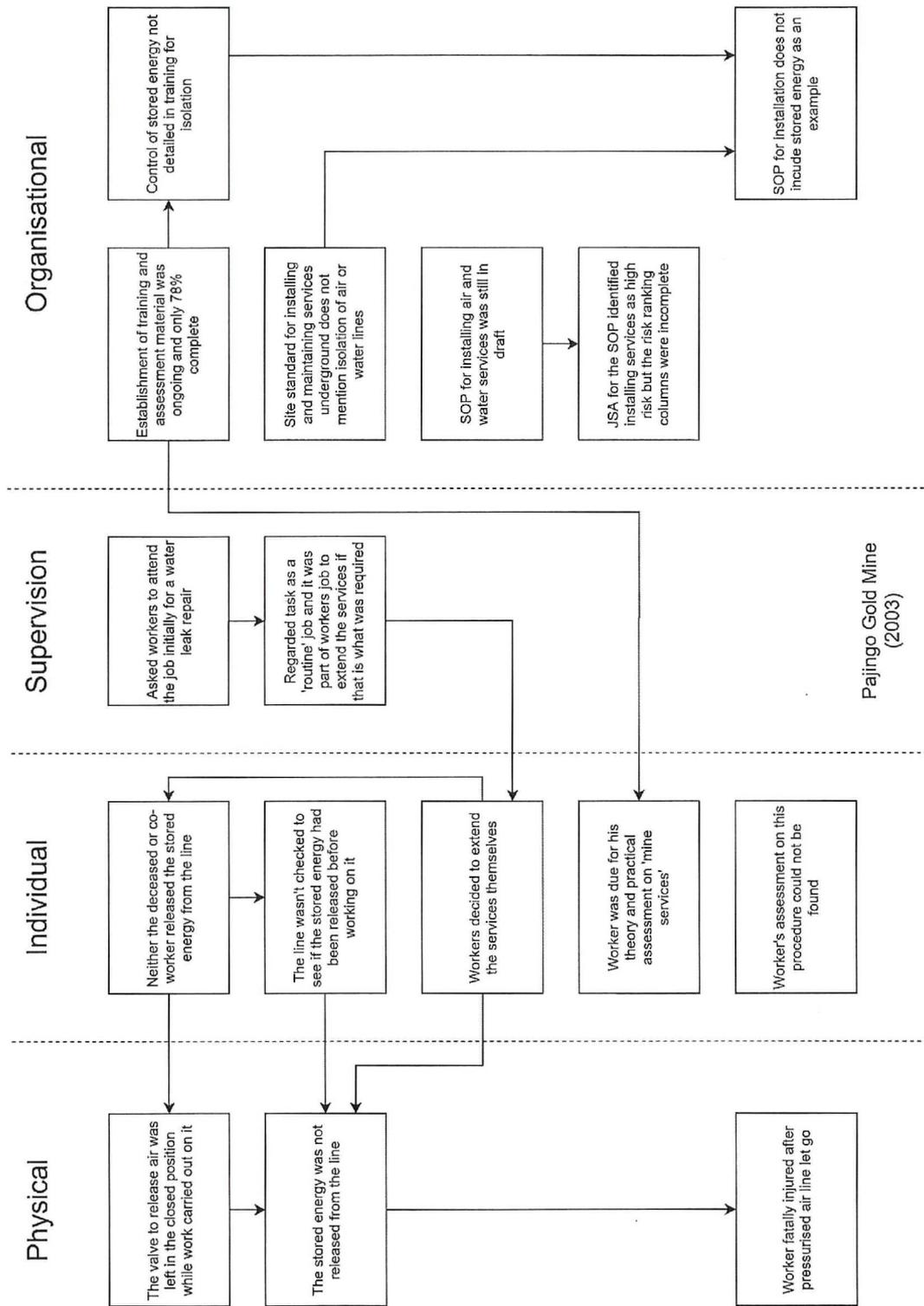


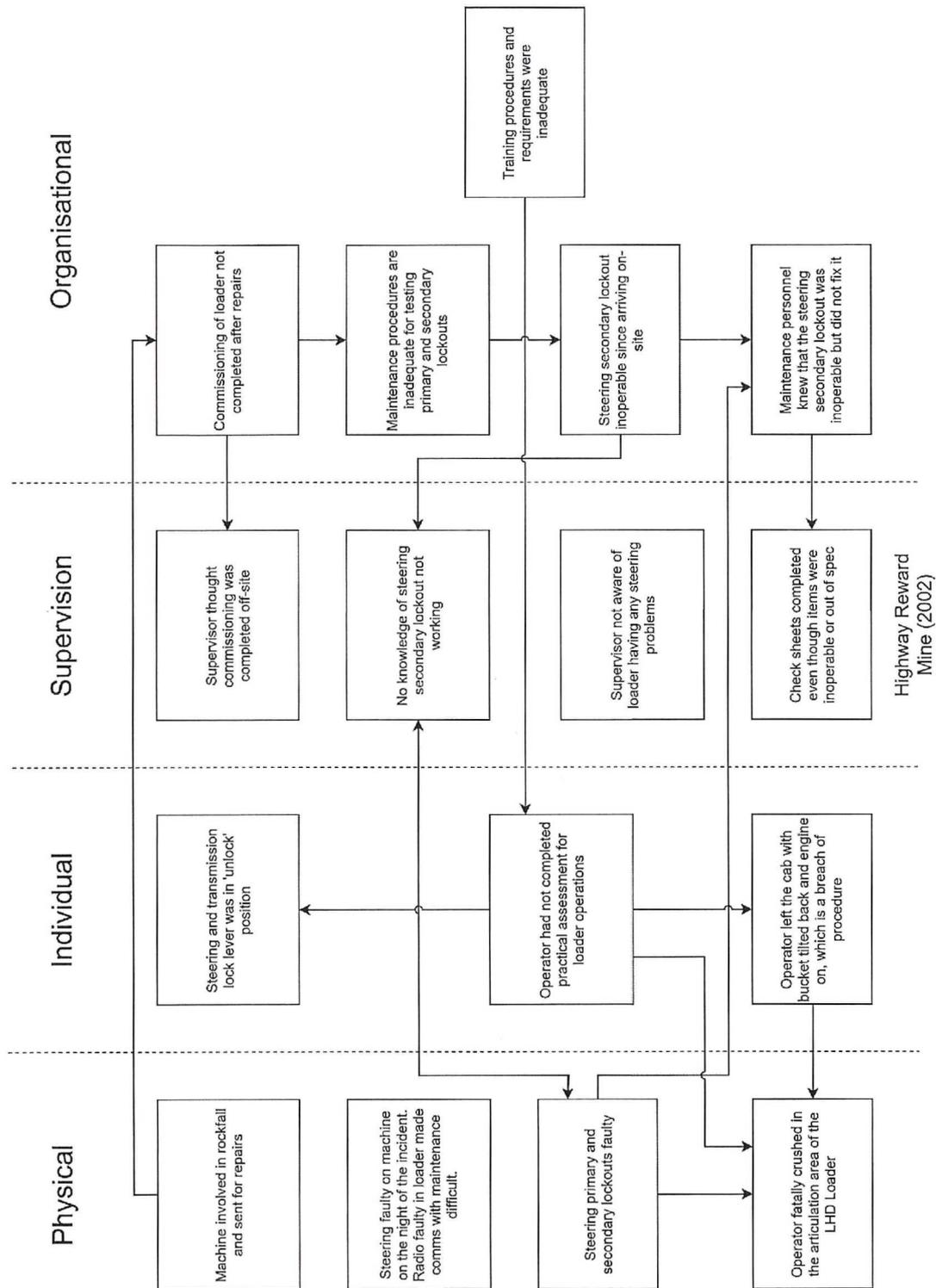
Mt Norma Mine (2004)



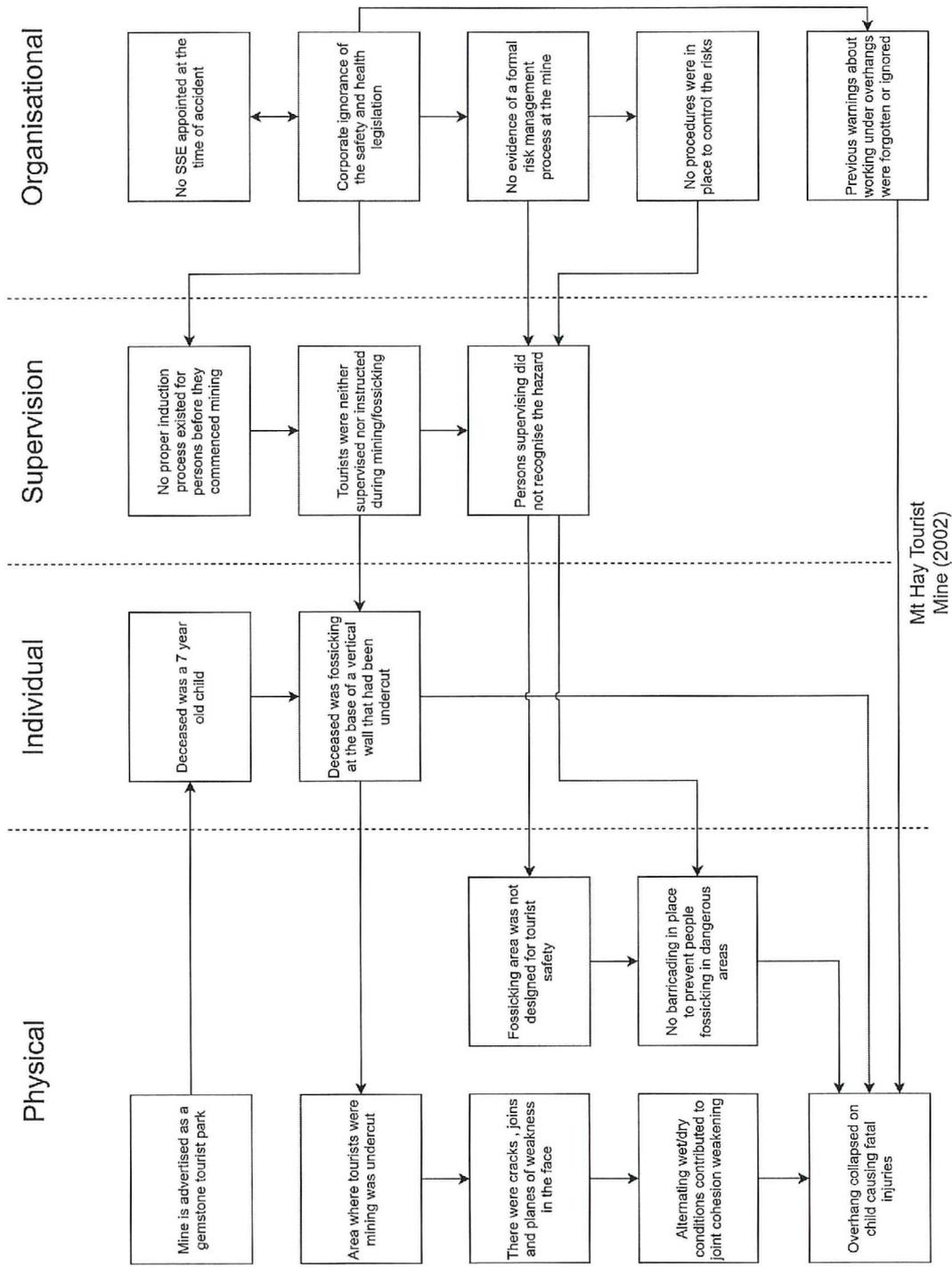


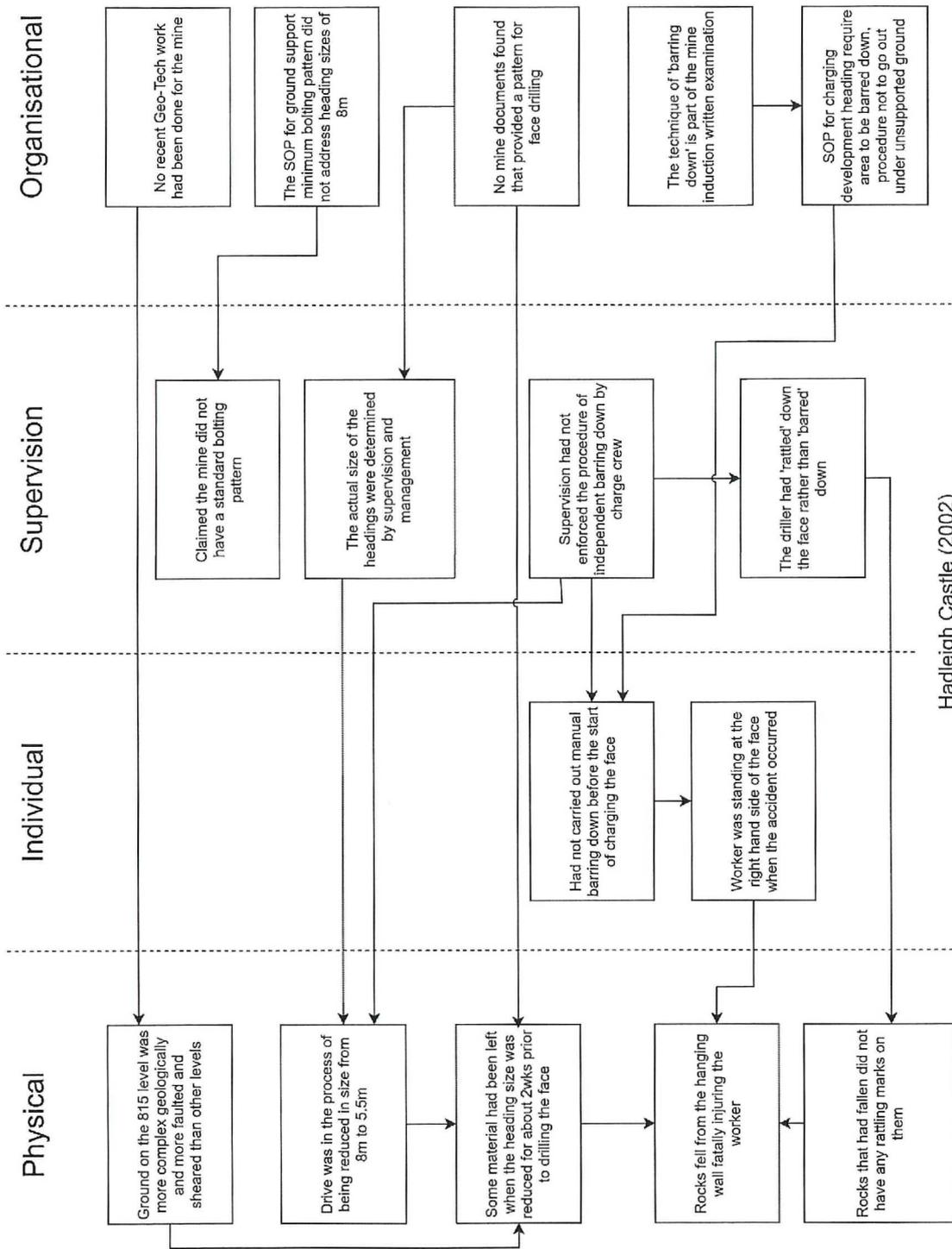


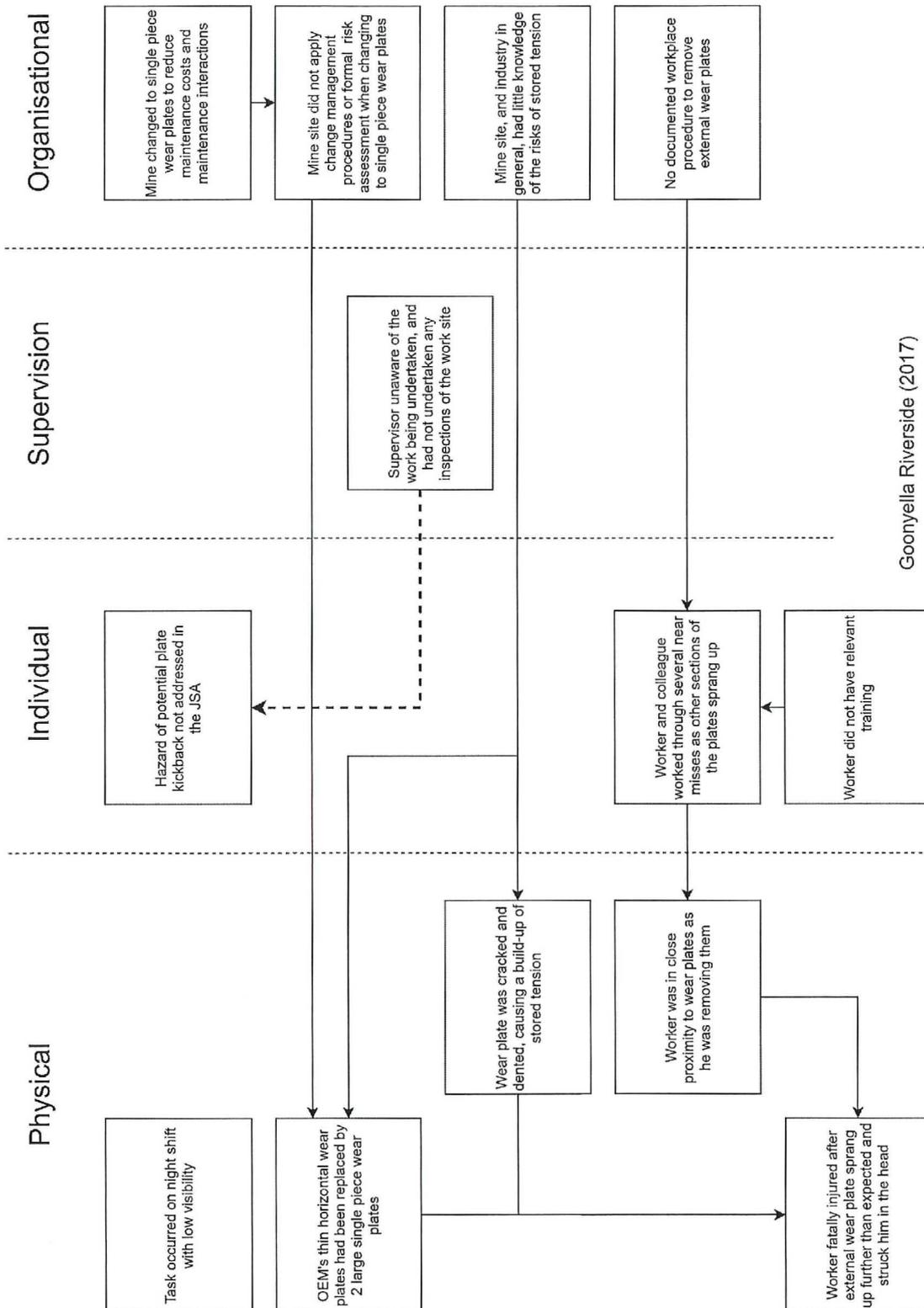


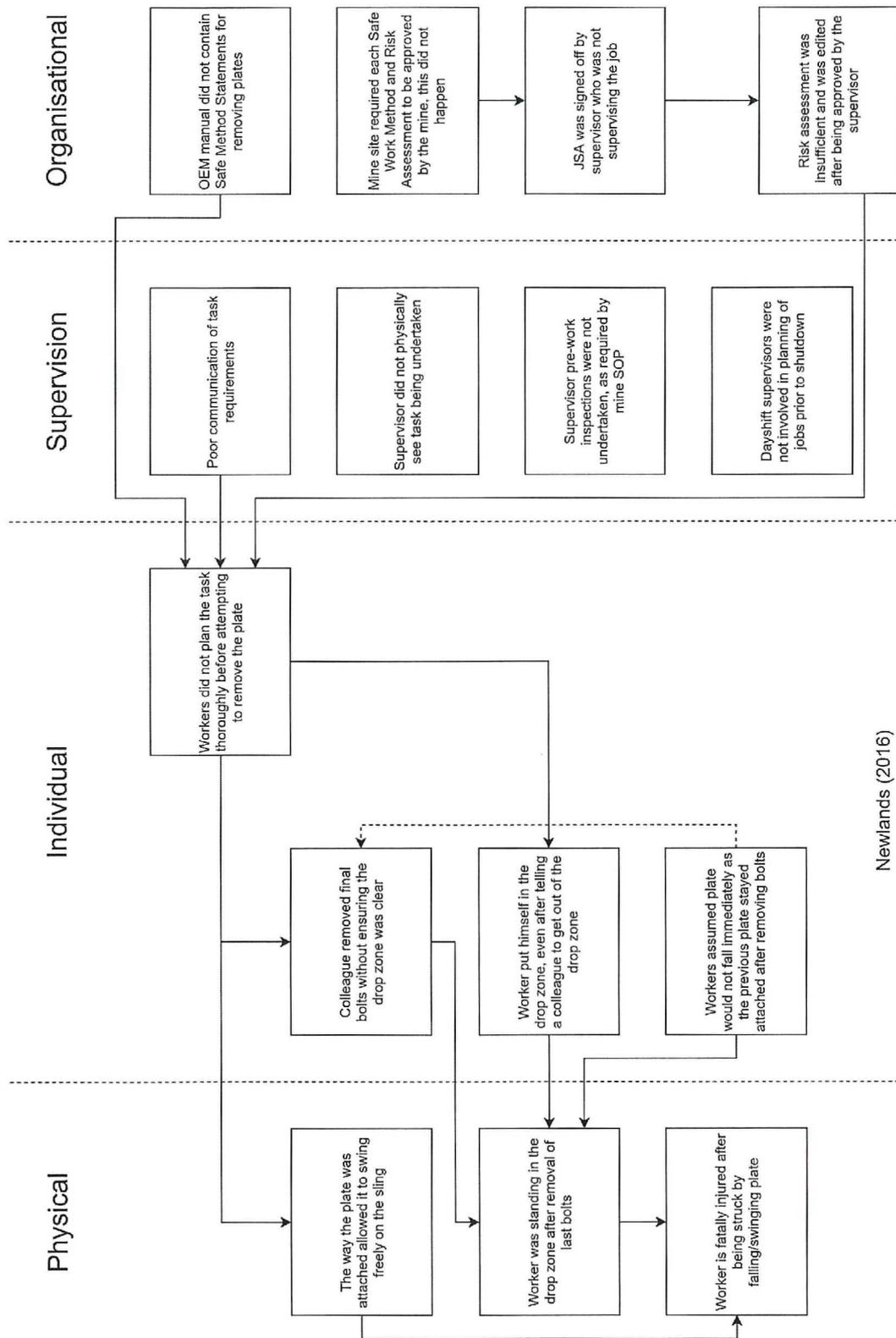


Highway Reward Mine (2002)

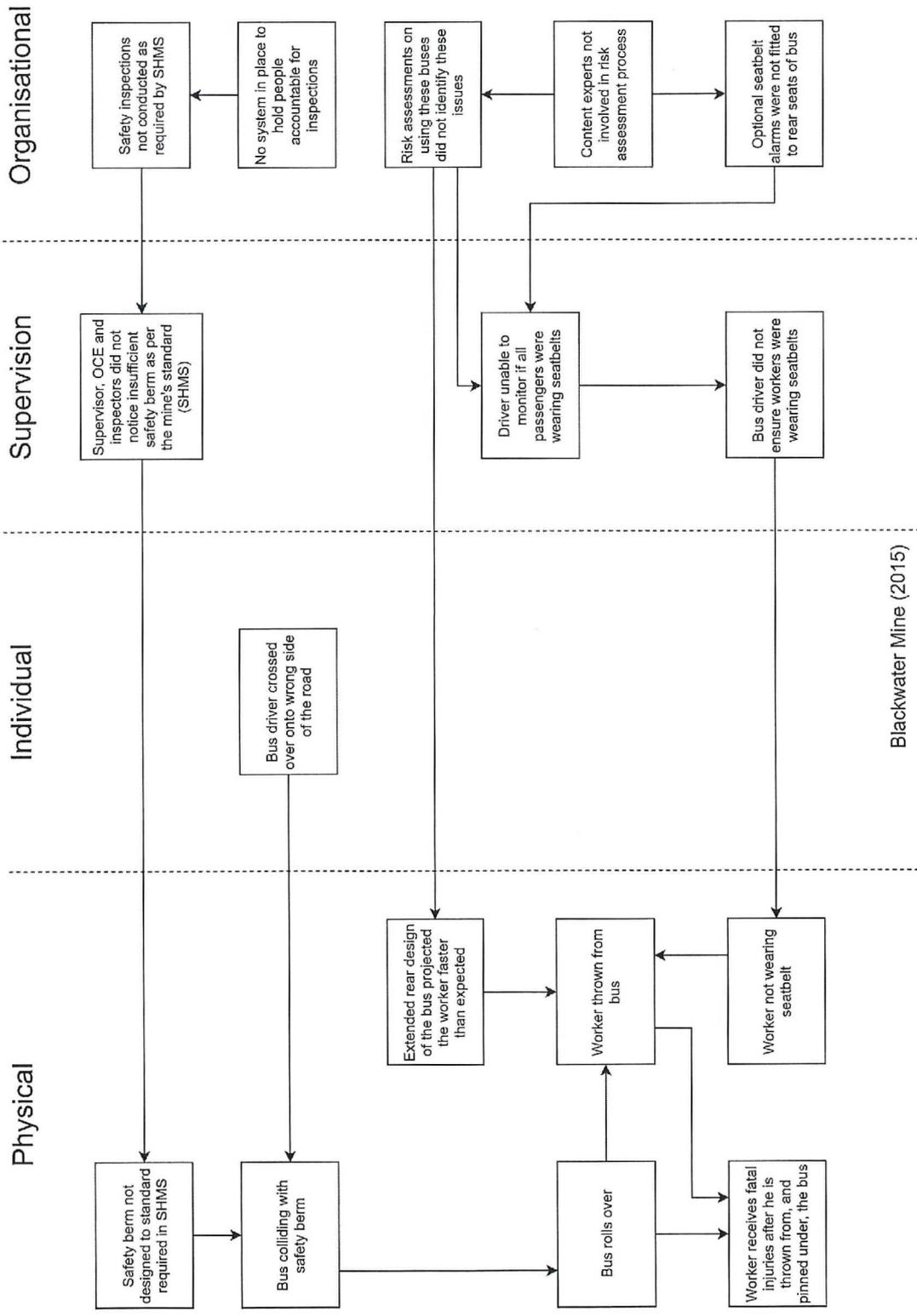




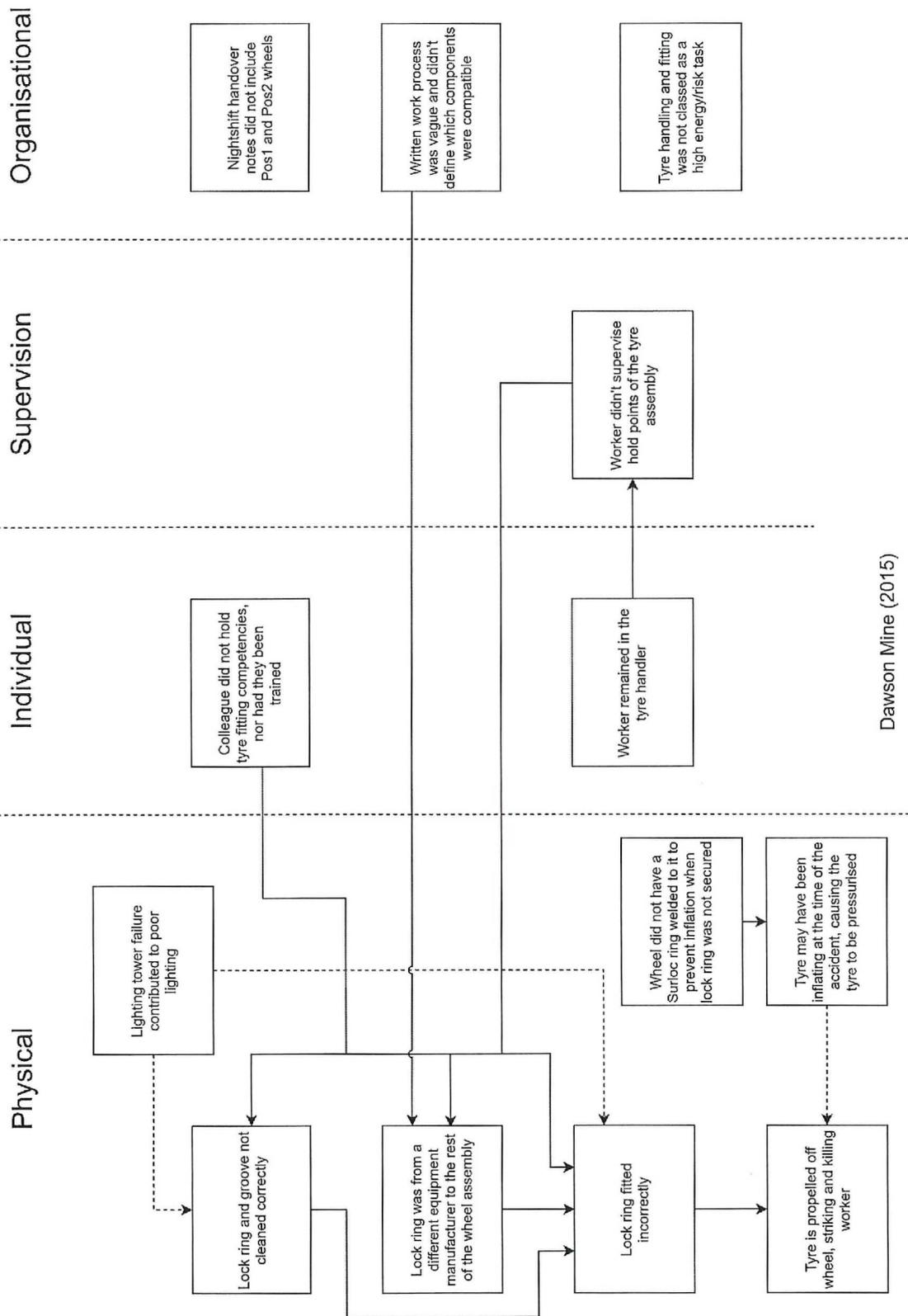




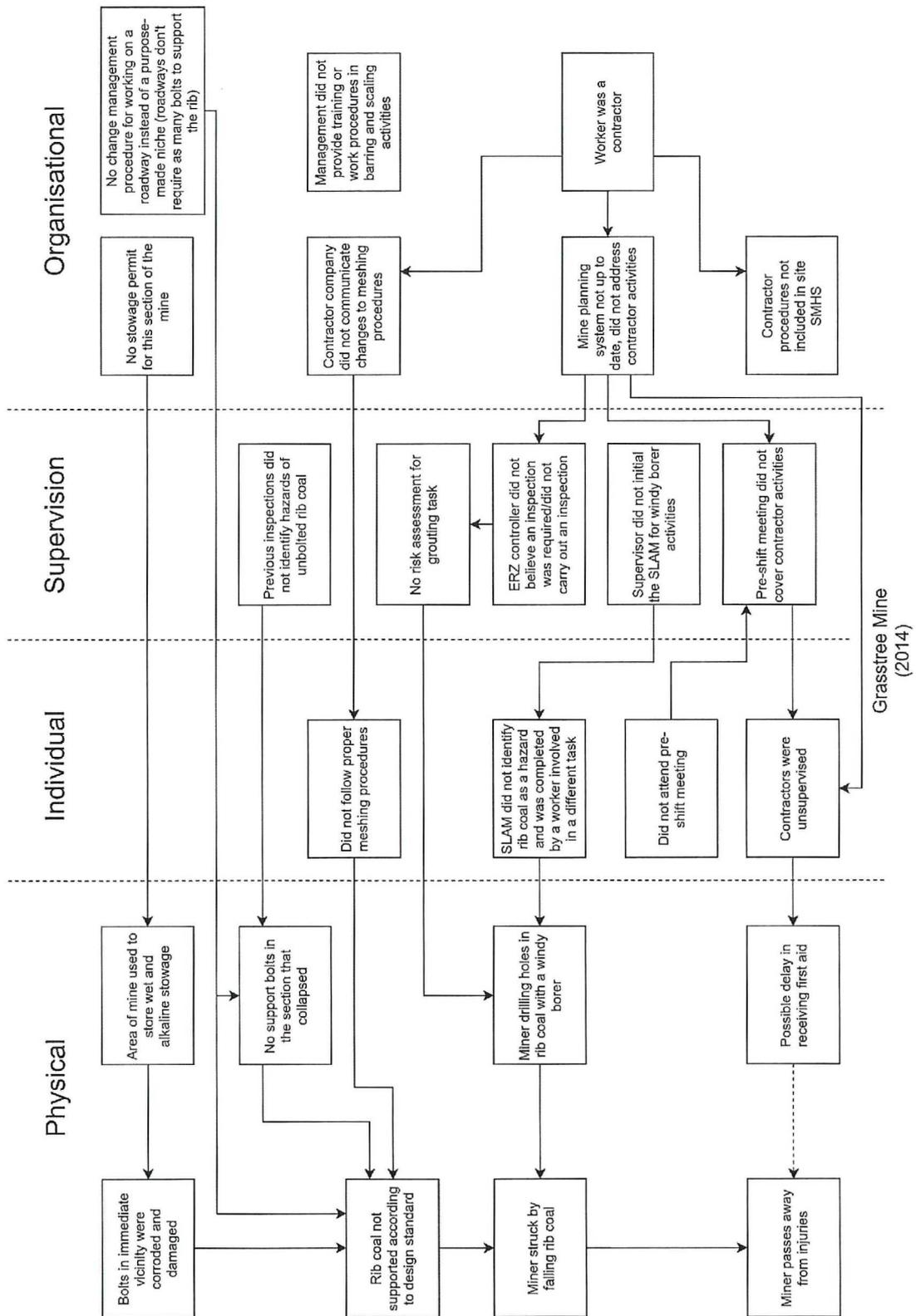
Newlands (2016)

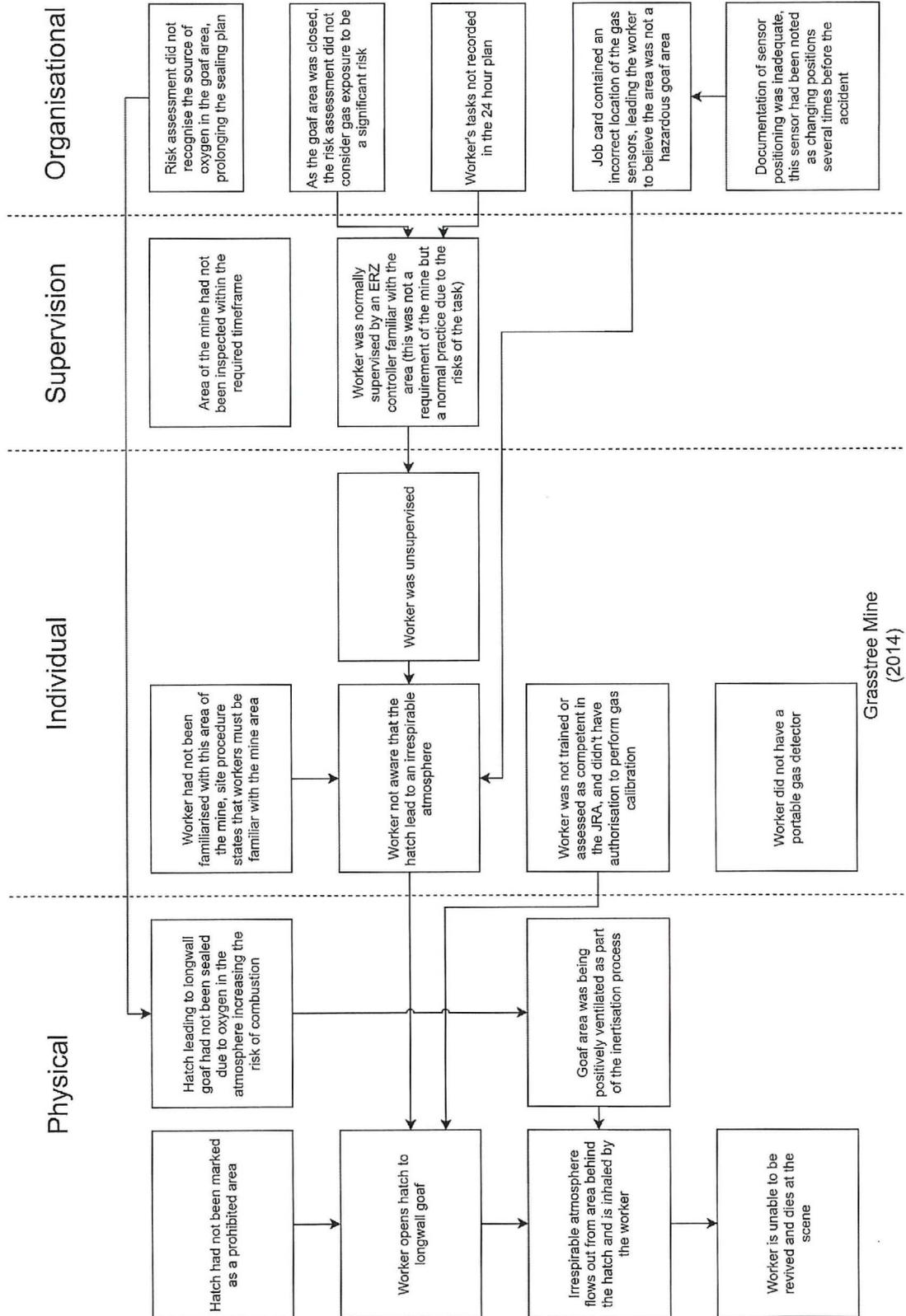


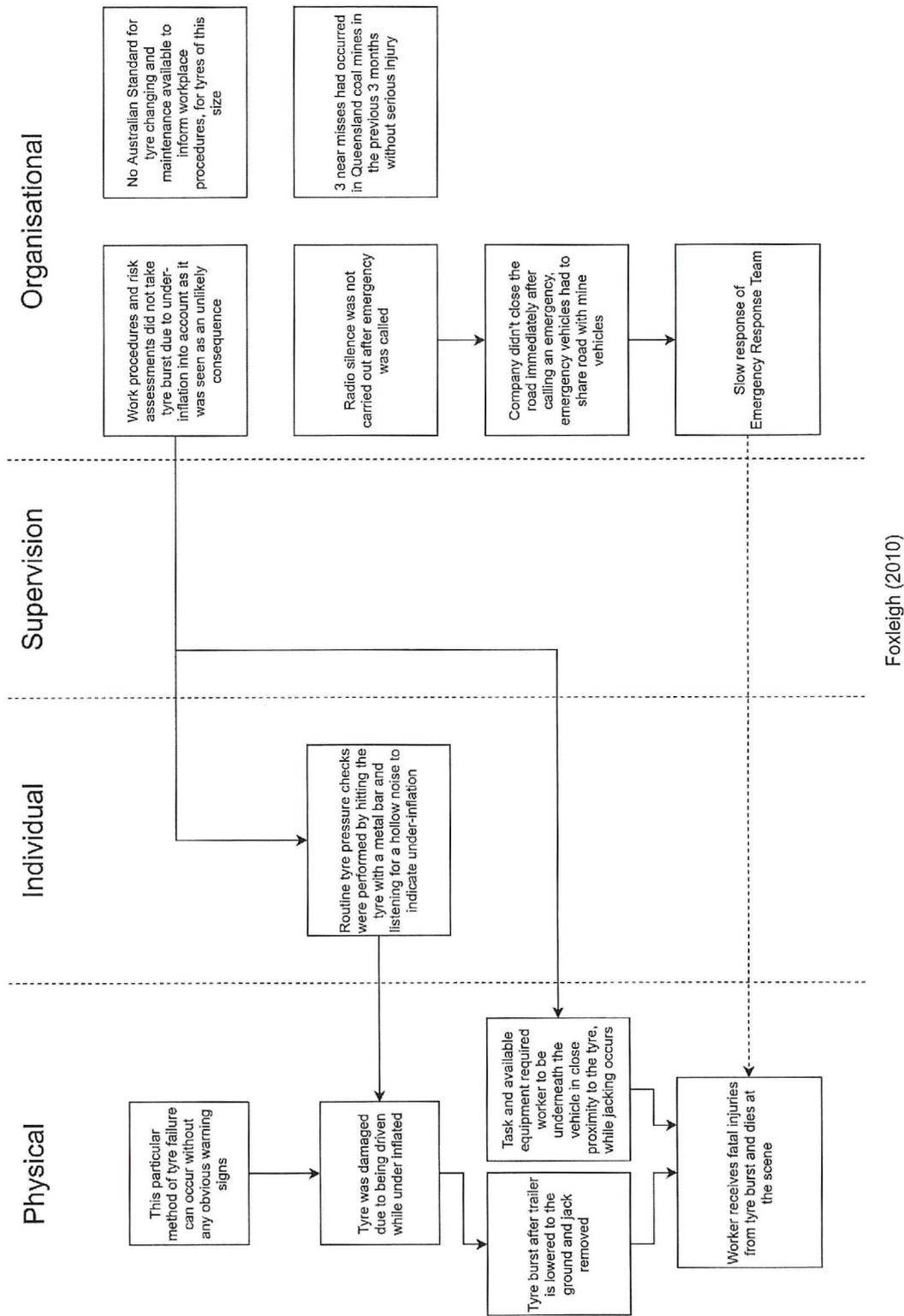
Blackwater Mine (2015)



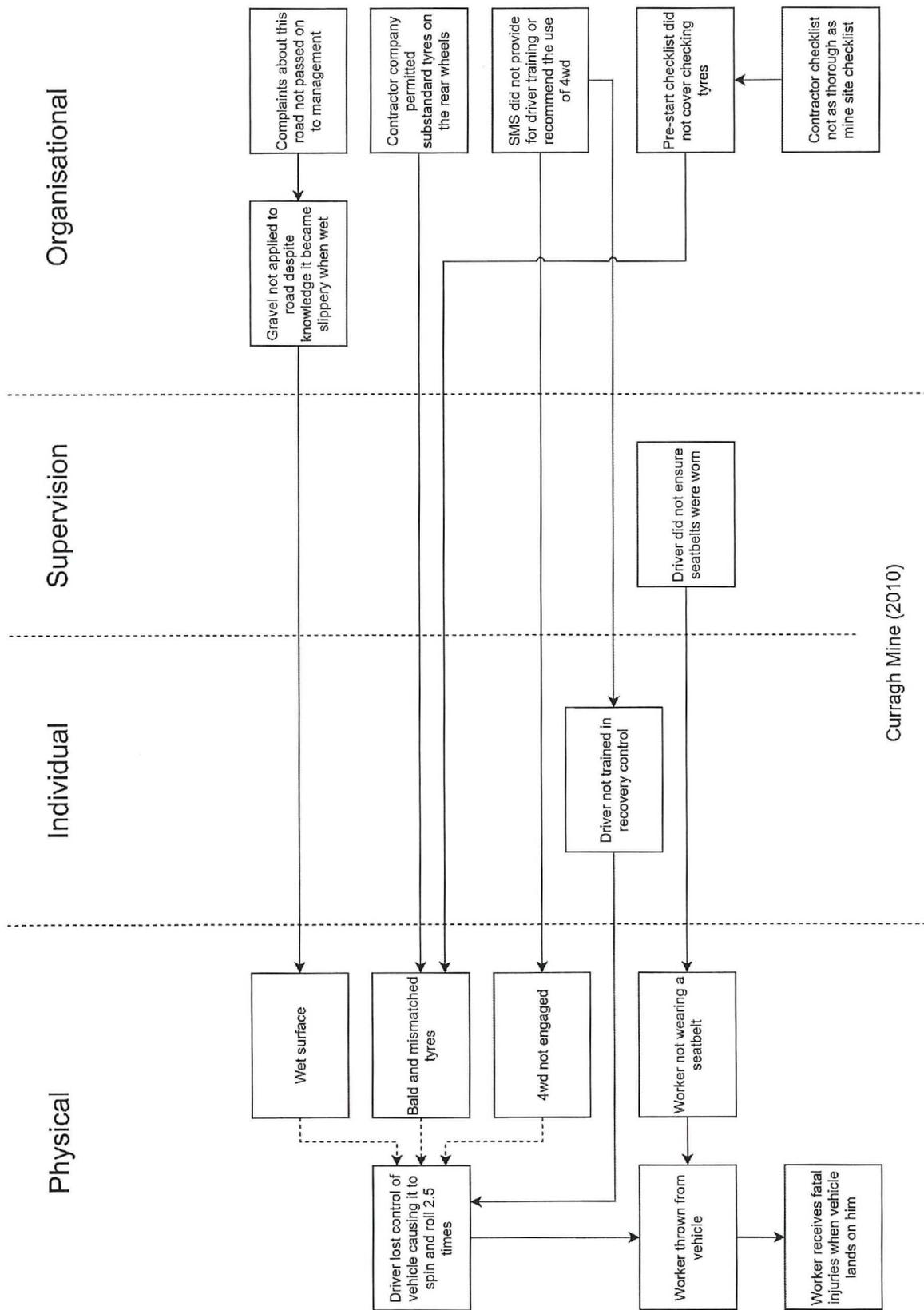
Dawson Mine (2015)



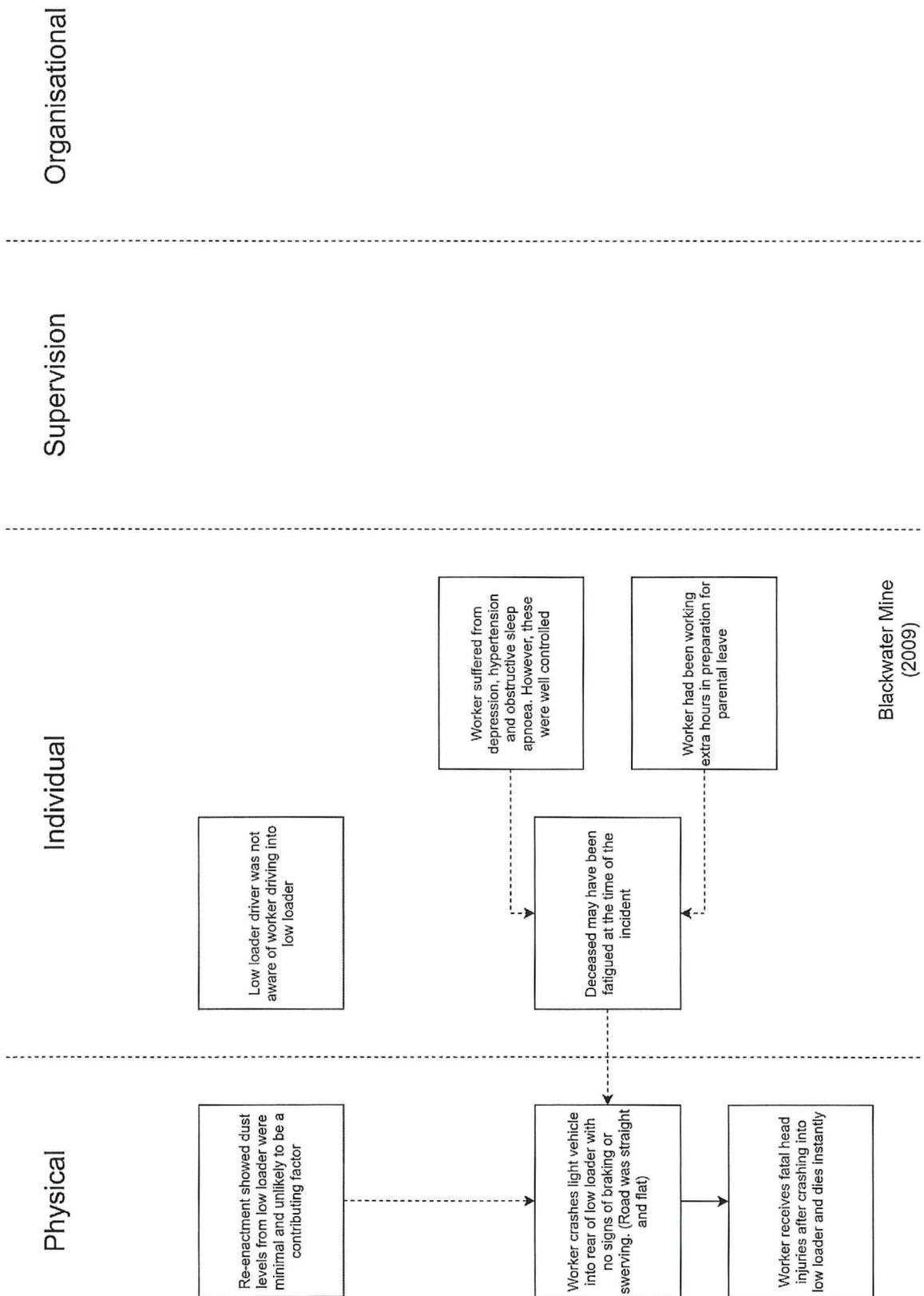


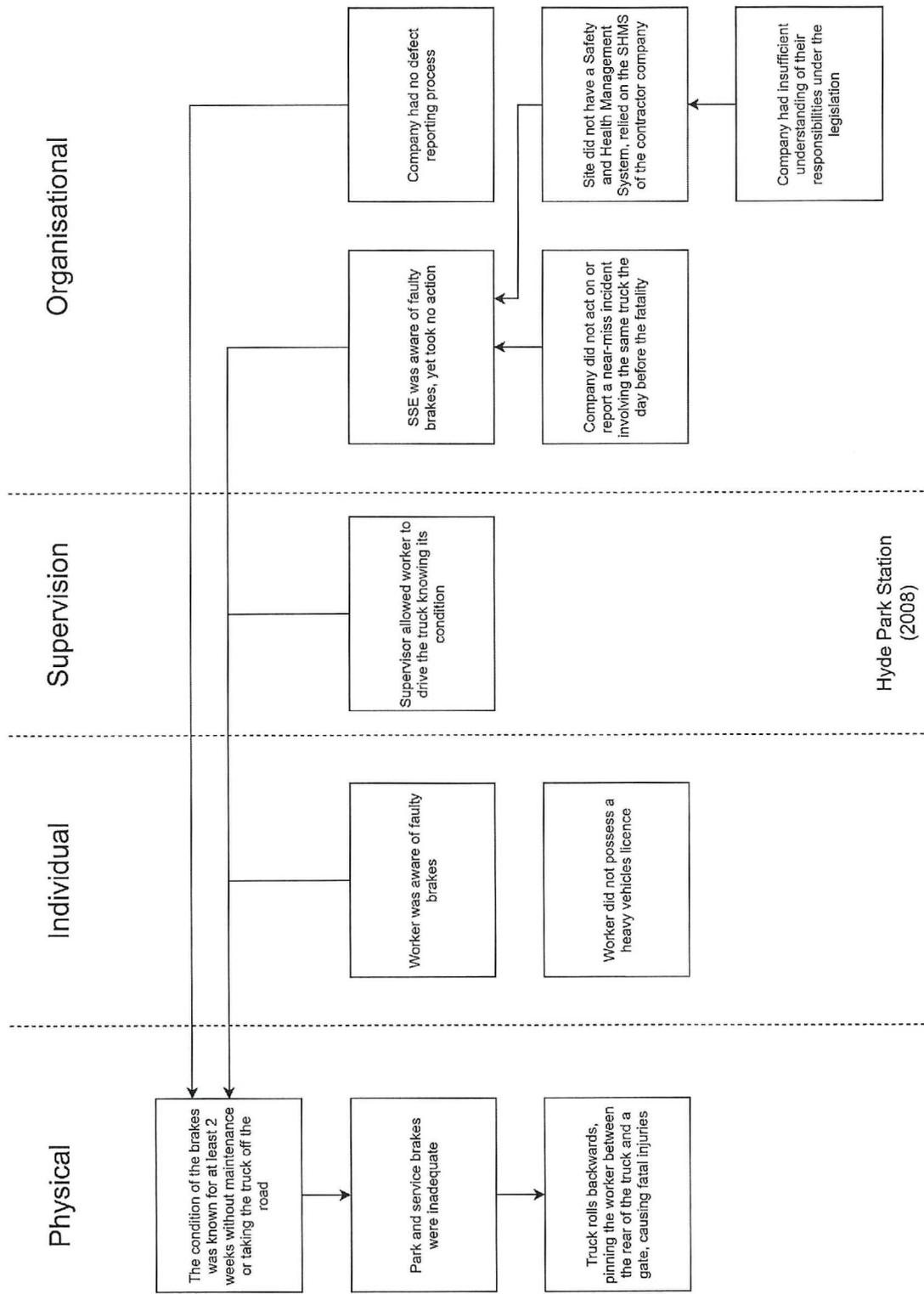


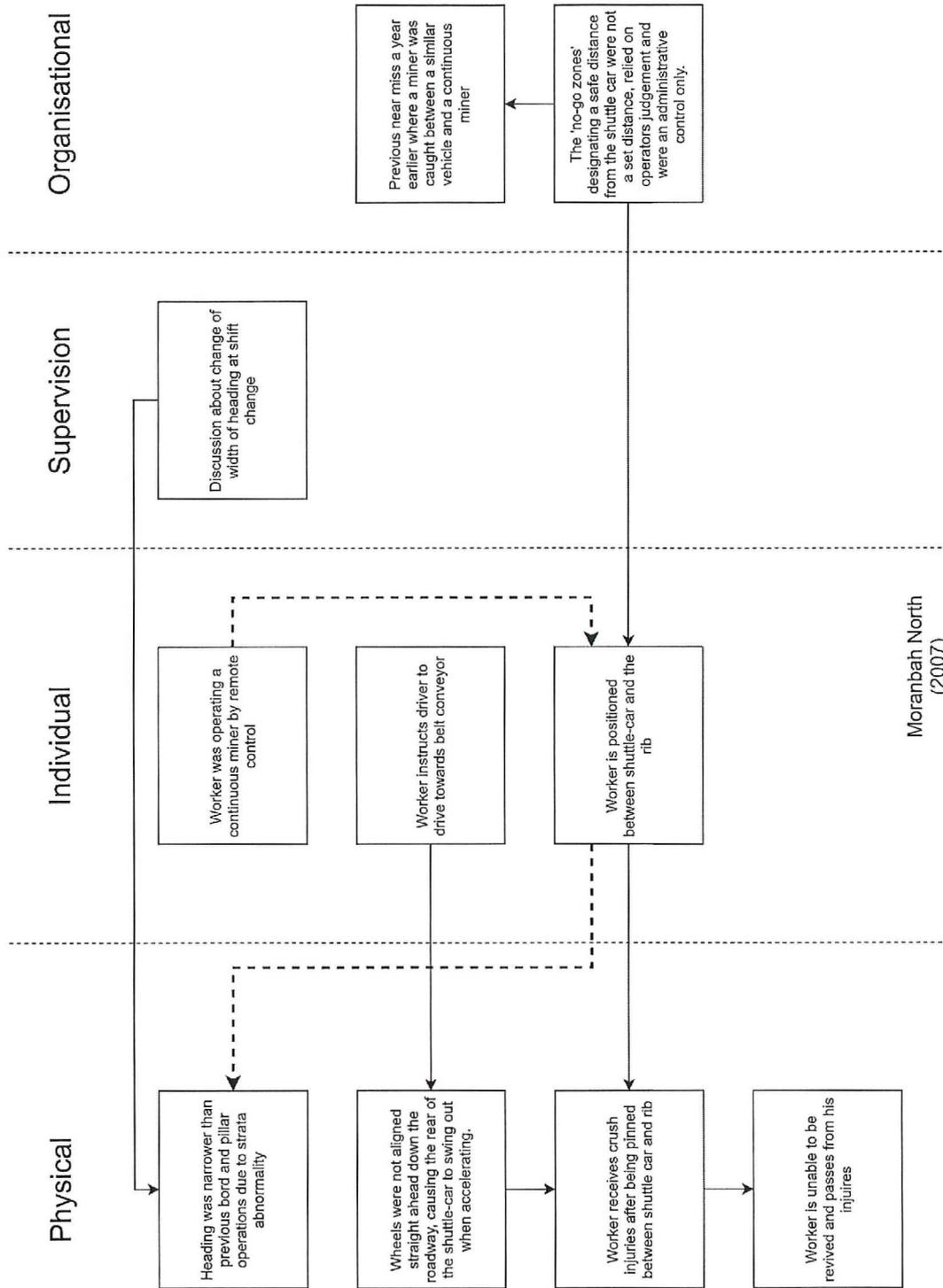
Foxleigh (2010)

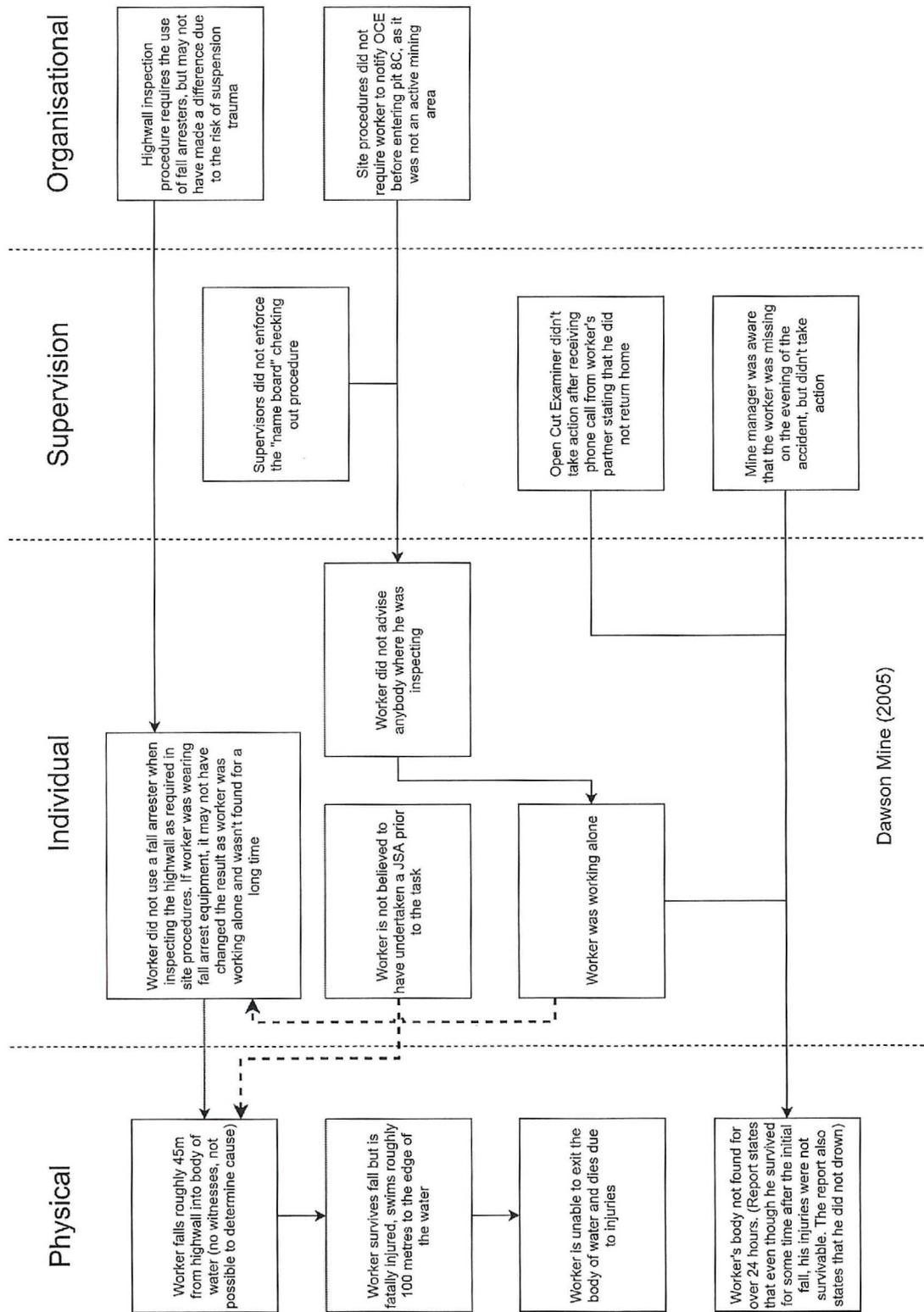


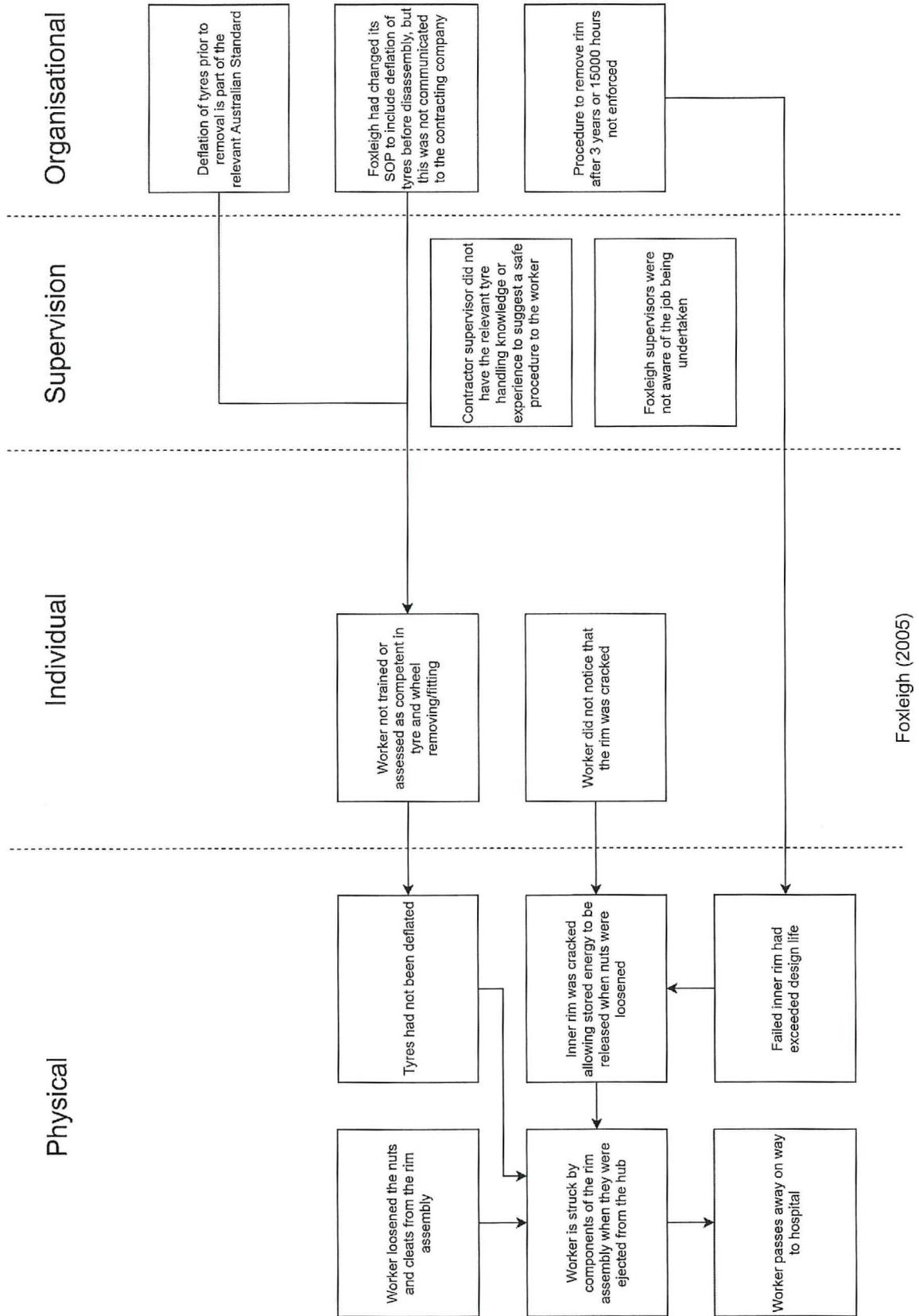
Curragh Mine (2010)



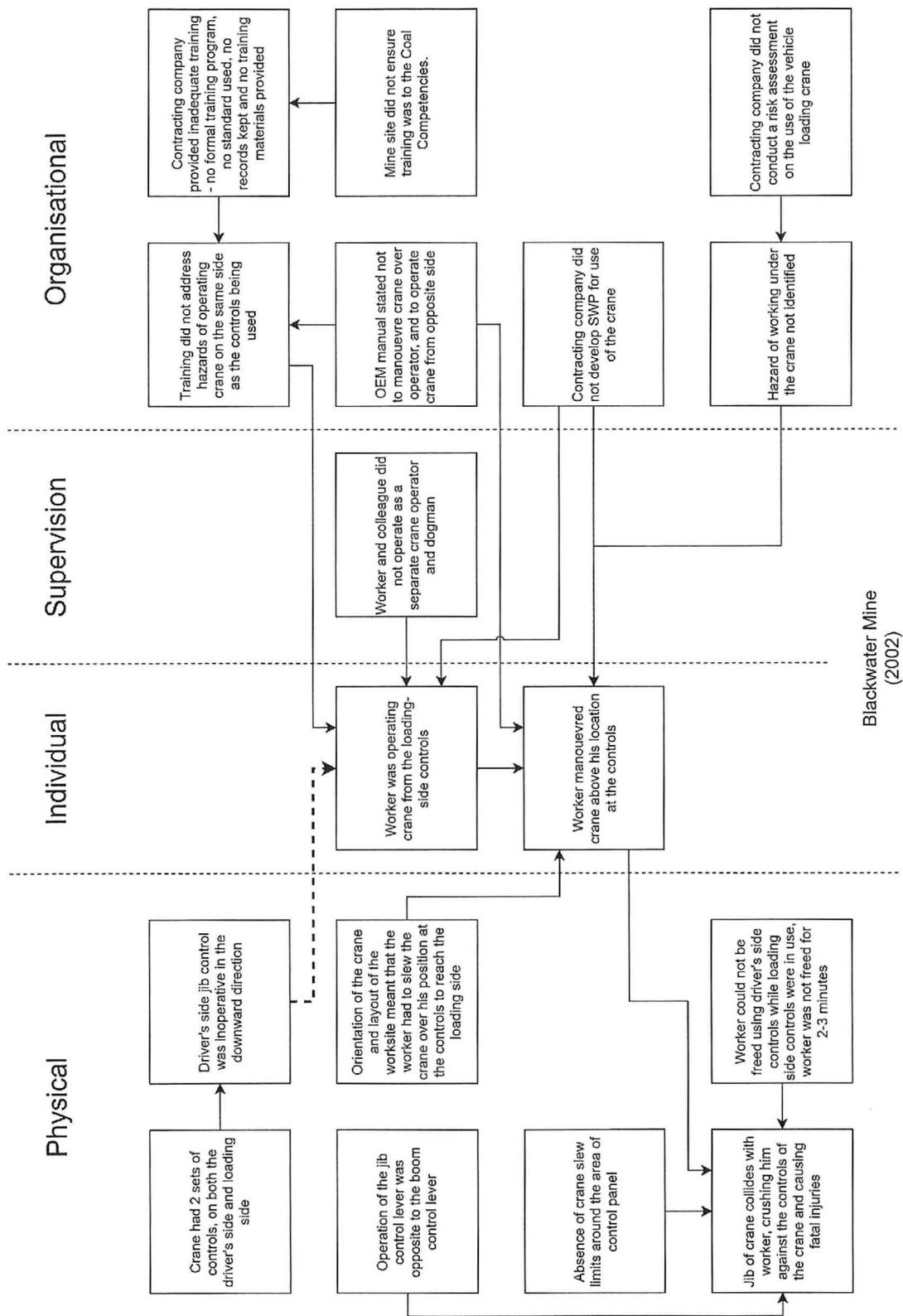


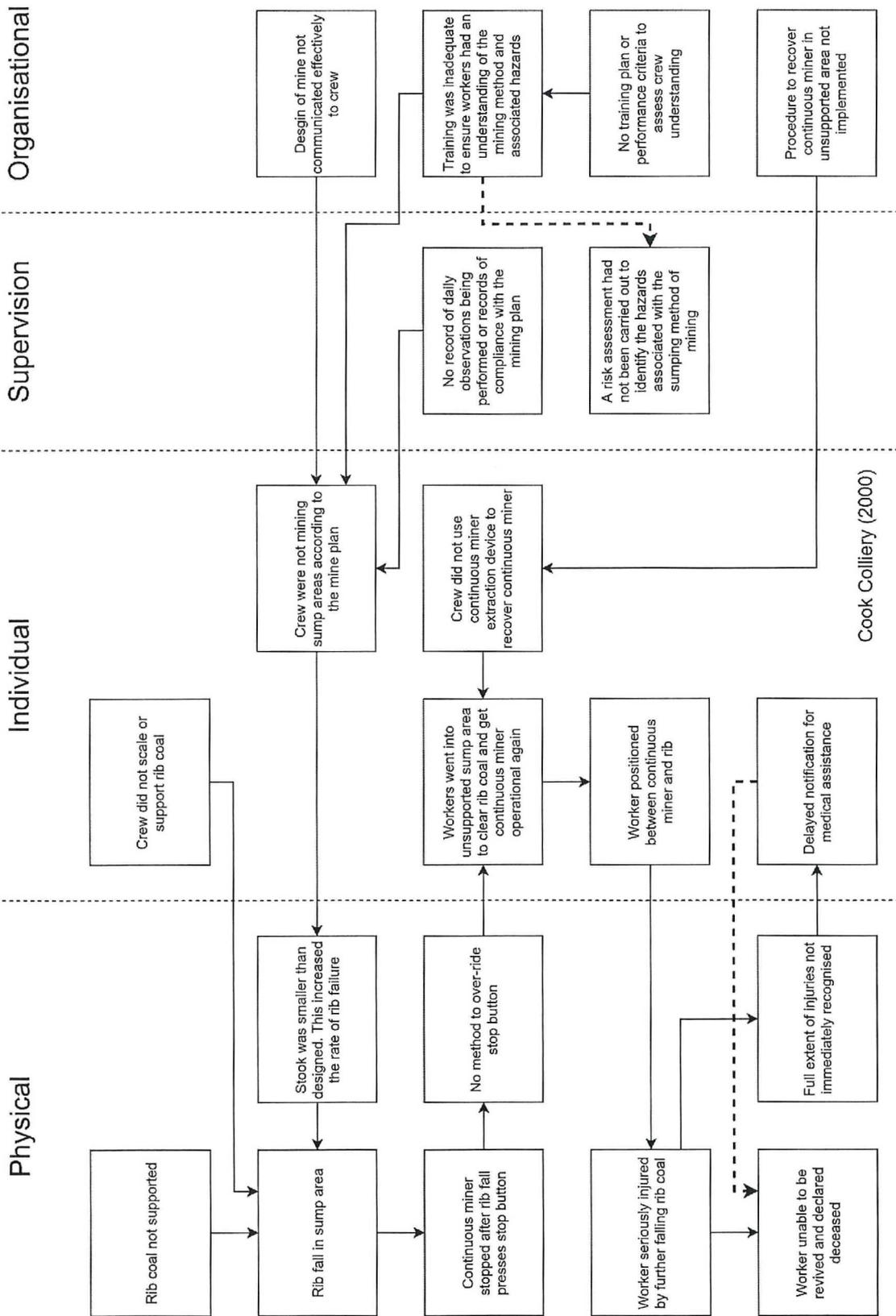


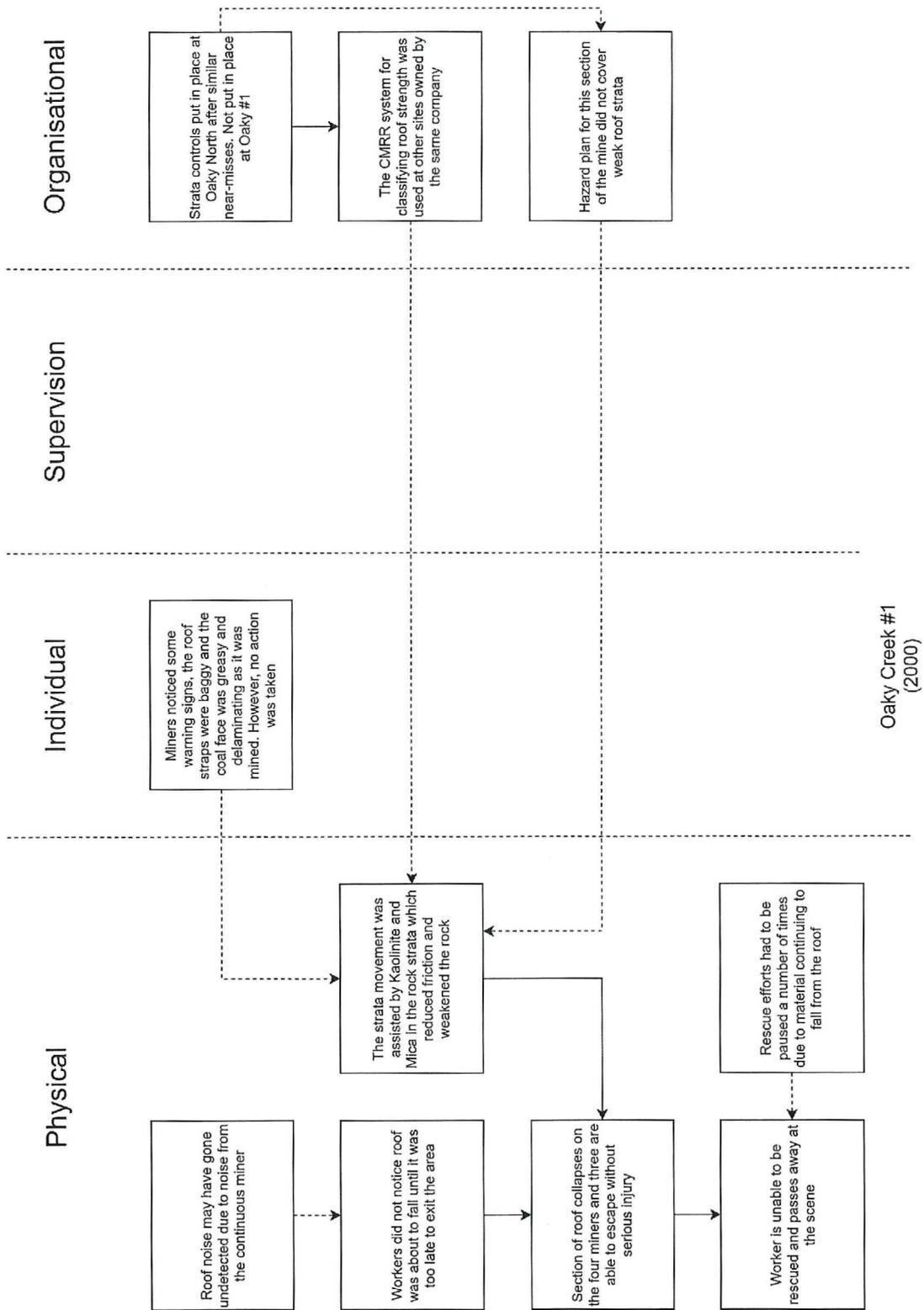


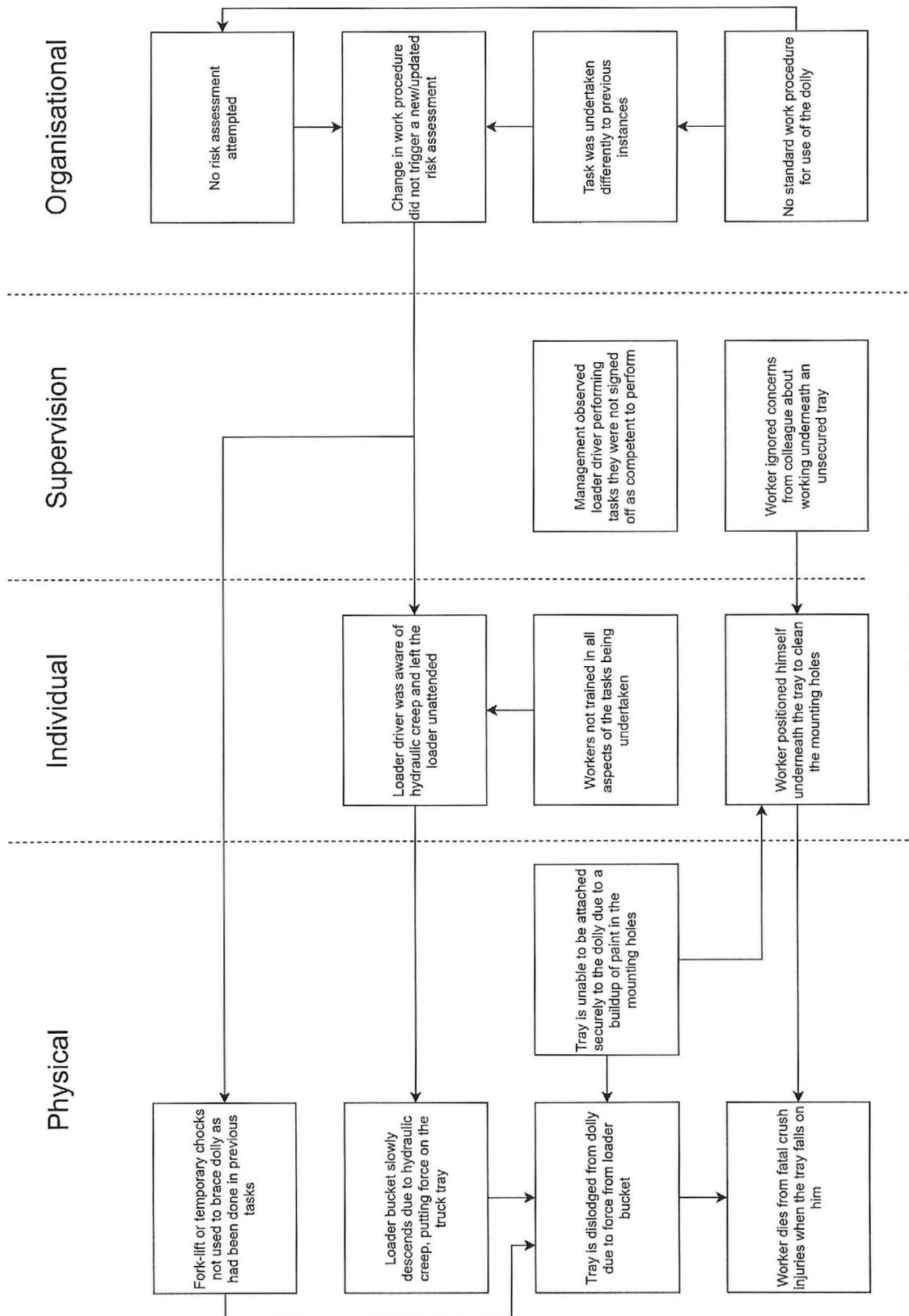


Foxleigh (2005)









Jellinbah Mine (2000)

APPENDIX C

Overview and History of Regulators Data Collection (2000–2019)

Introduction

The purpose of this section is to review the history of the Regulator's incident reporting system from 2000 to July 2019.

Overview of Incident Reporting System from 2000–2019

The key elements of the system are:

Initial notification: An initial notification containing basic information is provided to an inspector by the mine soon after an incident occurs. This notification is only required for Serious Accidents (which includes fatalities) and High Potential Incidents, but can also be submitted for Lost Time Injuries and Non-Reportable Incidents if the mine is unsure whether they need to report or believe they are otherwise significant.

Form 5A: A more detailed description of the incident is provided by the mine to an inspector at a later date. Required for Serious Accidents, High Potential Incidents (including Fatalities) and Lost Time Injuries.

LTAD entry: A verified version of the Form 5A is entered into the Lost Time and Accidents Database (LTAD) by a departmental administration officer after the Form 5A is reviewed. This is a requirement for Serious Accidents, High Potential Incidents and Lost Time Injuries.

Currently, the general process for reporting an incident is as follows:

Incident occurs,

Initial notification:

- i. A mine-worker, usually the Site Senior Executive (SSE), notifies an inspector via phone (optional),
- ii. If the SSE makes the initial notification orally (via phone), the SSE must provide an inspector with written confirmation of the incident within 48 hours, or 24 hours in the case of a fatality. Further, the legislation prescribes specific detail (*primary information*)³⁰ that must be included in the notification if the incident is one of the following:
 - (i) Serious Accidents resulting in a person receiving bodily injuries endangering or likely to endanger the person's life,
 - (ii) Injuries causing or likely to cause a permanent injury to the person's health,
 - (iii) High Potential Incidents of a type prescribed under regulation,
 - (iv) A fatality at a mine, whether or not the fatality was caused by an accident at the mine.
 - (v) Written confirmation and basic information usually provided using Form 1A^{31,32}.

³⁰ S198(3) of the *Coal Mining Safety and Health Act 1999* and s195(3) of the *Mining and Quarrying Safety and Health Act 1999*.

³¹ The Form 1A is a template created by the department which contains areas to enter all information needed to satisfy legislative requirements.

³² Across Coal, there is no one form, many operators have amended it to suit their needs.

- (vi) Inspector records all details from Form 1A into an Incidents Database in Lotus Notes, including selection of appropriate classification options as required³³.

Form 5A:

- i. Mine completes and submits Form 5A via online Portal within 1 month of incident,
- ii. Details from Form 5A automatically entered into MIR Website Submissions database in Lotus Notes (Form 5A Database). This database also collects monthly statistics such as hours worked,
- iii. Form 5A emailed to regional inspector, administration officers and departmental statisticians.

LTAD entry:

- i. Administration officers and mines inspectors review Form 5A for accuracy,
- ii. Administration officers or mines inspectors raise potential issues with mines and resolve them,
- iii. If incident is a Lost Time Injury, mines inspector selects appropriate classification options for 4 additional fields³⁴,
- iv. Administration officers enter corrected information from Form 5A and additional fields completed by mines inspector into the Lost Time and Accidents Database (LTAD) within 1 month of receiving Form 5A. Information entered into HPI section, LTI section or both, as appropriate. If entered into both, administration officer links the two records,
- v. Administration officers link Form 5A record in Website Submissions database in Lotus Notes to matching Form 1A record in Incidents database in Lotus Notes.

Since 2000, this system has undergone a number of changes:

- 1 In 2000:
 - a) Mine provides initial notification of incident via phone call to inspector,
 - b) Form 1A exists in paper form. It is a general notification form, not limited to the reporting of incidents. It is held in inspectorate offices and completed by departmental staff based on information provided by mines,
 - c) Form 5A exists in paper form. It is broadly similar to the current Form 5A. It is issued to mines, which submit them to the inspectorate after an incident, via post or fax. Form 5As are not linked to Form 1As. Reporting of Lost Time Injuries had been in place for over a decade by 2000, but reporting of High Potential Incidents had been implemented only a few years earlier,
 - d) LTAD exists electronically. It is essentially the same as it is in 2019.
- 2 In 2004:
 - a) Details of initial notification begin to be recorded electronically by inspectors in the Incidents Database. A review of the data suggests that there may have been a transition period to electronic recording - the number of records gradually increased over a period after 2004 before stabilising. For a short period of time, some members of the Coal Inspectorate recorded initial notification details electronically in the File Notes database in Lotus Notes, instead of the Incidents database³⁵.
3. In 2011:
 - a) An electronic version of Form 5A is introduced. Form is to be completed by the mine, and is accessed via website, requiring valid Mine ID and email to enter. Once

³³ These classification options include the hazards involved in the incident, and the type of incident that occurred.

³⁴ The additional fields completed by mines inspectors are 'Breakdown Agency', 'Agency of Injury', 'Mechanism of Injury', and 'Occurrence Class'

³⁵ The total number of notifications recorded in the File Notes database was less than 300.

the electronic form was submitted, it is automatically entered into the Form 5A Database, and sent as an email to administration officers, and departmental statisticians. The paper version of Form 5A was discontinued at this time³⁶. The data suggests that industry may have taken some time to adjust to the electronic Form 5A system³⁷.

4. In 2012:

- a) Serious Accidents are introduced as a classification option in the Incidents Database for inspectors to select when recording an incident (if appropriate). Prior to this, whether an incident was considered a Serious Accident or not wasn't recorded in the Incidents database, in the Form 5A, or in LTAD, and could only be inferred from descriptions.

5. In 2014:

- a) Additional fields and classification options were added to the Form 5A in anticipation of the implementation of the National Mine Safety Framework (NMSF). This framework was not implemented, but would have aligned incident reporting fields and classification options across states. As the framework was not implemented, these changes were not carried across to LTAD.

These changes are summarised in Figure 1.

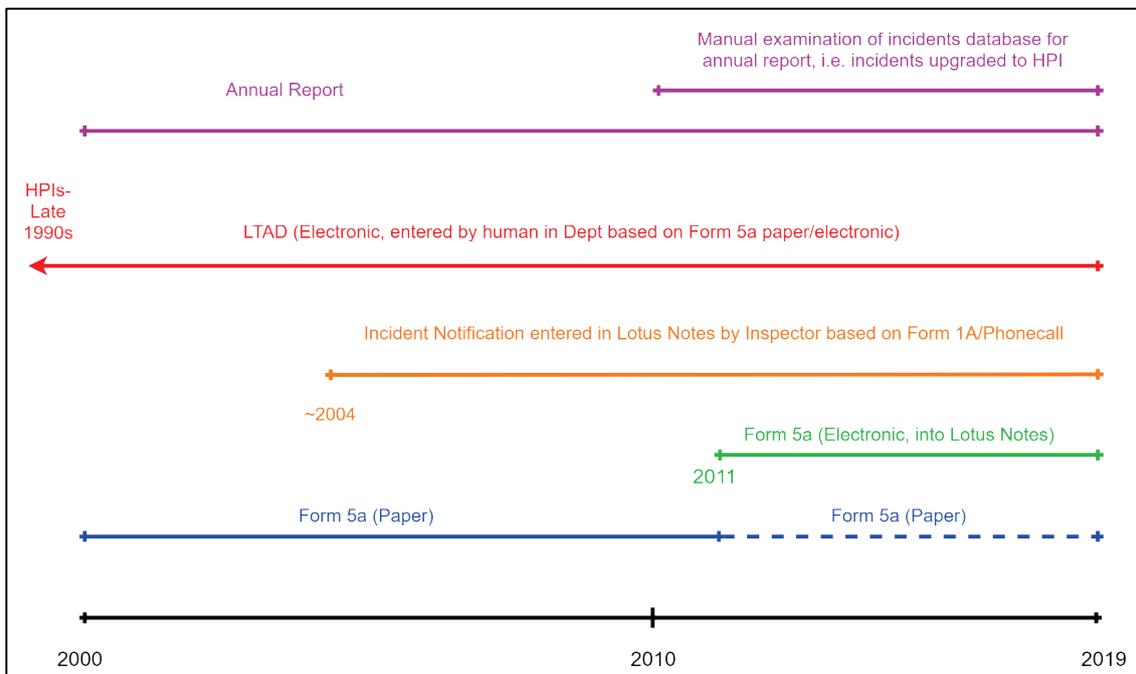


Figure 1 Timeline of changes to incident reporting system

Based on the above, the status of the data held by the Regulator, prior to this review, can be summarised as follows:

LTAD is based on data from both the paper and electronic versions of the Form 5A and covers the review period. While this may appear to be the most complete dataset, it does not definitively identify an incident as a Serious Accident in the way that the Incidents Database does from 2012 onwards. Additionally, LTAD does not contain all the HPIs – there are HPIs recorded in the Incidents Database, which never had a corresponding Form 5A submitted, which meant they were not recorded in LTAD. Also, as LTAD stores records of HPIs and LTIs separately, they must be recombined to generate a complete dataset before use. LTAD does not include the fields completed by inspectors when entering a record in the Incidents Database,

³⁶ However, paper version was still accepted if mine submitted an old one. In this case, no electronic record would be entered to Website Submissions database in Lotus Notes, but LTAD entry would still be completed.

³⁷ During the period of 2011 to 2014, we see a substantial number for HPIs entered in the Incidents database in Lotus Note without a corresponding Form 5A in the Website Submissions database in Lotus Notes or a corresponding entry in LTAD.

nor does it include the fields added to the Form 5A in anticipation of the implementation of the NMSF,

Lotus Notes contains the data identified as absent from LTAD above. However, neither the Incidents or Form 5A Databases span the entire period back to 2000. The Incidents Database covers the period from 2004 onwards, but only specifically records Serious Accidents from 2012. The Form 5A Database covers the period from 2011 onwards. This database does not collect all of the information that a mine enters online. The data has been limited for the NMSF and what was considered relevant to collect to prove the database concept before ultimately moving away from LTAD. Both databases also omit the 4 additional fields completed by a mines inspector when creating a LTI entry in LTAD.

The regulator has attempted to manage these issues when creating the Annual Mining Safety and Health Performance Report. It is understood that the annual report was prepared as follows:

LTAD forms the primary data source for the report. Prior to the 2009–10 annual report, it was the only data source used for incident statistics,

From the 2009–10 annual report onwards, the Regulator has manually examined the Incidents Database to check whether incidents that were not classified as HPIs should have been classified as such, and also to identify incidents that should have an entry in LTAD, but don't have one as no Form 5A was submitted. Incidents that should have been classified as HPIs were counted towards statistics. Incidents in the Incidents Database that should have had a corresponding entry in LTAD were also counted towards statistics as appropriate³⁸.

Based on the above, this approach taken by the Regulator is considered reasonable – the Annual Report remains the best record of the actual number of incidents, specifically HPIs, that are occurring in the industry.

³⁸ While this process was undertaken, these corrections were not carried across to LTAD or the Form 5A Database. Instead, these amendments are recorded in a separate series of Excel Spreadsheets.

APPENDIX D

Incident Statistics (2000–2019)

Current Manner of Data Collection

Fundamentally, the Regulator requires that a mine reports a fatality as soon as practicable, and a Serious Accident, LTI, or HPI within 48 hours³⁹. Then within 30 days the mine provides follow-up details on the event or incident⁴⁰. This information is collated and stored by the Regulator in various systems, namely Lotus Notes and the *Lost Time Accident Data* (LTAD) database⁴¹.

The Regulator's current reporting system is cumbersome, ambiguous, time consuming, prone to data entry errors and difficult for the industry to use⁴². This is largely because it is a product of its evolution over the past 19 years: Additional requirements have been added onto the system, elements of the system have changed, and some elements have moved from being paper based to electronic.

A key aspect of this reporting process is coding various types of information for the incidents. For example, the reporting involves completing many *free-text fields*⁴³ (e.g., a description of how the accident occurred), and *selection fields*⁴⁴ (e.g. hazard, equipment involved, location of incident).

Each of these fields have several *classification options*⁴⁵, e.g., under the equipment involved field, the *classification options* included Dozer, Grader, etc. A review of the coding of incidents showed a considerable number of *classification options* were available, but the industry only used very few on a regular basis.

Data Integrity Issues

Following a detailed examination of the Regulator's incident data, significant data integrity issues were encountered, including:

- No single system, neither Lotus Notes nor LTAD, captured all of the events, incidents or data reported to the Regulator. For example, Lotus Notes included many events that were not included in LTAD⁴⁶,
- There were mismatches between information stored in Lotus Notes and LTAD,
- The datasets contained duplicates, some of which were obvious, while others remained less obvious.

Based on these findings a process to improve the integrity of the dataset was undertaken. These steps included:

- Combining all of the data from the various data sources, removing duplicates and resolving conflicting data,

³⁹ The report is captured on what is known as a Form 1a, which is stored in Lotus Notes.

⁴⁰ This report is completed using a Form 5a, and stored in LTAD and Lotus Notes.

⁴¹ LTAD means Lost Time Accident Database.

⁴² A history of data collection is provided in Appendix C.

⁴³ A field is a specific piece of information entered when filling out a form. A free-text field is a field that allows the user to type their own response.

⁴⁴ A selection field is a field that requires the user to select from a set of classification options provided by the form. A selection field may allow for the selection of only one classification option, or multiple classification options.

⁴⁵ A classification option is one of a set of predetermined responses that can be selected when completing a selection field.

⁴⁶ This appears to have been because of an absence of a Form 5a for the incident. The incident was reported on a Form 1a, and was recorded in Lotus Notes, but the absence of a Form 5a meant the same incident was not included in LTAD. Note that the incident statistics provided in the annual reports do appear to include these 'missing' events, which is appropriate.

- Introducing a greatly simplified set of fields and classifications for events and incidents. This simplification focused on significantly reducing the number of available reporting classifications and removing ambiguity,
- Each of the circa 40,000 events and incidents were then manually checked to ensure that the classification coding matched the incident descriptions.

These steps are considered to have significantly improved both the dataset's accuracy and simplicity. Any errors remaining in the dataset are considered minor and highly unlikely to alter the conclusions and recommendations of this report.

Additional Charts

Figure 2 reproduces the distribution of fatalities per sector.

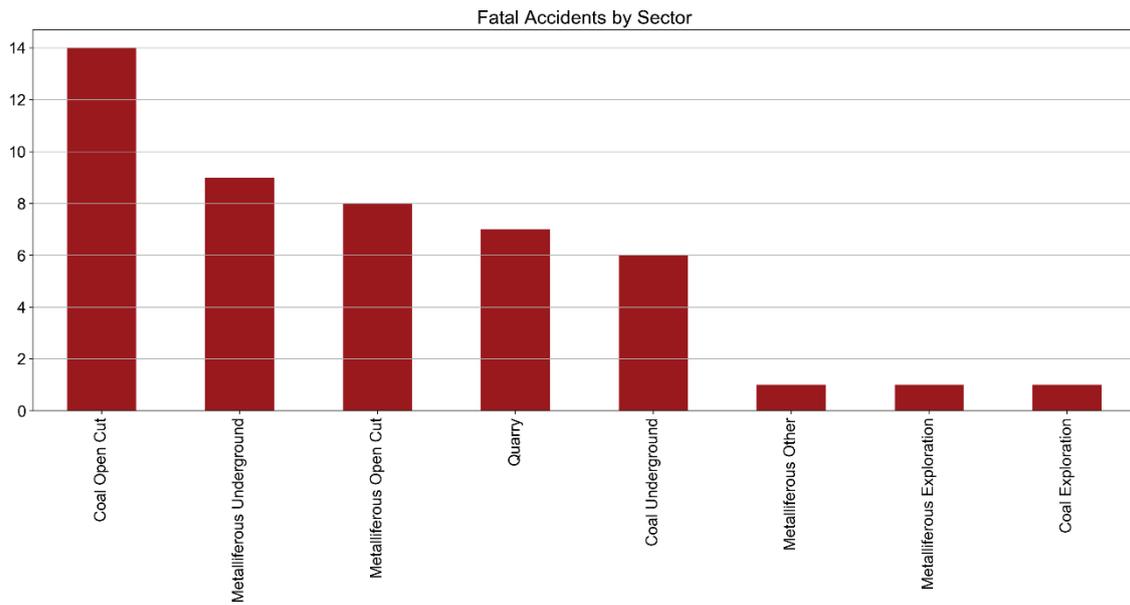


Figure 2 Distribution of Fatalities per Sector

Figure 3 shows the boxplot for the number of Serious Accidents per million hours worked per sector⁴⁷. The box plots are based on yearly totals for both Serious Accidents and hours worked.

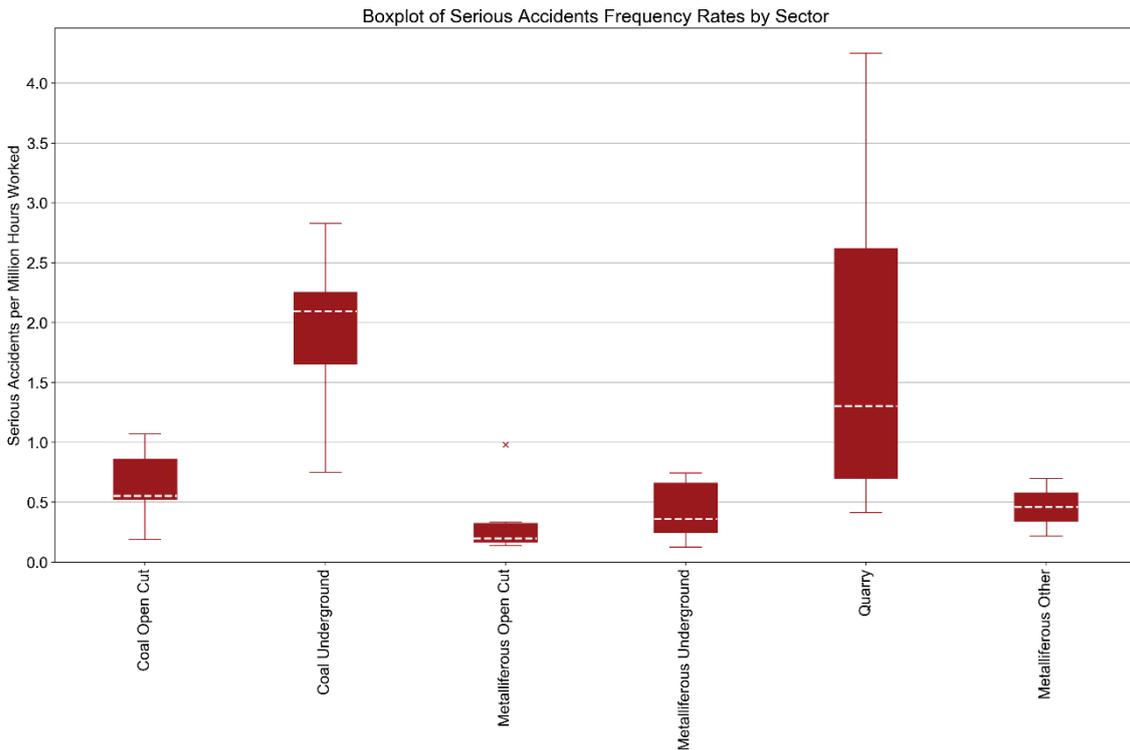


Figure 3 Boxplot of Serious Accidents per million hours worked per sector

⁴⁷ A boxplot provides a picture of the distribution of data. The horizontal line in the centre of each blue rectangle marks the median observation – 50% of observations have a value higher, and 50% have a value lower. The rectangle contains 50% of the overall observations, while the top and bottom 25% are distributed along the lines extending from the top and bottom of the rectangle. Outliers – values significantly different from the other observations – are excluded and are marked by crosses.

Excluding coal and materials exploration, mineral quarries had the highest rate of Serious Accidents. These box plots also indicate that the typical rate of Serious Accidents is between 0 and 2.5 per million hours worked, with some variation among the sectors.

Figure 4 shows the hazards for Serious Accidents.

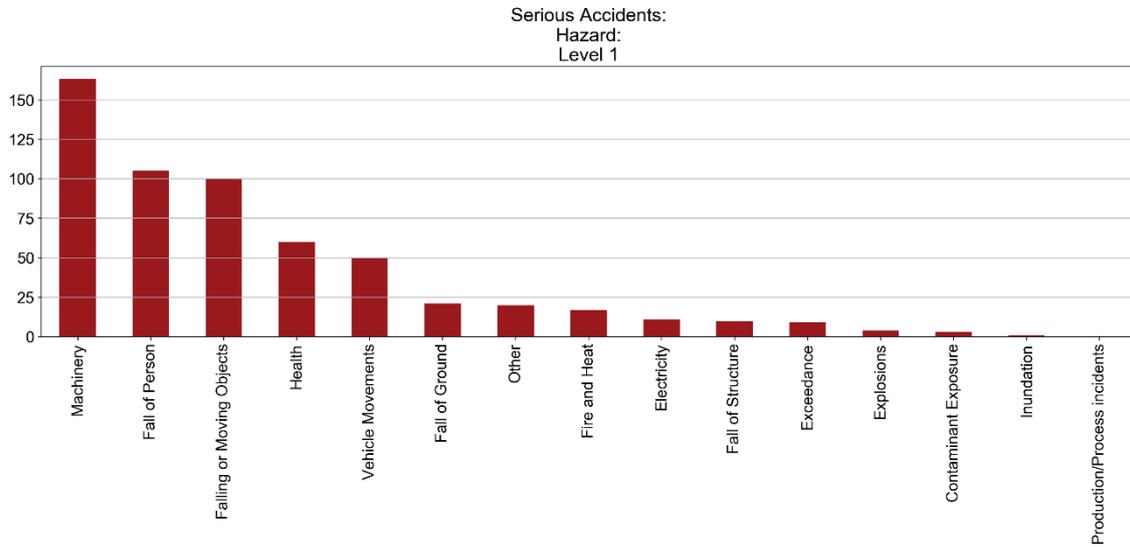


Figure 4 Hazard for Serious Accidents

Machinery was the most common hazard for Serious Accidents, followed by falls of people, and then falling or moving objects. Figure 5 shows a breakdown of machinery related Serious Accidents. Getting caught in a nip point is a major cause, as is entanglement. Laceration by a sharp object and being struck by moving machinery also remains high.

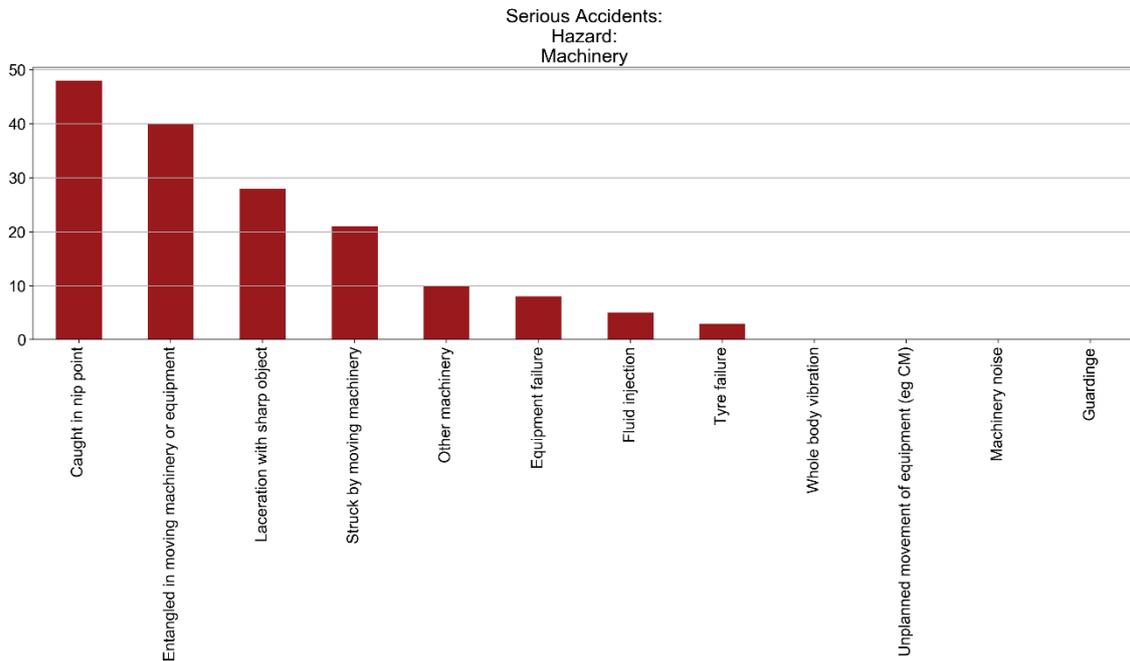


Figure 5 Machinery related incidents

Figure 6 show a further breakdown of vehicle movement related Serious Accidents.

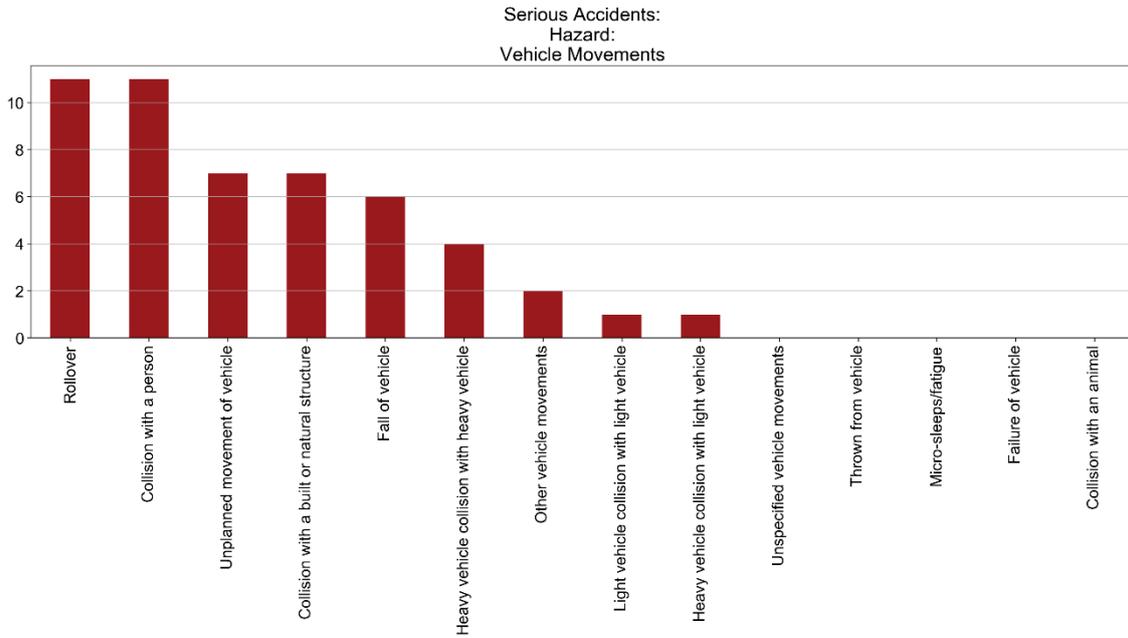


Figure 6 Breakdown of vehicle movements

Figure 7 shows the occupation of those involved in a Serious Accident. Miners were involved in the largest number of Serious Accidents, with fitters and truck operators also recording significant numbers.

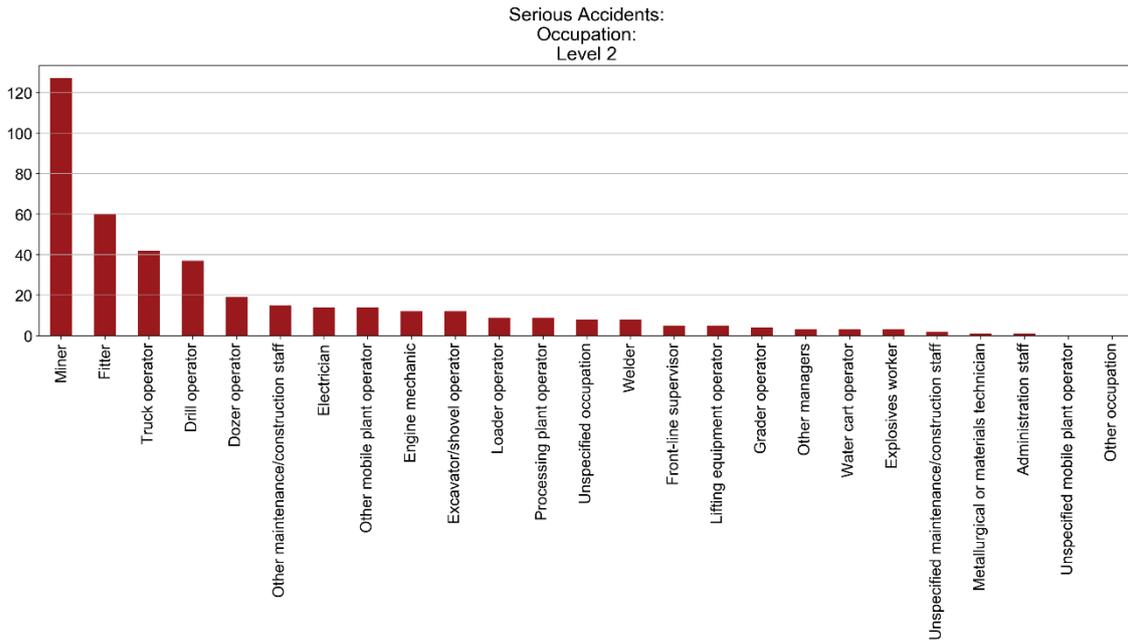


Figure 7 Occupation of person involved in a Serious Accident

Figure 8 show the body location where the injury was sustained.

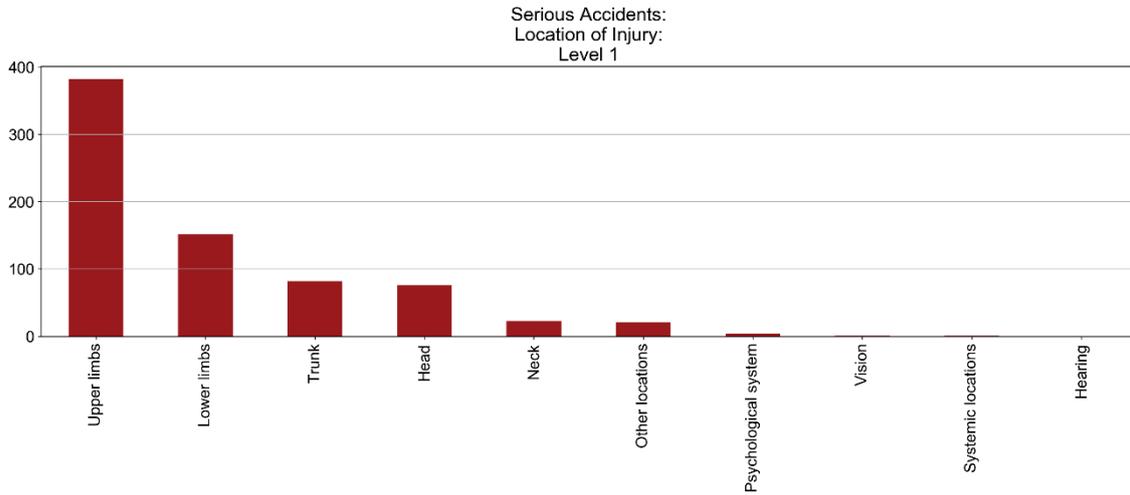


Figure 8 Body location where injury occurred ⁴⁸

Figure 9 provides a further breakdown on the body location. Injuries to fingers are the most common, followed by the hands, thumbs and lower leg.

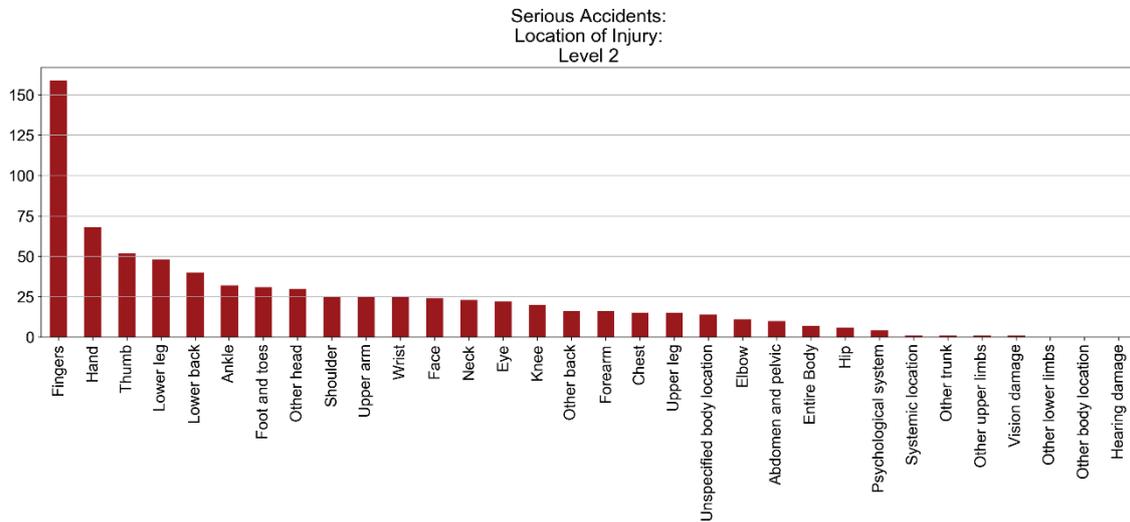


Figure 9 Further breakdown of body location

Figure 10 shows the Serious Accident body location for employees and contractors.

⁴⁸ In some cases, it is possible for numerous body parts to be affected. These charts present the overall total of body locations, and therefore will total more than the number of discrete accidents.

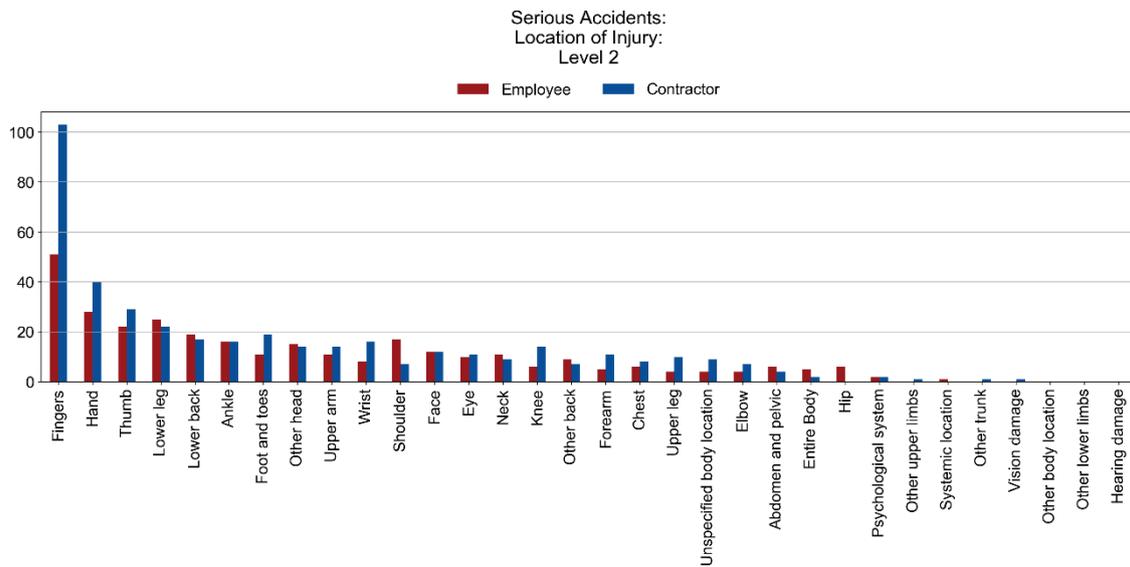


Figure 10 Location of Injury for Serious Accidents for Employees and Contractors

Figure 11 provides an overview of the number of HPIs reported per million hours worked per industry sector⁴⁹. The box plots are based on yearly totals for both HPIs and hours worked.

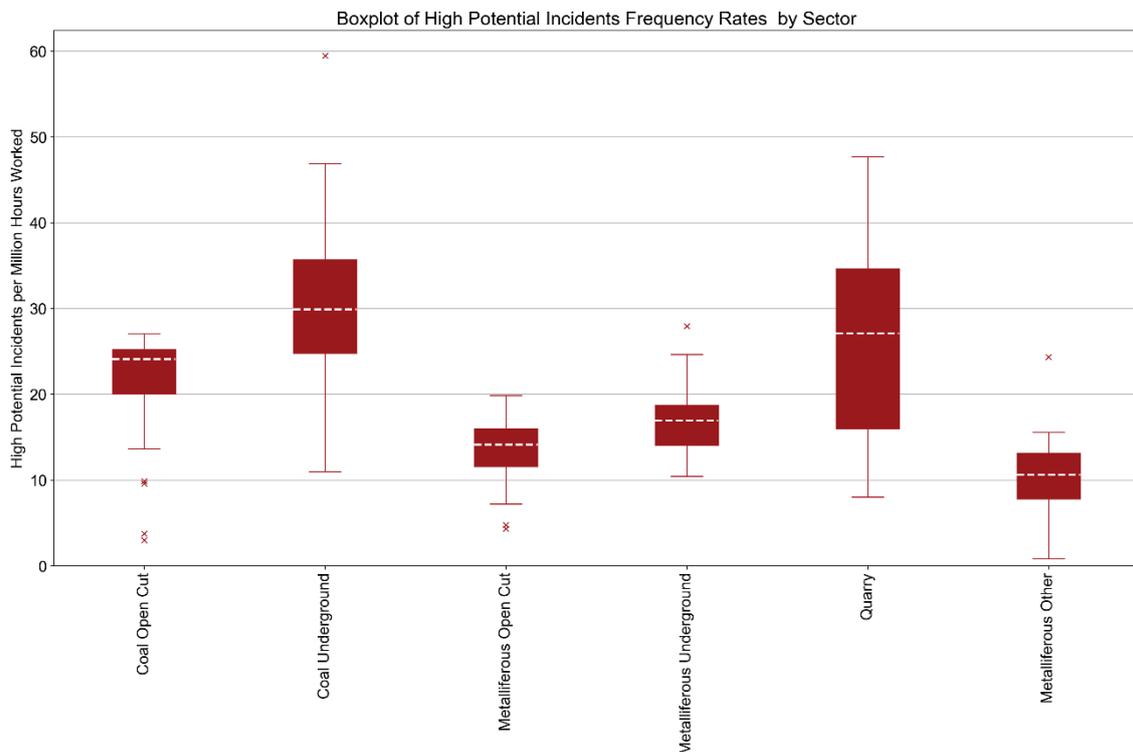


Figure 11 Boxplot of HPIs per million hours worked per sector ⁵⁰

On average the HPI rate for underground coal is higher than the other industries. Quarries also have a high HPI rate, with the lowest rates being for minerals open cut and mining other.

⁴⁹ The boxplots are based on the yearly number of HPIs reported per sector, divided by the number of hours worked in that year per sector.

⁵⁰ A boxplot provides a picture of the distribution of data. The horizontal line in the centre of each blue rectangle marks the median observation – 50% of observations have a value higher, and 50% have a value lower. The rectangle contains 50% of the overall observations, while the top and bottom 25% are distributed along the lines extending from the top and bottom of the rectangle. Outliers – values significantly different from the other observations – are excluded and are marked by crosses.

Figure 12 shows the hazards for HPIs. The largest number of HPIs occur because of vehicle movements, fire and heat, and electricity.

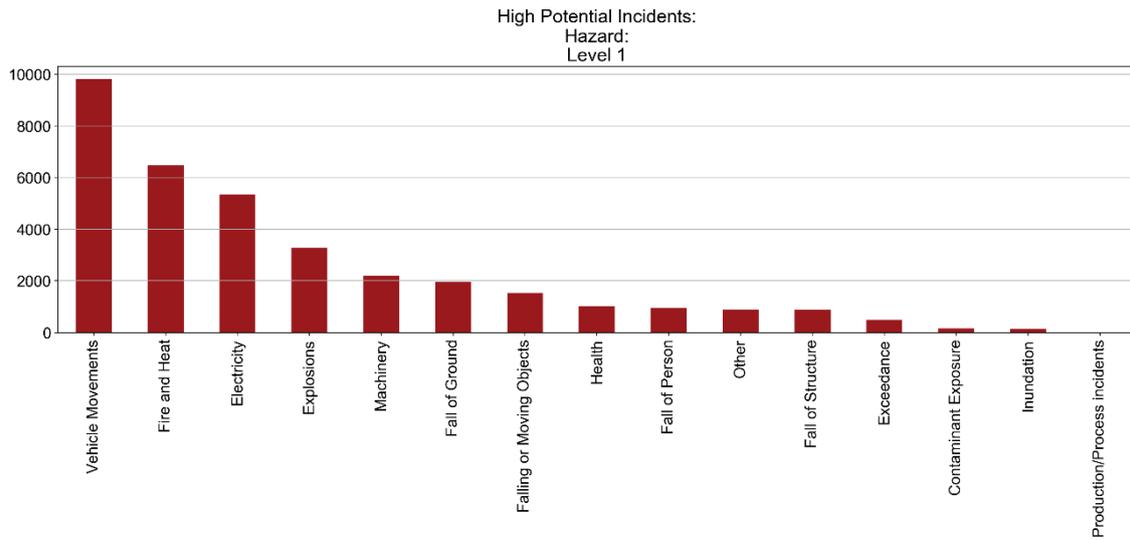


Figure 12 Hazards for HPIs

Figure 13 shows the hazards for Serious Accidents, included here for comparison purposes.

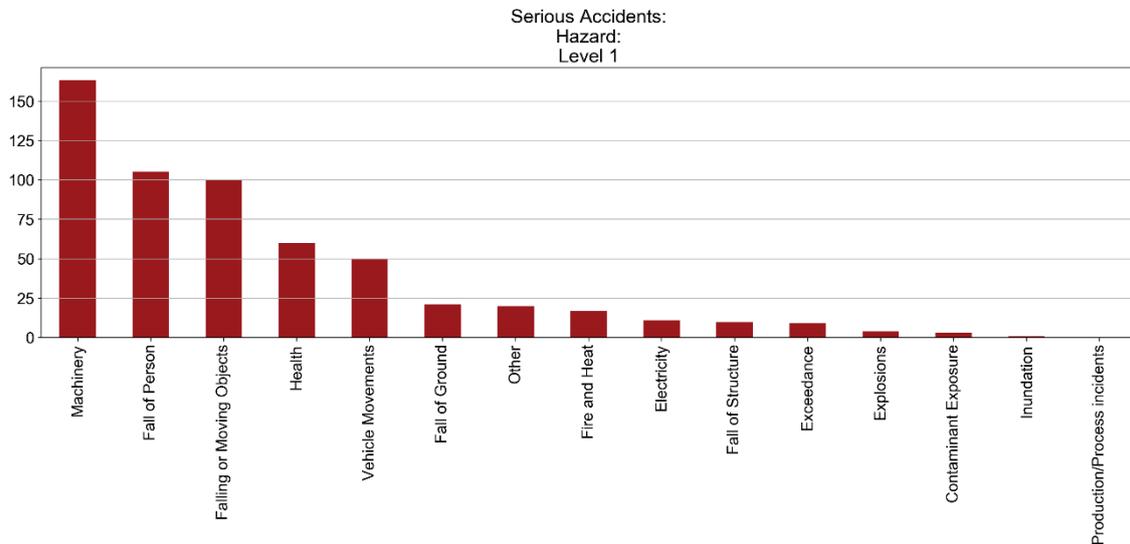


Figure 13 Hazards for Serious Accidents

The figures are quite different – while the largest source of HPIs were vehicle movements, fire and heat, and electricity, the largest sources of Serious Accidents were machinery, fall of person, falling or moving objects, health, followed by vehicle movements and fall of ground.

Also of interest is the ratio of HPIs that were also Serious Accidents. For vehicle movements there were circa 10,000 HPIs and 50 Serious Accidents. This is not surprising, many near misses are to be expected with vehicles, without them necessarily resulting in an injury. Contrast this ratio with Machinery, where there were circa 2,000 HPIs and 160 Serious Accidents.

Figure 14 shows the breakdown of vehicle related HPIs.

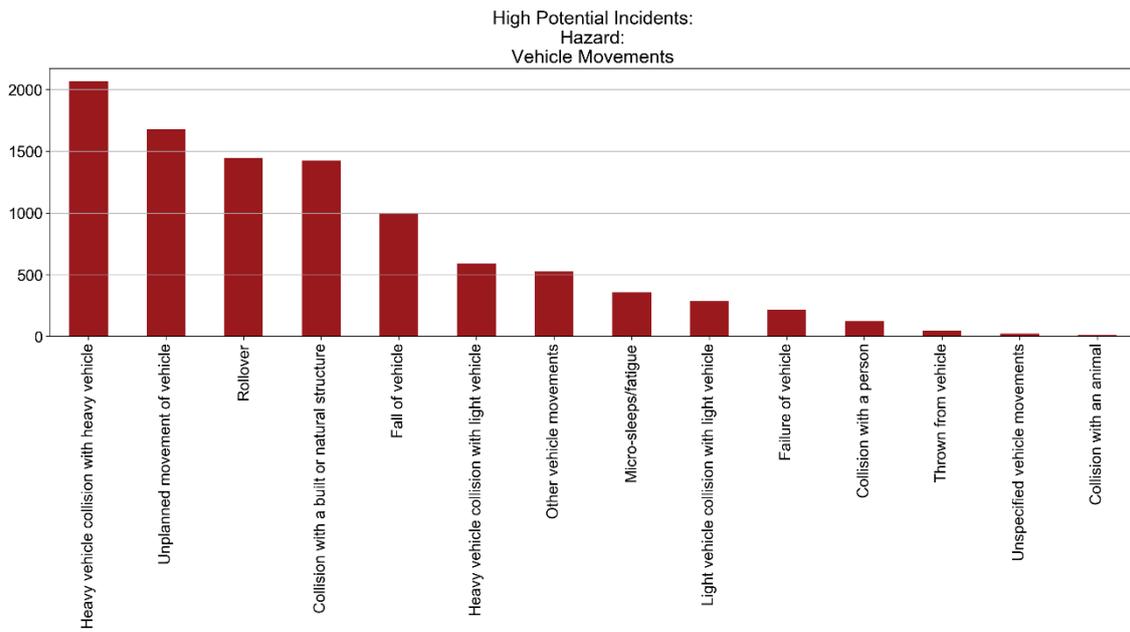


Figure 14 Breakdown of vehicle movements

Figure 15 shows the breakdown of fire and heat – with vehicle fires generating the most HPIs. However, while vehicle fire generates a significant number of HPIs, it is not, as yet, resulting in Serious Accidents.

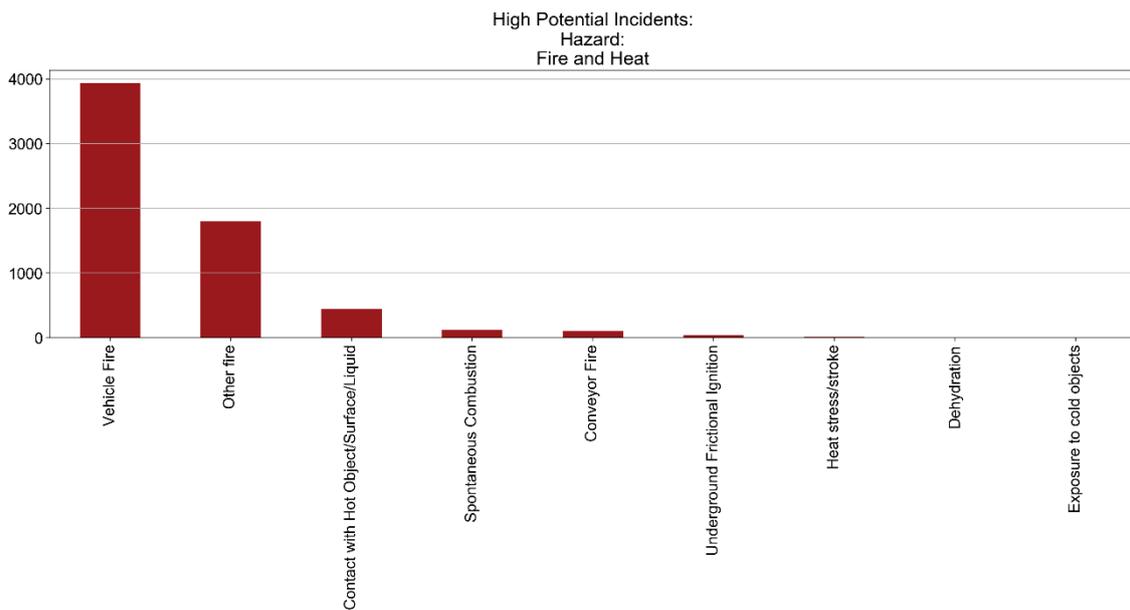


Figure 15 Breakdown of fire and heat

Figure 16 shows the equipment involved in HPIs.

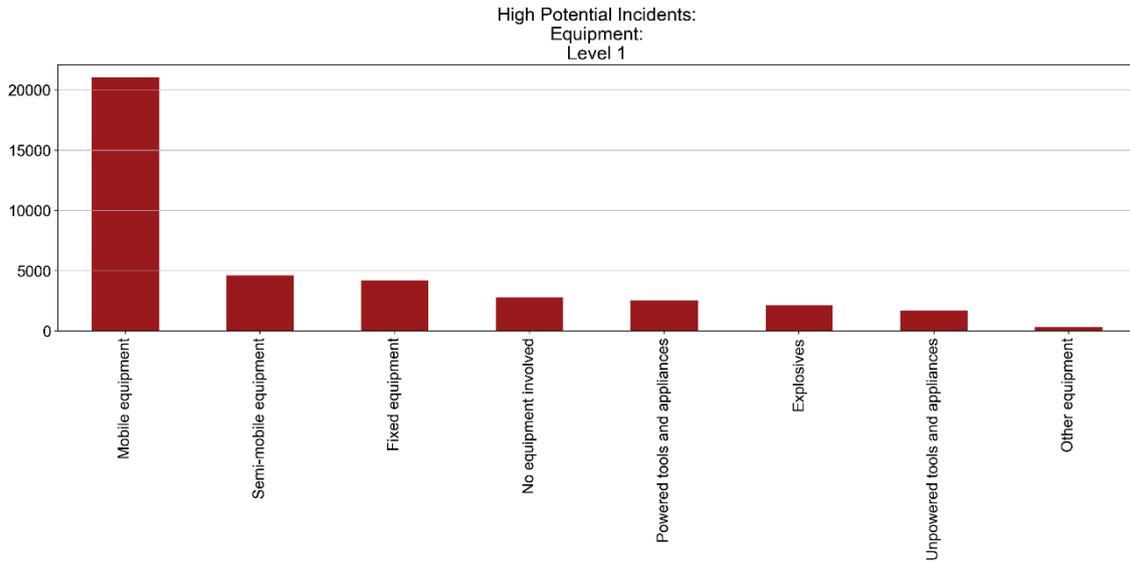


Figure 16 Equipment

Figure 17 shows a further breakdown for equipment. Rear dump trucks generate the most HPIS, followed by dozers and vehicles under 5 tonnes.

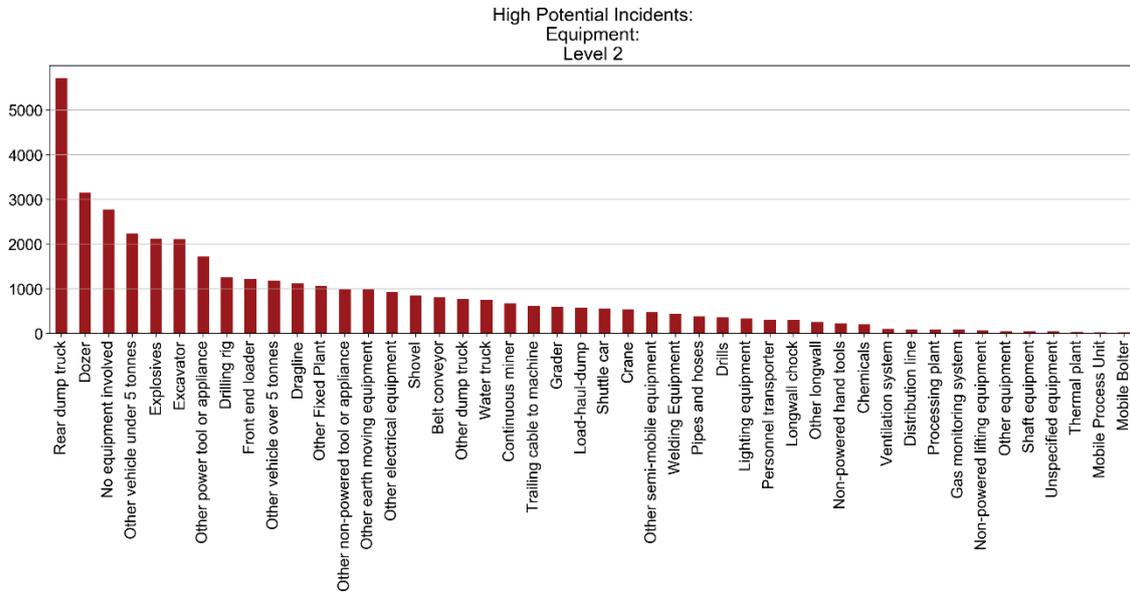


Figure 17 Equipment Level

Figure 18 shows the distribution of LTIs across various industry sectors.

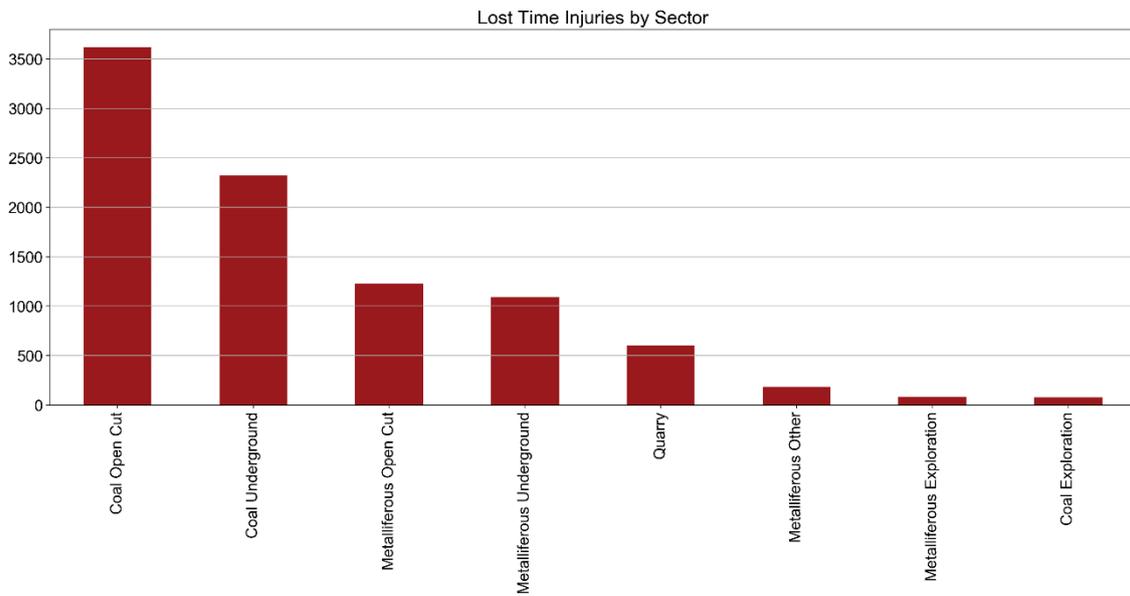


Figure 18 Distribution LTIs by Sector

Figure 19 shows the number of LTIs per million hours worked per sector. The boxplot is based on yearly totals.

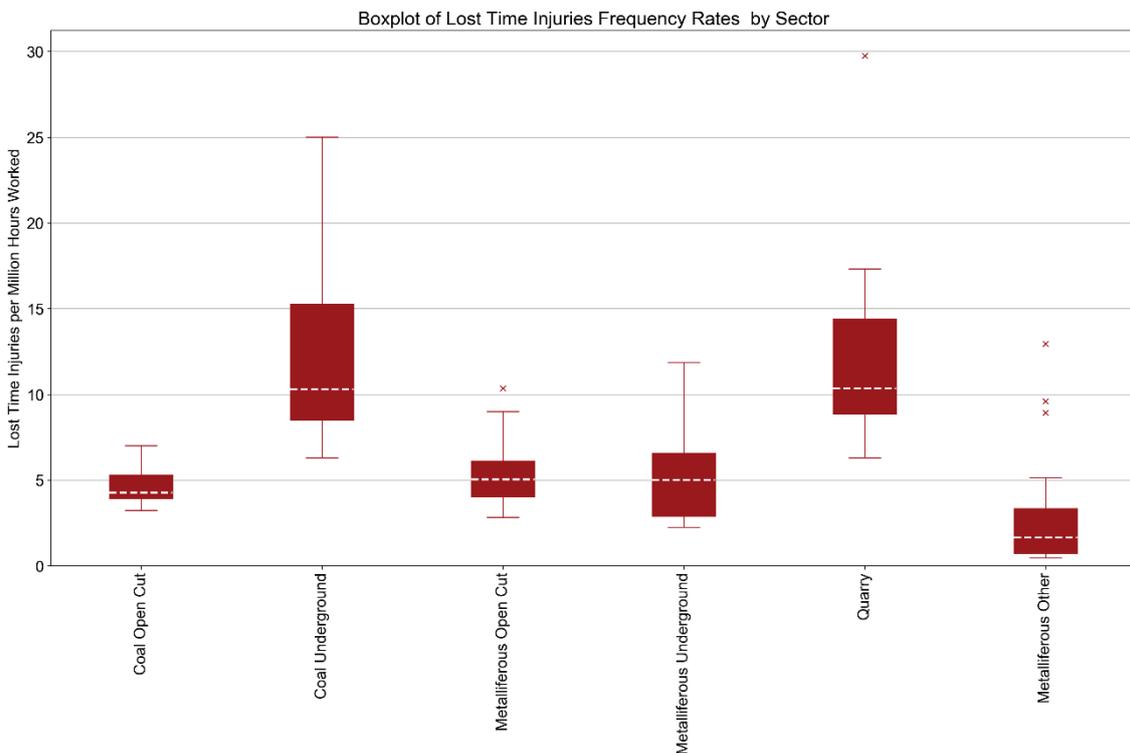


Figure 19 Number of LTIs per million hours worked

Excluding coal and mineral exploration, underground coal and quarries have the next highest rates. This is consistent with both the HPIs and the Serious Accidents.

Figure 20 shows the hazards for LTIs. Health generates the greatest number of LTIs, followed by fall of person, machinery, and falling or moving objects.

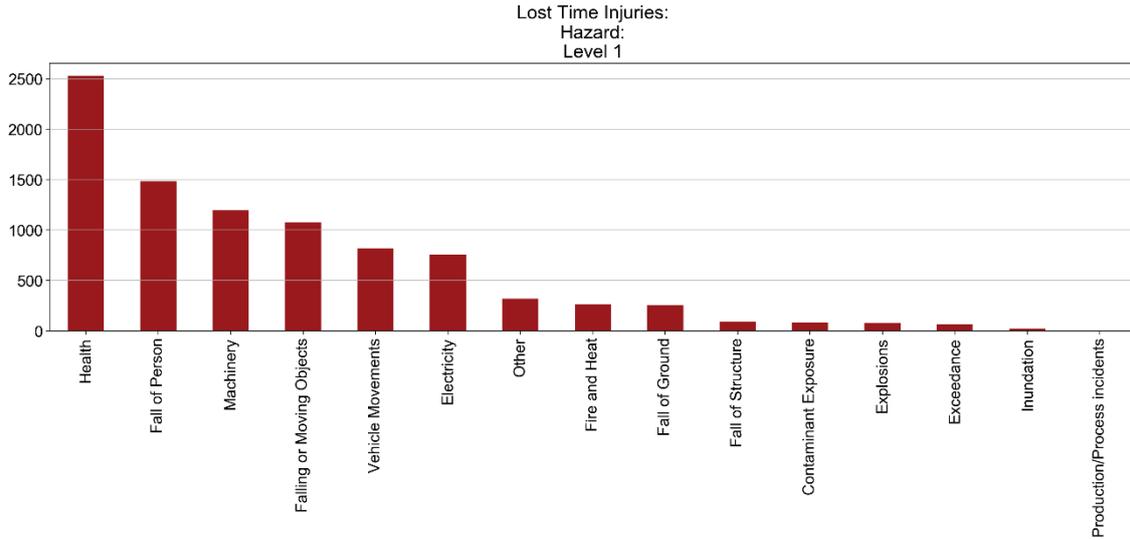


Figure 20 Hazards for LTIs

Figure 21 shows a breakdown of health related LTIs.

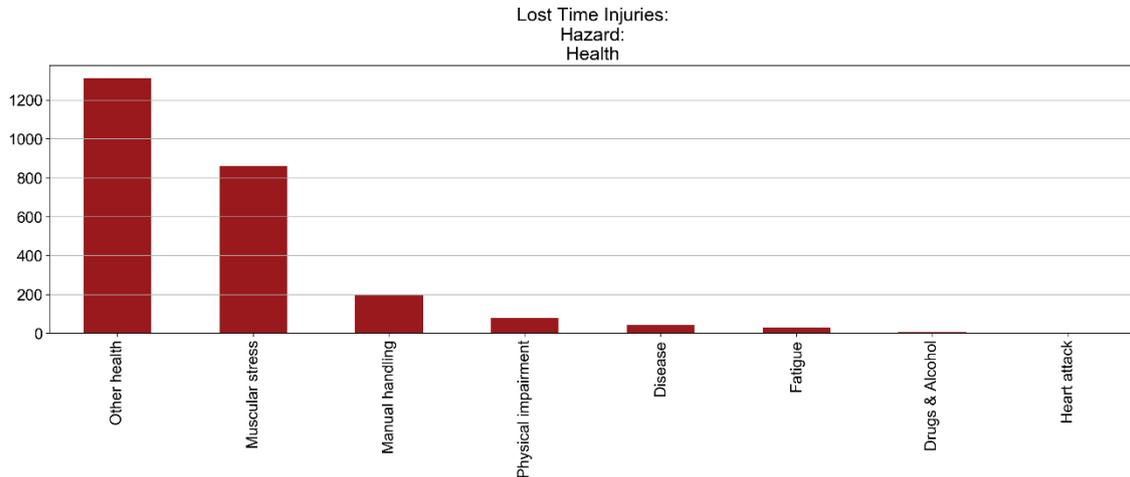


Figure 21 Breakdown for Health category for LTIs

Figure 22 shows the breakdown for Machinery, with entanglement and other machinery generating the highest number of LTIs.

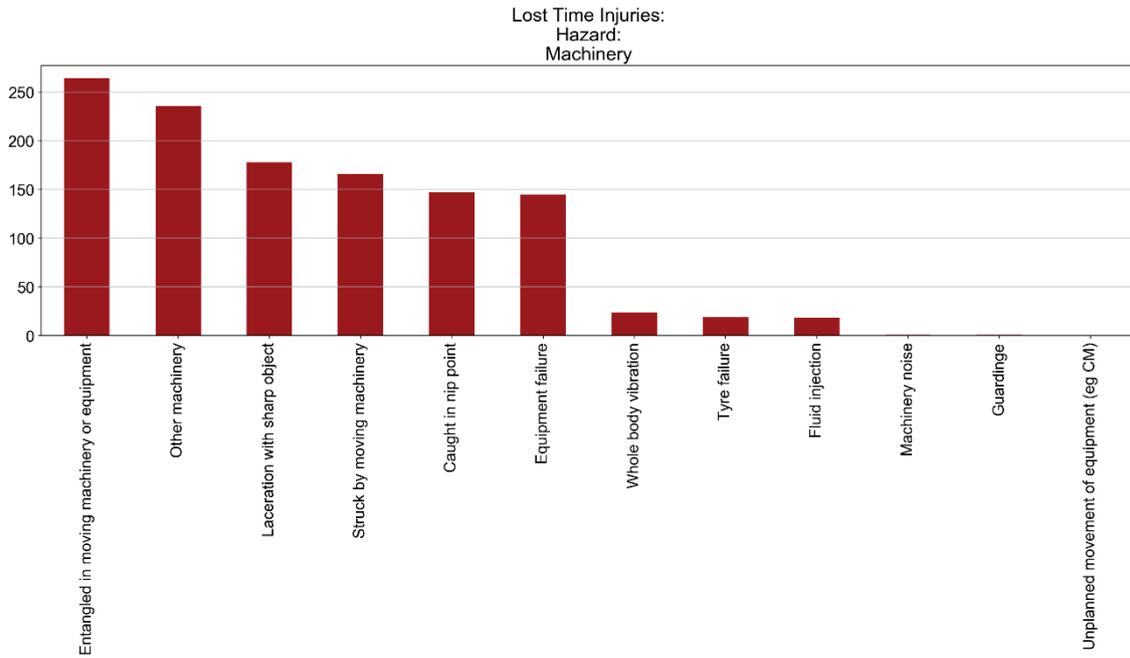


Figure 22 Breakdown for Machinery category for LTIs

Figure 23 shows the breakdown of the various occupations for LTIs. Miner, truck operator and fitter generate the greatest number of LTIs. This is a similar finding to the Serious Accidents.

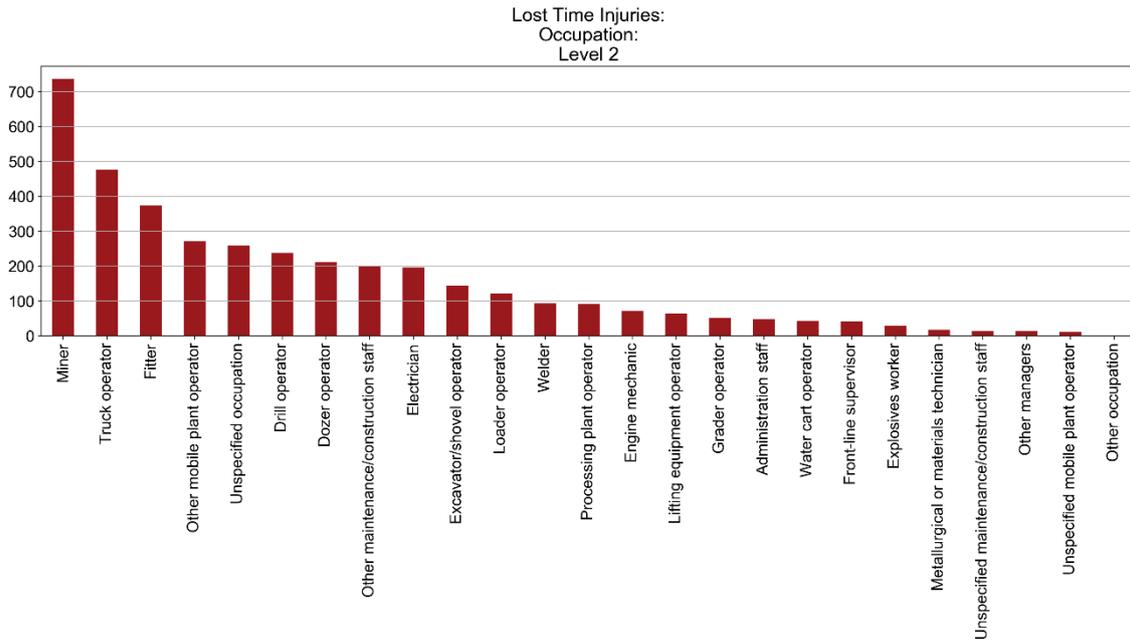


Figure 23 Distribution by Occupation of LTIs

Figure 24 shows the fatality frequency rate by sector. Quarries have the highest rate, with open cut coal having the lowest.

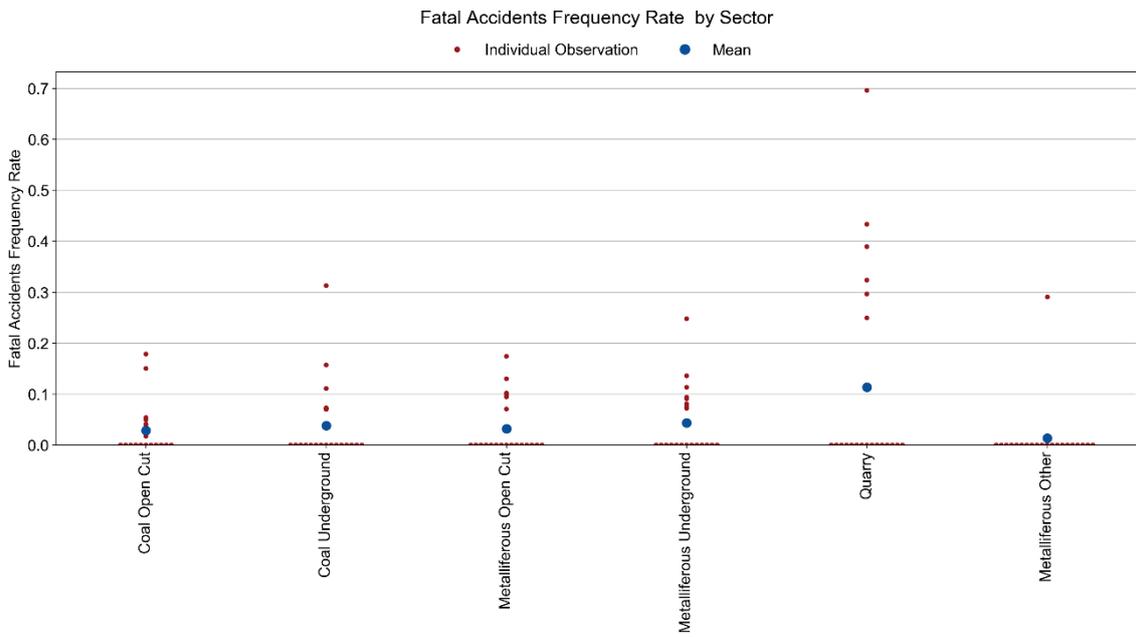


Figure 24 Fatality Frequency Rate for each sector

Figure 25 and Figure 26 show the employee Serious Accident Frequency Rate versus employee hours and the contractor Serious Accident Frequency Rate versus contractor hours.

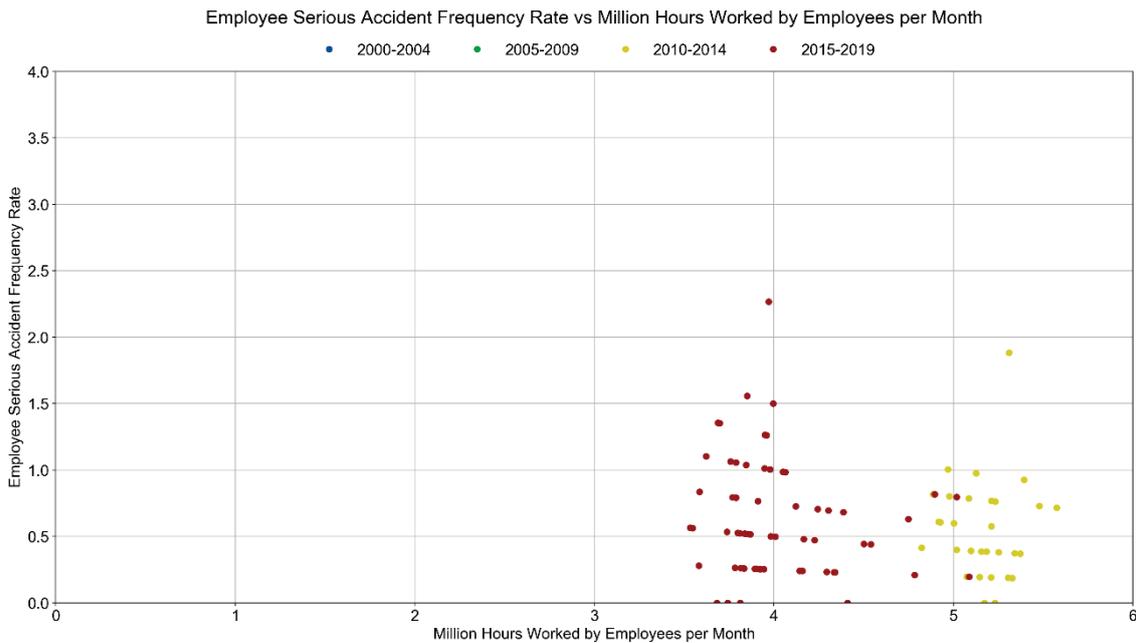


Figure 25 Serious Accidents per million hours versus total hours per month—Employees Only

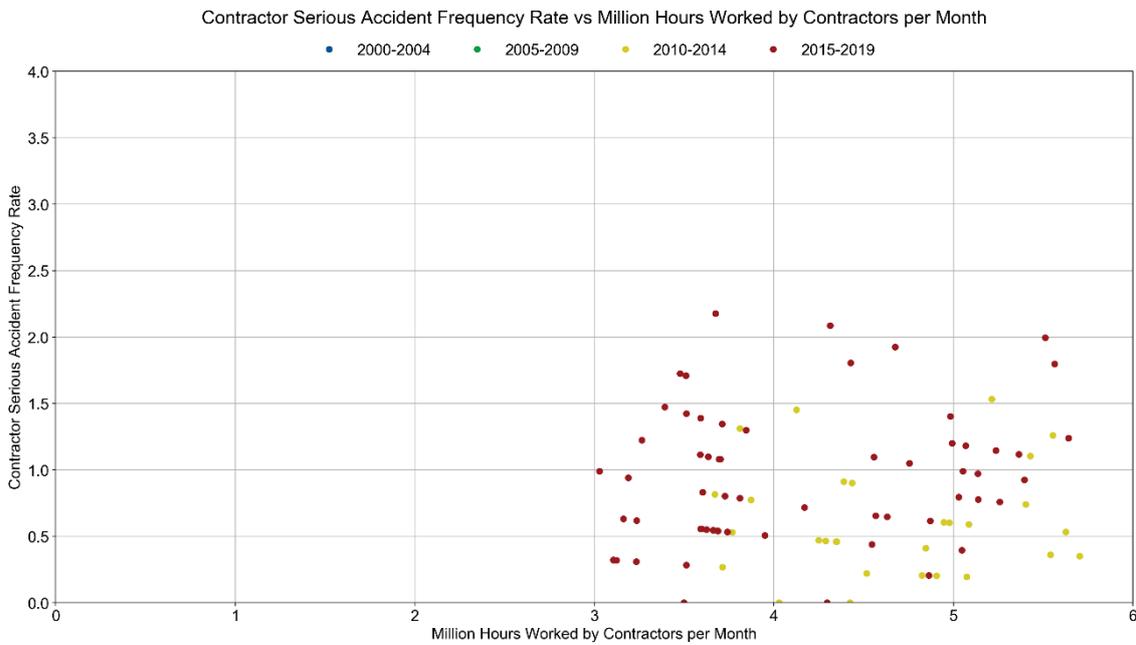


Figure 26 Serious Accidents per million hours versus total hours per month—Contractors Only

These charts show that the Serious Accident Frequency Rate for contractors is on average higher than for employees.

In order to examine the relationship between employees and contractors further, it is useful to define a ratio of contractor hours to employee hours – the contractor/employee ratio. A contractor/employee ratio of 1 means that there are equal number of contractor hours and employee hours worked in the industry. A ratio of 2 means that there are twice as many contractor hours worked as employee hours. A ratio of less than 1 means there are more employee hours worked than contractor hours. This contractor/employee ratio provides an estimate of the mix of contractors and employees in the industry.

Figure 27 shows the Serious Accident Frequency Rate versus this contractor/employee ratio.

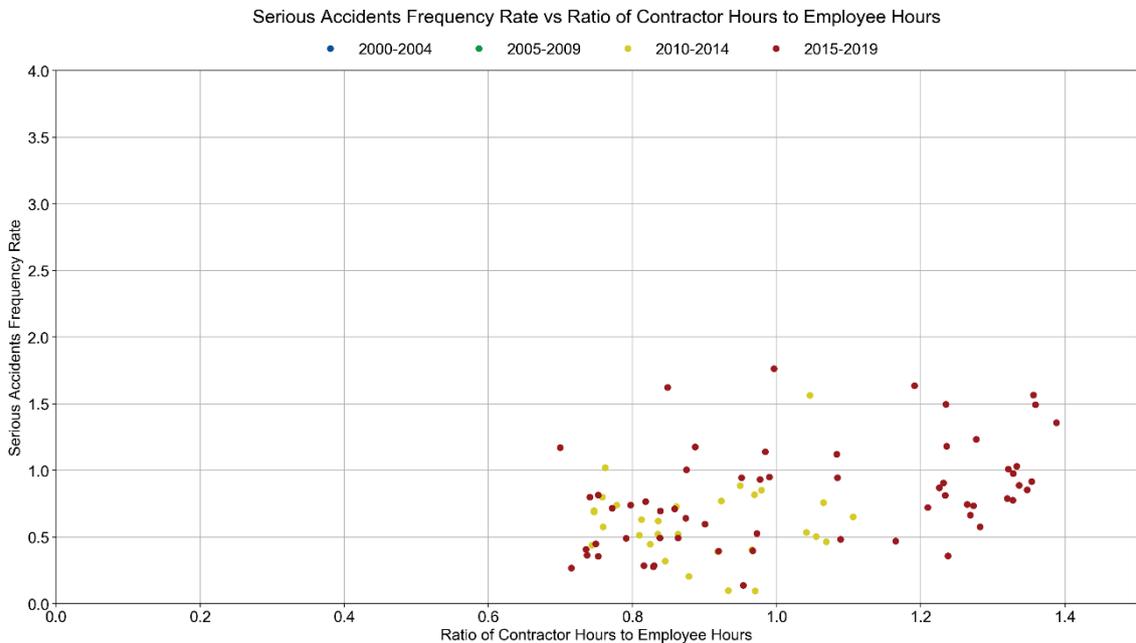


Figure 27 Number of Serious Accident Frequency Rate versus contractor/employee ratio

The Serious Accident Frequency Rate appears to remain reasonably constant or only slightly rises as the contractor/employee ratio rises. The greater the percentage of contractors, as compared to employees, the greater number of Serious Accidents are likely to occur.

Figure 30 shows the monthly coal price for the review period. Prices are shown for both thermal and metallurgical coal, as well as the average price⁵¹. The coal price varies with time, and there is a noticeable dramatic increase in both thermal and metallurgical coal price circa October 2008.

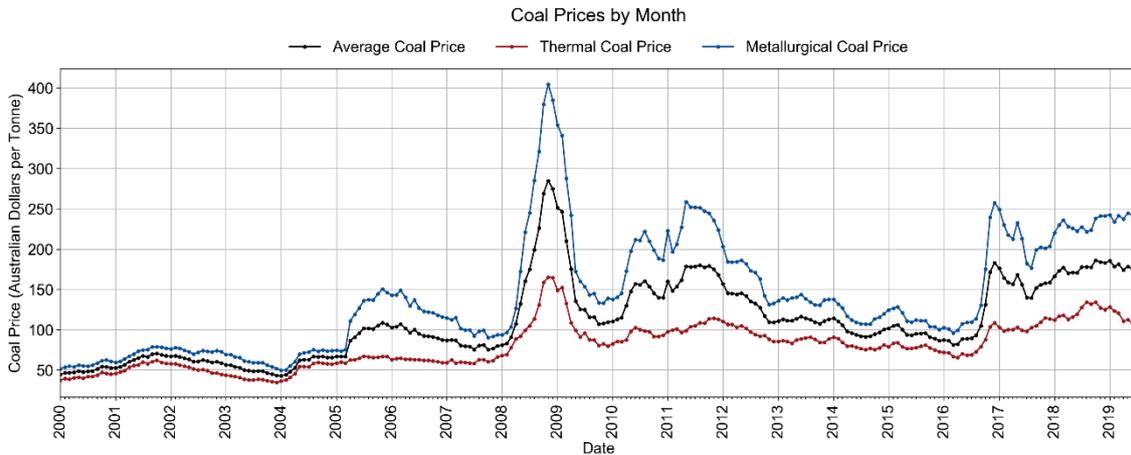


Figure 28 Coal price over time

Figure 31 shows a plot of millions of hours worked per month, against the average coal price per month⁵².

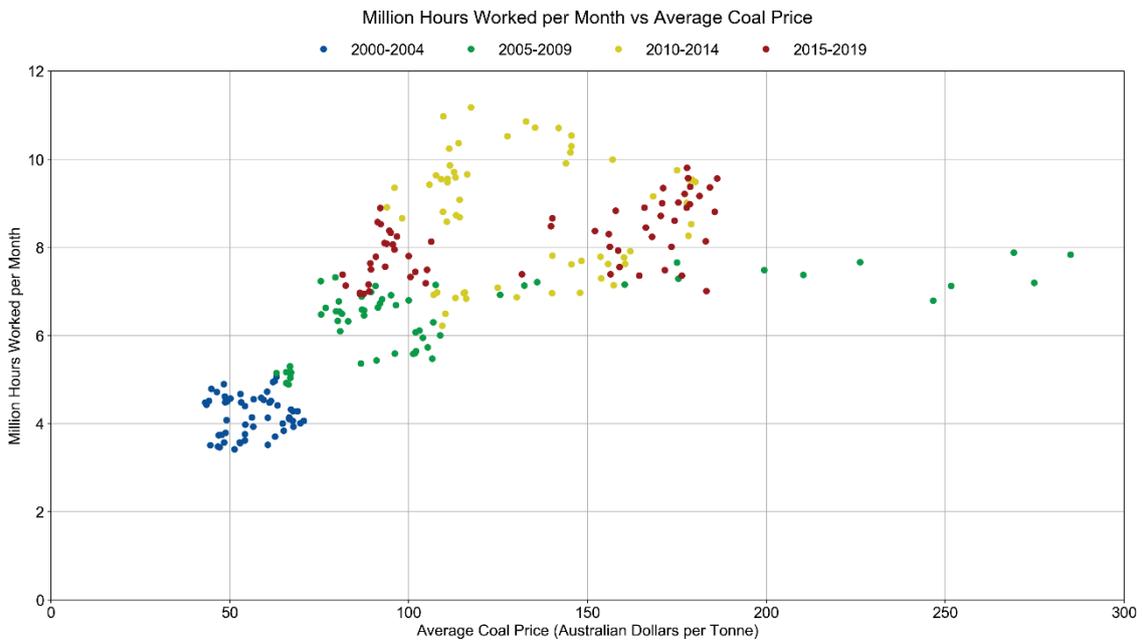


Figure 29 Millions of Hours worked per month versus coal price

As the average coal price increases, the number of hours worked in the industry also increases, and then levels off. However, the 8 points on the right of the figure represent the sudden coal price spike that occurred circa October 2008. If this spike is considered an outlier, the 8 points can be removed from the figure, as in Figure 32.

⁵¹ From <https://publications.industry.gov.au/publications/resourcesandenergyquarterlyseptember2019/index.html> - Historical Data, Tab 21.

⁵² For the purposes of comparing commodity prices, only the coal price was used. Future analysis may include exploration of the hours worked versus other commodity prices.

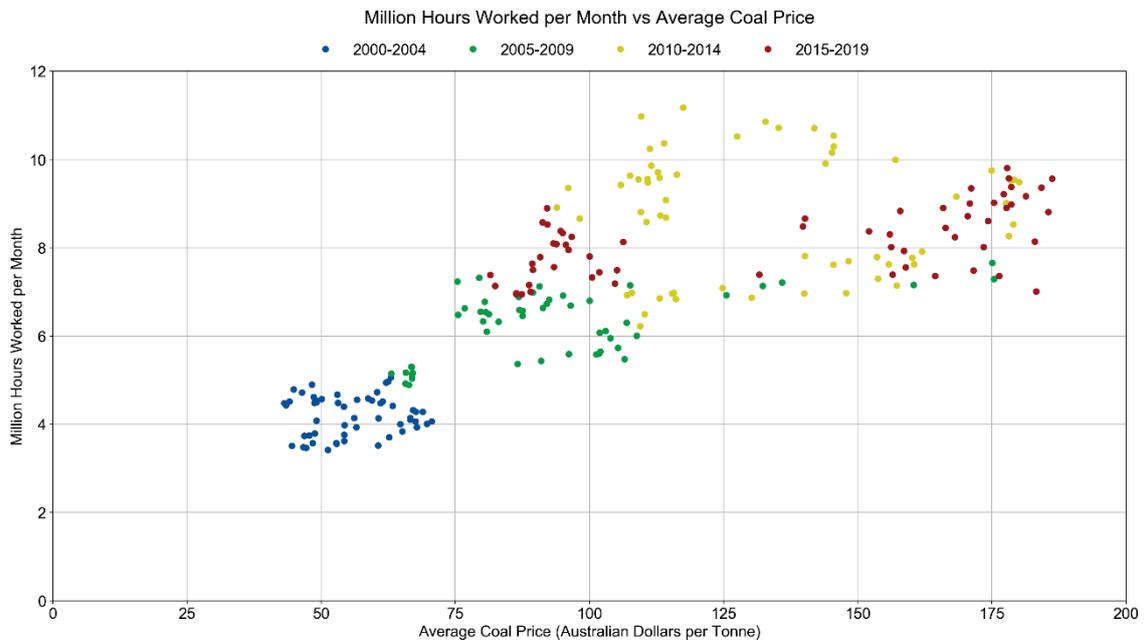
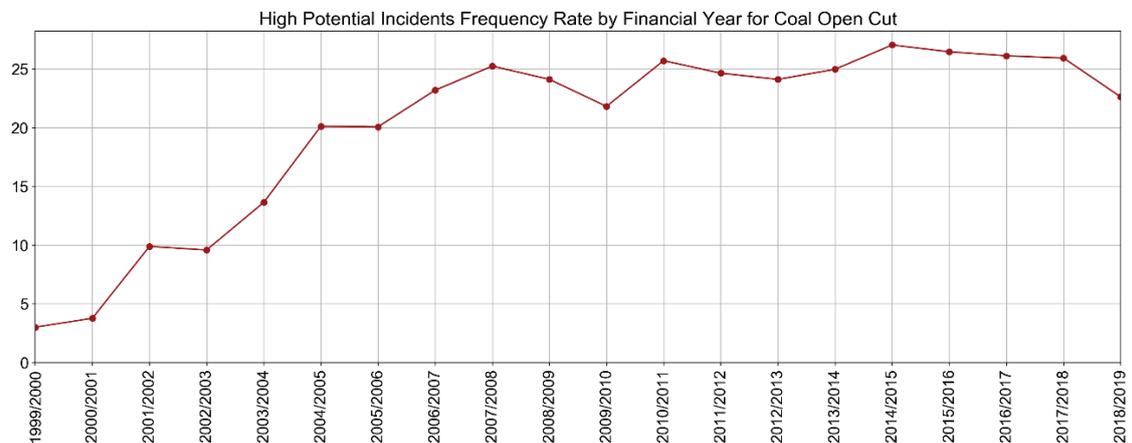


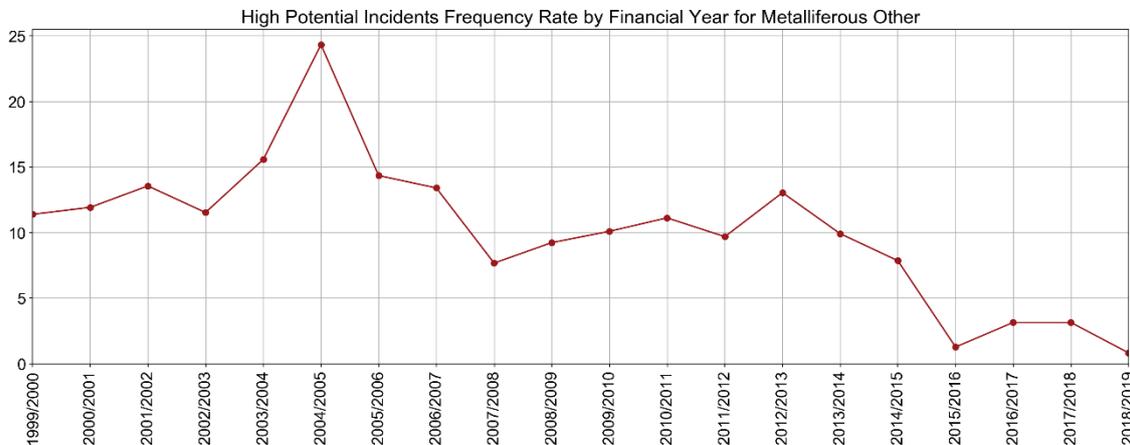
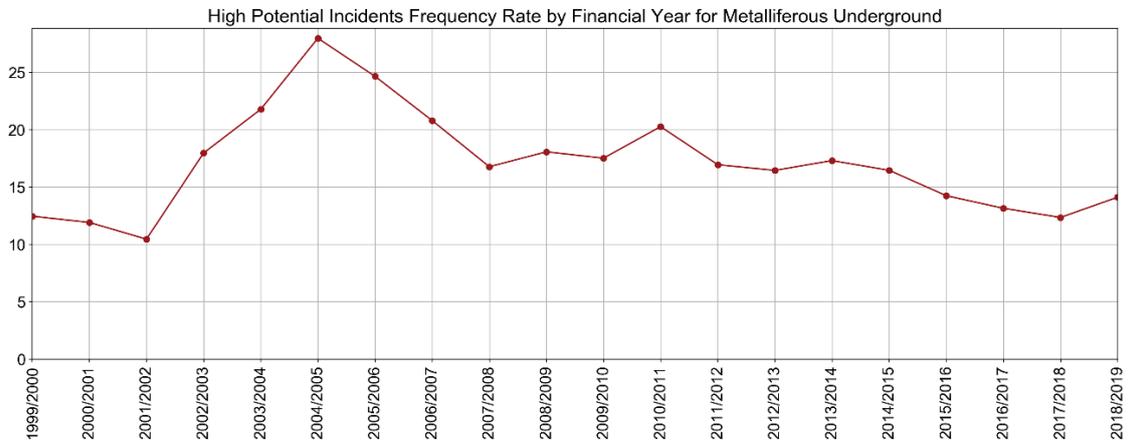
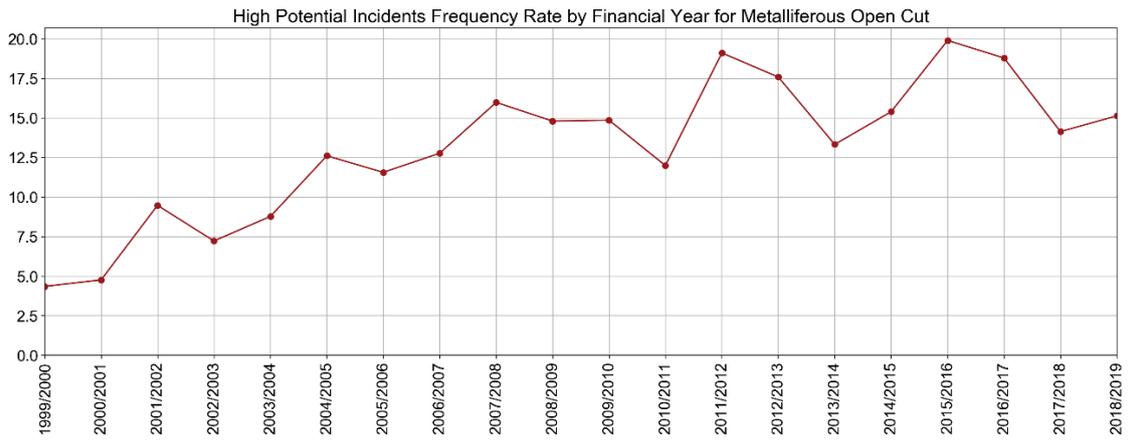
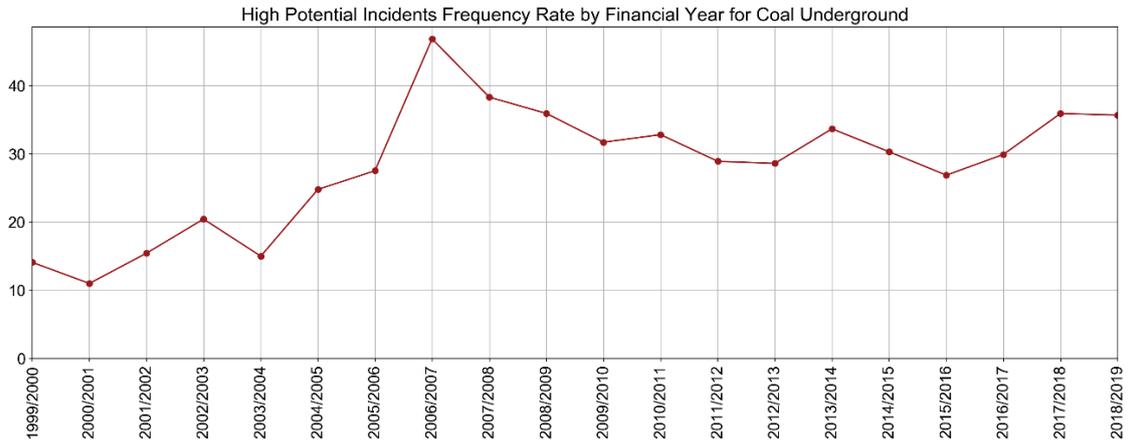
Figure 30 Millions of Hours worked per month versus coal price (spike in coal price removed)

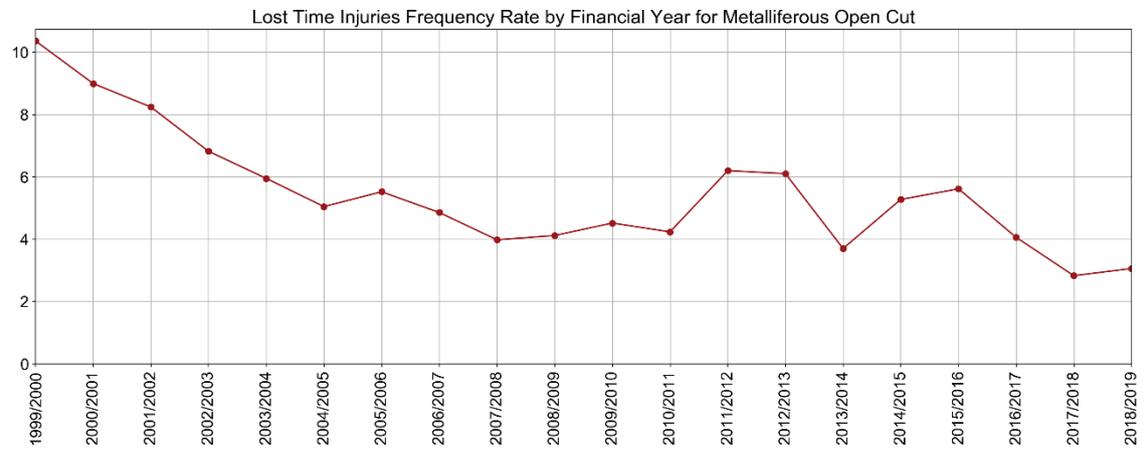
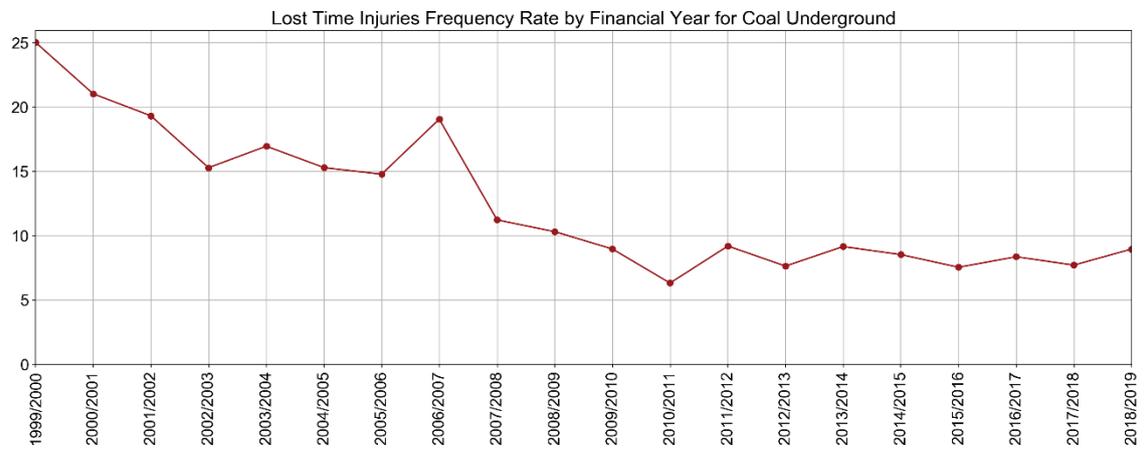
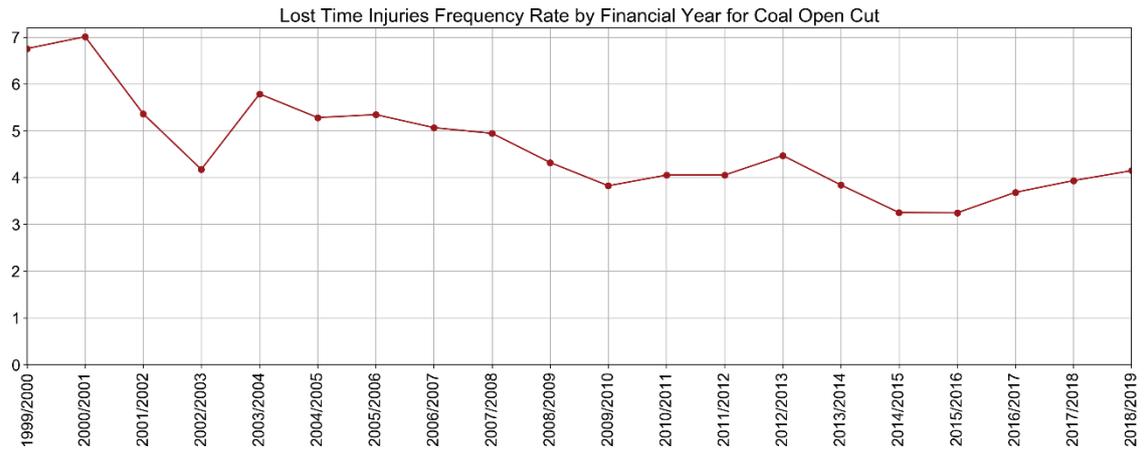
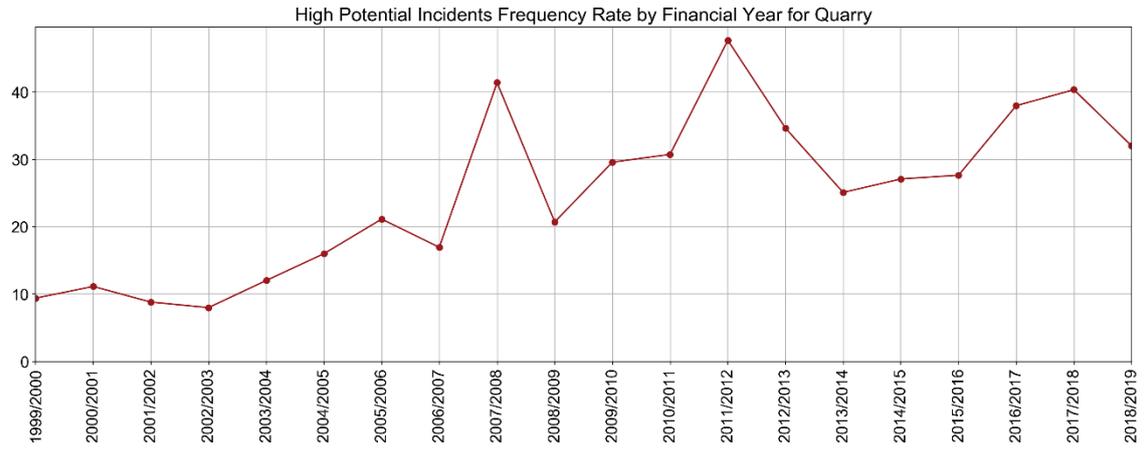
This figure illustrates that there is a relationship between the average coal price and the total hours worked in the industry. As the coal price moves from 100 to 175 dollars per tonne, the number of hours worked per month rises from circa 6 million to 8 million.

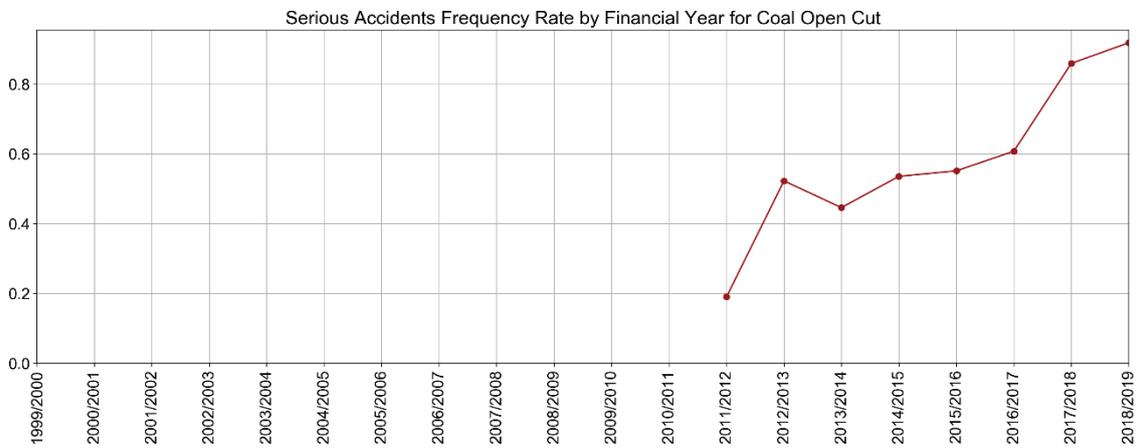
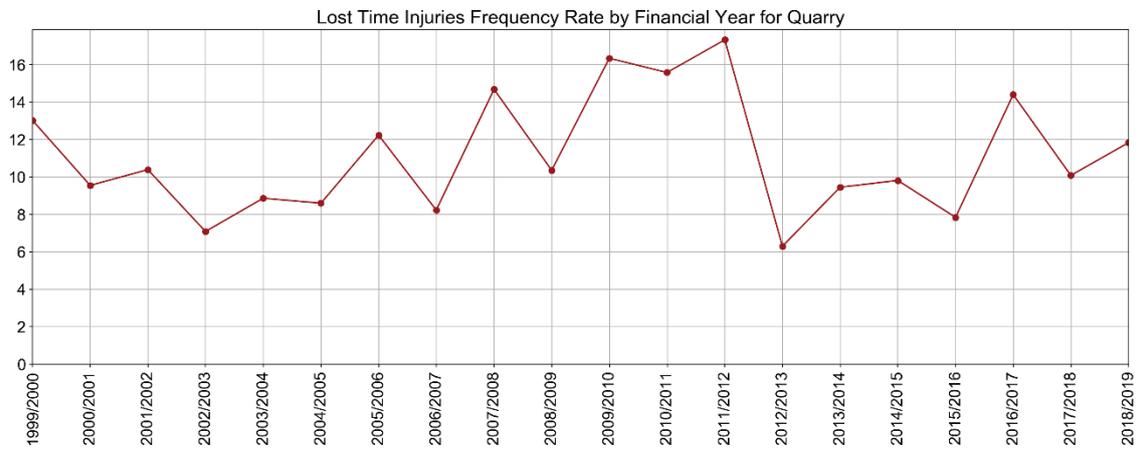
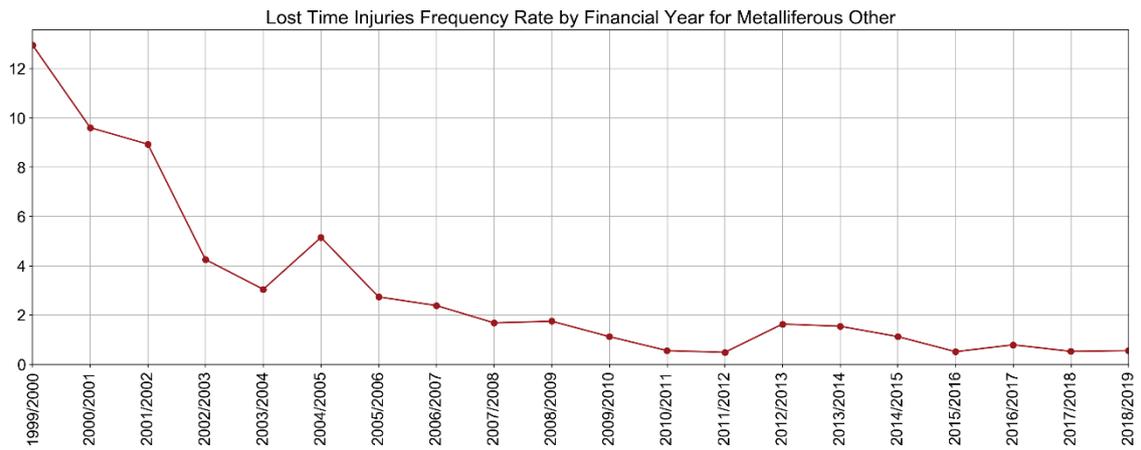
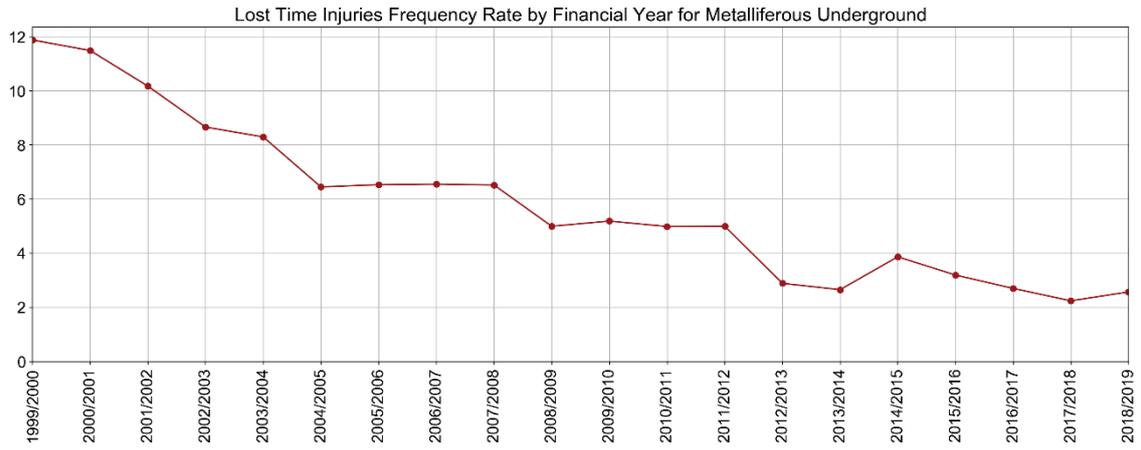
This relationship, which is necessarily broad because it relates all commodities to the coal price, suggests there is some form of relationship between worked hours and the coal price. Therefore, because of this commodity price and worked hours relationship, there is also a relationship between the coal price and HPIs, Serious Accidents and LTIs.

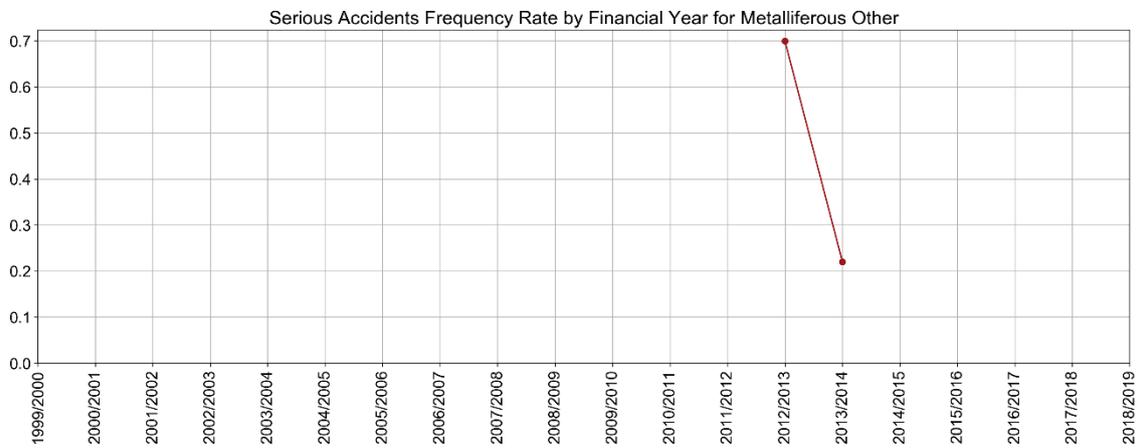
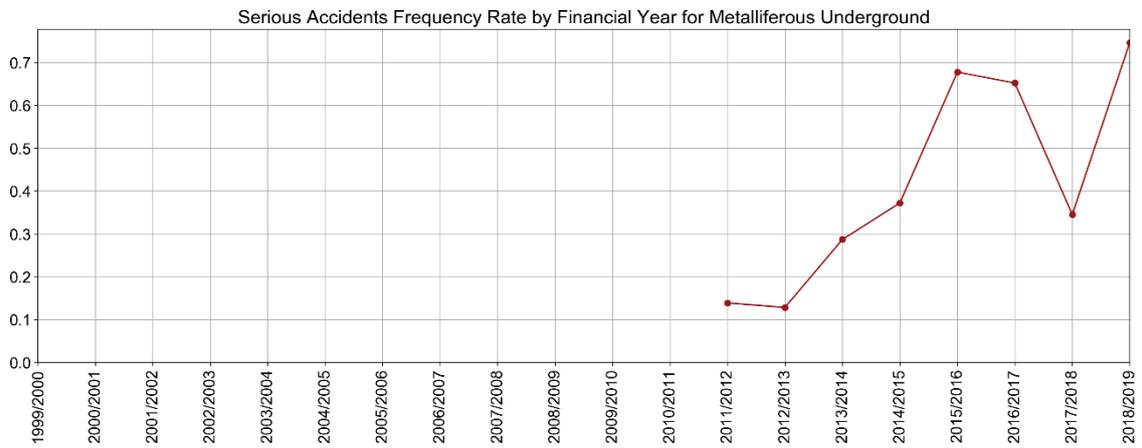
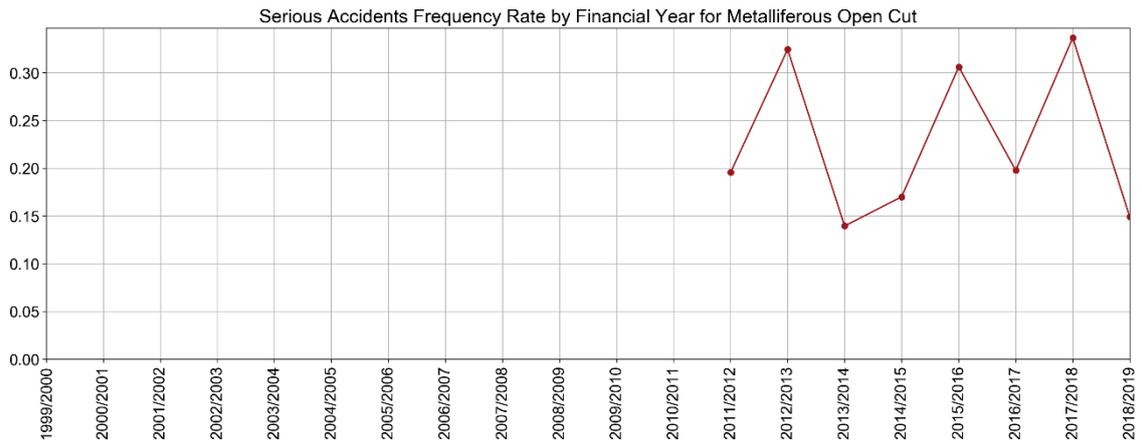
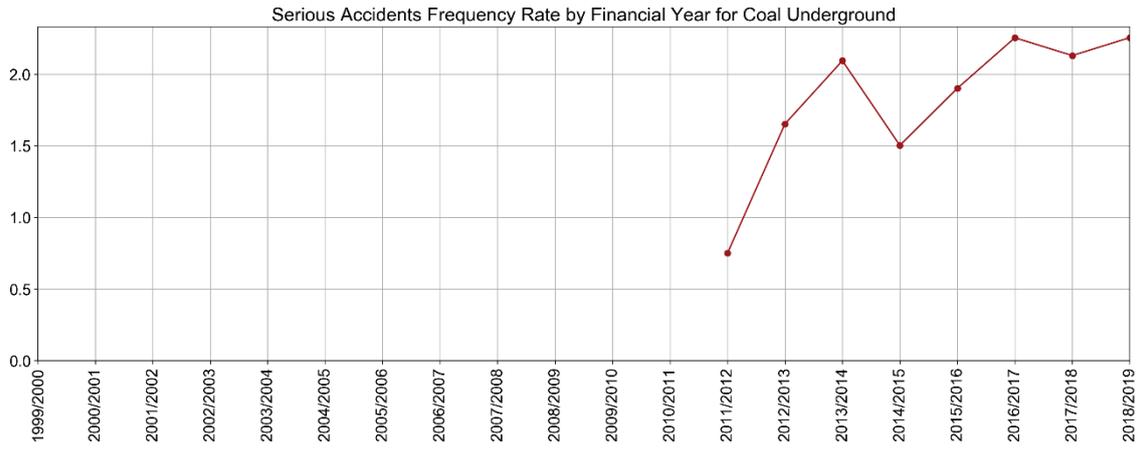
This section provides a statistical summary relating to all incidents in the QLD mining industry from January 2000 to July 2019. The following charts show the changes in incident rate, over time and for each mine type.

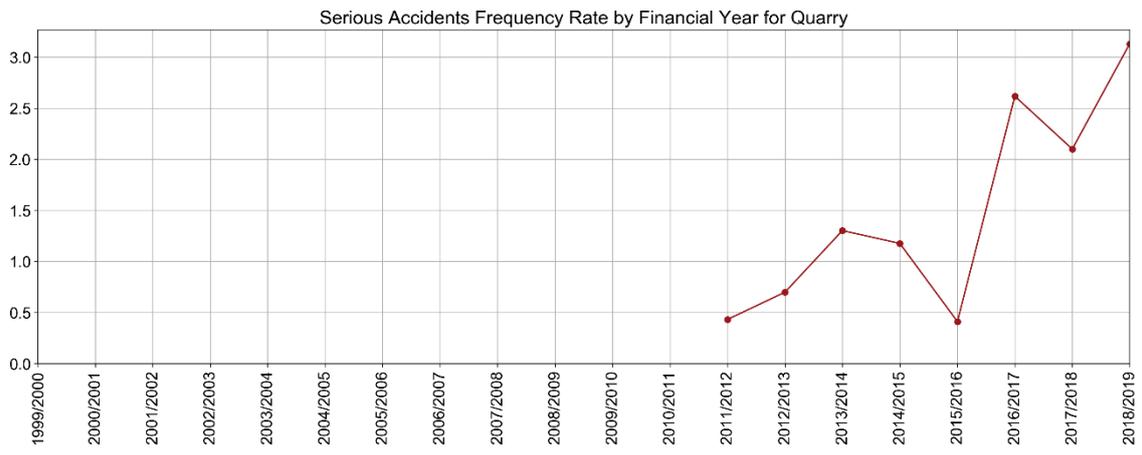




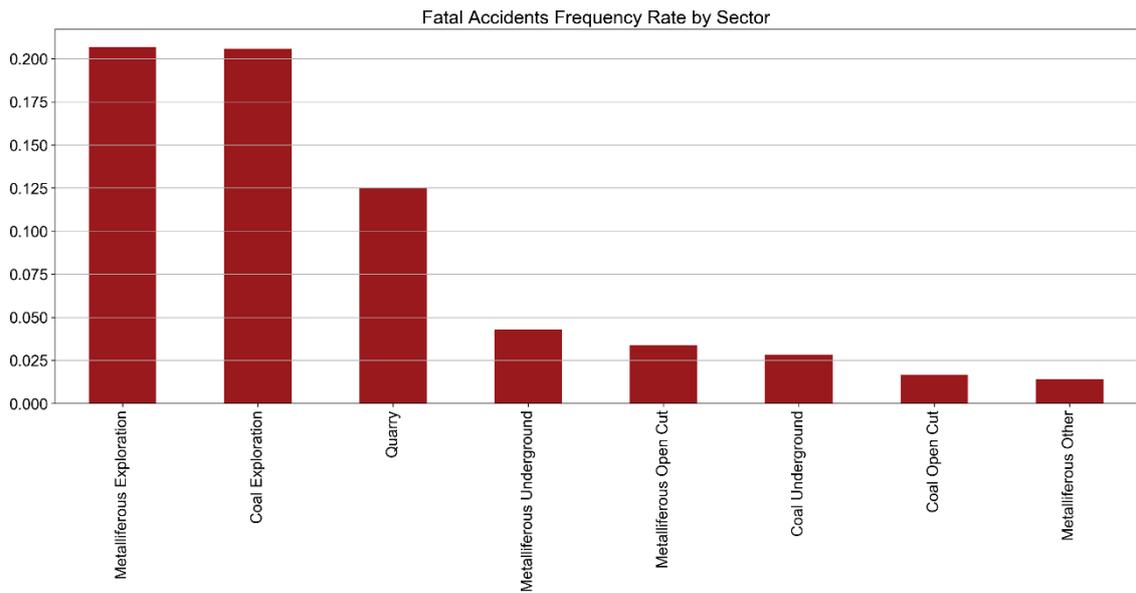
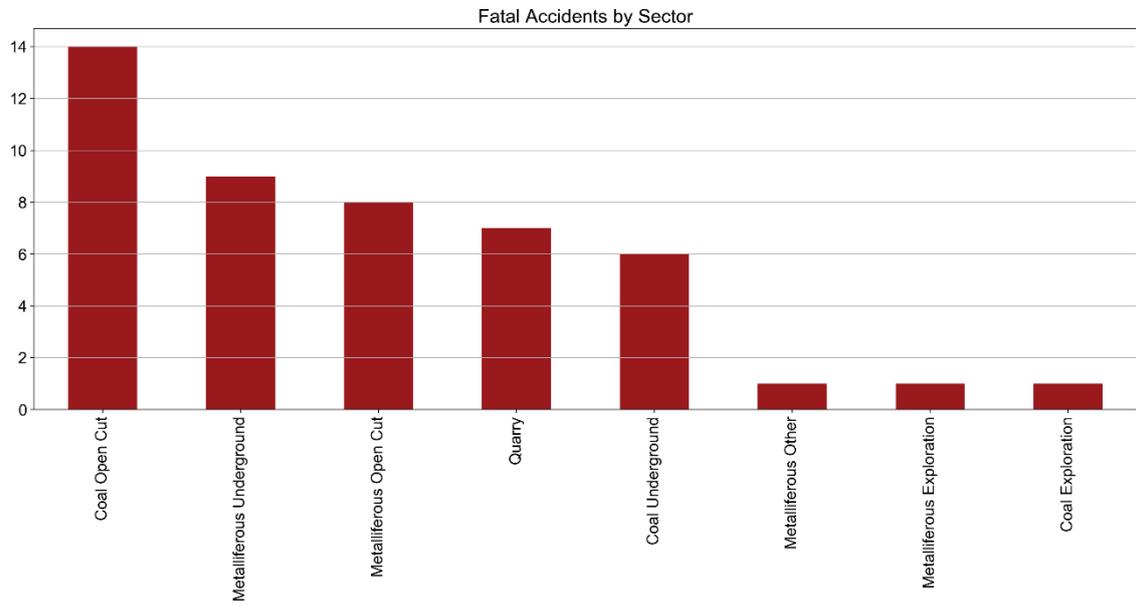
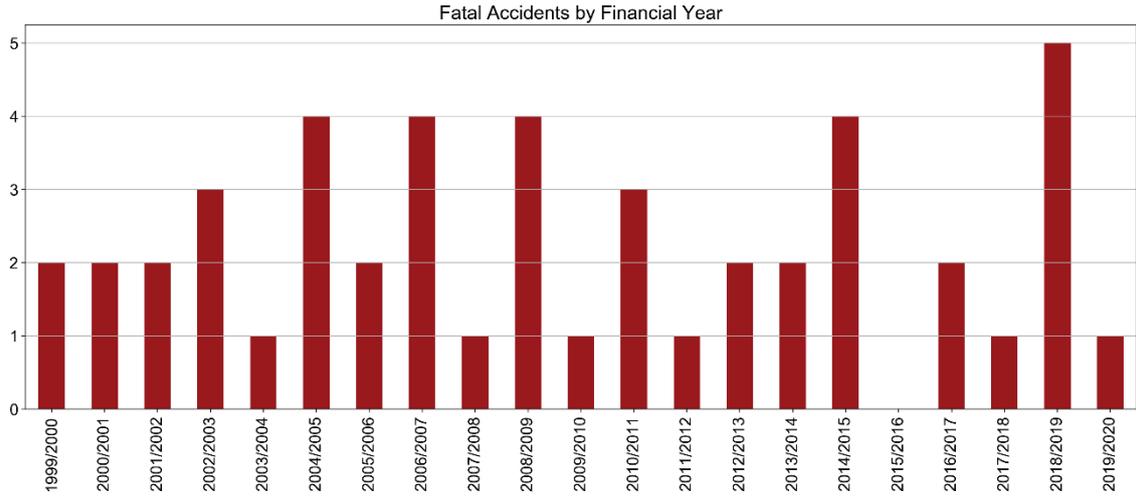




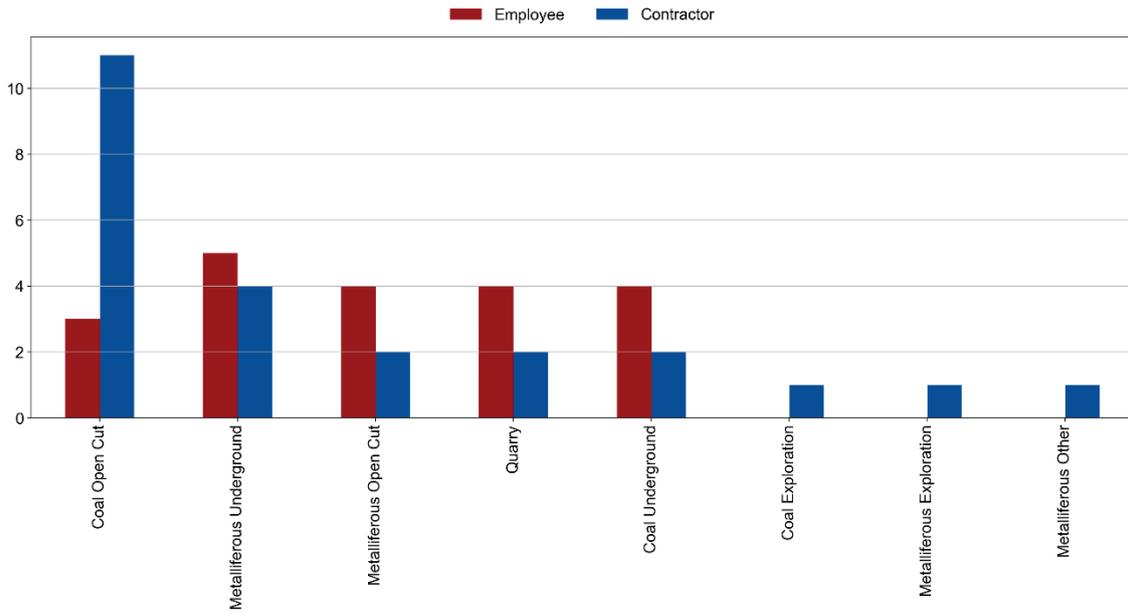




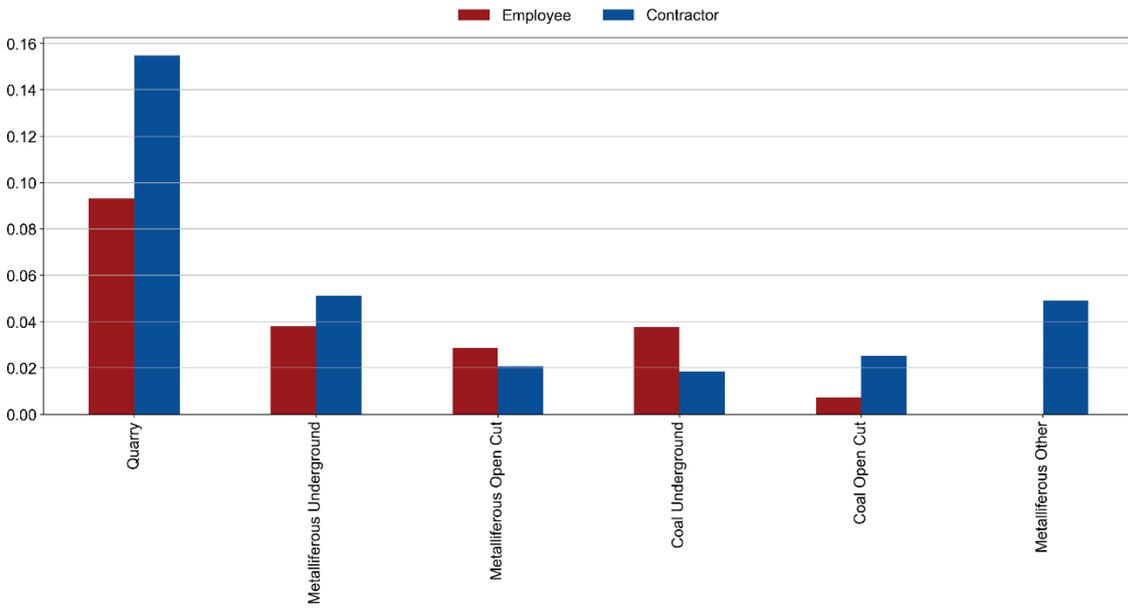
Fatalities



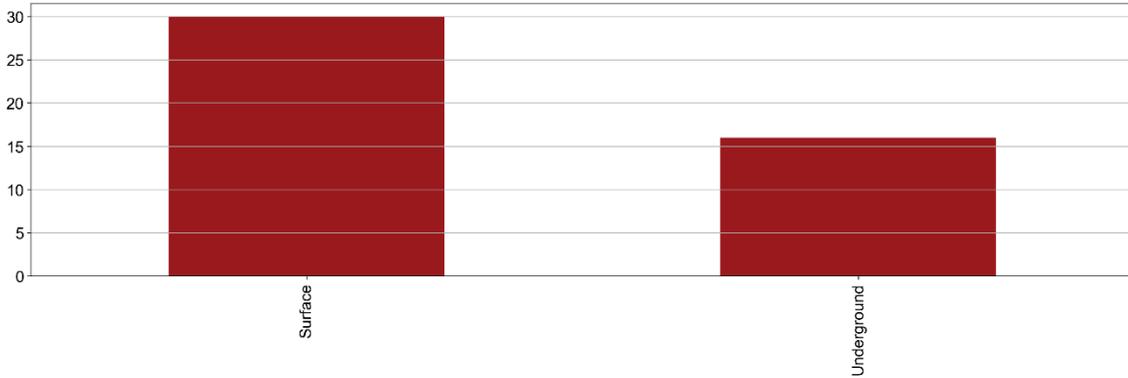
Fatal Accidents by Sector by Worker Type

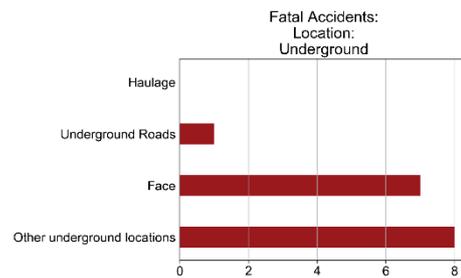
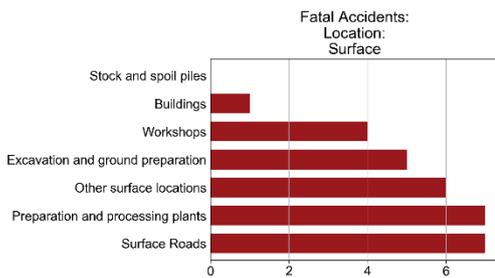
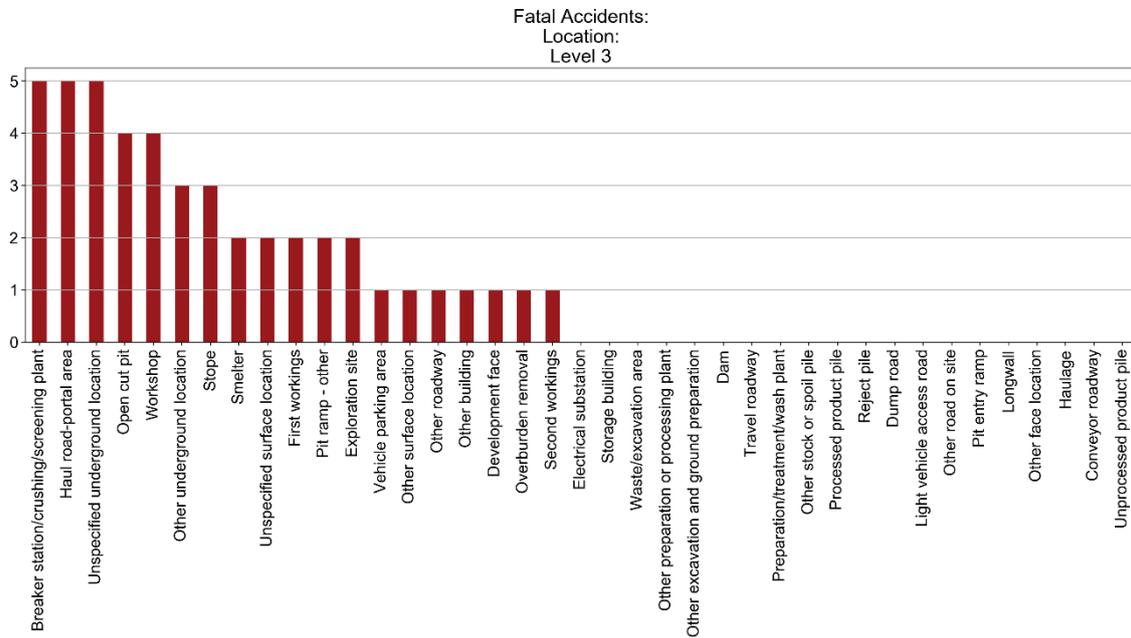
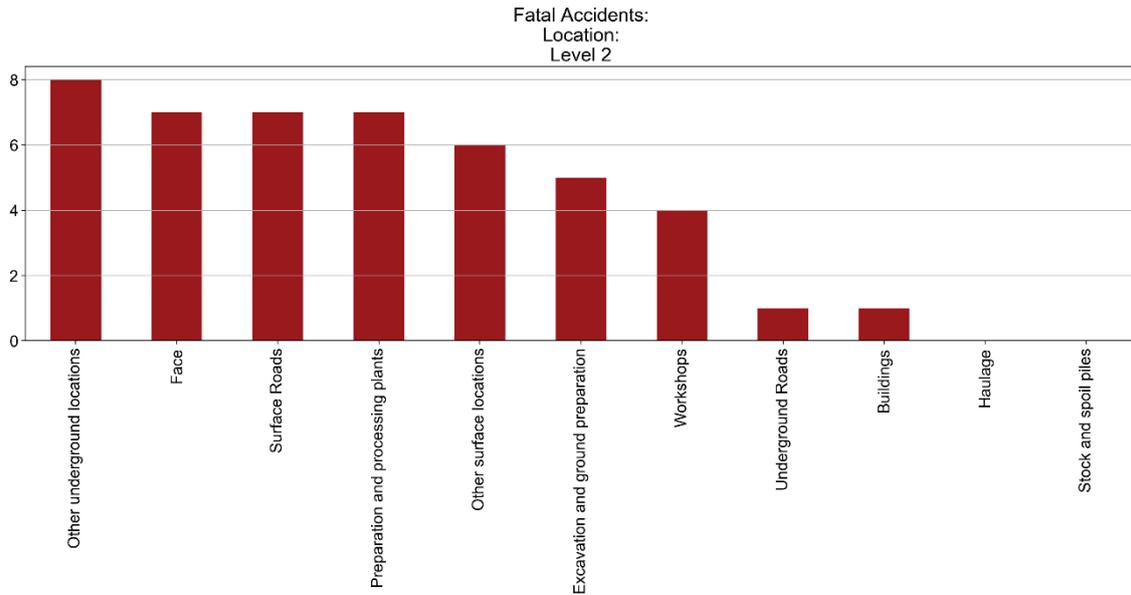


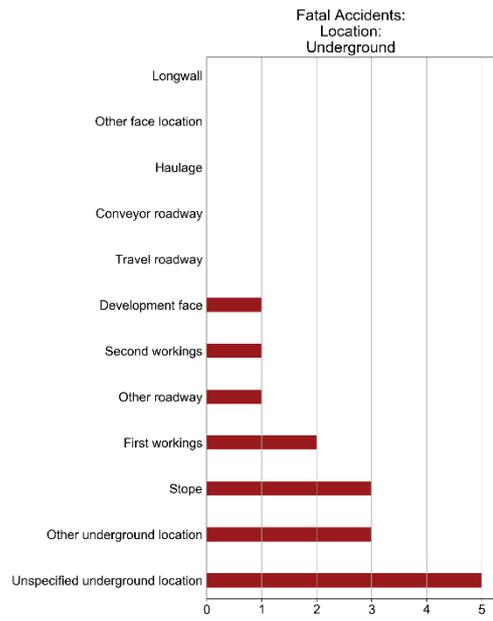
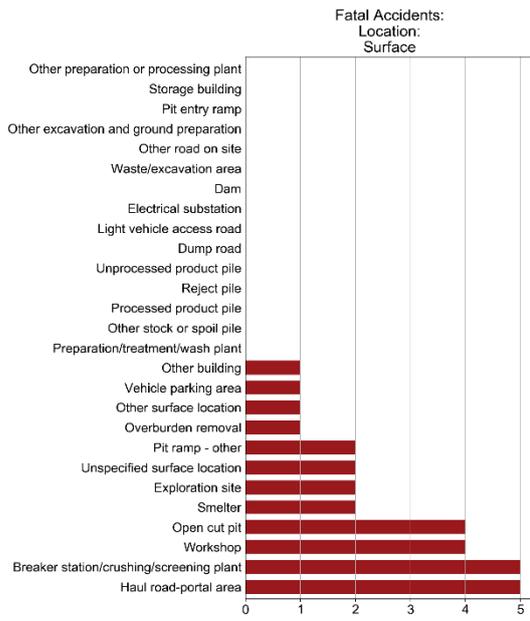
Fatal Accidents Frequency Rate by Sector by Worker Type

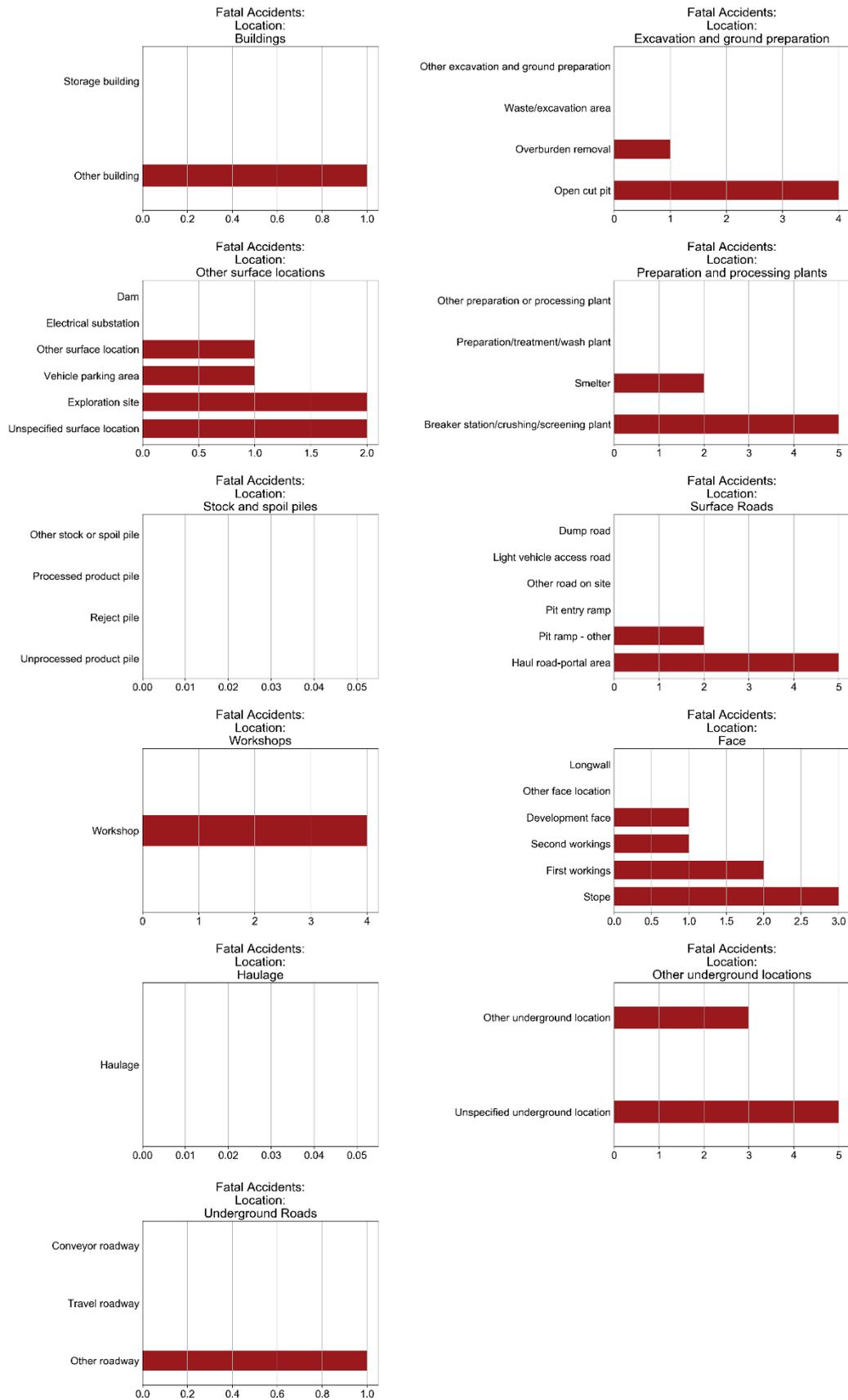


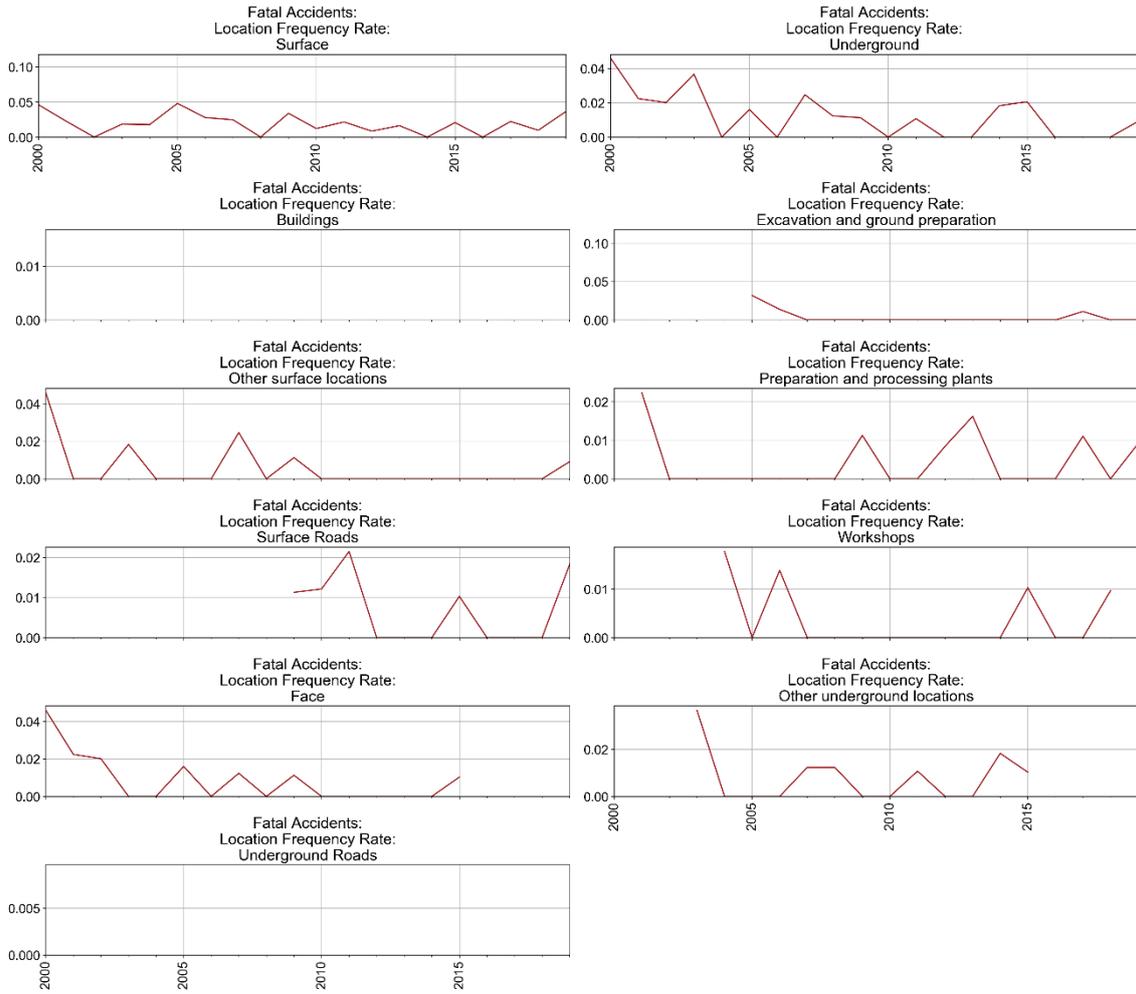
Fatal Accidents:
Location:
Level 1

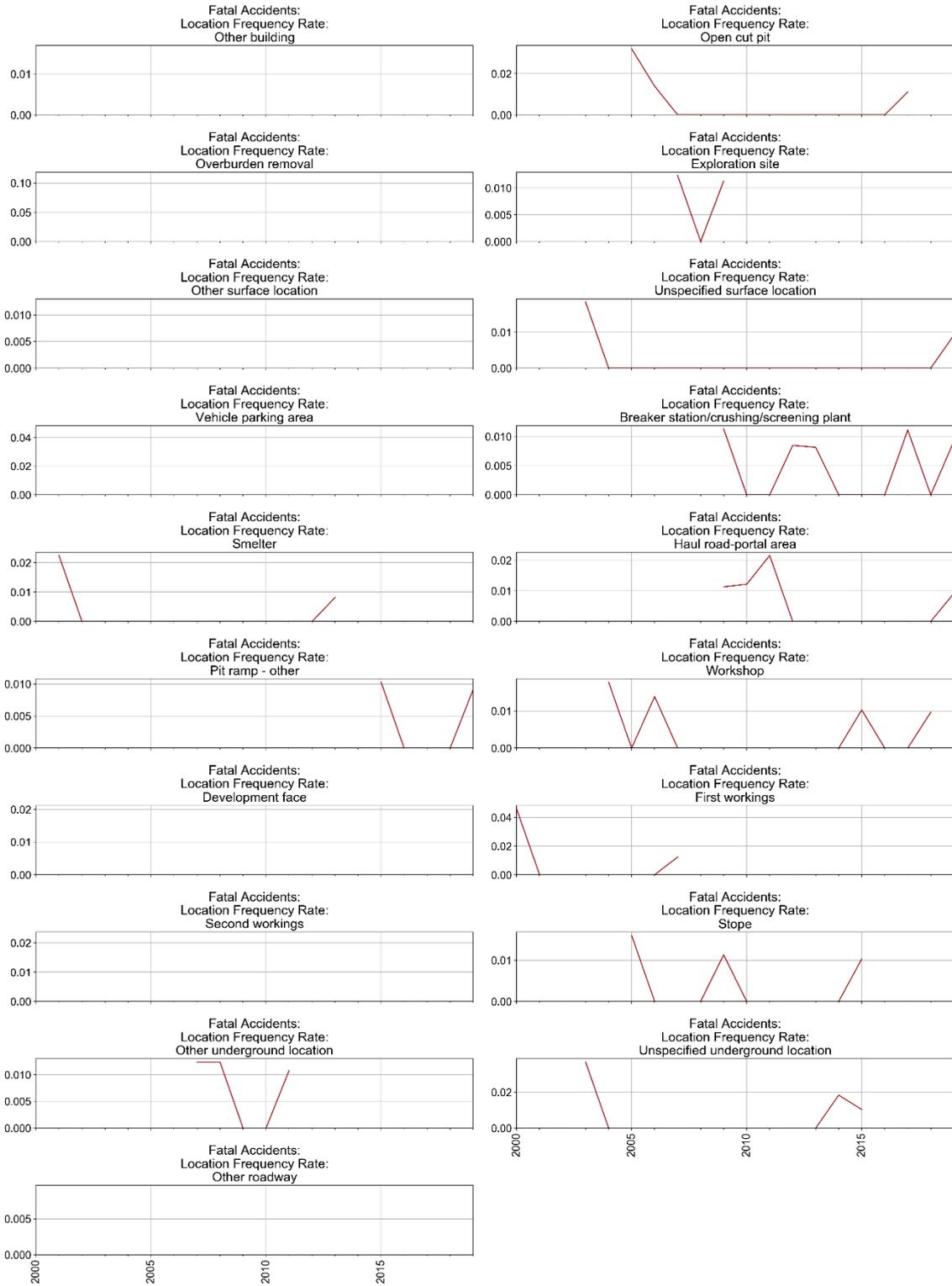




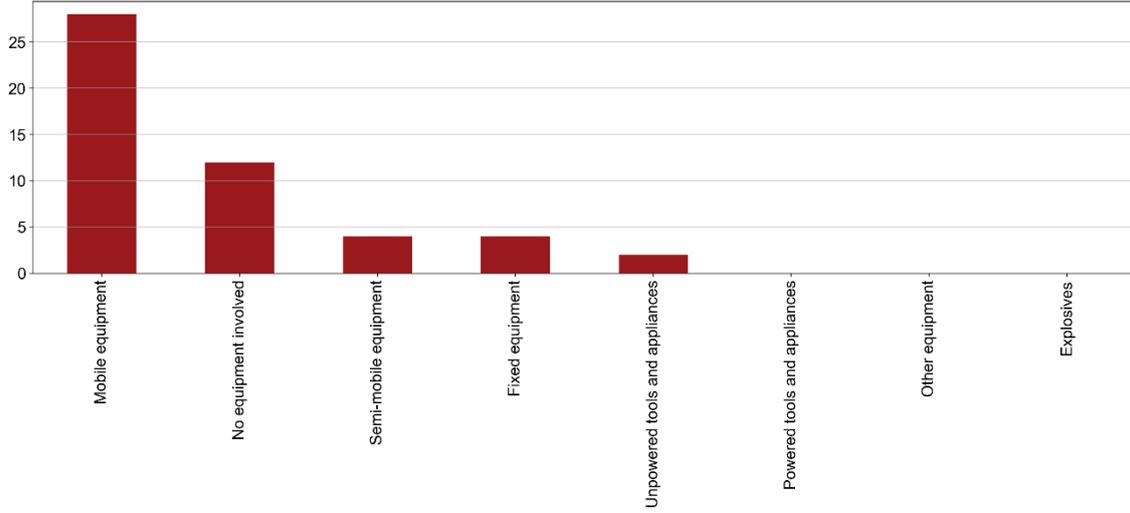




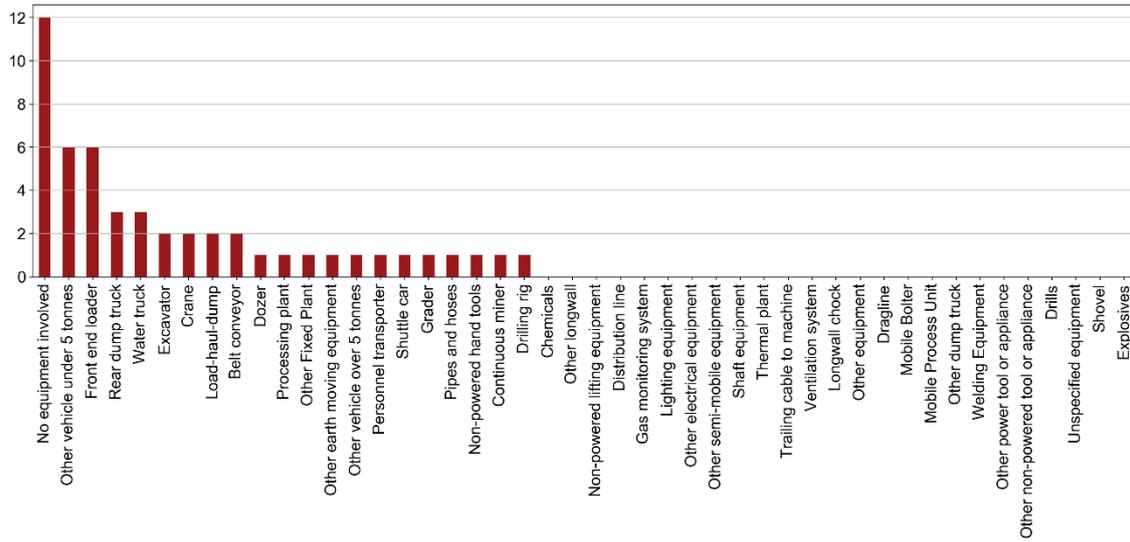


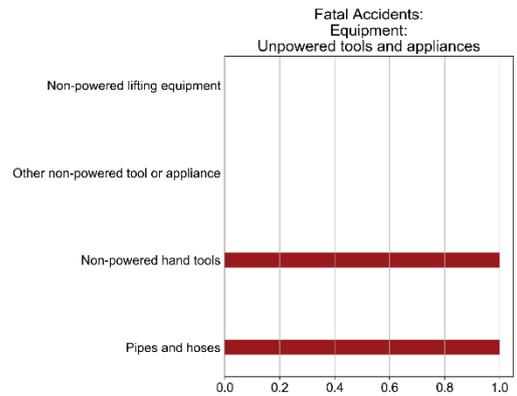
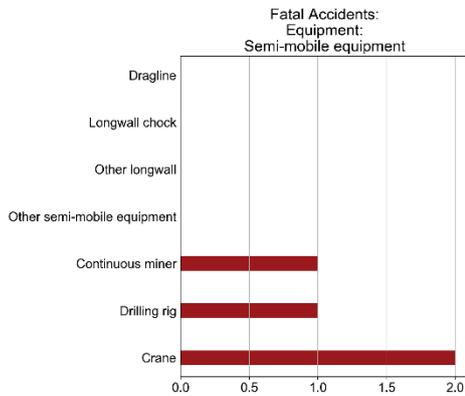
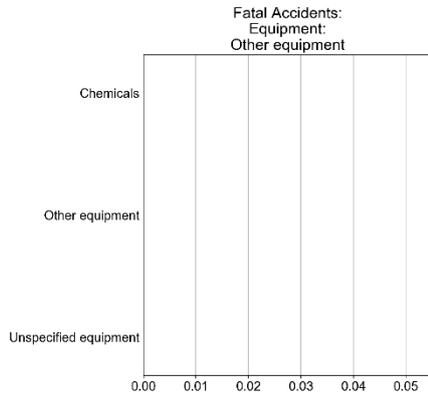
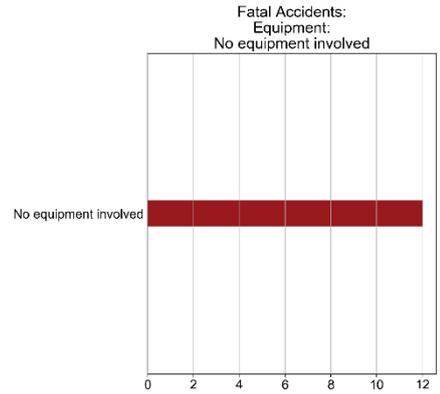
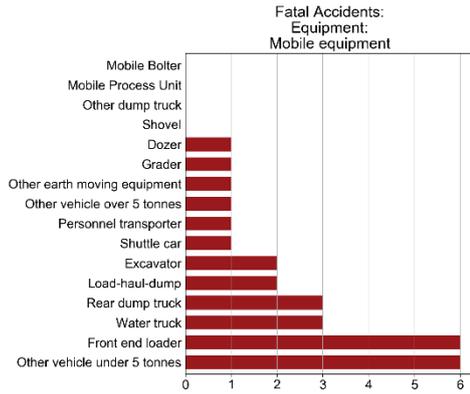
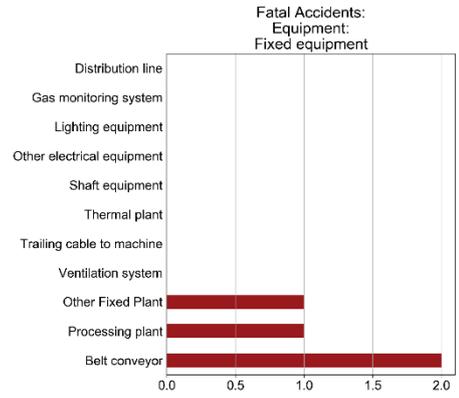
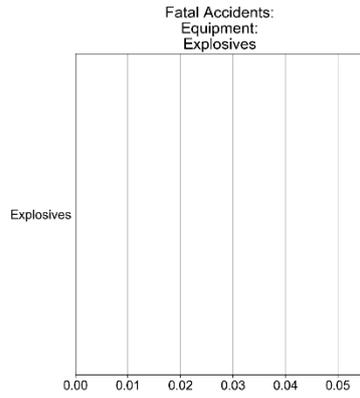


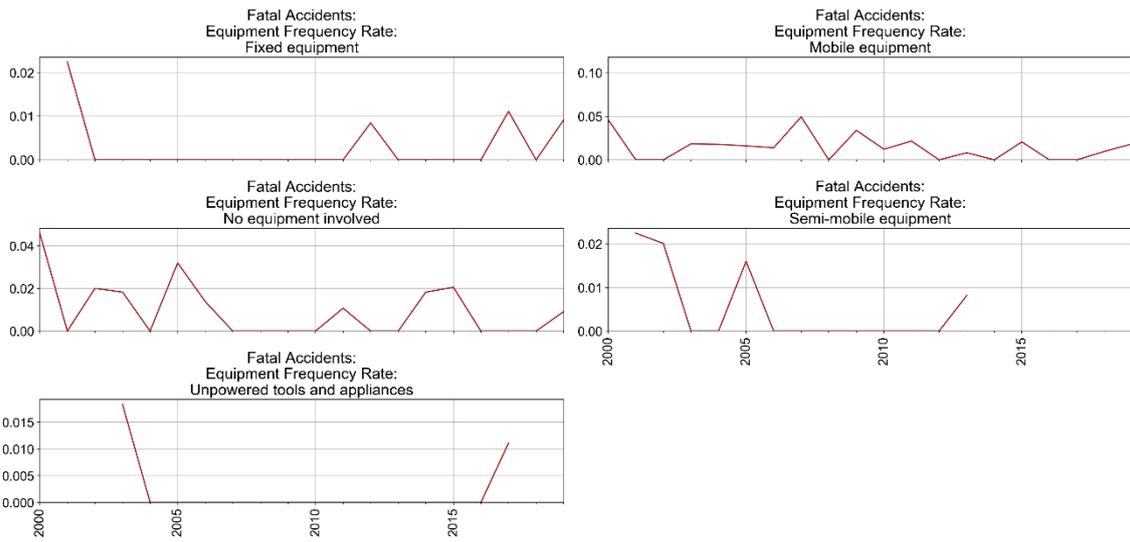
Fatal Accidents:
Equipment:
Level 1

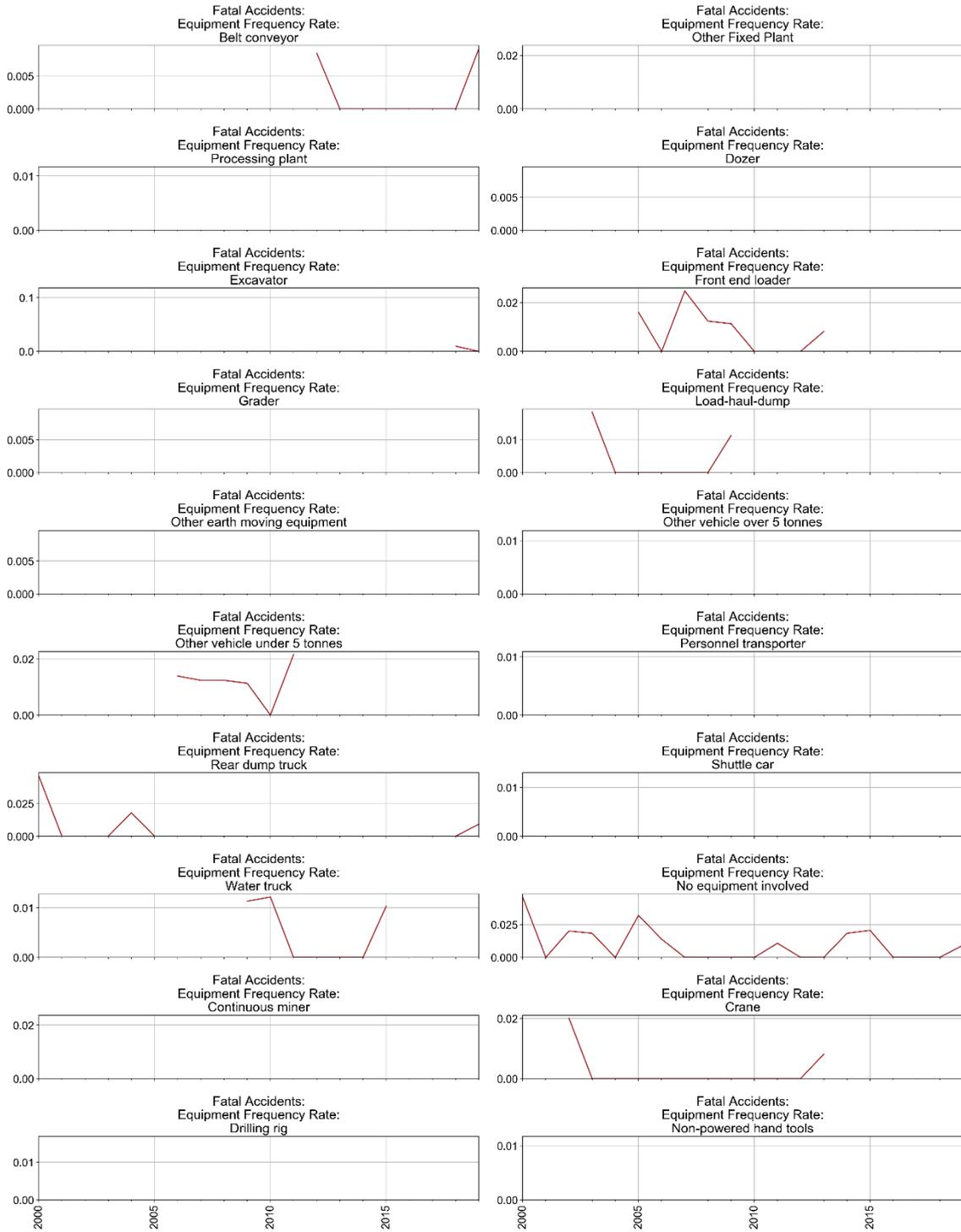


Fatal Accidents:
Equipment:
Level 2

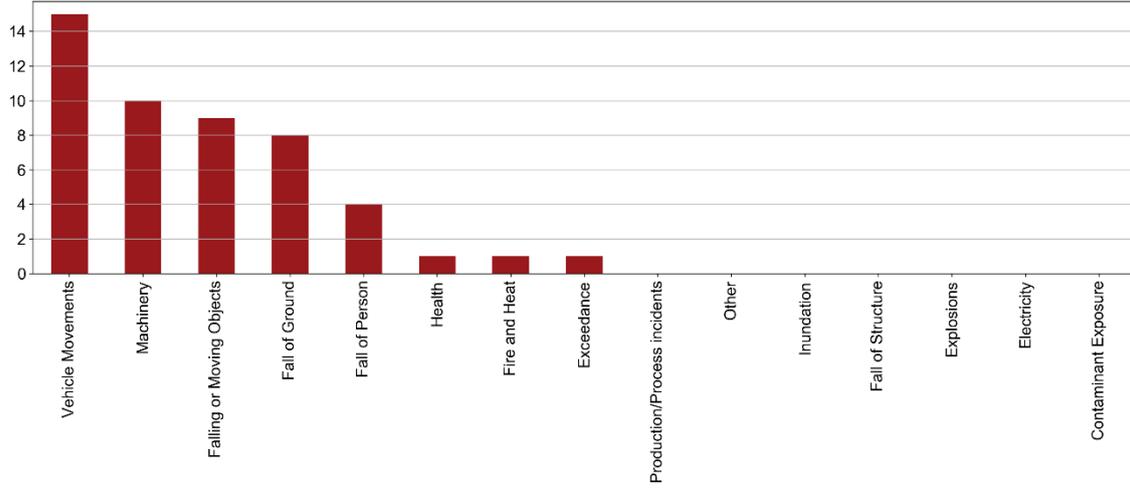




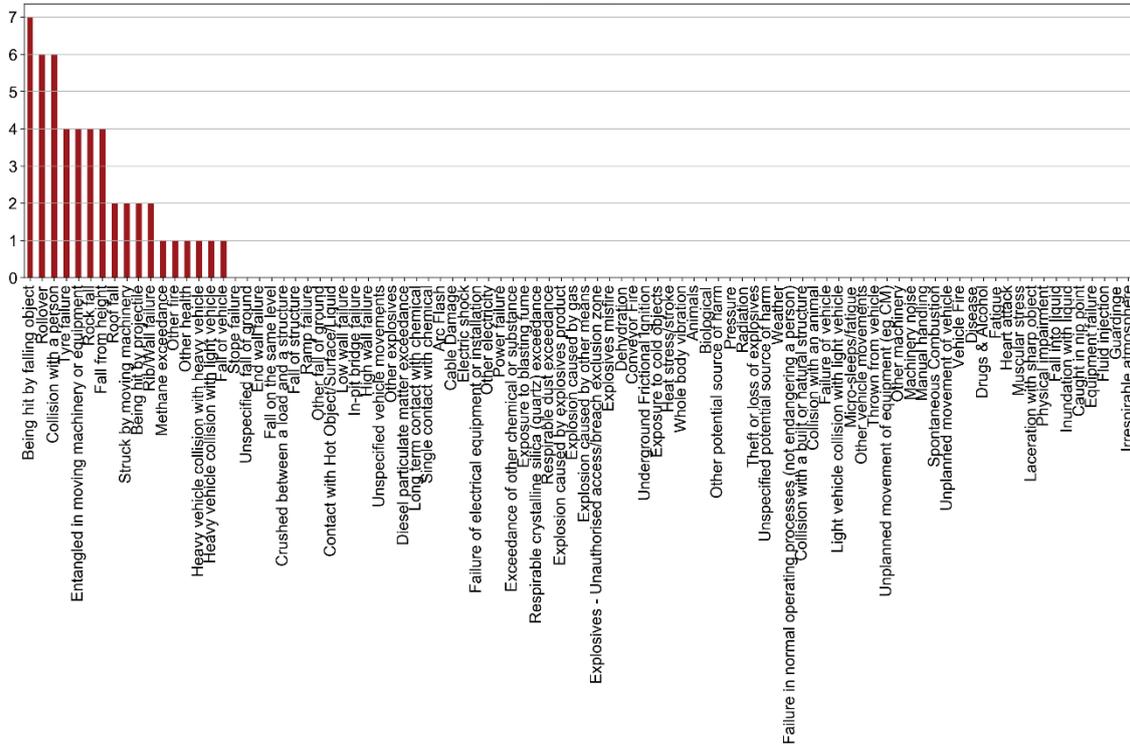


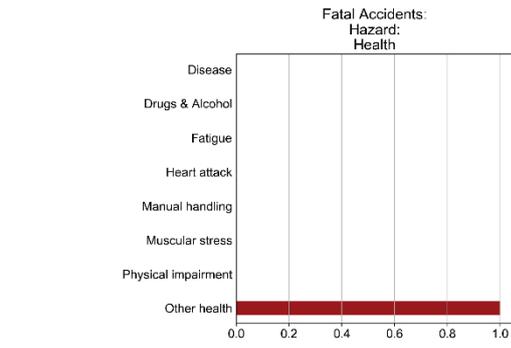
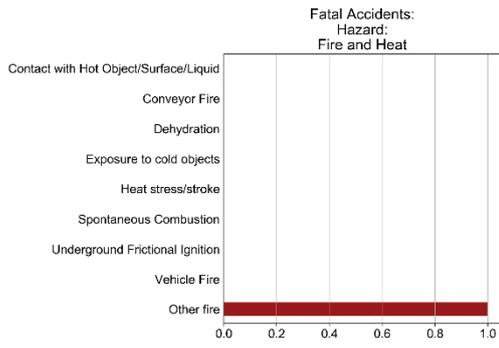
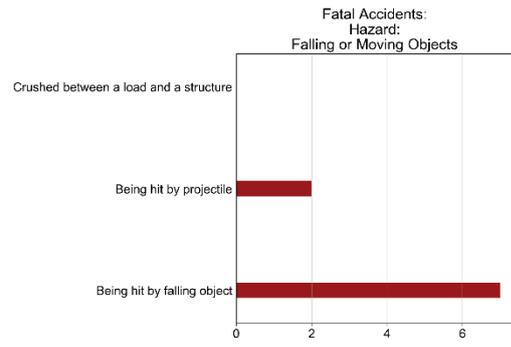
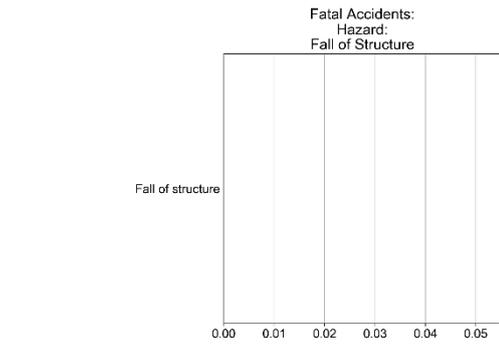
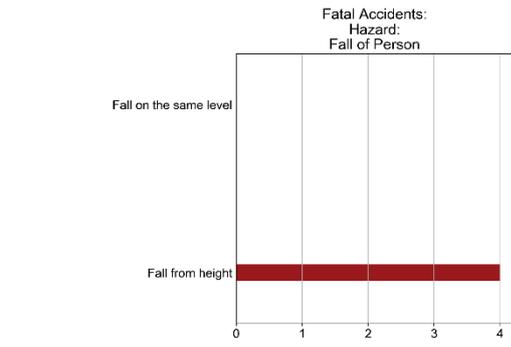
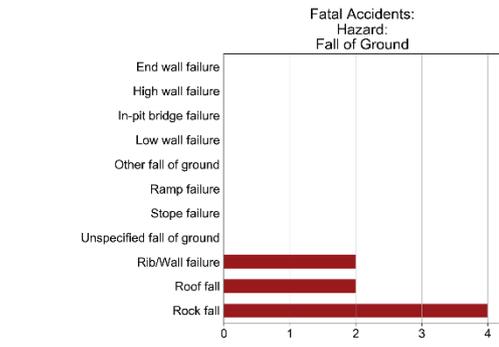
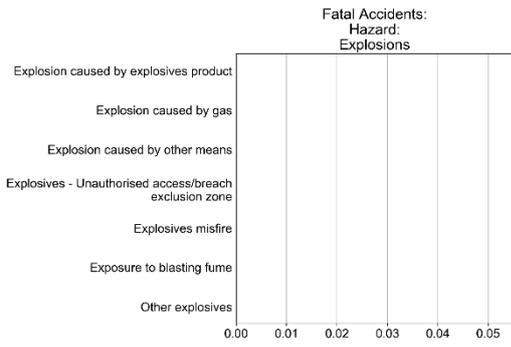
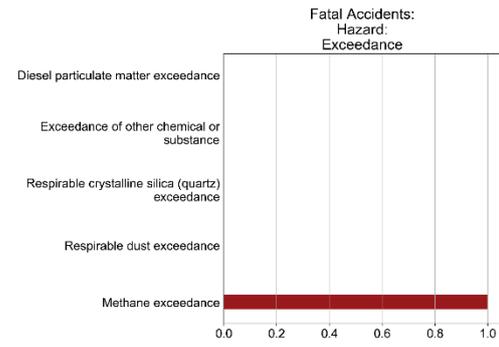
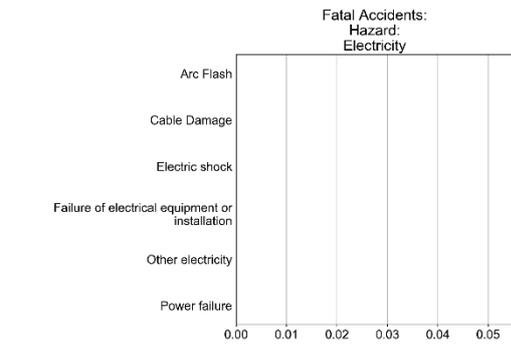
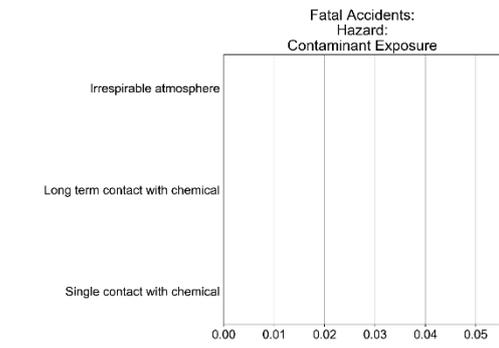


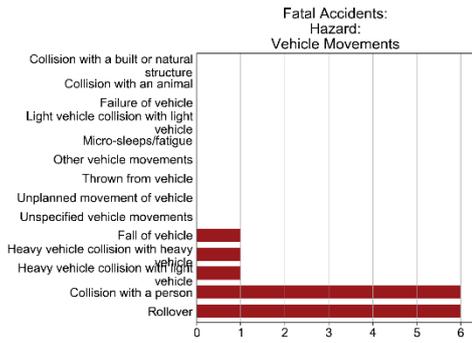
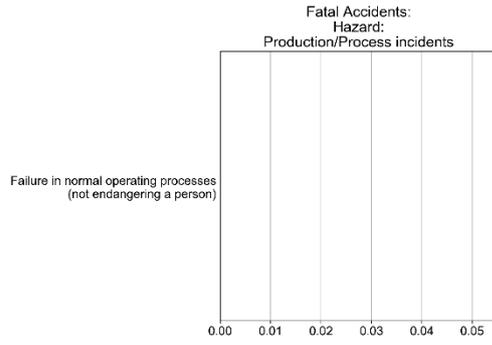
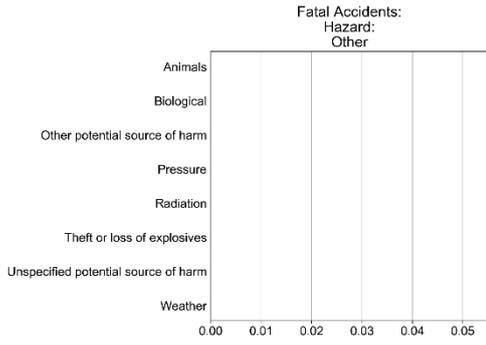
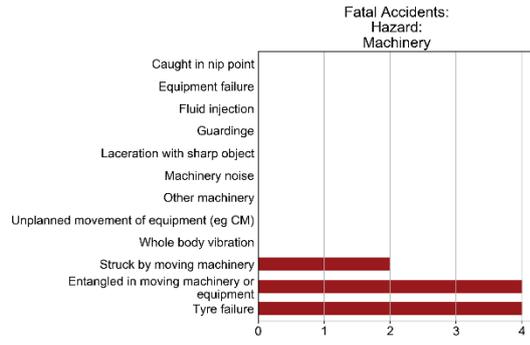
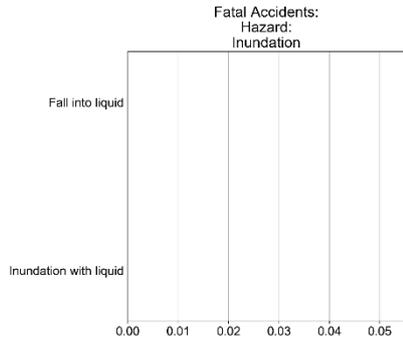
Fatal Accidents:
Hazard:
Level 1

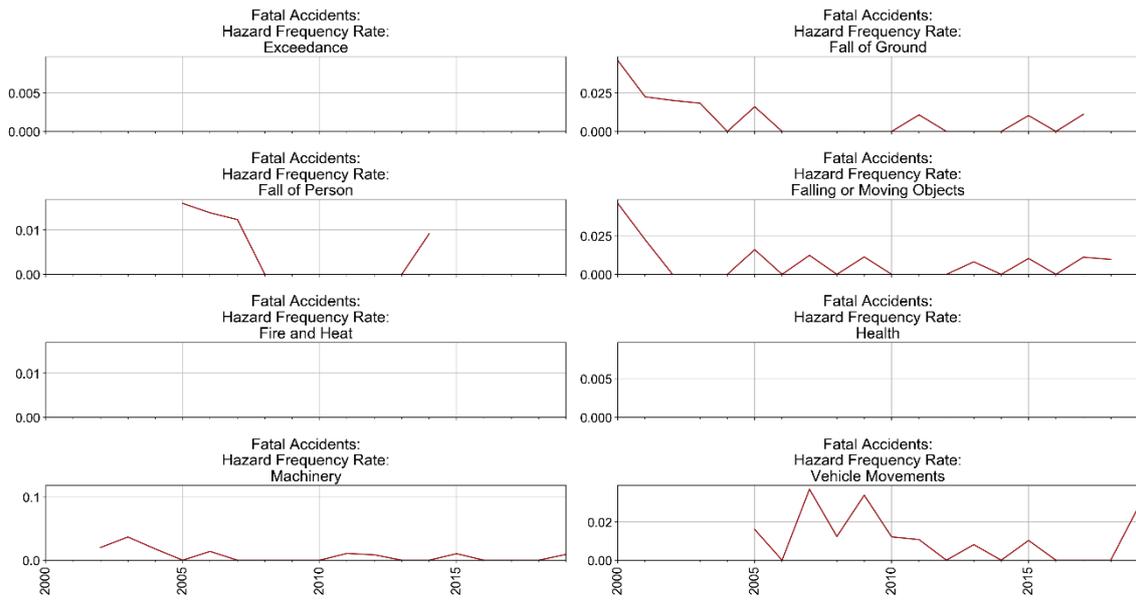


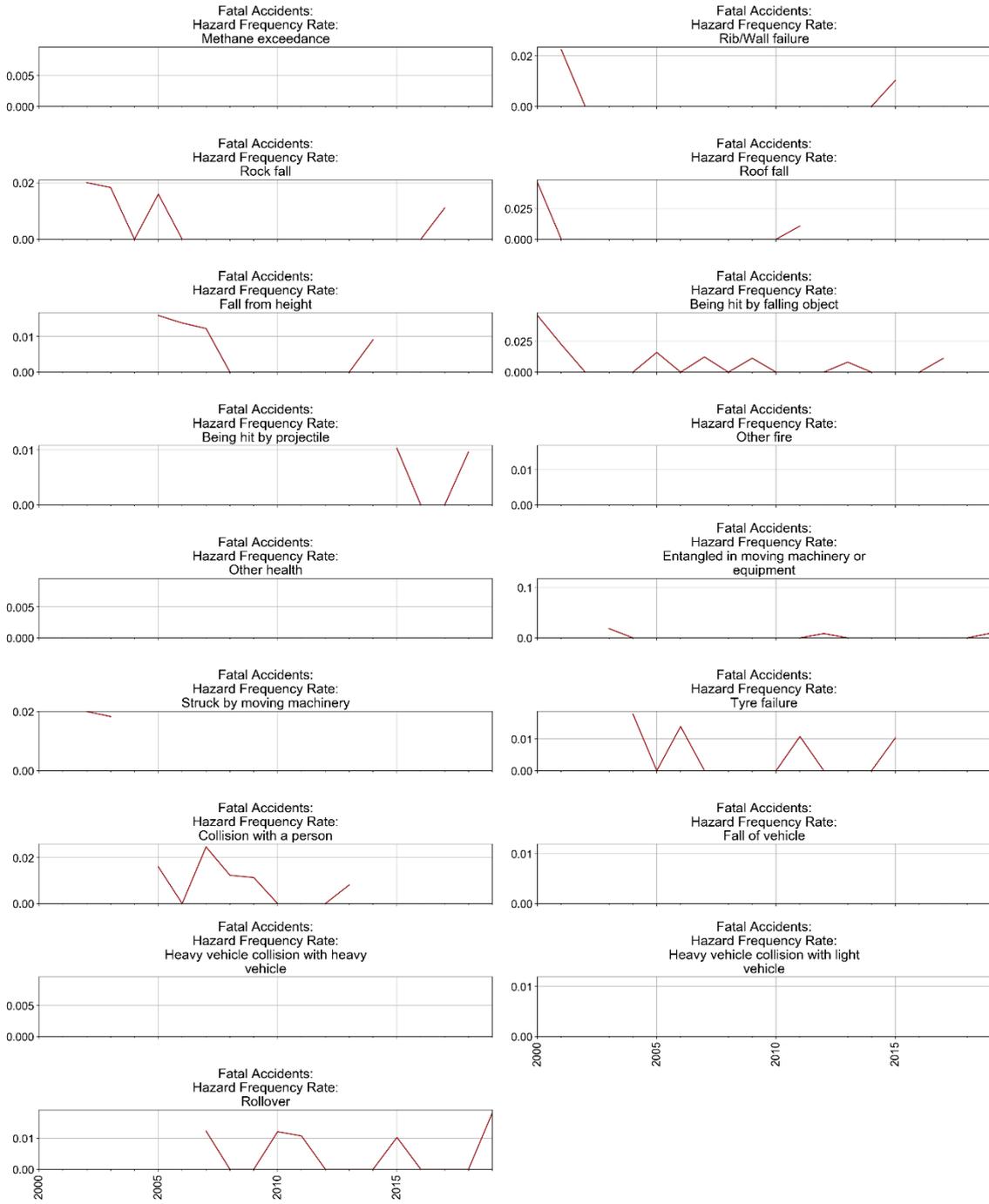
Fatal Accidents:
Hazard:
Level 2



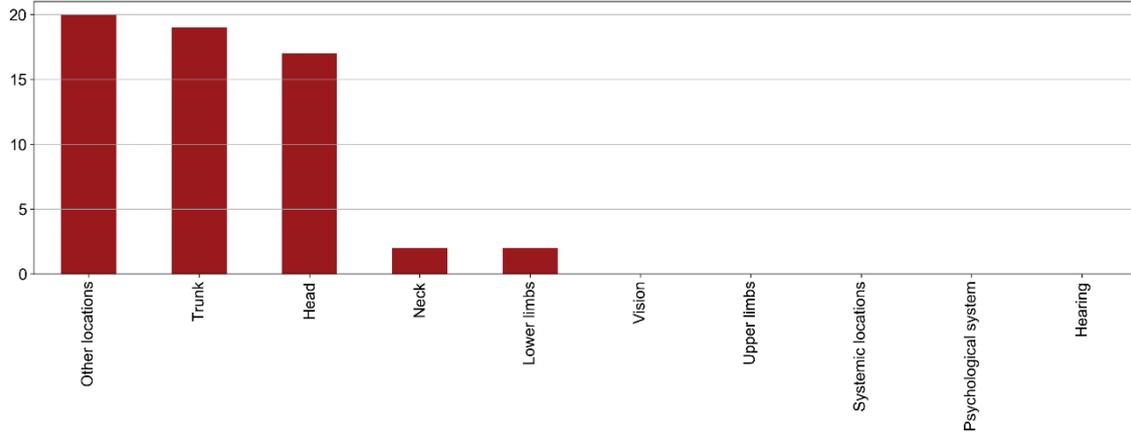




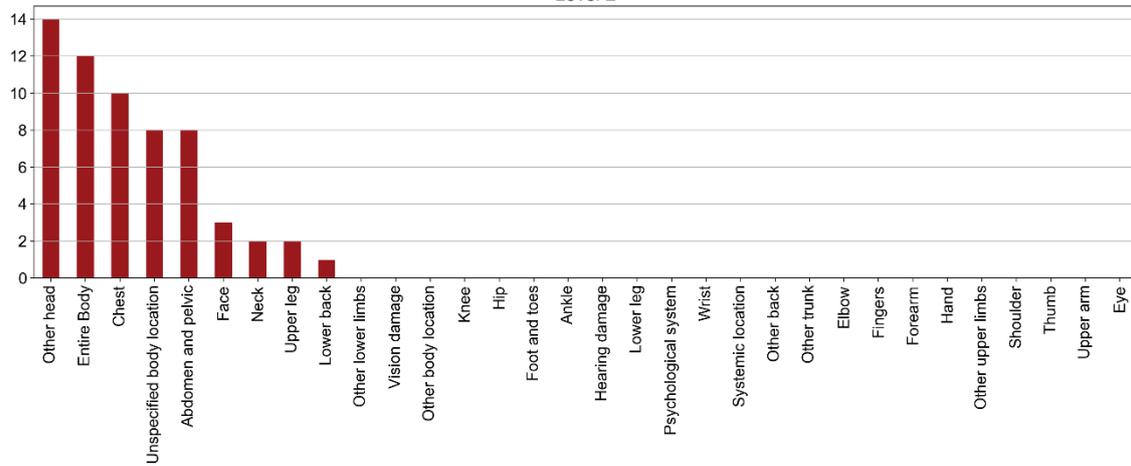


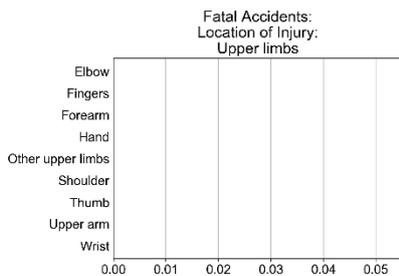
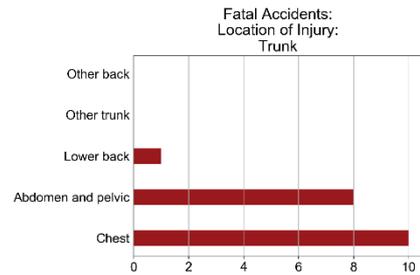
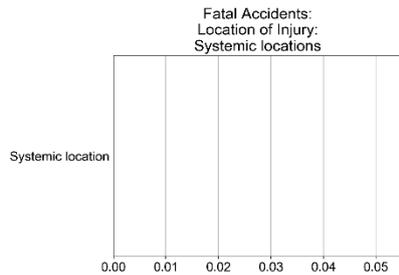
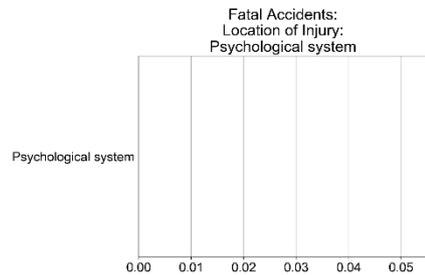
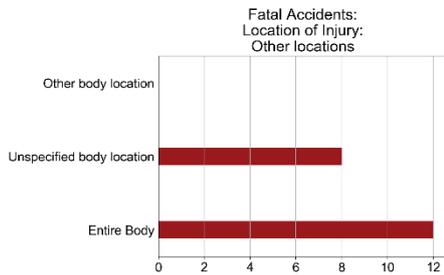
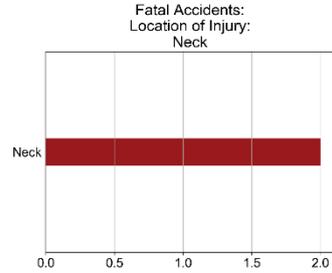
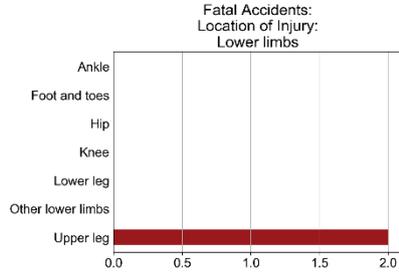
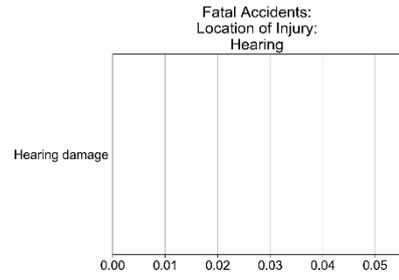
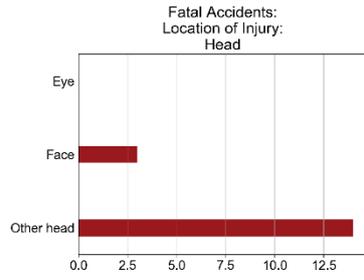


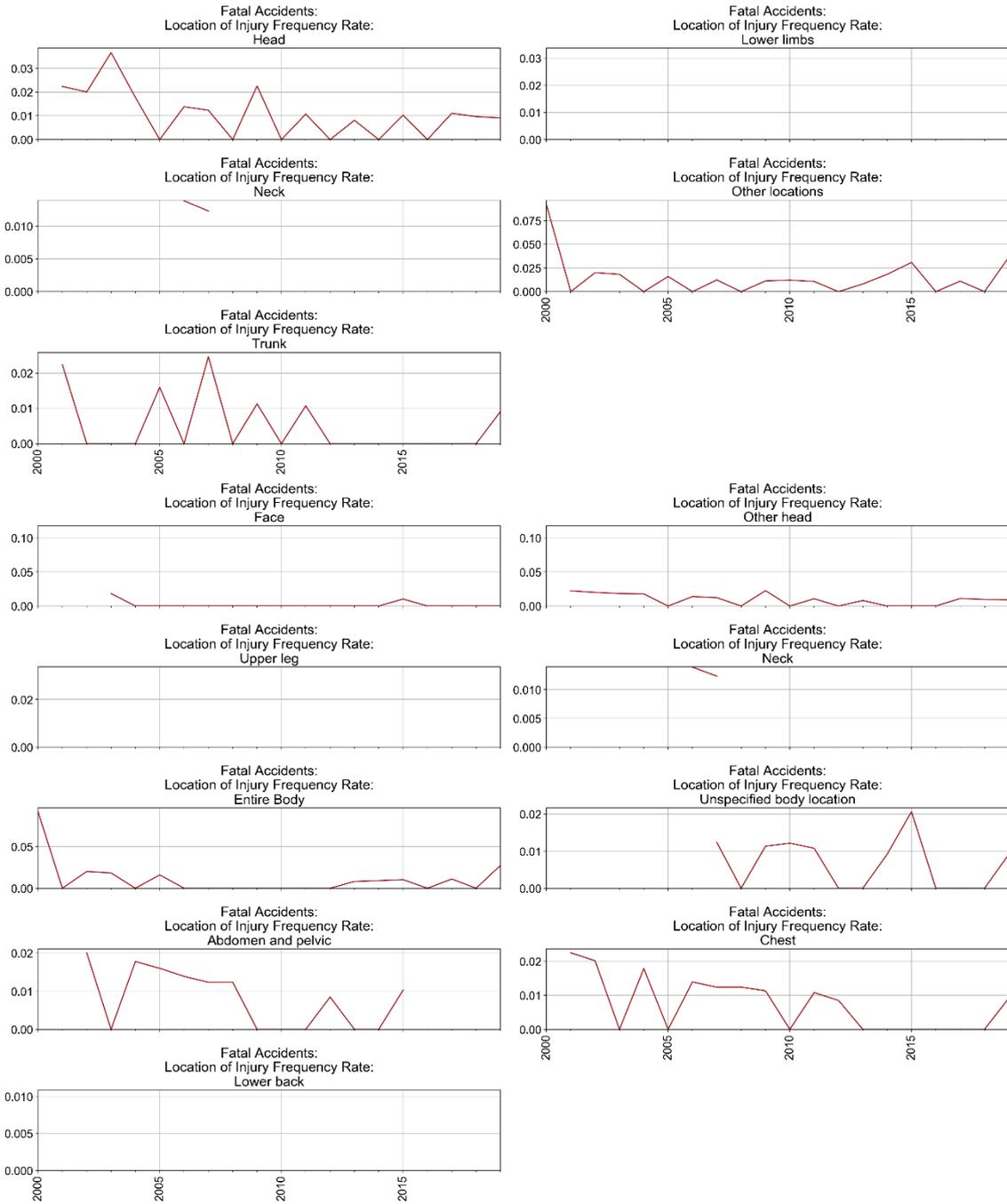
Fatal Accidents:
Location of Injury:
Level 1



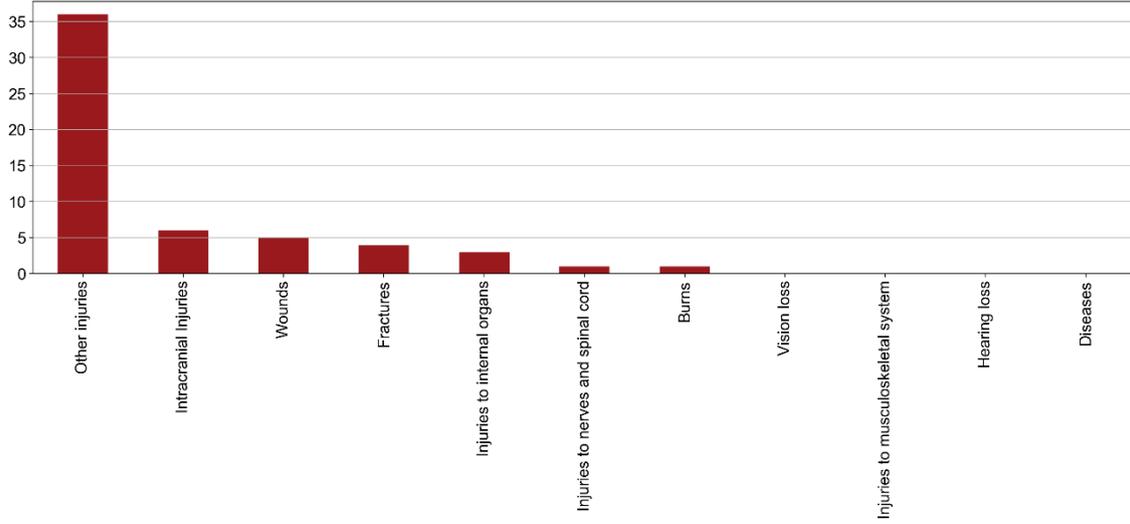
Fatal Accidents:
Location of Injury:
Level 2



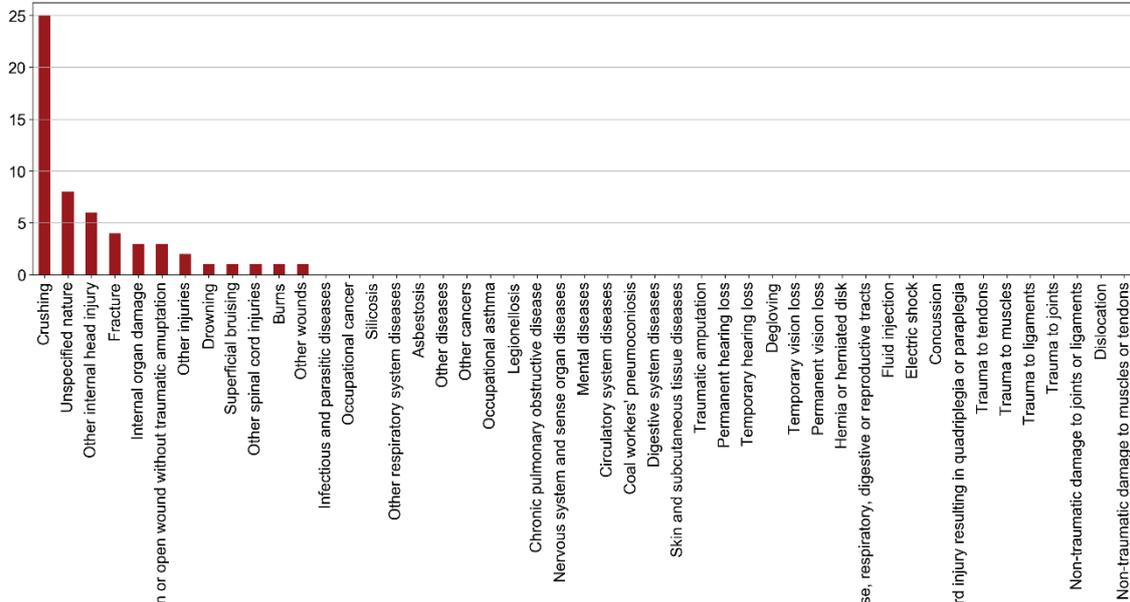


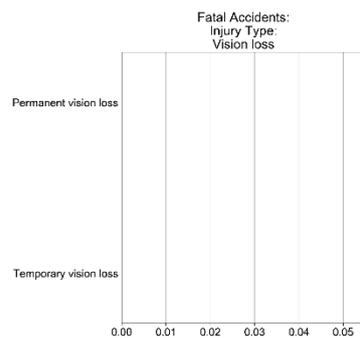
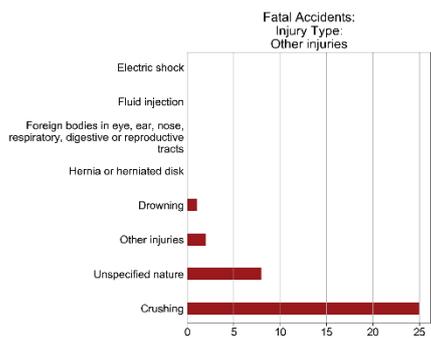
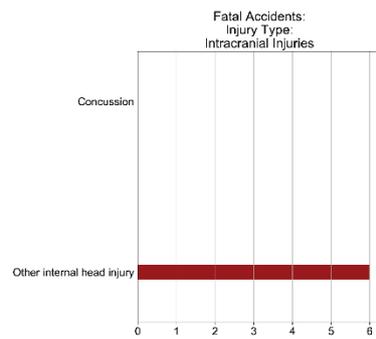
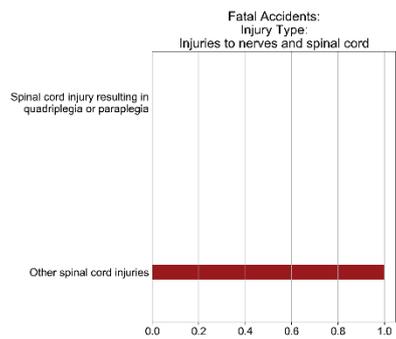
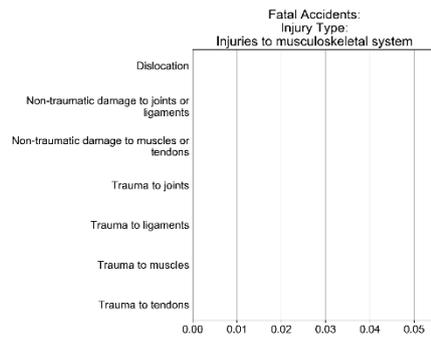
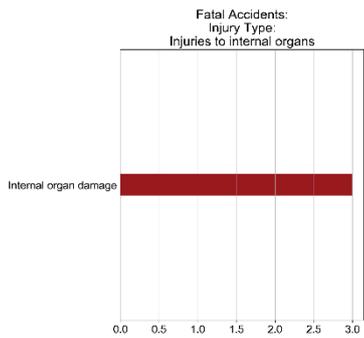
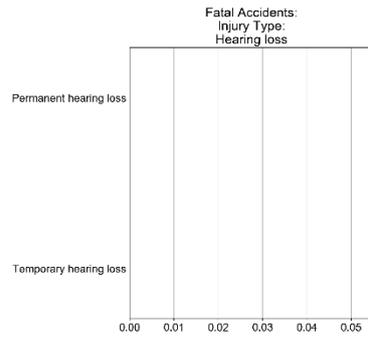
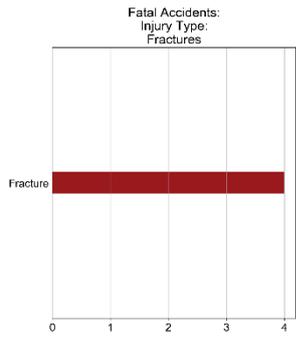
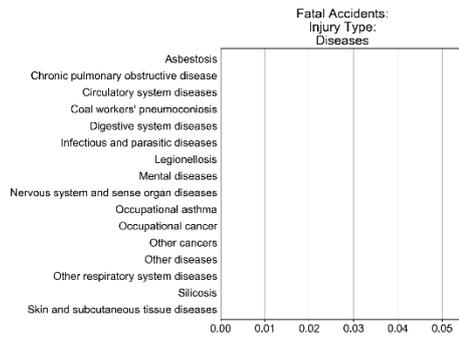
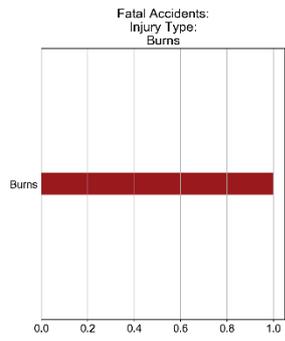


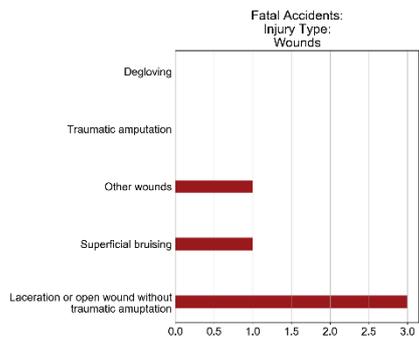
Fatal Accidents:
Injury Type:
Level 1

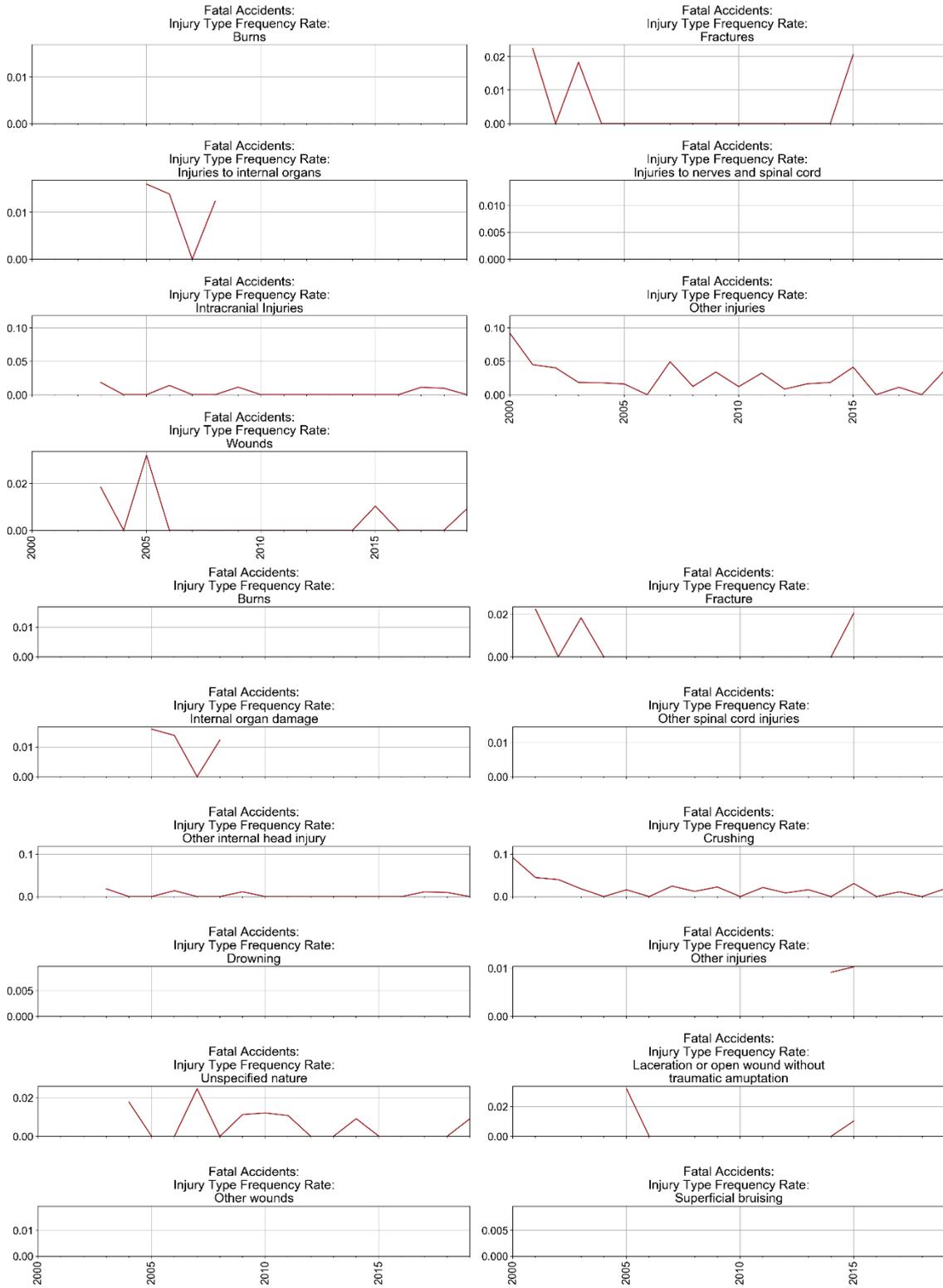


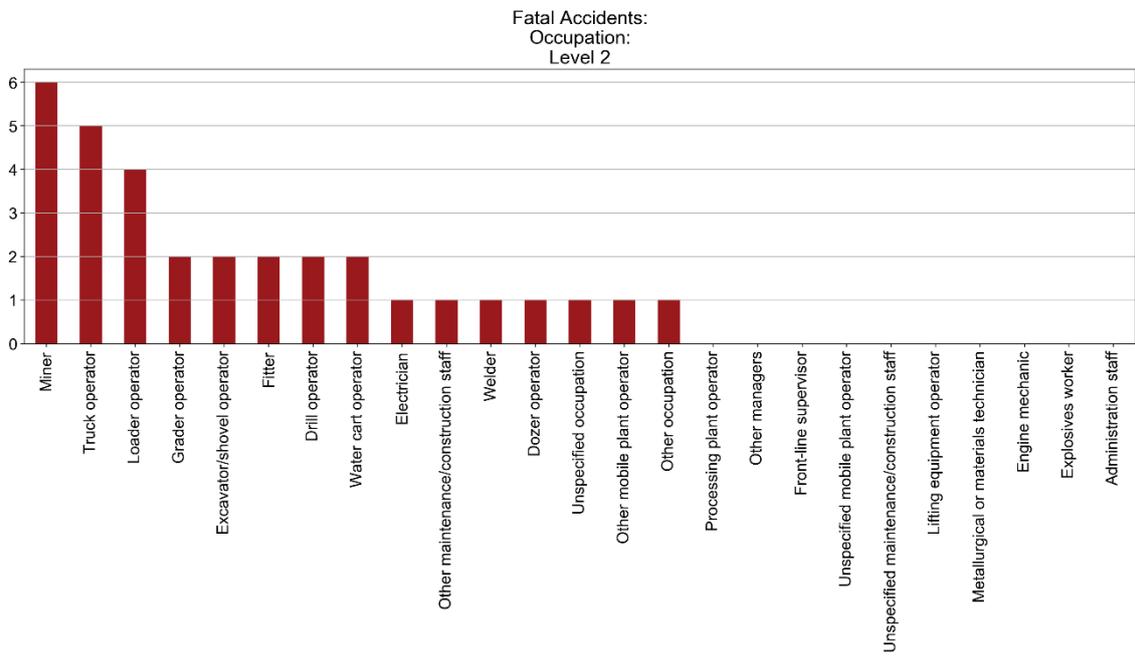
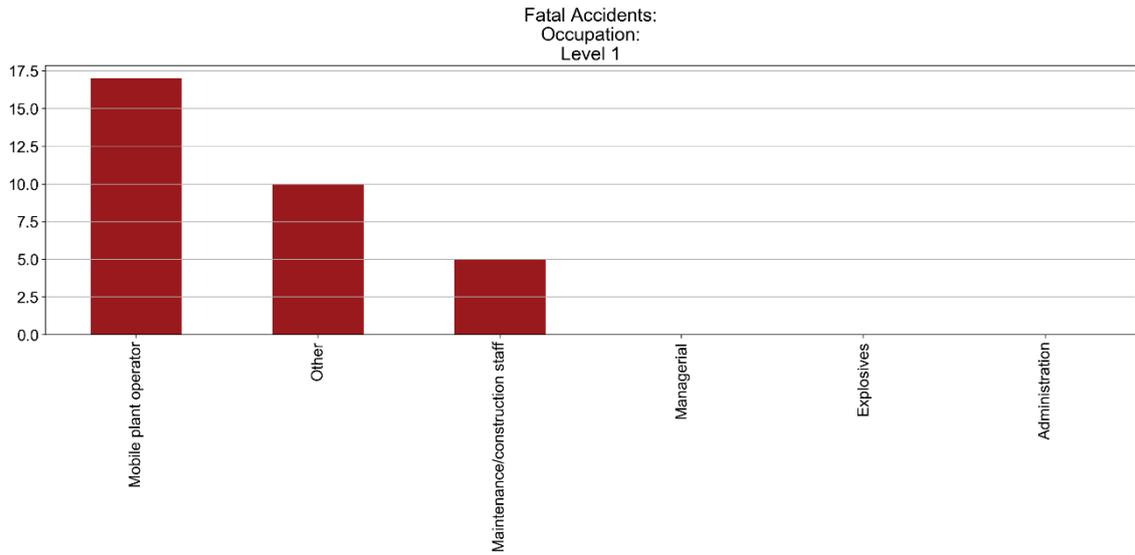
Fatal Accidents:
Injury Type:
Level 2

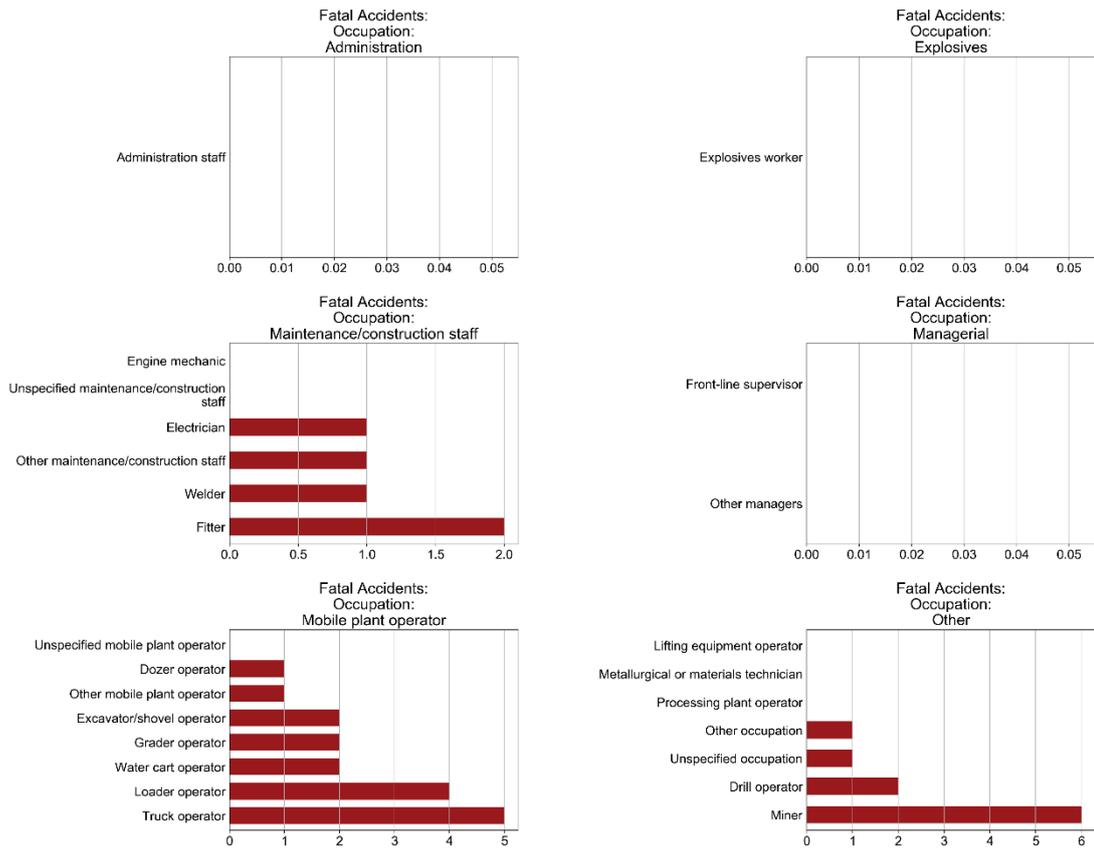


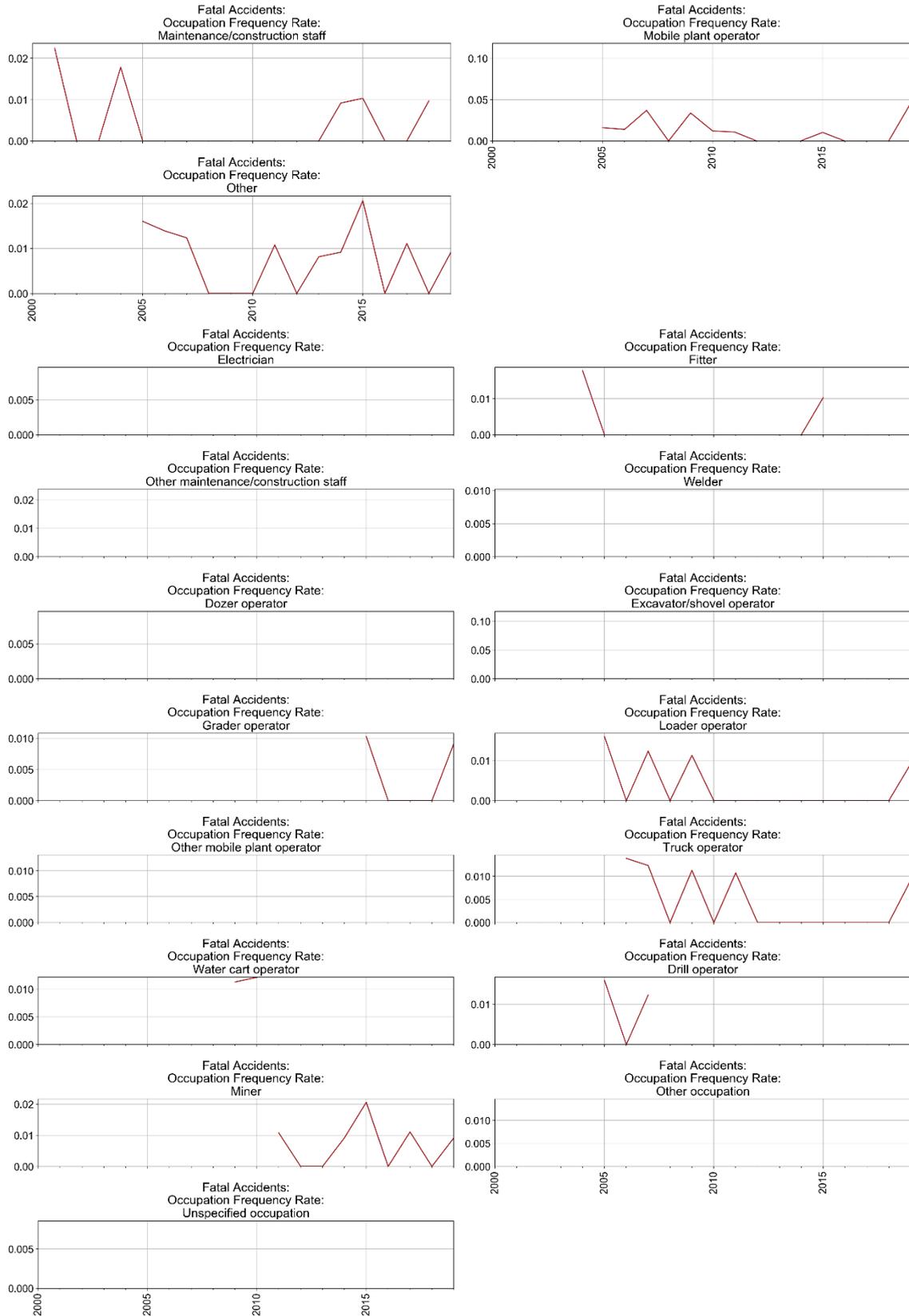




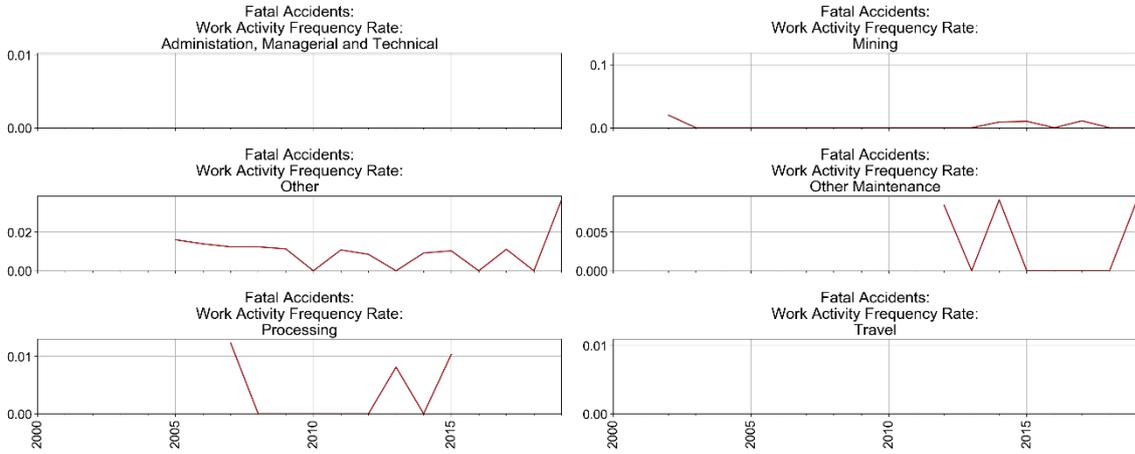
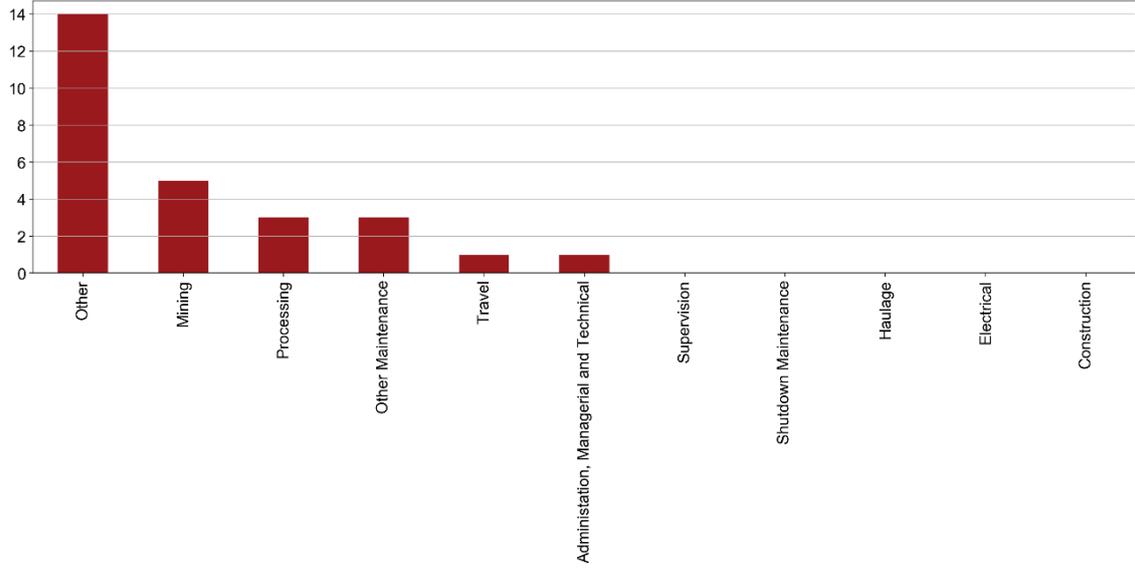


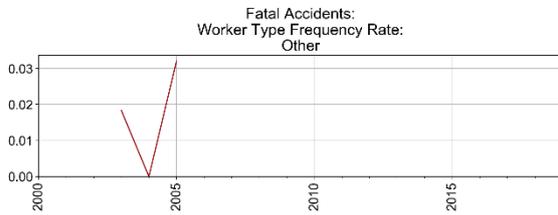
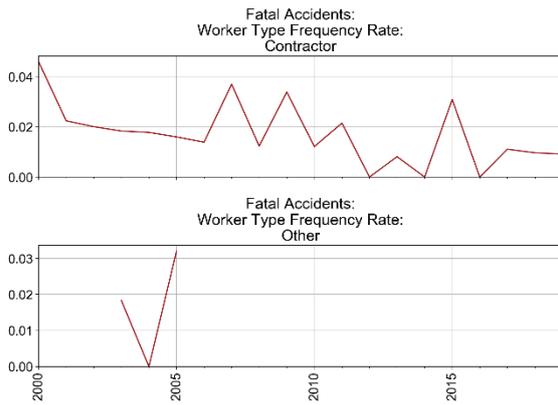
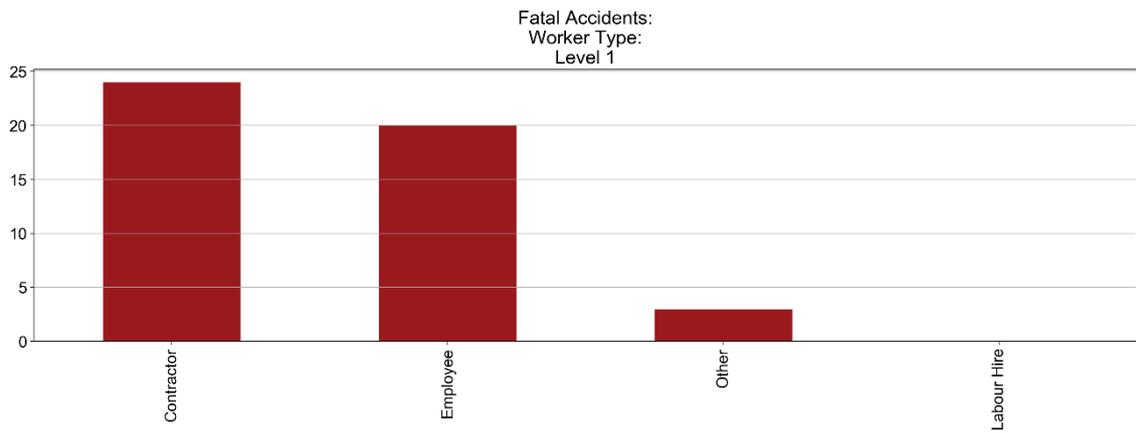




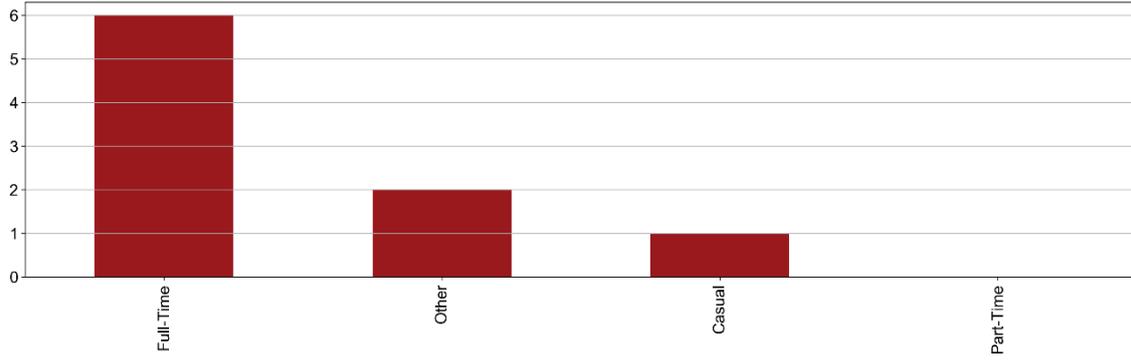


Fatal Accidents:
Work Activity:
Level 1

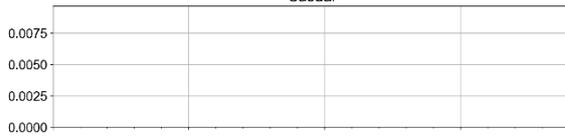




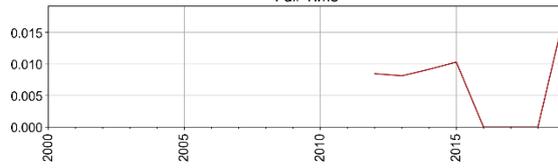
Fatal Accidents:
Nature of Employment:
Level 1



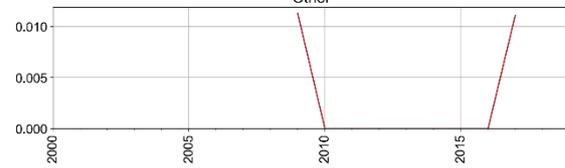
Fatal Accidents:
Nature of Employment Frequency Rate:
Casual



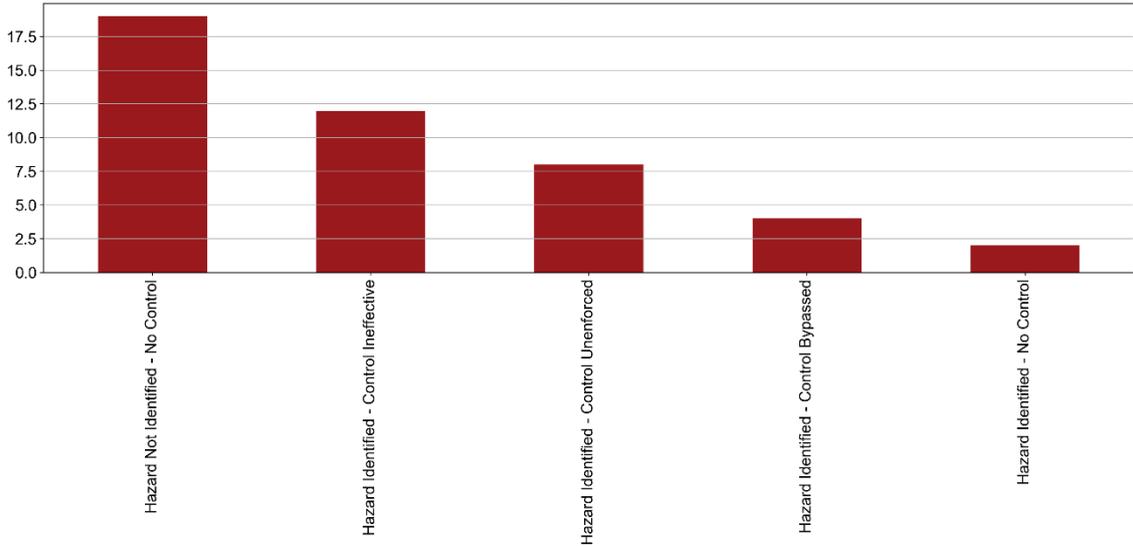
Fatal Accidents:
Nature of Employment Frequency Rate:
Full-Time



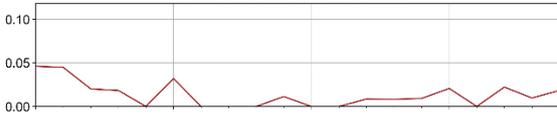
Fatal Accidents:
Nature of Employment Frequency Rate:
Other



Fatal Accidents:
Absent or Failed Controls:
Level 1



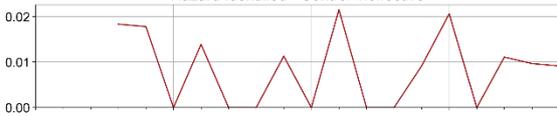
Fatal Accidents:
Absent or Failed Controls Frequency Rate:
Hazard Not Identified - No Control



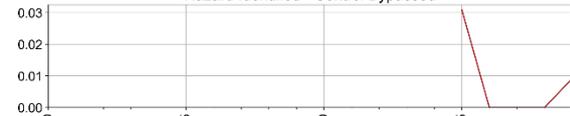
Fatal Accidents:
Absent or Failed Controls Frequency Rate:
Hazard Identified - No Control



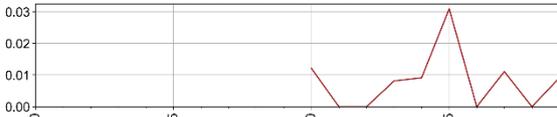
Fatal Accidents:
Absent or Failed Controls Frequency Rate:
Hazard Identified - Control Ineffective



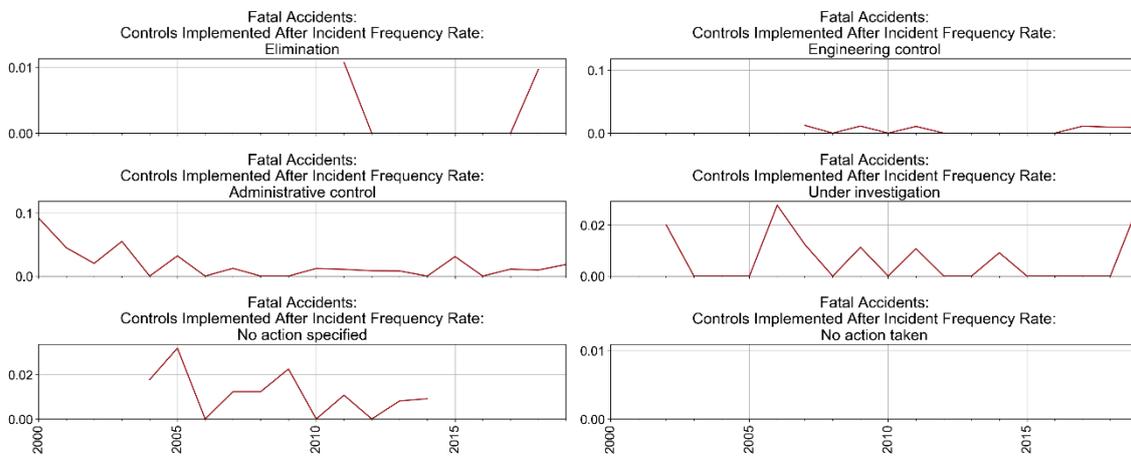
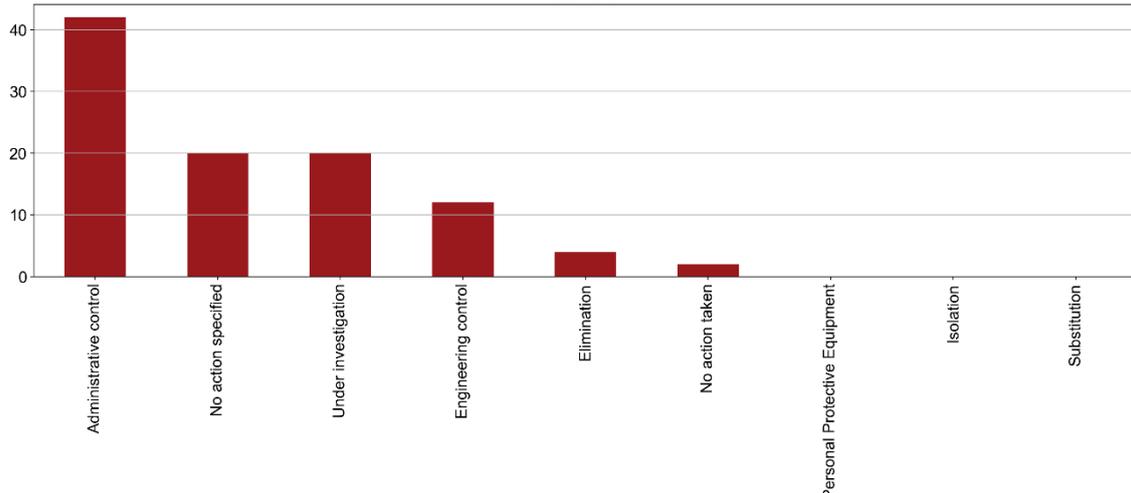
Fatal Accidents:
Absent or Failed Controls Frequency Rate:
Hazard Identified - Control Bypassed



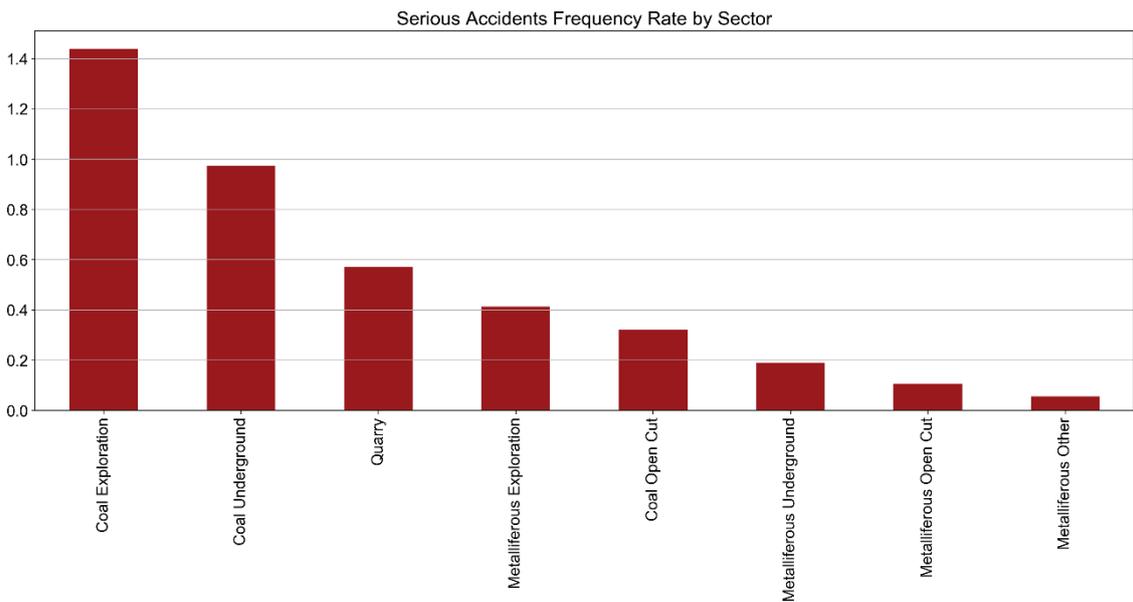
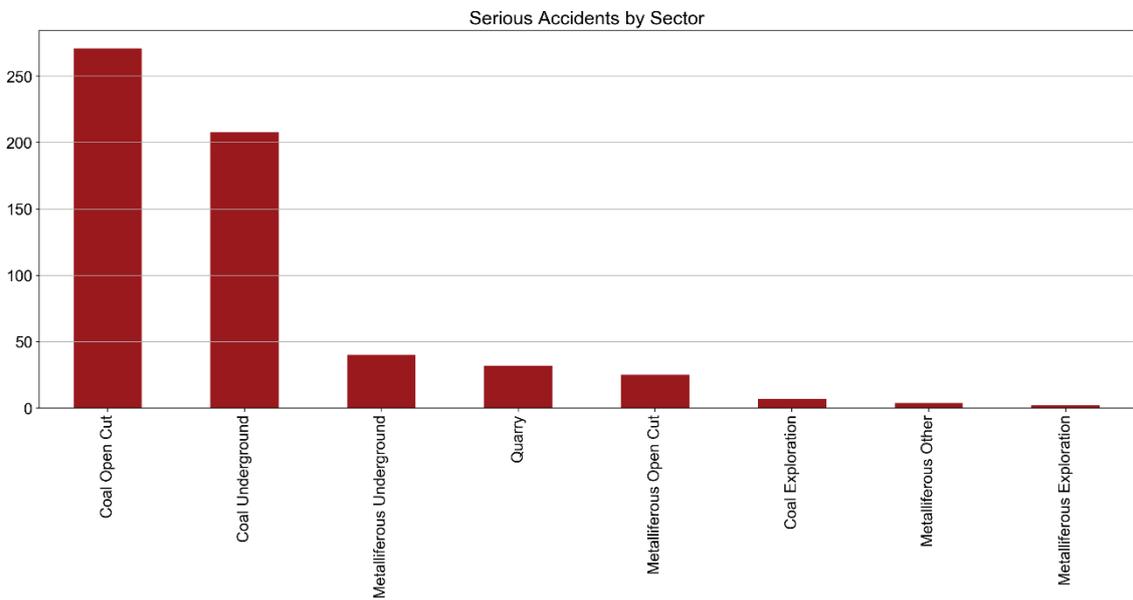
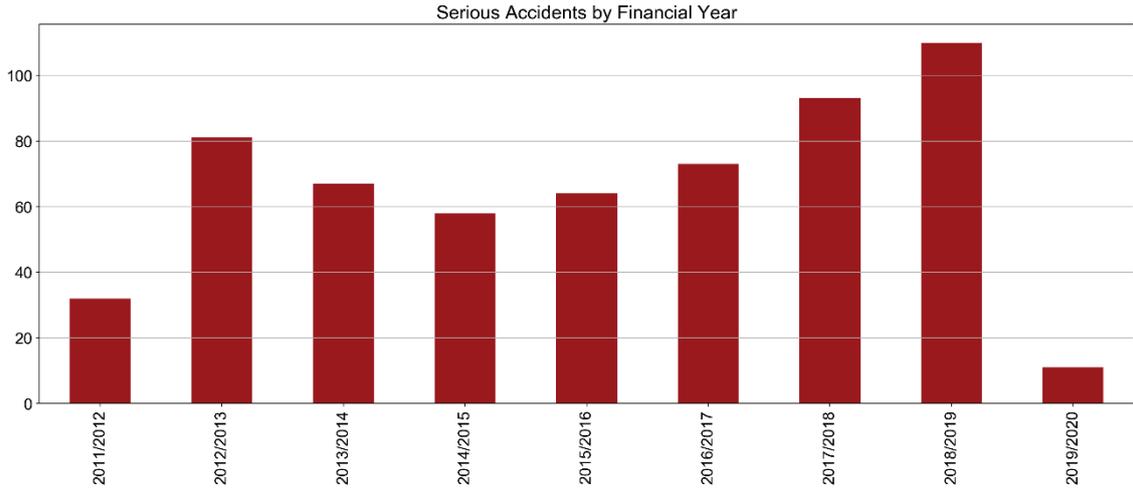
Fatal Accidents:
Absent or Failed Controls Frequency Rate:
Hazard Identified - Control Unenforced

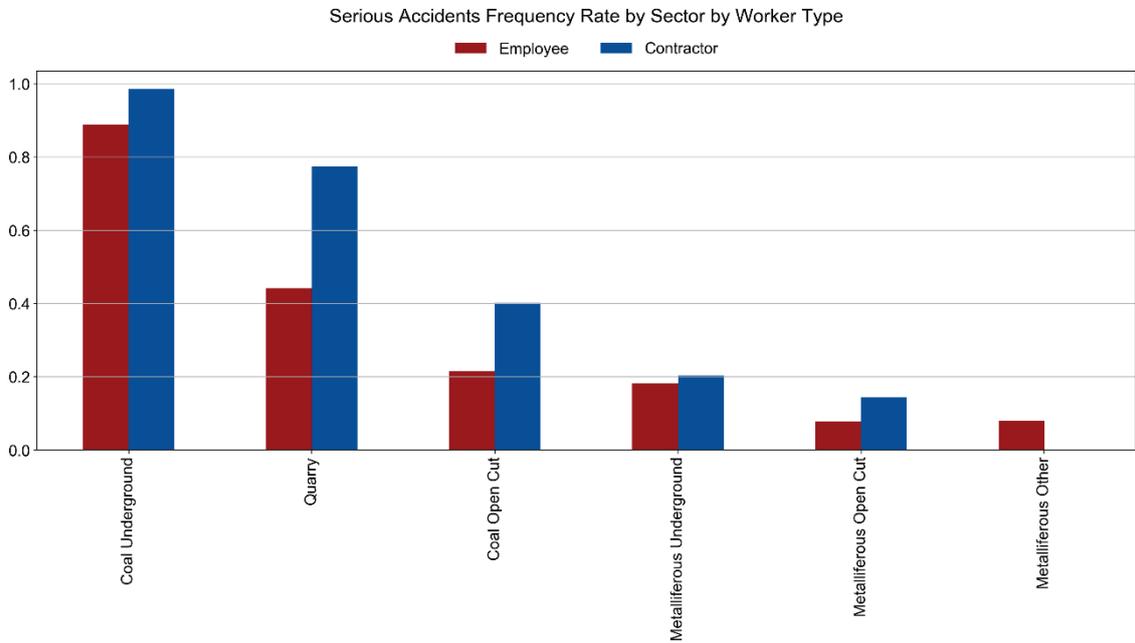
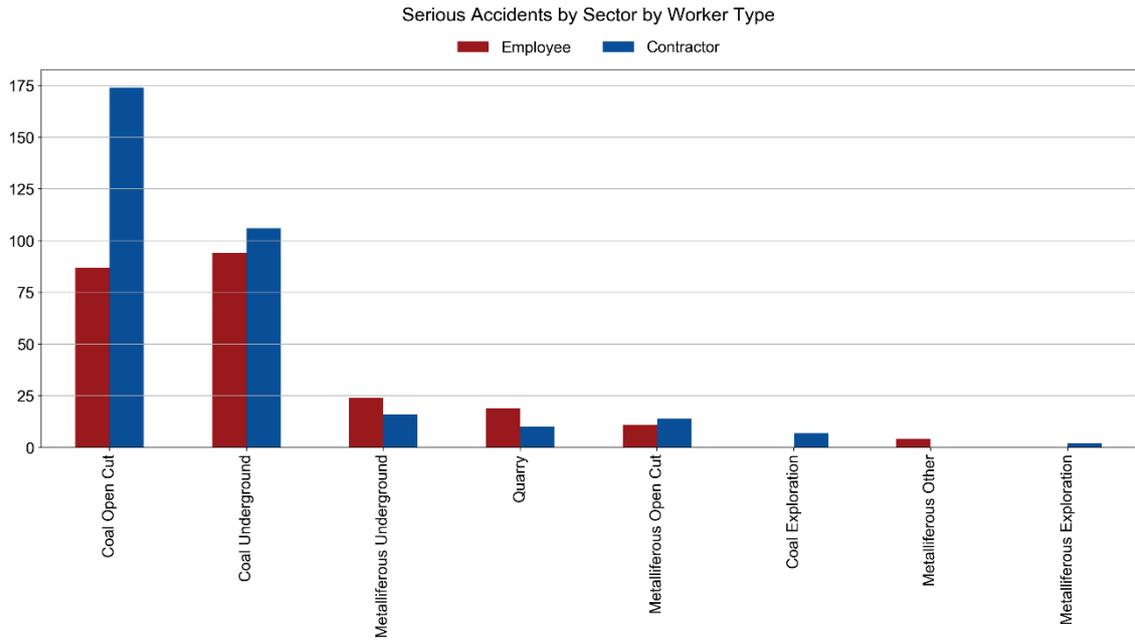


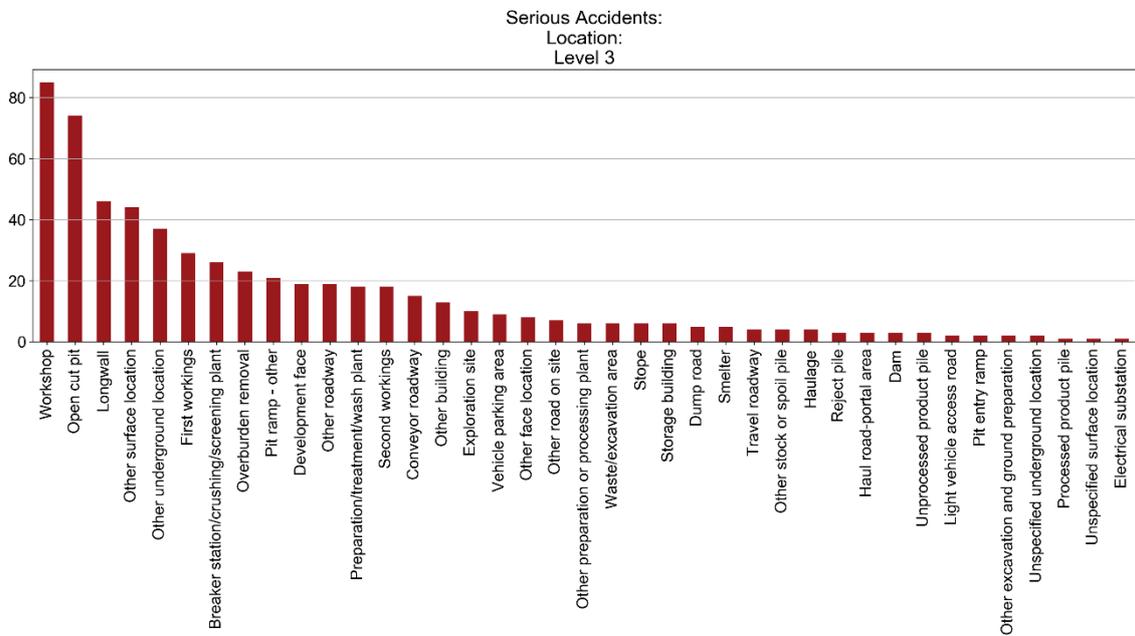
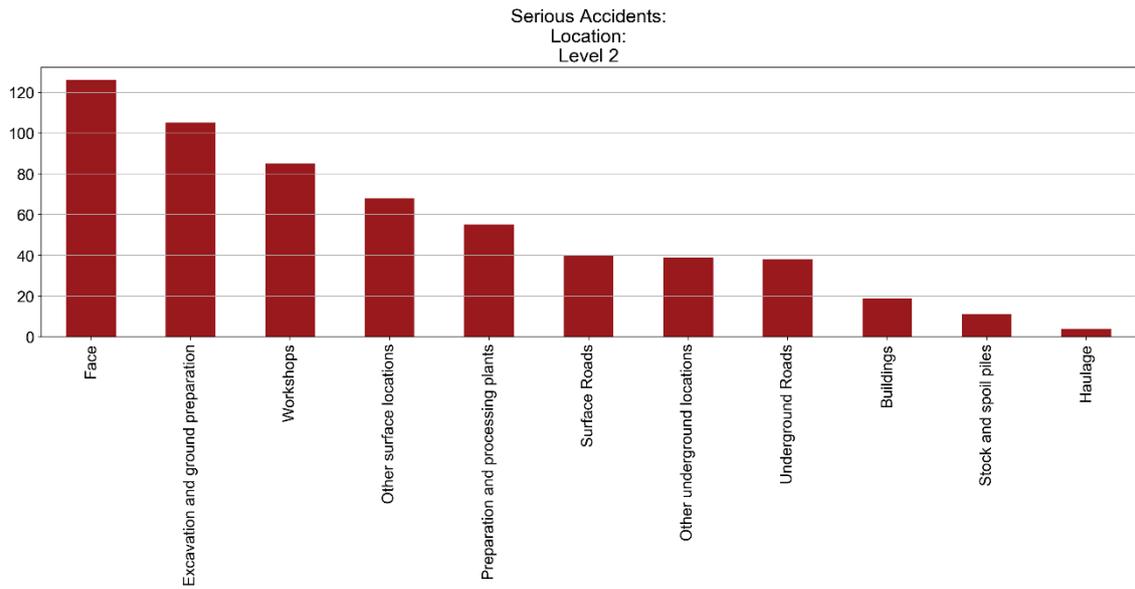
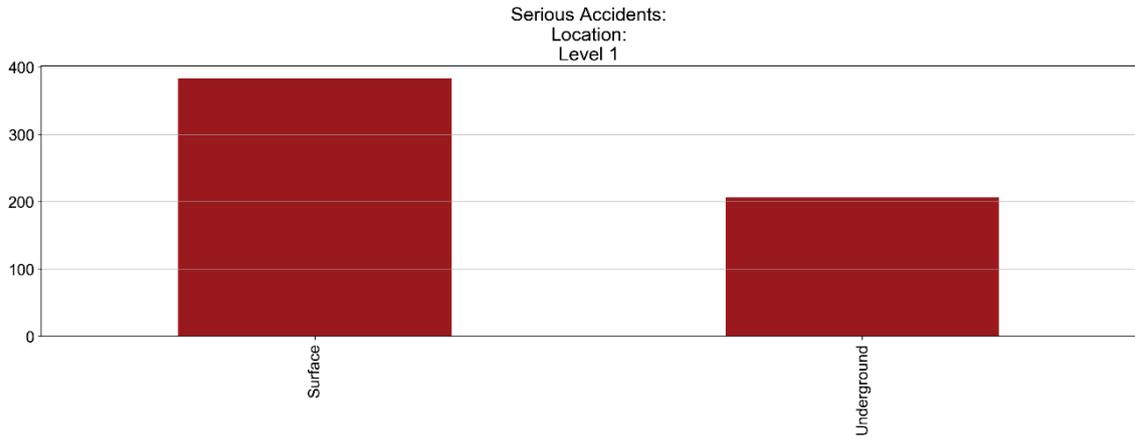
Fatal Accidents:
Controls Implemented After Incident:
Level 1

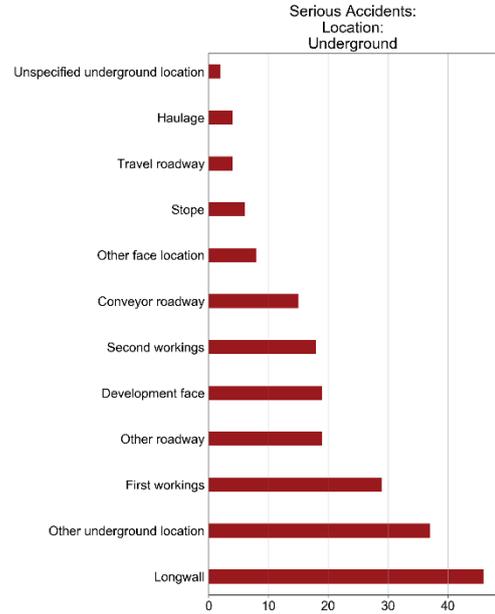
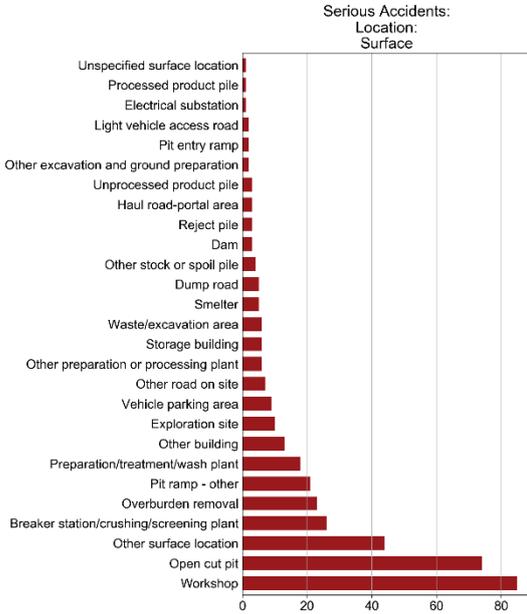
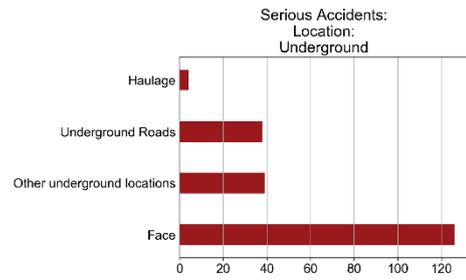
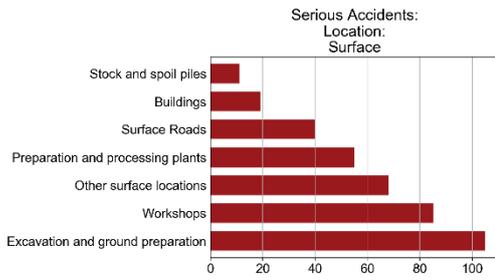


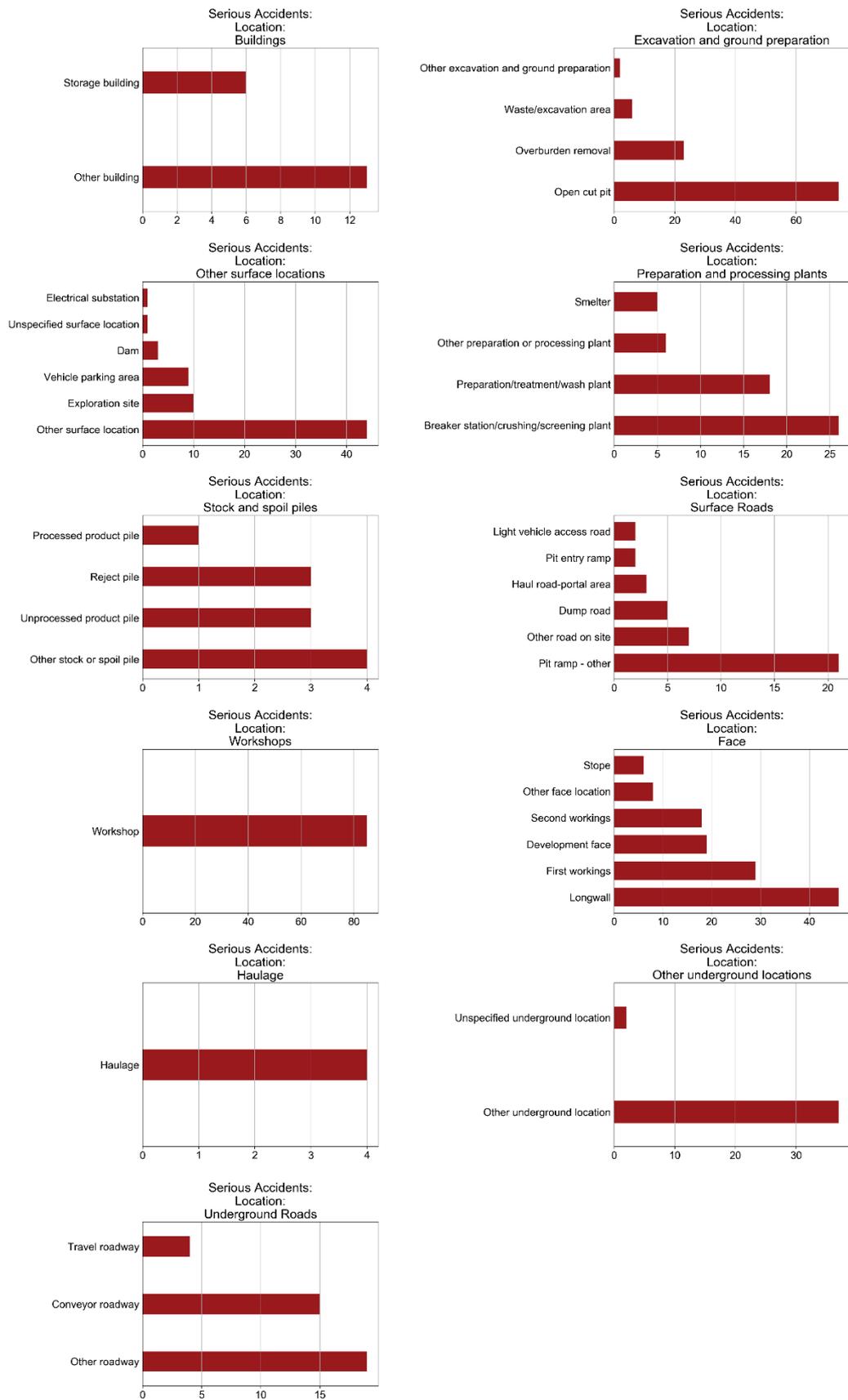
Serious Accidents (SAs)

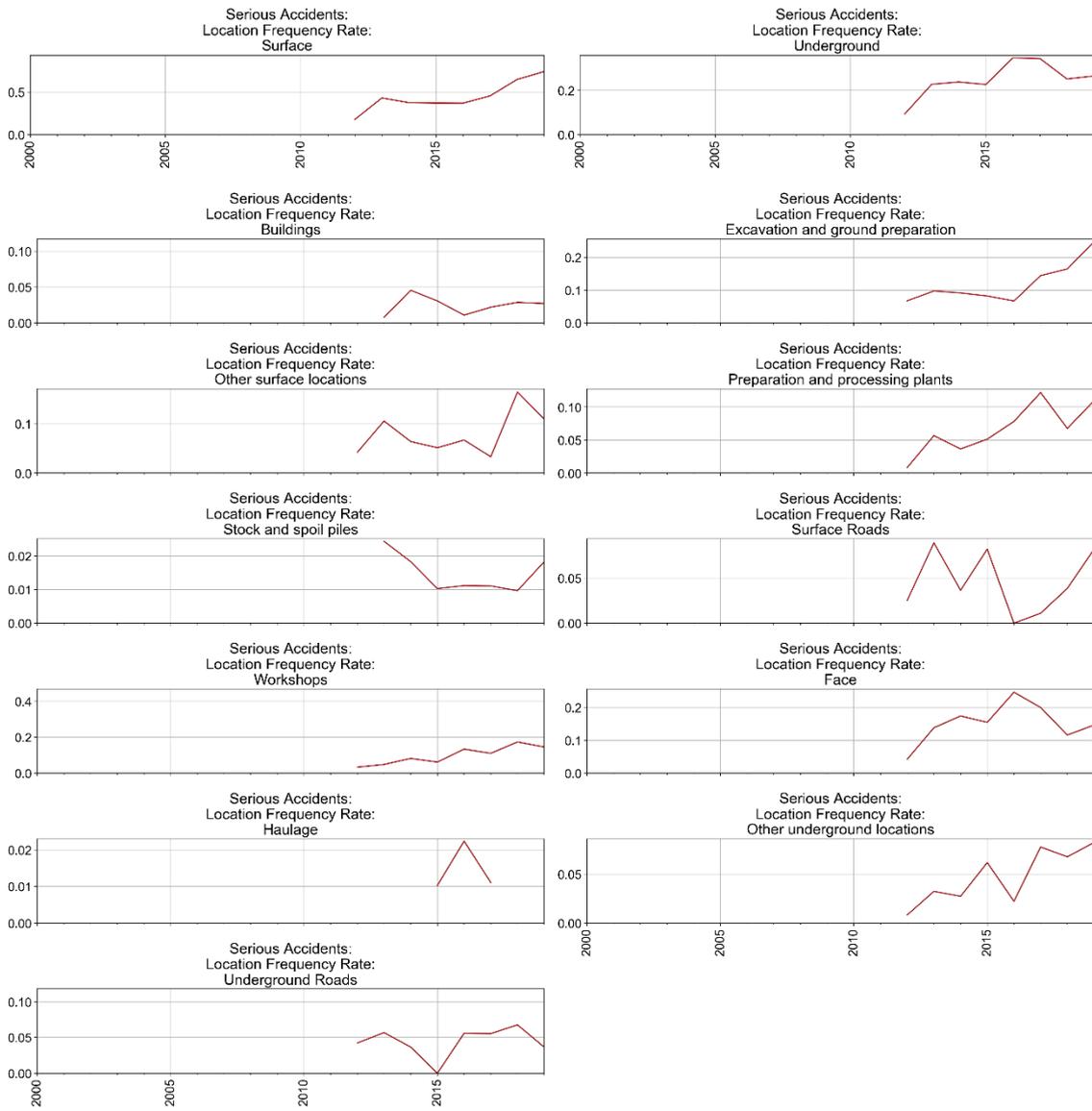








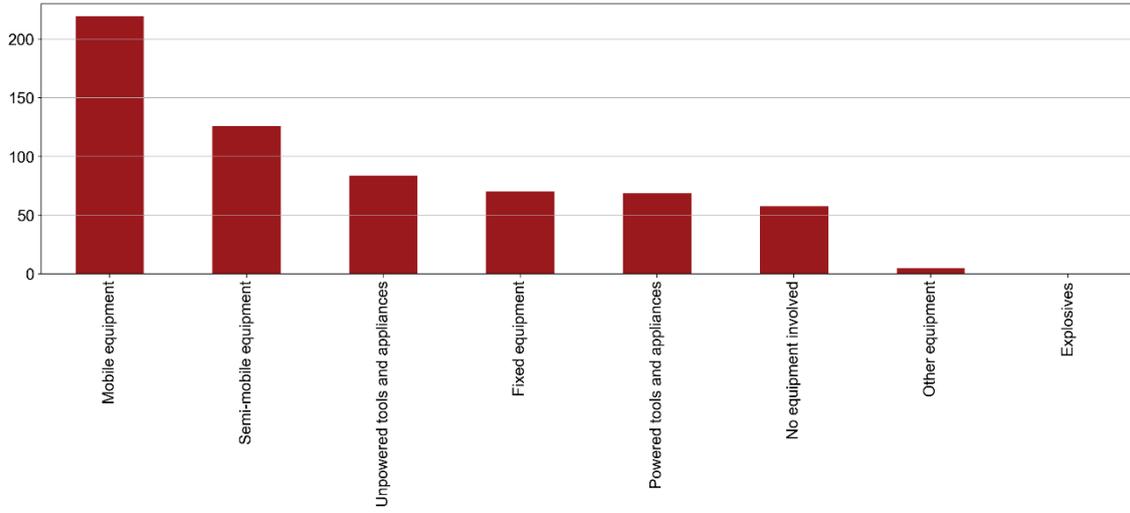




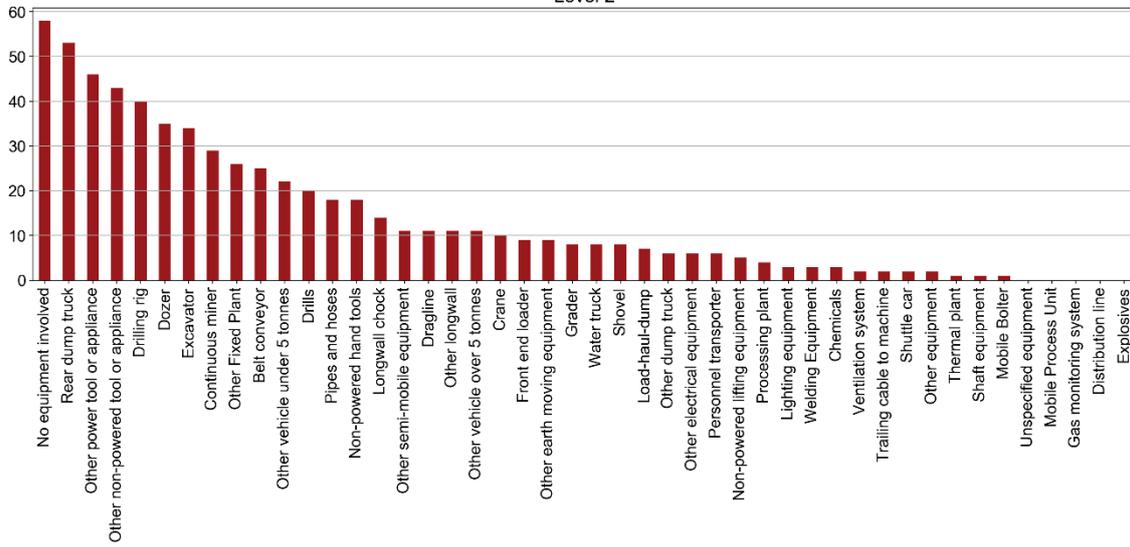


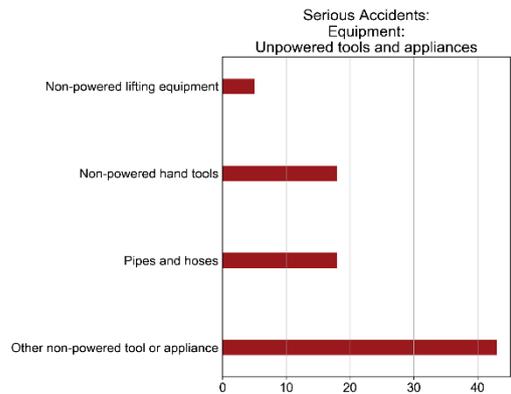
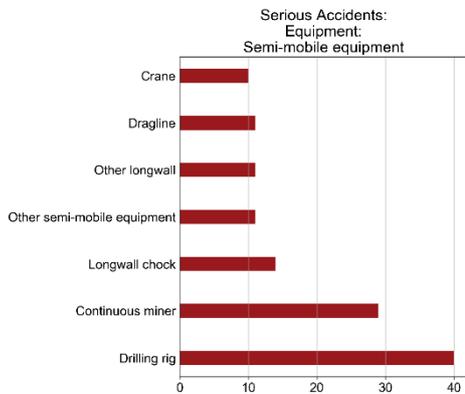
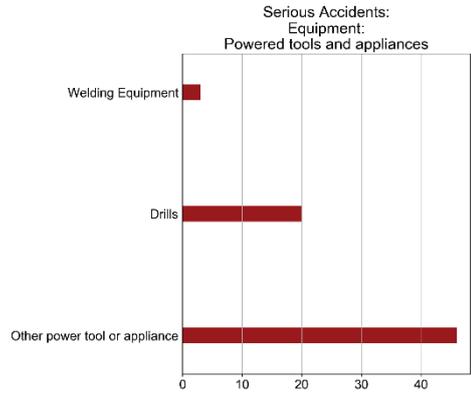
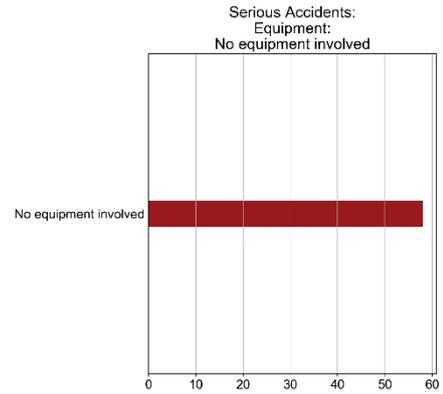
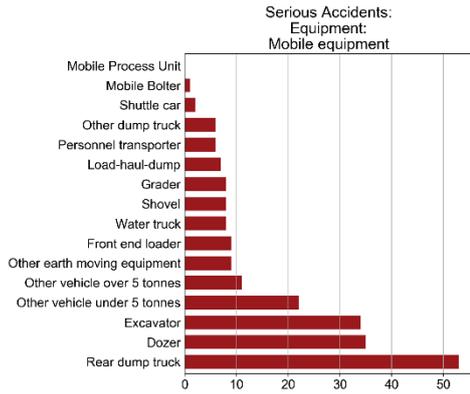
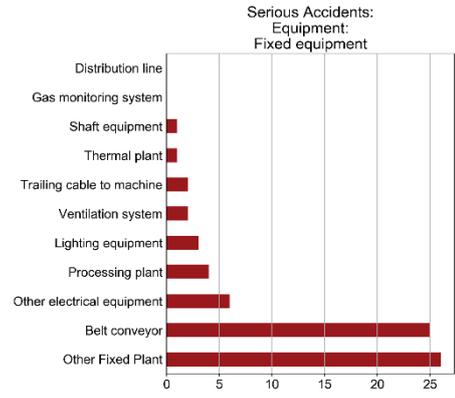
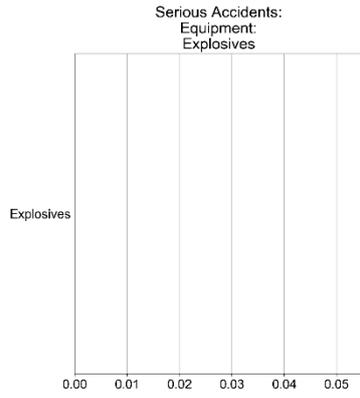


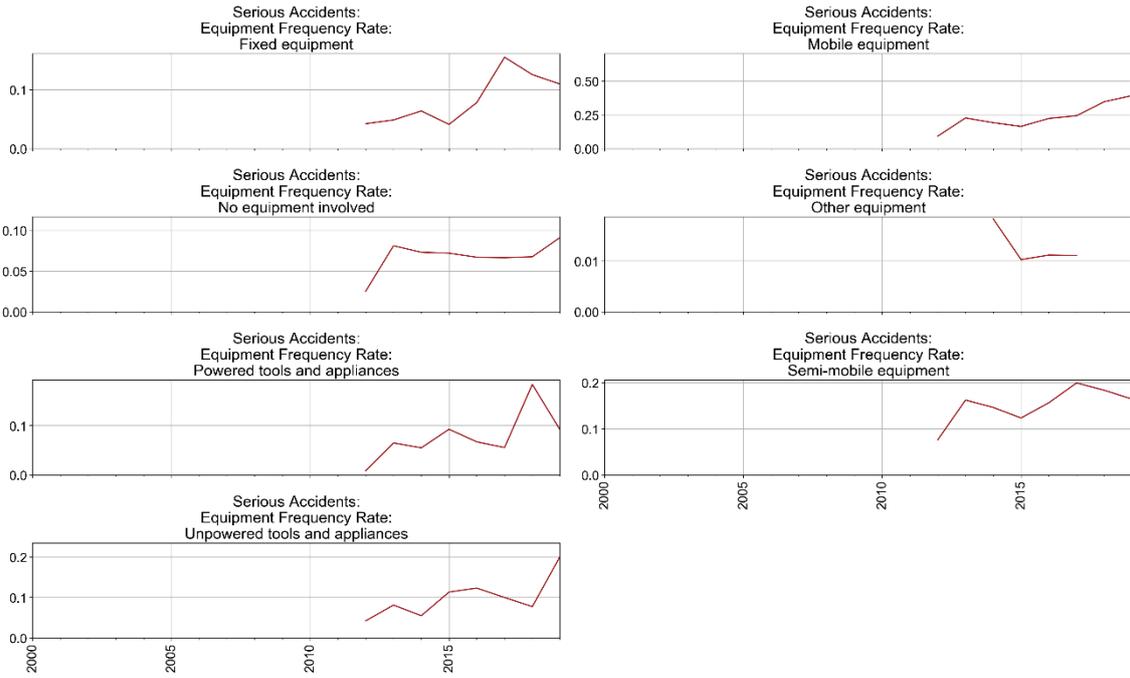
Serious Accidents:
Equipment:
Level 1

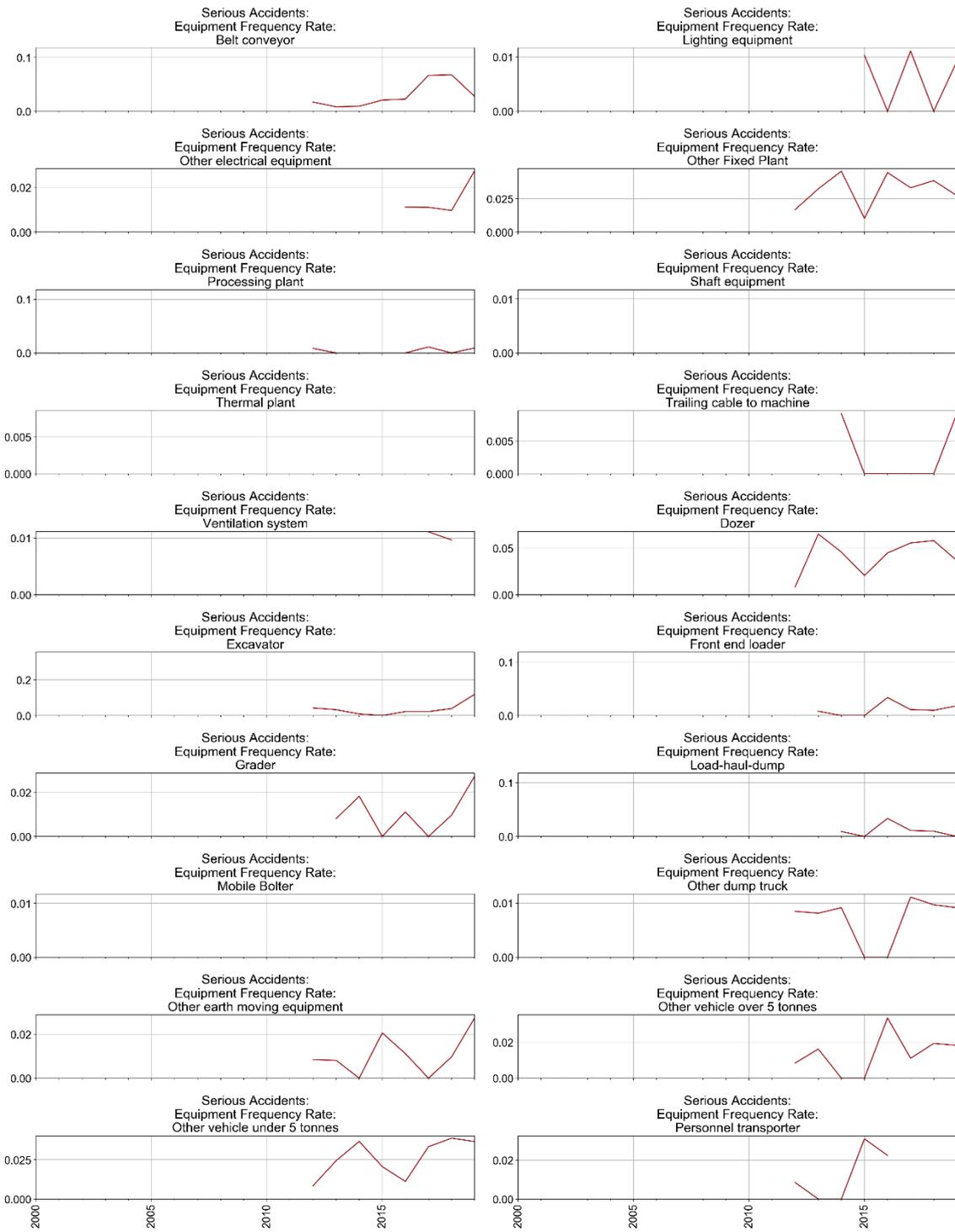


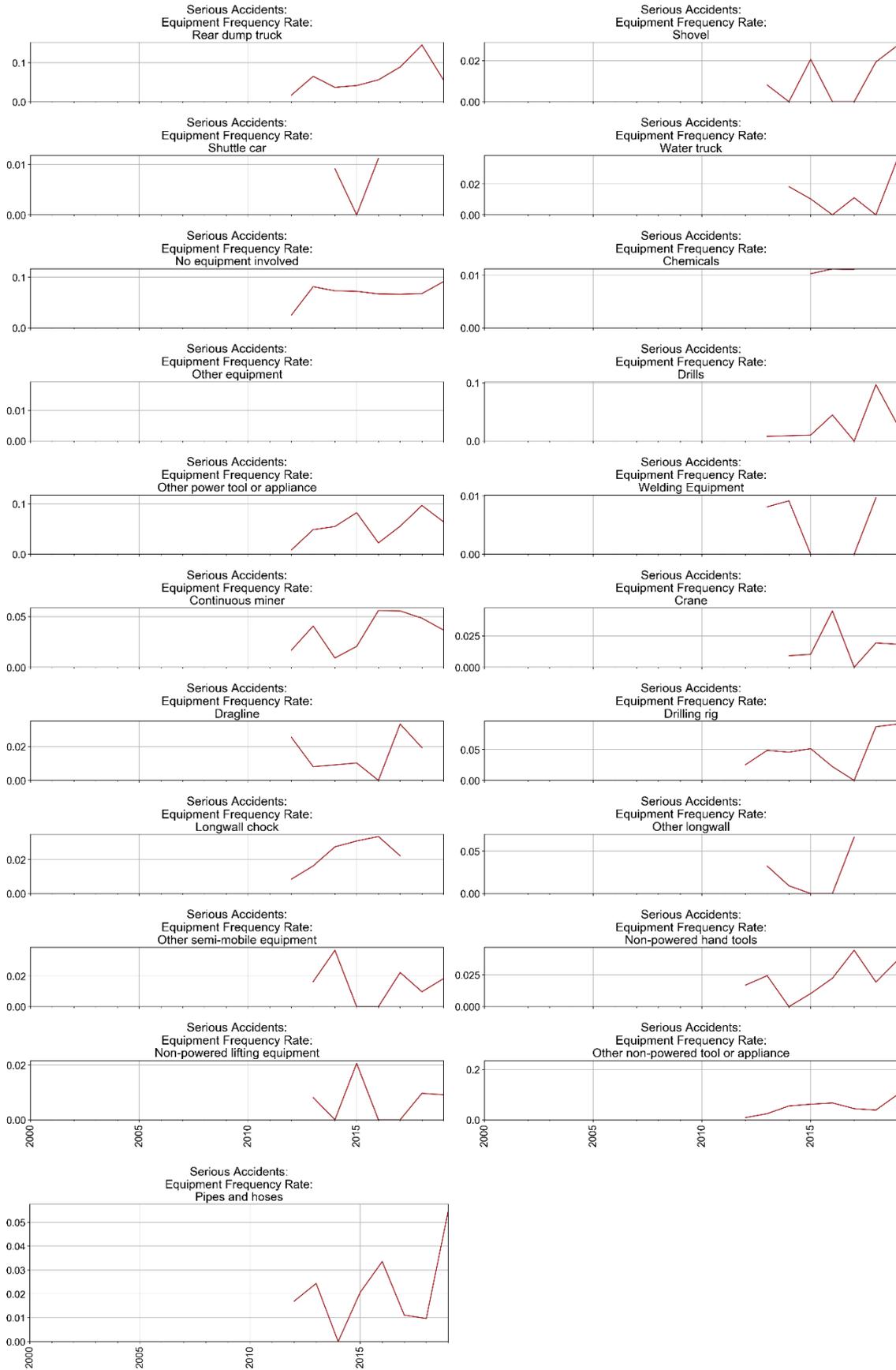
Serious Accidents:
Equipment:
Level 2



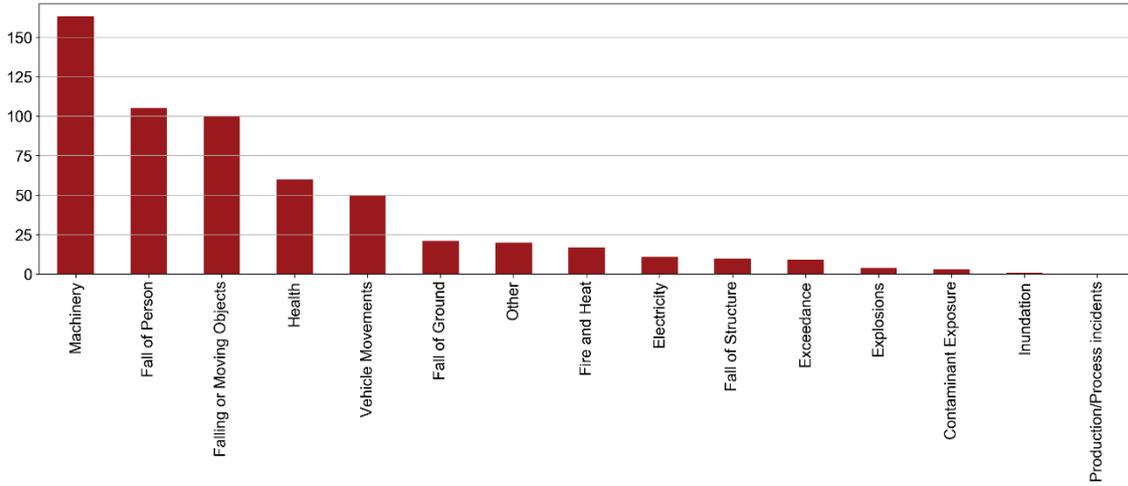




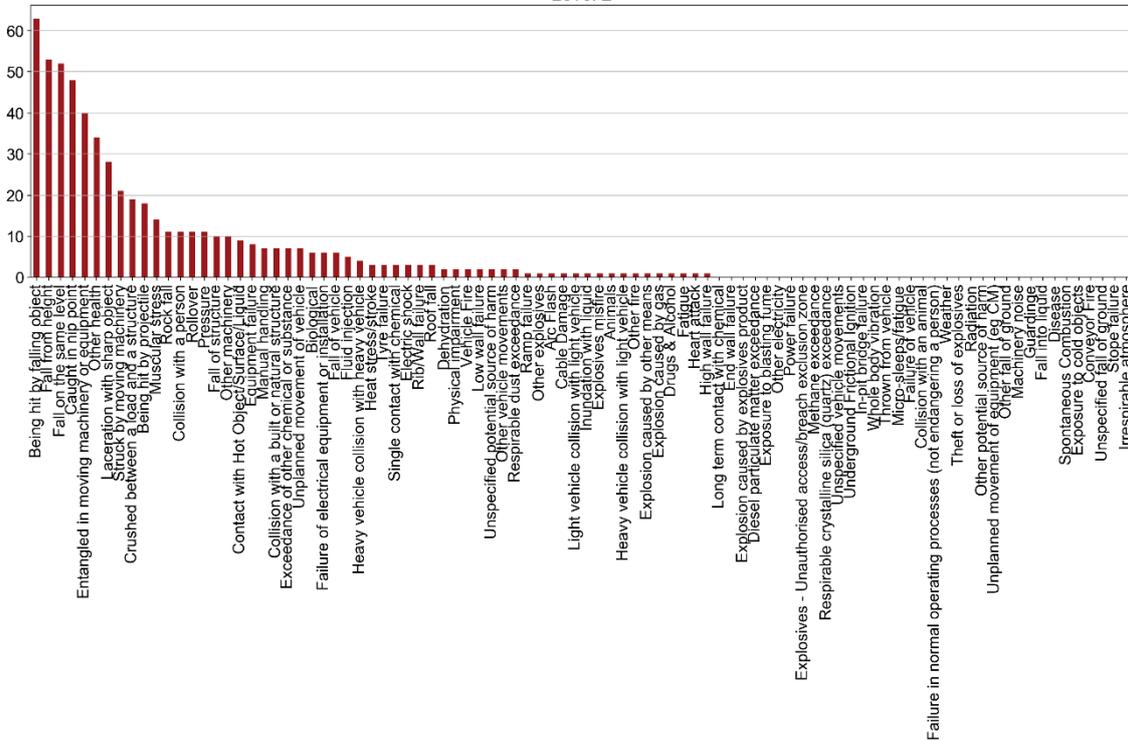


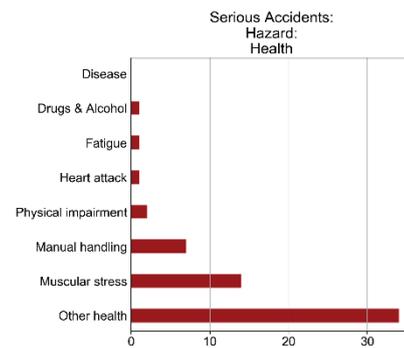
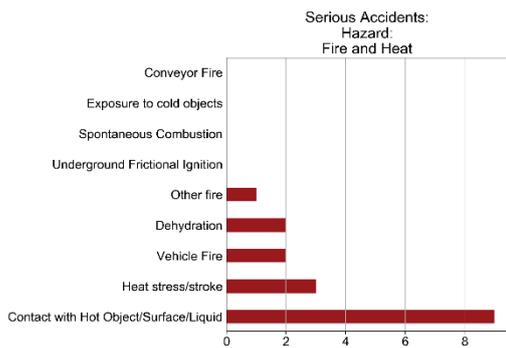
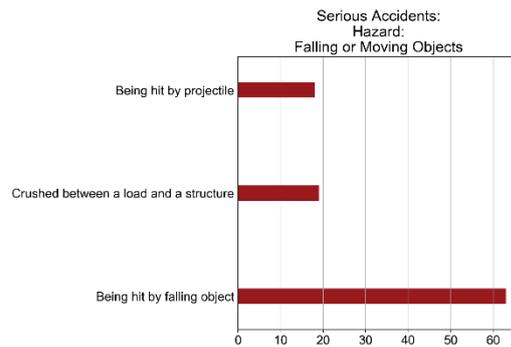
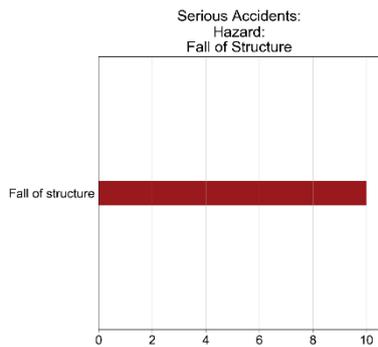
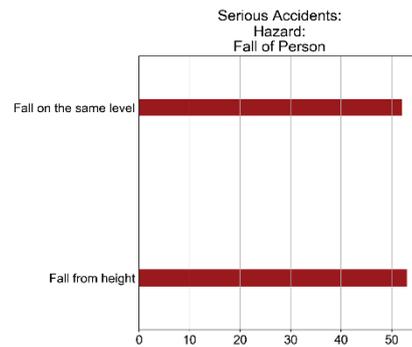
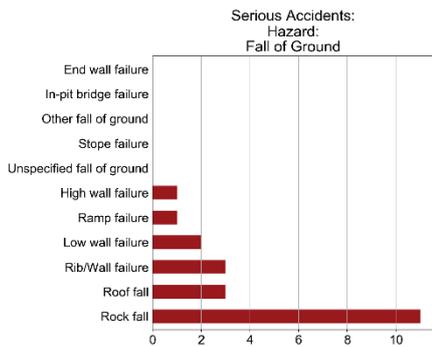
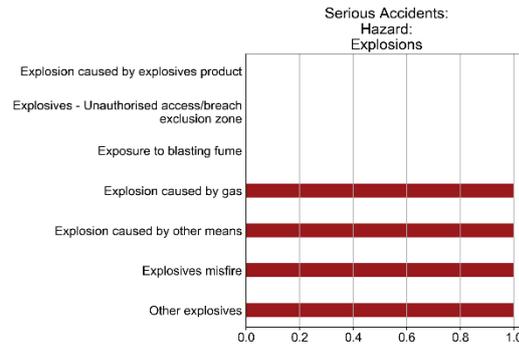
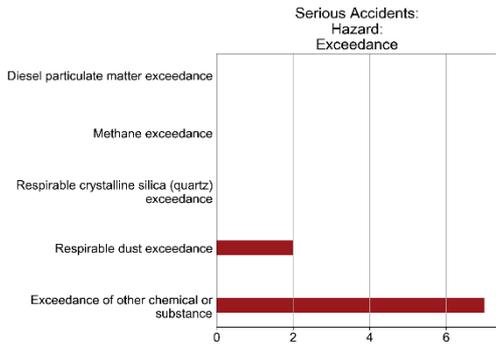
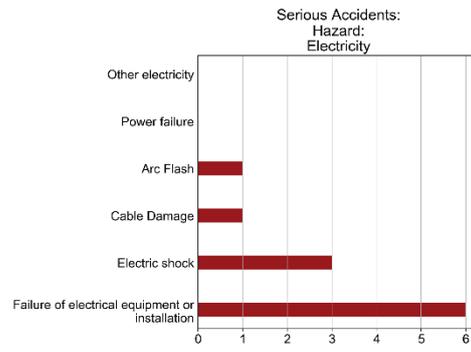
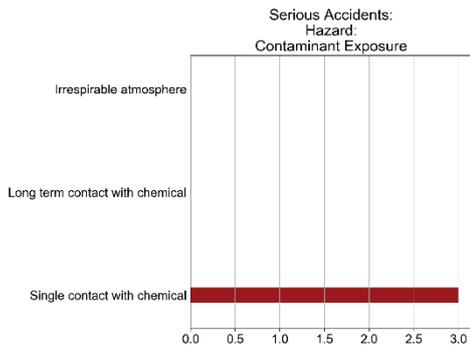


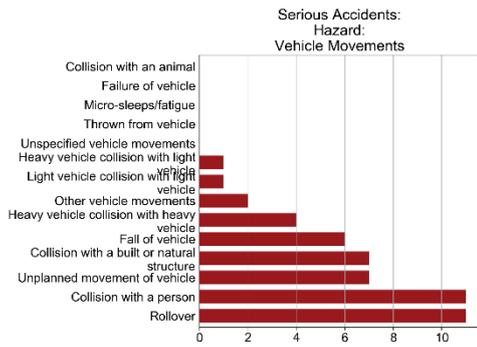
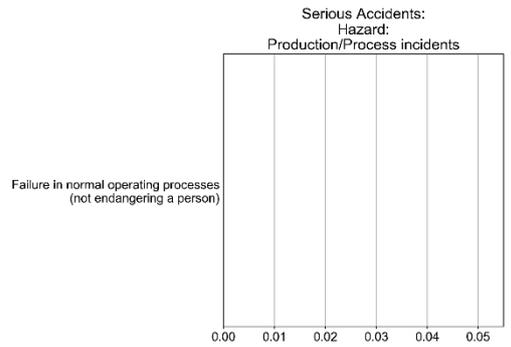
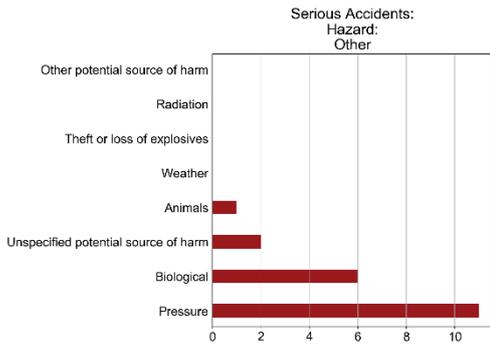
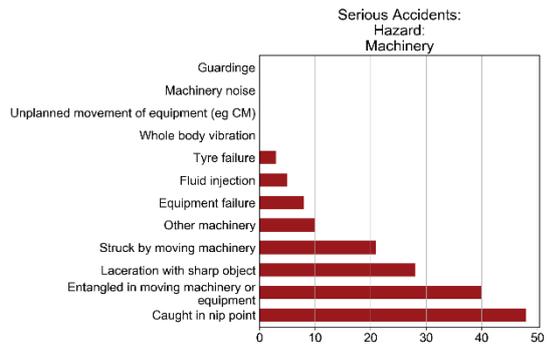
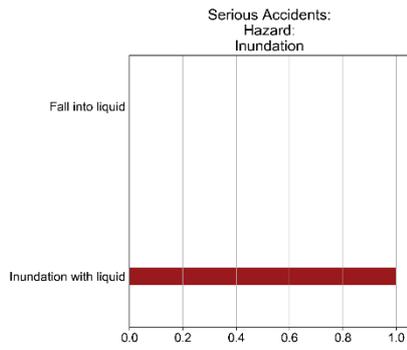
Serious Accidents:
Hazard:
Level 1

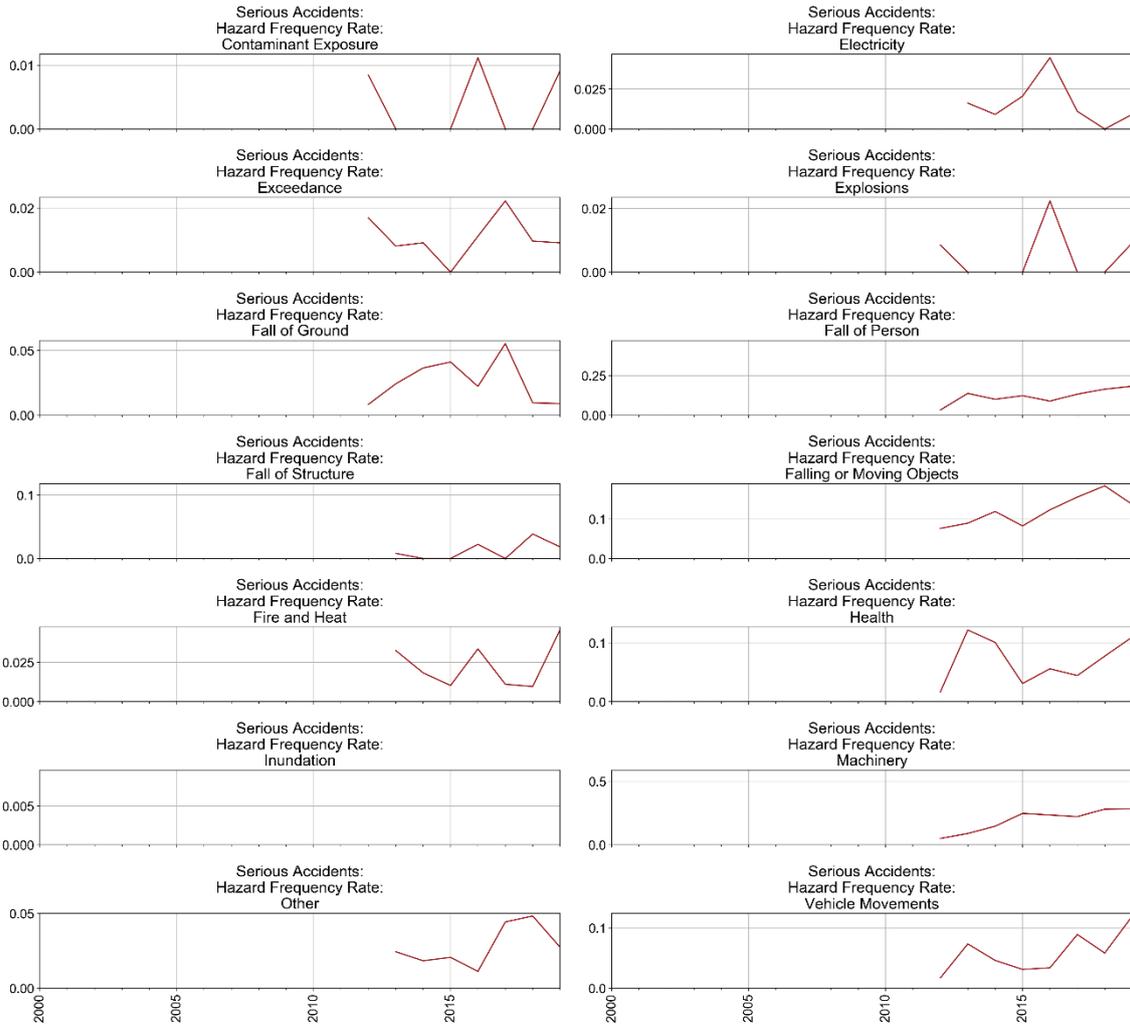


Serious Accidents:
Hazard:
Level 2

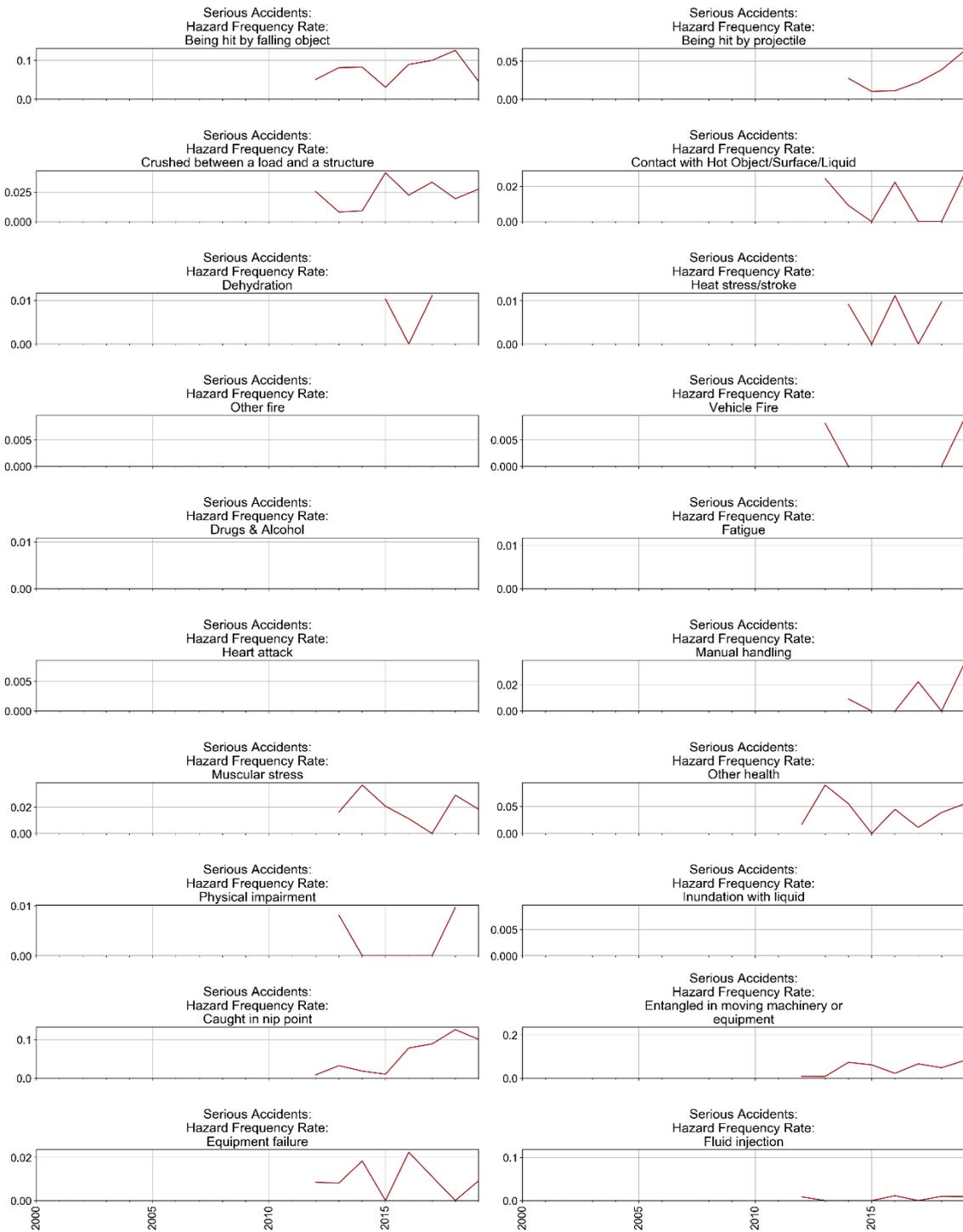


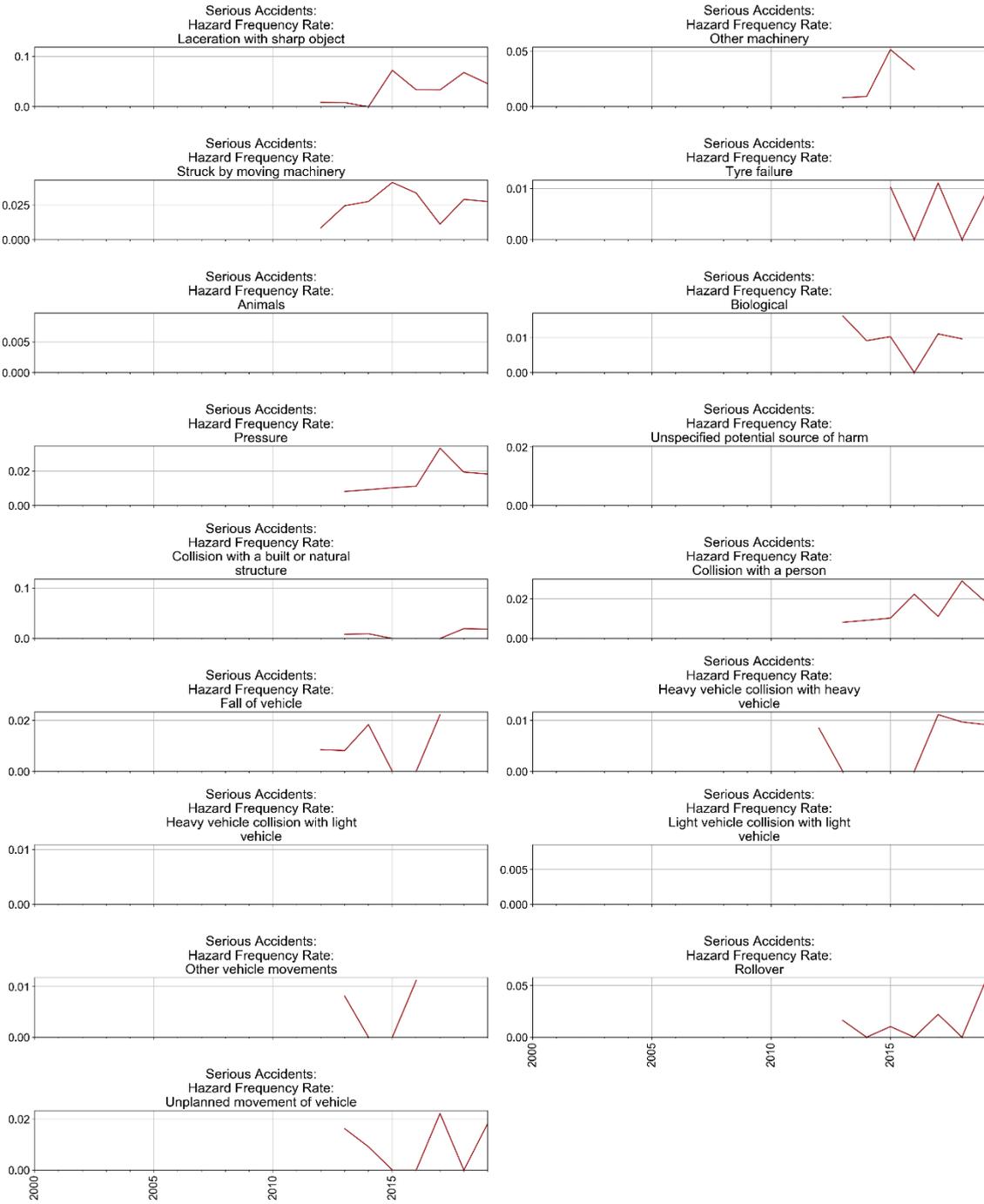


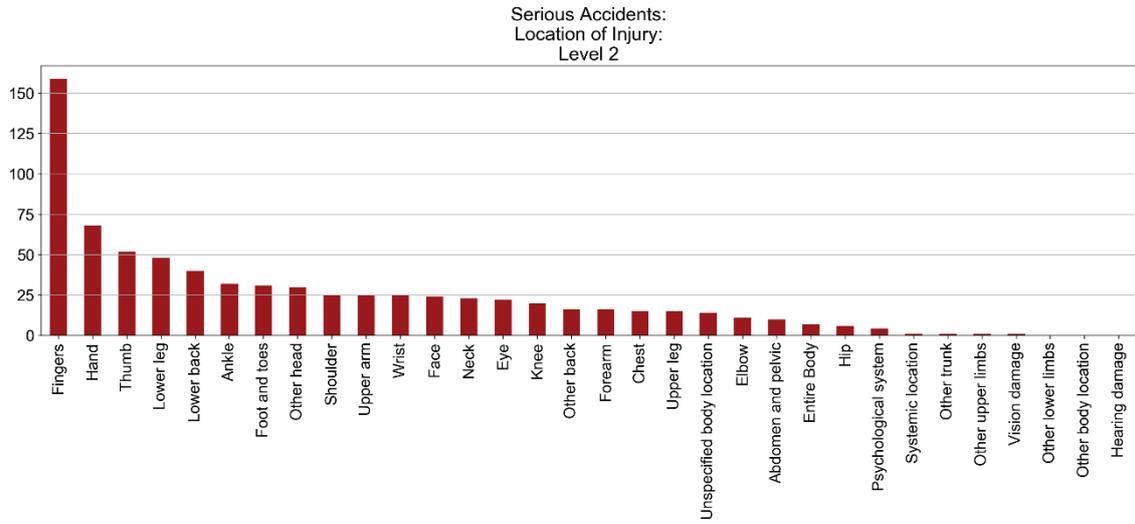
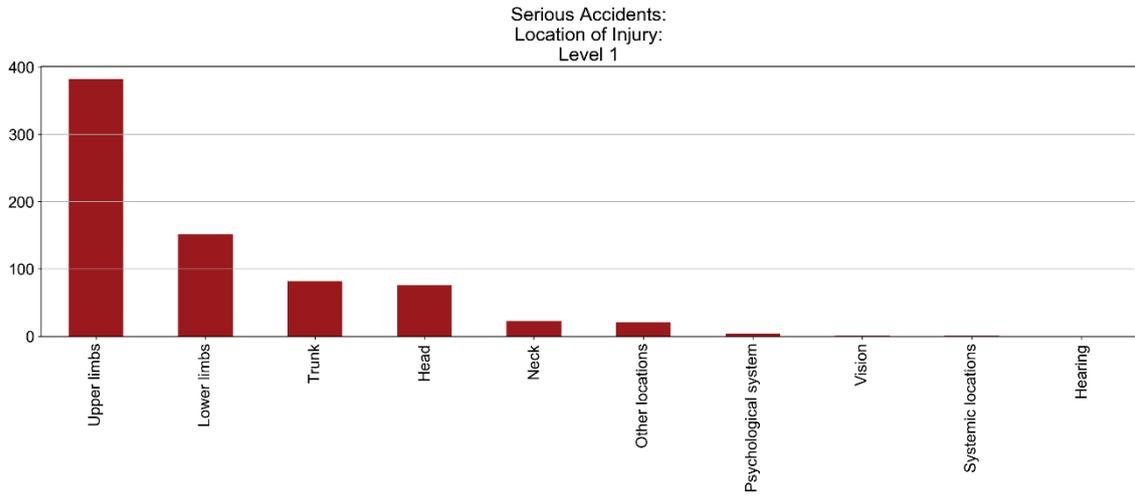


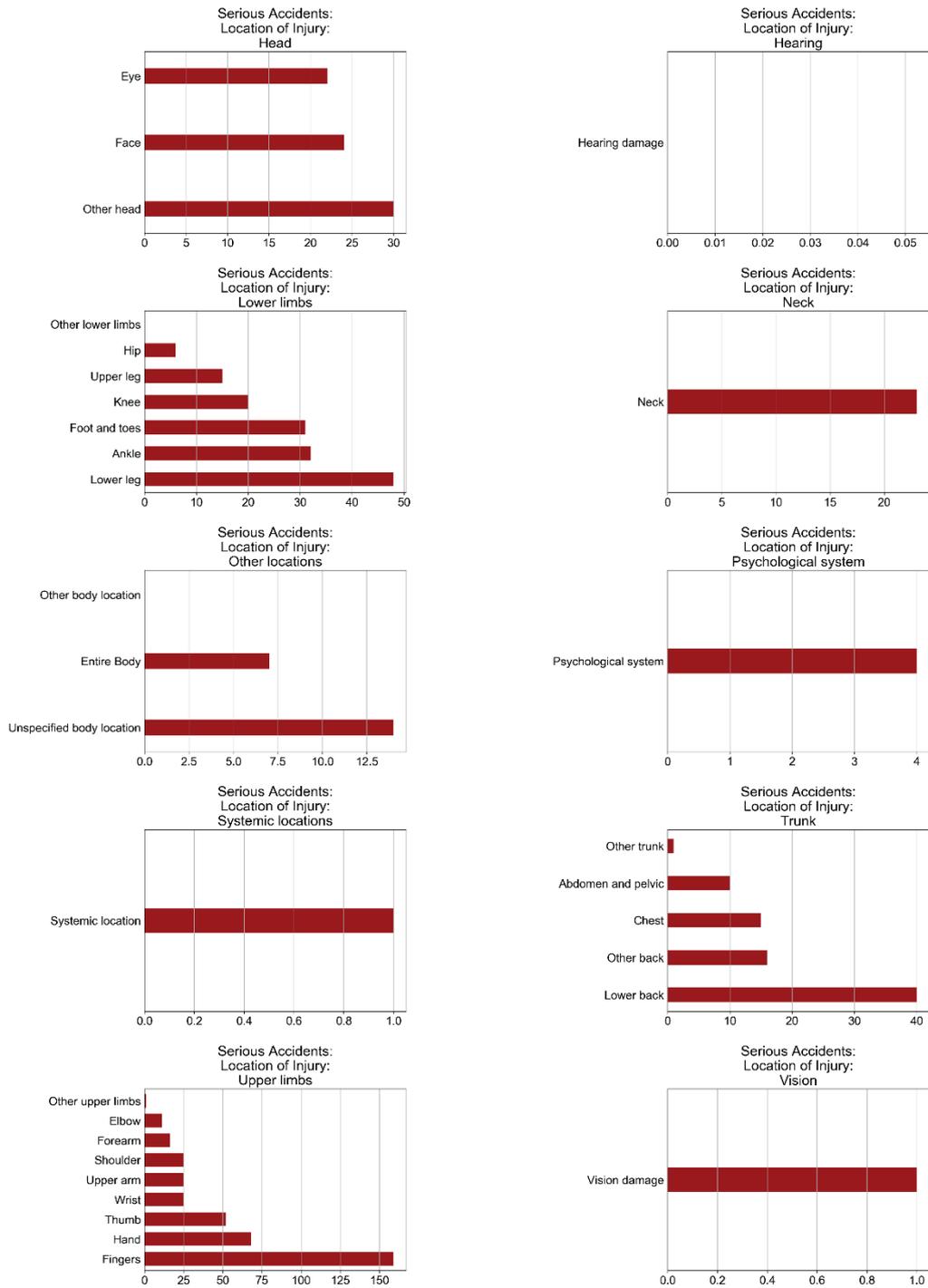


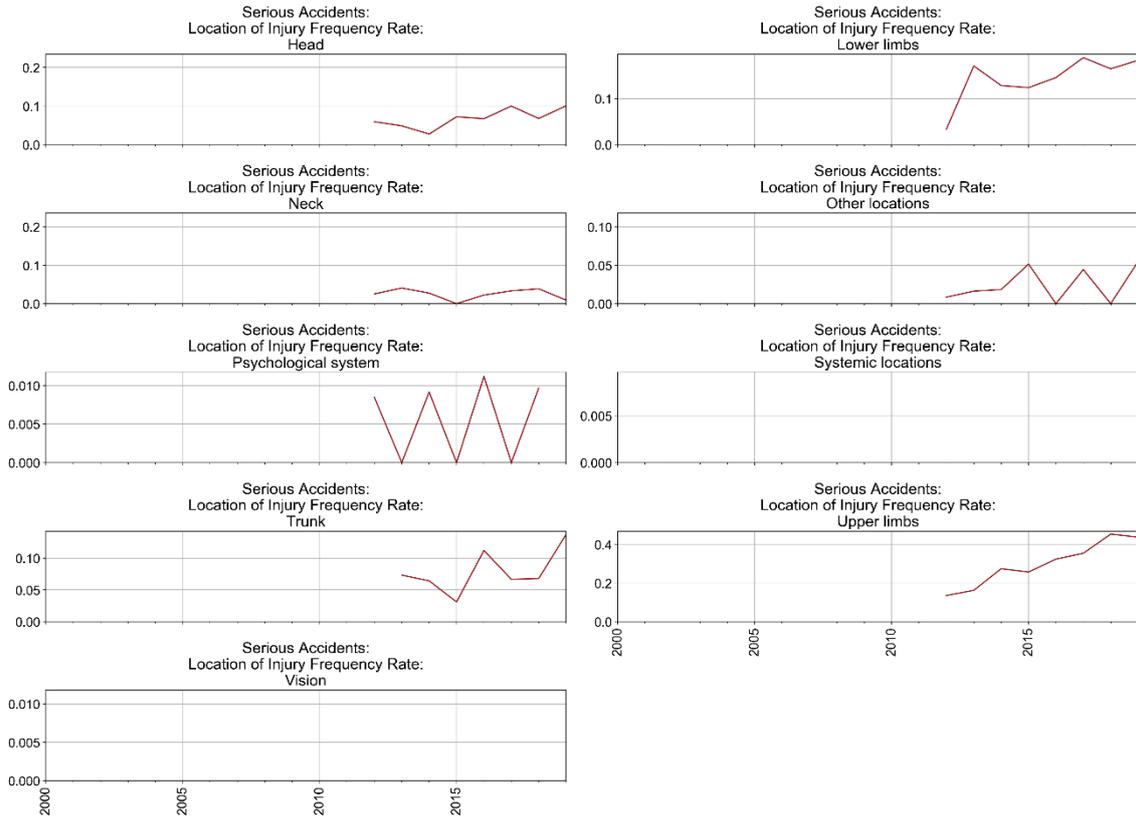


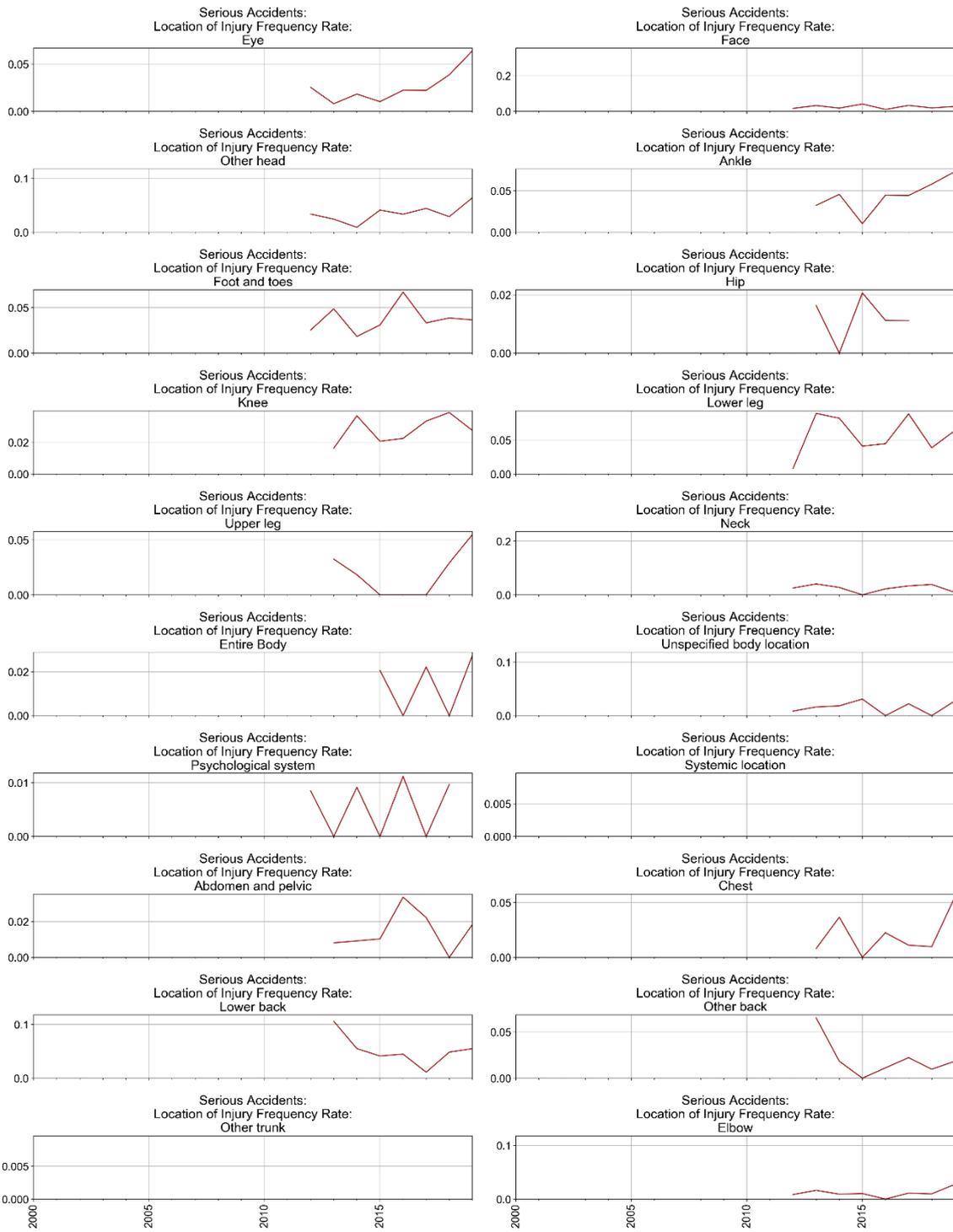


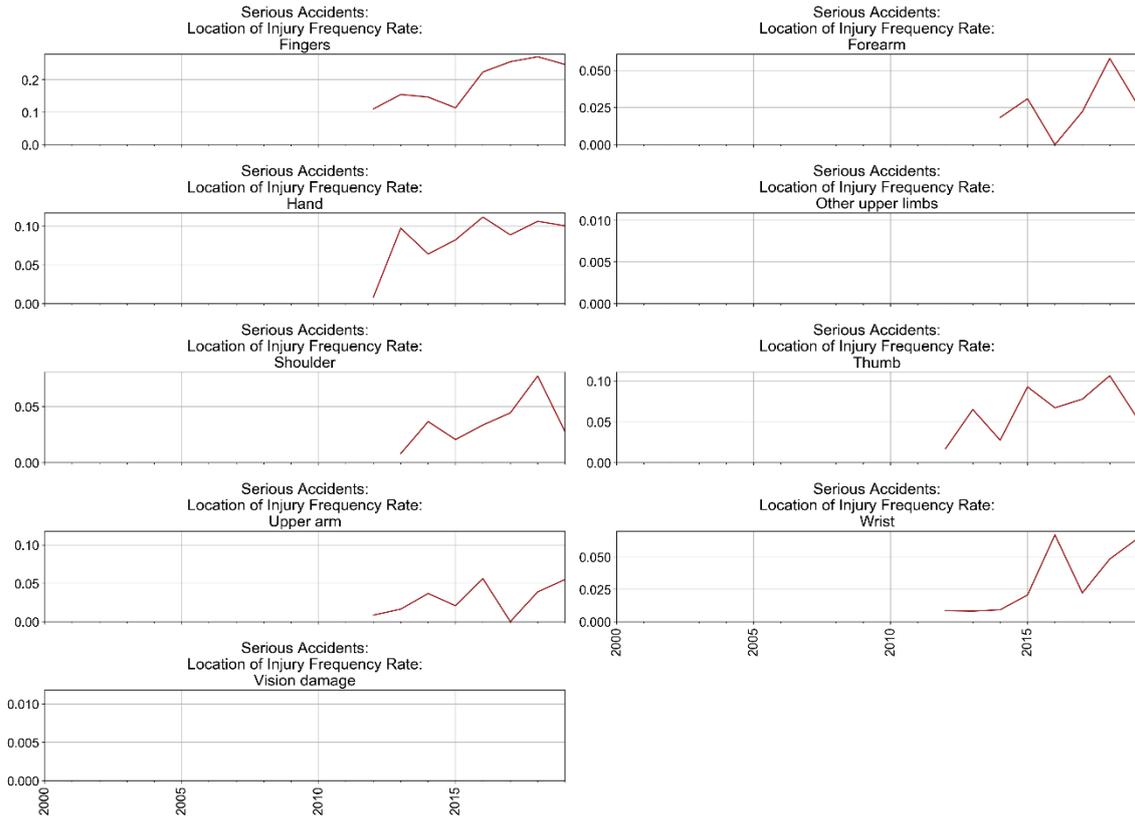




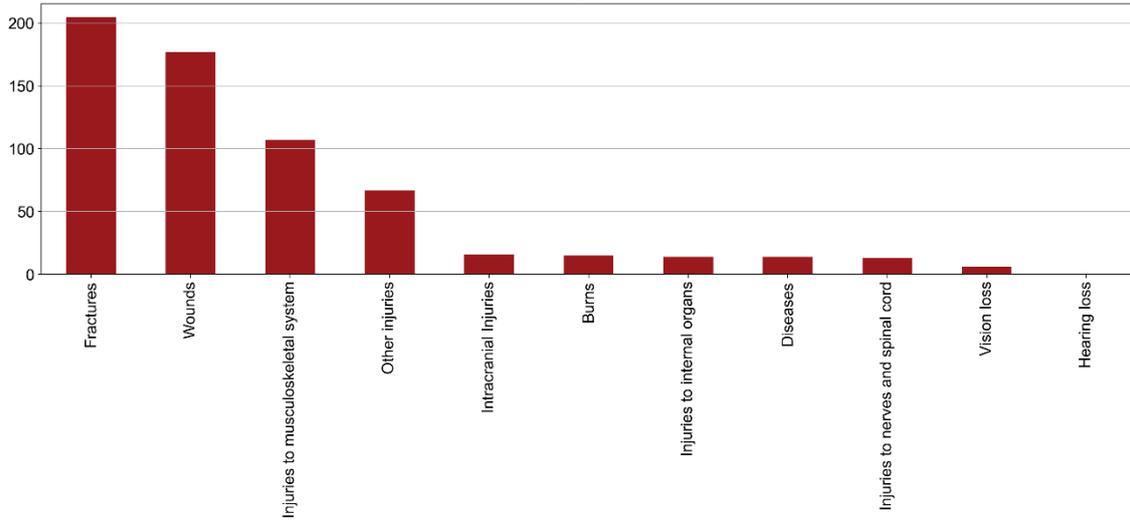




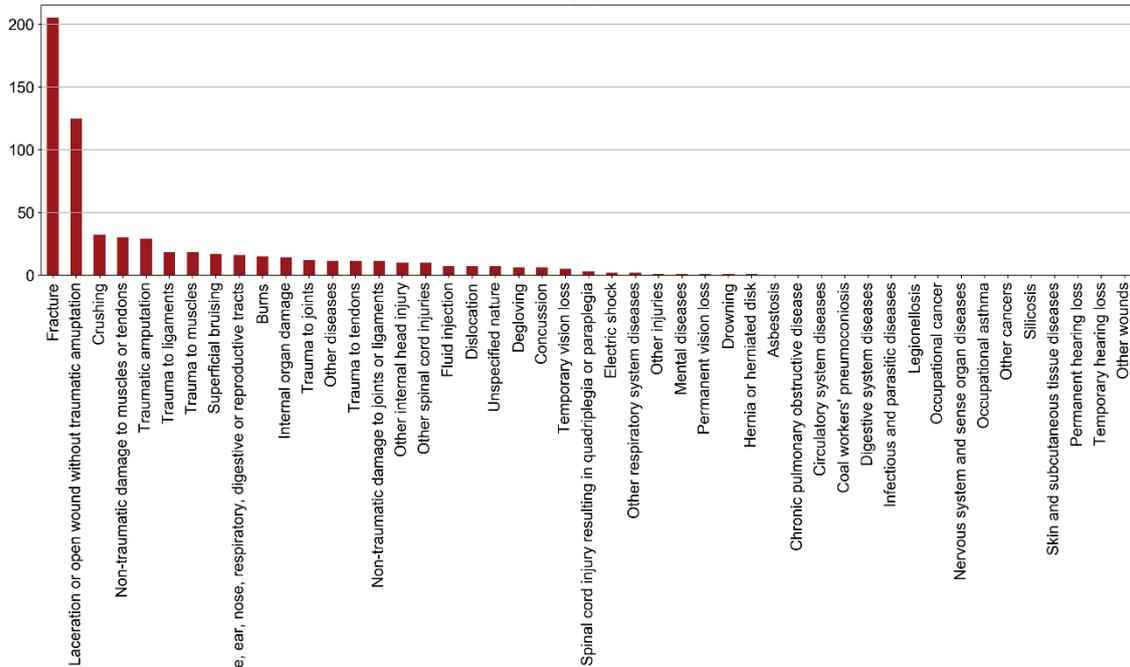


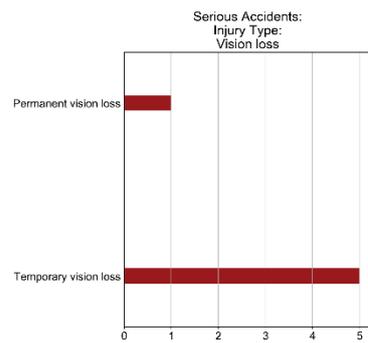
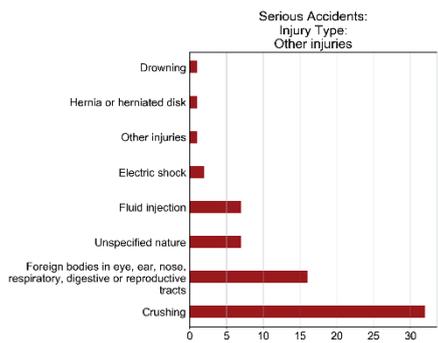
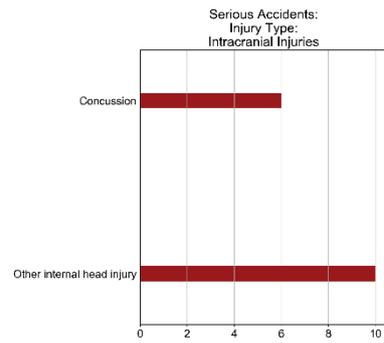
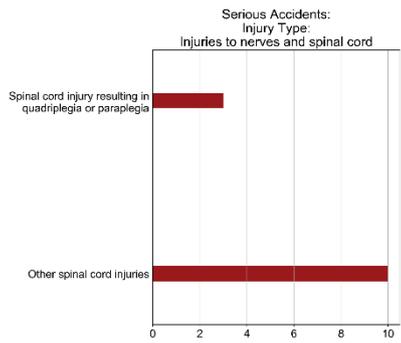
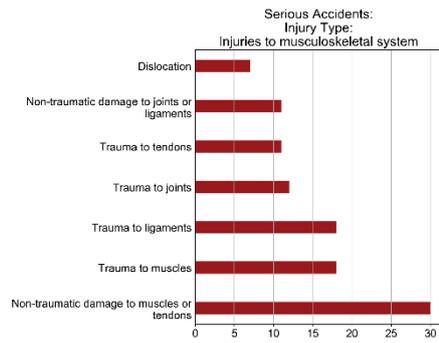
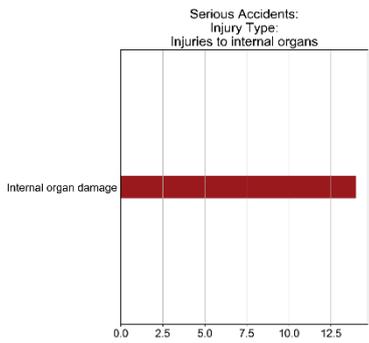
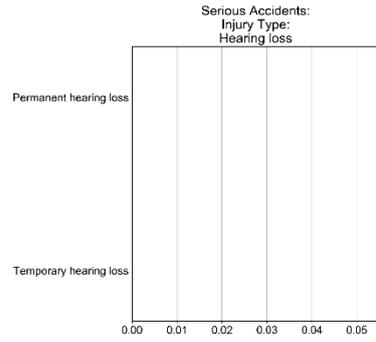
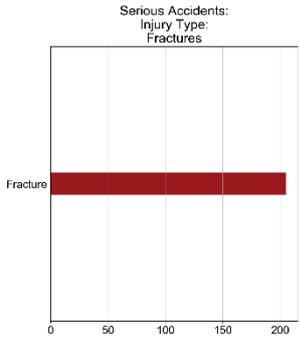
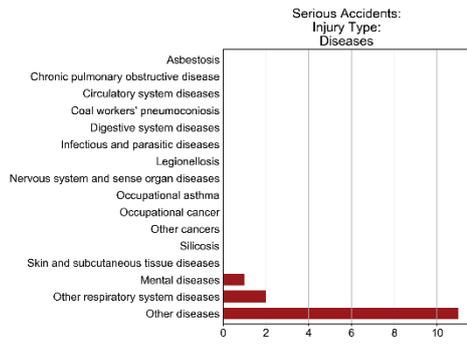
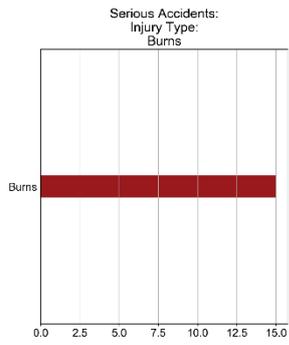


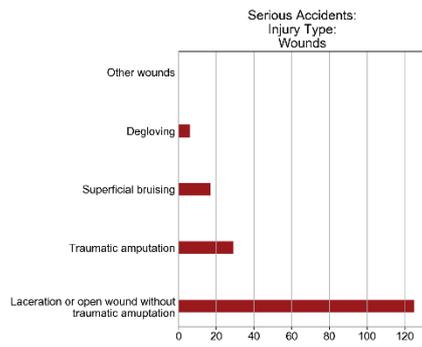
Serious Accidents:
Injury Type:
Level 1

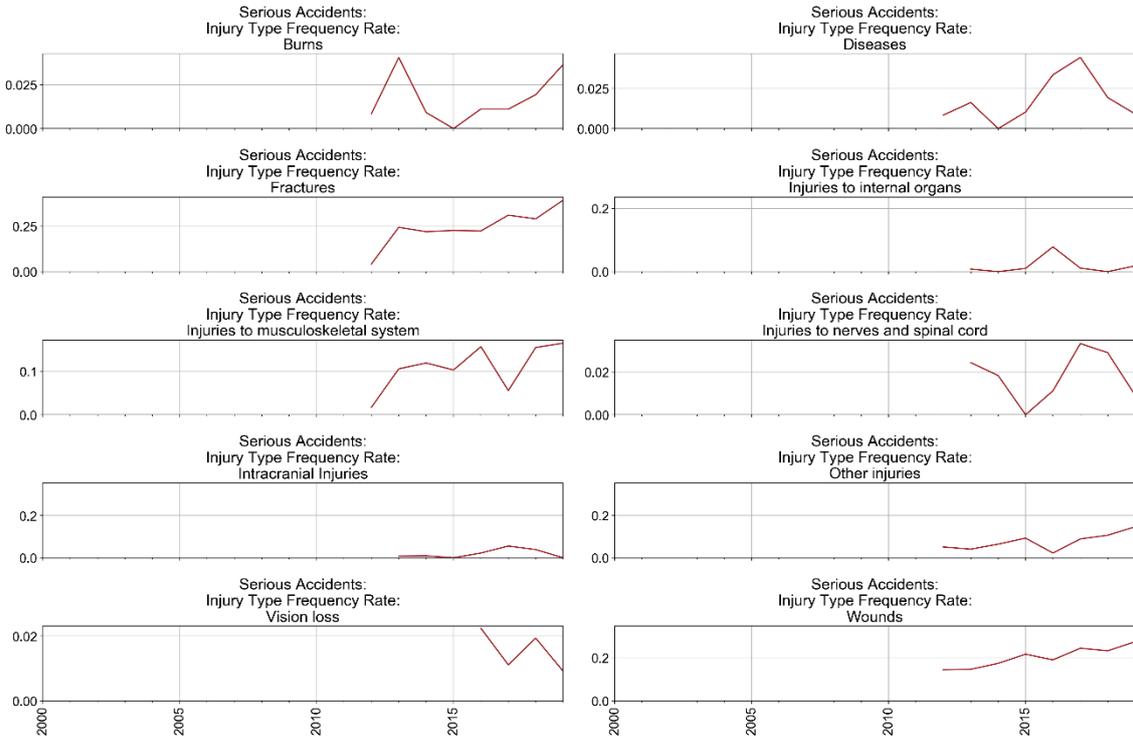


Serious Accidents:
Injury Type:
Level 2

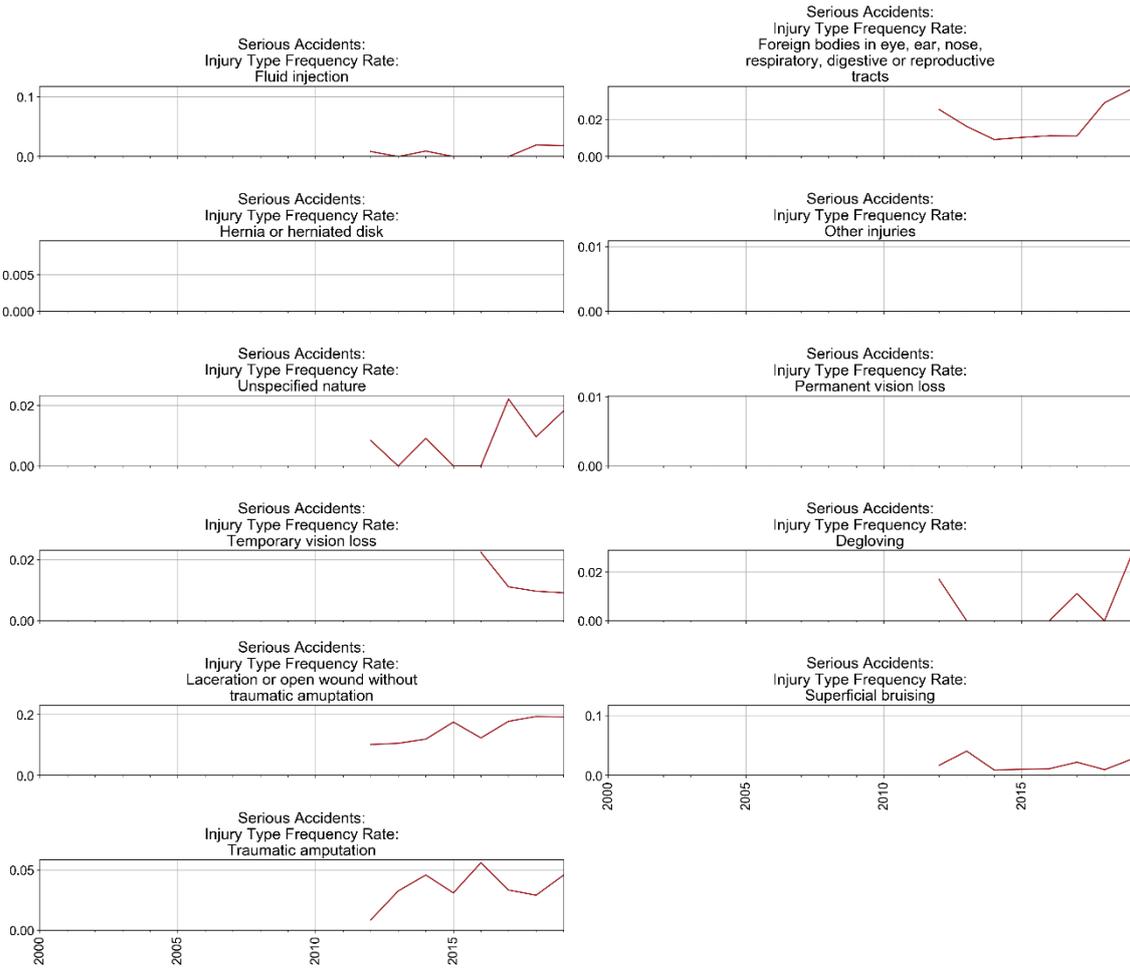




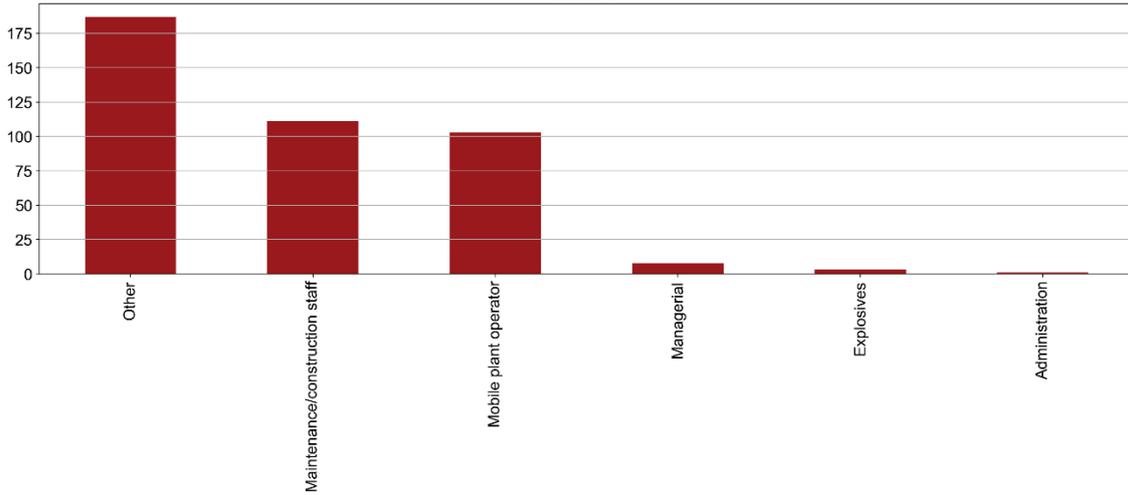




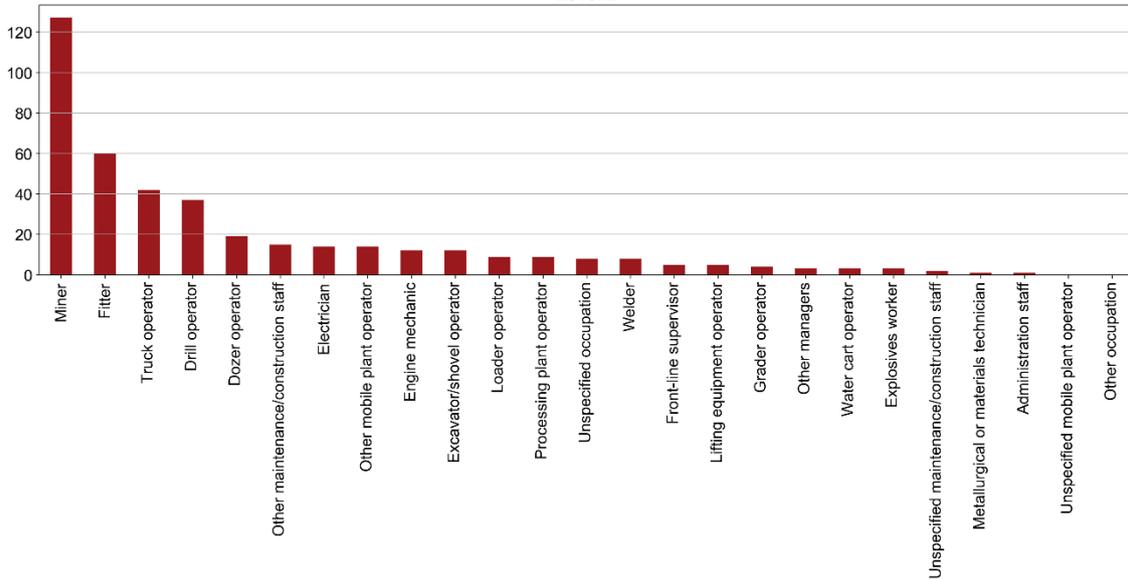


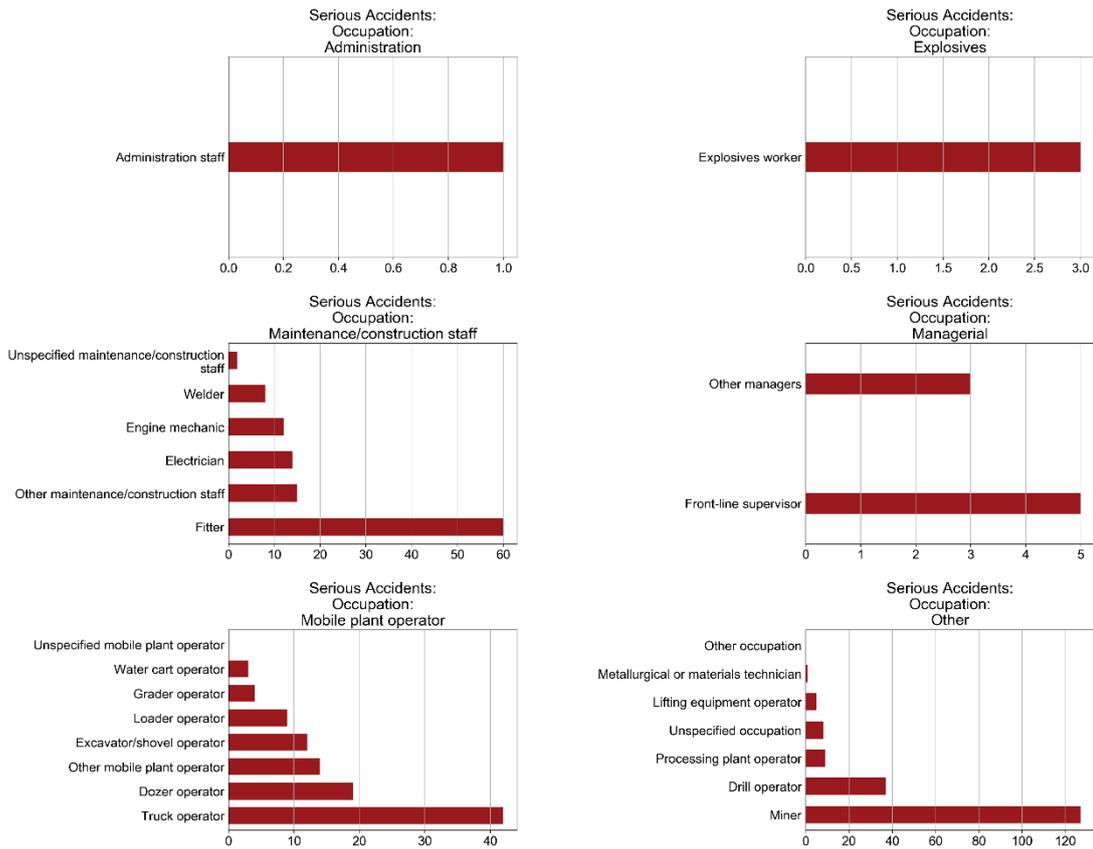


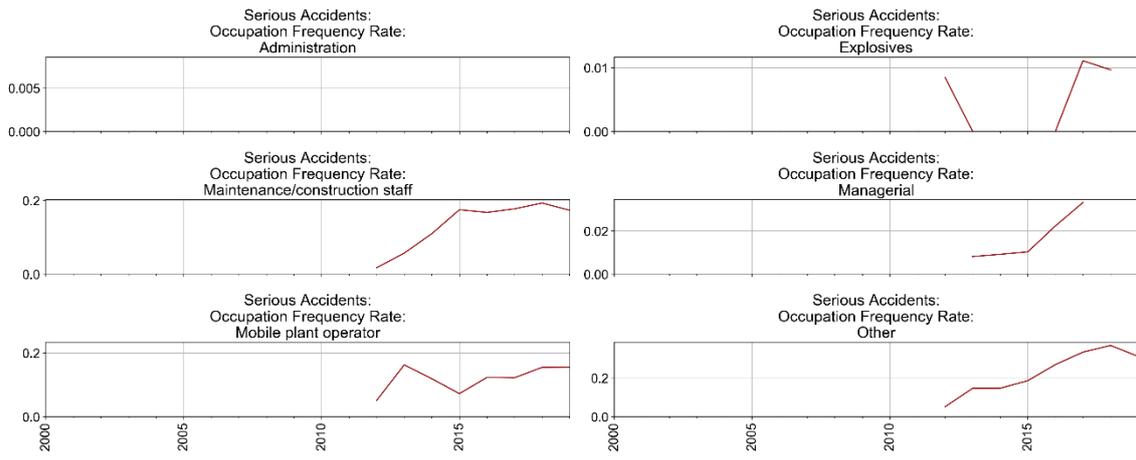
Serious Accidents:
Occupation:
Level 1

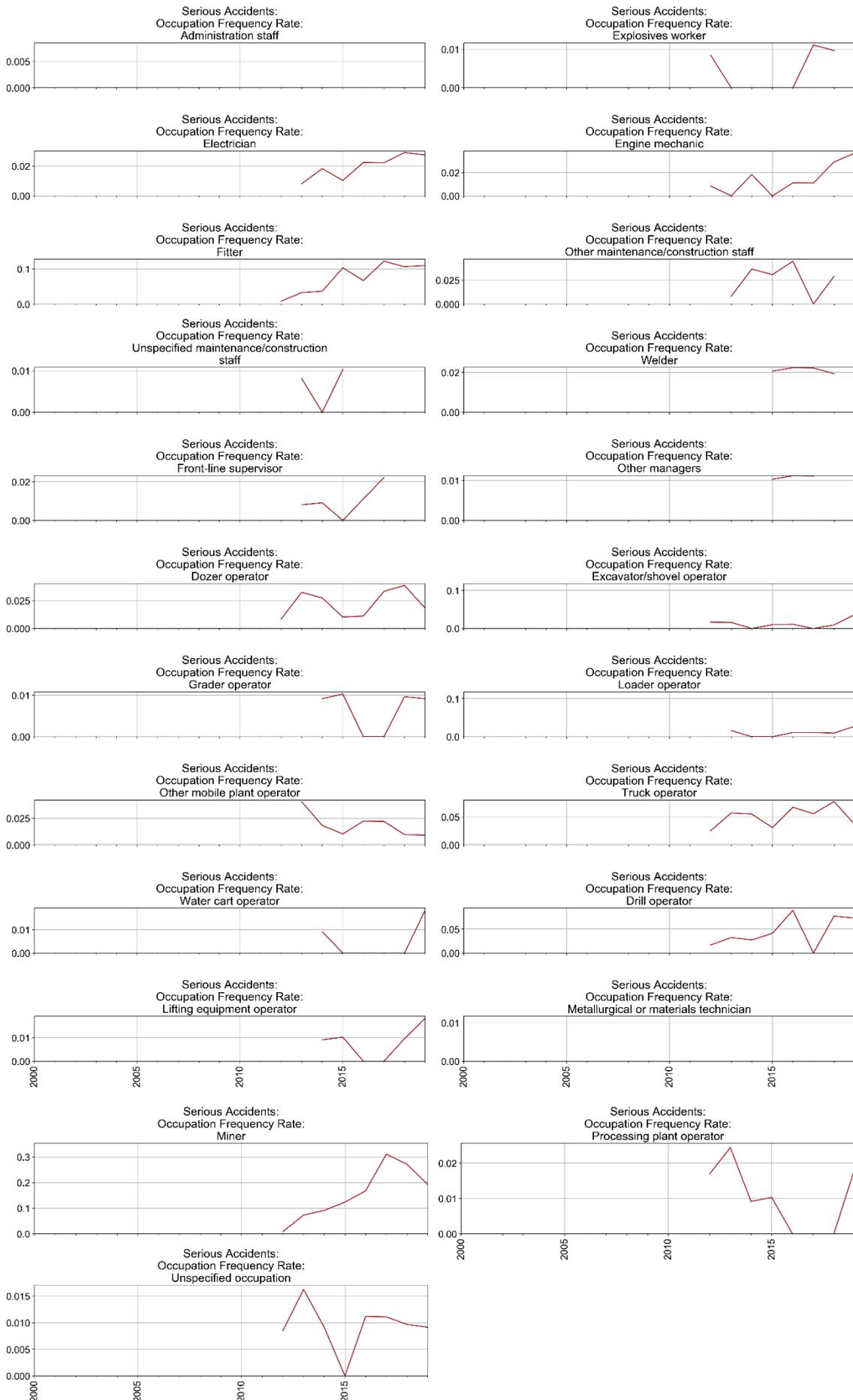


Serious Accidents:
Occupation:
Level 2

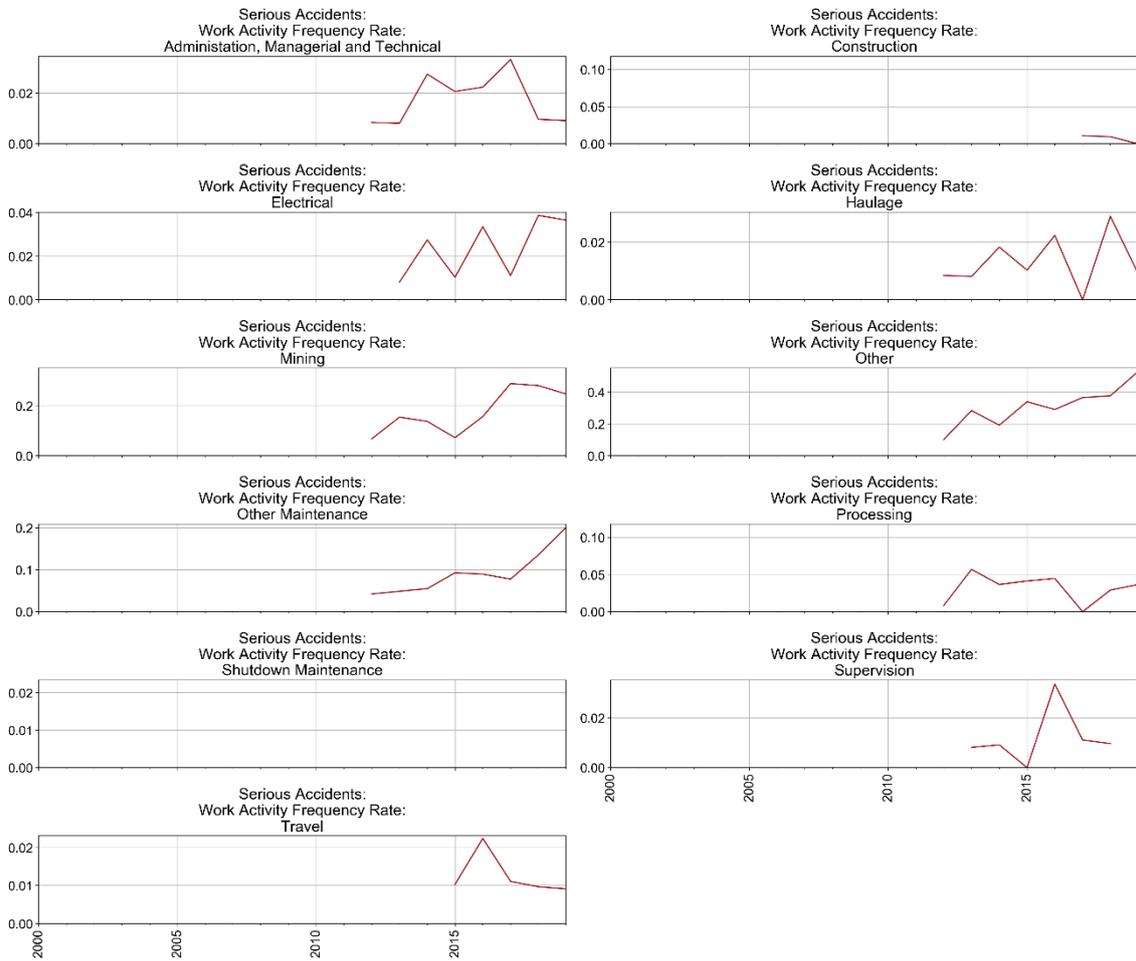
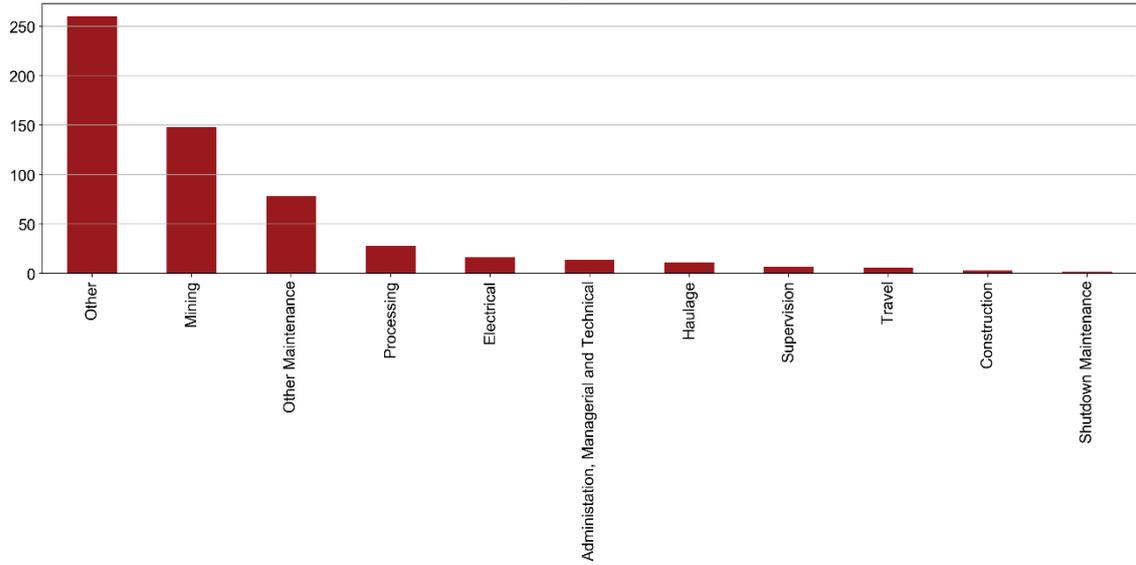


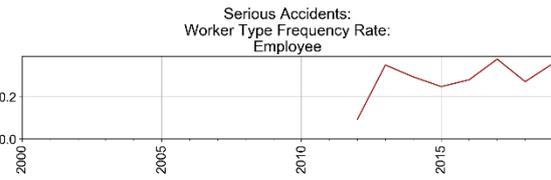
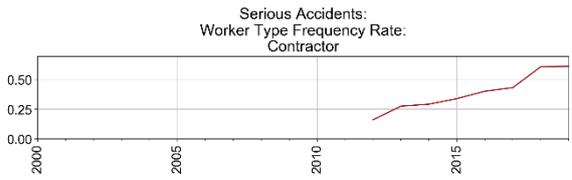
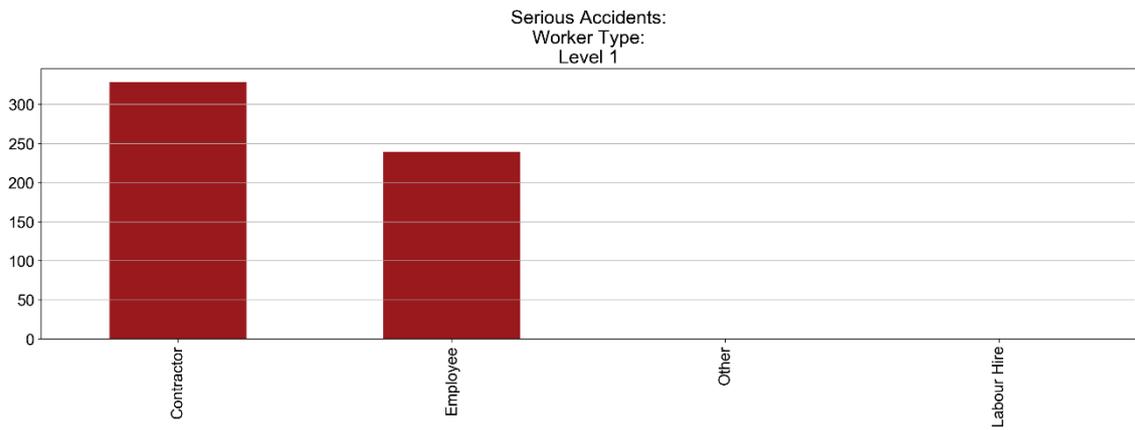




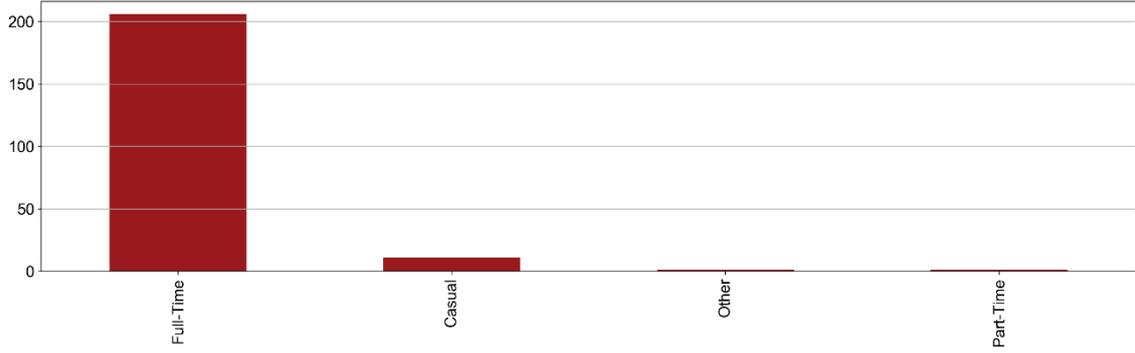


Serious Accidents:
Work Activity:
Level 1

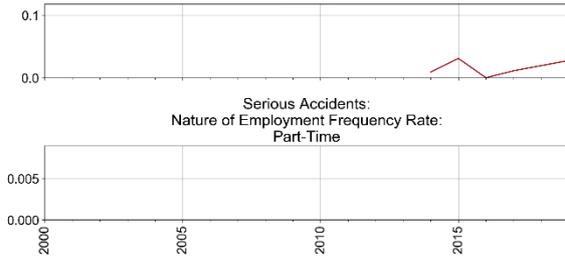




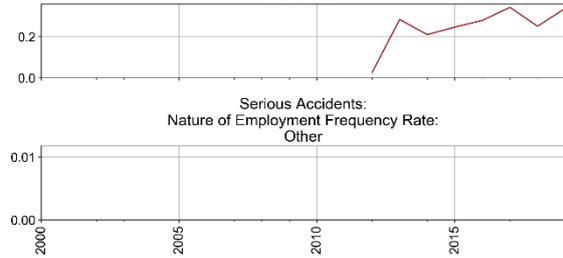
Serious Accidents:
Nature of Employment:
Level 1



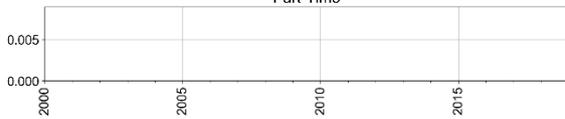
Serious Accidents:
Nature of Employment Frequency Rate:
Casual



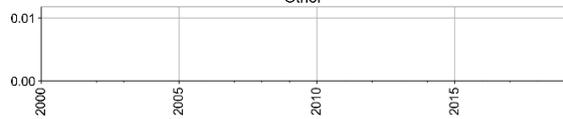
Serious Accidents:
Nature of Employment Frequency Rate:
Full-Time



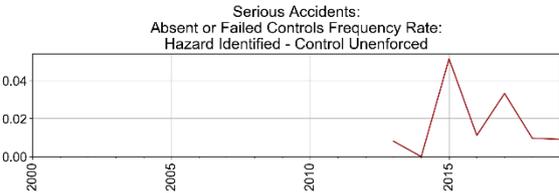
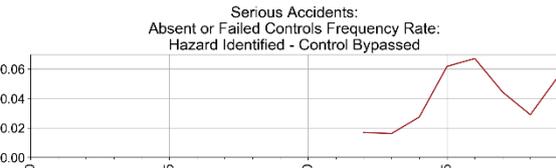
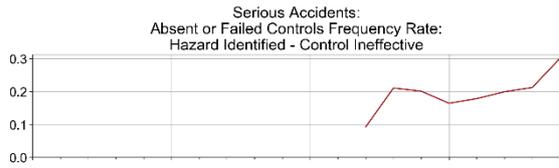
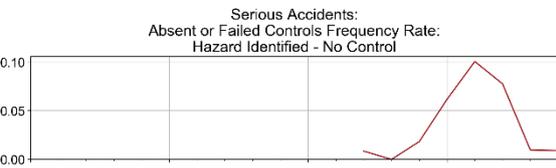
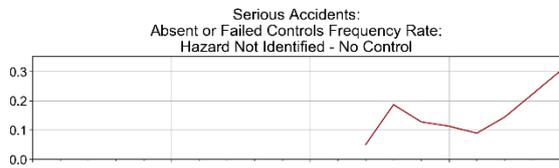
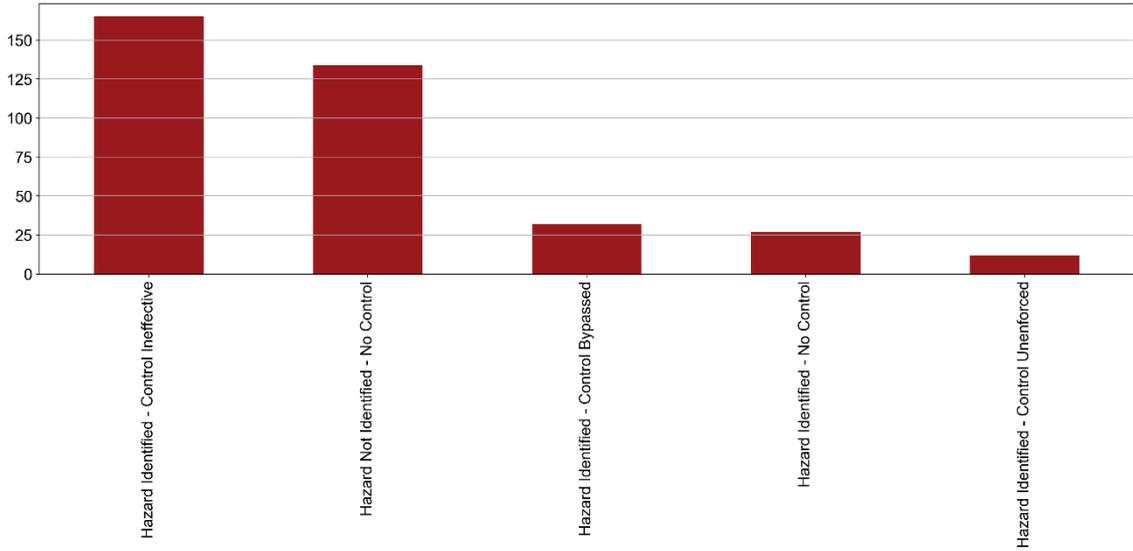
Serious Accidents:
Nature of Employment Frequency Rate:
Part-Time



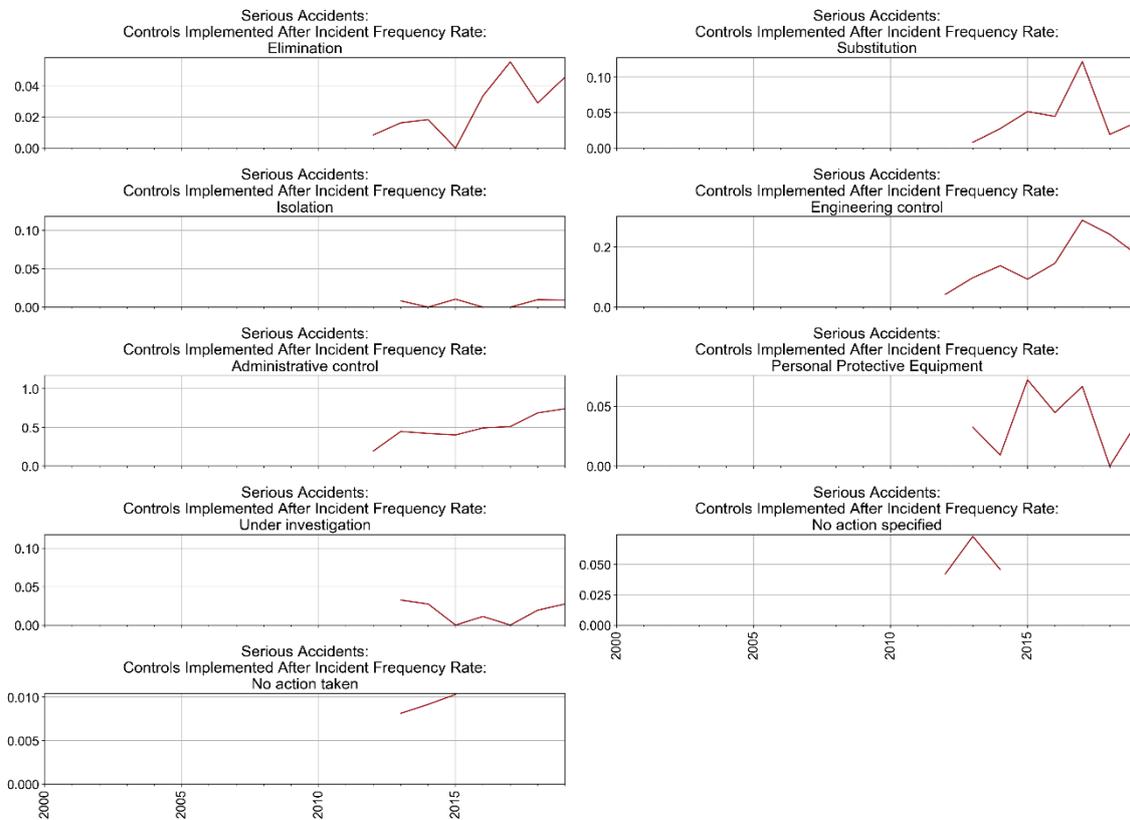
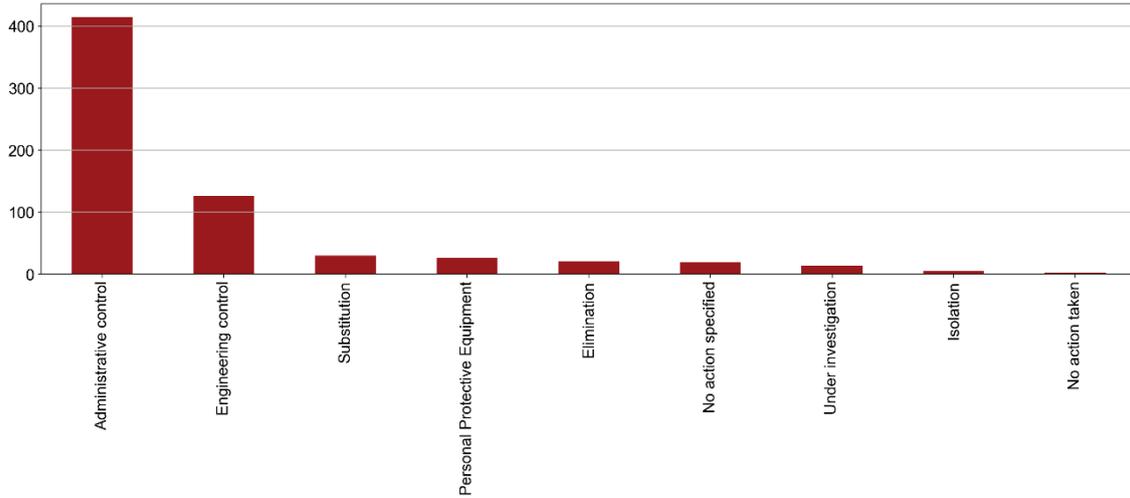
Serious Accidents:
Nature of Employment Frequency Rate:
Other



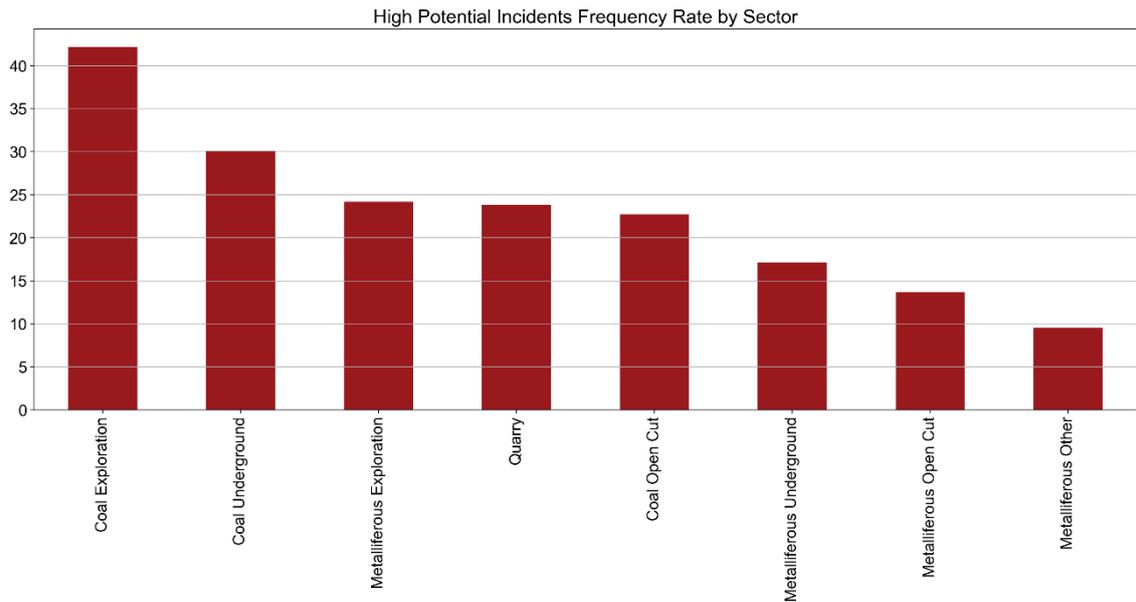
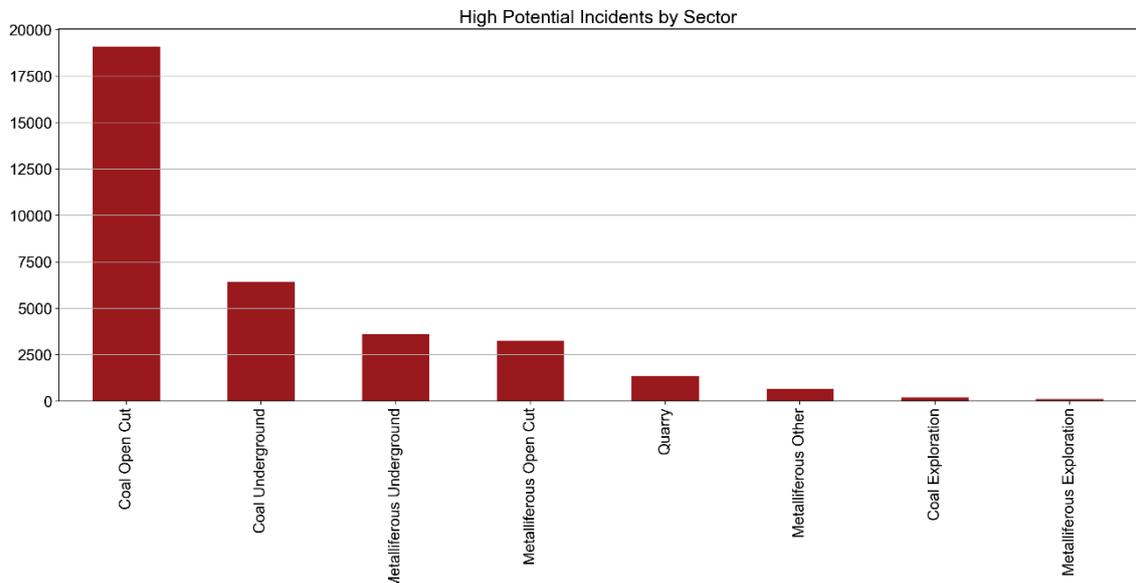
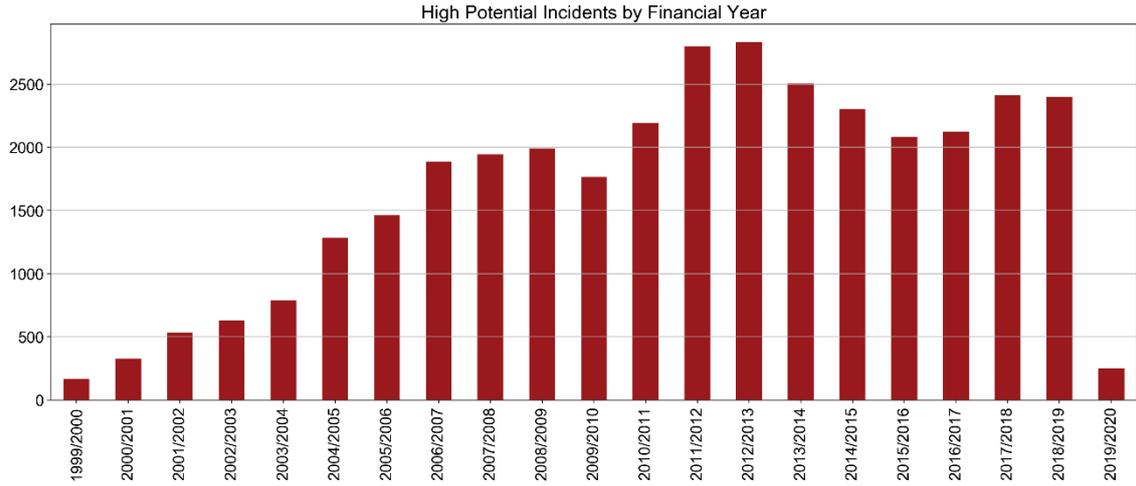
Level 1
 Serious Accidents:
 Absent or Failed Controls:



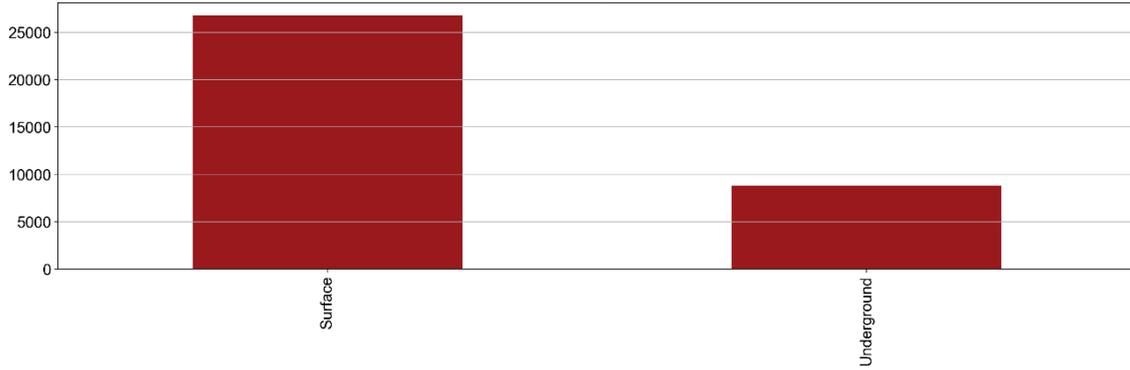
Serious Accidents:
Controls Implemented After Incident:
Level 1



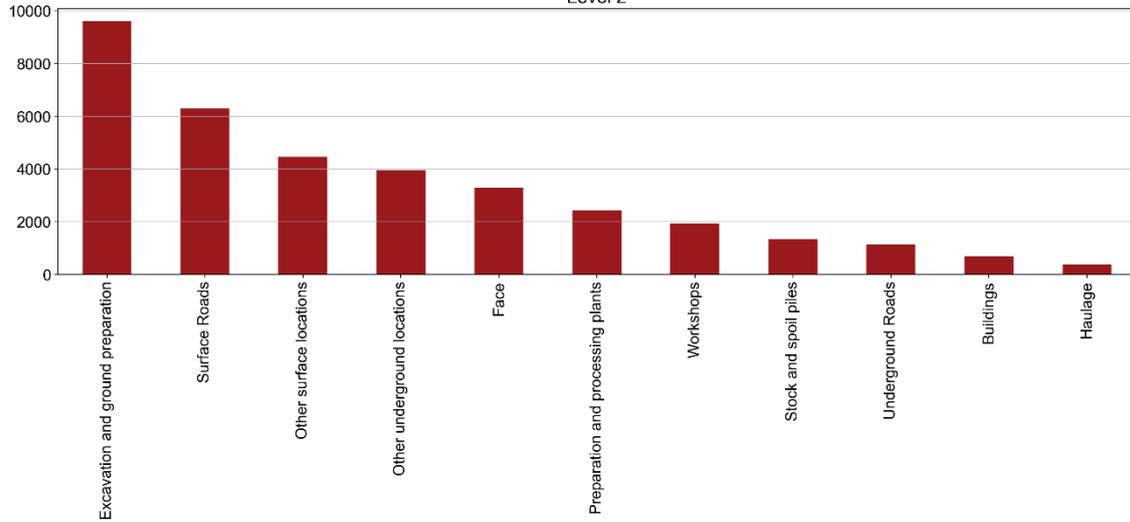
High Potential Incidents (HPIs)



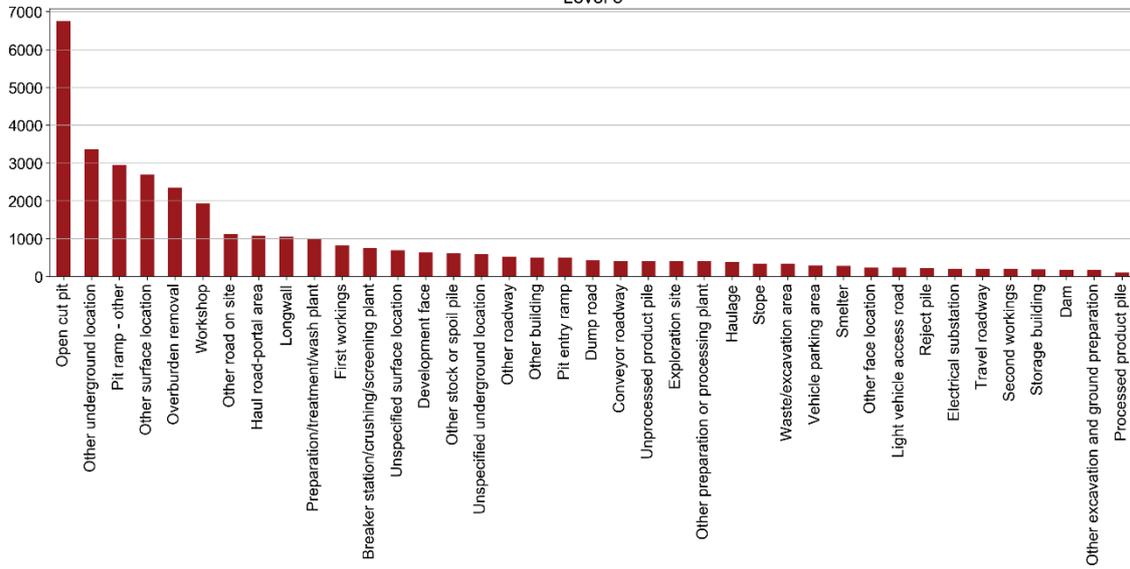
High Potential Incidents:
Location:
Level 1

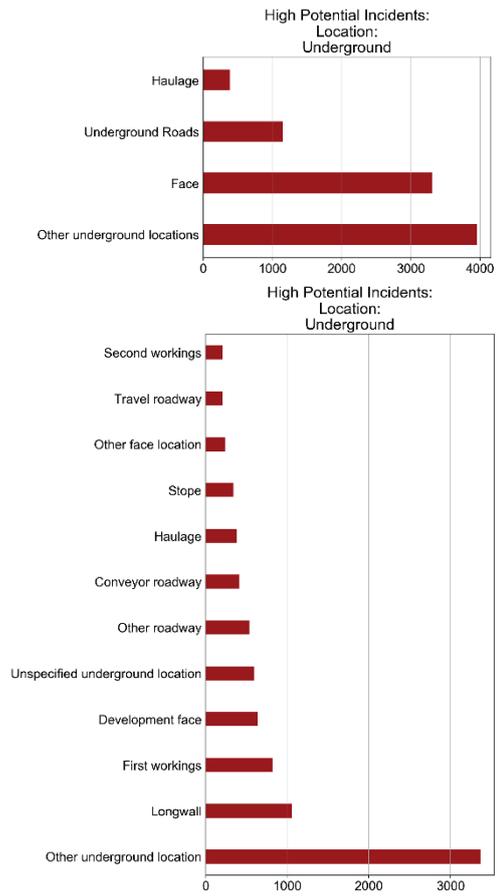
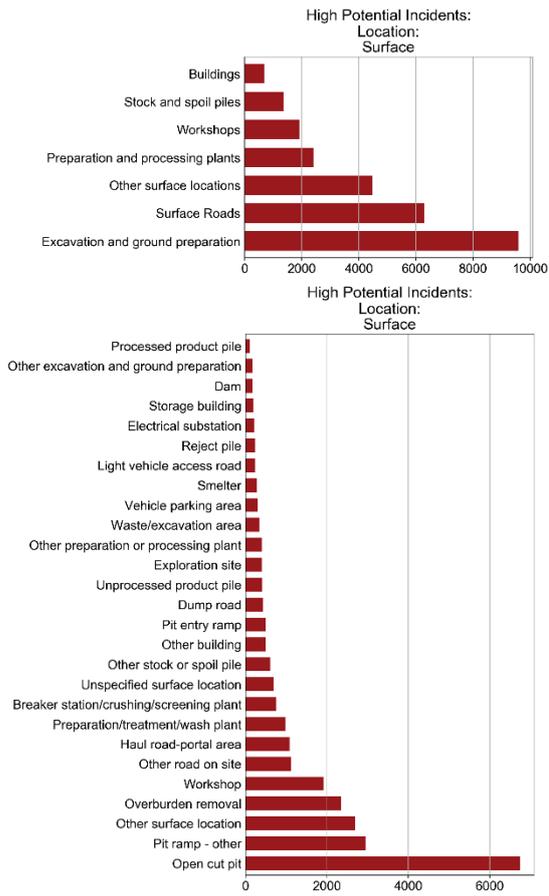


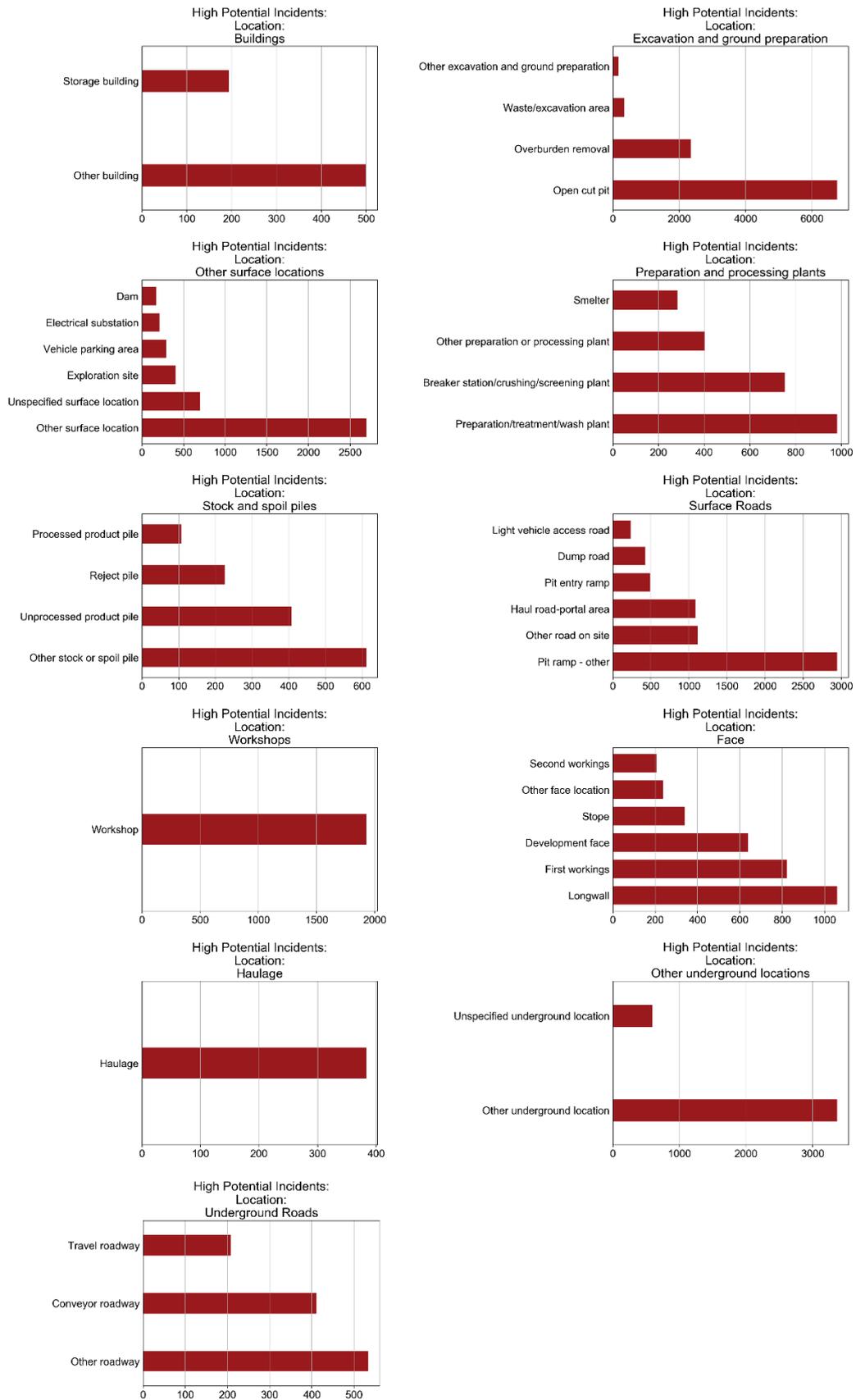
High Potential Incidents:
Location:
Level 2

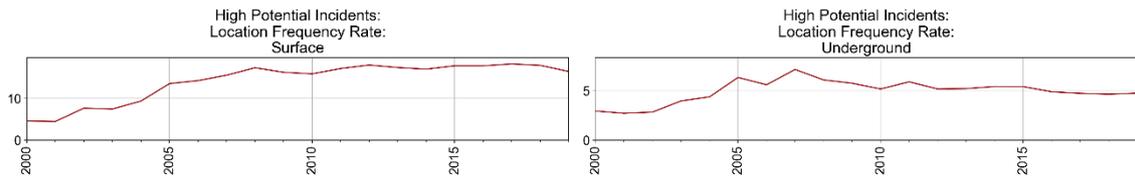


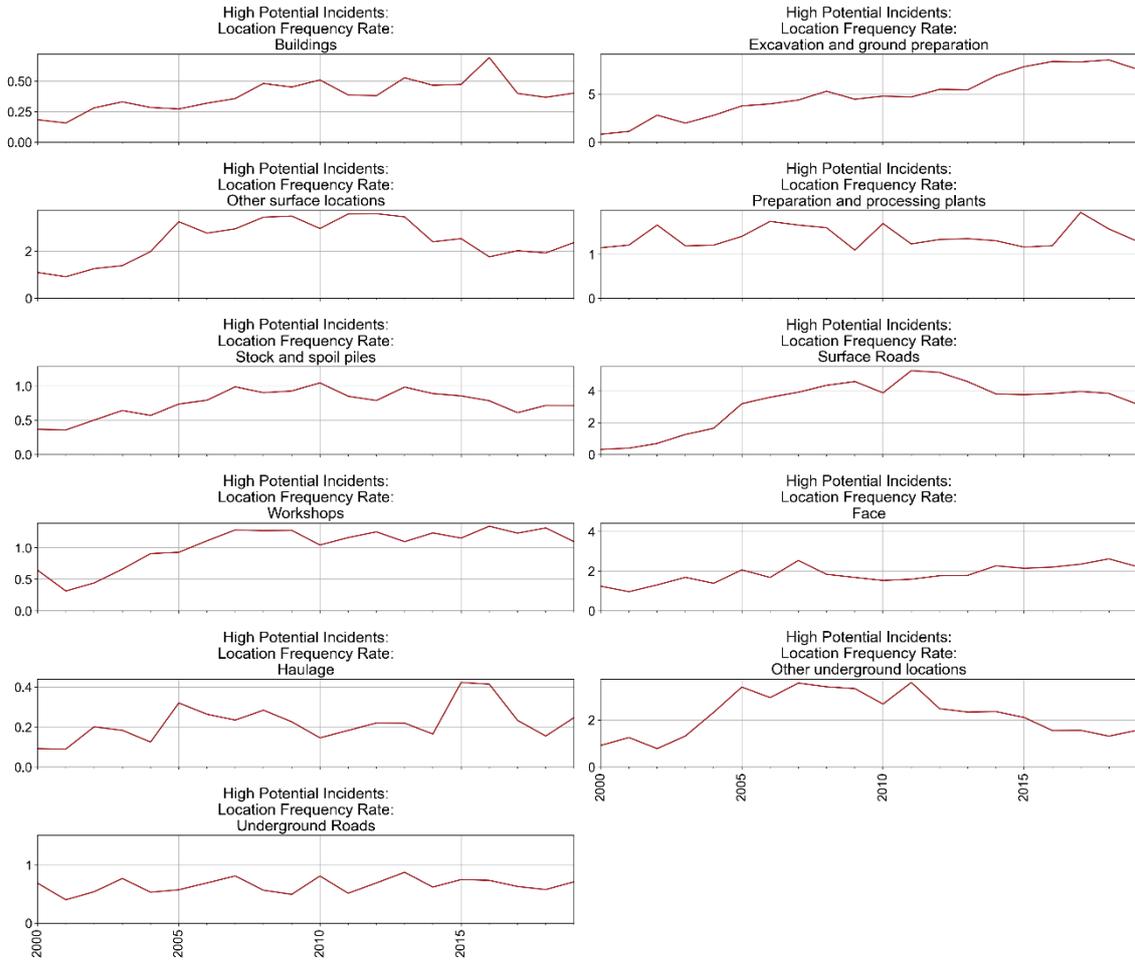
High Potential Incidents:
Location:
Level 3

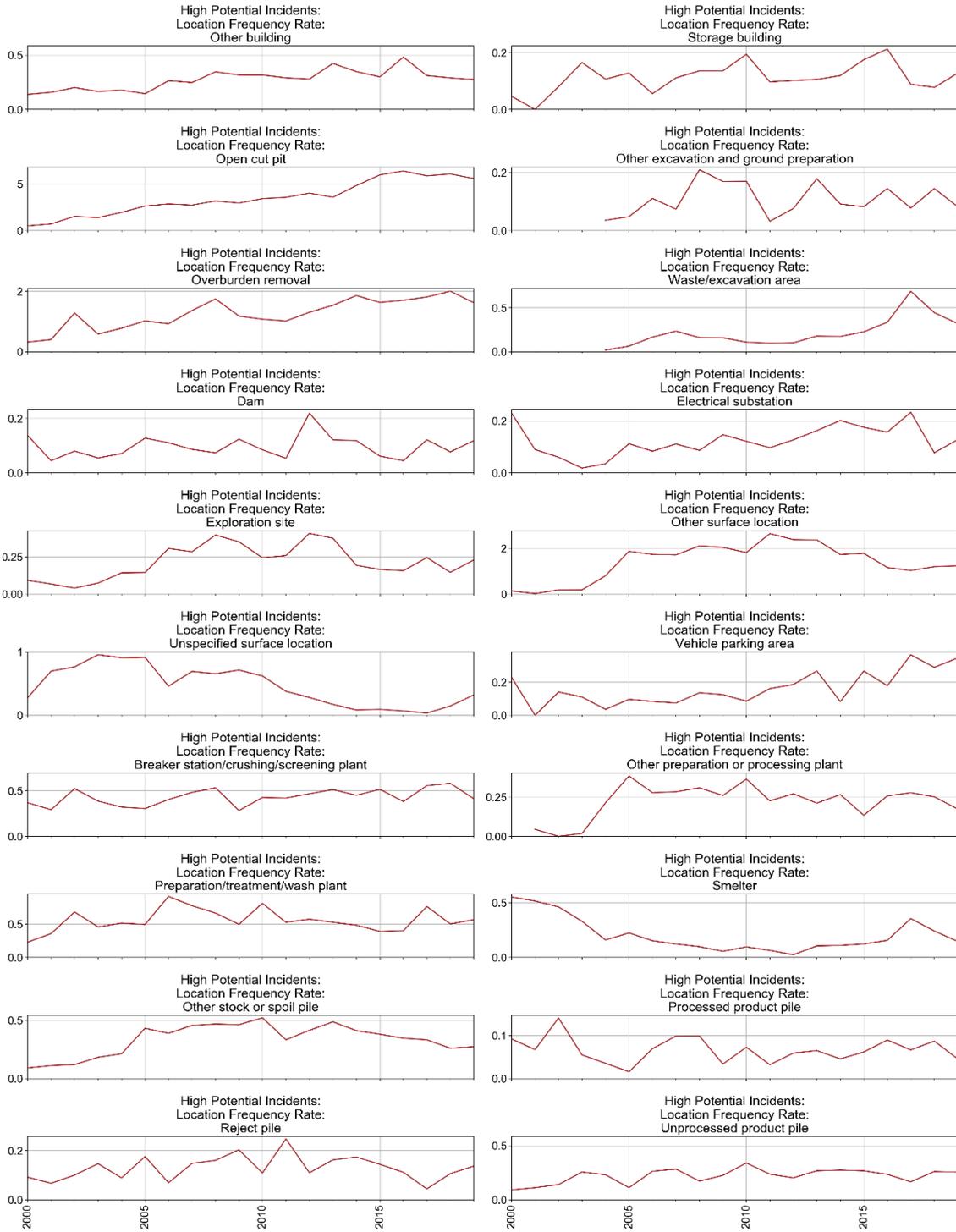


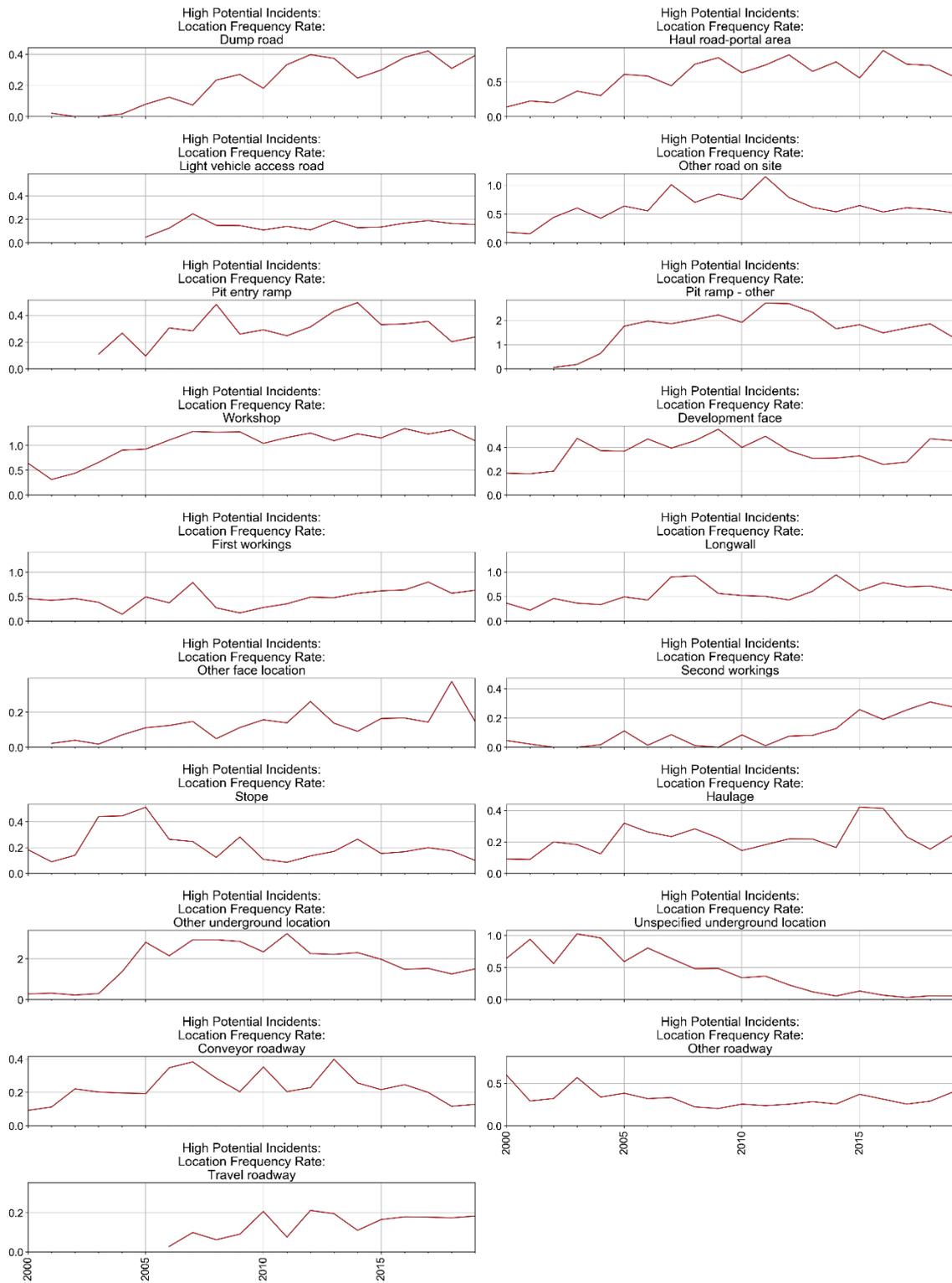




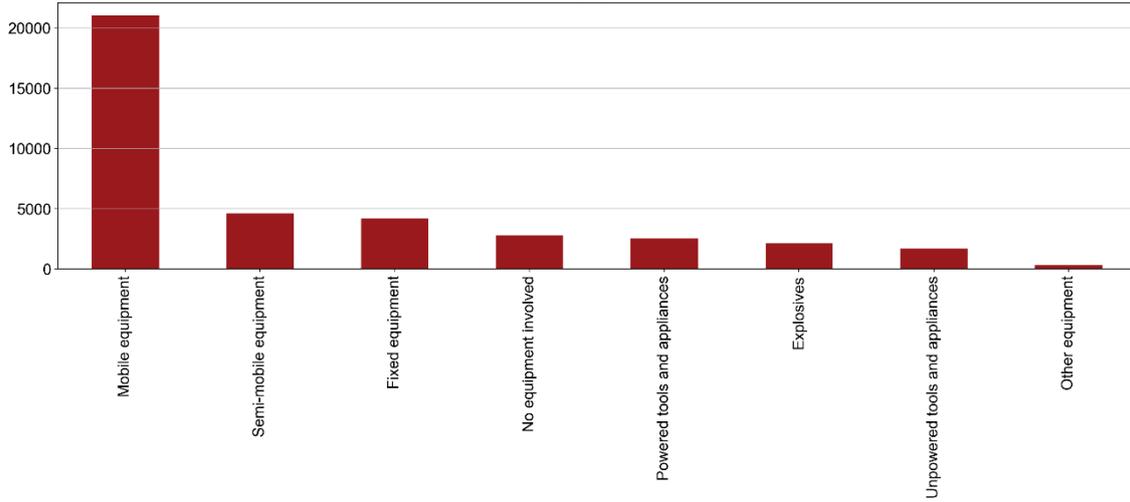




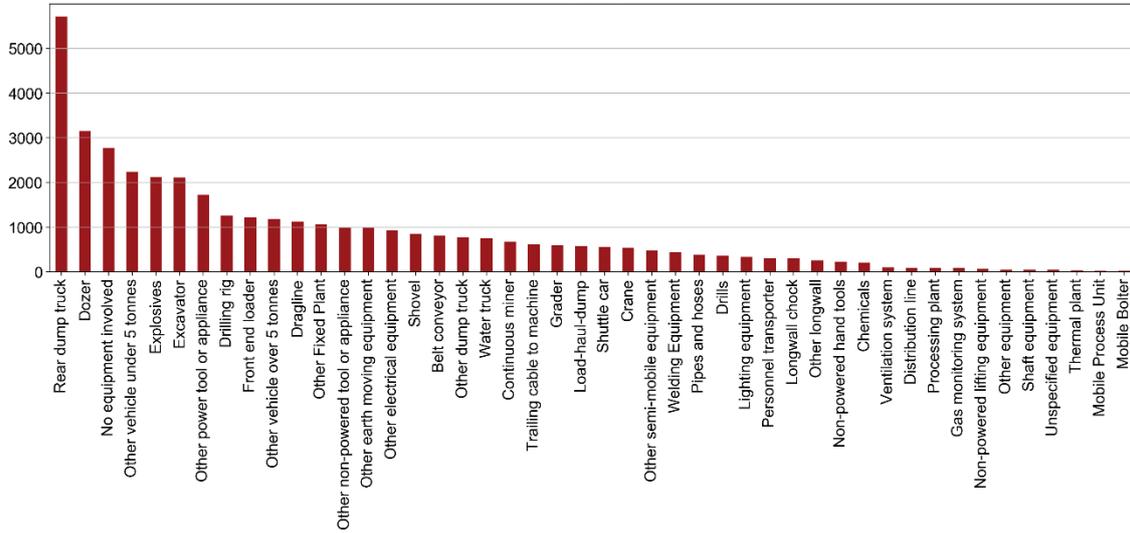


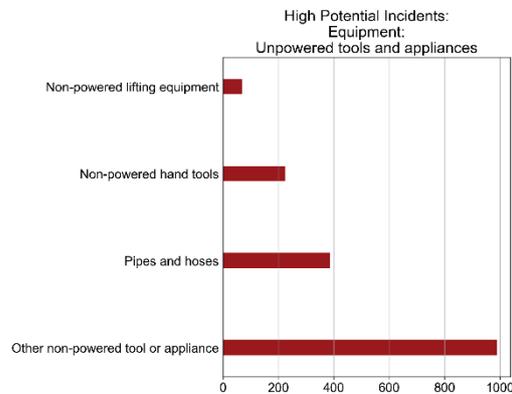
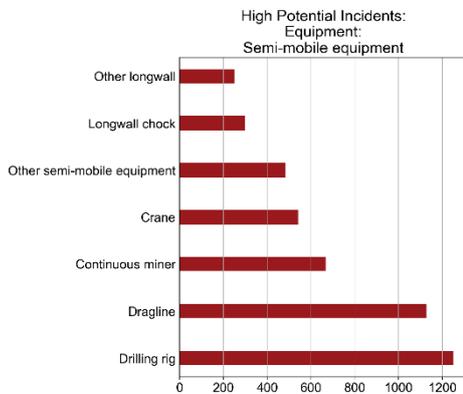
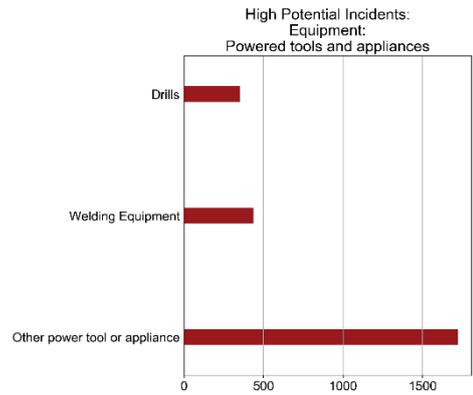
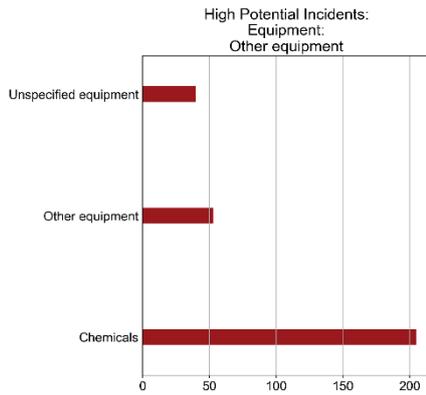
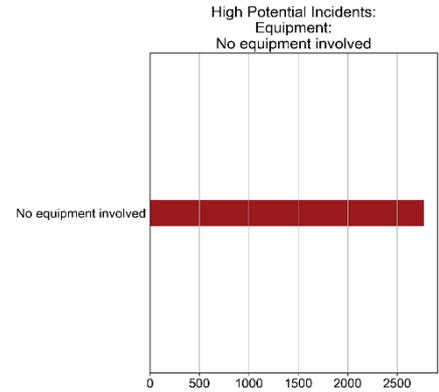
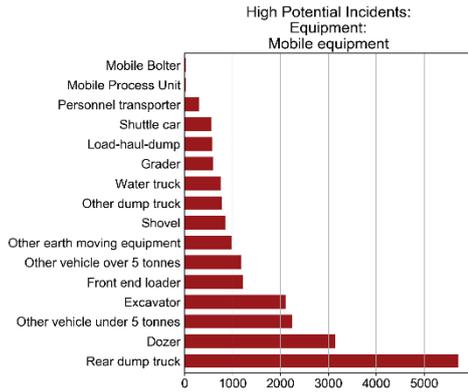
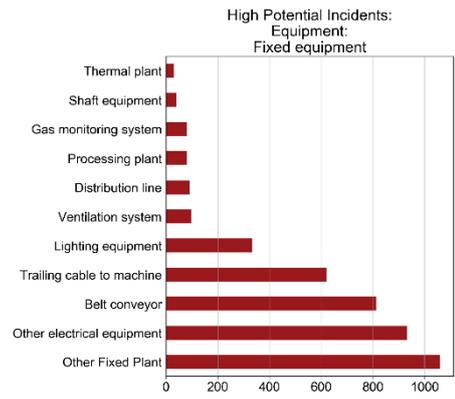
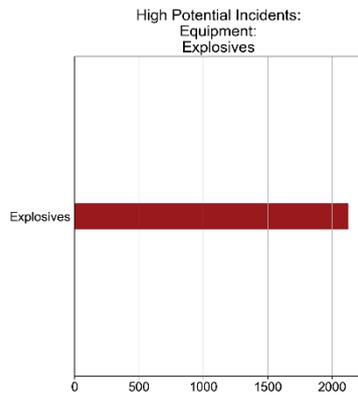


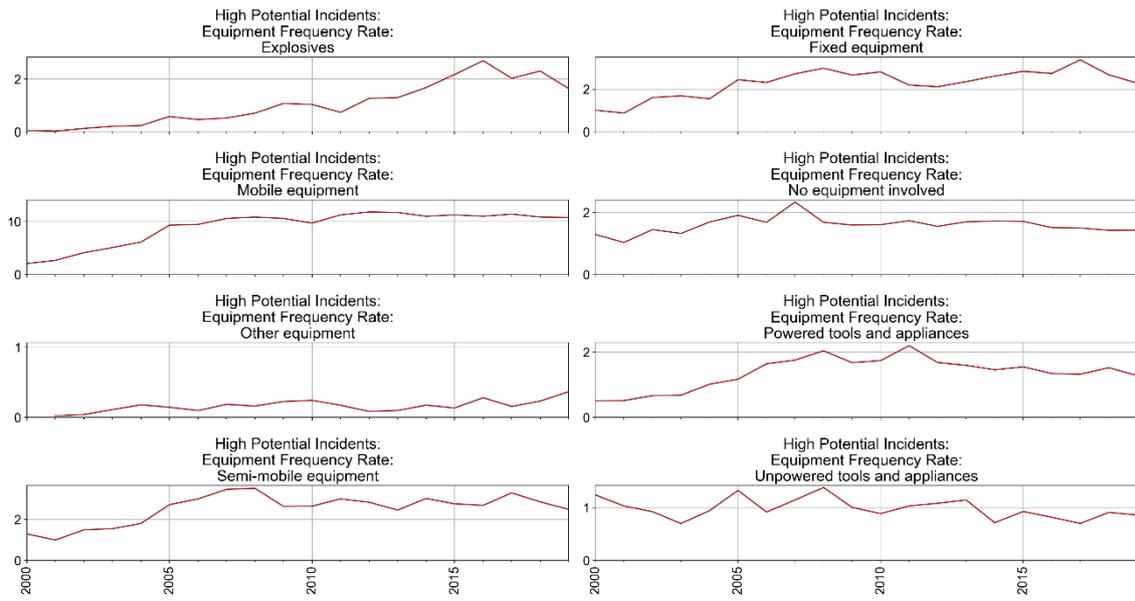
High Potential Incidents:
Equipment:
Level 1

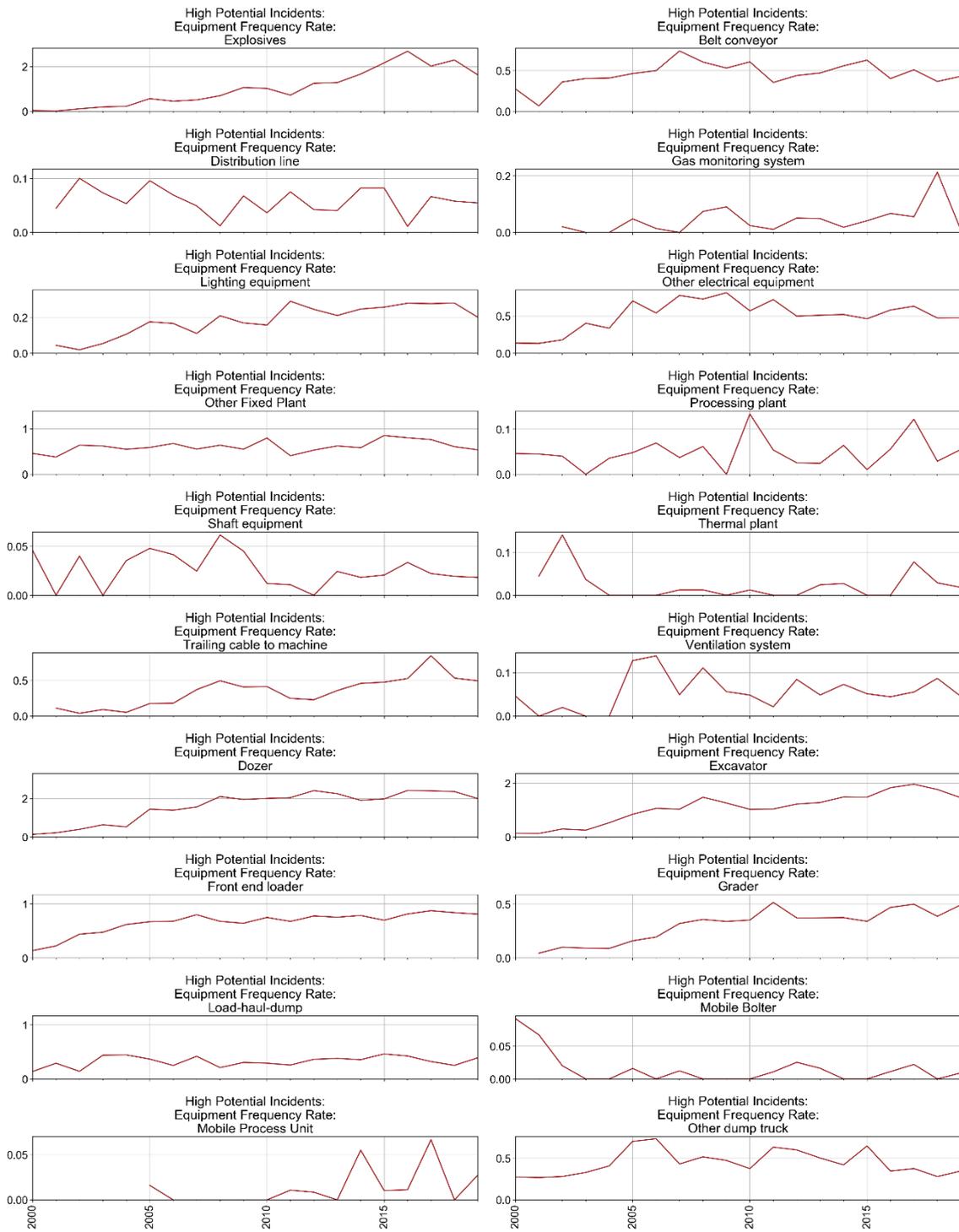


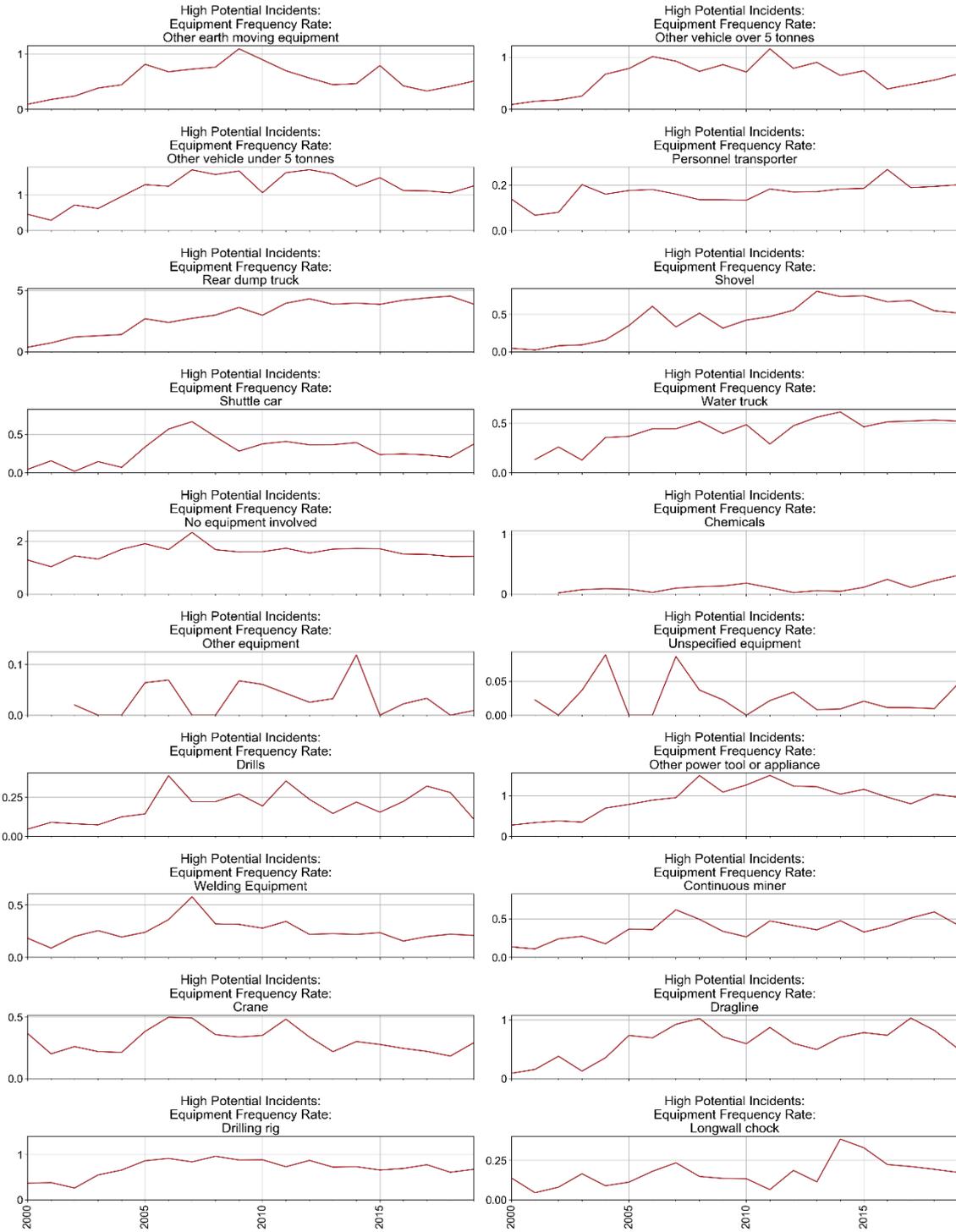
High Potential Incidents:
Equipment:
Level 2

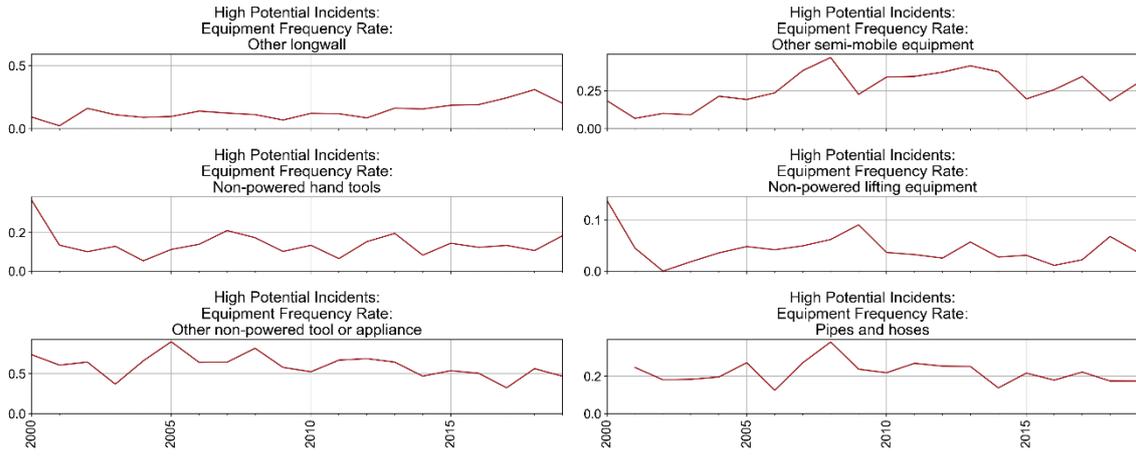


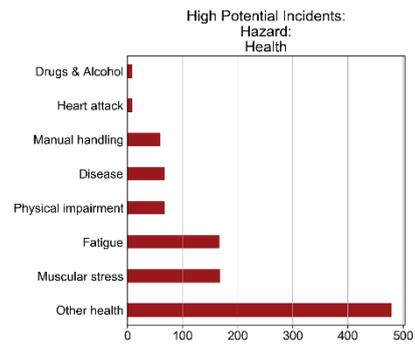
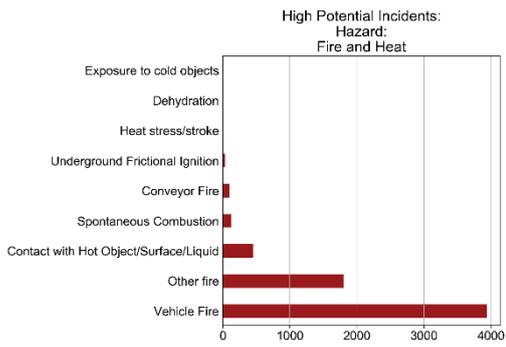
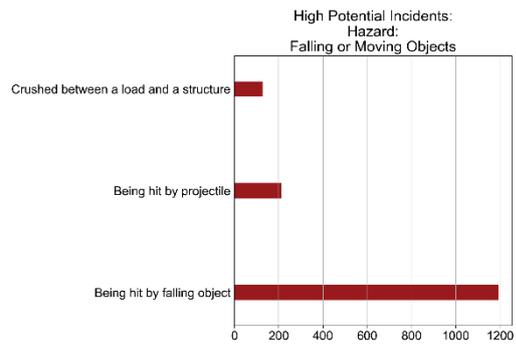
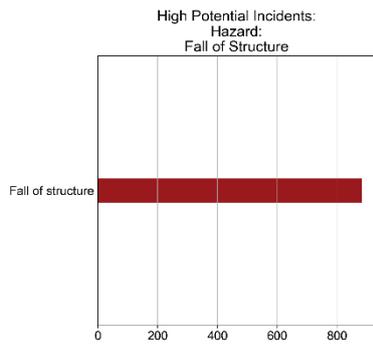
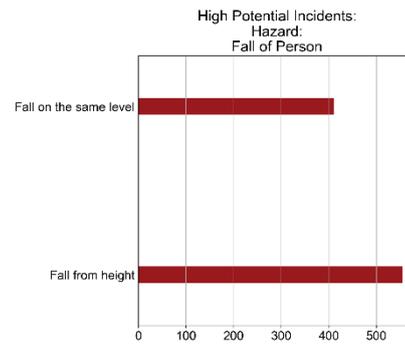
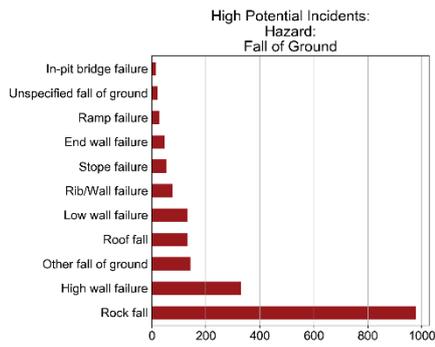
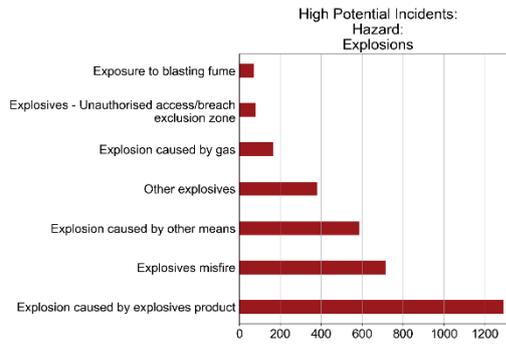
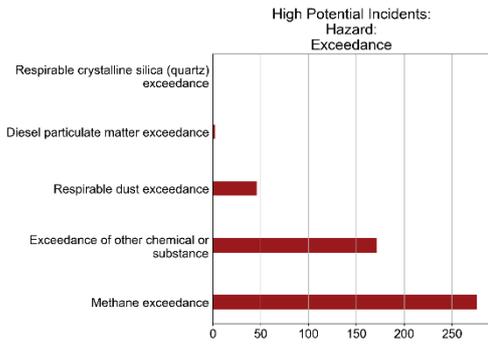
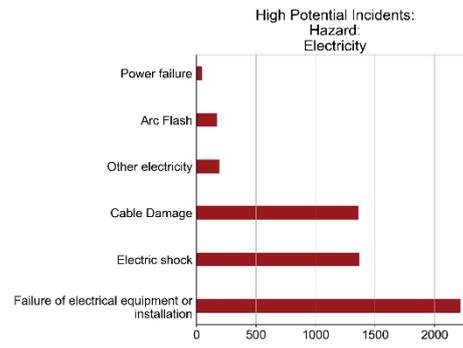
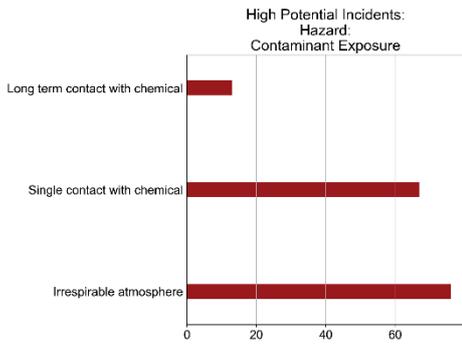


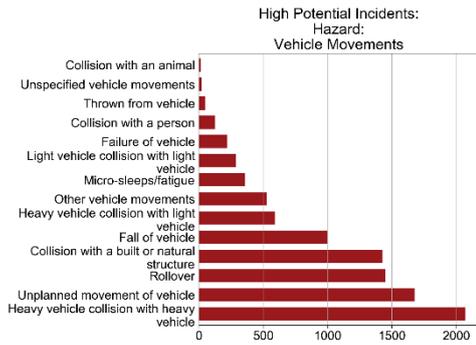
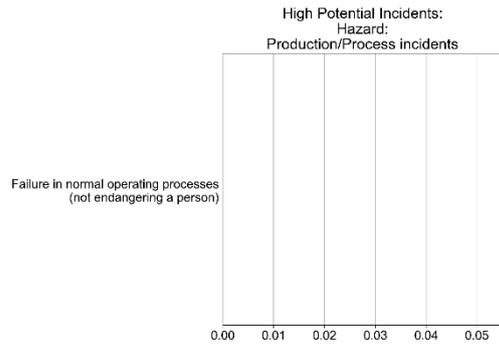
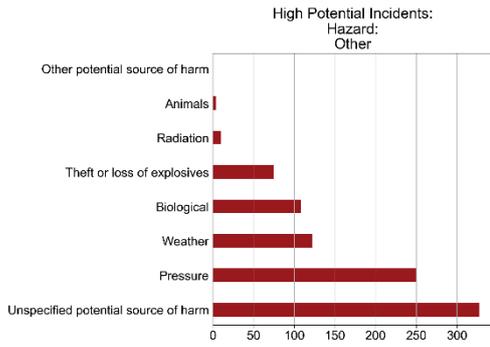
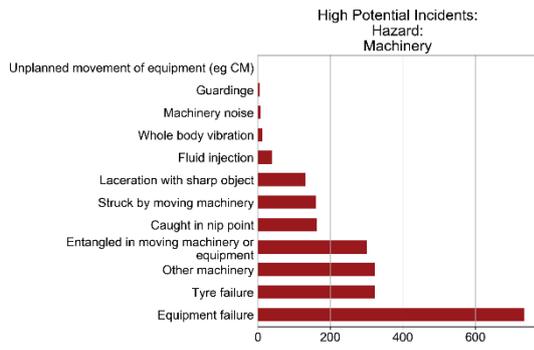
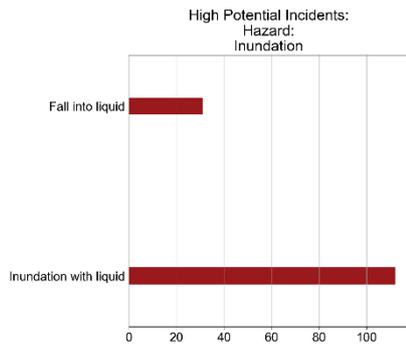


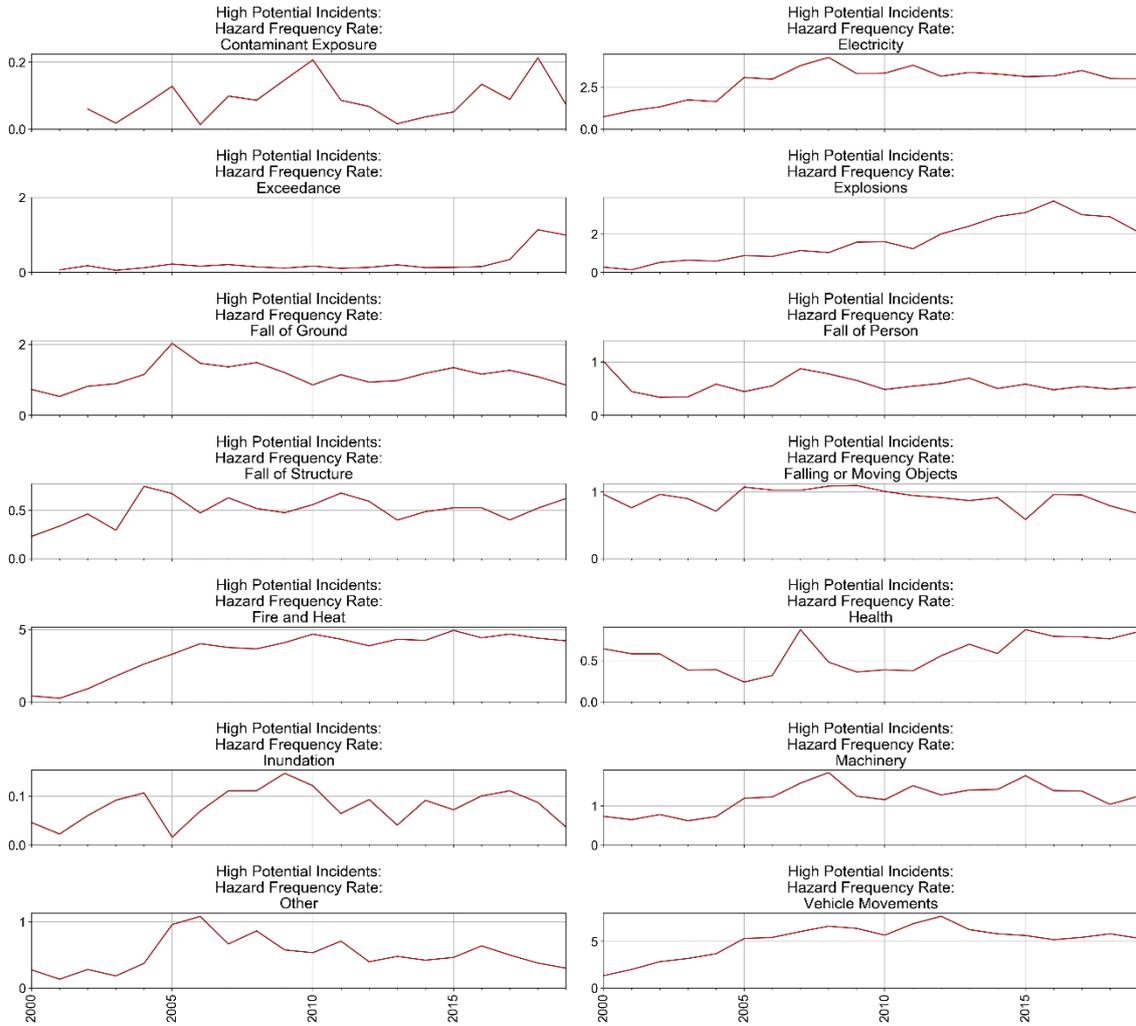


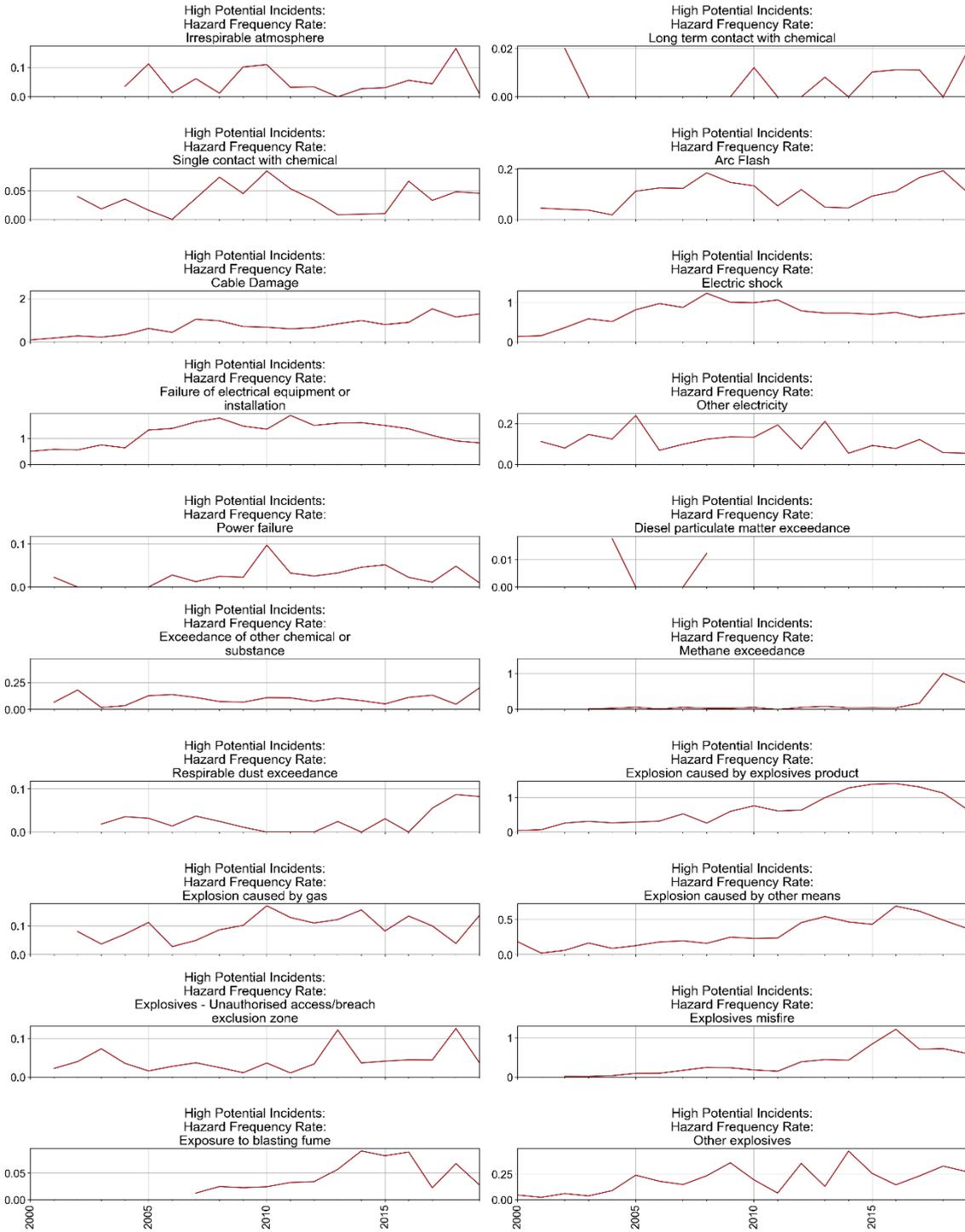


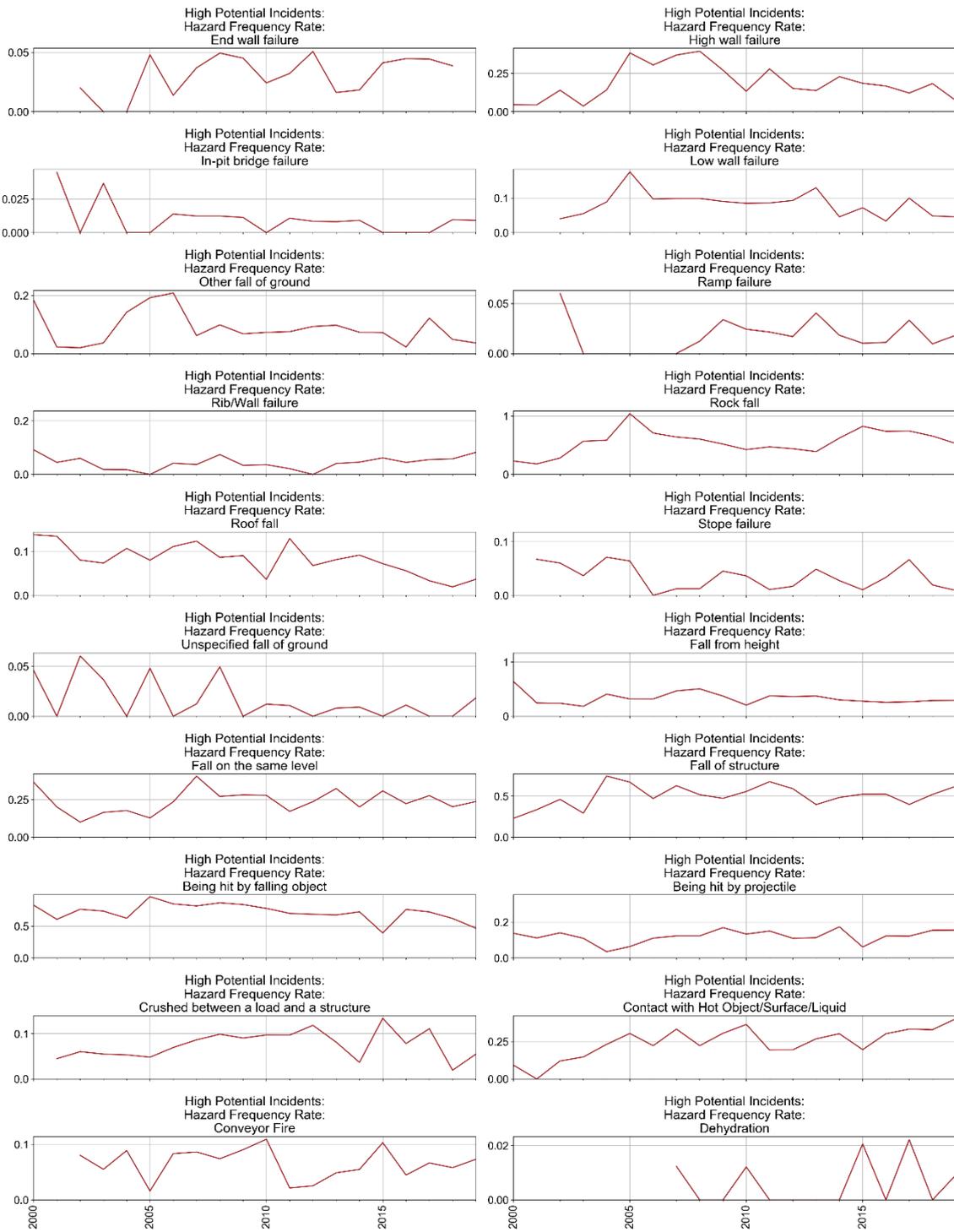


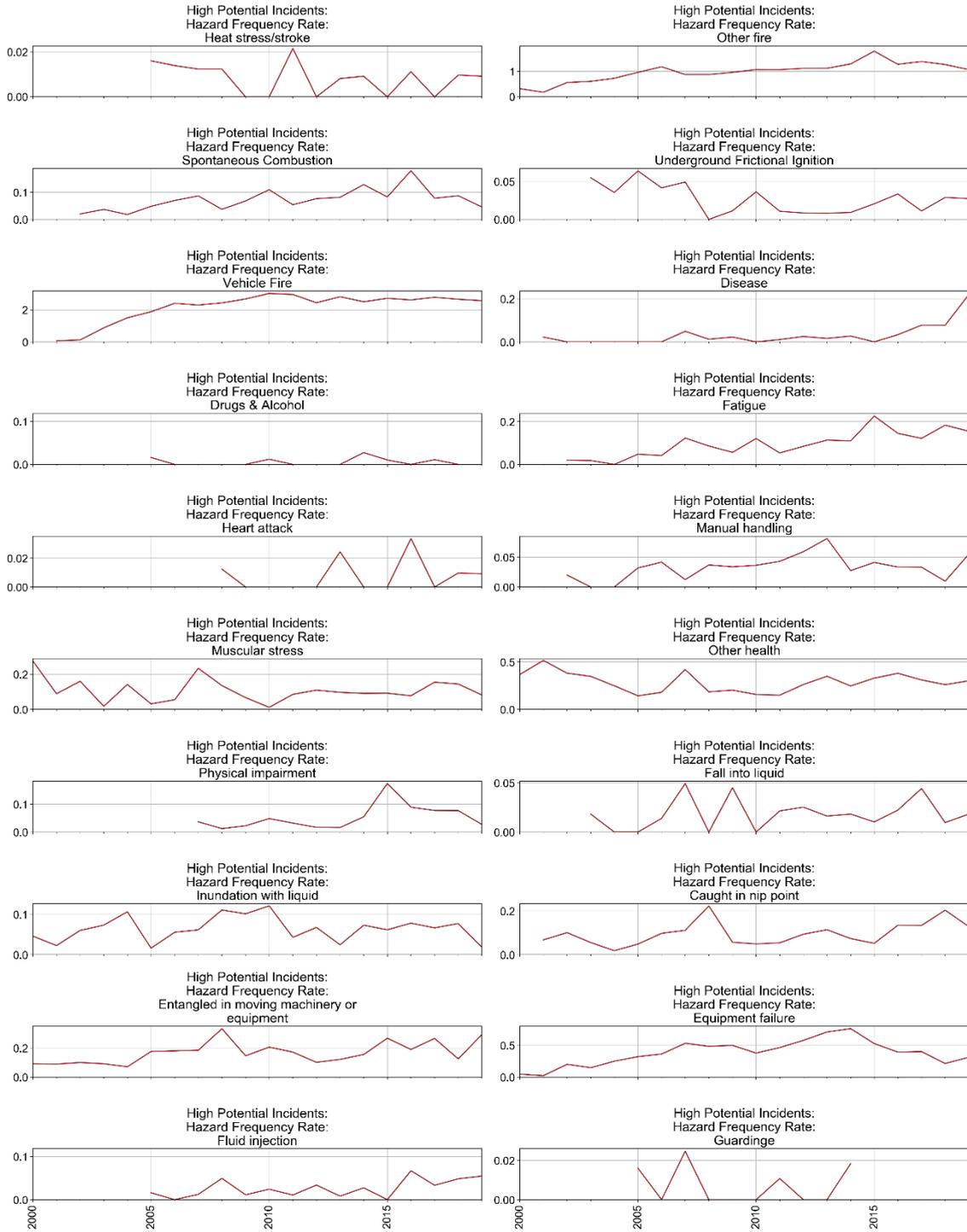


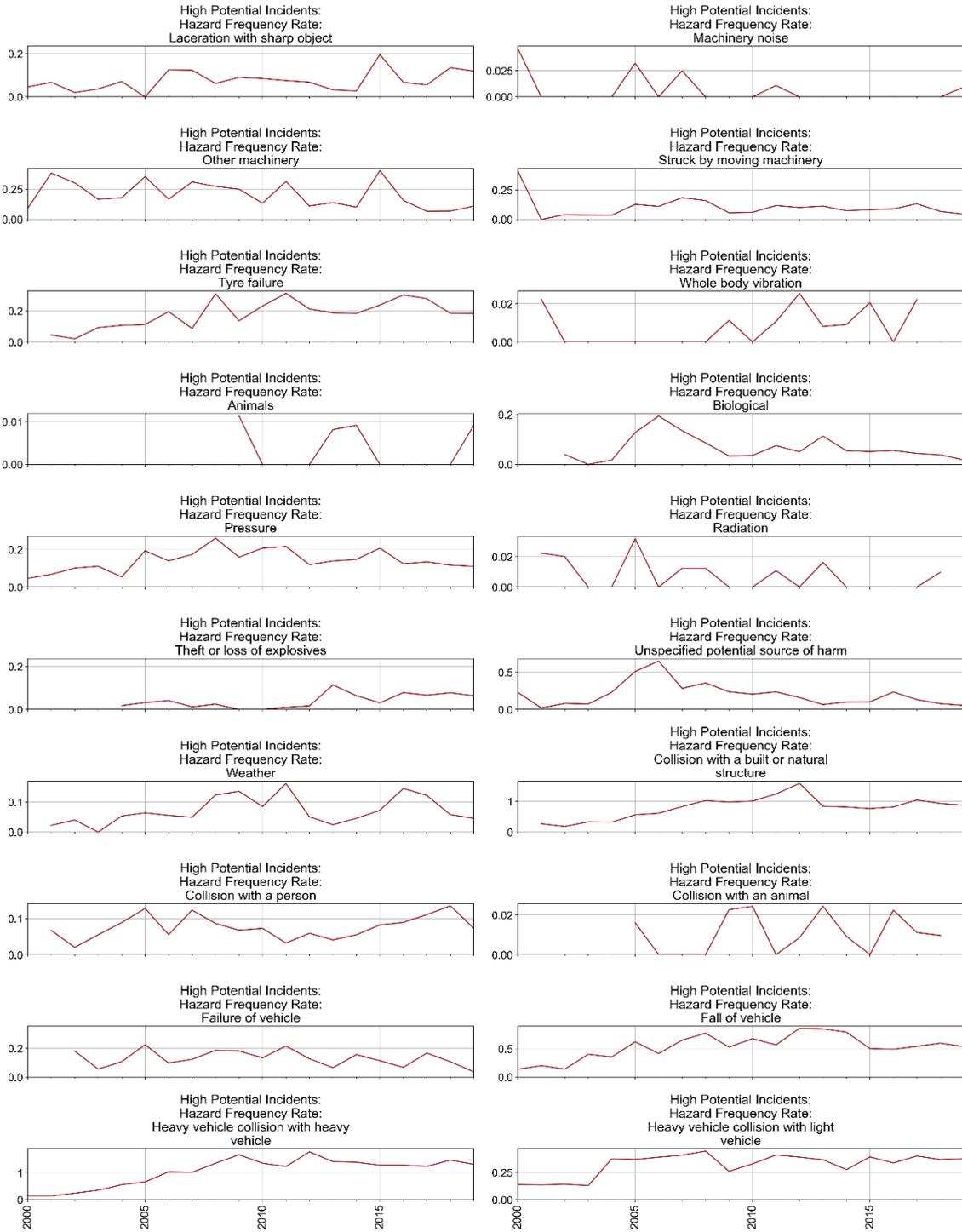


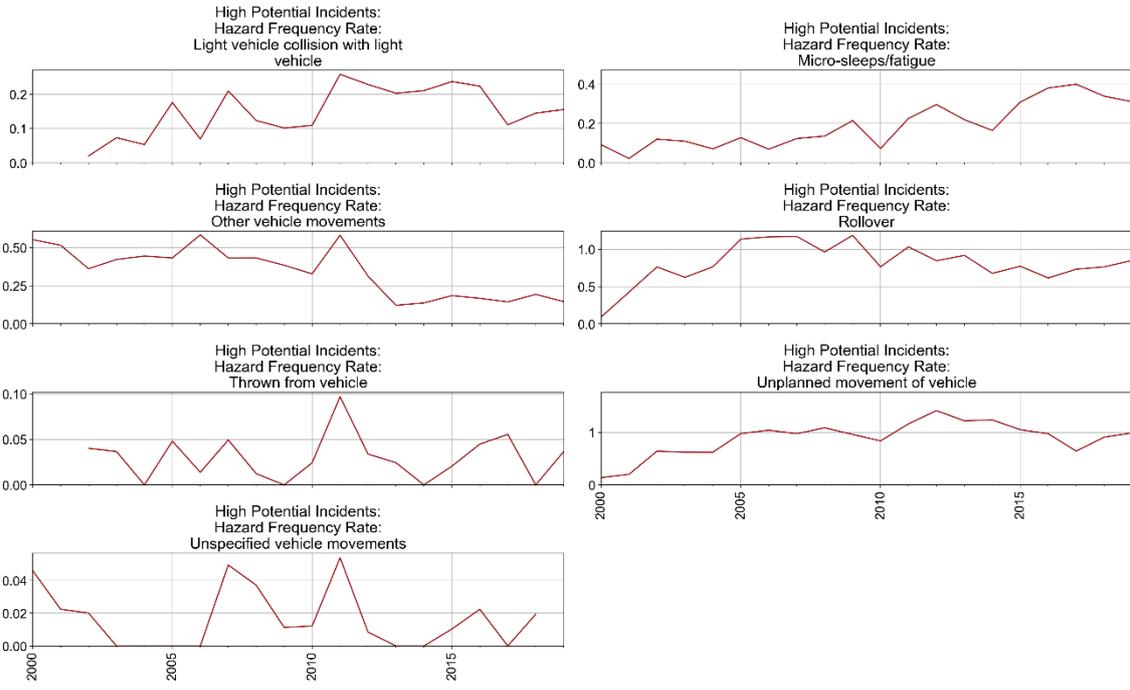




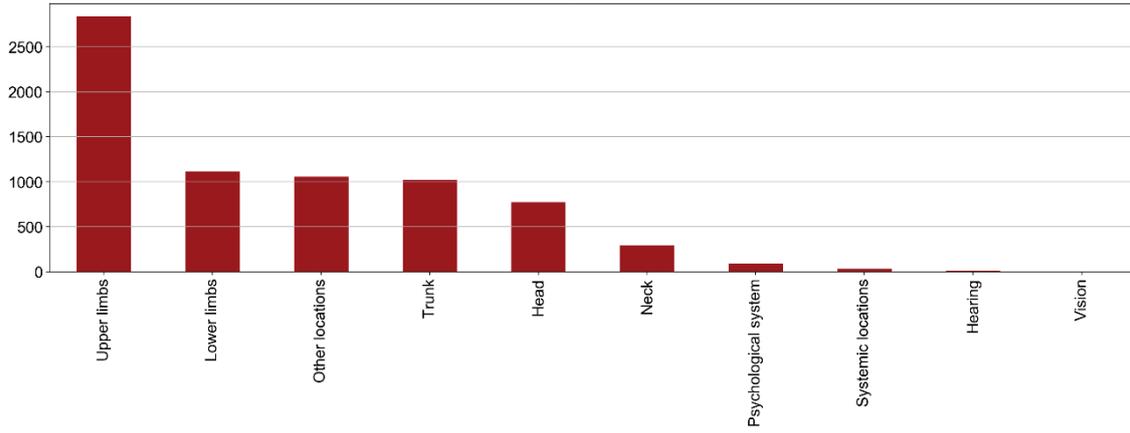




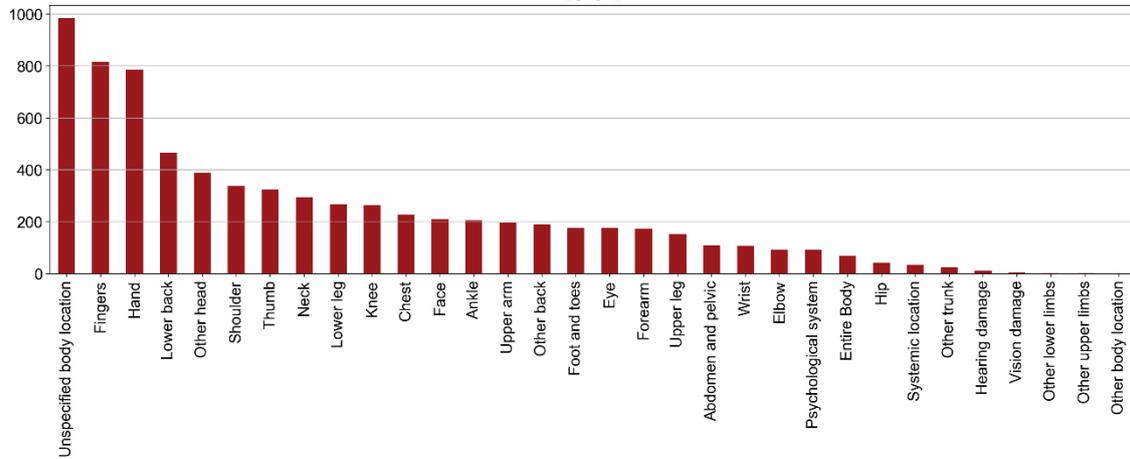


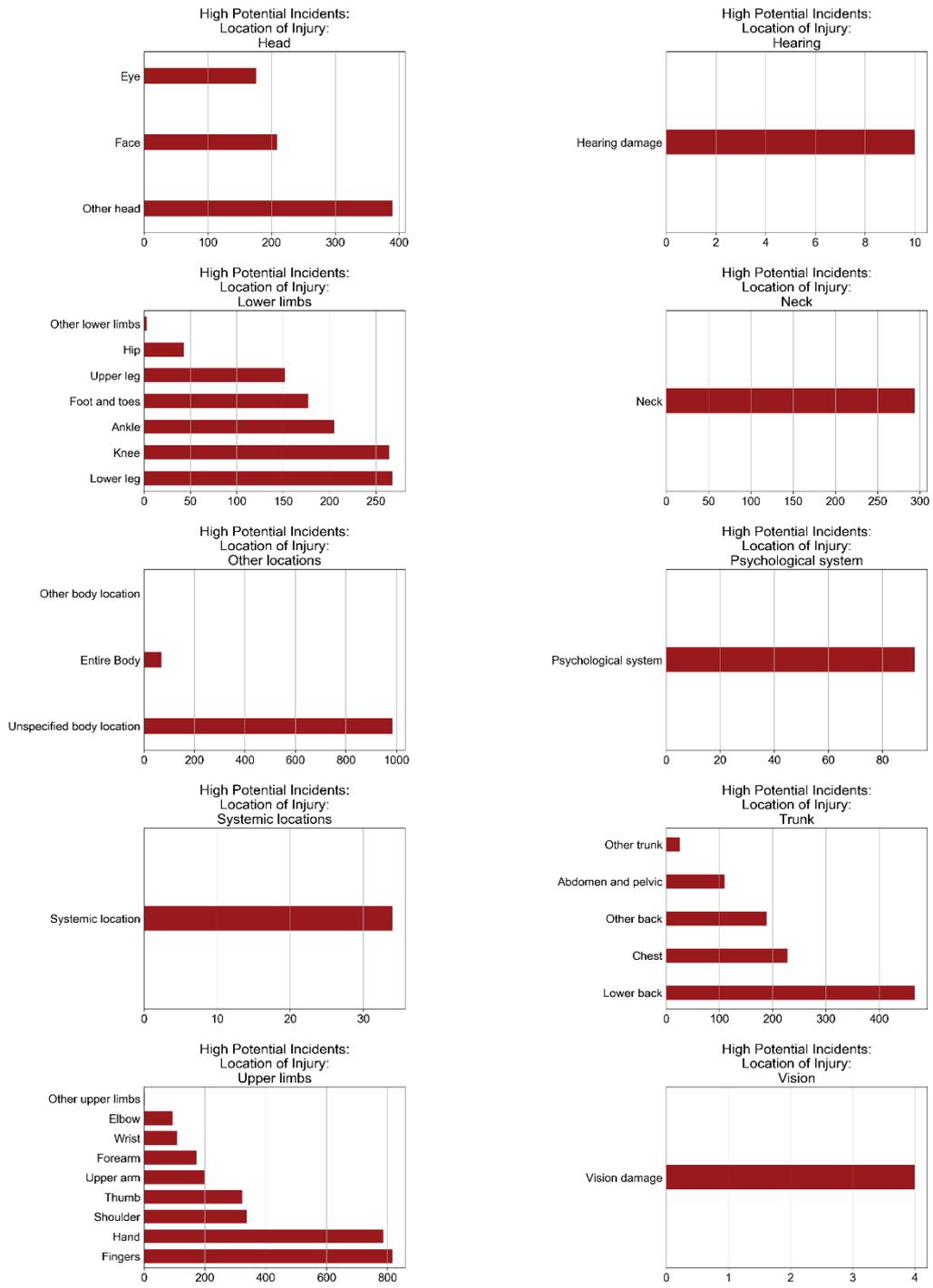


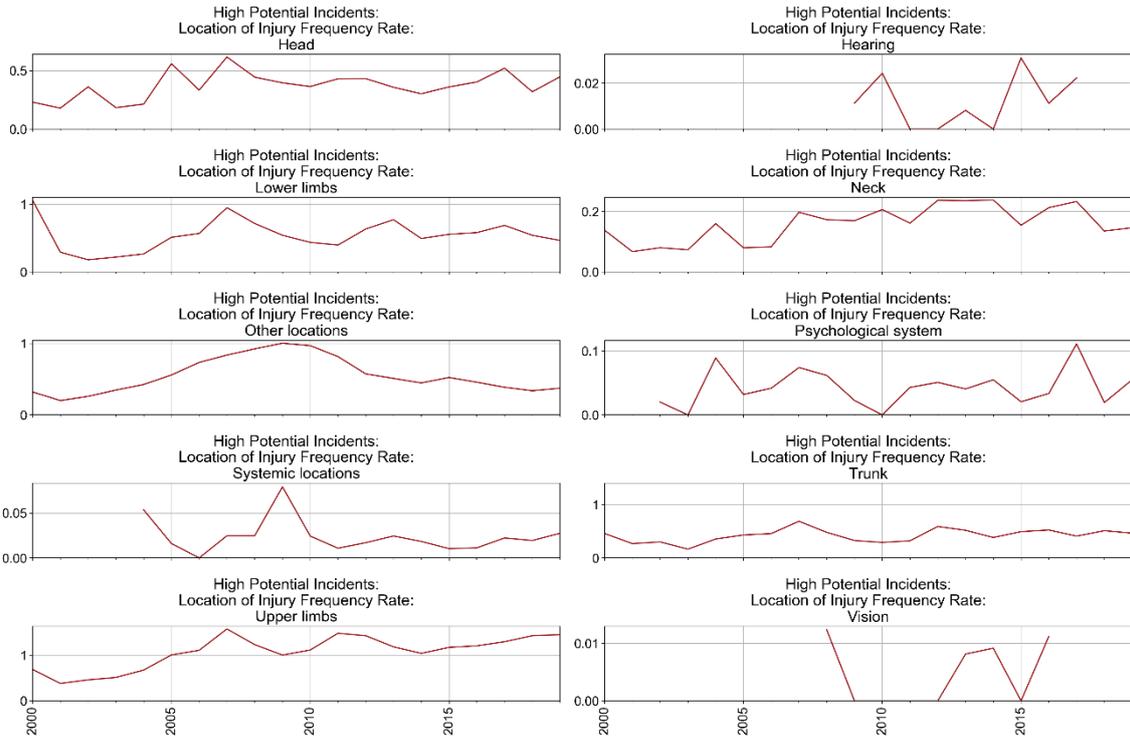
High Potential Incidents:
Location of Injury:
Level 1

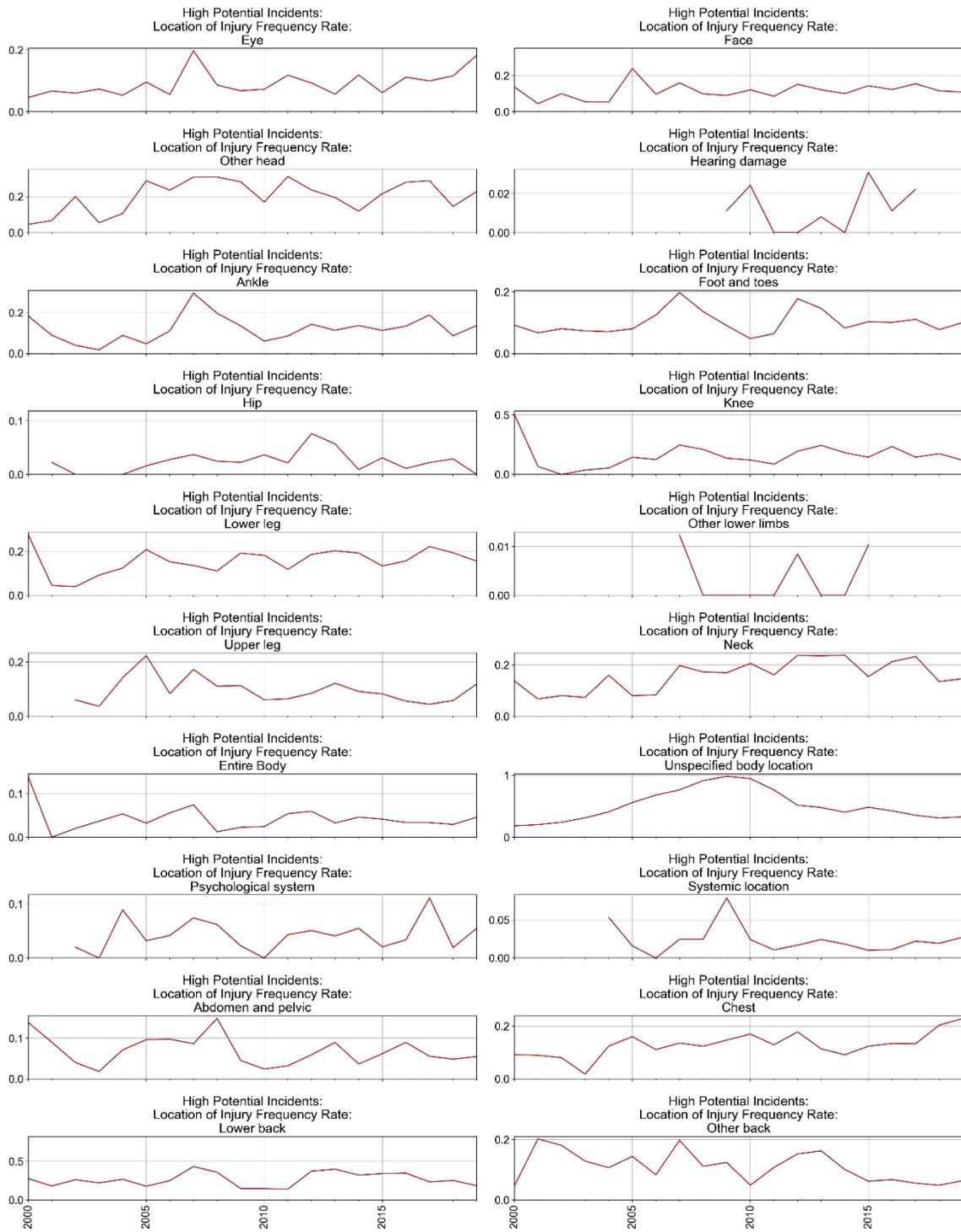


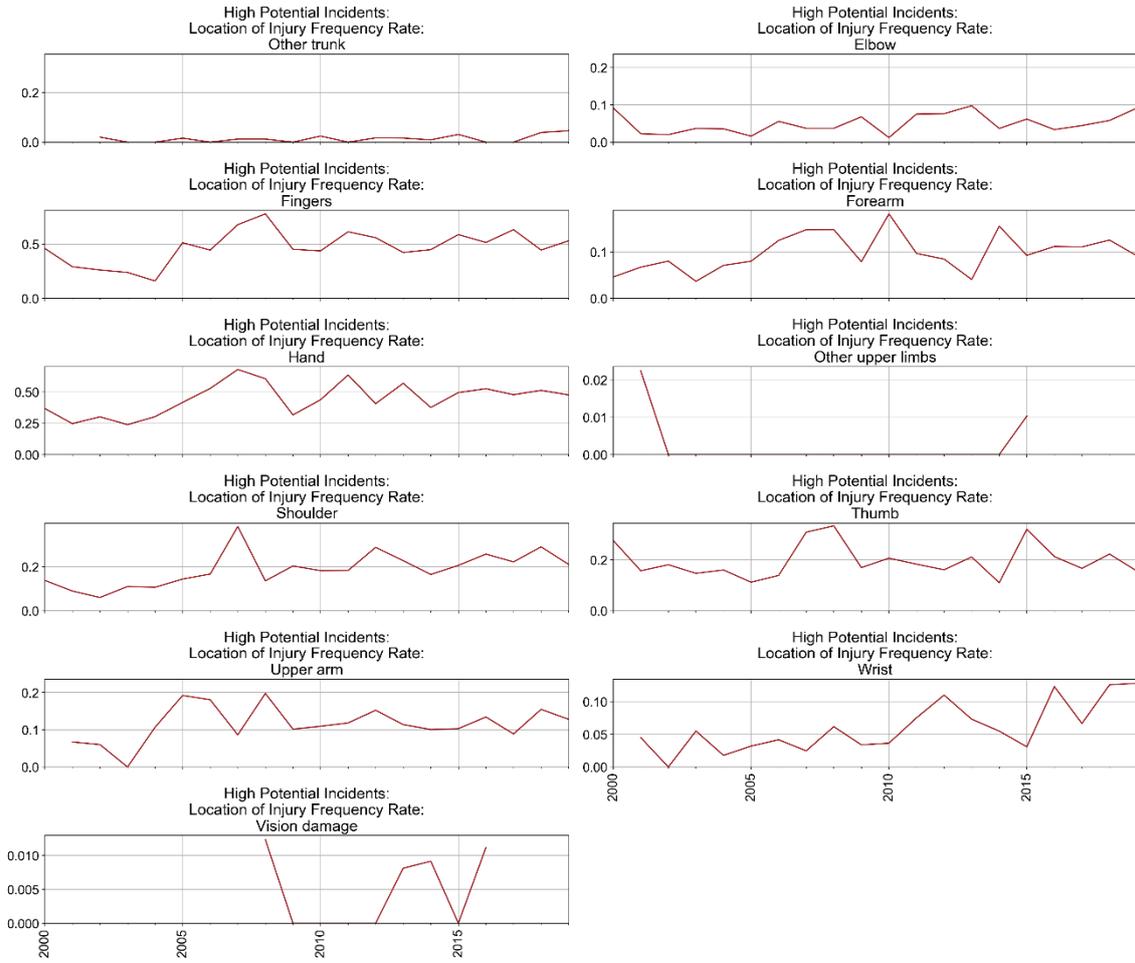
High Potential Incidents:
Location of Injury:
Level 2



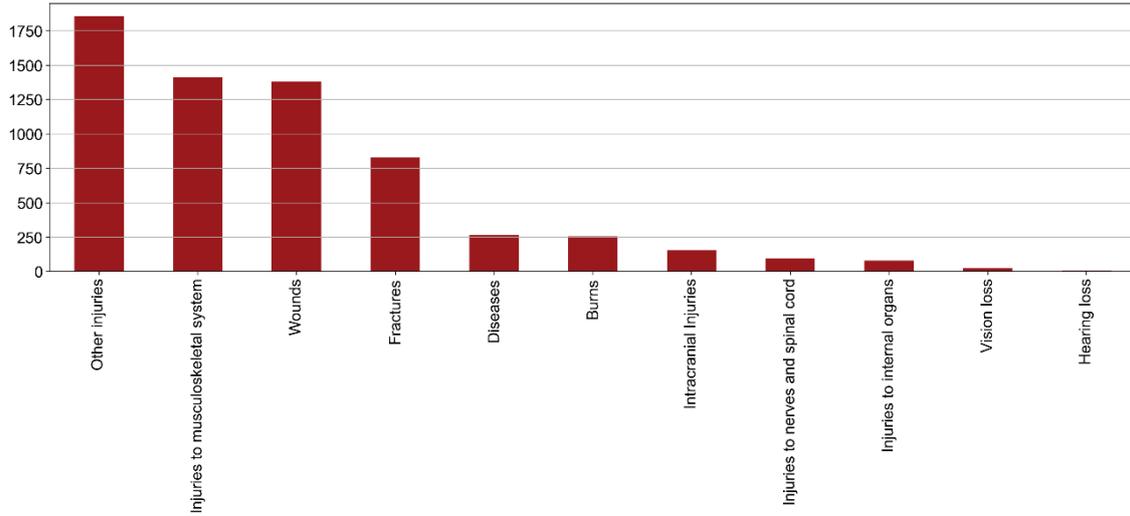




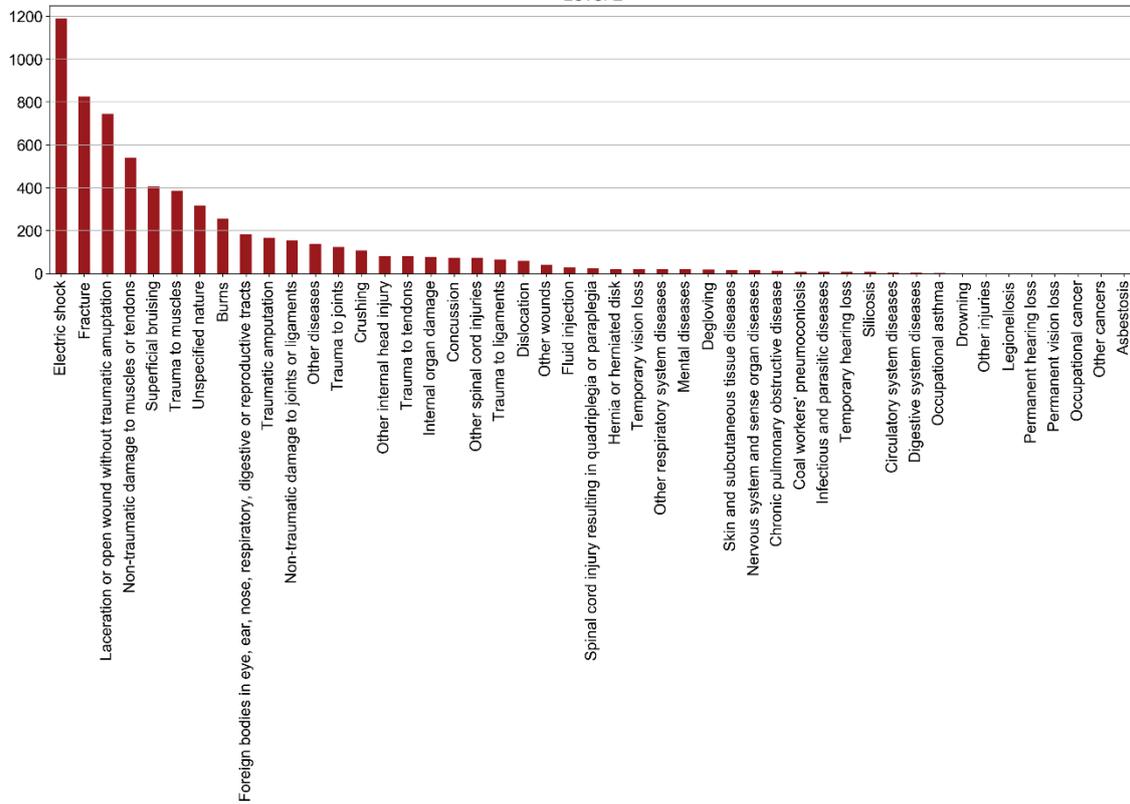


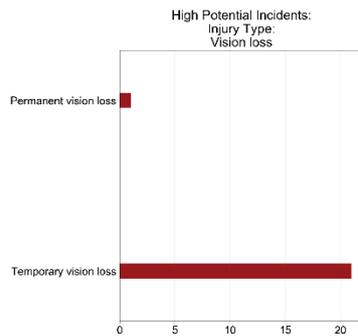
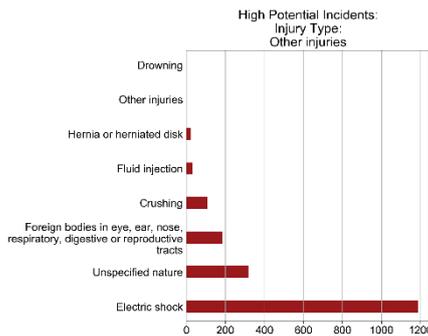
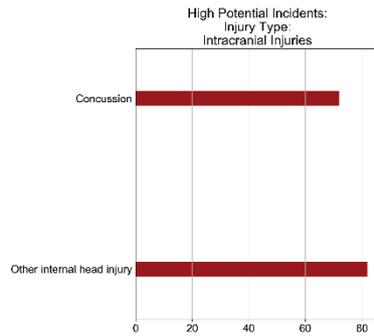
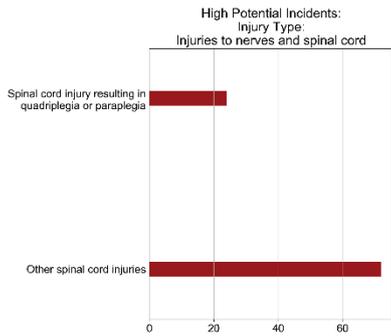
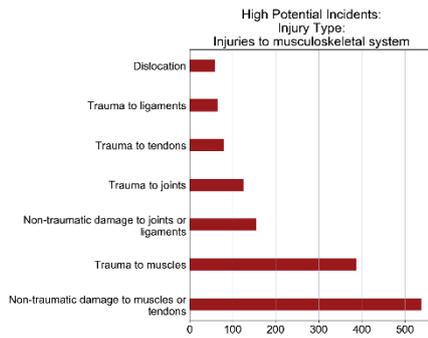
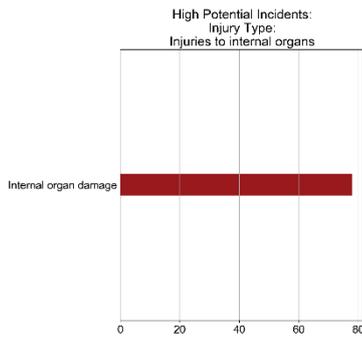
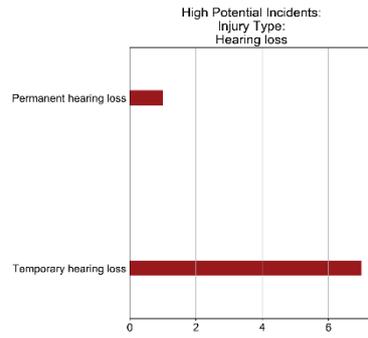
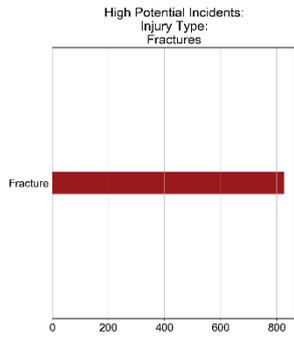
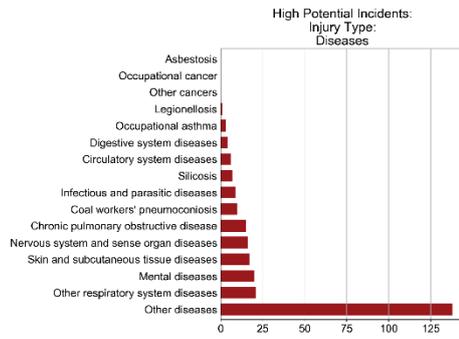
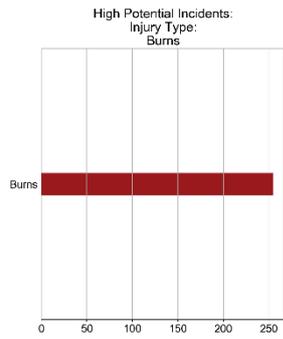


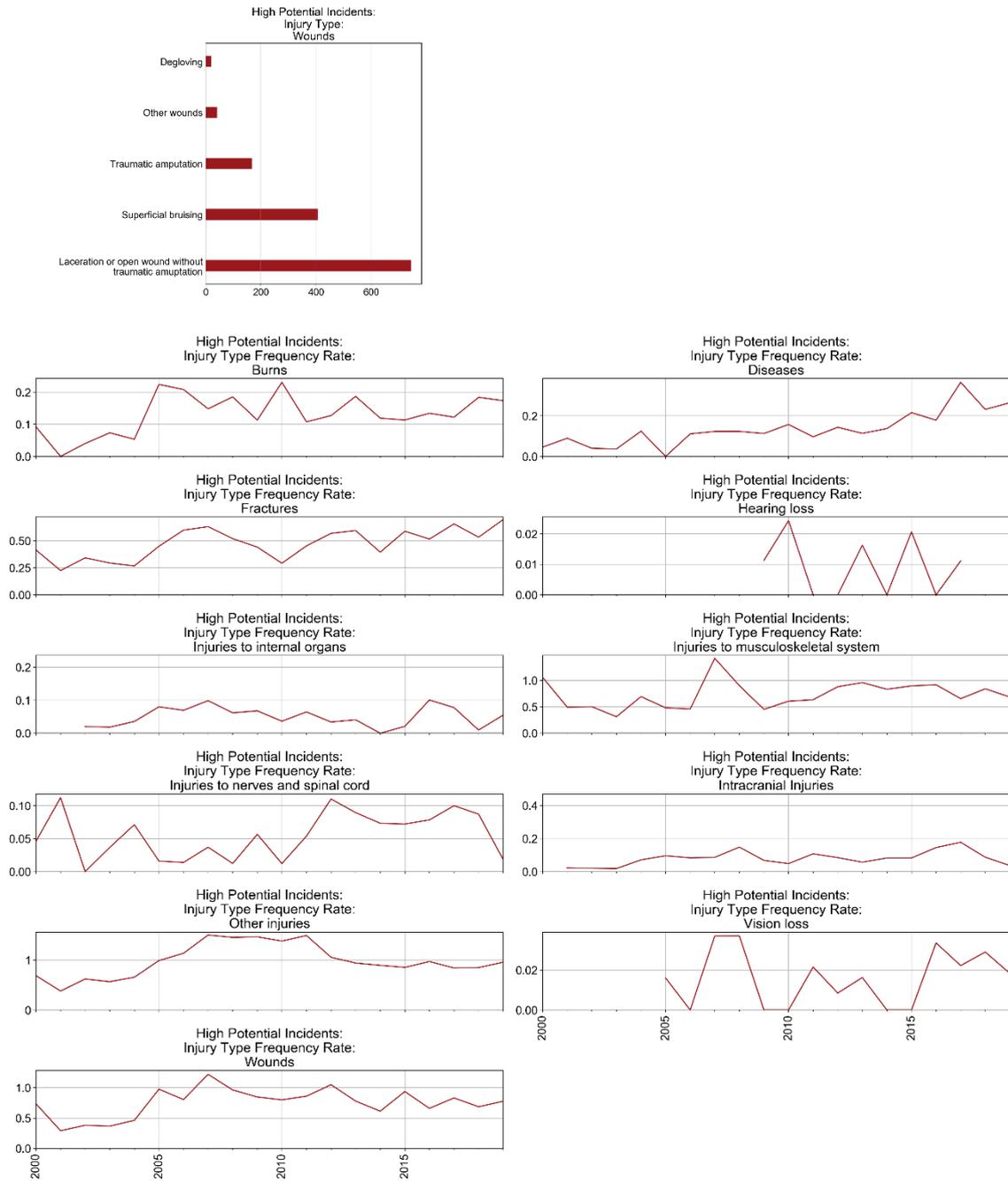
High Potential Incidents:
Injury Type:
Level 1

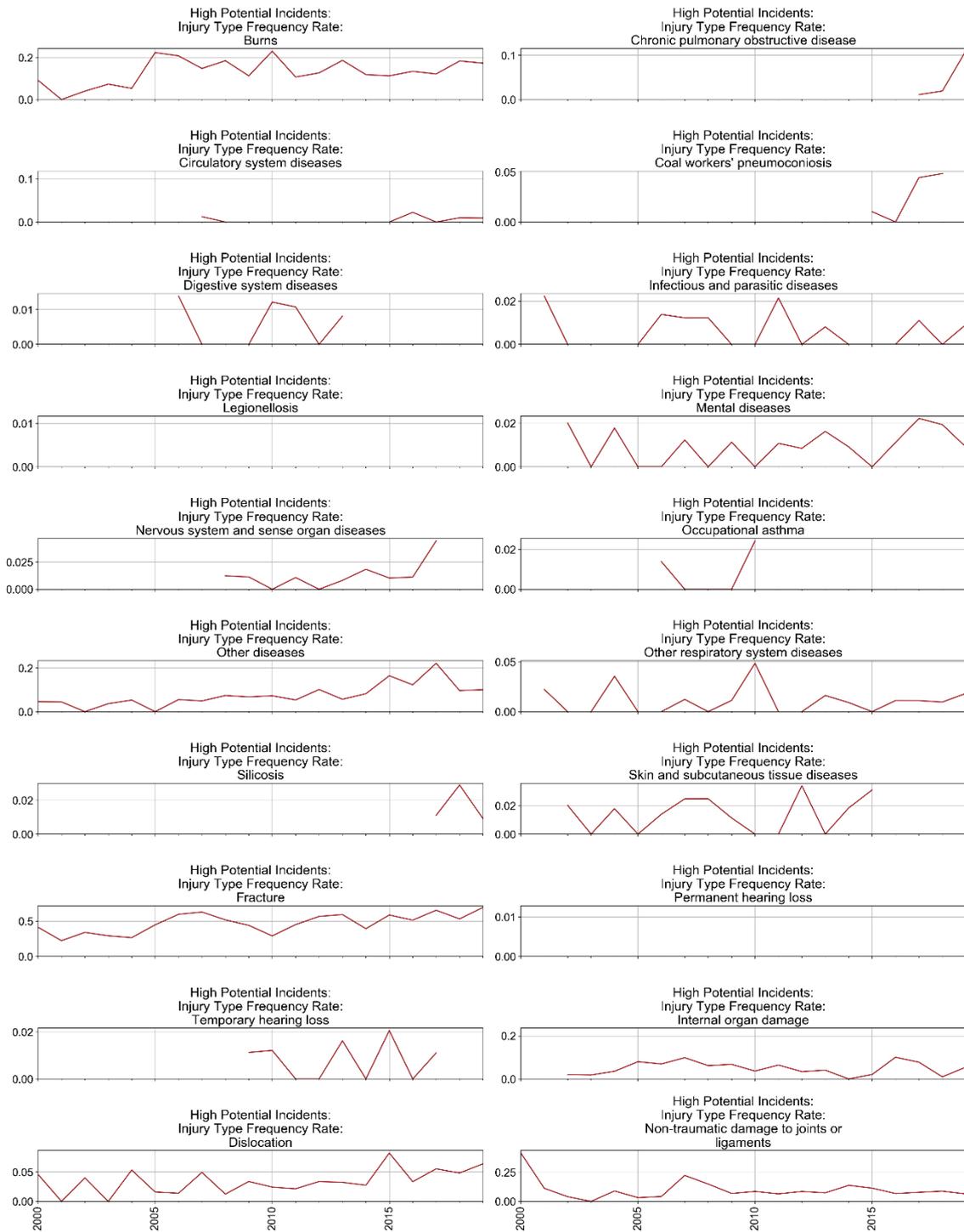


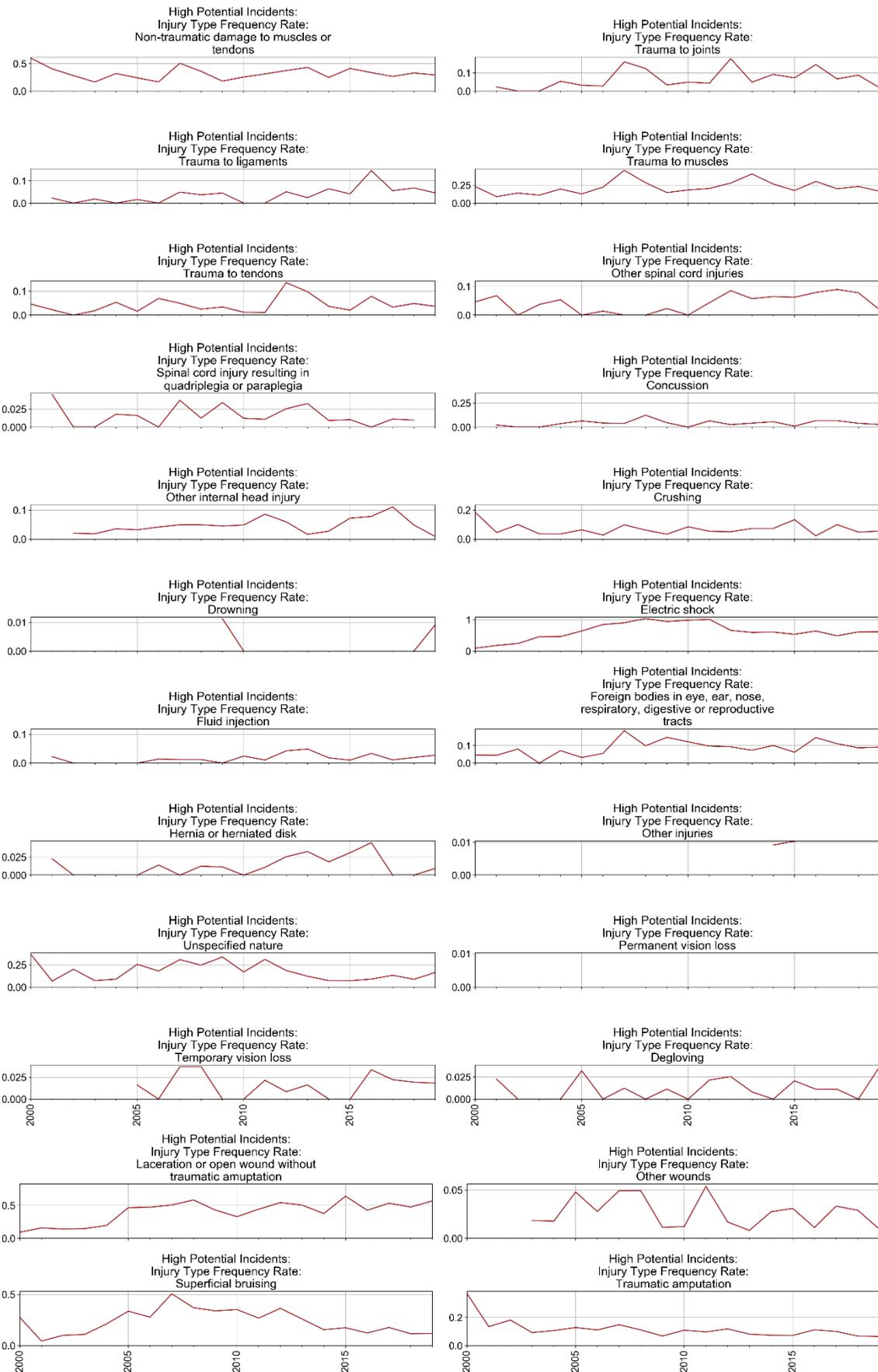
High Potential Incidents:
Injury Type:
Level 2

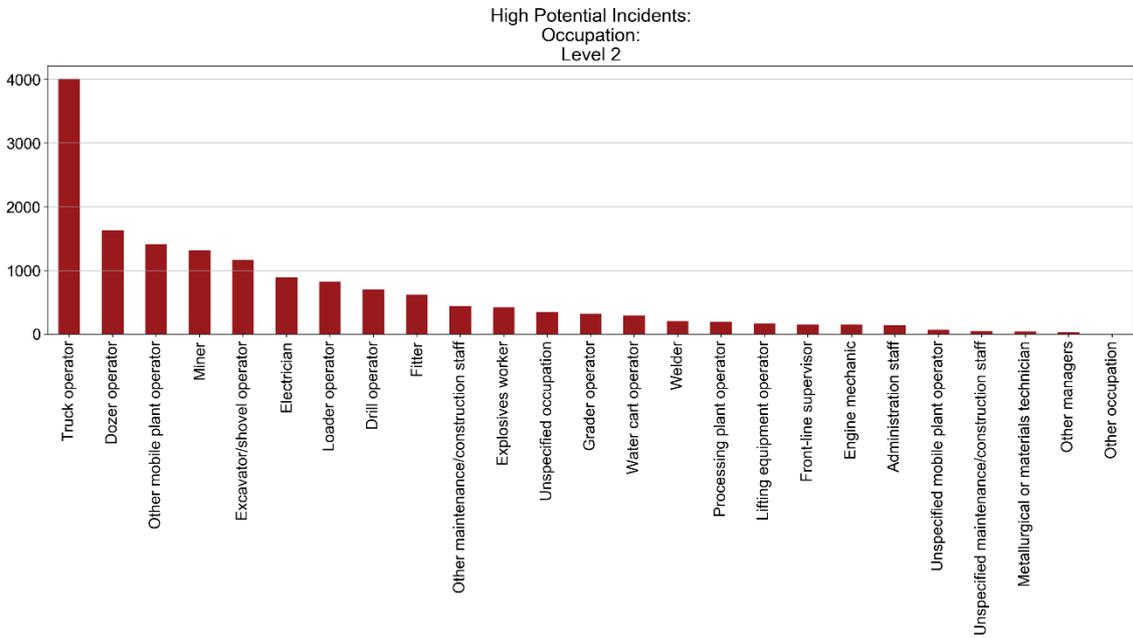
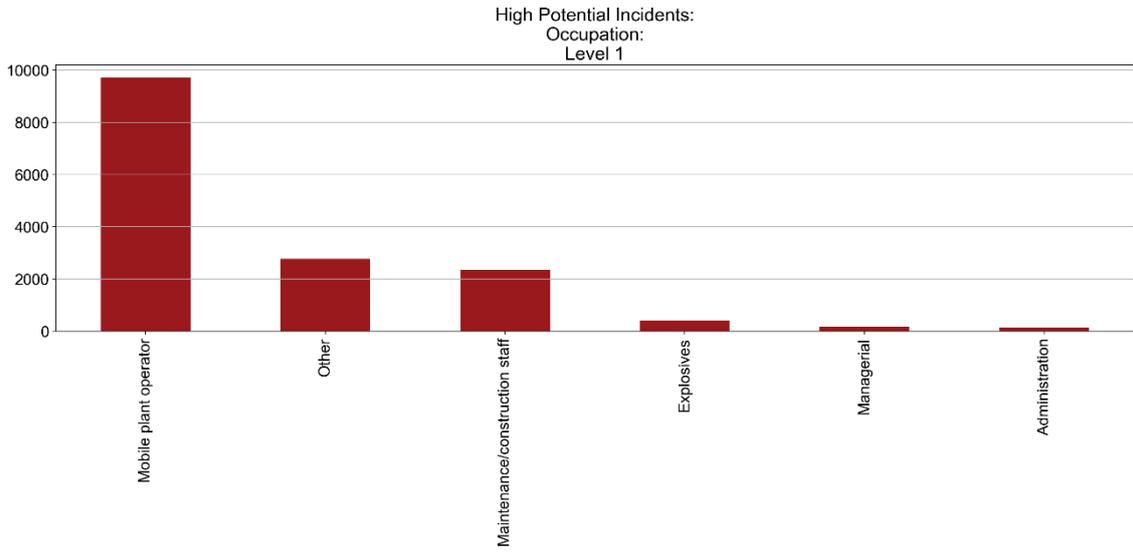


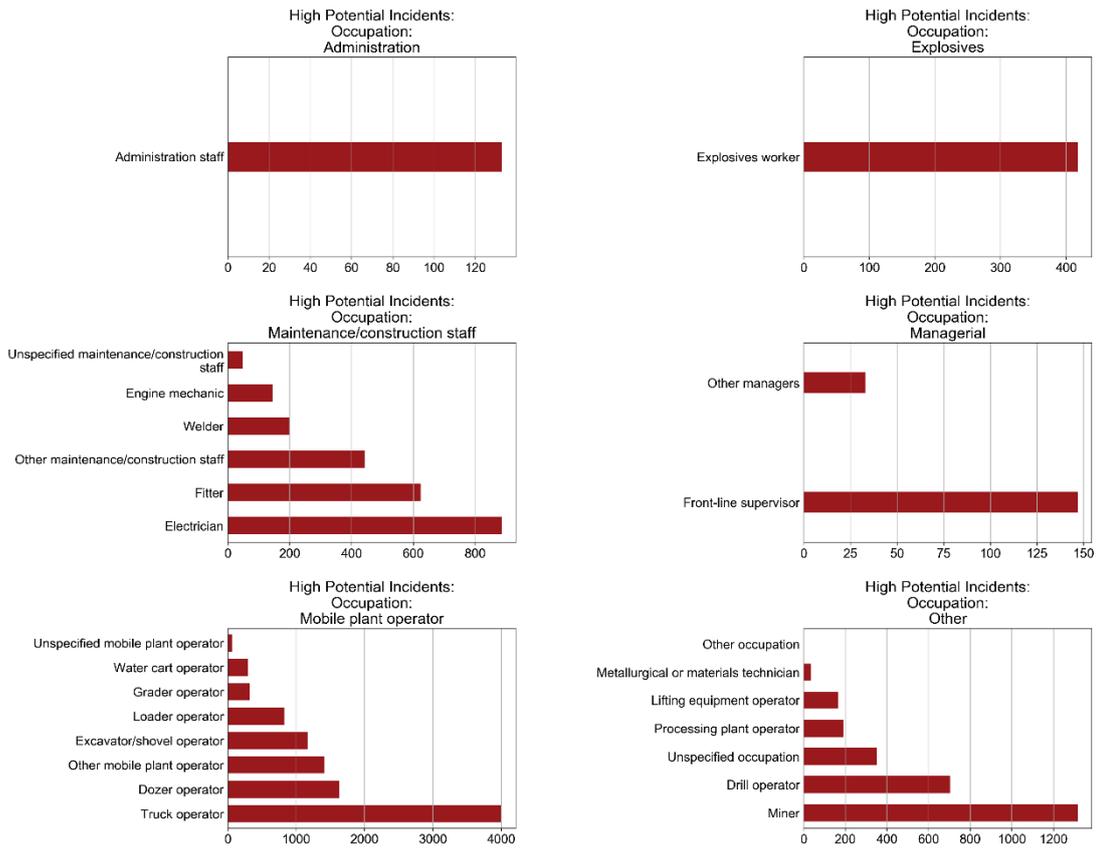


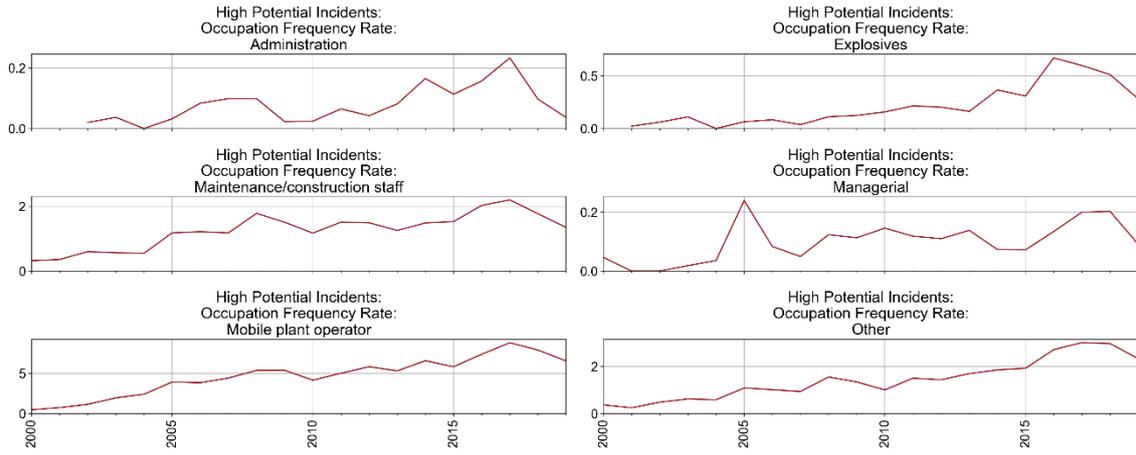


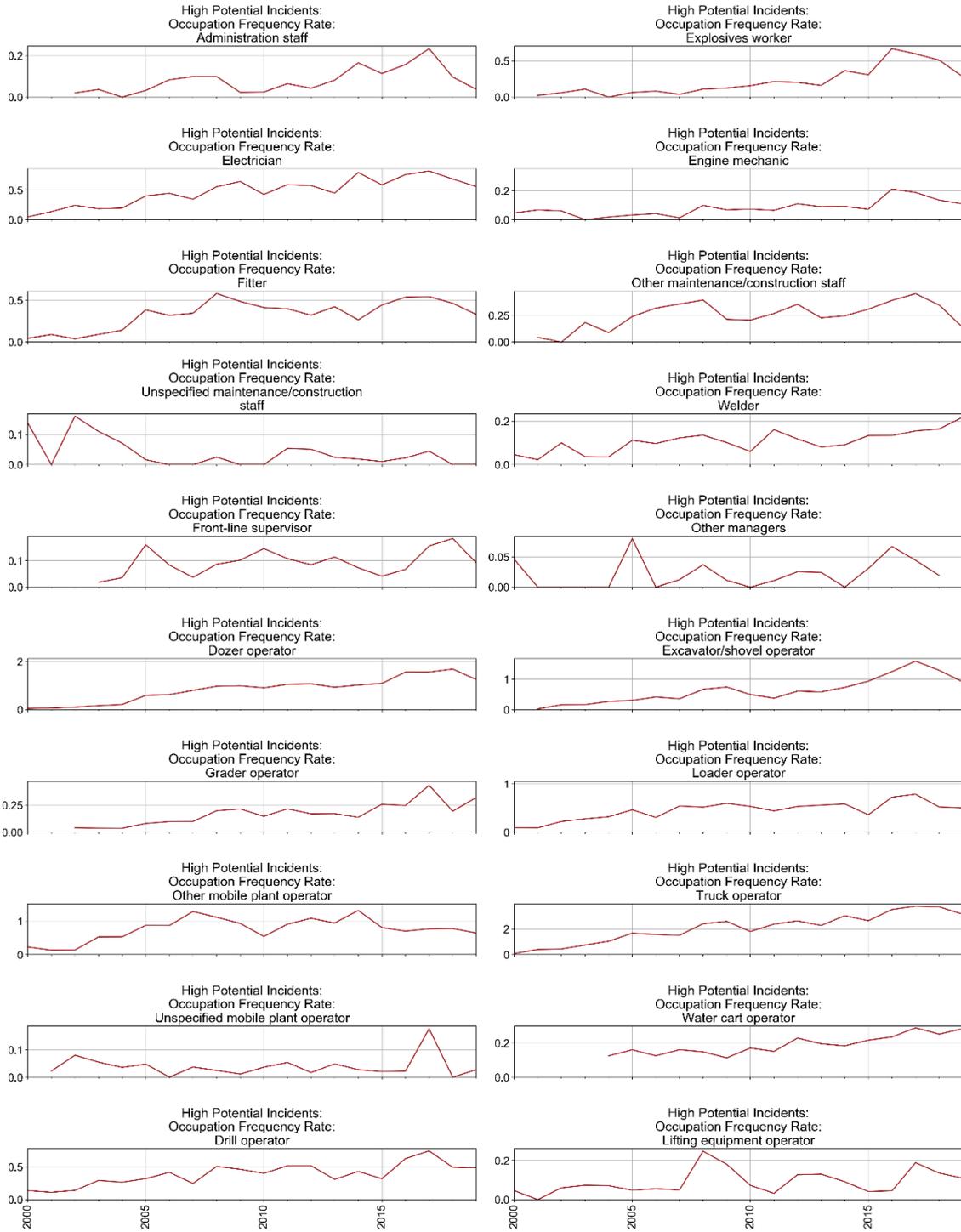


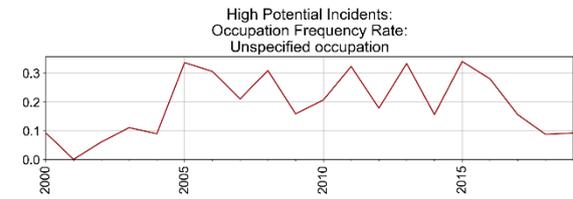
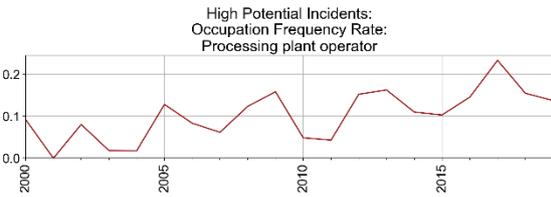
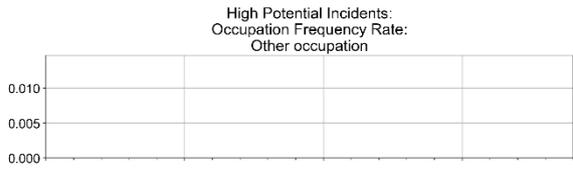
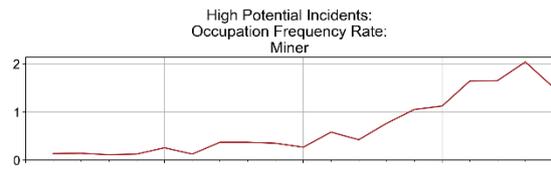
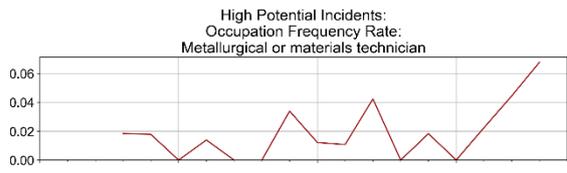




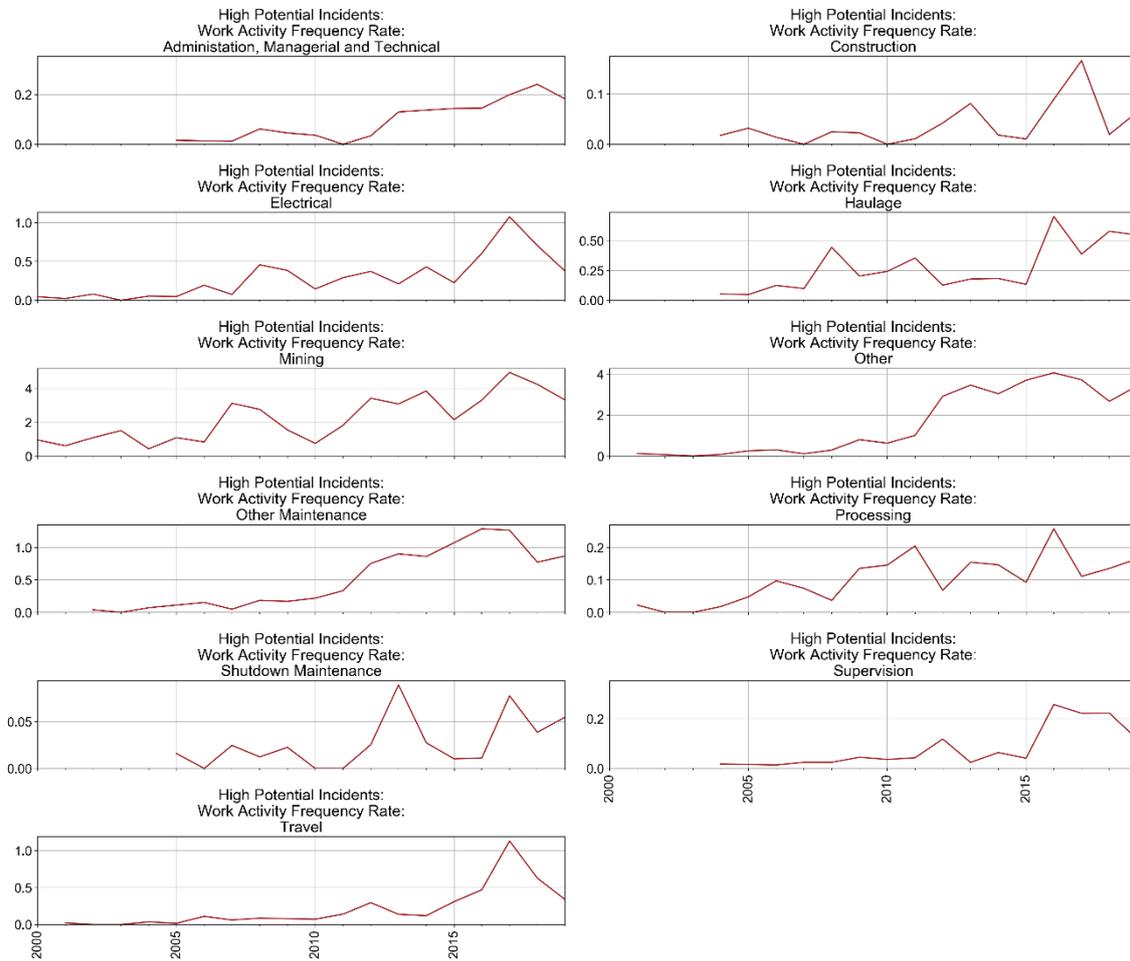
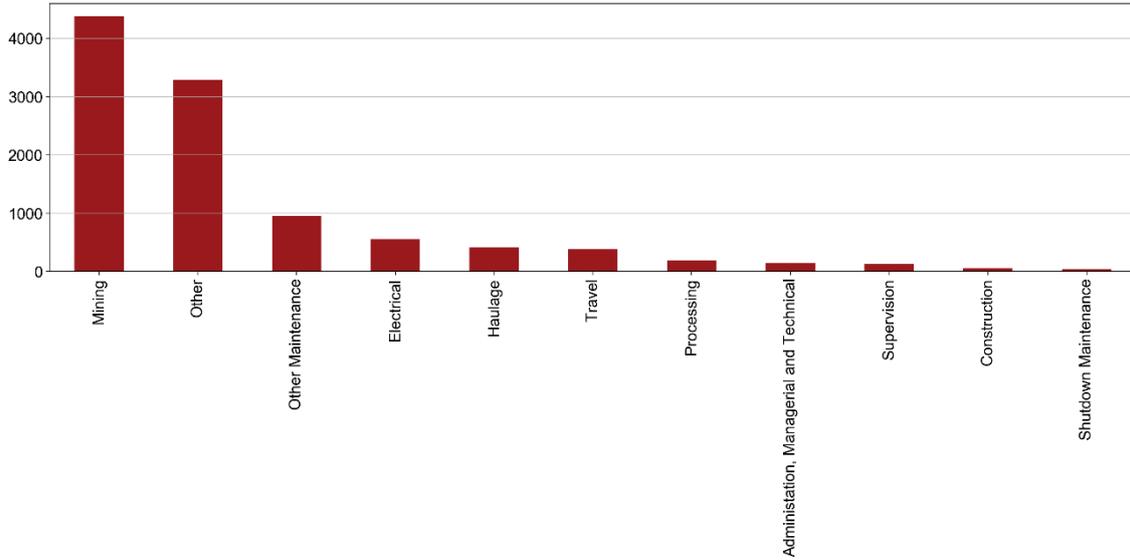


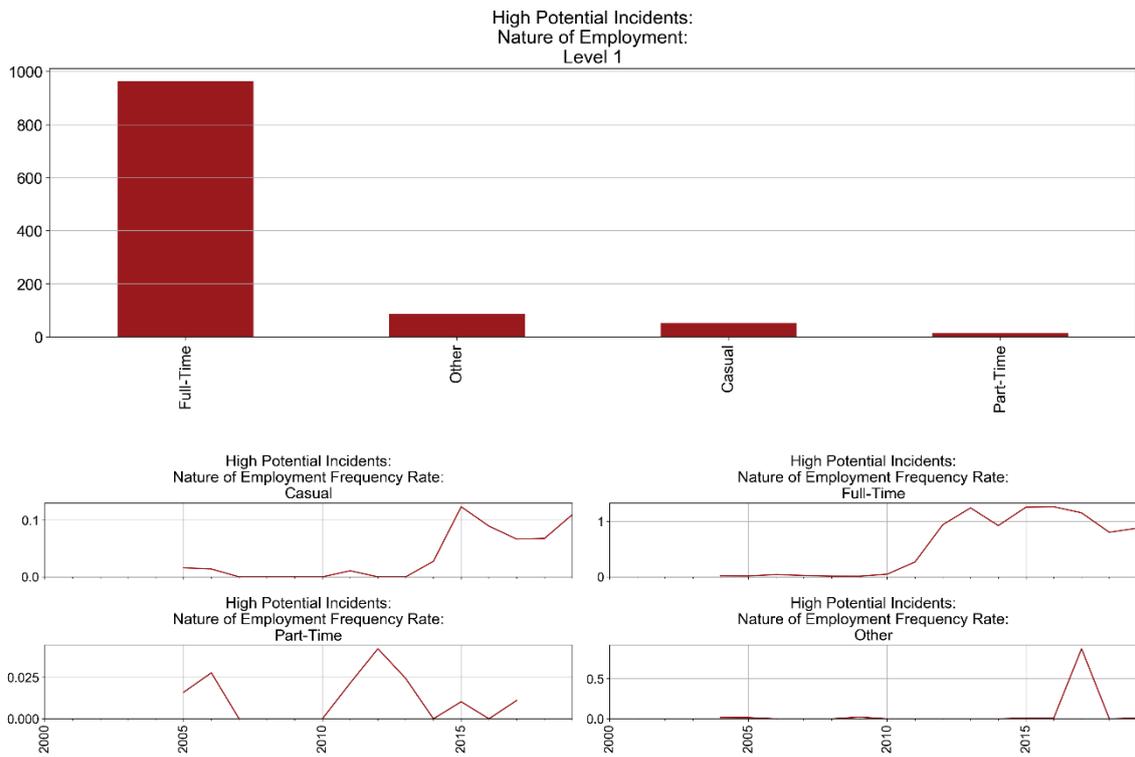




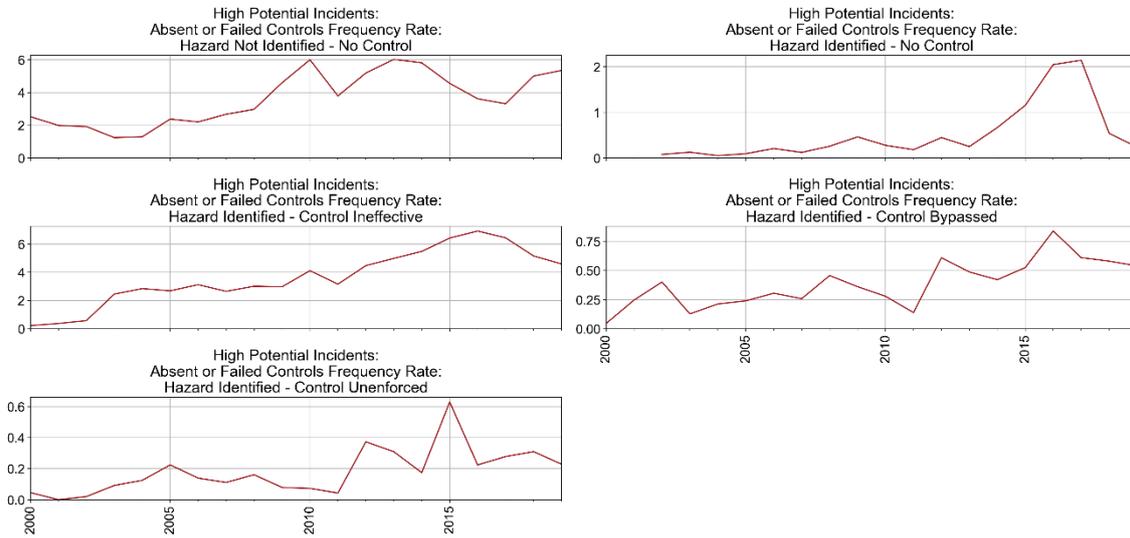
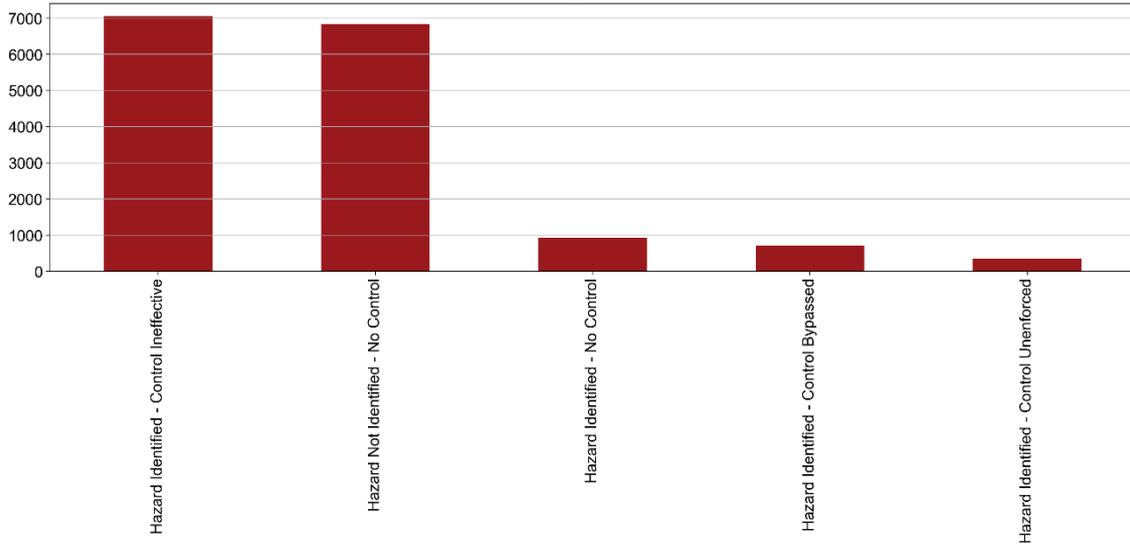


High Potential Incidents:
Work Activity:
Level 1

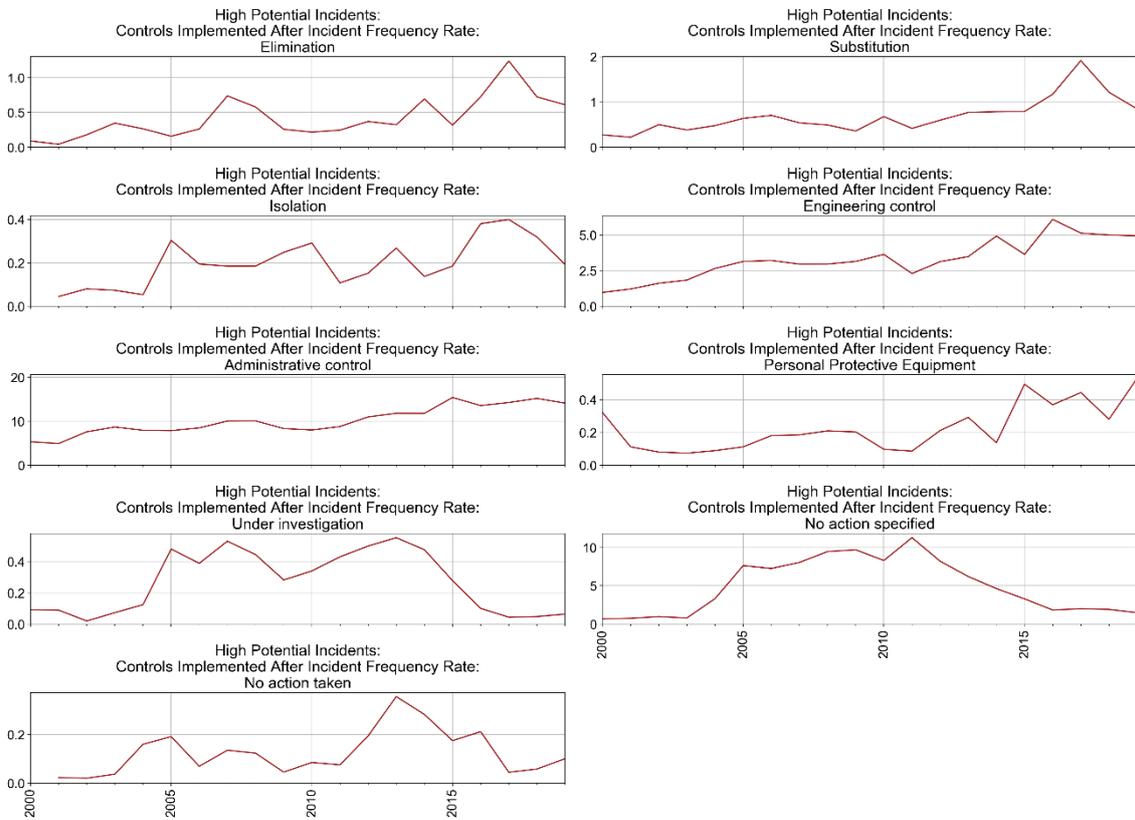
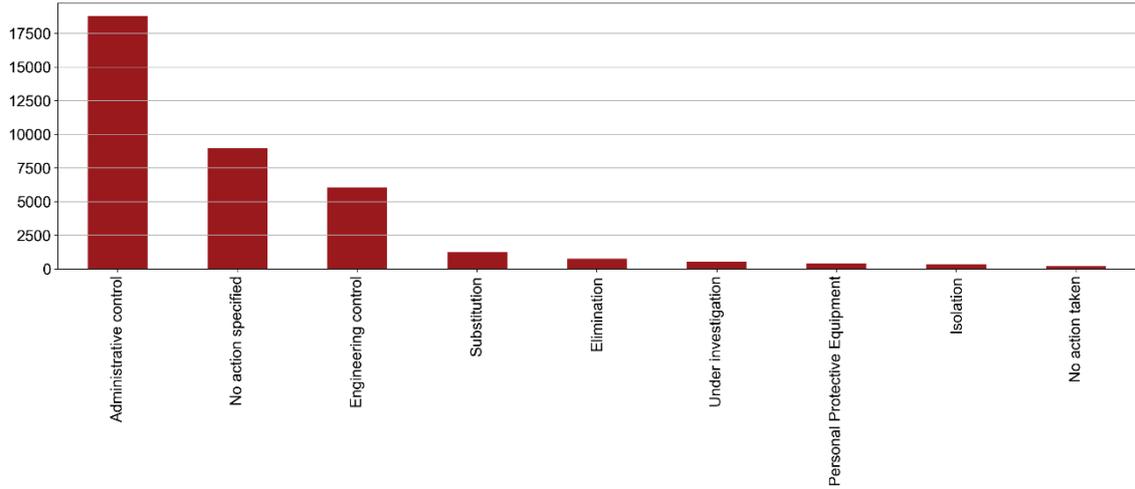




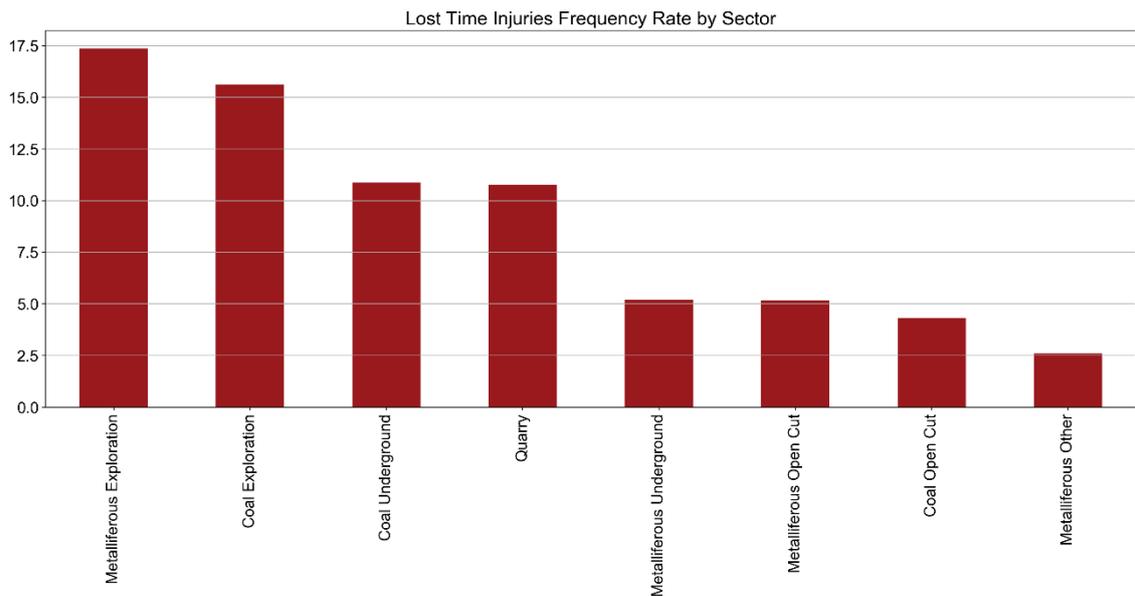
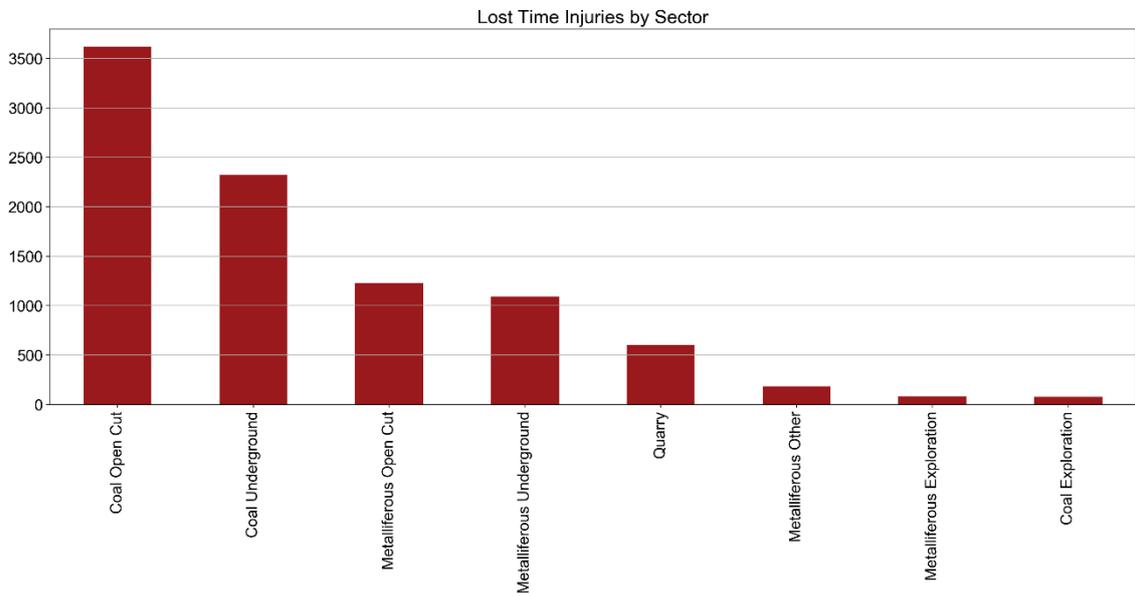
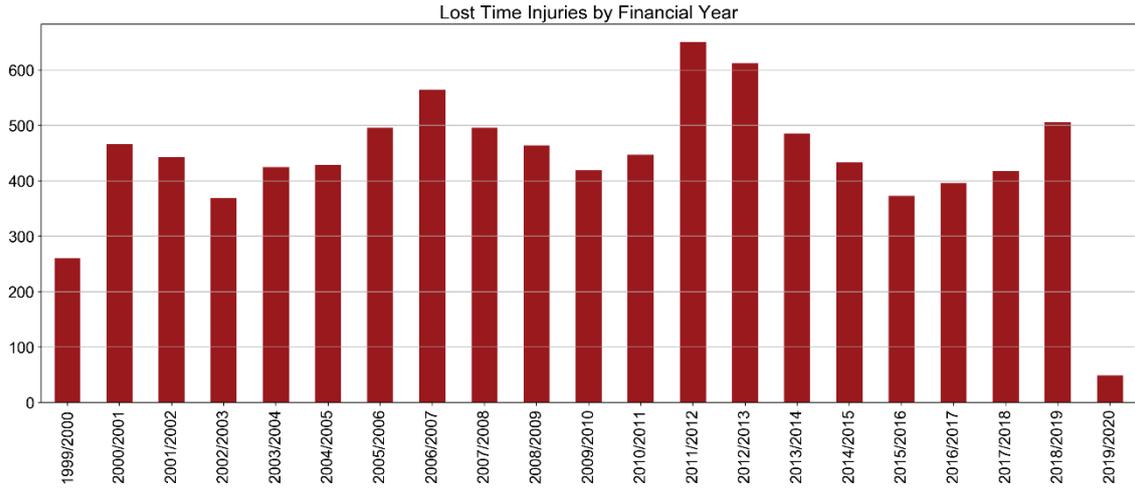
High Potential Incidents:
Absent or Failed Controls:
Level 1



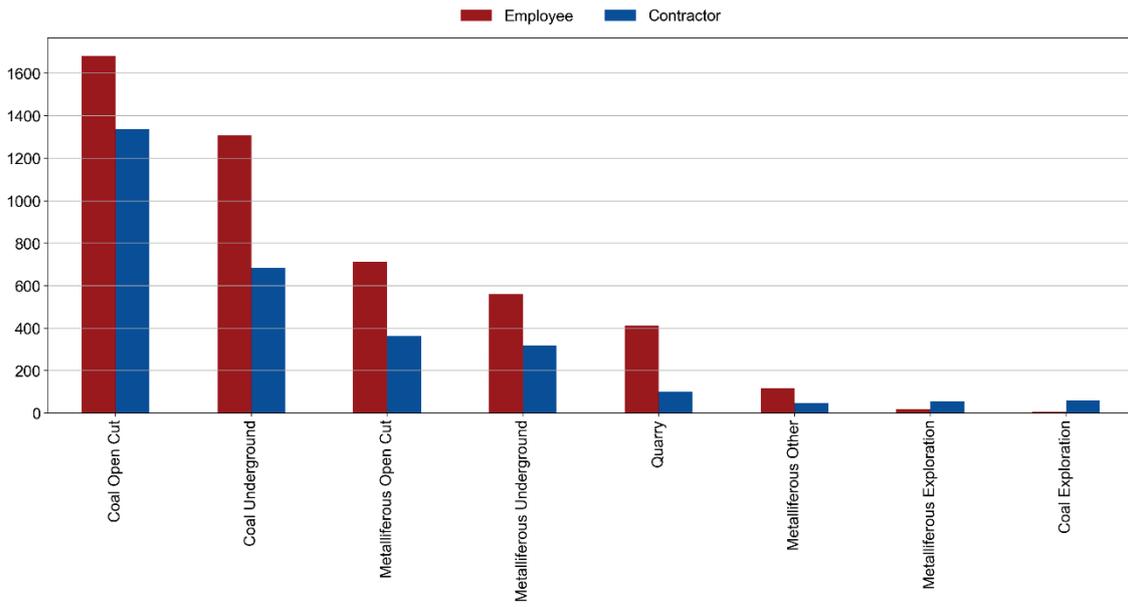
High Potential Incidents:
Controls Implemented After Incident:
Level 1



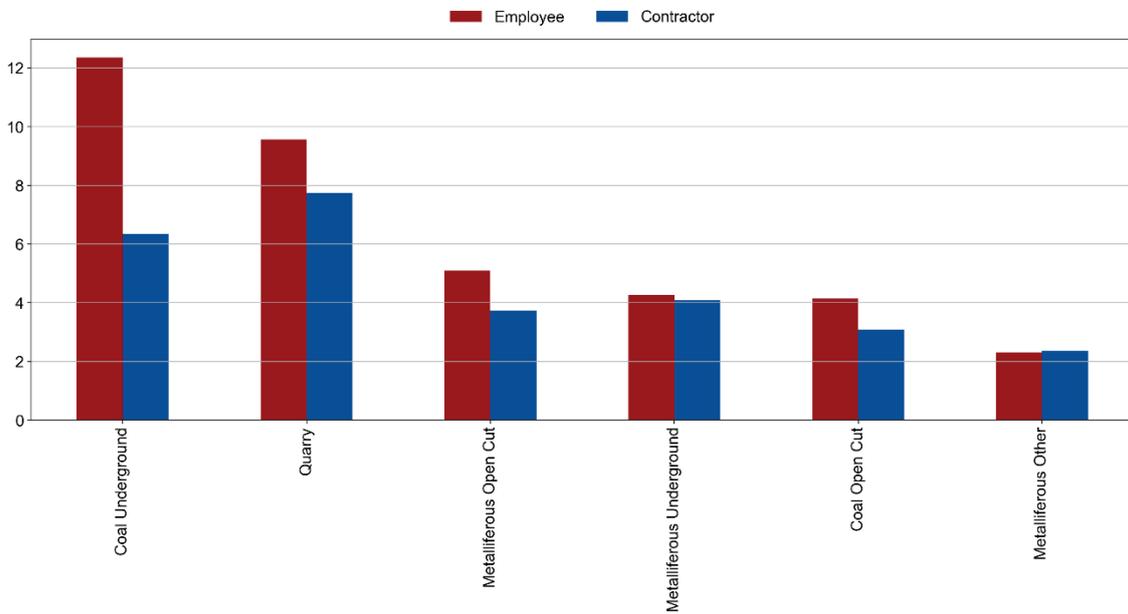
Lost Time Injuries (LTIs)

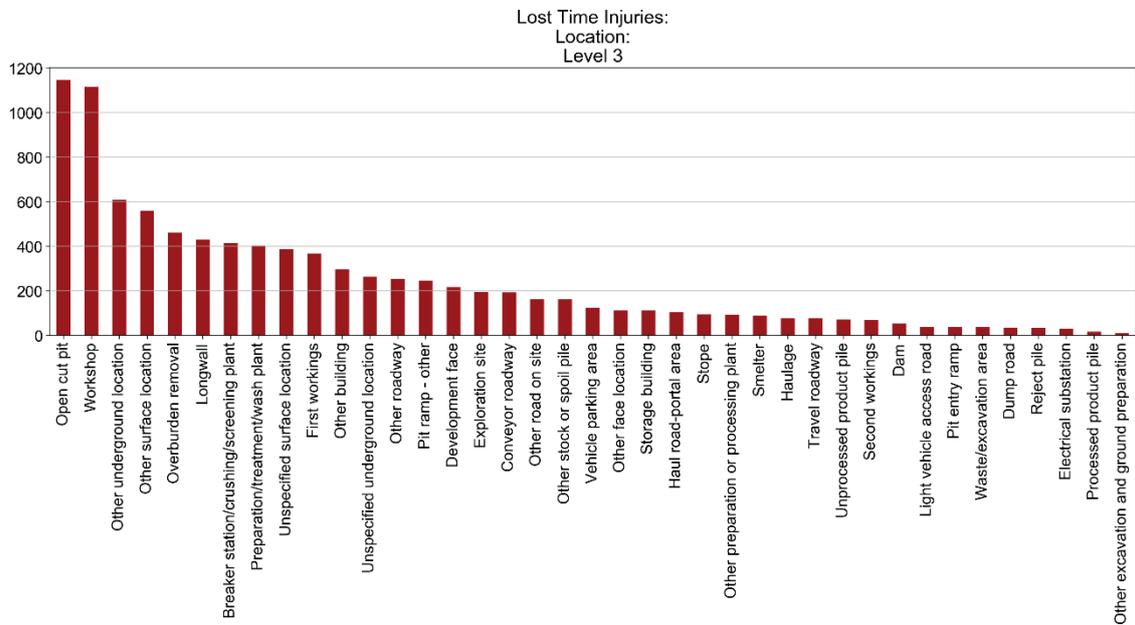
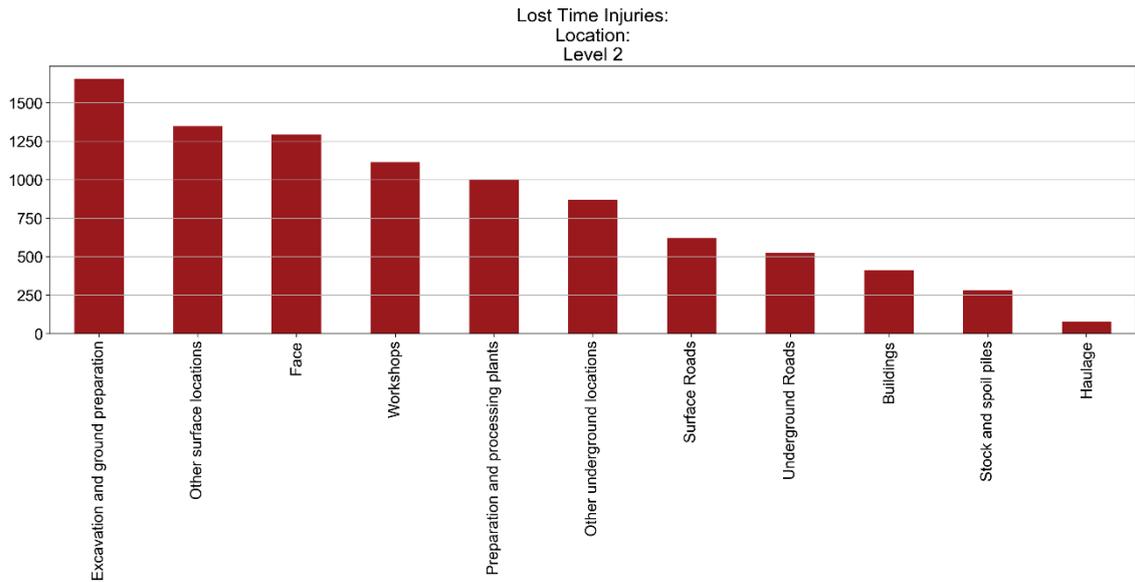
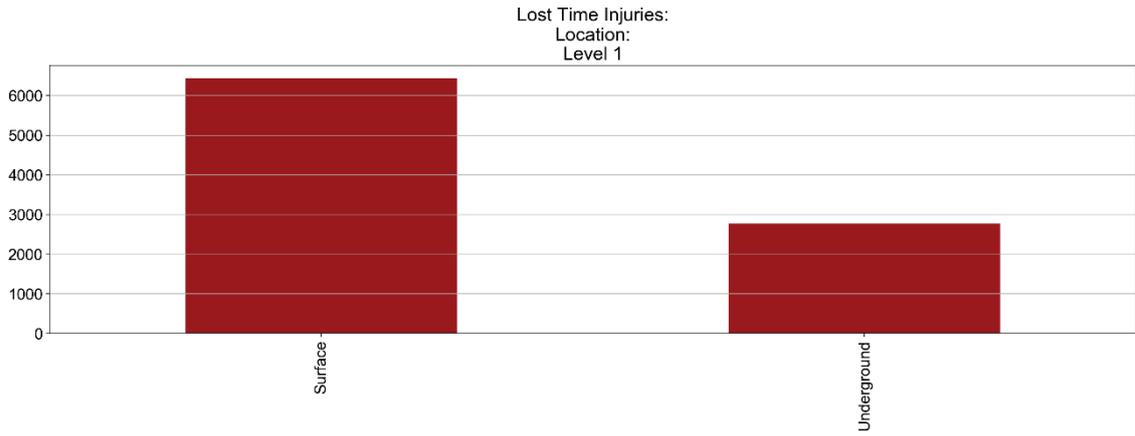


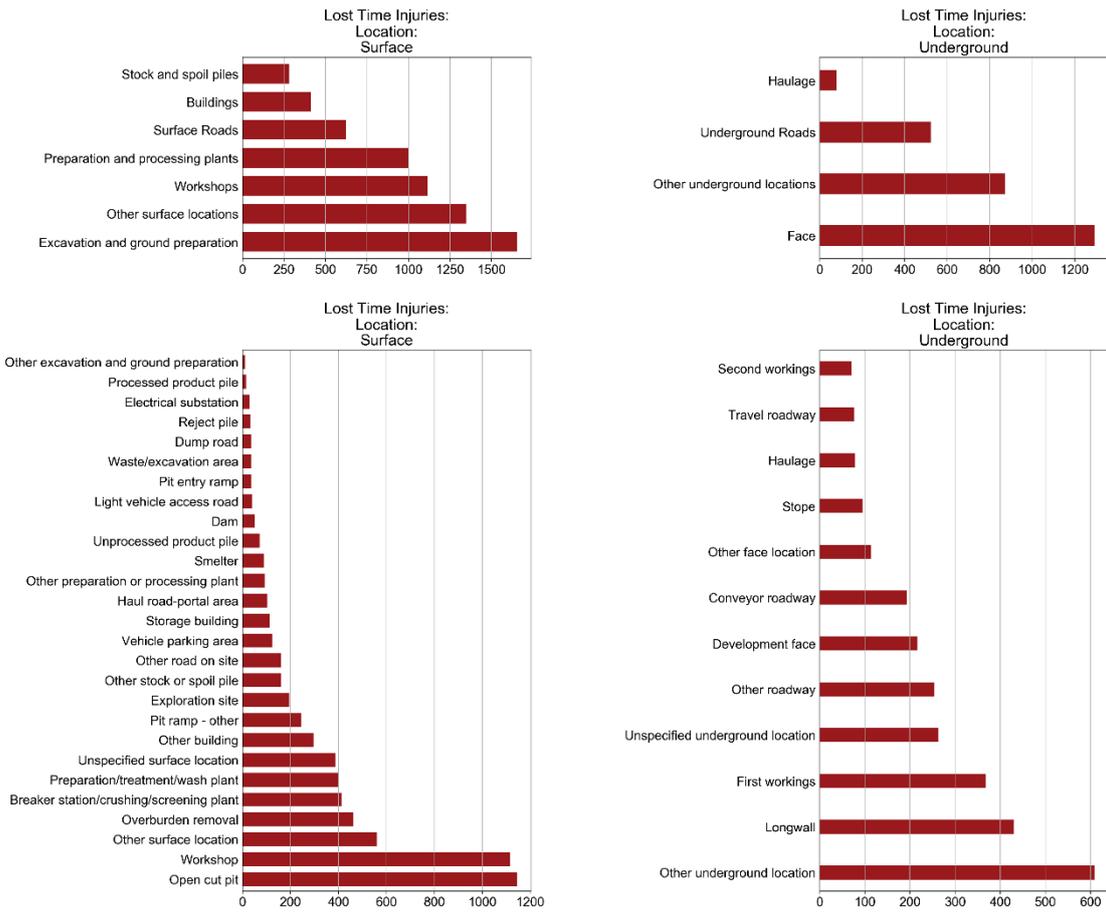
Lost Time Injuries by Sector by Worker Type

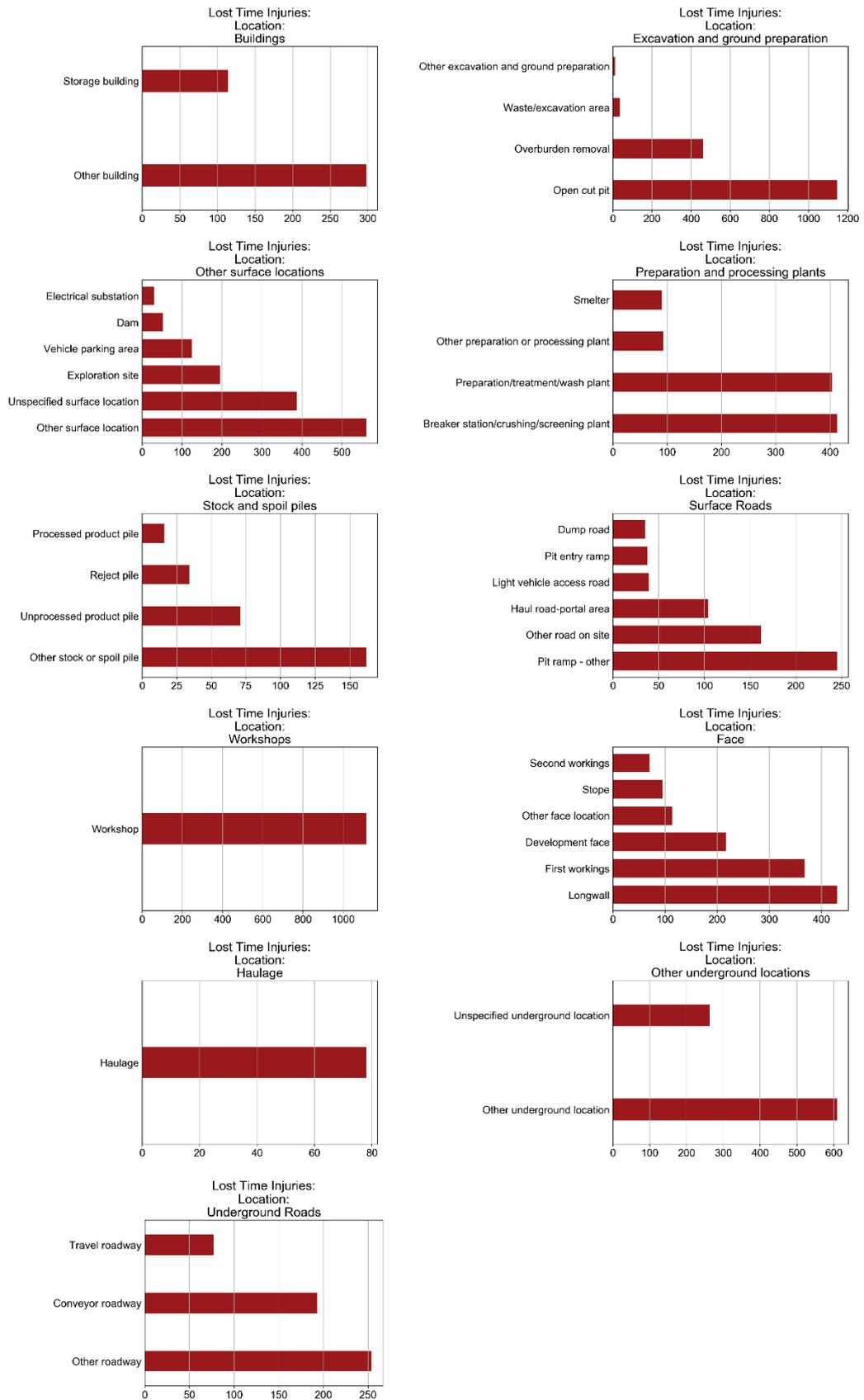


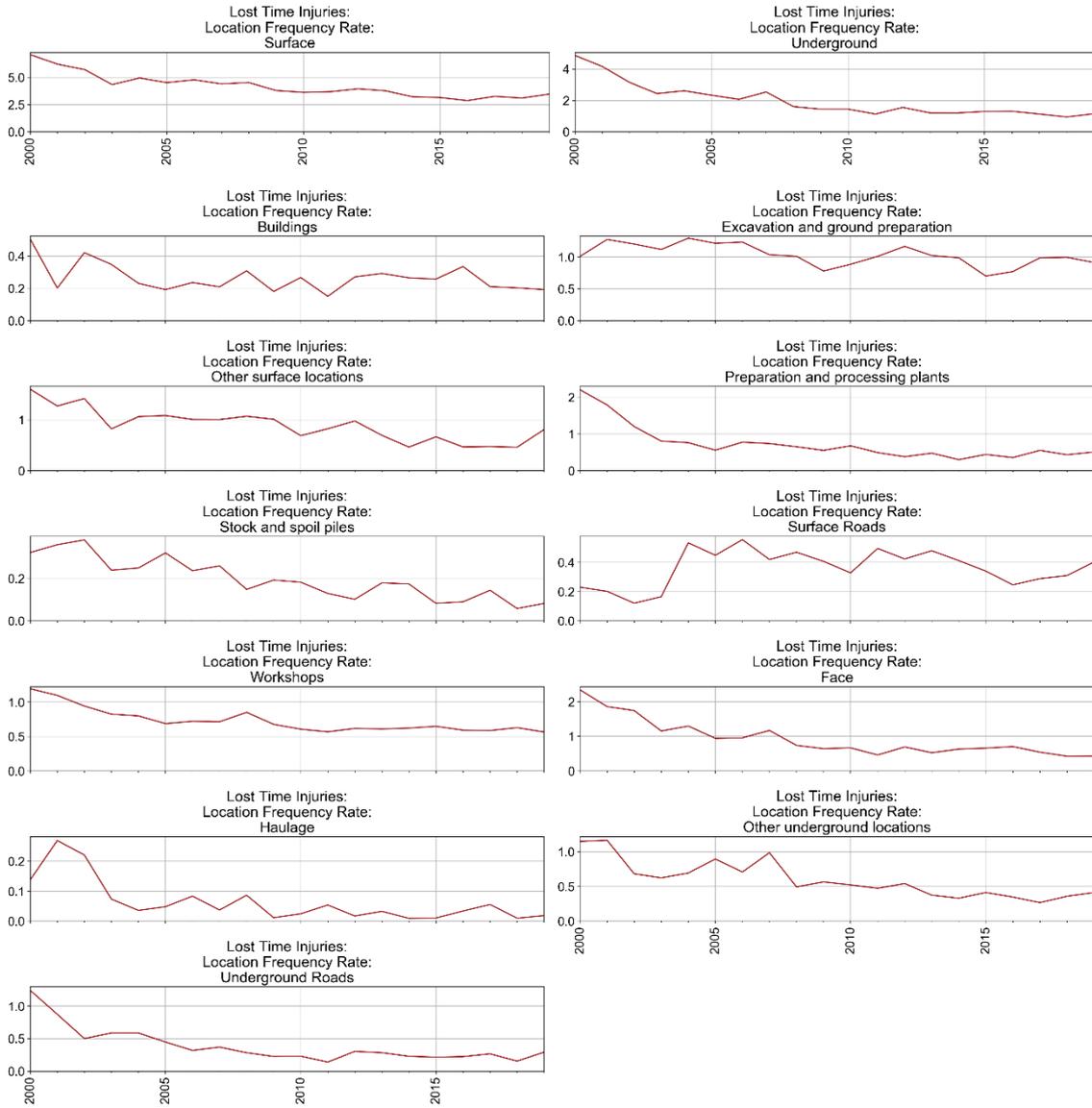
Lost Time Injuries Frequency Rate by Sector by Worker Type



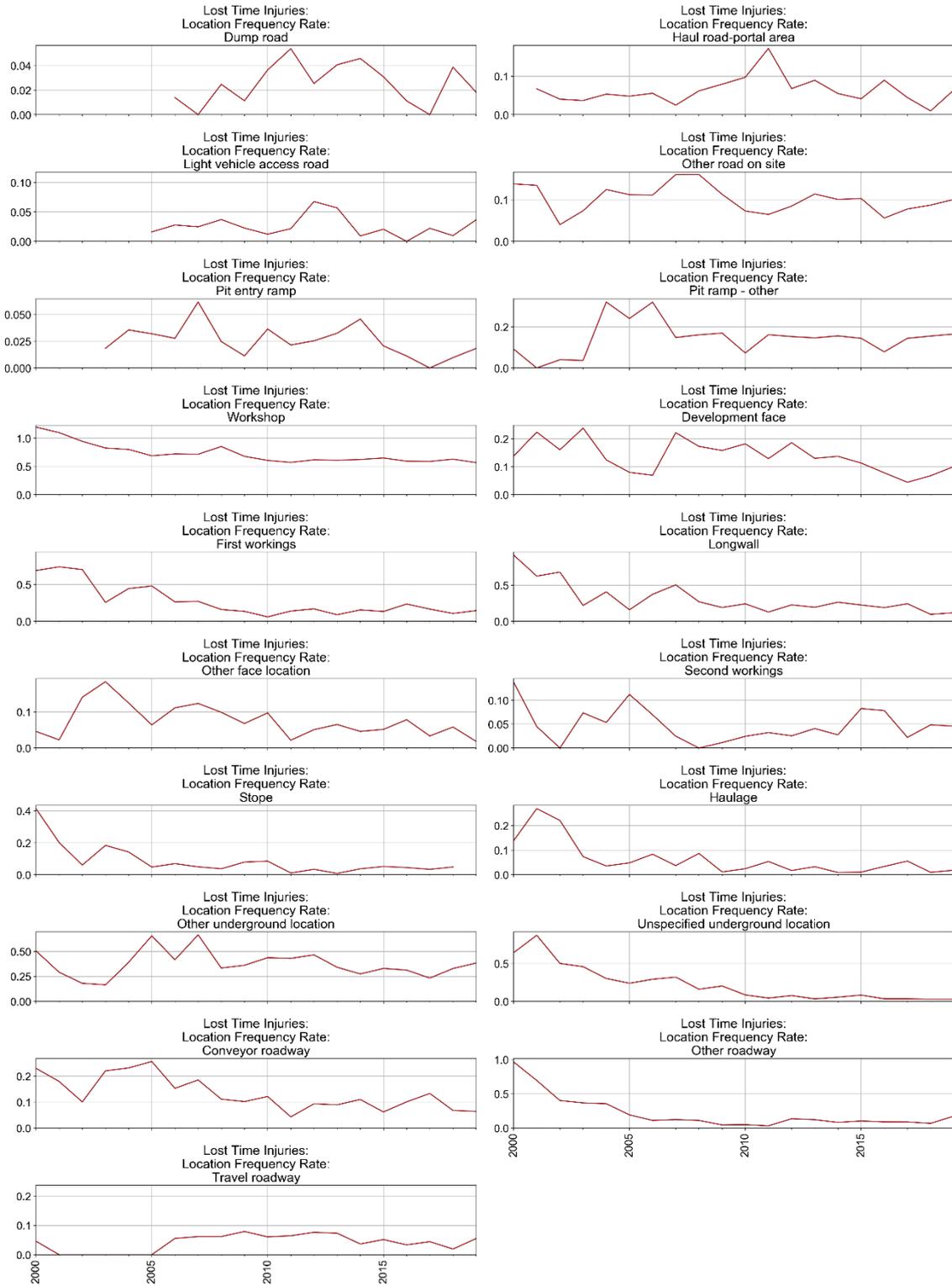




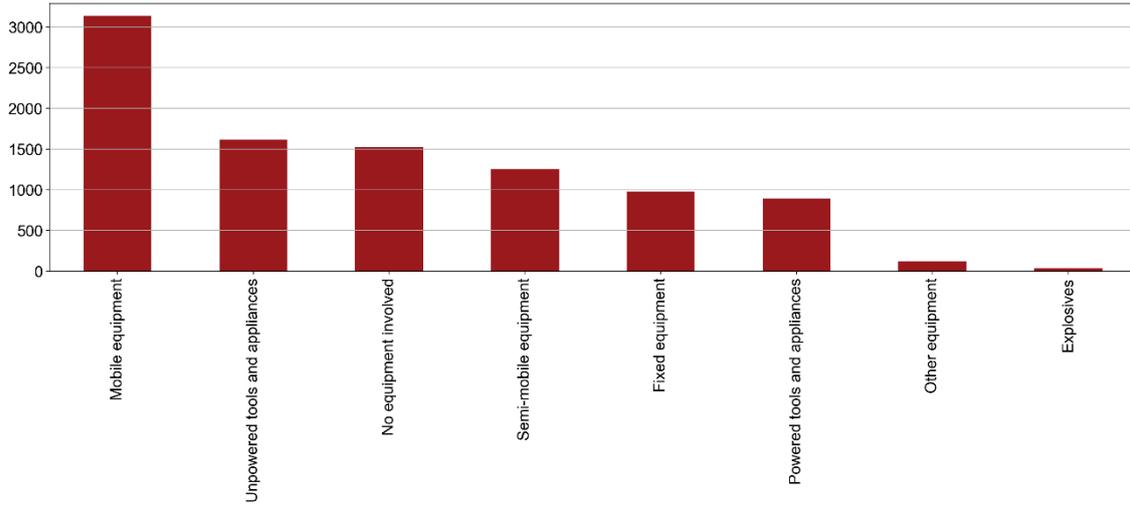




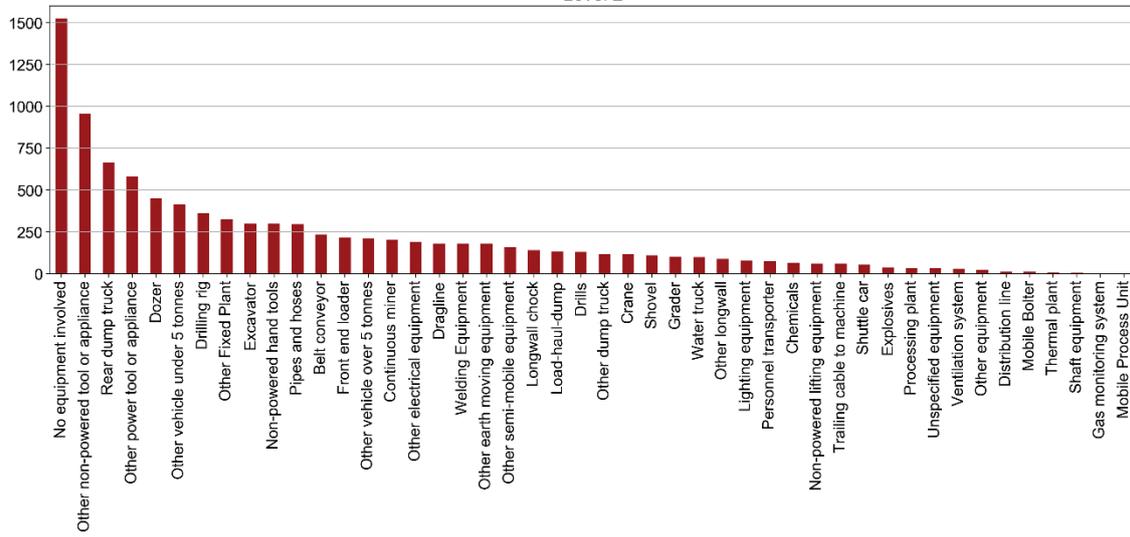


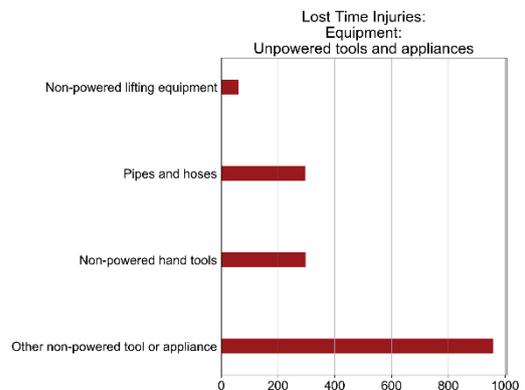
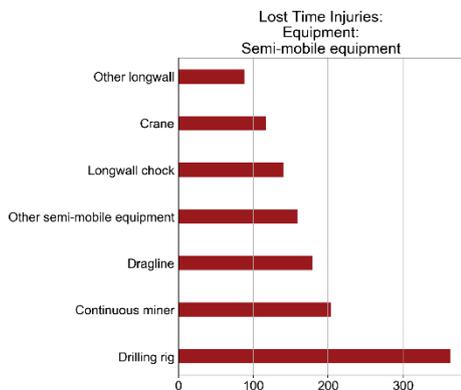
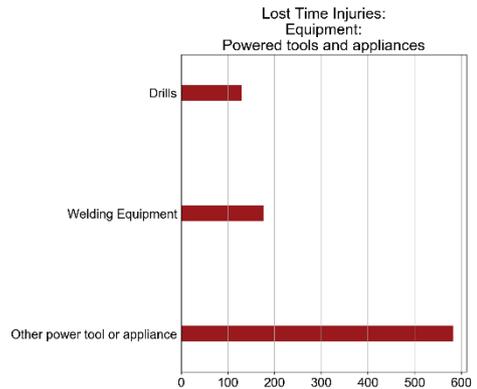
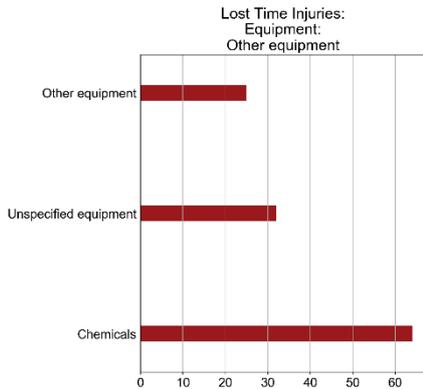
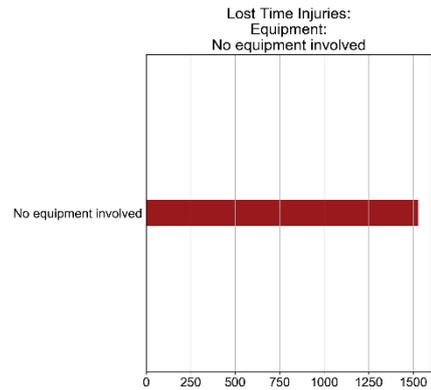
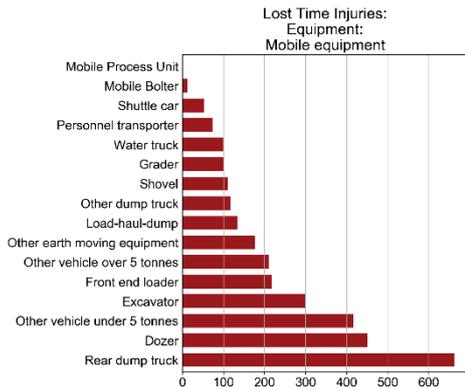
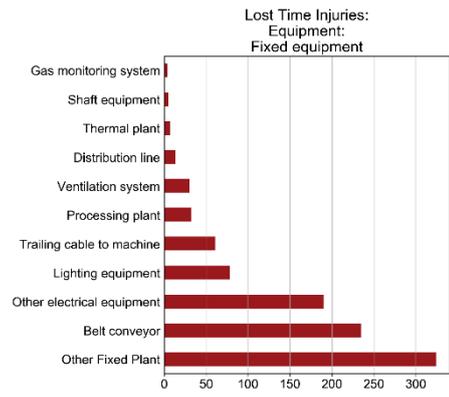
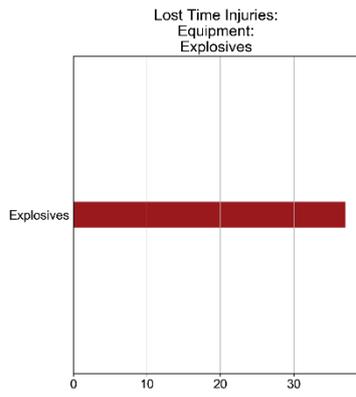


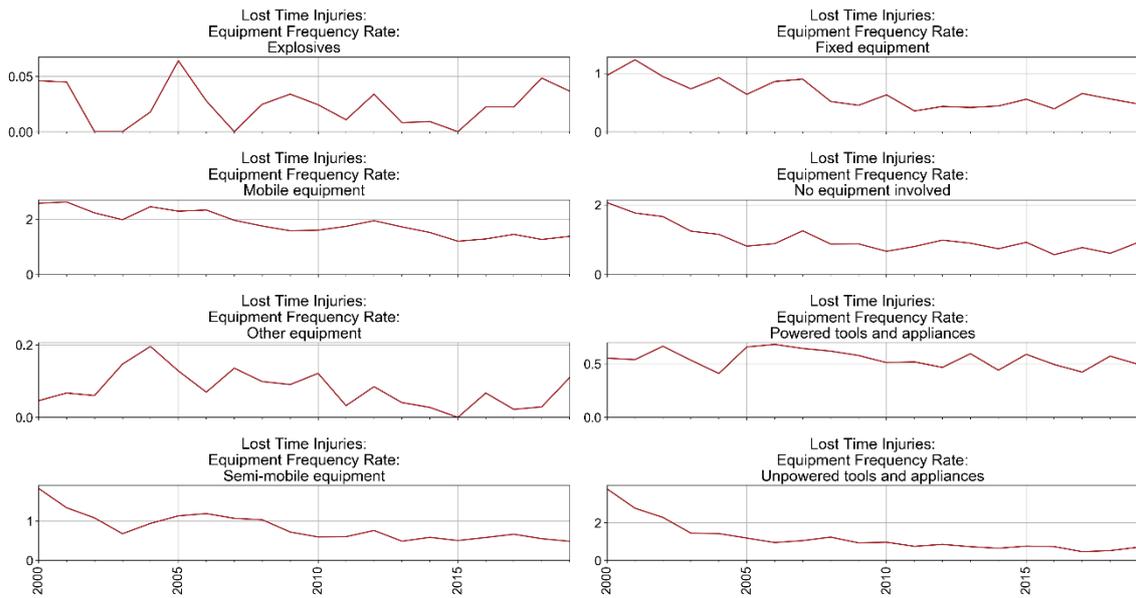
Lost Time Injuries:
Equipment:
Level 1



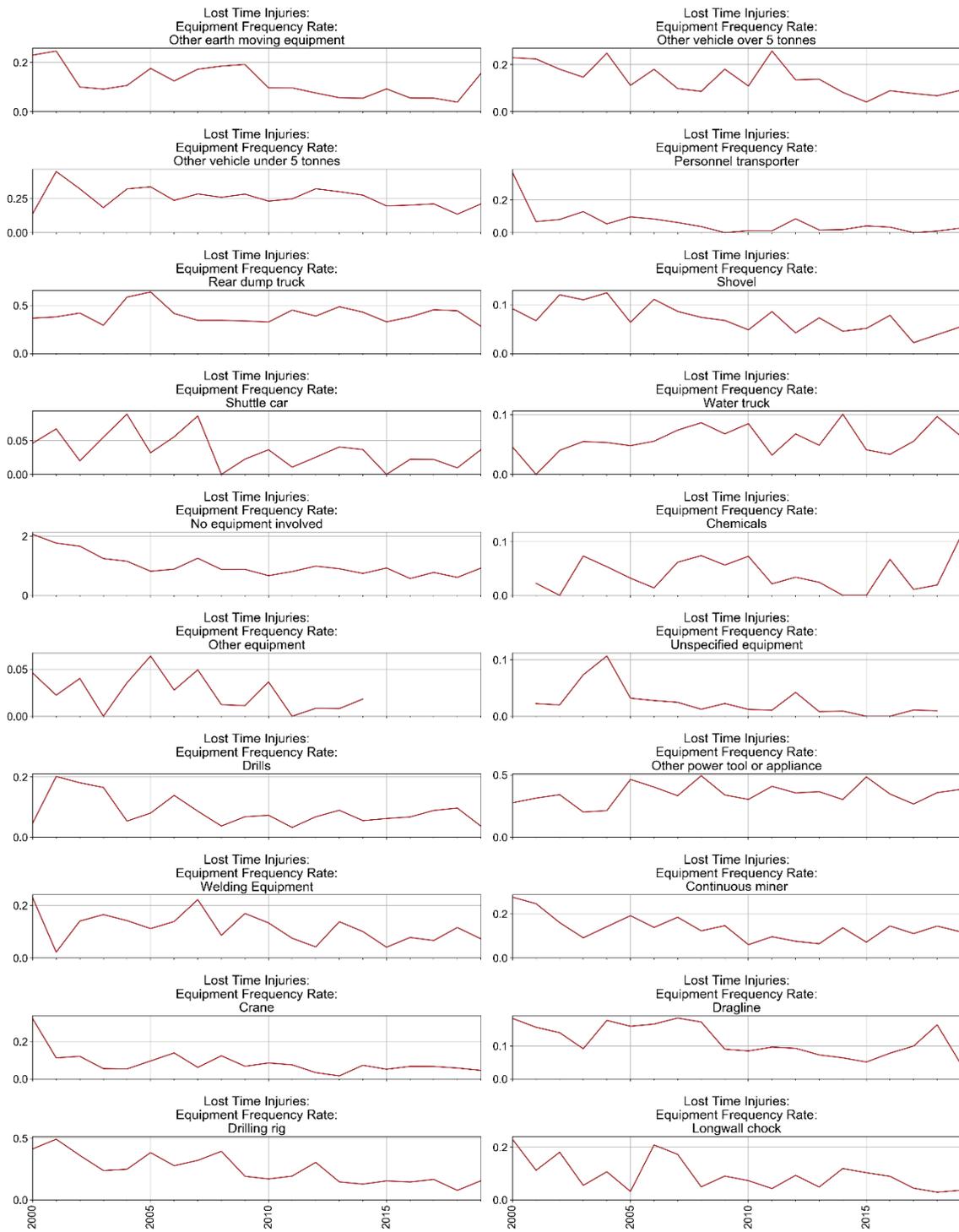
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Equipment:
Level 2

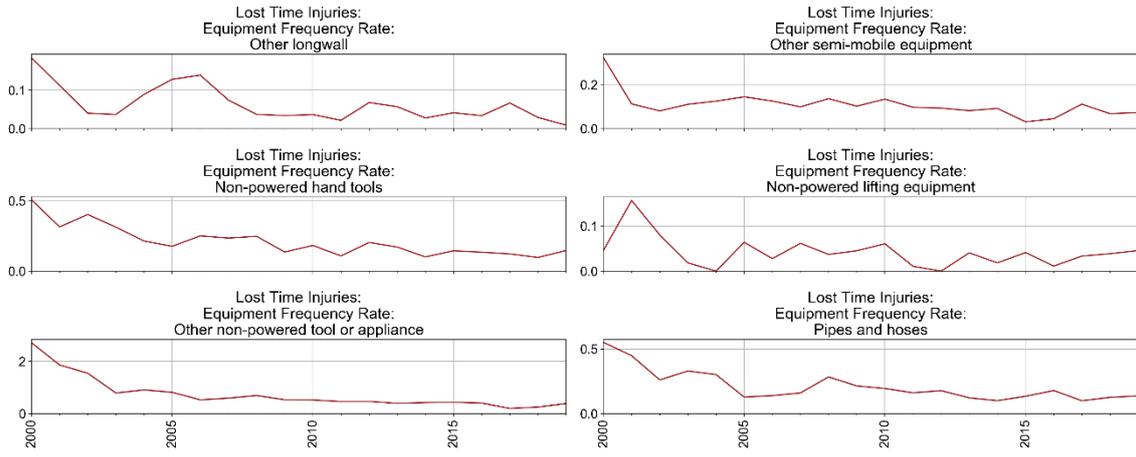




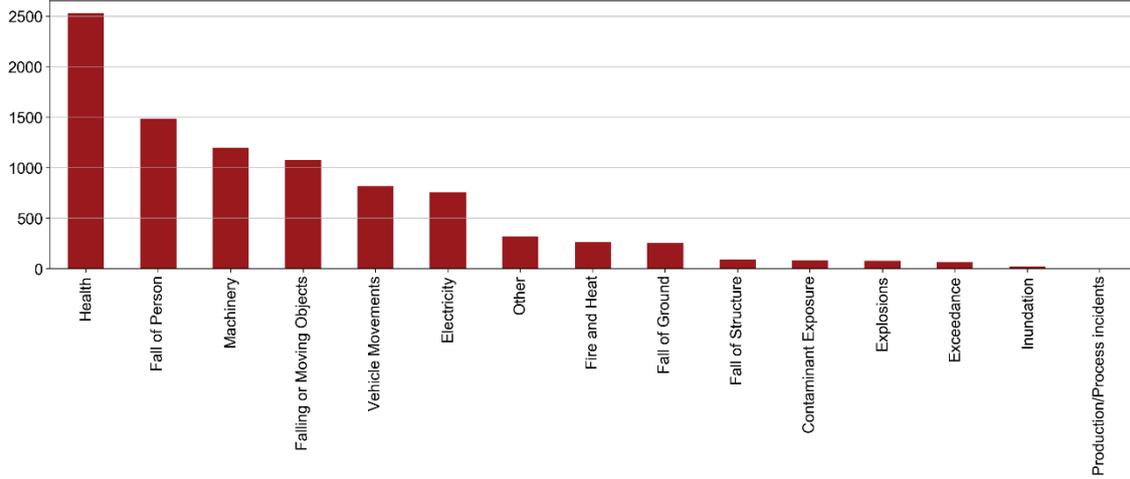




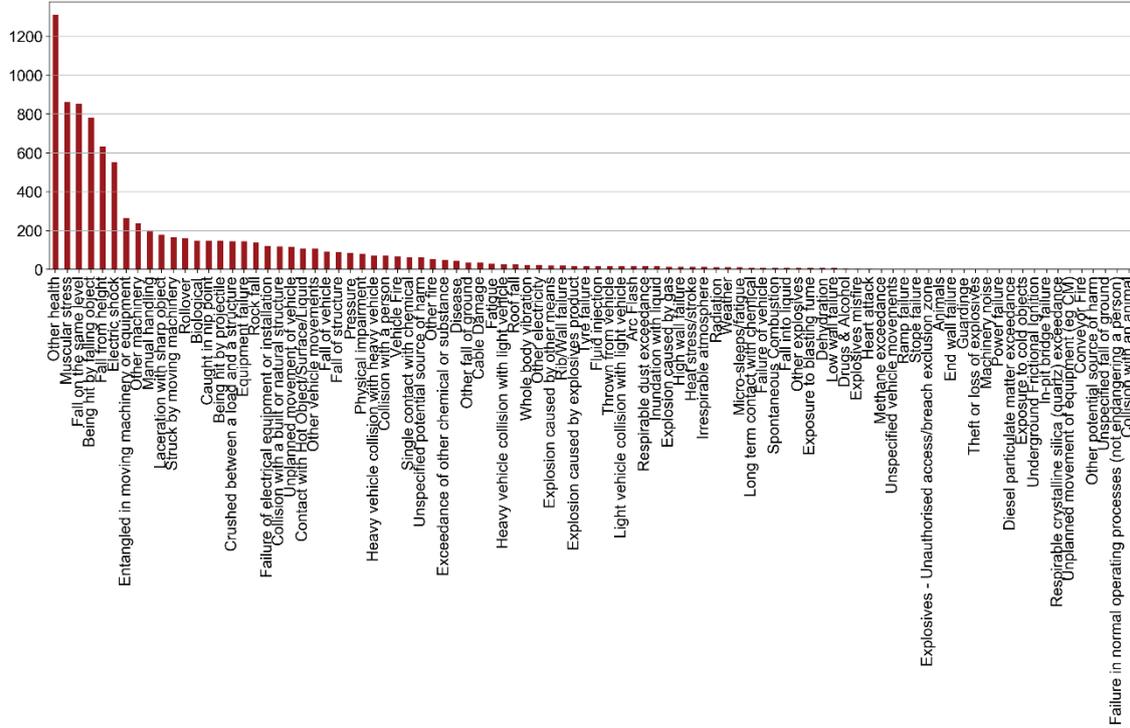


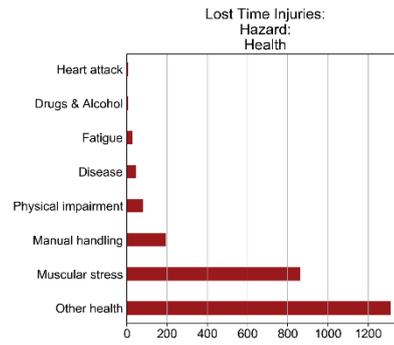
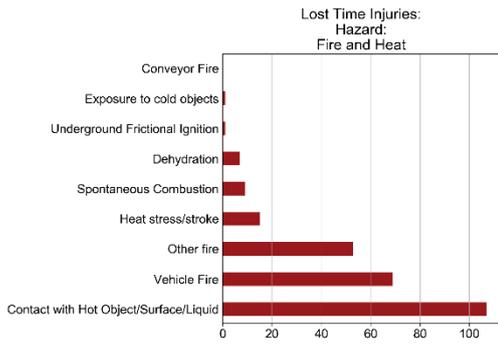
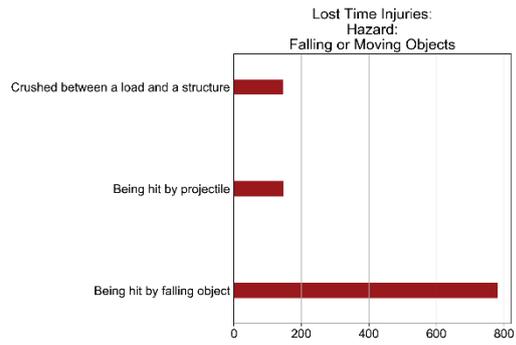
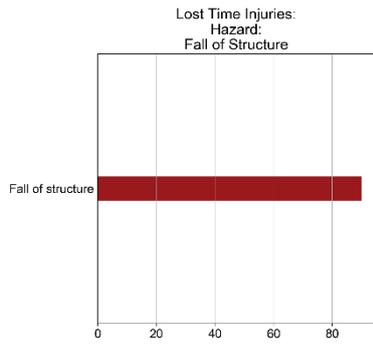
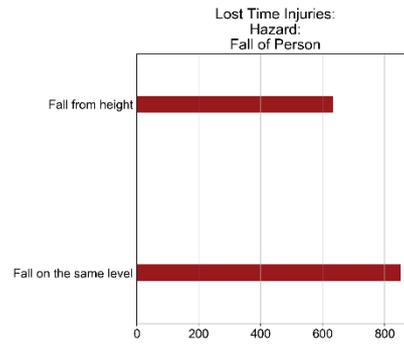
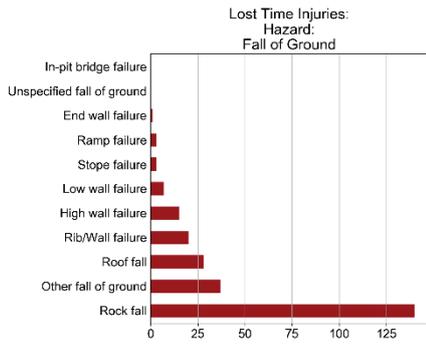
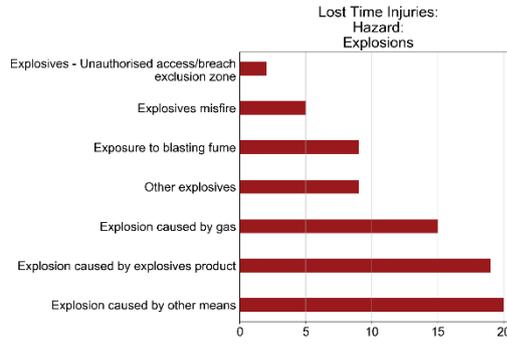
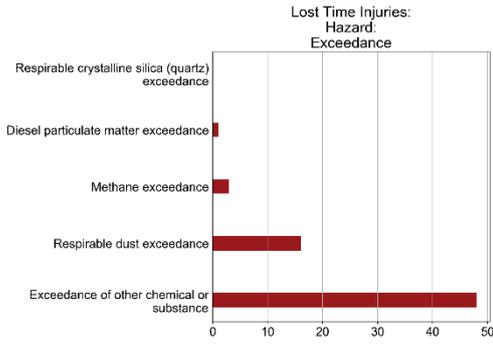
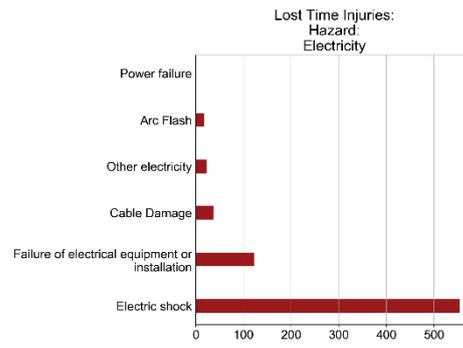
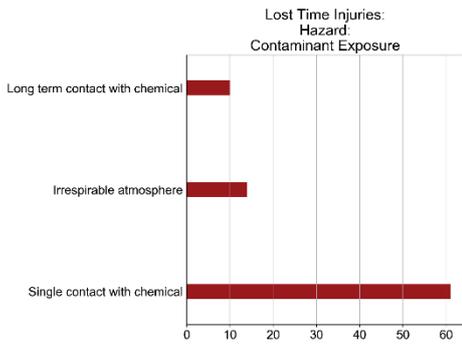


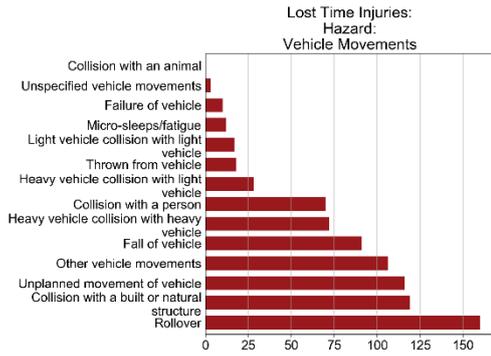
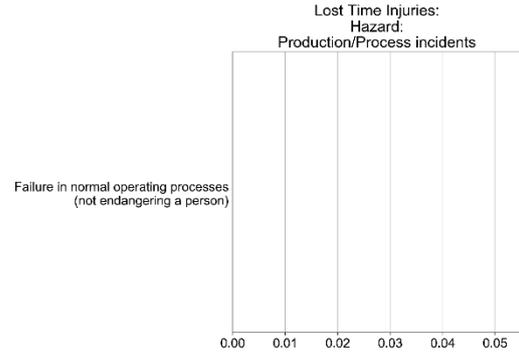
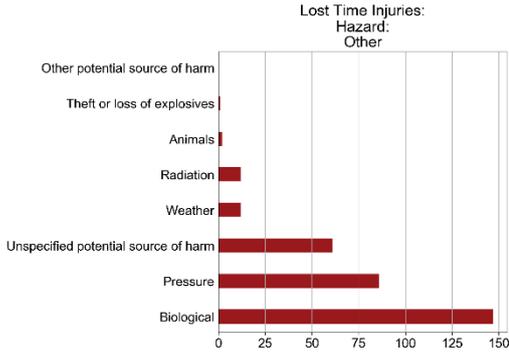
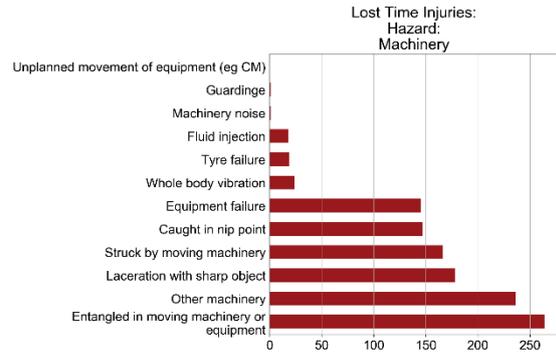
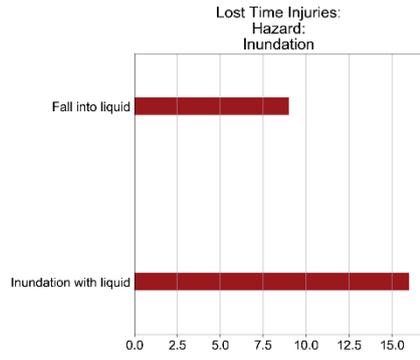
Lost Time Injuries:
Hazard:
Level 1

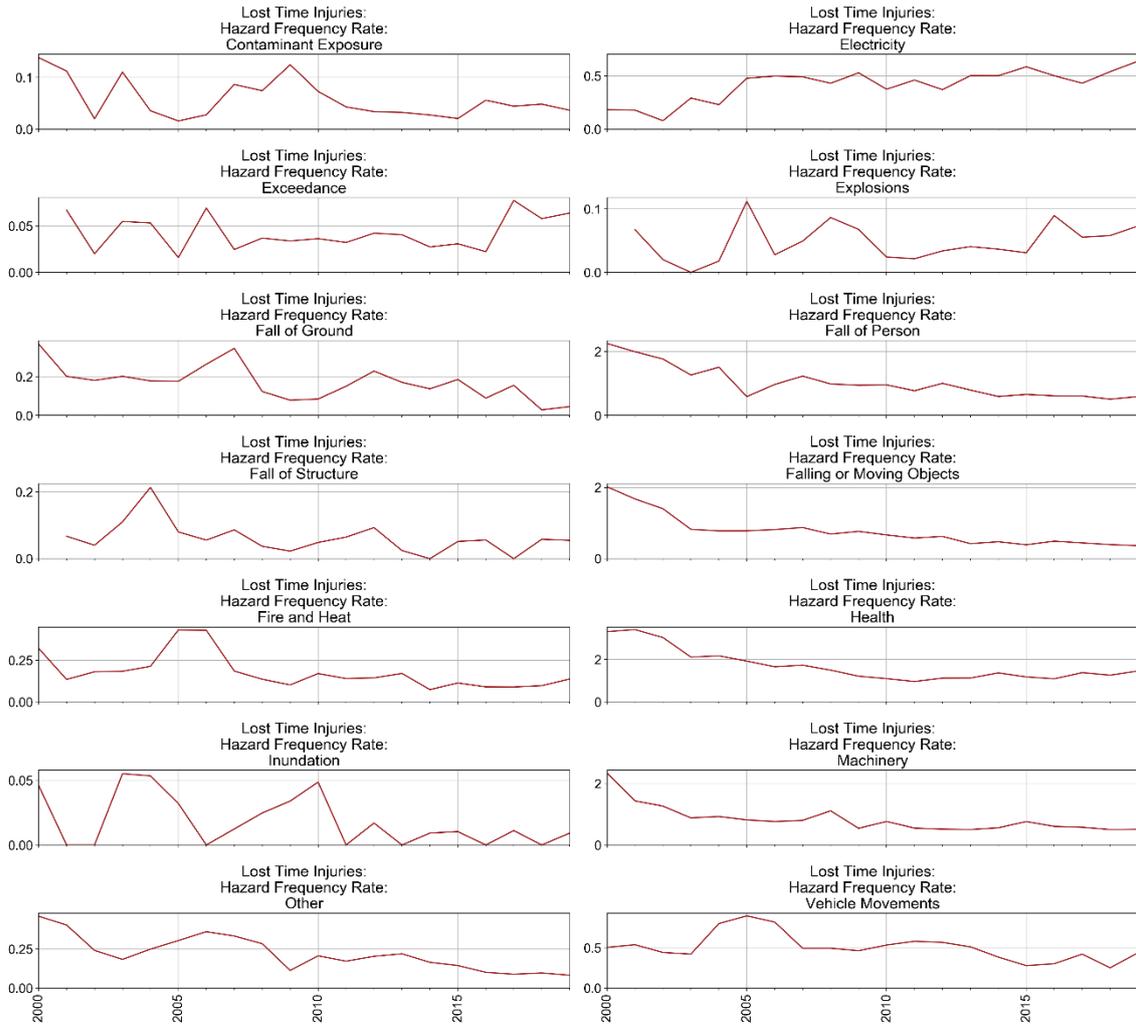


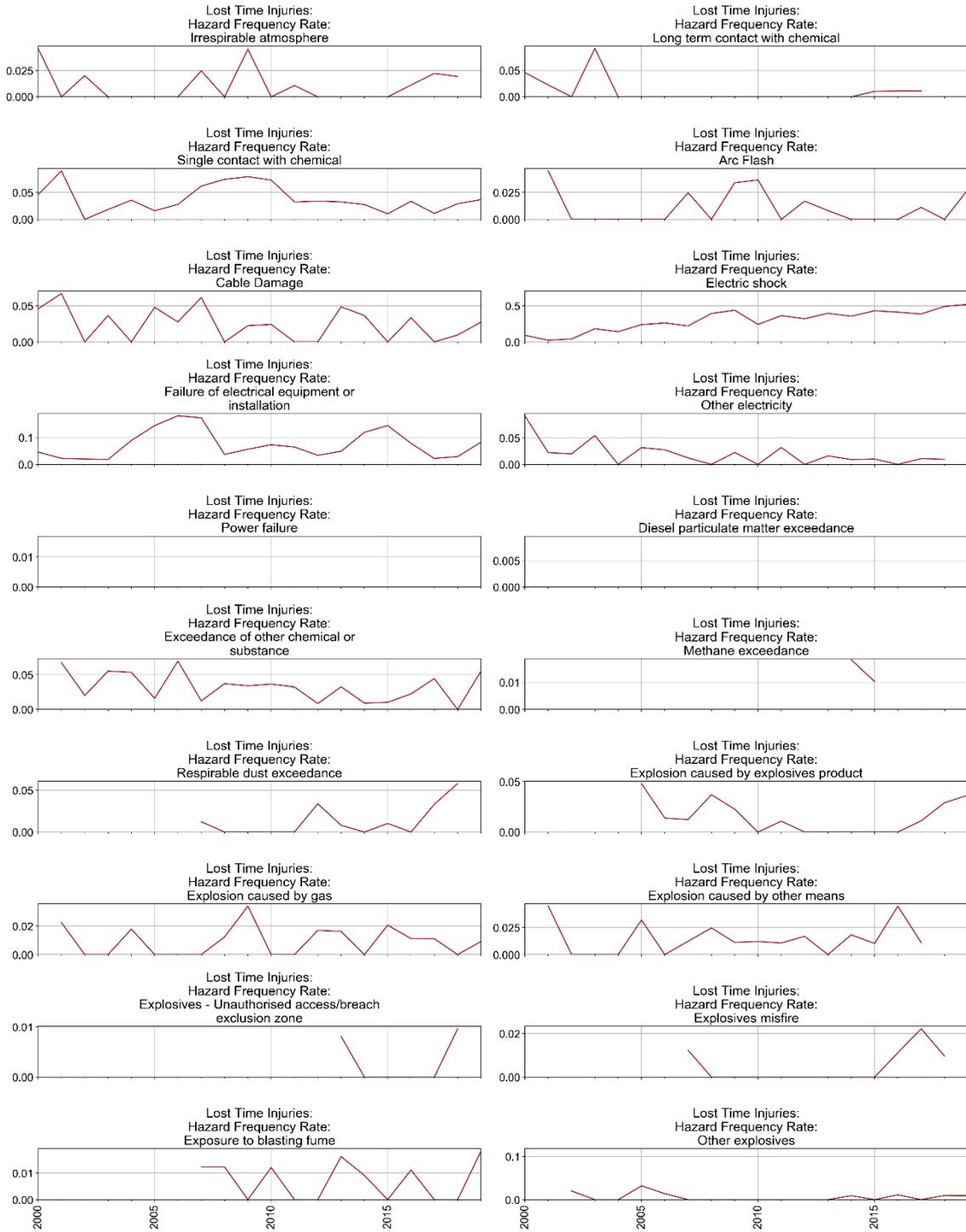
Lost Time Injuries:
Hazard:
Level 2

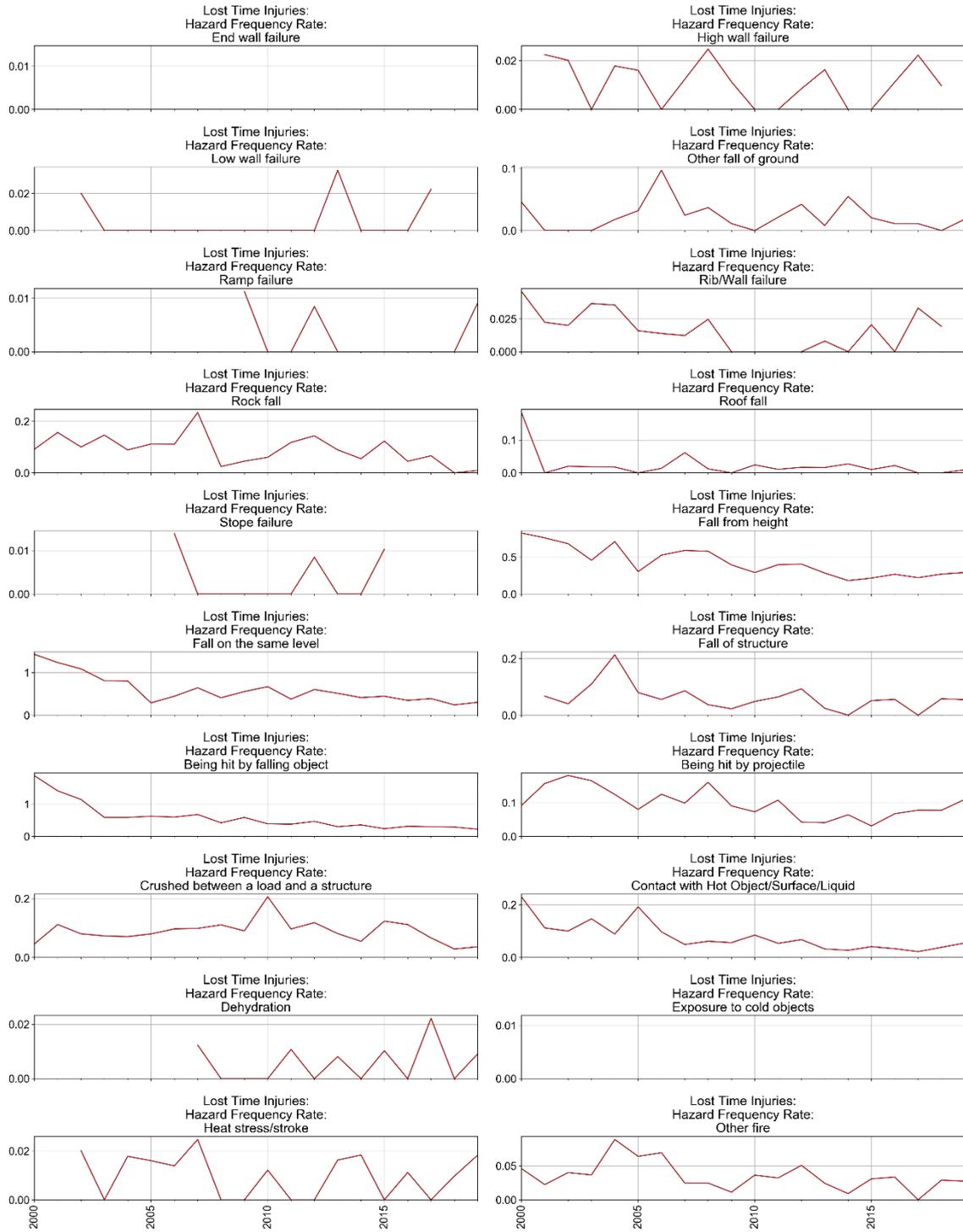


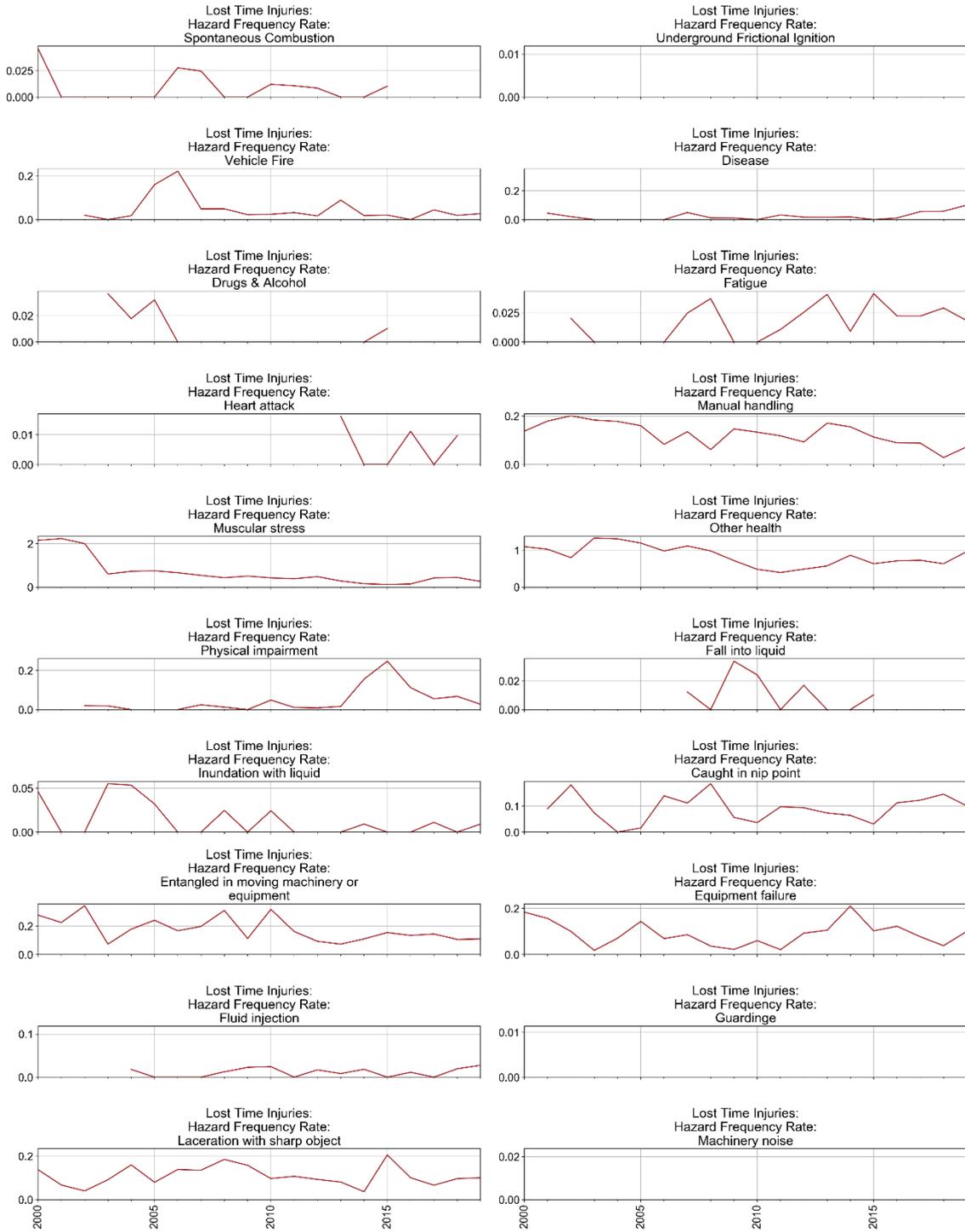






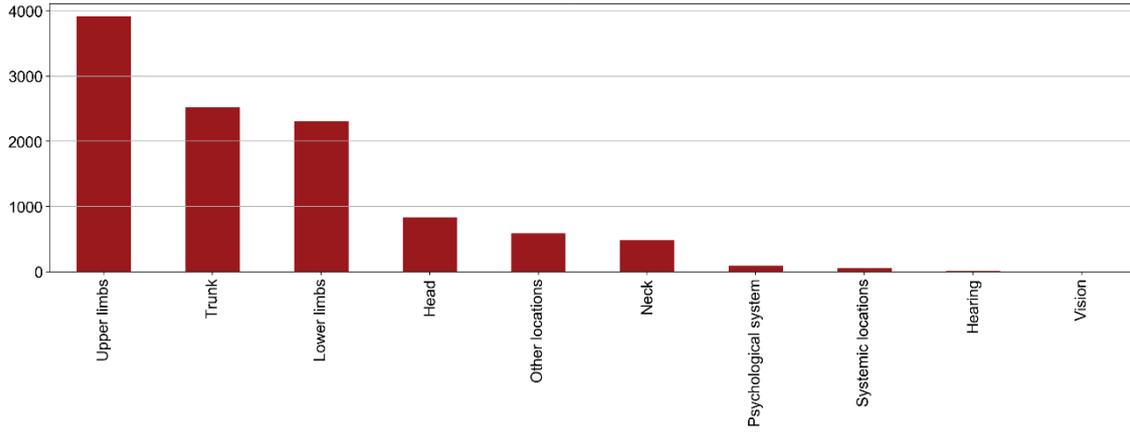




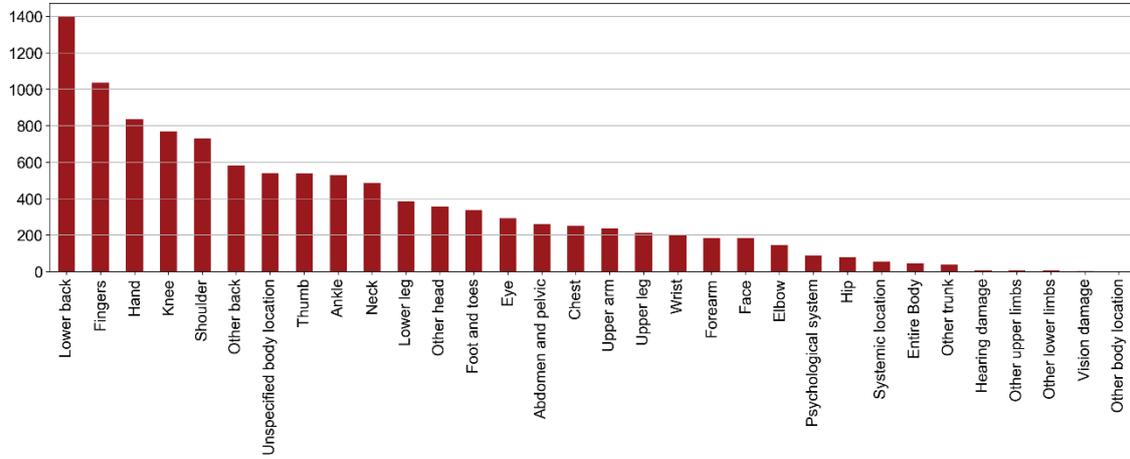


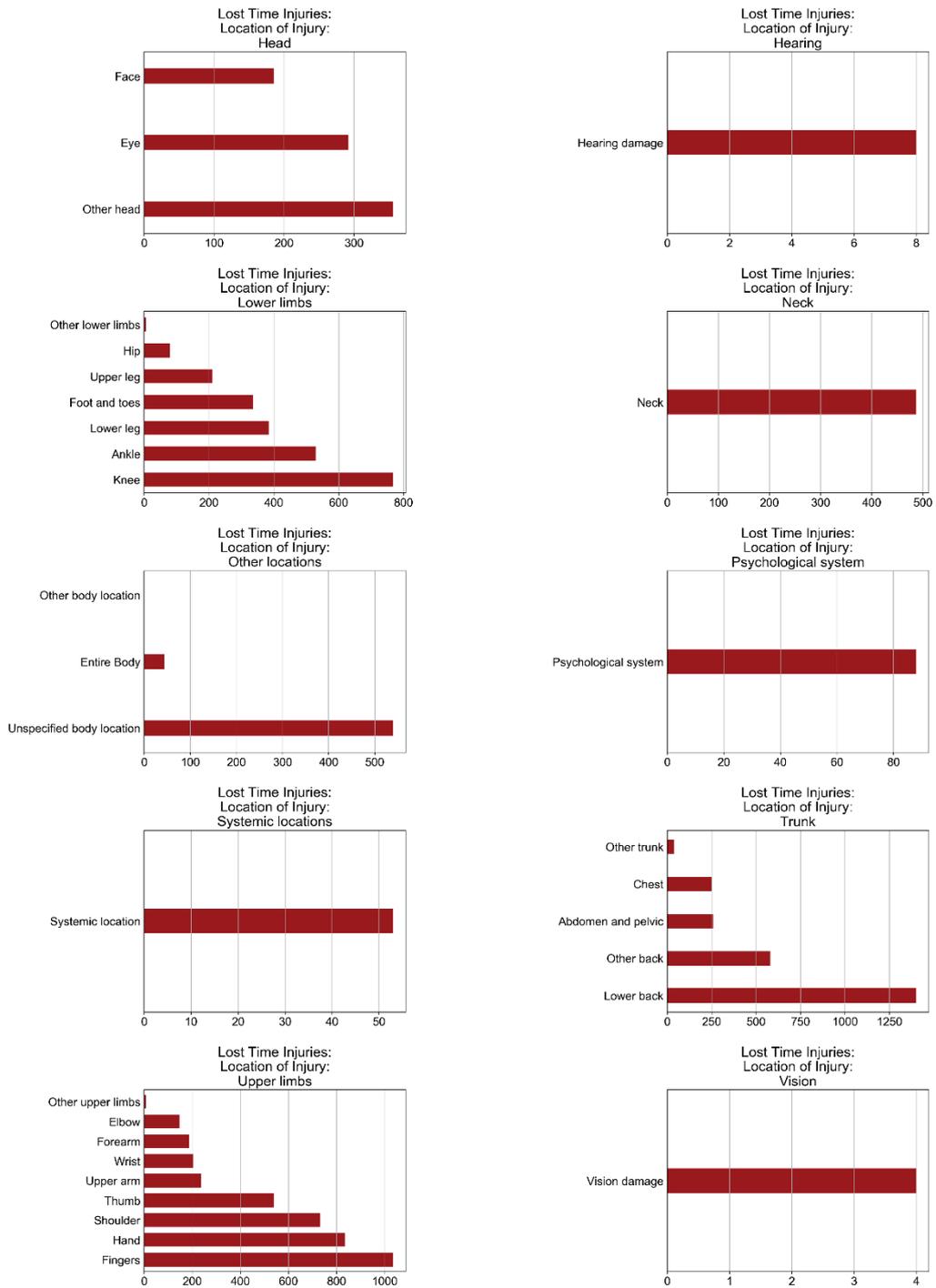


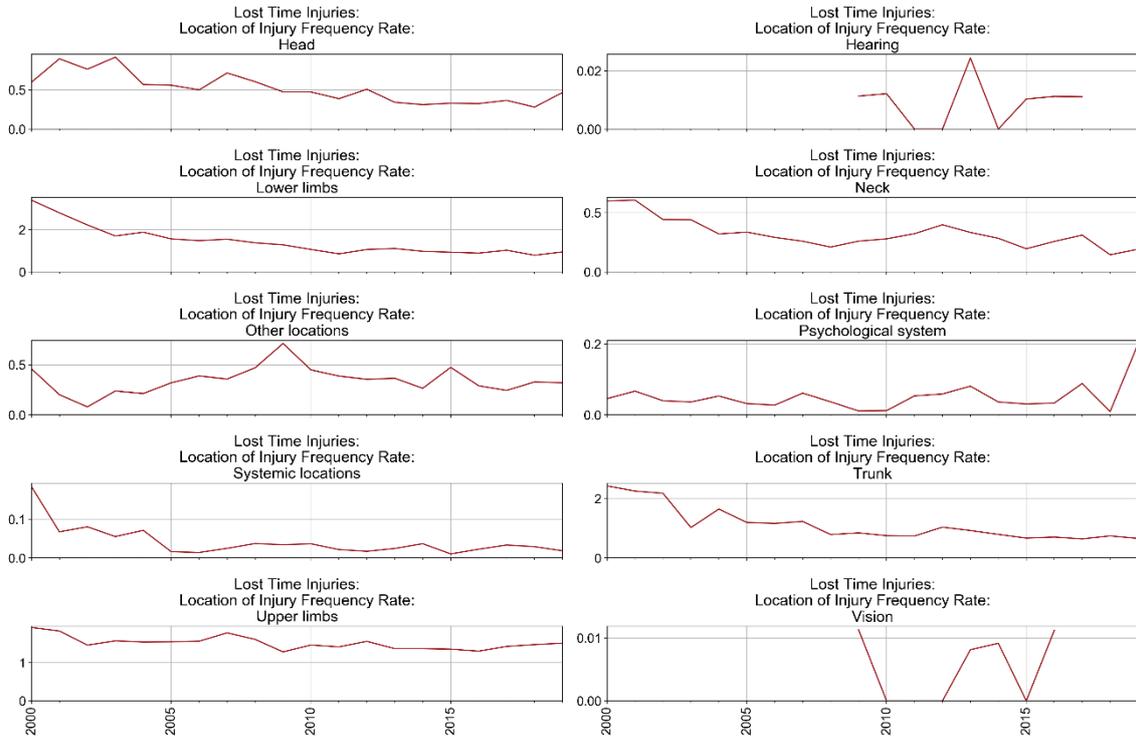
Lost Time Injuries:
Location of Injury:
Level 1

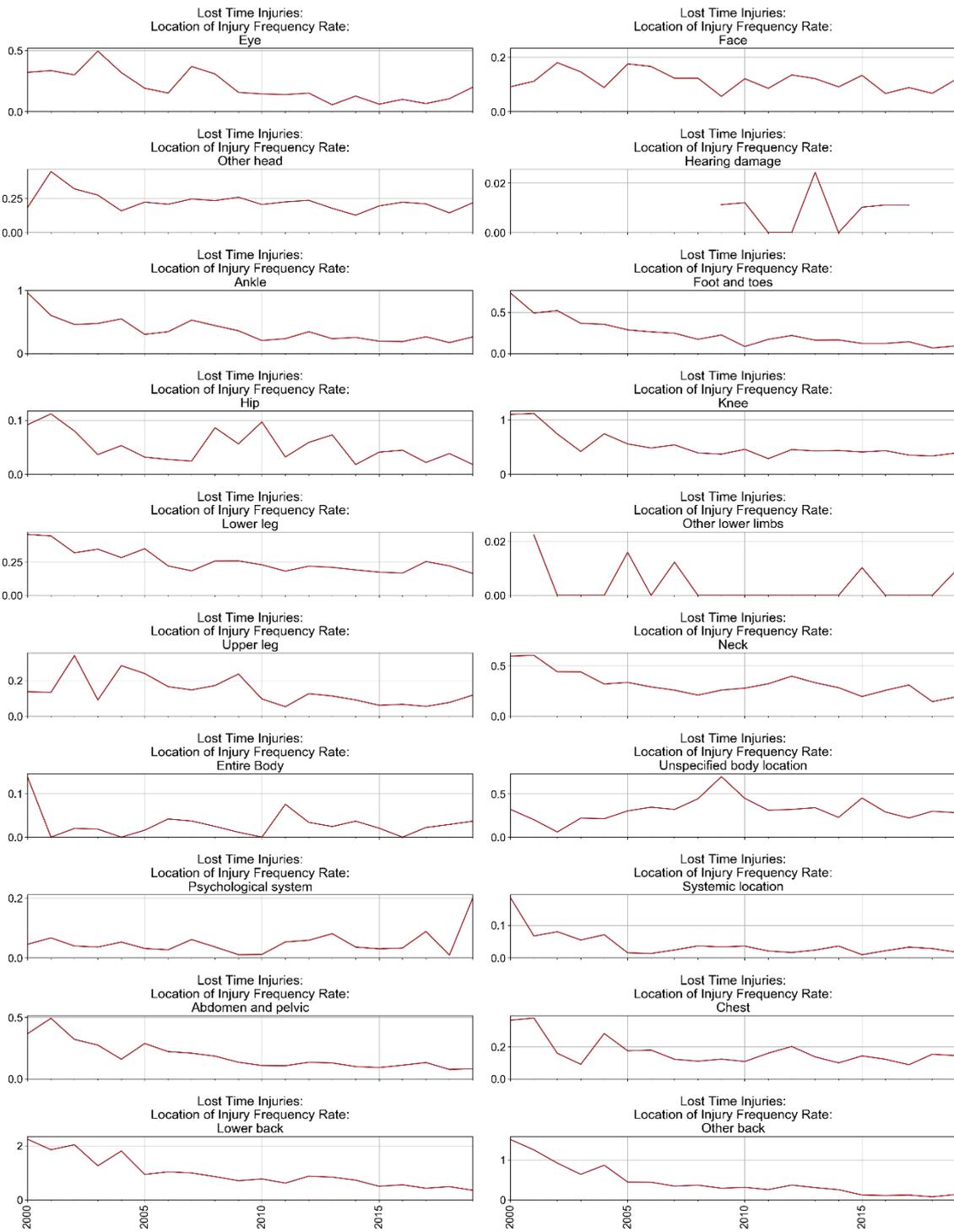


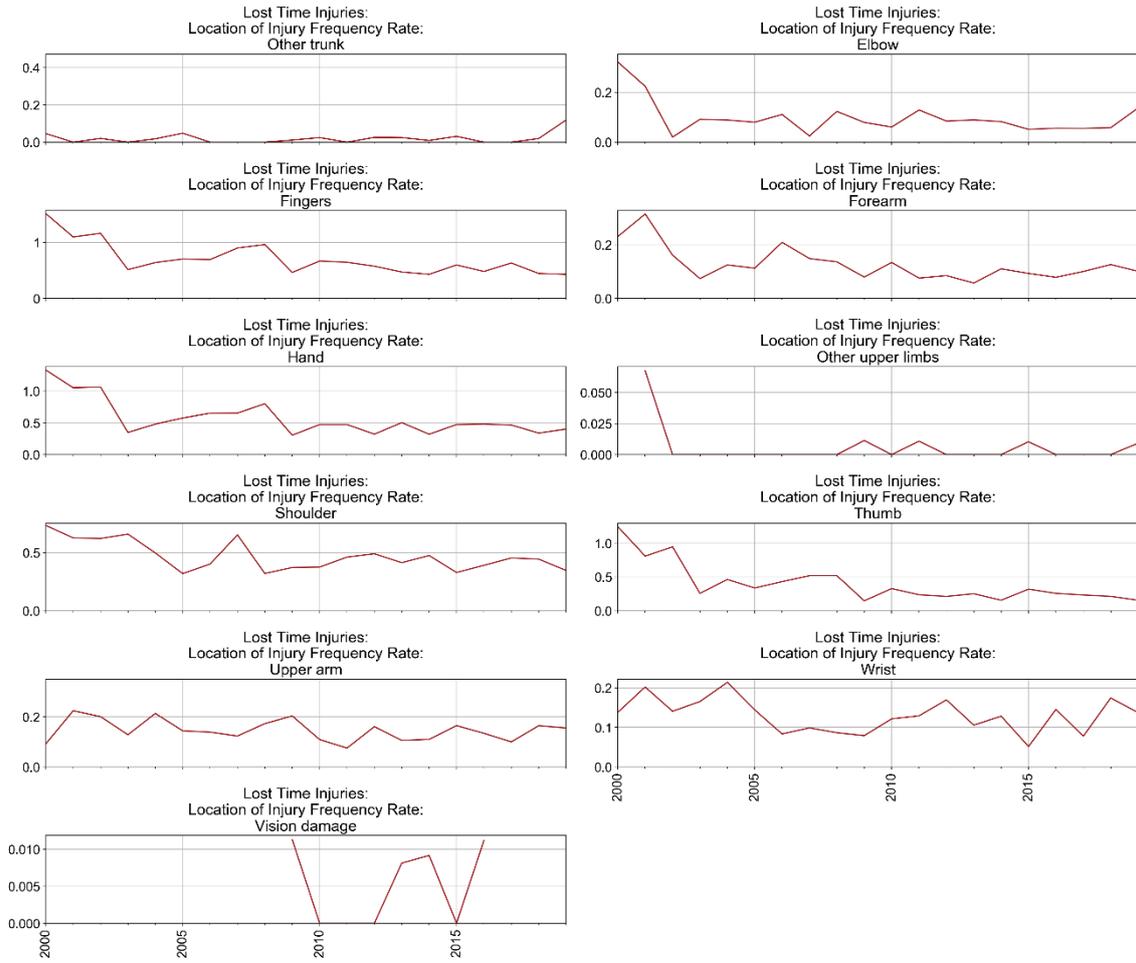
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Level 2

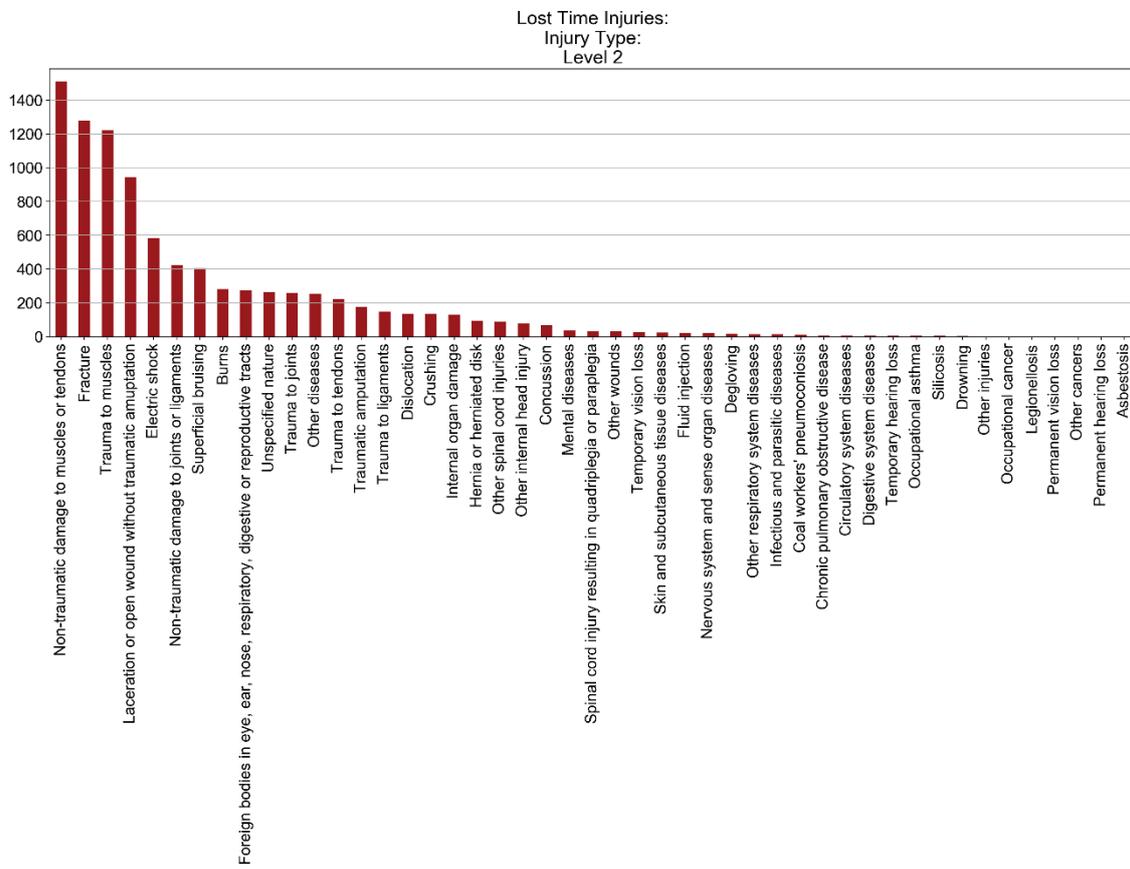
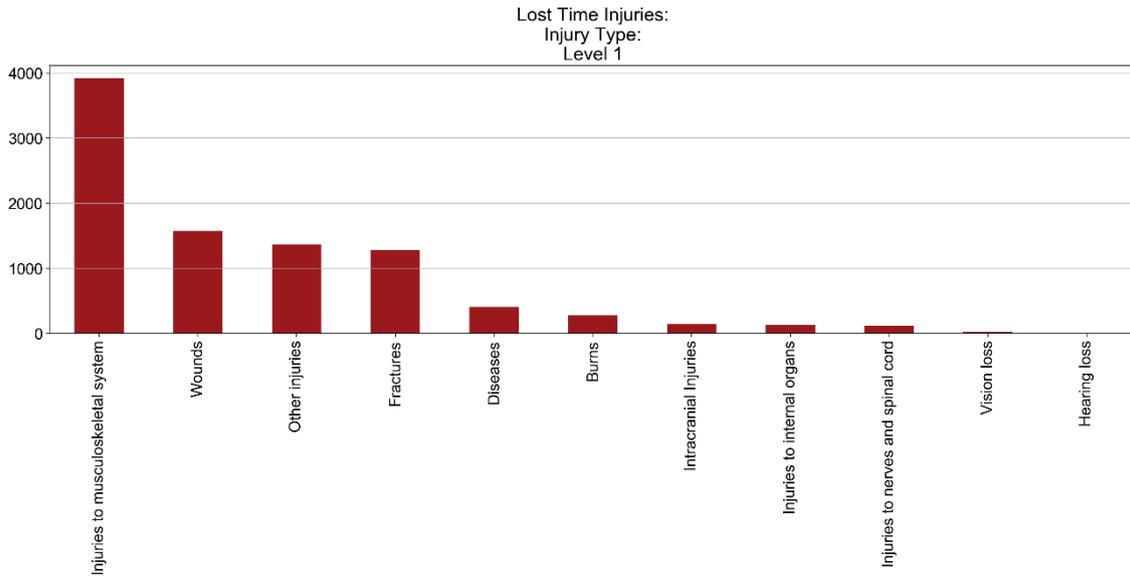


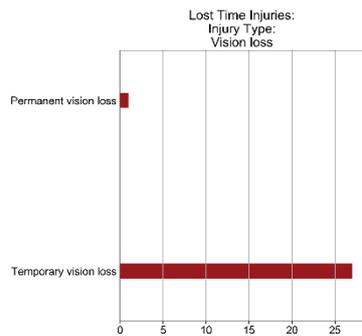
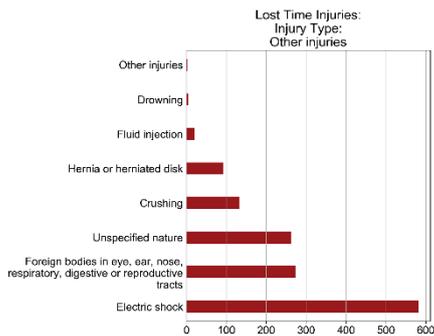
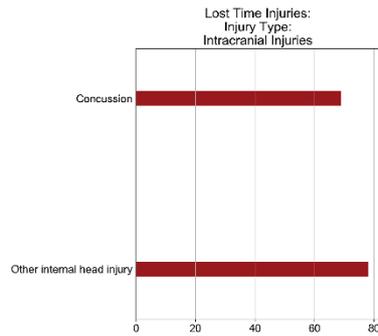
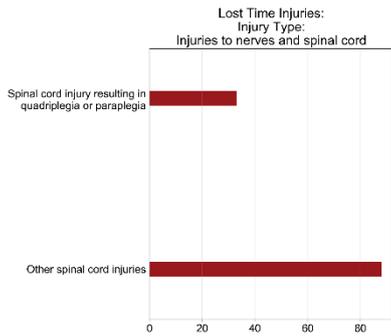
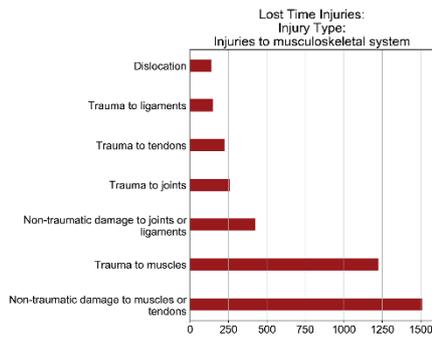
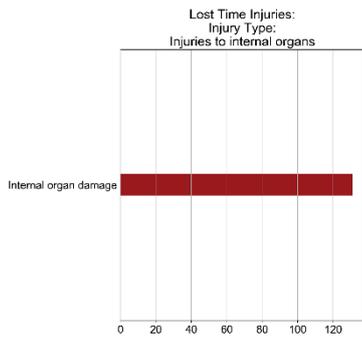
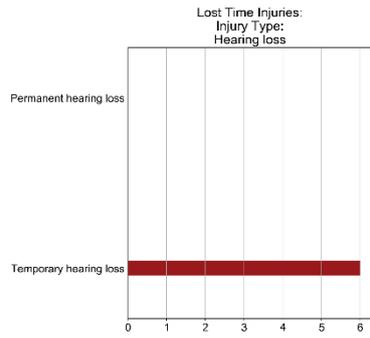
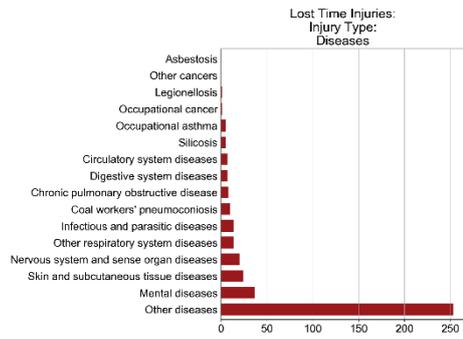
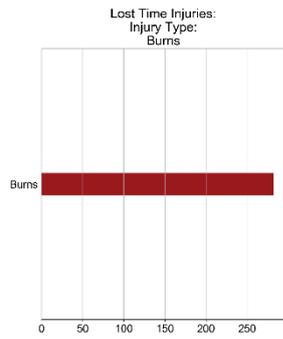


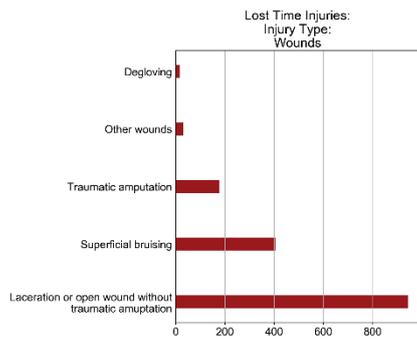


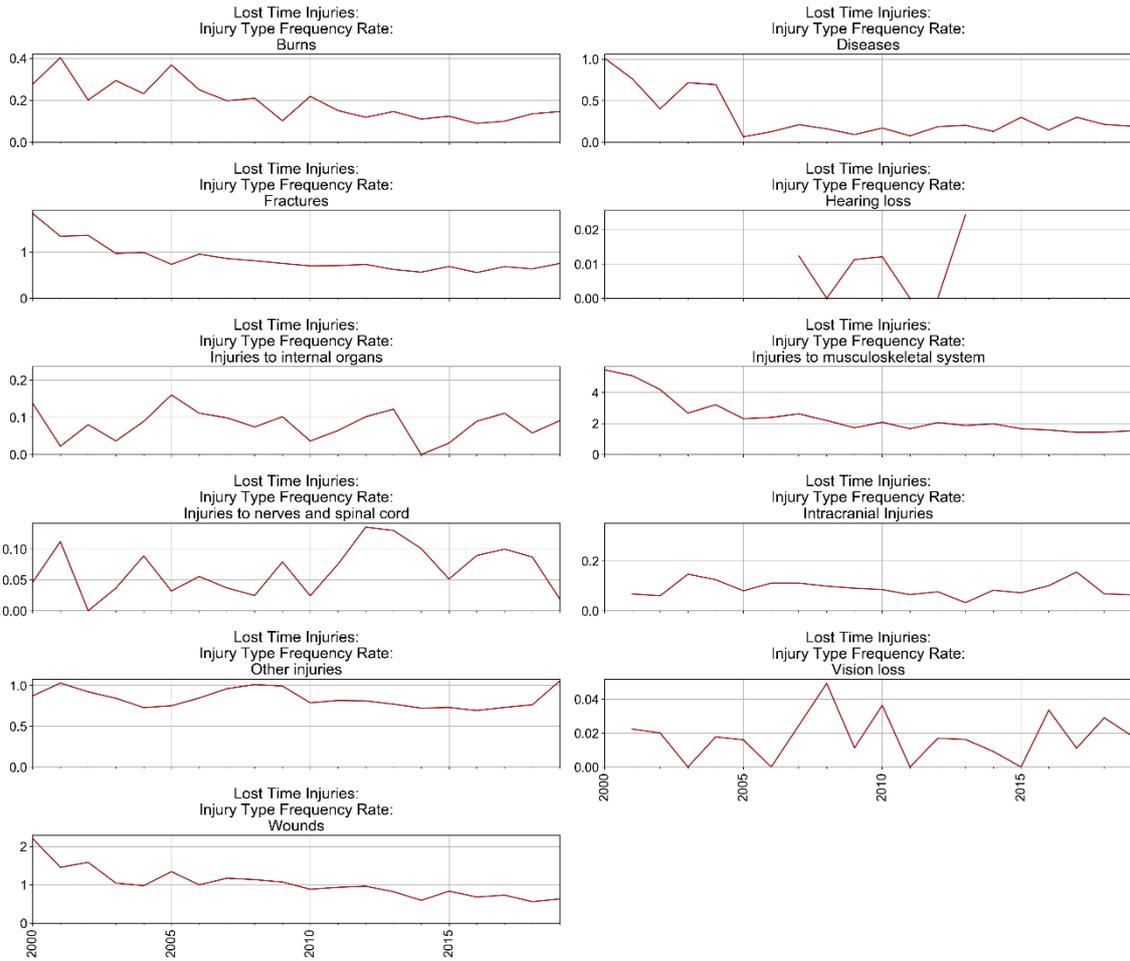


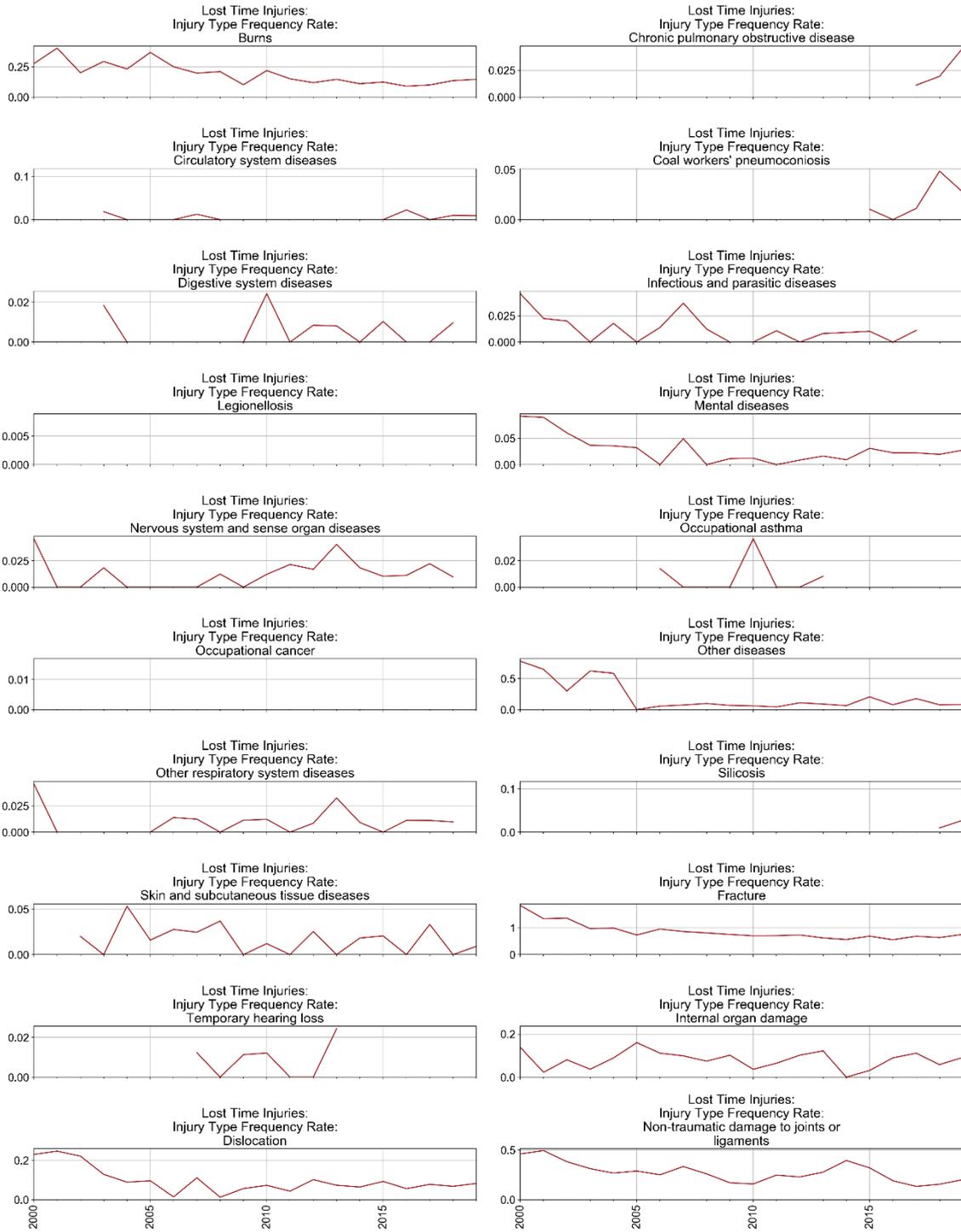


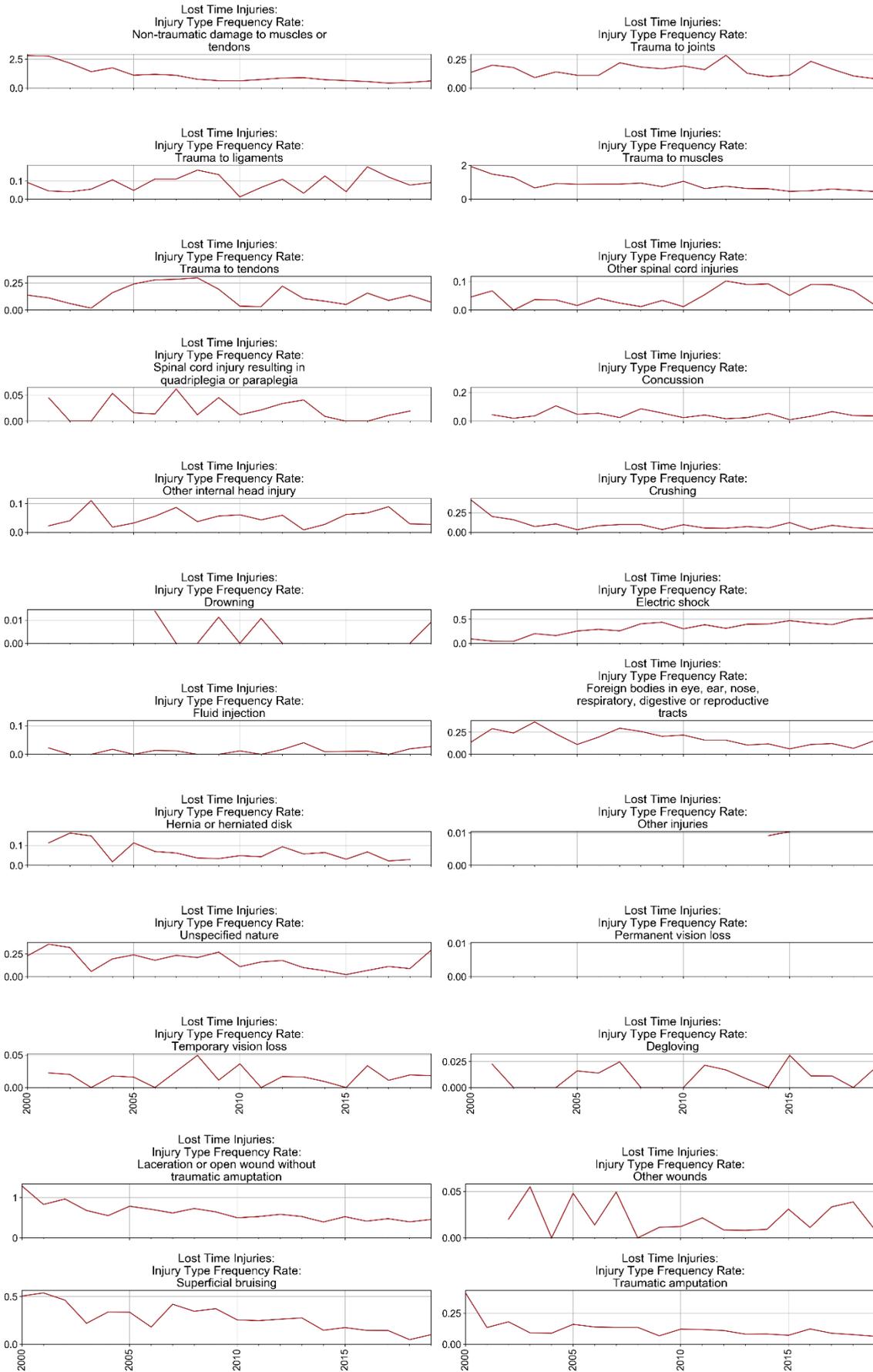


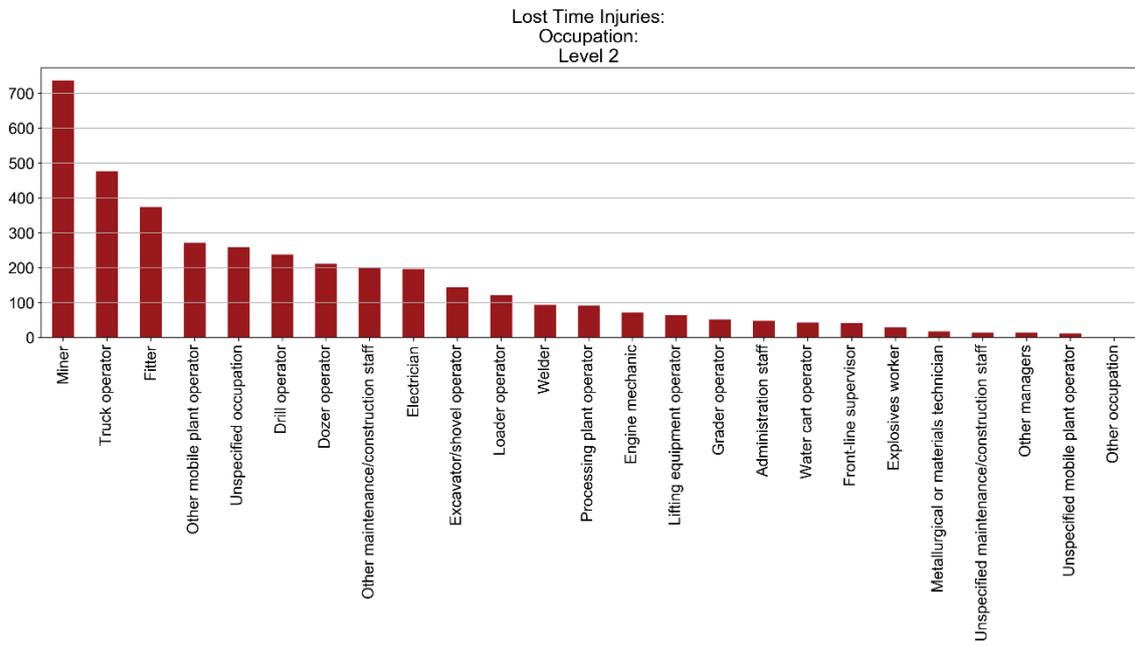
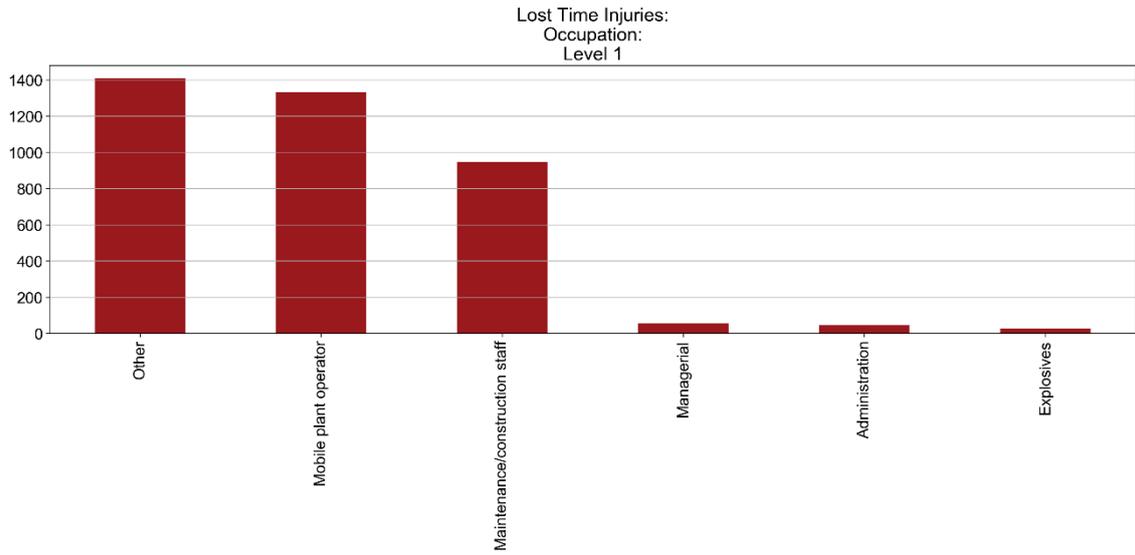


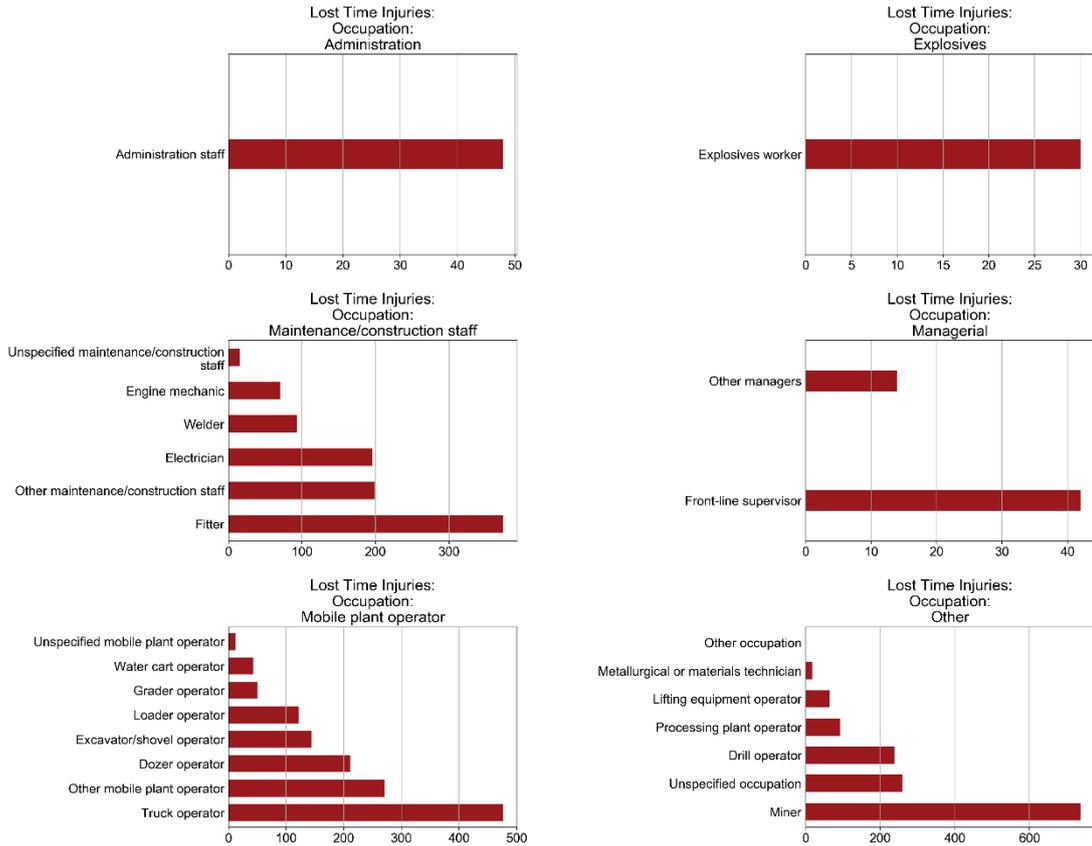


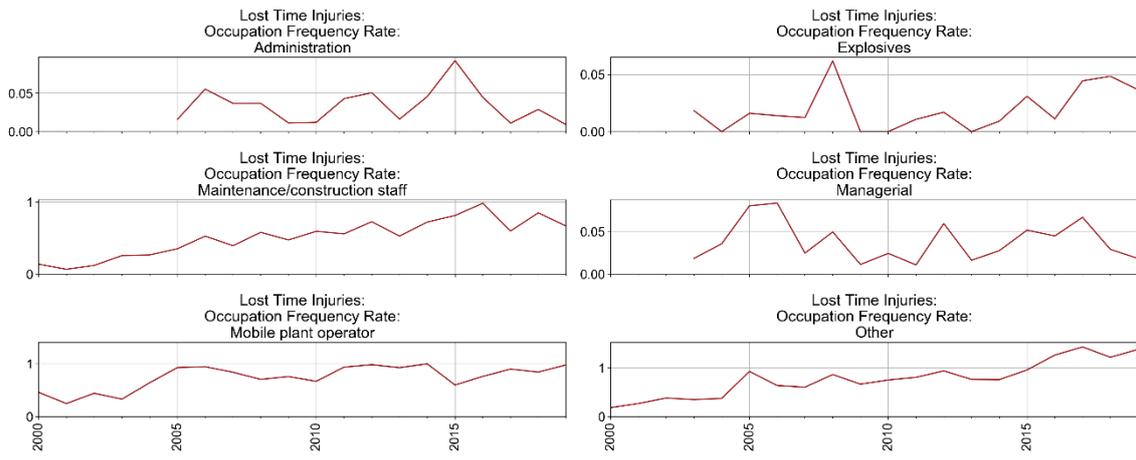


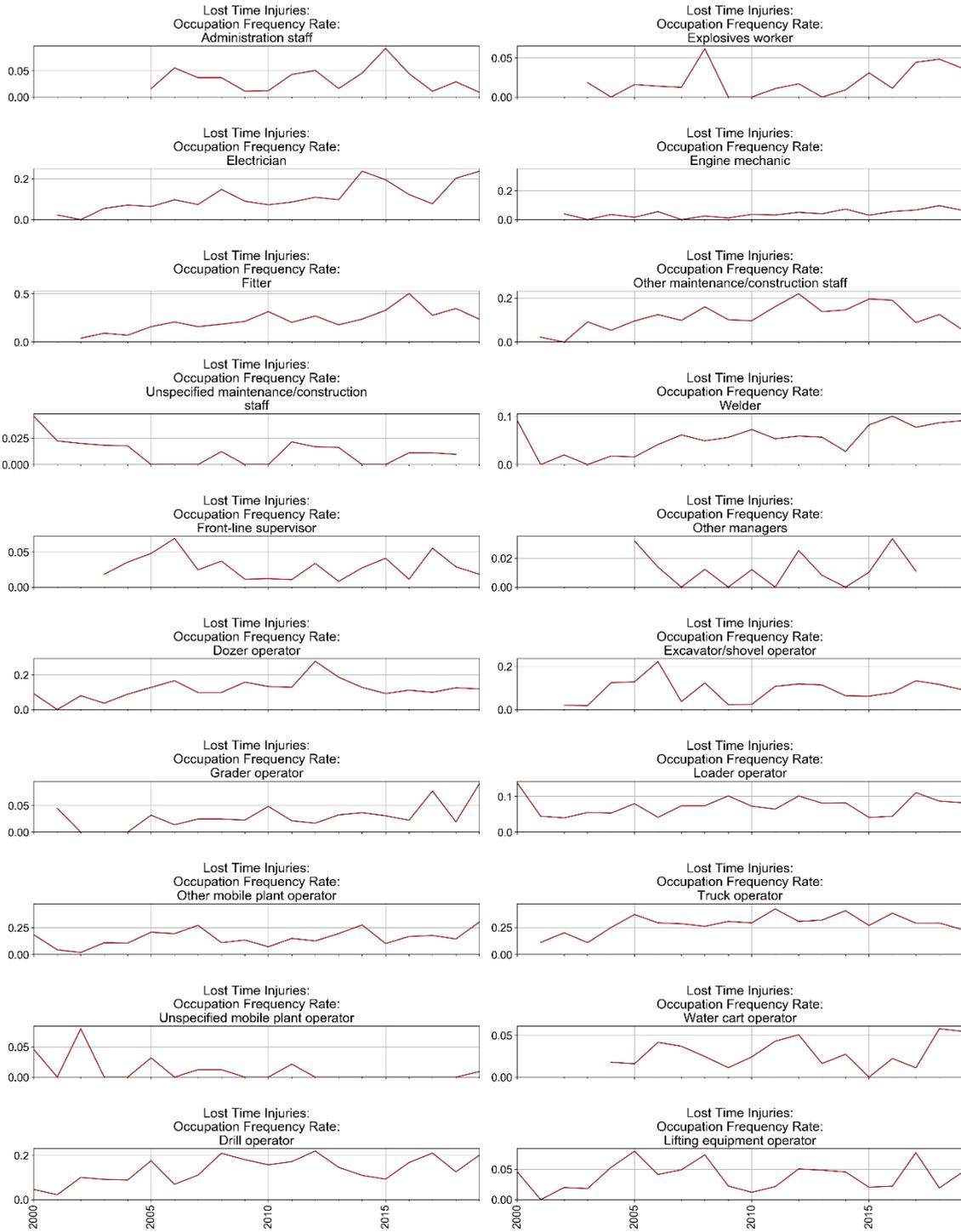


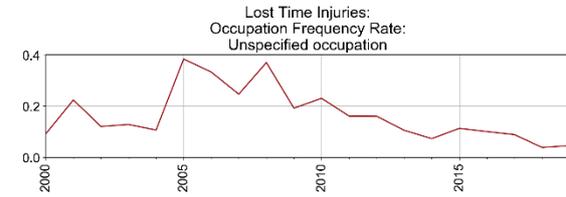
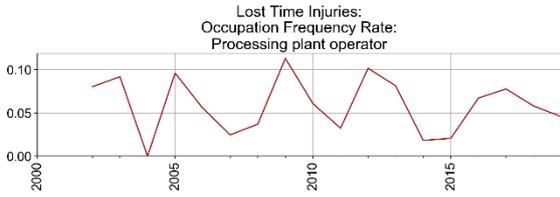
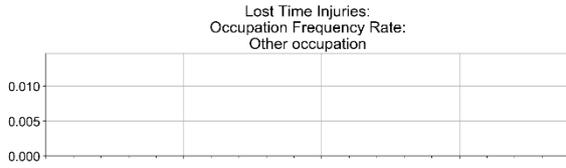
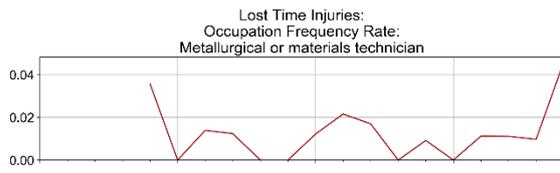




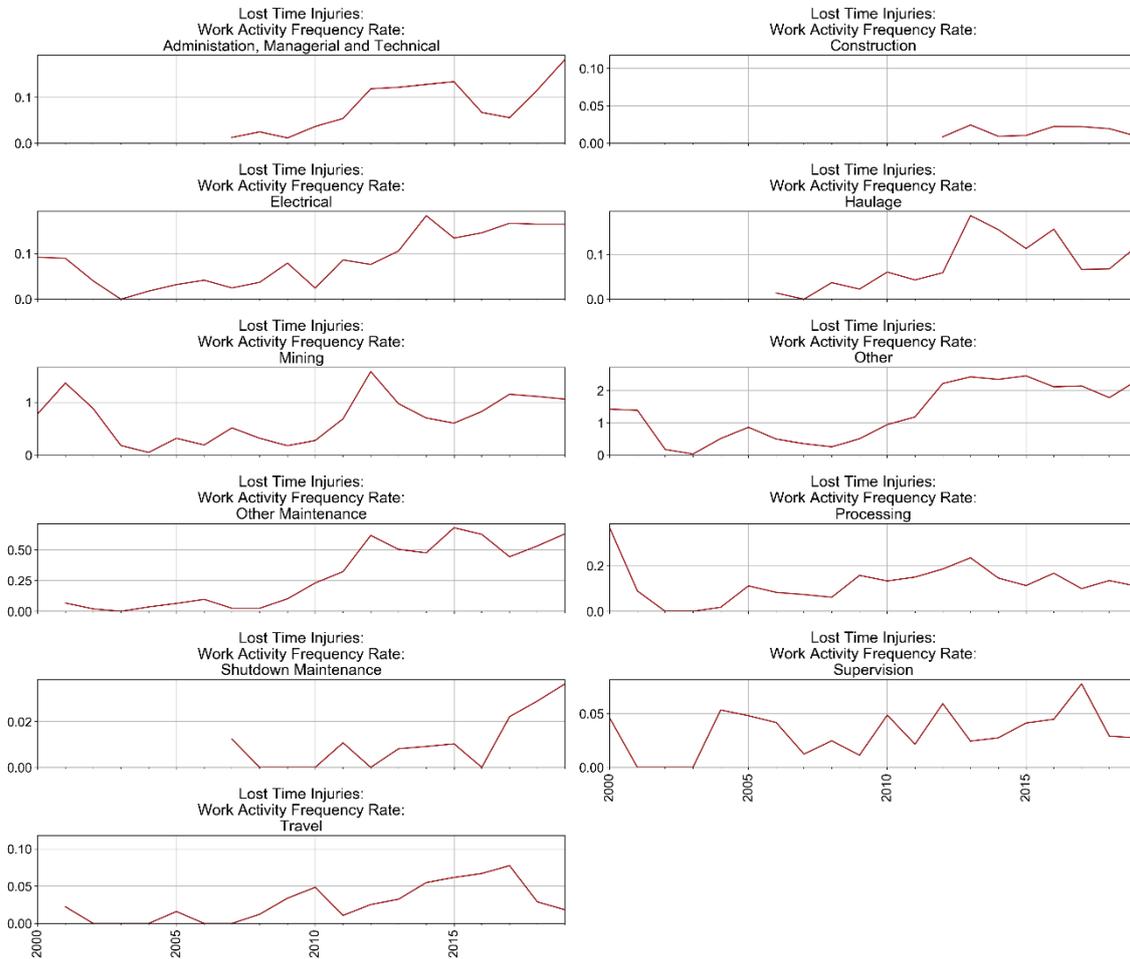
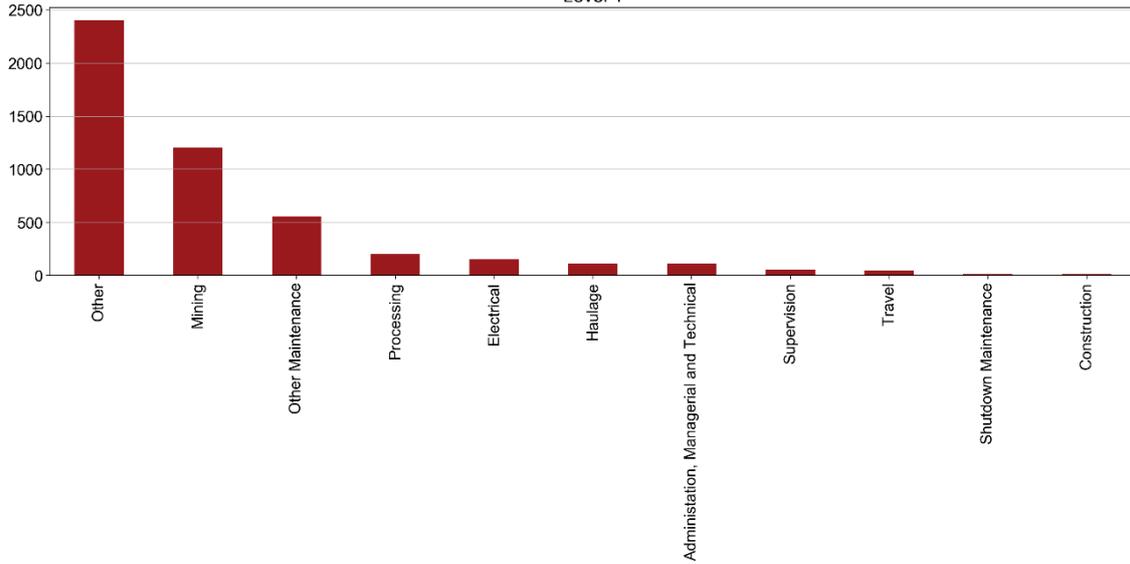


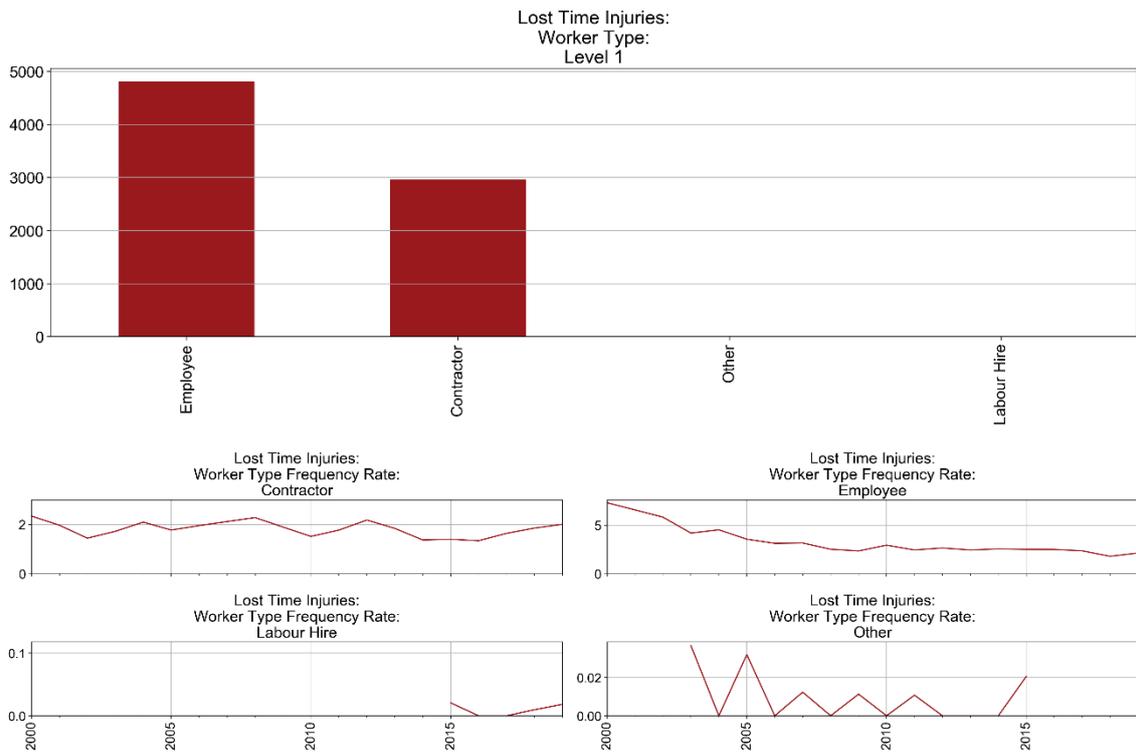




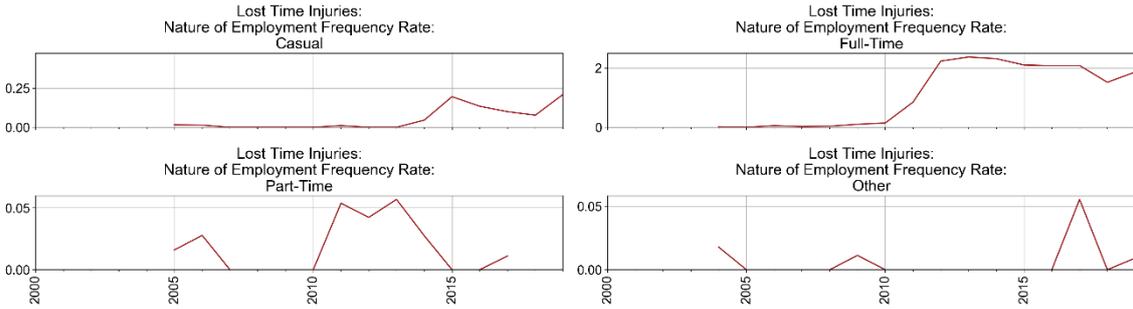
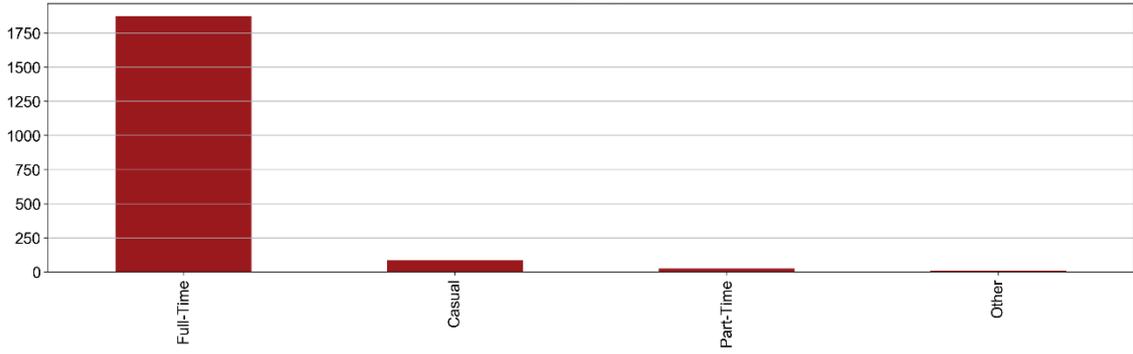


Lost Time Injuries:
Work Activity:
Level 1

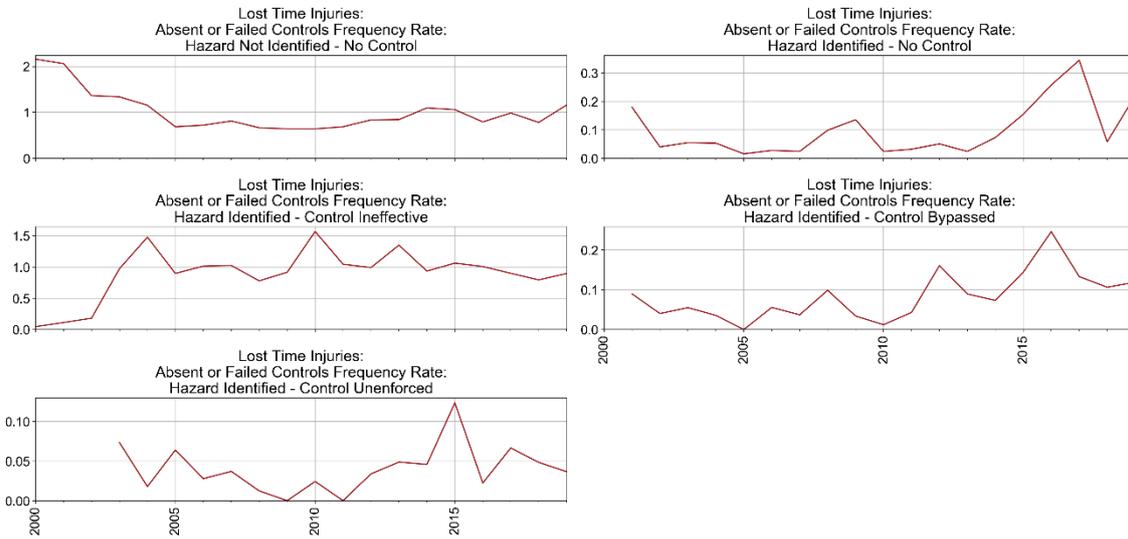
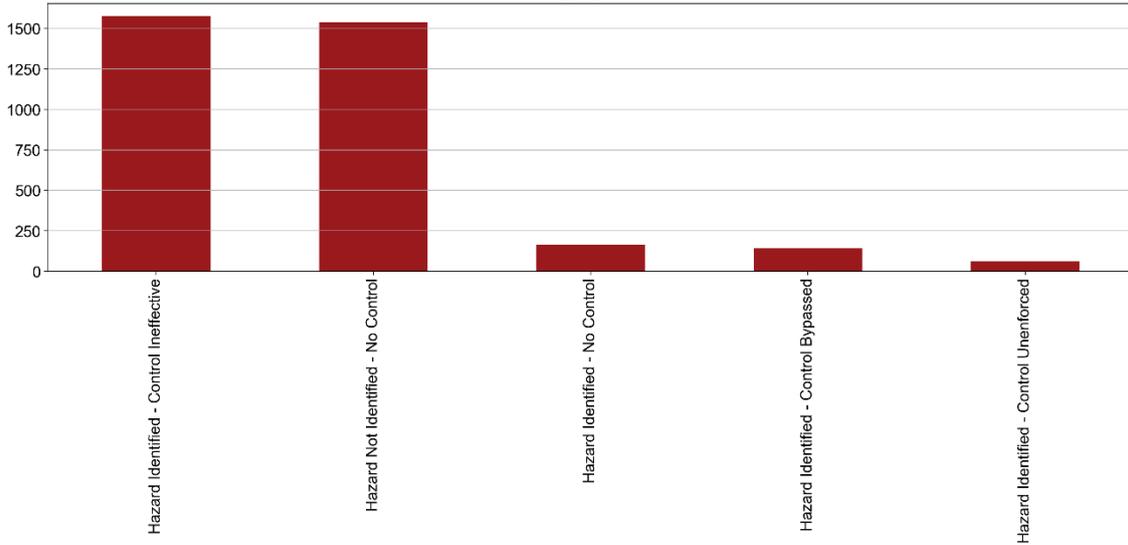




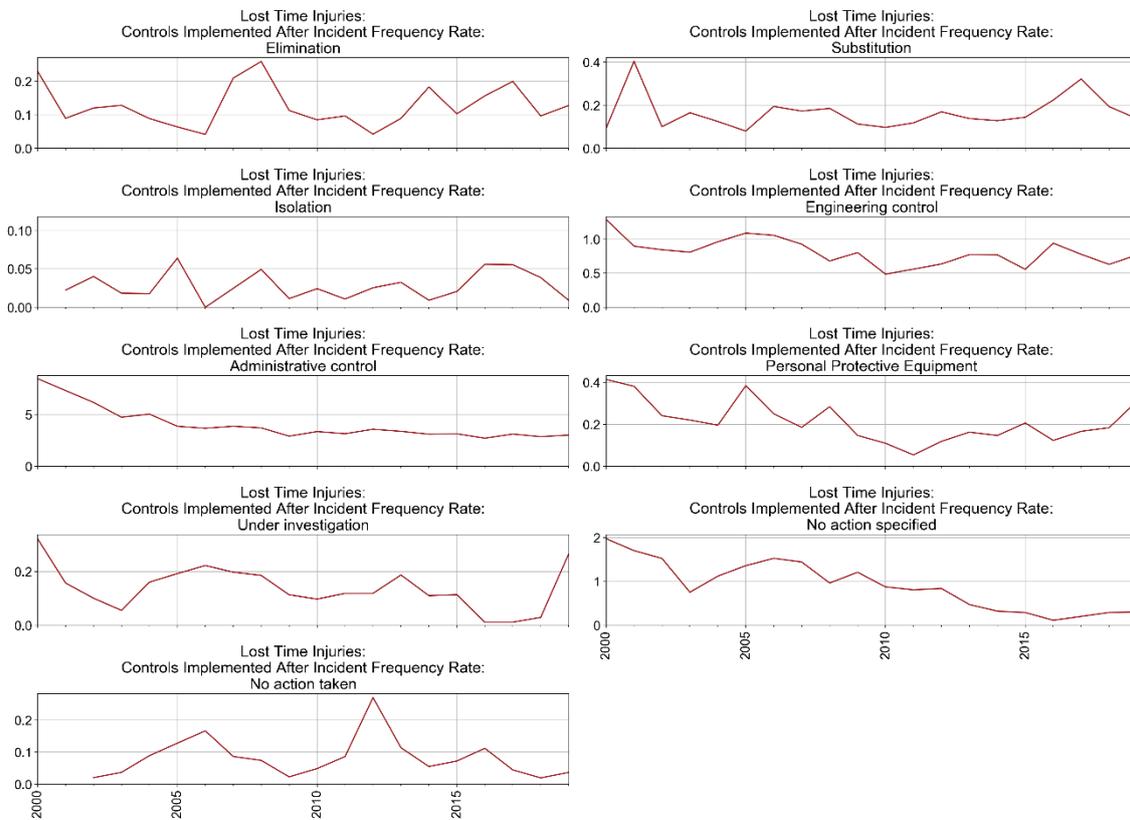
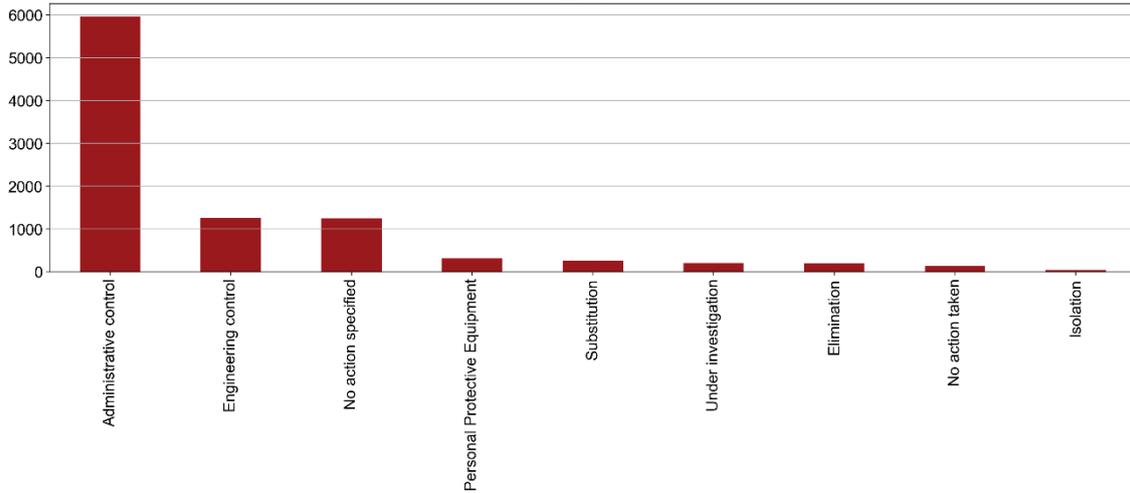
Lost Time Injuries:
Nature of Employment:
Level 1



Lost Time Injuries:
Absent or Failed Controls:
Level 1



Lost Time Injuries:
Controls Implemented After Incident:
Level 1



APPENDIX E

Submission from Mine Managers' Association of Australia

On the 28th of October 2019 a call for submissions was released to the industry. The following response was received from the Mine Managers' Association of Australia.



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Queensland Mines Inspectorate
Department of Natural Resources, Mines and Energy
PO Box 15216
CITY EAST
Queensland 4002

28 November 2019

e-mail: OLDMinesInspectorate@dnrme.qld.gov.au

Dear Members,

Subject: Fatal Incidents in the Queensland Mining Industry

We thank you for the opportunity to comment on fatal incidents in the Queensland resources sector. We will however, restrict our comments to the coal sector as that is the industry in which the vast proportion of our Queensland members are employed.

The Mine Managers' Association, as you are aware, represent senior operational personnel. Our current membership has grown to over 430 members and membership, whilst mainly directed to practising mine managers, also includes a diverse range of senior management in the coal mining industry; from chairmen and directors of companies, mines inspectors, academics, consultants and senior technical managers. In Queensland we have over 115 members and to our knowledge all practising underground mine managers (UMMs) in Queensland are members of the Association, as are a significant number of Site Senior Executives (SSEs).

We are firmly of the belief that all fatal incidents are avoidable and the pillars of safety and health to prevent incidents are;

- An effective regulatory regime,
- a well-resourced and competent inspectorate,
- competent and statutorily qualified management,
- a well-trained workforce and in particular one where all personnel are hazard aware,
- a risk-based safety and health management system (SHMS) where all hazards are effectively identified and effective hierarchy of controls are enacted to bring risk to acceptable levels or ALARP (as low as reasonably practicable) and
- fit for purpose equipment.

The above principles have been established through many years of Royal Commissions, Courts of Enquiry (Mining Warden) and accident investigations going back to the mid-1800s. Tragically too many times the lessons of the past have been either ignored or forgotten. To demonstrate the validity of the establishment of positive guidelines and recommendations, with the at times creeping lack of industry and corporate knowledge, we have appended to this submission quotes and recommendations from various incident enquiries.

1. **Effective regulatory regime** – the first regulatory instruments were prescriptive, the belief being that after every incident if proscribed regulation was introduced that would eliminate further

Fatal Incidents in the Queensland Mining Industry

incidents. Unfortunately, proscription was proven less than adequate as fatal incidents still continued to occur and of more concern, mine explosions and the attendant multiple fatalities.

In Queensland, following the Moura No2 explosion, an extensive review of best practice legislation and the theory of safety and health legislation were initiated. That review indicated that proscription was not the panacea as first perceived and that self-enabling legislation was more effective. Whilst Queensland did not fully adopt self-enabling legislation they went a long way toward that and augmented the legislation by making it risk based.

By any measure, whilst not perfect, the *Coal Mining Safety and Health Act 1999* and the attendant *2001 Regulation* have been more efficacious than the older prescriptive legislation and there has been a marked improvement in safety and health. Recently though, both statistically and anecdotally there appears to be a decline in safety and health. This, we would contend, is due to a number of factors:

- i. There has been a marked diminution in the employment of statutory officials in the open cut sector with the removal of the requirement of a statutory mine manager and a reduction in open cut examiners. This will be explored in greater detail in the section dealing with competent and statutorily qualified personnel. Similarly, the subjugation of an underground mine manager's position will also be discussed.
 - ii. The increasing introduction of Recognised Standards and Codes of Practice which are increasing the level of prescriptive legislation, the previously identified nemesis of effective legislation.
 - iii. The break-down of Safety and Health Management Systems. In many instances risk assessments and the formulation of procedures have not been undertaken with a genuine cross section of the workforce. The absence of subject matter experts involved in risk assessments and overly complex procedures that the average coal mine worker finds difficult to follow and achieve compliance are impediments to safe working systems. Many instances where multiple procedures exist for the same task and ineffective document control that does not ensure the current and correct procedure is being utilised are further impediments.
 - iv. A RIS (Regulatory Impact Statement) procedure that enjoyed wide consultation in the early part of this decade resulted in only a few recommendations being enacted. Certain vested interests were not happy with the outcome and that has prevented amelioration of the legislation. Consultation is not consensus. Perceived shortcomings in legislation need to be effectively addressed not tied up in some talk fest for political reasons.
2. **A well-resourced and competent inspectorate** – this was recognised in the United Kingdom in 1850 as being a necessity to ensure compliance with Mining Safety Laws and effective safety systems and in Australia this was recognised as far back as the Royal Commission into the 1902 Disaster at Mount Kembla Colliery in NSW¹. Even though the requirement for competent and well-resourced Inspectors has been recognised since the turn of last century, in Australia yet again, the Mining Warden's Inquiry into the 1994 Moura #2 explosion² saw fit to make firm recommendations on recruitment, retention and salary levels due to perceived inadequacies. Those recommendations from the 1995 Mining Warden's Report have never been enacted and

¹ See Appendix A

² See Appendix B

Fatal Incidents in the Queensland Mining Industry

we now see a dearth of suitably qualified inspectors being recruited and retained. Indeed, there is a paucity of First Class Mine Managers in the ranks of the Inspectorate. Inspectors are an integral part in the overall health of the industry and there must be sufficient feet on the ground to ensure regular inspections and audits of SHMSs. It is noted that the Minister has called for the appointment of an additional three Inspectors, it will be interesting to see how many with First Class Certificates can be recruited given the current remuneration package which is well short of the Moura #2 recommendation.

3. **Competent and statutorily qualified management** – given the complex nature and unique hazards of underground coal mining it was recognised in the UK as far back as 1872 that mine managers be required to hold statutory certification to demonstrate their competence to safely and effectively manage underground coal mines. That was later followed by the requirement to have statutorily qualified undermanagers and deputies.

Over the years, as a consequence of a number of disasters, the competency requirements of statutory officials have been significantly enhanced through recommendations resulting from the ensuing enquiries. It is therefore a concern to our Association that despite those recommendations the senior person on a mine site in Queensland, the Site Senior Executive (SSE) is not required to have any qualification in mining. When this was raised at the time of the drafting of the *Coal Mining Safety and Health Act 1999* it was stated that due to the inadequacies of the system at Moura the senior person on the mine site should be the most senior representative of the operator and that individual would have access to all the necessary resources to ensure safe operation of the mine. Further, as there would be a requirement for an Underground Mine Manager (UMM) to be appointed at an underground coal mine and that individual would require a First Class Mine Manager's Certificate and be responsible for the 'control and management' of the mine, hazards would be under control.

As predicted by some at the time, the theory and the practice are not aligned. In many instances the SSE has no real control over the resources, those being dictated by corporate headquarters and the UMM in some instances has been relegated to that of a compliance manager and not even on the actual, as opposed to unofficial, management structure at the mine. This we perceive as a major concern as that type of structure could lead to a significant incident.

We again call for the requirement of every underground coal SSE to have as a minimum a First Class Mine Managers' Certificate. This was a recommendation of the Regulatory Impact Statement (RIS) of 2013 and it still has not been actioned.

At open cut coal mines the requirement for a First Class Mine Manager who was responsible for the mining operations at the mine was eliminated. This effectively meant at some operations the only statutorily qualified personnel are Open Cut Examiners (OCEs) and their numbers are being depleted to the bare minimum. We know of operations where there are no persons with either mining or civil engineering qualifications being appointed to Mining Manager positions. Indeed, there is one notorious incident where the newly appointed Mining Manager asked her predecessor if the 'large wall' in front of them was known as the high wall. This unacceptable situation combined with the appointment of supervisors that have limited experience means that hazards are not being identified and or effective control measures are not being applied.

It is significant, in our opinion, that the number of fatalities in the Queensland open cut sector now far exceeds those of the NSW open cut sector. Between 2000 and 2009 there was one open cut fatality in NSW and four in Queensland. Between 2010 and 2019 that gap had widened to two fatalities in NSW and eight in Queensland. Essentially the same operating companies, same

Fatal Incidents in the Queensland Mining Industry

resource and systems of work but a different management structure, something perhaps to ponder and review further.

We again call for the reinstatement of the appointment of an individual with a First Class Mine Managers' Certificate at an open cut coal mine. This was a recommendation of the Regulatory Impact Statement (RIS) of 2013 and it still has not been actioned.

There are sound and valid reasons why statutory qualifications have been developed and we are at a complete loss as to why they should be ignored other than the fact that very senior management, many new to the industry, are oblivious to the hazards inherent in the coal industry.

In a number of incidents of which we are aware, the experience and competence of the immediate 'supervisor' was less than what we would describe as desirable. The qualification, experience and training standard of supervisors, particularly in the open cut sector require urgent review. We would question the ability of some supervisors to adequately identify hazards and implement the necessary controls to minimise the risk to acceptable levels. Supervisors should not, in our opinion, be a substitute for statutorily qualified individuals.

4. **A well-trained workforce and in particular one where all personnel are hazard aware** – a review of the training manuals and systems in place for mine worker induction and training in many instances leaves much to be desired. We can cite two examples where open cut mine sites were having a spate of serious incidents. In discussion it was recommended that the SSE would be better placed if they retrained the complete workforce in hazard awareness given the hazard training programme and the trainers were acceptable to the Inspectorate. That training was undertaken and almost immediately there was a significant decrease in the incident rate at those operations.

We ponder how effective the overall hazard training is, particularly at open cuts and whether lip service is being paid to that most fundamental safety and health requirement. It would appear to us that the fundamental question of what will occur as a consequence of a specific action is not being asked and we cite recent examples of lancing pins, cutting wear plates with an oxygen torch and interfacing with remotely operated equipment.

The absolute necessity for supervisors to be trained to the highest level of hazard awareness should be a mandatory requirement for supervisors and be required by the Coal Mining Advisory Committee.

We note and applaud the 'safety reset' dictated by the Minister however, unless that 'reset' contained dedicated and meaningful hazard awareness programmes delivered by subject matter experts we doubt there will be a lasting effect.

5. **A risk-based safety and health management system (SHMS) where all hazards are effectively identified and effective hierarchy of controls are enacted to bring risk to acceptable levels or ALARP (as low as reasonably practicable)** – over the years we have witnessed a diminution in the quality of persons delivering Risk Management programmes. Trainers who have only just been assessed as competent are training trainers who in turn with little or no practical experience are then undertaking training classes. It thus appears the original intent and critical components are being lost as the training moves farther from the source of the recognised industry experts.

Fatal Incidents in the Queensland Mining Industry

Some Risk Assessments that have been audited following incidents have detected fatal flaws in the process which in turn have led to incidents through the incorrect identification of a hazard or the application of ineffective controls. Those flaws have included the non-utilisation of subject matter experts, utilisation of a non-genuine cross section of the workforce, particularly the non-utilisation of individuals with practical experience in the matter under review.

Safe Guard Audits were designed to assess systems but given the paucity of Inspectors those Audits are either not being undertaken or are seriously restricted in number and quality. We recognise more audits of this type are required. As mine managers we would rather have any defect in the system identified in the Audit as opposed to an investigation into a serious incident.

An effective document control management system should be implemented at each site as it would appear many sites have permitted a multiplicity of work procedures to be developed, some many times over. At one site they stopped counting when they reached 8,000 documents in the system. Clearly this is a ludicrous situation.

- 6. Fit for purpose equipment** – overriding this topic is again, the subject of competence. In many instances engineering managers, both mechanical and electrical are being appointed and their knowledge of mining equipment and legislation is highly questionable. They are being appointed by corporate officers and because many corporate officers are ignorant of industry safety and health requirements they are oblivious to what is required. Just because one has tertiary qualifications in engineering does not mean you have a working knowledge and understanding of mining equipment.

Whilst there has been a revolution in the recent past with mining equipment design and operational reliability there are areas that continue to be less than acceptable. Not the least of these is the continuing fires on surface equipment and even after many incidents of equipment being lost to fire and at least one fatality that we are aware of in South Australia these issues are not being effectively addressed. Another matter is the ergonomics of machinery including access. Equipment manufactures need to be taken to task under the existing legislation and to date we have not seen equipment manufactures being pursued as legislation permits.

Again, with hazard awareness, there have been a number of serious incidents and tragically fatalities where trades persons working on heavy equipment have failed to be aware of potential hazards with ineffective hazard identification and introduction of effective risk controls. More effective training in hazard awareness and risk management would appear to be warranted.

The above are some of our considerations relating to fatal incidents and we would be pleased to meet with you to discuss those matters. Our Secretary, Ray Robinson, can be contacted on 0419 545 767 and I can be contacted on 0418 360 925.

Yours sincerely



Gavin Taylor
President
MMAA

Date: 28 November 2019

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Fatal Incidents in the Queensland Mining Industry

APPENDIX A

Mount Kembla explosion, 1902, NSW, 96 killed

Mount-Kembla-Colliery-Disaster-Report-of-the-Royal-Commission-part-1

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92. The Commission have also included, among the suggestions which follow, recommendations which, if brought into operation, will have the effect of raising the standard of Managers and Under-Managers, by providing that, in future, no person can obtain the necessary certificate for such a position except by proving his competency by examination;

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100.There shall be three descriptions of certificates of competency under this Act

- (1) Certificates of fitness to be Manager
- (2) second-class certificates, that is to say, certificates of fitness to be Under-manager and
- (3) Third-class certificates, that is to say, certificates of competency for the combined position of deputy and shot-firer; but no person shall be entitled to a certificate of competency under this Act unless he has had practical experience in a mine for at least five years.

101. While dealing with this subject of Certificates of Competency, the Commission desire to also recommend that section 7 be amended as under, and that an addition be made to it, as shown, to provide for the recognition in New South Wales of Certificates of Competency gained elsewhere in the British Empire, provided that the standard of examination is equal to that required in this State.

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135 ... The Governor may, on the recommendation of the public service board, appoint as inspectors of mines duly qualified persons and assign them their respective duties, and may award them such salaries as the public service board think fit or parliament shall approve. and each such person shall be, at the time of his appointment, the holder of a first-class certificate of competency.

137. The Commission unanimously desire to point out that, in their opinion, the salaries at present paid to the Inspectors are far too low to attract the best men; though, in saying this, they do not desire to, in any way, reflect on the present holders of the positions.

Fatal Incidents in the Queensland Mining Industry

APPENDIX B

Moura #2 explosion, 1994, Qld, 11 died

Warden's inquiry Page 78 – The Inspectorate

Evidence to the Inquiry indicated significant differences of opinion between field based inspectors and the Chief Inspector of Coal Mines (and, therefore, one might presume the Department of Minerals and Energy) regarding an appropriate role for the inspectorate and sufficient resourcing to support that role.

An effective inspectorate is seen as a vital support to the coal industry and there is concern that the apparent lack of agreement regarding the role and resourcing of the inspectorate may compromise its effectiveness.

There is a need for the Department of Minerals and Energy to develop a common philosophy throughout the inspectorate with that philosophy becoming the basis for an agreed, clearly defined role for the inspectorate. That defined role may then provide a basis for decisions about the numbers of people and types of skills required by the inspectorate, and so to strategies to develop, or attract and retain those skills within the Department. Such strategies may include training, recruitment and remuneration arrangements.