Developing a heavy vehicle fatigue data framework

Discussion Paper

August 2015

NTC AUSTRALIA

National Transport Commission

Report outline

Title	Developing a heavy vehicle fatigue data framework
Type of report	Discussion paper
Purpose	For public consultation
Abstract	The purpose of the report is to identify how governments can work together and with industry to develop a national heavy vehicle data framework to collect and analyse fatigue data to better inform future policy. An improved evidence base is needed to demonstrate the impact of any future reforms to the fatigue regulations in the Heavy Vehicle National Law. The report identifies regulatory fatigue issues that could be addressed through the development of the data framework. The report proposes framework activities. These include: standardisation of crash investigation recording, improved data collection, industry surveys and new scientific research in partnership with the Alertness CRC.
Submission details	Submissions will be accepted until **Friday 16 October 2015** online at www.ntc.gov.au or by mail to: Heavy Vehicle Compliance and Technology team National Transport Commission Level 15/628 Bourke Street Melbourne VIC 3000
Key words	Heavy Vehicle National Law, HVNL, fatigue-regulated heavy vehicle driver, road safety, fatigue impairment, alertness, data collection, Alertness CRC, co-operative research centre
Contact	National Transport Commission Level 15/628 Bourke Street Melbourne VIC 3000 Ph: (03) 9236 5000 Email: enquiries@ntc.gov.au www.ntc.gov.au
ISBN	**978-1-921604-83-6**

Foreword

The Heavy Vehicle Driver Fatigue reforms (the Model Fatigue laws) were introduced in 2008. The Model Fatigue laws sought to address the challenge of developing a universal rule set that is scientifically and legally defensible for all operators in all circumstances. As a result, the Model Fatigue laws include prescriptive work and rest hour rules, and incentives for operators to adopt fatigue management systems within an overarching duty not to allow drivers to work impaired by fatigue.

These reforms resulted in an improvement in fatigue-related heavy vehicle crashes. Through the efforts of operators and drivers, we have seen the development in many workplaces of sound fatigue management systems supported by a culture of safety. Police and road agencies undertake highly visible roadside enforcement, supplemented with chain of responsibility investigations and back-office audits.

Nonetheless, fatigue remains a cause of impairment and long-distance truck driving is one of the most dangerous occupations in Australia. Driver fatigue remains a policy challenge, with many contributing factors and many manifestations. For example, a driver's alertness is clearly impacted by the number of hours worked, but other factors include time of day, the time since a driver last slept, sleep quantity and quality, driving conditions and a driver's health and wellbeing.

The laws are also complex and difficult to comply with. Heavy vehicle drivers have to comprehend complex regulations in relation to work and rest hours, night rest breaks and overlapping 24-hour counting periods. The greater the complexity, the greater the focus of industry on compliance with rules and regulations rather than managing driver fatigue.

In 2014, the Transport and Infrastructure Council considered the fatigue impact of the counting time rules, in particular the ability for drivers to work two long work shifts between a major rest break. However, given there was no consensus amongst fatigue experts or jurisdictions on the degree of the fatigue risk with these schedules, ministers recognised that more data is needed to better understand the link between specific work and rest hours and fatigue.

Ministers have asked that the heavy vehicle fatigue data framework not be limited to the counting time issue. The purpose of the framework is to ensure that we have sufficient data to underpin any future reforms of the fatigue regulations in the Heavy Vehicle National Law.

I would like to thank staff at the National Transport Commission, the National Heavy Vehicle Regulator and the Alertness Cooperative Research Centre (CRC) for their strong collaboration in the development of this discussion paper.

David Anderson PSM
Chairman and Commissioner

Contents

Report outline ii

Foreword iii

Executive summary 1

1 Context 5

1.1 Objectives 5

1.2 Scope of the project 5

1.3 Problem definition 6

1.4 Background 6

1.5 Method 10

1.6 Overview of the issues and potential approaches 11

2 Consultation 13

2.1 Early feedback we have received 13

2.2 Consultation 15

3 Priority issues with current laws 17

3.1 Impact of nose-to-tail schedules on driver fatigue 17

3.2 Quantity and quality of sleep attained in major rest breaks 18

3.3 Night time driving and ending shifts at night 18

3.4 Continuous hours of work – including BFM and AFM 19

3.5 Minimum rest times for BFM two-up drivers 21

3.6 Impact of local work 21

3.7 Threshold application of fatigue laws and record-keeping 22

3.8 Driver wellbeing and fitness to work 22

3.9 Unlawful activities 23

3.10 Prioritisation of fatigue issues 24

4 Current data collection activities 26

4.1 Current approach – who collects and publishes data 26

4.2 ATSB operational definition of fatigue 33

4.3 Assessment of current data 34

5 Developing a data framework 37

5.1 Need for a data framework 37

5.2 Why data comparability and accessibility matters 37

5.3 What is the data framework? 38

5.4 Delivering comparable fatigue data 40

5.5 Principles of data collection and research 45

6 Activities the framework could support 48

6.1 Group 1 activities: work diary and commercial data 48

6.2 Group 2 activities: research to measure impact of laws 50

6.3 Group 3 activities: periodic industry surveys 54

7 Project risks and final considerations 56

Appendix A: Glossary **58**
Appendix B: Government databases **59**
Appendix C: Examples of alertness monitoring devices **60**
Appendix D: Example of crash investigation guidelines relating to fatigue **62**
Appendix E: References **64**

Executive summary

The National Transport Commission (NTC) is working with governments, industry and fatigue and alertness experts to develop a national framework to collect and analyse fatigue data to better inform future fatigue and alertness policy.

Without these improvements in data collection, supported by robust and validated research, the baseline data will not be available to support further improvements to fatigue laws.

Context

In May 2014 the Transport and Infrastructure Council considered potential fatigue risks associated with different ways to count 24-hour periods in the Heavy Vehicle National Law (HVNL) for fatigue-regulated heavy vehicle drivers. Governments and industry have not reached consensus on whether amendments to the fatigue rules are warranted without further data demonstrating the case for change. It was therefore agreed that the NTC and the National Heavy Vehicle Regulator (NHVR) should develop a national framework to collect real-life operational data to better inform broader fatigue policy directions in the future, including (but not limited to) the counting time rule.

The Transport and Infrastructure Council approved the project in November 2014. The NTC is committed to advising the Council on recommendations for a national data framework by late 2016.

The project involves identifying critical questions to address, including the impact of current rules and regulations on driver fatigue. Capturing fatigue-related data over longer timeframes would provide more information and evidence on the effectiveness of the current rules and any future proposed changes.

The framework should support data comparability and accessibility.

Consultation to date

In December 2014 the NTC surveyed industry and governments, including police agencies, to understand their issues with the current fatigue regulations and to assess what data is currently collected and for what purposes. In March 2015, we further commissioned advice from fatigue experts in relation to which issues associated with current fatigue regulations in the HVNL the framework should address, and what data should be collected to help inform and improve the assessment of fatigue risk for future policy decision-making.

Initial feedback from industry, governments and fatigue experts is reflected in the regulatory fatigue issues identified, and proposed activities outlined in this discussion paper.

Summary of the fatigue issues

Feedback from stakeholders to date has indicated that the following issues with the current regulations should be prioritised for data collection and research conducted under the framework:

1. Nose-to-tail schedules: assess if there are any residual fatigue risks which can arise from legal patterns of work under the counting time rule. In particular, if the ability under the current rules to work two long periods in a 24-hour period has an unacceptable level of fatigue impairment.

2. Insufficient sleep, including quantity and quality of sleep attained in major rest breaks: data is required to further understand the extent to which heavy vehicle drivers are only resting to the minimum amounts required in the regulations, and the quantity and quality of sleep obtained within the sleep opportunity.

3. Continuous hours of work – including Basic Fatigue Management (BFM) and Advanced Fatigue Management (AFM) options: assess the impact of working additional hours, including BFM and AFM – in particular the impact of working additional hours without an additional sleep/rest opportunity to offset the fatigue risk. One of the most sought after outcomes for the framework is to be able to report statistically on the number of fatigue-related crashes caused by drivers working under BFM or AFM – agencies are not currently recording this information in crash reports.

4. Minimum rest times for BFM two-up drivers: assess the fatigue impact of two-up drivers operating under BFM that are not required to take minimum rest times within 24-hour periods.

5. Night time driving and ending shifts in the early morning: assess the impact of time of day on alertness, particularly when ending a long shift between midnight and 6am.

6. Impact of local work: assess the impact of local work on driver fatigue. In particular, there are two areas of concern raised by stakeholders: 1) fatigue issues associated with working in congested traffic and meeting tight delivery deadlines; and 2) fatigue and enforcement issues associated with working 100+ km and local work and not recording local work in the work diary.

7. Threshold application of fatigue laws and work diary record-keeping: linked to the issue of local work are threshold parameters more generally. This could include an assessment of the 100+ km threshold for work diary record keeping and the 12-tonne threshold for application of the fatigue laws as it applies to the definition of a fatigue-regulated heavy vehicle driver.

8. Driver wellbeing and fitness to work: improve our understanding of driver wellbeing and fitness. Stakeholders have concerns regarding heavy vehicle driver fitness before starting a shift and the over-representation of undiagnosed and untreated medical conditions, including sleep apnoea, in heavy vehicle drivers.

Current data collection and challenges

Data is collected in each jurisdiction, usually based on police data. Across the country, methods of recording fatigue data differ, leading to limitations on national, comprehensive analysis. Comparable and available data would support improved decision-making on policy, ensuring that regulations mitigate the safety risks whilst providing the flexibility that drivers and operators require.

Scoping the data framework

The greatest benefits of a data framework can be achieved through changes to agreed preconditions (primarily terminology), systems and processes. The framework distinguishes between data collection obtained through major crash investigations, police recording of incidents and categorising crashes as fatigue-related for statistical purposes:

1. **When investigating a heavy vehicle crash,** improve how crash investigators identify and categorise fatigue as a contributing factor, by replacing a binary yes/no choice with *fatigue likelihood* and *fatigue impact* scales.
2. **When recording a heavy vehicle crash,** introduce standard three questions that are always asked of the heavy vehicle driver, regardless of whether fatigue was identified as a contributing factor.
3. **When categorising a crash for statistical purposes**, review and nationally implement the operational definition of relative fatigue.

As discussed in **section 5.2**, data generated from these activities should be comparable and available for analysis. This may be integrated within an open data approach or require a data custodian with gate-keeping responsibilities.

Activities the framework could support

The data framework could support a range of data collection and research activities. Guided by the research objectives, potential activities are grouped within three areas.

Group 1 activities – collection and analysis of work diary records and/or commercial fatigue management data.

Police and road agencies interact with heavy vehicle drivers through compliance and enforcement activities. While the priority is to undertake enforcement, investigation or audit activities in a regulatory and compliance context, these interactions provide an opportunity to collect improved fatigue data.

If this approach is adopted, authorised officers would collect 28-day work diary records when a relevant pattern of behaviour is identified during compliance or enforcement activities. A relevant behaviour would be a behaviour that is legal. It could include the identification of nose-to-tail schedules and short rest breaks for BFM two-up drivers.

The provision of commercial fatigue management data by third party service providers to the framework for research analysis is another rich source of driver data, which – properly de-identified and provided with consent – can provide valuable information about driver patterns of behaviour. Commercial systems that capture driver logbook and scheduling data could have a higher value than written work diary records because they are likely to be highly accurate and not provided in an enforcement context.

De-identified copies of the work diary records and/or commercial fatigue management data would be transmitted to a data custodian for analysis of the fatigue and alertness impairment issues and in particular for assessment of the practices of concern in the context of broader work patterns. Data collected may become an input into data modelling undertaken by the Alertness CRC.

Group 2 activities – research to measure impact of specific fatigue regulations.

Harnessing the capabilities of the Alertness CRC and others will enable comparison of different schedules to determine if there are measurable differences in fatigue impairment.

Three research areas are proposed:

- field studies using alertness monitoring devices to scientifically compare fatigue and alertness impact of different schedules (e.g. a comparative analysis of nose-to-tail and conventional shifts; or a comparative analysis of work periods in excess of 12 hours in a 24-hour period)
- objective monitoring of sleep and rest periods in conjunction with sleep/work diaries, to assess the level of sleep drivers are achieving on short and long rest breaks
- using modelling and data fusion capability of the Alertness CRC[1] and other modelling programmes to model fatigue impacts of different work patterns.

Group 3 activities – periodic industry surveys.

These would collect large-scale attitudinal and behavioural data regarding driver and operations' management of fatigue.

If this approach is adopted, large-scale periodic industry surveys would be undertaken to measure industry practices and attitudes. The aim would be to survey and quantify the range of operating schedules and practices across the industry so that baseline risk levels can be established.

A number of industry surveys have been previously undertaken, including driver fatigue surveys such as the reform evaluation surveys undertaken on behalf of the NTC in 2012, and wave surveys commissioned by Transport for New South Wales (TfNSW) every four years.

The periodic surveys could be collected and analysed by a data custodian, or by agencies on behalf of a data custodian. Survey results could also form inputs into the Alertness CRC's data fusion model.

The **following table** summarises which fatigue issues would be supported by these activities.

Issue	Fatigue scales	Standard three Qs	ATSB definition	Work records	Scientific research	Industry surveys
Nose-to-tail	-	-	-	Yes	Yes	Yes
Insufficient sleep	Yes	Yes	-	-	Yes	Yes
Hours of work: BFM/AFM	Yes	Yes	-	-	Yes	Yes
BFM short rest breaks	-	Yes	-	Yes	Yes	Yes

[1] The CRC is developing a physiologically-based model of alertness, sleep and circadian dynamics. This model will be the core element for the development of a Data Fusion System for real-time individual predictions of these dynamics.

Night driving	Yes	Yes	-	Yes	Yes	Yes
Local work	-	-	-	-	Yes	Yes
Threshold applications	-	Yes	Yes	-	-	Yes
Driver wellbeing	-	Yes	-	-	Yes	Yes

Consultation questions

The following consultation questions are provided as a guide only – submissions are encouraged to respond to any element or discussion point raised in the paper.

1. Do you agree with the fatigue issues identified in the discussion paper? Are there other issues that should be included?
2. What is your view on the proposed prioritisation of fatigue issues identified in the discussion paper?
3. What other data collection activities exist in government or industry that the data framework should consider?
4. Do you agree with the need for more comparable and accessible fatigue data to underpin future reforms? If not, what alternative approach do you propose?
5. Do you support an open data approach to fatigue data? Consider in your response the benefits and challenges of open data compared to other data handling approaches.
6. What is your view on the proposed framework methodology relating to proposed terminology and coding, proposed system changes and proposed process changes?
7. What is your view on the validity and characteristics of a fatigue likelihood scale?
8. What is your view on the proposed framework principles?
9. What is your view on the data collection and research activities proposed in the discussion paper?
10. How best should the data framework be funded and governance arranged? Consider in your response organisations that could be best placed to undertake responsibility for the framework.

Next steps

Submissions in response to this discussion paper close **Friday 16 October 2015**.

Submissions will be considered in the development of final recommendations to the Transport and Infrastructure Council.

Based on the decisions of the Transport and Infrastructure Council, a policy paper finalising the data framework will be published in 2016.

1 Context

Key points

The objective of the framework is to collect real-life operational data to better inform future fatigue policy. Feedback is sought on the characteristics of the data framework, proposed data collection and research activities and the regulatory fatigue issues to address.

1.1 Objectives

In November 2014 the Transport and Infrastructure Council endorsed development of the National Heavy Vehicle Fatigue Data Framework as part of the National Transport Commission (NTC) work program, with implementation of the framework by late 2016.

Council endorsement: that the NTC and National Heavy Vehicle Regulator (NHVR) collaborate with industry and governments to develop a national framework to facilitate collecting real-life operational data to better inform future fatigue policy. This would involve an initial consultation phase seeking input from industry and governments to determine a results-driven co-designed project scope.

The framework is anticipated to have four focus areas:

- standardised recording of fatigue in crash investigations
- compliance and enforcement data collection
- research activities to measure the impact of specific fatigue regulations
- periodic industry surveys.

This discussion paper is seeking your feedback on the development of the framework. This includes feedback on what the data framework should achieve, activities the framework should support and the priority fatigue issues the framework should address. It is recognised that some proposed activities would have significant impacts on agency systems and processes – detailed feedback is therefore sought from each agency on what practical steps would need to be taken to achieve framework outcomes.

1.2 Scope of the project

While fatigue issues related to nose-to-tail schedules initiated the project, the scope of the framework is to gather data to support any broader review of fatigue policy settings in the future. This may include:

- NTC research to identify the relationship between fatigue, including the application of specific fatigue rules, and crash risks (based on both collisions and near misses)
- measuring impact and frequency of nose-to-tail schedules on the fatigue risk in the context of other fatigue regulations
- identifying the relationship between specific regulations and fatigue risks, such as night work, fitness for duty and assessment of sufficient sleep opportunity in minimum rest times
- capturing data over longer timeframes
- assessing opportunities for open data to support research
- contributing to a nationally standardised definition of fatigue as a crash-contribution factor, and subsequently improving fatigue crash reporting systems.

Principles underpinning the framework should ensure that data collection and research activities are consistent with privacy principles and are not used for enforcement purposes. Clear governance arrangements should therefore also be implemented as part of the data framework.

1.3 Problem definition

Fatigue is widely acknowledged as a core safety issue in the transport industry (House of Representatives 2000, p. xxix). Heavy vehicles were involved in 220 road fatalities in 2014 (BITRE 2015, p. 2) and yet the true impact of fatigue on these fatalities remains obscured. For example, the Bureau of Infrastructure, Transport and Regional Economics (BITRE) identifies fatal crashes by vehicle type, jurisdiction, area, speed and alcohol in its annual report of heavy vehicle crash data – but not fatigue or driver distraction (2015 p. 24). Likewise, VicRoads' annual analysis of the Victorian road toll does not include any attribution to fatigue, on the grounds that there is insufficient data (VicRoads 2015, p. 10).

National Transport Insurance (NTI) data, which is based on insurance claims of $50,000 or more, indicates that fatigue is a growing problem. NTI's *2015 Major Accident Investigation Report* found that fatigue was the principal contributing factor in 12.8 per cent of crashes, the worst result since 2007, with Western Australia (WA) having the highest proportion of major crashes attributed to fatigue (NTARC, p. 7).

While estimates of the impact of fatigue on crash statistics vary considerably, there is also uncertainty about what causes fatigue. Many factors other than hours worked affect the alertness of a driver, and they include time since the driver last slept, sleep quantity and quality, alcohol consumption, external stressors and a driver's health and wellbeing.

Furthermore, how current regulations impact fatigue remains to be tested. Without improvements to data collection, supported by robust and validated research, the baseline data is not available to support further improvements to fatigue laws. Sufficient data is required to underpin any future reforms of the fatigue regulations in the HVNL – this includes, but is not limited to, the safety impact of the counting time rule.

Data on driver fatigue is collected in each jurisdiction, usually based on police data. Across the country, methods of recording fatigue data differ, leading to limitations on national, comprehensive analysis. Comparable and available data would support improved decision-making on policy, ensuring that regulations mitigate the safety risks whilst providing the flexibility that drivers and operators require.

The laws are also complex and difficult to comply with. The heavy vehicle driver in Australia has to comprehend complex regulations in relation to work and rest hours, night rest breaks and overlapping 24-hour counting periods.

Technology is available to manage fatigue. Technology includes vehicle and alertness monitoring devices and fatigue management tools which could include, for example, electronic work diary (EWD) information in the longer term. But operators do not always have the resources available to introduce sophisticated software to manage fatigue or compliance with work and rest hours. Furthermore, the greater the complexity, the greater the focus of industry on compliance with rules and regulations rather than managing driver fatigue

1.4 Background

The regulation of heavy vehicle driver fatigue in Australia has been in a process of reform from the late 1990s. In 2000, the House of Representatives delivered its landmark report *Beyond the Midnight Oil: an inquiry into managing fatigue in transport*, which found merit in an overarching duty not to drive while impaired by fatigue and in moving towards a more outcomes-based approach towards fatigue management. In 2008, Heavy Vehicle Driver Fatigue National Model Legislation implemented a three-tier approach to fatigue management with the introduction of standard hours, basic fatigue management (BFM) and advanced fatigue management (AFM). This approach was replicated in the HVNL.

The HVNL regulates heavy vehicle driver fatigue in every Australian jurisdiction except WA and the NT.

Fatigue management in the HVNL

The objectives of the HVNL are to establish a national scheme for facilitating and regulating the use of heavy vehicles in a way that:

- promotes public safety
- manages the impact of heavy vehicles on the environment, road infrastructure and public amenity
- promotes industry productivity and efficiency in the road transport of goods and passengers by heavy vehicles
- encourages and promotes productive, efficient, innovative and safe business practices.

Section 4 of the HVNL provides that these objectives are to be achieved through a regulatory framework with various mechanisms. In relation to fatigue management, this includes a general duty not to drive while impaired by fatigue, chain of responsibility obligations, maximum work and minimum rest rules and record-keeping requirements.

What is fatigue?

The HVNL primarily defines fatigue based on how a driver feels and observation of driver behaviour. Fatigue includes (HVNL, s. 223), but is not limited to:

(a) *feeling sleepy; and*
(b) *feeling physically or mentally tired, weary or drowsy; and*
(c) *feeling exhausted or lacking energy; and*
(d) *behaving in a way consistent with paragraph (a), (b) or (c).*

The HVNL does not define fatigue based on inputs that cause or contribute to fatigue (such as hours of sleep the previous night). However, the legislation does allow the courts to consider causes of fatigue and any relevant body of fatigue knowledge. At present, there is no scientifically measurable biomedical test of a driver's alertness incorporated in the definition of fatigue.

Thresholds in the HVNL

There are important thresholds in the HVNL that determine whether a driver is regulated under the fatigue laws. Thresholds parameters relate to both vehicle type and record-keeping requirements based on distance from base.

A driver is a fatigue-regulated heavy vehicle driver if the vehicle is a:

- vehicle with a gross vehicle mass (GVM) of more than 12 tonnes
- combination when the total of the GVM is more than 12 tonnes
- bus weighing more than 4.5 tonnes fitted to carry more than 12 adults (including the driver); or
- a truck, or combination including a truck, with a GVM of more than 12 tonnes with a machine or implement attached.

While the general duty not to drive while impaired by fatigue, chain of responsibility obligations and work and rest rules apply to operations undertaken by any vehicles that meet these GVM sizes, the record-keeping requirements only apply to 100+ km work or drivers operating under BFM or AFM (HVNL, s. 294).

A fatigue-regulated heavy vehicle driver is undertaking 100+ km work if the driver is driving an area with a radius of more than 100 km from a driver's base (HVNL, s. 289). Drivers undertaking local work ('100 km work') have less onerous record-keeping requirements and do not have to carry a work diary in the vehicle. The NHVR also has exemption powers in the HVNL and to date has exempted primary production transport from work diary requirements up to 160 km from the drivers' base in all participating jurisdictions except Victoria.

Employers also have general duties to ensure a safe workplace under work, health and safety laws in each jurisdiction.

Work and rest hour options

There are three work and rest options that a fatigue-regulated driver may be working under:

1. Standard work and rest arrangements apply to all fatigue-regulated drivers not working under BFM, AFM or an exemption. Under standard hours, a solo driver can work up to 12 hours in a 24 hour period and must:
    - comply with minimum rest requirements for 5½ , 8 and 11-hour periods
    - have at least seven hours of continuous stationary rest every 24 hours
    - have at least 24 hours of continuous stationary rest every seven days
    - have at least four night rest breaks in every 14 days, two of which must be consecutive.
2. BFM allows up to 14 hours in a 24-hour period and greater flexibility in relation to rest breaks. BFM specifies controls required to mitigate the risk associated with the increased likelihood of fatigue, such as night work restrictions. To access BFM, operators must be accredited in the National Heavy Vehicle Accreditation Scheme (NHVAS) and comply with six BFM standards relating to:
    - scheduling and rostering
    - fitness for duty
    - fatigue knowledge and awareness
    - responsibilities
    - internal review
    - records and documentation.

    Short rest break requirements do not apply to BFM drivers engaged in two-up operations.
3. AFM allows for flexibility in work schedules. An NHVAS-accredited operator may propose a trip plan for which risks associated with longer working times are mitigated by additional risk controls. Operators are required to develop a specific organisational safety case that sets out how the operator and it's drivers safely manage the fatigue risks. Operators must also comply with the six BFM standards, in addition to the following standards:
    - health
    - workplace conditions
    - management practices
    - operating limits.

The NHVR has led recent changes to AFM. These have included the introduction of an AFM risk classification system to make it easier for operators to assess the proposed level of fatigue risk. This includes a template approach which incorporates counter-measures to offset risks identified with a specific schedule.

Counting time rule – nose-to-tail schedules

Maximum work and minimum rest rules are based on 24-hour periods. As a consequence, when a 24-hour period begins and ends becomes an important issue. This is known as the counting time rule. It is not feasible for a 24-hour period to start from midnight, because that could enable a long period of work before midnight followed by a long period of work directly after midnight. Therefore a number of alternative approaches have been explored or implemented, including counting a 24-hour period from the end of a major rest break, from the end of any rest break and from any point within the work diary. All of these approaches enable overlapping 24-hour periods.[2]

In 2011, the then Australian Transport Council (ATC) agreed to adopt a single counting time rule in the fatigue regulations, which was carried over to the HVNL. The method chosen was for periods of 24 hours or more to be counted forward only at the end of a relevant major rest break.

As a consequence of the ATC's decision, it is possible that a driver can work *nose-to-tail schedules* where, for example, a driver on standard hours can legally exceed 12 hours of work in some

[2] For more information about nose-to-tail schedules see **section 3.1**; and NTC *Counting Time and Residual Risk Final Report*, 2014.

24-hour periods by the placement of short work periods that enable the driver to work for seven hours, break for seven hours and then work a further seven hours.

Victoria's and South Australia's (SA) agreement to the ATC decision was based on the NTC undertaking a subsequent review of the residual risk of nose-to-tail schedules, to determine whether the additional risk of nose-to-tail schedules has an unacceptable impact on road safety.

Expert fatigue advice

The residual risk review of the counting time rule was undertaken by the NTC in 2013-14, in close consultation with road agencies, police and operators. Fatigue experts advised on whether there was a greater fatigue risk posed by nose-to-tail schedules. In response:

> *All experts acknowledged that nose-to-tail schedules can potentially present an increased fatigue risk. However, the advice suggests that the increase in fatigue risk posed by nose-to-tail schedules may vary from modest to significant depending on the details of the actual work schedule (*NTC 2014, p. 8).

The fatigue advice identified that the risk attributable to nose-to-tail schedules was dependent on a number of factors, including:

a) insufficient sleep – taking only the minimum seven-hour major rest break between long work periods, as the driver is likely to have six hours or less of actual sleep

b) long work shifts – where a single work opportunity is longer than 12 hours

c) circadian impacts – work schedules that include night work, sleeping during the day and starting shifts in the early morning or at significantly different times on consecutive days

d) frequency of nose-to-tail schedules – particularly consecutive nose-to-tail schedules.

One of the main challenges in determining the fatigue risk is a lack of data, not only in relation to the prevalence of nose-to-tail schedules, but also linking crash and incident data to these work practices. Without data, it is difficult to make a definitive judgement about the nature and extent of the fatigue risk and what steps might be required to mitigate the risk (NTC 2014, p. 8).

Council's recommendation in 2014

The NTC published the *Counting Time and Residual Fatigue Risk* report in October 2014. The report summarises the expert advice and documents the challenge of measuring the impact of nose-to-tail schedules on fatigue impairment.

Ministers agreed with the report's recommendation that there should be no policy changes until a framework is developed to facilitate collecting real-life operational data to better inform future fatigue policy, including nose-to-tail schedules.

Fatigue management in other Australian jurisdictions

The data collection and research activities undertaken as part of the data framework are not limited to jurisdictions participating in the HVNL. Data and research findings may be equally valuable for other legislative regimes that regulate heavy vehicle driver fatigue.

The WA fatigue management regulations are contained in Occupational Safety and Health laws and are administered by the Department of Commerce (Worksafe). The regulations require drivers to comply with *the Code of Practice: Fatigue Management for Commercial Vehicle Drivers 2004* which includes an online assessment. The Western Australian Heavy Vehicle Accreditation (WAHVA) scheme, managed by Main Roads WA, is mandatory for individuals and organisations that require a permit or notice to perform any transport task as part of a commercial business. Accreditation involves fatigue and vehicle maintenance modules, which operators are required to incorporate into their daily work practices (Main Roads WA 2015). Mass, Dimension and Loading modules are currently being implemented.

Fatigue regulations in WA require that a commercial vehicle driver can work no more than 17 hours between breaks of at least seven continuous hours, and that the driver must have 27 hours of non-work time in any 72-hour period. If 17 hours are worked per day on two consecutive days, the

driver can work no more than 11 hours the next day. There must be at least two periods of 24 continuous hours of non-work time in any 14-day period (NHVR 2015).

The NT has adopted an outcome-based approach to managing driver fatigue. Under NT work health and safety laws, employers have an obligation to provide a safe workplace (NHVR 2015) rather than regulate driving hours under transport law.

Alertness CRC

The proposed framework will be supported by the Alertness Safety and Productivity Cooperative Research Centre (Alertness CRC). The Alertness CRC brings together industry, academics, technology developers and end-users (such as NTC) to develop predictive tools to reduce occupational fatigue, and improve alertness, safety and productivity.[3] **Appendix C** provides two examples of alertness monitoring devices that are part of the Alertness CRC.

The Alertness CRC has four major platform projects:

1. Laboratory-based development of systems and biomarkers to assess, predict and monitor circadian, sleep and alertness states.

2. Modelling and software development for prediction of alertness, schedule optimisation and a data fusion system for the estimation, prediction and control of individual alertness dynamics.

3. Assessing individual vulnerability to shift work and integrated sleep health and alertness management interventions in occupational settings.

4. Sleep disorder phenotyping.

The Alertness CRC is developing a physiologically-based model of alertness, sleep and circadian dynamics. This model will be the core element for the development of a Data Fusion System (DFS) for real-time individual predictions of these dynamics.

While the data framework can apply CRC research to measure the impact of fatigue regulations, the longer-term challenge is to develop a simple, repeatable indicator of when a person is too tired to drive safely that can be applied in the workplace or at the roadside.

If science can achieve this, governments can work with industry and the community to develop a straightforward performance-based law that is simple enough to be easily understood by those who need to comply with the law and those who enforce the law.

1.5 Method

Method adopted in this paper
Chapter 3 identifies and prioritises issues with current fatigue regulations that could be addressed in the data framework
Chapter 4 identifies current data collection activities, inconsistencies and gaps
Chapter 5 outlines benefits of a data framework and how it can be implemented
Chapter 6 discusses proposed data collection and research activities

Timeframes and actions to implement the data framework and the data collection and research activities will be developed as part of the final policy paper.

[3] More information about the Alertness CRC objectives and research activities can be accessed on the CRC website.

1.6 Overview of the issues and potential approaches

This section provides an overview of the priority fatigue issues and potential activities relevant to each. The priority fatigue issues are discussed in more detail in **chapter 3**.

Nose-to-tail schedules

Aim: to investigate any residual fatigue risks which can arise from legal patterns of work which are permitted under the counting time rule. In particular, if the ability under the current rules to work two long periods in a 24-hour period has an unacceptable level of fatigue impairment.

Potential approaches

- Field studies using alertness monitoring and actigraphy devices to measure impact of nose-to-tail schedules.
- Work diary data collection and analysis.
- Periodic industry surveys.

Insufficient sleep

Aim: to understand the impact of minimum rest breaks on driver sleep patterns, and in particular the quantity and quality of sleep attained by drivers and the extent to which minimum rest breaks sufficiently reduce sleepiness to drive safely.

Potential approaches

- Fatigue likelihood and fatigue impact scales in crash recording.
- Standardised crash recording questions to collect information about sleep.
- Monitoring of driver sleep quantity and quality during major rest breaks.
- Periodic industry surveys.

Additional hours of work in BFM and AFM

Aim: to measure the impact of working additional hours under BFM and AFM with current risk offsets. Further, to report on the number of fatigue-related crashes caused by drivers working under BFM or AFM (agencies are not currently recording this information in crash reports).

Potential approaches

- Fatigue likelihood and fatigue impact scales in crash recording.
- Standardised crash recording questions to collect information about BFM and AFM.
- Field studies using alertness monitoring devices to measure impact of BFM and AFM.
- Periodic industry surveys.

Minimum rest times for BFM two-up drivers

Aim: to assess the fatigue impact of two-up drivers operating under BFM, who are not required to take minimum rest times within 24-hour periods.

Potential approaches

- Standardised crash recording questions to collect information about sleep.
- Work diary data collection and analysis.
- Monitoring of driver sleep quantity and quality during BFM two-up driving.
- Periodic industry surveys.

Night time driving

Aim: to understand the impact of night driving on alertness, particularly when ending a long shift in the early morning between midnight and 6am; and to assess how the placement of rest breaks can impact the restorative benefits of sleep and maximise alertness.

Potential approaches

- Fatigue likelihood and fatigue impact scales in crash recording.
- Standardised crash recording questions to collect information about sleep.
- Monitoring of driver alertness during night and day.
- Modelling and data fusion analysis.
- Periodic industry surveys.

Impact of local work

Aim: to measure the impact of local work on driver fatigue: 1) fatigue issues associated with working in congested traffic and meeting tight delivery deadlines; and 2) fatigue and enforcement issues associated with working 100+ km and local work and not recording local work in the work diary.

Potential approaches

- Monitoring of driver alertness undertaking local work in a stressful road environment.
- Periodic industry surveys.

Threshold application of fatigue laws and work diary record-keeping

Aim: to assess the impact of current thresholds related to GVM and 100+ km work on driver fatigue. This could include assessing the extent to which record keeping reduces fatigue.

Potential approaches

- Standardised crash recording questions to assess if fatigued drivers are on standard hours, BFM or AFM – and consequently if drivers not keeping a work diary are over-represented.
- Implementation of refreshed operational definition of relative fatigue – because improved proxy definitions may provide insight into scale of fatigue in local areas.
- Periodic industry surveys.

Driver wellbeing and fitness to work

Aim: to improve our understanding of driver wellbeing and fitness, notably in relation to fitness to work before starting a shift and the over-representation of undiagnosed and untreated medical conditions, including sleep apnoea, in heavy vehicle drivers. Fitness to work could be better understood by operators surveying drivers before starting a shift and asking questions relating to sleep quantity and quality, and family, health and lifestyle issues that affect the wellbeing of drivers.

Potential approaches

- Assess individual vulnerability to fatigue and responsiveness to alertness management interventions.
- Sleep disorder phenotyping.
- Periodic industry surveys.

2 Consultation

Key points

Early feedback on the development of a data framework has been received through government and industry surveys, expert advice and the *Alertness Summit 2015*. Submissions in response to this discussion paper close **Friday 16 October 2015**.

2.1 Early feedback we have received

To help inform development of this paper, in early 2015 the NTC surveyed governments and industry to seek their views on the development of a data framework. In addition, we commissioned expert advice on the key issues. Unless otherwise stated, the views expressed by individuals or organisations in the paper are based on responses to these surveys or the expert opinions.

Baseline government survey

We circulated a data framework survey to police, road agencies and transport departments. The survey established a baseline of what fatigue data jurisdictions currently collect, identified regulatory fatigue issues of concern to governments, and identified data framework options.

Respondents included the Commonwealth Department of Infrastructure and Regional Development, Queensland (Qld) Department of Transport and Main Roads (TMR), Qld Police Service, Transport for New South Wales (TfNSW), VicRoads, Victoria Police, Tasmanian Department of State Growth, SA Department of Planning, Infrastructure and Transport (DPTI), the Australian Capital Territory (ACT) Government, the NT Government and Main Roads WA. None of the respondents requested anonymity. The NHVR provided feedback separately.

Summary of government responses

Governments support development of a data framework. Responses indicate that a common definition of a fatigue crash has not been consistently applied and there is opportunity to improve fatigue data collection and recording. This includes improvements in understanding and measuring fatigue as a contributing factor in heavy vehicle crashes and improvements in understanding the impact of specific regulations on driver fatigue (such as recording when a fatigued driver was working under BFM).

Common issues with the current fatigue regulations include nose-to-tail schedules, length of the major rest break, and work and rest rules for the BFM option. Unlawful behaviours were also identified as issues of concern, including the concealment of local work by 100+ km drivers, (un)loading during periods recorded as being rest, and the use of illicit drug-taking.

Costs associated with system changes were seen as the most significant barrier to introducing a framework or further harmonising crash data recording.

Baseline industry survey

We developed multiple-choice and free-text survey questions with input from the Australian Trucking Association (ATA) and NatRoad. The survey was hosted by survey monkey and made available on the NTC website. The survey was also promoted by the ATA and NatRoad. The survey established a baseline of what fatigue, crash and incident data operators collect and how operators assess fitness to work. The survey also identified fatigue issues for industry and identified data framework options.

There were 107 respondents. Over half were operators, a quarter were drivers and less than 10 per cent were trade associations. One respondent was a freight customer. Many questions were unanswered and the results can only be considered indicative of industry views.[4]

[4] The survey questionnaire and aggregated survey responses are available on request from the NTC.

Summary of industry responses

Respondents to the industry survey on the whole welcomed the collection and use of higher-quality data on crash incidents and near misses, with over half of respondents collecting some data on crash incidents and near misses. The complexity of the fatigue laws was a clear and consistent theme identified by industry respondents. Coupled with manual systems and generally an under-reliance on technology solutions, these are the two key factors in the survey that impact operators' management of fatigue. The majority of respondents rely on manual systems, driver interviews and observational information to assess driver fatigue. Only around a fifth of respondents reported using outward and inward-facing camera and other technologies to record driving style and incidents.

Managing driver fatigue and improving work health and safety were the two most reported reasons for data collection.

Highly-rated fatigue issues: a third of respondents identified driver health and wellbeing as a significant contributory factor. Highly-rated factors contributing to fatigue from their perspective was poor fitness for work, especially pre-trip fatigue caused by insufficient sleep and rest during the re-set rest break. Other contributing factors rated highly by respondents included the availability and quality of rest stop areas and the quality of sleep obtained on a driver's rest break. Around a third of respondents also regarded a driver's work schedule as a crucial fatigue risk factor.

Other fatigue issues: a fifth of respondents identified night driving and the type of journey as significant contributory factors. Examples given of the type of journeys that contribute to driver fatigue include long-distance driving and local work. A similar number of respondents identified the driver's first shift after a long break as a high-risk period. A small number of respondents identified the length of the driver's rest break as an issue.

The importance of delays at distribution centres was also a suggested factor that should be assessed for correlation with crashes and near misses.

Another issue is the complexity of the fatigue laws which makes it more challenging to manage fatigue. Linked to this is the issue of regulations that require drivers to rest when they are not tired. For example, one operator reported that driver confusion about how a seven-hour rest period needs to be taken was causing their drivers to rest when they were not ready for quality sleep.

Respondents were concerned that sensitive commercial and personal data collected as part of the framework will be misused or not kept confidential, and that the data might be used for enforcement purposes. If not addressed, these issues will be a barrier to industry participating in data collection and research activities.

Expert advice

In March 2015, we commissioned expert advice from Professor Narelle Haworth,[5] Professor Ann Williamson,[6] Dr Mark Howard,[7] and Professor Drew Dawson[8] on the following matters:

- fatigue issues with current fatigue regulations in the HVNL
- additional practices and behaviours that should be addressed
- data that should be collected for future policy development
- potential Alertness CRC research activities.

We also received advice on whether the Australian Transport Safety Bureau (ATSB) operational definition of a fatigue-related crash should be adopted nation-wide, or else significantly improved.

Summary of expert views

The expert advice recognised fatigue risks linked to insufficient rest opportunities in the regulations, night driving (especially work periods that end between midnight and 6am), length of work opportunities and threshold issues relating to the exclusion of local work. Identifying whether there

[5] Centre for Accident Research and Road Safety, Queensland University of Technology.
[6] Transport and Road Safety Research, School of Aviation, University of New South Wales.
[7] Institute for Breathing and Sleep, Austin Hospital.
[8] Appleton Institute, Central Queensland University.

were adequate counter-measures in place to offset additional work permitted under BFM was also a significant issue. Similarly, concerns were raised that the risk classification system and counter measures adopted in the refreshed AFM have not yet been validated.

In relation to the development of a data framework, experts advised the framework needs to have clearly articulated high-level goals and specific objectives, with a clear implementation path to realisation. The data framework should be organised around collection of scientific evidence, based on a scale of fatigue impairment.

There was agreement the ATSB operational definition of fatigue could be refined to reflect a standardised criteria and methodology to determine the fatigue likelihood of an incident.

Alertness Summit

In June 2015, the NTC and the Alertness CRC co-hosted the *Alertness Summit 2015: a new framework driving heavy vehicle safety*. The summit brought together scientists and alertness monitoring technology providers with police, road agencies, the NHVR, trade associations and heavy vehicle operators. The aim of the summit was to identify factors that contribute to increased fatigue risk, including feedback on what data is required to assess the effectiveness of current fatigue rules.

The *Alertness Summit 2015* was an opportunity to share different perspectives on the challenges of fatigue policy and data collection.

A major theme explored in the summit was consistent and accurate terminology. The Alertness Summit canvassed a number of matters relating to drowsiness and a propensity to sleep. There was also an extensive review of the term fatigue and how it is applied in the literature, which highlighted how the term fatigue is applied in different ways and with different meanings. This was valuable, but it was also recognised the NHVR and enforcement agencies need to apply the concept of fatigue as it is defined in HVNL.

The HVNL applies the term fatigue, but within the definition sits a wide range of characteristics: including sleepiness, drowsiness and feeling tired or weary. Each outcome has its own causes, symptoms and treatments. For example, fatigue in the sense of weariness could be caused by driving for a long time, but the driver may not be sleepy and the treatment would be a change of task, not sleep. Alternatively, the only treatment for a driver with a high propensity to fall asleep—that is, a driver who is feeling sleepy—is to sleep. Data analysis needs to be clear about which characteristic is being considered and the terminology should be consistently applied.

Operators at the summit recognised the importance of reform and the need for a compelling evidence base. A key challenge from industry's perspective is reflecting the diversity of the industry in the research findings – freight transport includes a wide range of business models and schedules, including dynamic courier operations and scheduled overnight interstate trunk routes. Where relevant, this complexity should be factored into the data collection and research activities.

2.2 Consultation

We are seeking submissions on this discussion paper by **Friday 16 October 2015**. We will consider submissions when developing recommendations to the Transport and Infrastructure Council.

Questions to consider

The following consultation questions are provided as a guide only. Submitters are encouraged to respond to any element or discussion point raised in the paper.

1. Do you agree with the fatigue issues identified in the discussion paper? Are there other issues that should be included?
2. What is your view on the proposed prioritisation of fatigue issues identified in the discussion paper?
3. What other data collection activities exist, in either government or industry, which the data framework should consider?

4. Do you agree with the need for more comparable and accessible fatigue data to underpin future reforms? If not, what alternative approach do you propose?
5. Do you support an open data approach to fatigue data? Consider in your response the benefits and challenges of open data compared to other data handling approaches.
6. What is your view on the proposed framework methodology relating to proposed terminology and coding, proposed system changes and proposed process changes?
7. What is your view on the validity and characteristics of a fatigue likelihood scale?
8. What is your view on the proposed framework principles?
9. What is your view on the data collection and research activities proposed in the discussion paper?
10. How best should the data framework be funded and governance arranged? Consider in your response organisations that could be best placed to undertake responsibility for the framework.

How to submit

Any individual or organisation can make a submission to the NTC.

To make an online submission, please visit www.ntc.gov.au and select 'Submissions' from the top navigation menu.

Or, you can mail your comments to:

Heavy Vehicle Compliance and Technology Team
National Transport Commission
Level 15/628 Bourke Street, Melbourne VIC 3000.

Where possible, you should provide evidence, such as data and documents, to support your views.

Unless you clearly ask us not to, we will publish all submissions online. However, we will not publish submissions that contain defamatory or offensive content.

The *Freedom of Information Act 1982 (Cwlth)* applies to the NTC.

3 Priority issues with current laws

Key points

Stakeholders are concerned about the fatigue impact of nose-to-tail schedules, the sleep opportunity within minimum rest breaks, and work and rest rules for BFM. Cutting across these regulatory issues are common themes: that the rules are too complex and that drivers' health and wellbeing needs to be taken into greater consideration.

Feedback to date from industry, road agencies, police and fatigue experts has indicated that the following issues with the current regulations should be prioritised for data collection and research conducted under the framework.

3.1 Impact of nose-to-tail schedules on driver fatigue

Victoria and SA have strongly advocated that the data framework should investigate any residual risk that may arise from patterns of work permitted under the current counting time rules that allow nose-to-tail schedules.

Victoria Police officials indicated their view that an immediate step to improving fatigue management would be to amend the counting time rule which currently allows a driver on standard hours to work up to 16.25 hours within a 24-hour period, up to four times in an eight-day period.[9]

Three of the four experts refer to nose-to-tail schedules as an important issue to resolve. Dr Howard advised these schedules share risks in common with other sequential night shifts and rotating shifts, which are 'associated with regular reduced sleep with a compounding impact on fatigue' (Howard 2015, p. 2).

Professor Williamson described the risk of nose-to-tail schedules as 'high concentrations of work [with] too little time between shifts' and advised that further research is needed to gauge the degree to which fatigue risk is increased in nose-to-tail schedules. It is also important to establish how often and how consecutive these shifts are worked (Williamson 2015, pp. 1-2). This view was reflected in earlier expert advice that the impact of nose-to-tail schedules depends on a range of other factors, including:

- quality and quantity of sleep, particularly in the major rest break between the two longer work periods
- long work shifts
- circadian impacts
- the frequency of nose-to-tail schedules, particularly consecutive nose-to-tail schedules.

Furthermore, industry has in the past indicated that while nose-to-tail schedules are possible, operators do not roster in this manner because they are inefficient. (A standard hours driver that works for eight hours in the 8½ hours immediately following a seven-hour major rest break can then only work for an additional 4 hours in the following 15½-hour period.)

In their advice to the NTC in relation to the residual fatigue risk of nose-to-tail schedules, Dr Howard, Dr Anderson and Professor Rajaratnam from Monash University suggested that protecting or increasing the length of the sleep opportunity between shifts should be the primary risk mitigation approach for managing the risk associated with nose-to-tail schedules.

Given the inter-relationship between the fatigue impact of nose-to-tail schedules and these wider contributing factors, it is appropriate the data framework should evaluate nose-to-tail schedules in the broader context of these contributing factors. This approach is consistent with Professor Dawson's advice that the data framework should develop platform data to enable a broad level of data collection rather than focus on short-term data needs to focus on very specific issues 'related to relatively transient regulatory concerns (Dawson 2015, p. 1).

[9] An alternative option may be to reinstate the rule previously adopted in Victoria and South Australia where 24-hour periods are counted from the end of *any* rest break. However this results in several overlapping 24-hour periods being counted.

3.2 Quantity and quality of sleep attained in major rest breaks

Related to nose-to-tail schedules is the quantity and quality of sleep of drivers. One of the principal issues raised by governments and fatigue experts is the length of major rest breaks, and if the sleep opportunity afforded by the regulations provides sufficient overhead for the quantity and quality of sleep needed for drivers to manage their fatigue. Victoria Police in particular stressed the adequacy of seven-hour major rest breaks as an issue.

One of the complexities of addressing insufficient sleep is that the optimum amount required varies between people. NTC guidelines provided to industry in 2007 acknowledged this issue, and suggested that 'the average daily sleep required for an adult generally varies between six to eight hours. People who have less sleep than necessary will build up a sleep debt' (NTC 2007, p. 7). The critical issue has been to regulate major rest breaks to ensure a median sleep requirement can be attained.[10] Hence, in the HVNL a major rest period for a driver on standard hours is seven hours and a major rest period for a driver on BFM is six hours.

The issue raised by stakeholders is that this sleep opportunity is insufficient, and that a minimum of seven hours' sleep every 24 hours is required to provide sufficient 'rest, recuperation and recovery from work (Williamson 2015, p. 2). In addition, Professor Williamson advised that sleep quality is known to be poorer for daytime sleep and longer periods of rest may be required if a driver is taking a major rest break during daylight hours. From Professor Williamson's perspective, this means there is a 'very strong rationale for investigating the effects of the length and timing' of different-length major rest breaks on driver fatigue (Williamson 2015, p. 2).

Dr Howard advised that a person who experiences less than five hours of sleep increases their risk of being involved in a serious crash the following day by threefold. While it is not possible to always measure adequate sleep duration and quality, Dr Howard advised that restricting a driver's sleep opportunity to seven hours ensures they will have restricted sleep and less than optimal alertness.

Data is required to further understand the extent to which heavy vehicle drivers are only resting to the minimum amounts required in the regulations, and the quantity and quality of sleep obtained within the sleep opportunity. This includes such factors as the period in which it takes to fall asleep: Dr Howard advised that even in optimal sleeping environments, the 'normal time taken to fall asleep is 15 minutes and during a period available for sleeping around 85 per cent is spent sleeping' (Howard 2015, p. 3). Further, personal activities such as eating and washing reduce the amount of time a driver spends asleep within the sleep opportunity. According to earlier studies, driver schedules allowing an eight-hour break can result in average sleep duration of around five hours and 20 minutes, or 66 per cent of available time. Dr Howard is therefore concerned that sleep opportunity breaks of seven hours may be restricting many drivers to less than five hours of sleep between major work periods. This limited sleep 'increases the frequency of lapses in attention and increases crash risk by threefold' (Howard 2015, p. 3).

Professor Haworth also emphasised the importance of rest between work opportunities, particularly if that rest period is less than seven hours. She advised the current major rest break regulation in the HVNL is a significant issue to be addressed.

The impact of smaller rest breaks and split rest breaks was also raised. While smaller rest breaks help reduce some of the effects of fatigue – stemming the monotony of the driving task in particular – a rest break without sleep will not reduce a driver's sleep debt. Dr Howard advised their impact is transient and has only a limited and temporary impact on overall fatigue. To optimise rest breaks, it is therefore advised that drivers take rest breaks when they are most likely to be fatigued, as well as to take breaks that are long enough to provide actual sleep opportunity. To this end, further research could indicate 'the optimal placement and duration of breaks/naps in operational settings and their impact on reducing fatigue' (Howard 2015, pp. 204).

3.3 Night time driving and ending shifts at night

The body has natural rhythms that are repeated approximately every 24 hours – this is called the body clock or circadian rhythm. The circadian rhythm regulates sleeping patterns, body temperature, hormone levels, digestion and many other functions.

[10] Recognising that drivers who need more sleep should ensure that they do so under a fatigue management plan.

The circadian rhythm programs a person to sleep at night and stay awake during the day. Body temperature drops during the night resulting in sleepiness, and rises during the day to assist feeling alert. The circadian rhythm is controlled partly by light and dark and partly by what activities are undertaken. Broadly speaking, our alertness is reduced in two periods: between midnight and 6 am and in the early afternoon between 2pm and 4pm. Drivers working during the night (the circadian low point) are routinely exposed to conditions that reduce the quantity and quality of sleep (NTC 2007, p. 7). The person working at night and sleeping during the day will sleep less and less well. A study of truck drivers in the United States cited by Dr Howard found the average sleep duration in those drivers working regular 13-hour night shifts was less than four hours in every 24-hour period (Howard 2015, p. 3).

Both research and crash statistics consistently suggest that fatigue impairment is higher during the circadian low periods. Combined with hours awake and quantity and quality and of sleep in the previous 24 and 48 hours, the circadian rhythm is a key factor in fatigue management.

Dr Howard referenced reports that indicated that the risk of involvement in a crash between 2 am and 5 am increases more than fivefold, irrespective of how much a person has previously slept.

Professor Williamson advised that night work is acknowledged to be of higher fatigue risk. It is therefore important to 'investigate the effects of the amount of night work allowed under standard hours and BFM' (Williamson, p. 2). Both inadequate night sleep and instances of work opportunities finishing between midnight and 6 am were two priority areas identified by Professor Haworth (2015, p. 3).

Linked to the issue of night driving is the adequacy of BFM counter-measures. For example, Professor Dawson acknowledged the importance of the issues relating to 'whether the additional risk controls associated with BFM are sufficient to counter the increased likelihood of fatigue due to longer shift durations - especially at night' (Dawson 2015, p. 4).

3.4 Continuous hours of work – including BFM and AFM

Stakeholders and experts raised the issue of prolonged continuous work—and linked to this, additional hours of work under BFM and AFM. TfNSW and VicRoads raised concerns regarding road trauma associated with heavy vehicle drivers using BFM and AFM permitted schedules to drive longer hours. TMR seeks better information to correlate accredited drivers to crash data.

Prolonged continuous work

In addition to additional hours of work permitted under BFM and AFM, Professor Haworth and Dr Howard identified prolonged periods of continuous work and lengthy work periods interspersed with insufficient sleep and rest as an issue in the current regulations.

Dr Howard advised that fatigue is impacted both by time-on-task and cumulative duty time effects, particularly with work duration of more than 10 to 12 hours. This may result in some schedules in standard hours, BFM or AFM options of prolonged continuous work periods of more than 10 hours putting drivers at risk of deteriorating performance.[11]

Prolonged continuous work periods may extend the time in which a driver remains awake – depending on the extent to which a driver uses rest periods to sleep. If a person remains awake for 17 hours, Dr Howard advised, his or her performance will deteriorate to be equivalent to that at an alcohol level of 0.05 per cent.[12]

[11] Particularly night-time driving, when 'the number of out of lane events increasing by fourfold after driving for 8 hours and increases evident after four hours of driving.' Howard M, 2015, *Advice to the National Transport Commission,* page 4.
[12] A person remaining awake for 24 hours is comparable with a BAC of 0.08-0.10 per cent: ibid.

Adequacy of sleep and rest opportunity for drivers using BFM

BFM allows fatigue-regulated drivers to perform significantly more work than drivers under standard hours. This greater work opportunity is available:

> *In terms of the length of the continuous work period (6 hours rather than 5 hours in standard hours) and the length of the work period in each 24 hours (14 hours rather than 12 hours in Standard) without increasing the amount of stationary rest time in 24 hours* (Williamson 2015, p. 2).

Over seven days, drivers under BFM may work a maximum 84 hours compared to drivers under standard hours who can work a maximum 72 hours.

In Professor Williamson's view, these additional hours of work are likely to increase fatigue risk. While BFM has more sleep opportunities at night (because it places more limits on the amount of night work that can be undertaken over seven days), there is insufficient evidence demonstrating 'whether, and the extent to which, this night work limit offsets fatigue risk under BFM'. This issue, Professor Williamson therefore advised that additional work hours under BFM needs to be evaluated (p. 2).

Professor Dawson also advised that BFM needs to be reviewed 'with the specific goal of determining whether the risk offsets associated with entry to the BFM program are sufficient to offset the additional risk over and above standard hours' (Dawson 2015, p. 4).

Professor Haworth advised all work and rest options, including BFM, should be comprehensively reviewed to determine whether drivers experience:

- insufficient time in breaks during work periods
- infrequent breaks from driving
- rest between work opportunities of less than seven hours
- inadequate night sleep
- work opportunities finishing between midnight and 6am
- work opportunities that are too long (2015, p. 3).

Adequacy of sleep and rest opportunity in AFM

AFM schedules are bound by outer limits of work, but operators accredited under AFM can design their own schedules by offsetting fatigue risk with sleep, rest and other management practices. The NHVR assesses AFM applications using a risk classification system (RCS). The RCS assesses levels of fatigue risk associated with various combinations of work, rest and sleep, using fatigue science and research and seven fatigue management principles.[13] For example, an AFM application could seek additional work hours, but the risk associated with those additional work hours could be offset by limiting night work and taking regular short rest breaks.

However, the safety impact of AFM and the sensitivity and robustness of the RCS has not yet been tested. Three of the four fatigue experts advised that the adequacy of sleep and rest opportunity permitted in AFM needs to be evaluated.

Professor Williamson (2015, p. 3) advised that an evaluation should 'establish whether the RCS achieves its objective' of appropriately balancing flexible work scheduling with necessary management of fatigue risk. Professor Dawson (2015, p. 1) noted that the seven principles used to assess AFM applications are well-established, but advised 'there is no clear evidence on the extent to which these mitigations actually reduce risk and whether they are sufficient to reduce the increased risk associated with the work-practices proposed in the exemption applications'. An effective evaluation requires identifying and standardising the relative risk mitigation (p. 2).

Professor Haworth (2015, p. 3) advised the lack of evidence about the effects of various work and rest options permitted under AFM should be addressed with additional data collection and research.

[13] See https://www.nhvr.gov.au/safety-accreditation-compliance/fatigue-management/work-and-rest-requirements/advanced-fatigue.

Based on the advice and stakeholder feedback, key questions to address include:

- How many fatigue crashes involve BFM and AFM drivers?
- Are there sufficient counter measures for the additional working hours?
- Is there an opportunity to validate AFM risk classification?

3.5 Minimum rest times for BFM two-up drivers

The Heavy Vehicle (Fatigue Management) National Regulation (HVNR) sets out maximum work times and minimum rest times for drivers operating under standard hours and BFM. These include minimum rest times within each 24-hour period. BFM hours for solo drivers ensure a minimum rest time of 15 minutes in any period of 6.25 hours, 30 minutes rest time in any period of nine hours, and 60 minutes rest time in any period of 12 hours. Rest time must be taken in blocks of 15 continuous minutes.

Two-up driving means an arrangement under which two persons share the driving of a heavy vehicle that has an approved sleeper berth. Two-up drivers operating under BFM do **not** have minimum rest time requirements. The HVNR provides that under BFM, in any period of 24 hours, a two-up driver must not work more than 14 hours. There are no minimum rest time requirements within the 24-hour period.[14] This includes short rest breaks of 15 minutes up to major rest breaks of seven continuous hours that a BFM solo driver must take as a minimum.

In the development of the Model Fatigue laws, minimum rest times for BFM two-up driving was not regulated based on the rationale that mandating a rest break for one driver is likely in practice to lead to the other driver taking over the driving, when they are not necessarily adequately rested. Two-up drivers have reduced pressures or incentives to keep driving if impaired by fatigue and are more likely to be able to manage their fatigue and share the driving task between them. The additional minimum rest break requirements prescribed for solo drivers was therefore considered an additional and unnecessary regulatory burden for two-up drivers, without improved road safety outcomes.

Victoria Police and TfNSW raised rest times for BFM two-up drivers as a regulatory issue to be addressed. Professor Williamson also advised that the adequacy of sleep opportunity for two-up drivers where the driver has a sleep opportunity for short periods in a moving vehicle should be examined, including in situations where there is no requirement for these drivers in the BFM option to take short rest breaks.

Further information is required to understand the crash risk of BFM two-up drivers by assessing common work and rest schedules relative to BFM solo drivers. It is important then to 'establish how two-up drivers organise rest when working BFM' (Williamson 2015, pp. 2-3). It is also important to better understand the scale and extent of drivers who abuse the BFM two-up driving regulations to drive 14 hours with nominal or limited rest breaks.

3.6 Impact of local work

Local work is work undertaken within a 100 km radius of the driver's base. A fatigue-regulated heavy vehicle driver (for example, a driver driving a vehicle with a GVM of more than 12 tonnes) must comply with fatigue regulations, including work and rest time requirements, but does not have to carry and use the national heavy vehicle work diary to record hours of work and rest. The record keeper of a driver undertaking local work is required to keep only a total of work and rest times on each day and for each week the driver has worked. This information does not have to be kept in the vehicle.

Stakeholders have raised two issues with local work:

1) Fatigue issues associated with working in congested traffic and meeting tight delivery deadlines – primarily a concern for industry.
2) Fatigue and enforcement issues associated with working 100+ km and local work and not recording local work in the work diary – primarily a concern for enforcement.

Victoria Police is concerned with the integrity of the record keeping system in relation to drivers working both local and long-distance work. Victoria Police is concerned that any local work

[14] Table 2, Schedule 2 of the Heavy Vehicle (Fatigue Management) National Regulation (2013).

undertaken by these drivers may be 'invisible to enforcement' but nevertheless contributes to driver fatigue. Victoria Police's preference is for the 100+ km record keeping requirements to be extended to all drivers of fatigue-regulated vehicles who engage in local work.

Professors Haworth and Williamson advised that more evidence is required and that the framework should seek to measure the likely incidence and effects of fatigue-related behaviour that arise from local work (Williamson 2015, p. 15). Research activities could address both the fatigue impact of local work and the fatigue impact of not requiring the same level of record keeping. The research could also distinguish between drivers who work exclusively within local work parameters and drivers who work a mix of both local work and long-distance work (for example, drivers who work long-distance during the week and local work on weekends).

While Professor Williamson advised the most important research may relate to the fatigue effects of combining long-distance and local work, Professor Haworth emphasised that survey evidence points to a high incidence of fatigue-related crashes within:

- the first two hours of driving
- 100 km of the start of the trip
- urban areas.

Understanding why fatigue occurs within these parameters is a key issue. These concerns relating to local work were also raised in discussions with the Australian Trucking Association.

3.7 Threshold application of fatigue laws and record-keeping

We have seen there are two key threshold requirements in the fatigue regulations:

- at what gross vehicle mass (GVM) or people capacity of a vehicle requires a driver of that vehicle to be fatigue-regulated under the HVNL
- at what distance from base a fatigue-regulated driver is required to keep and use the national work diary.

What impact do these thresholds have on driver fatigue? An assessment could include analysis of whether the vehicle thresholds unnecessarily capture low-risk operations, or fail to capture high-risk operations. For example, whether there are vehicles outside the thresholds that regularly undertake long-distance work, or vehicles inside the thresholds that rarely or occasionally undertake long-distance work. However, whether this means that the fatigue risk is higher or lower is dependent on whether fatigue associated with local work is fully understood, as discussed in section 4.6.

The issue of applying thresholds could also include an assessment of whether there is a substantive and measurable link between record keeping and road safety outcomes, and consequently the impact (if any) of NHVR exemptions and changes to record keeping thresholds that are currently permitted in the HVNL.

3.8 Driver wellbeing and fitness to work

The health and wellbeing of the driver population was consistently raised across stakeholder groups. This relates to a collection of issues, including medical conditions and treatments that impact alertness, drug and alcohol use, and overall driver wellbeing and fitness to work.[15] Because high-risk medical conditions such as sleep apnoea are impacted by body mass index levels, the general fitness of drivers is also an issue.

VicRoads raised concerns regarding heavy vehicle driver fitness to work *before starting a shift*, and the over-representation of undiagnosed and untreated sleep apnoea in heavy vehicle drivers. TMR noted the aging population of drivers, exacerbated by long sedentary periods of driving, which has impacts on weight for many drivers, some of whom are experiencing sleep apnoea. The Queensland Police Service noted that improvements in the health and wellbeing of the heavy vehicle driving population should be a key policy goal.

[15] *Fitness to work* relates to the fitness of a driver to work on a particular day. *Fitness to drive* relates to a driver's fitness to hold a heavy vehicle licence.

Medical conditions that can affect driver alertness include:

- blackouts
- cardiovascular disease
- neurological conditions (such as epilepsy)
- psychiatric conditions
- sleep disorders (Howard 2015, pp. 4-5).

Various measures for dealing with existing medical conditions are already in use. Importantly, many of these medical conditions *are treatable*. Obstructive sleep apnoea, for example, can be diagnosed and treated. While drivers operating under BFM must work with a system that ensures the driver is in a fit state to safely perform duties and to meet specified medical requirements, there is no general requirement that heavy vehicle drivers in Australia are medically examined on a periodic basis, or tested for sleep disorders.

By contrast, periodic screening for sleep disorders, including obstructive sleep apnoea, is undertaken in the rail sector in Australia, while heavy vehicle operators are screened on a periodic basis in the United States. The impact of health screening continued to be evaluated. However, Dr Howard advised that screening for, and managing, sleep disorders can reduce the risk of fatigue-related incidents (Howard 2015, p. 5).

A range of medications to suppress pain or accelerate the onset of sleepiness, including benzodiazepines, narcotic analgesics and anti-histamines, are also used by some heavy vehicle drivers. While there is no reliable data on the current usage of these medications, these medications 'clearly interact with the recognised factors that cause fatigue and impaired alertness' (Howard 2015, pp. 4-5).

Professor Williamson also advised that driver health and wellbeing is likely to influence fatigue risk and safe driving outcomes and advised the framework be used to evaluate these effects (Williamson 2015, p. 3).

It is further noted that the ATA has championed the inclusion of fitness for duty medical factors within the existing Assessing Fitness to Drive (AFTD) guideline for some years, covering such factors as diabetes, sleep apnoea, and cardiac screening. The ATA proposes that a new assessment standard and guideline should include 'fitness for duty' medical assessments for certain drivers, so that a single assessment can capture different accreditation and industry schemes. This is an NTC candidate project for our future work programme.

3.9 Unlawful activities

Unlawful activities impacting alertness was raised by a number of road agencies and police services. These issues concern both the consumption of illicit substances and the integrity of the record-keeping system, in particular non-compliance with work and rest time requirements.

TMR provided an overview of the non-compliance issues in its response to the data survey:

- drivers working locally during the day and line-haul overnight
- drivers being directed by the company to work in excess of legal hours
- drivers loading and unloading during periods recorded as rest in the work diary

Additional work not recorded in the work diary could also include driving weekends for a local company or other sub-contacted driving. VicRoads also raised concerns with the use of illicit substances by BFM and AFM drivers.

The fatigue experts focused on better understanding how some drivers consume illicit substances as a remedy to fighting drowsiness. Professor Haworth and Dr Howard advised that objective testing for the consumption of illicit substances as well as alcohol should be conducted at the scene of fatigue-related crashes. Subsequent to roadside testing, Professor Haworth advised that the number of heavy vehicle drivers tested for illicit drug use should be recorded, based on a positive/negative and work hours option categorisation.

The objective of the data framework is to assess *the impact of regulations* on driver alertness, rather than to measure or collect data directly in relation to unlawful activities. Nonetheless, the data framework may provide a meaningful contribution to better understand these issues. Periodic

industry surveys, for example, could include questions in relation to substance abuse to identify any linkages between substance abuse and longer hours of work.

> Prescribed medicinal intake also relates to the broader issues of driver health and fitness to work, discussed above in **section 3.8.**
> Substance abuse is also a research risk, discussed below in **chapter 7**.

3.10 Prioritisation of fatigue issues

A range of issues relating to heavy vehicle driver fatigue have been raised by stakeholders through initial consultation discussion, government and industry surveys, fatigue expert advice and the Alertness Summit. It will be necessary to prioritise regulatory fatigue issues to be addressed through the framework's data collection and research activities.

Criteria for prioritisation of the fatigue issues

Prioritisation of the fatigue issues is based on the following draft criteria. They are aligned with the project objectives. The NTC welcomes feedback on the criteria.

1. The issue relates to a current fatigue provision or regulation in the HVNL.
2. The provision or regulation is complex and/ or difficult to comply with.
3. The issue could be addressed in a future review of fatigue regulations.
4. The benefit of addressing the issue is greater than the cost to industry and regulators to collect the data to address the issue.
5. Data collection and research activities could be undertaken to demonstrate measurable and validated relationships between regulations and provisions relating to fatigue alertness and the degree of alertness impairment.

Initial prioritisation of the fatigue issues

A prioritisation of the fatigue and alertness issues is outlined in **Table 1**. At this initial phase of the project, this is an initial prioritisation only, developed for consultation purposes. A finalised prioritisation will be recommended as part of the policy paper to ministers.

The prioritisation does not reflect the relative importance of the issue. The importance of each issue depends on the stakeholders' perspective. For example, driver wellbeing and fitness to work is a key issue for industry, whereas for some police agencies the priority is nose-to-tail schedules. The prioritisation is therefore directly linked to what the data framework can constructively collect data to address, and issues that are within the direct ambit of current regulations. This approach is reflected in the criteria for prioritisation of the fatigue issues.

Table 1: initial prioritisation of fatigue issues to be addressed

Priority	Fatigue impairment attributable to –
Priority 1	Nose-to-tail schedules
Priority 2	Quantity and quality of sleep attained in major rest breaks
Priority 3	Continuous hours of work - including BFM and AFM
Priority 4	No short rest breaks required for two-up drivers working BFM
Priority 5	Night time driving and ending shifts in the early morning
Priority 6	Impact of local work

Priority 7	Threshold application of fatigue laws and work diary record-keeping
Priority 8	Driver wellbeing and fitness to work

Data collection and research activities may provide insight into other behaviours, such as substance abuse and non-compliance with work and rest hour rules. However, it is proposed that the primary activities of the data framework should be directed to those issues that could be the subject of any future review of the fatigue provisions.

4 Current data collection activities

Key points

Data is currently collected by governments and industry and crash data is generally sourced from police or coronial reports. Data is collected for different purposes and is not always comparable or publicly available for policy decision-making.

The framework provides an opportunity to nationally standardise current data collection, but this requires strong commitment from government and industry stakeholders.

The purpose of the framework is to collect real-life operational data to better inform future policy. The NTC surveyed police, road agencies, the NHVR, BITRE and police to assess what data is currently collected, and to identify differences in approaches and data gaps that could be addressed to improve operational data.

In this section we address:

4.1 Current approach – who collects and publishes data

4.2 ATSB operational definition of fatigue

4.3 Assessment of current data – availability and comparability of data

4.3 Opportunities to improve fatigue data collection availability and comparability.

4.1 Current approach – who collects and publishes data

Based on survey responses and literature review, a summary of current data collection activities is provided based on the following areas:

- the definition of fatigue that has been adopted
- the operating system within which data is collected
- crash-sourced data: static data that can be established at the scene of the incident
- driver-sourced data: data reliant on questioning the driver in the field
- fatigue data collected by operators
- fatigue data collected by others in industry.

How fatigue is defined

Section 223 of the HVNL provides that ***fatigue*** includes (but is not limited to)—

(a) feeling sleepy; and

(b) feeling physically or mentally tired, weary or drowsy; and

(c) feeling exhausted or lacking energy; and

(d) behaving in a way consistent with paragraph (a), (b) or (c).

Section 226 provides matters that a court may consider in deciding whether a person was impaired by fatigue. This includes:

(a) any relevant cause of fatigue or sign of fatigue that was evident, and the degree to which it may indicate that the driver was impaired by fatigue;

(b) any behaviour exhibited by the driver that may have resulted from the driver being impaired by fatigue;

Examples for the purposes of paragraph (b)—

- the circumstances of any incident, crash or near miss
- poor driving judgement
- inattentive driving such as drifting into other lanes on a road or not changing gears smoothly;

(c) the nature and extent of any physical or mental exertion by the driver;

(d) whether the driver was in breach of the driver's work and rest hours option.

A court may consider the driver to be impaired by fatigue even if the driver has complied with the minimum work and rest hours, or any other law.

Where there is variation between jurisdictions and agencies is how the broad definition of fatigue in the HVNL is understood and interpreted by police and investigating officers.

In NSW, Inspectors Vehicle Regulations (IVRs) who conduct the road side enforcement are provided with guidance on indicators of fatigue in enforcement guidelines. This allows IVRs to assess if a driver is impaired by fatigue. Outside of the HVNL definition, NSW Police does not have a formal definition used to determine a crash as being caused by fatigue.[16] Other jurisdictions have similar approaches.

In a crash investigation in NSW, the criteria used for determining fatigue involvement are:

A motor vehicle controller (includes heavy vehicle driver) is assessed as having been fatigued if:

- *The vehicle's controller was described by police as being asleep, drowsy or fatigued*
- *The vehicle performed a manoeuvre which suggest loss of concentration due to fatigue, that is:*
  - *The vehicle travelled onto the incorrect side of a straight road and was involved in a head-on collision and was not overtaking another vehicle and no other relevant factor was identified; or*
  - *The vehicle ran off a straight road or off the road to the outside of a curve and the vehicle was not directly identified as travelling at excessive speed and there was no other relevant factor identified for the manoeuvre.*

In Victoria, crash investigations involving a heavy vehicle rely on the definition of fatigue used in the HVNL. Outside of heavy vehicle drivers, driver fatigue is defined as the involuntary and progressive withdrawal of attention from road and traffic demands. There is no surrogate measure based on time of occurrence or type of crash although witness accounts, especially in fatal crashes, are used to identify fatigue-related crashes (ATSB 2002).

In Queensland, TMR defines fatigue as:

> *a reduction in driving or riding ability as a result of prolonged driving or being tired while driving. It should be noted that prolonged driving/riding activity is not solely responsible for fatigue. Other factors such as the elapsed time since the person last slept, the time of the day or the night, as well as the human circadian rhythm may be involved.*

TMR provides an extensive questionnaire for crash investigators when fatigue is identified in a major investigation. This includes questions relating to prior sleep, rest and work. The Qld Police Service *Traffic Crash Investigation* handbook (5th ed.) includes fatigue under matters to be

[16] Information provided by ANZPAA, 12 August 2014.

considered when investigating a traffic crash. It provides that 'physical evidence at the crash scene can assist in the determination of fatigue-related crashes. Such evidence includes departure angle of tyre marks and vehicles from the roadway and corrective steering or braking input evidence'.

Additionally, the *Data Analysis Road Crash Glossary* (Qld TMR 2014) includes definitions of how TMR codes fatigue-related crashes into the road crash database. These codes distinguish between fatigue reported by police and fatigue identified based on the operational definition.

For statistical purposes, a crash in Qld is only categorised as caused by fatigue if it is a single vehicle crash in a speed zone of 100 km/h or higher (the ATSB threshold, outlined in **section 4.2** below, is 80 km/h or higher) and is between 10 pm and 6 am (the ATSB threshold is between midnight and 6 am).

In SA, crash investigations involving a heavy vehicle rely on the definition of fatigue used in the HVNL. The ATSB operational definition, without alteration, is used for statistical purposes.

In WA, a crash is assessed as being fatigue-related if:

- police or the driver, stated that fatigue was a likely cause
- a vehicle travelled to the incorrect side of the road and was involved in a head-on collision while not overtaking another vehicle
- the vehicle ran off the carriageway and the vehicle was not directly identified as travelling at excessive speed and there was no other factors identified as causing loss of control (such as alcohol, road condition, tyre blow-out, sun glare, side wind, headlights, driver condition, broken screen).

Additionally, WA Police use an extensive questionnaire that can be used in major crash investigations. The questionnaire captures hours of sleep before the incident, rest periods and hours of work.

In Tasmania, fatigue statistics are based on police reporting of inattentiveness or of the driver allegedly being drowsy or falling asleep. Tasmania Police does not apply additional guidelines as to how the HVNL definition should be interpreted, and before the HVNL commenced in Tasmania in 2015, there was not a formal definition of fatigue in regard to crash causation. A decision that fatigue was an issue is left to the common sense judgment of the investigating police officer.[17]

The HVNL has not commenced in the NT, and there is no agency or police definition of fatigue or guideline to categorise fatigue as a contributing factor in a crash. Each crash is investigated fully and cause of crash is identified from that.[18] Work health and safety laws would be the most appropriate place to agree a fatigue definition.

In the ACT, crash investigations involving a heavy vehicle rely on the definition of fatigue used in the HVNL. The ACT does not have additional guidelines or a definition of fatigue for crash investigation purposes, except to the extent that fatigue is understood as the driving being impaired by fatigue to such an extent as to not have proper control of the vehicle.[19] The ACT categorises casualties according to: *received medical treatment*; *admitted to hospital;* and *fatal*.

Current data systems

Appendix B contains an overview of data systems operated in each jurisdiction and an example of comprehensive fatigue-related questions asked in a major investigation.

Current data systems in New South Wales

In NSW, police generally record crash details in a free-format at the crash site, then enter data directly into the Computerised Operational Policing System (COPS). The Centre for Road Safety maintains this data on the CrashLink database and codes fatigue from the crash circumstances.[20]

[17] Ibid.
[18] Ibid.
[19] Ibid.
[20] See: http://roadsafety.transport.nsw.gov.au/statistics/reports.html. Fatigue is defined on page 14 of the 2013 report.

CrashLink is used for road safety analysis and research, strategic planning and police development. CrashLink also sources data from other avenues including registration and licensing systems, ABS databases for kilometres travelled, and NSW Health driver blood alcohol content (BAC) data.

NSW Roads and Maritime Services (RMS) also has access to the results of compliance and enforcement activities carried out by heavy vehicle inspectors and investigators, data collected by on road monitoring and detection systems including traffic volumes, road condition, heavy vehicle travel times and speeds and intelligence through complaints and an established hotline. This includes fatigue compliance data collected at Heavy Vehicle Safety Stations.

RMS uses a number of analytical tools to identify risks including the Heavy Vehicle Rating System (HVRS); a database that accesses information from inspections carried out at Heavy Vehicle Safety Stations and on-road enforcement and through the Heavy Vehicle Inspection Scheme.

During roadside enforcement, inspectors will usually check work diary records back to the last 24-hour break. If a specific non-compliance is detected, the inspector will check further work diary pages beyond the last 24-hour break – this can involve up to 28 days of records. If non-compliance is detected, inspectors will remove the duplicate page of the work diary as evidence.

Current data systems in Victoria

Victoria Police is responsible for collecting details of all road crashes involving injury in Victoria. A summary of Victorian crash details reported to and by Victoria Police is provided in the Collisions Management Information System (CMIS). The CMIS obtains its information by reading data from the Traffic Incident System (TIS), which is updated daily. Similarly the Fatal Collisions Management information System (FCMIS) provides detail on road traffic fatalities throughout Victoria, as well as operational and management information relating to fatal traffic accidents.[21] The Corporate Statistics section of Victoria Police is responsible for the collection, collation, analysis of data and management of both systems.

VicRoads offers an online Victorian accident statistics and mapping program known as CrashStats. The TIS is the source of data available in the VicRoads CrashStats, however, only approved incident reports can be accessed and analysed by VicRoads and then subsequently loaded into CrashStats, thus the data available in CrashStats is incomplete.[22] In analysis of the data obtained from TIS, VicRoads supplements the data through cross-referencing with the Licensing and Registration Databases, and location data. VicRoads also has access to traffic volume data (Austroads 2013, p. 26).

Victoria Police collects fatigue data in an electronic crash reporting system known as the Traffic Incident System (TIS). The Victoria Police Heavy Vehicle Unit also collects additional information in a paper-based form.

The crash type (DCA code) and comments in the TIS can be used by VicRoads to infer if a crash was the result of driver fatigue. Coronial data can also be requested for research purposes.

Crash data is stored on the Road Crash Information System (RCIS) but specific fatigue-related data is not stored in RCIS.[23]

Transport Safety Services (TSS), an operational adjunct of VicRoads, collects work diary pages at on-road interceptions: this data is currently collected on paper then entered and recorded on the VicRoads' Regulatory Services Lotus Notes Database.

VicRoads shares data with other jurisdictions and has a MoU with WorkSafe. It will also share data with the Monash University Accident Research Centre (MUARC) for research purposes.

[21] http://www.police.vic.gov.au/content.asp?document_id=1246
[22] http://www.vicroads.vic.gov.au/Home/SafetyAndRules/AboutRoadSafety/StatisticsAndResearch/CrashStats.htm
[23] A public version of the VicRoads crash stats are available at https://www.vicroads.vic.gov.au/safety-and-road-rules/safety-statistics/crash-statistics.

Current data systems in Queensland

The Queensland crash reporting system is QPRIME. All QPRIME data is cleansed and obtainable through TMR for research purposes. Information collected in QPRIME includes duration of last break, time since last sleep and duration of last sleep – but this data is not provided from every investigation or incident. QPRIME does not record work diary records.

QPS provides data to RoadCrash via the QPRIME database. Heavy vehicle fatigue-related data is not entered into any central database by TMR: information about driver schedules, hours' option, rest breaks and so forth is only recorded in work diary annotations and officer notes and is not readily available for analysis.

RoadCrash database is a TMR database developed in Oracle and contains road traffic crash data for Queensland. The TMR Data Analysis Unit can provide annual or six-monthly data extracts from the RoadCrash database

Queensland Road Crash Data Unit (QRCDU) is part of Treasury and provides economic, demographic and social data including the processing of road crash data (that is, codes and cleanses) within the RoadCrash database on behalf of TMR.[24]

Current data systems in South Australia

In SA, heavy vehicle crash data is recorded in the Vehicle Collision System (VCS). The VCS categorises commercial vehicles based vehicle type and crash error codes include fatigue. The VCS does not capture whether the driver was a fatigue-regulated heavy vehicles driver, hours' option or distance from base.

The Offender Record Management System (ORMS) and Expiation Notice System (ENS) would also detail any fatigue breaches via offence code and section number.

DPTI manages the safe-t-cam data in SA and is able to monitor travel and work time violations. Based on this data, further investigations could identify or confirm fatigue impairment.

Work diary records obtained from drivers are not scanned and kept electronically. However, when an offence is detected, some reports are submitted in electronic format—that is, jpeg images of relevant work diary pages, not the actual pages. Electronic copies are likely to be deleted after paper copies are produced for court files.

Current data systems in Western Australia

Main Roads WA maintains the Integrated Road Information System (IRIS), which includes information from police-reported road crashes. This data is cross-referenced with vehicle registration information, kilometres travelled data obtained from the Australian Bureau of Statistics (ABS), and BAC results. Similar to some other jurisdictions, Main Roads also has access to information on traffic volumes and speed (including specific details on heavy vehicles), although this is generally limited to arterial routes. WA Main Roads investigates all fatal crashes and some heavy vehicle crashes that result in serious injury.

Main Roads WA owns and maintains the Crash Analysis Reporting System (CARS) software to analyse reported road crashes. It is available to state and local government road asset managers.

Current data systems in Tasmania

Tasmania Police record information from all reported crashes on Traffic Accident Report forms. Information is then loaded onto the Crash Data Manager (CDM) system, which is maintained by the Department of State Growth. Crashes are categorised by severity on the Traffic Accident Report forms in terms of the most severe injury received by any person involved in that crash.

The CDM includes variables such as vehicle and load characteristics and licensing details. The CDM is also cross-referenced with a number of other databases such as the Motor Registry Database, Forensic Science Service Tasmania for drug and alcohol information, reports from Transport Inspectors (who investigate all fatal crashes), and information from Coroner reports.

[24] Data can be provided on request and a range of data available via the website: https://data.qld.gov.au. Additional data can be accessed by Queensland officials through WebCrash2.

Current data systems in the Northern Territory

The NT Department of Transport maintains a Vehicle Accident Database, which is based on information received from NT Police reports. Police reports are based on major crash investigations.

Crash-sourced data

Crash-sourced data is static data that can be established at the scene of the incident. For example: *identifying how many vehicles were involved in the crash*.

Crash-sourced data is typically consistent across jurisdictions and includes:

- date and time of crash
- day of week
- number of vehicles involved
- location of crash
- weather and light conditions
- crash location and road environment
- vehicle registration number
- vehicle type
- make, model, colour and year of manufacture of vehicle
- damage to vehicle
- driver information, including licence details, gender and date of birth
- restraint information (for example, if a seatbelt was worn)
- number of passengers and their position in the vehicle (such as front seat)
- injury details.

Except for elements such as light conditions at the time of the incident, these crash elements are generally easy to observe by a crash investigator. The collection and recording of this information by agencies is comprehensive.

A coronial investigation or prosecution will also be more extensive. Victoria Police, for example, reconstructs the driver's activities and fatigue expert witnesses will give evidence as to the driver's likely level of impairment. Evidence will include electronic data, telephone data and video surveillance data.

Driver-sourced data

Driver-sourced data is data reliant on questioning the driver in the field. For example: *identifying how much sleep the heavy vehicle driver had in the last 24 hours.*

There is significant variation in relation to driver-sourced data. The extent of the questions asked, and whether a heavy vehicle driver is questioned at all, will depend on the crash severity, police resources and policies and guidelines across different agencies.

The collection of work diary records or schedules is nearly always linked to an enforcement activity and whether the driver was impaired by fatigue is not usually recorded or known if the enforcement activity is not related to a work diary breach. There are exceptions. Victoria Police's Heavy Vehicle Unit will collect between seven and 28 days of work diary records if fatigue is identified as a factor, in addition to the collection of additional information about the driver, such as the driver's physical characteristics.

In Queensland, investigators are provided with the guidance to assist them to track time and the location of a driver's movements before the crash. **Appendix D** provides a summary of

fatigue-related questions that investigators are required to ask in a crash investigation in Queensland. It includes questions about sleep, time since last slept and work and rest hours, in addition to questions about medical conditions that may impact driver alertness.

Common across agencies is that when fatigue is identified as a possible contributory factor, crash investigation reports and forms indicate that fatigue is only stated as a yes/no cause, with some form of free text usually available.

Aside from crash reporting, the NSW Centre for Road Safety has undertaken attitudinal surveys from time-to-time. These surveys have captured self-reporting of fatigue and included questions about near misses.

Fatigue data collected by operators

The NTC survey of industry in early 2015 provides an initial impression of what data is collected by operators and how it is used.

Just over half of respondents collect at least some data on crash and near misses, but systems and approaches vary widely, with systems including Global Navigation Satellite System (GNSS) records, Fatigue Management System records and training and maintenance records cited. Data holding systems are a mix of electronic and manual, but manual data systems predominate amongst smaller operators.

Interest in collecting and acting on fatigue data varied amongst respondents. On the one hand, one operator referred to data collection vital to operations that is essential as a driver training and behaviour modification tool. On the other hand, another respondent expressed concern that building complex data systems for fleet managers would create additional workload and burden on operators.

Industry capacity to identify and process data relating to the role of fatigue in near misses also varies. Of the 65 respondents who described how their organisation identified near misses, 58 stated they were identified through driver self-reporting. A further 28 respondents relied on observations of third parties; 21 respondents reported using outward-facing camera technology and 18 respondents reported using an in-vehicle driver camera or similar technology.

Of the 60 respondents who described their processes for identifying fatigue, 50 respondents stated they relied on driver self-reporting, while another 40 respondents identified fatigue as a cause from the type of incident that occurred – an example provided was a single vehicle run off the road. Twenty-nine respondents reported using outward or inward-facing camera technology to identify fatigue.

Various forms of data are collected and analysed by industry to identify and gauge the role of fatigue as a factor in a crash or near miss. This data includes:

- work schedule or roster of fatigued driver and time/date of crash (45 respondents)
- traffic, road and weather conditions at time of the incident (44)
- time since driver had long rest break (24+ hours) (42)
- time since driver commenced long shift after long consecutive break (7+ hours) (39)
- location of incident (38)
- time since driver took short rest break (37)
- single/multiple vehicle involvement and type of journey (short or long distance) (32)
- type of vehicle (29).

Eleven respondents also reported they examined their total fleet schedules at the time of an incident, to search for any repeated patterns of fatigue.

Operators also have different motivations for sharing data. Less than half of respondents provided information on this issue and of these, most respondents (39 of 52) share data because of a commercial benefit or because they are required to do so by law or for insurance purposes. Only

25 respondents share data with enforcement agencies and only 16 respondents share data with road agencies.

Fatigue data collected by others in industry

Three recent surveys relating to heavy vehicle driver fatigue provide examples of how others in industry, including insurers and fatigue consultants, have defined driver fatigue and undertaken fatigue data collection and recording. The research reports we examined were:

- AMR Interactive, 2013, *Reform Evaluation in the Road Transport Industry, 2012: Driver Fatigue* (commissioned by the NTC)
- National Truck Accident Research Centre, 2015, *Major Accident Investigation Report: covering major accidents in 2013*, National Truck Accident Research Centre, Brisbane
- Integrated Safety Support, 2011, *The Value of Rest: Investigating the impact of rest opportunities on sleep quantity and quality in Australian Truck Drivers* (commissioned by NatRoad).

AMR surveyed over of 500 heavy vehicle drivers and 400 road freight companies during April and May 2012. For face-to-face interviews with drivers, the interviewers defined fatigue as meaning feeling drowsy or sleepy and also meaning being tired, lethargic or bored, unable to concentrate, unable to sustain attention, and being mentally slowed. This approach is broadly consistent with the HVNL definition of fatigue.

The surveys asked drivers about the frequencies in which they experienced fatigue while driving, types of fatigue-related incidences experienced (that is, crossing lane lines, a near miss, nodding off for a moment, late braking, over or under-steering, running off the road, having a collision, and falling asleep at the wheel) and fatigue-related symptoms experienced within the previous month – that is, being exhausted at the end of the day, having heavy or tired eyes, having a loss of concentration, trouble sleeping, or headaches.

The National Truck Accident Research Centre reported 12.8 per cent of heavy vehicle crashes (that resulted in an insurance claim) were primarily caused by driver fatigue. The report did not define fatigue and only provided high level criteria that were used to help determine crash causation. These factors included vehicle tracking, engine management systems, in-cab cameras, crash investigations, police reports and witness statements.

The Value of Rest examined the restorative qualities of rest taken at home compared to sleeper cabs and other places including hotels and motels. This study was a first in Australia to examine resting qualities for heavy vehicle drivers in real life operations (as opposed to general populations examined in laboratory settings). This research did not provide any definition of fatigue.

4.2 ATSB operational definition of fatigue

Fatigue data can be improved through the review, update and national adoption of the operational definition of a fatigue-related crash.

In 2002, the ATSB published an operational, or proxy, definition of fatigue in consultation with jurisdictions and safety experts (**Table 2**). The purpose of the operational definition of fatigue is to identify for statistical purposes *relative fatigue* crashes to supplement those crashes where fatigue is identified as a contributing factor by crash investigators. The ATSB stated in its 2002 report (p. iii):

> *[a] precise identification of fatigue-related crashes is hindered by the absence of a universally accepted definition of fatigue. Furthermore, it is difficult to quantify the level of driver fatigue due to difficulties in objectively measuring the degree of fatigue involved in a crash. To overcome these obstacles the [ATSB] has proposed an operational definition of a fatigue-related crash*.

Table 2: Current ATSB operational definition of a fatigue-related crash

Includes	Excludes crashes that
single vehicle crashes that occurred during 'critical times' (midnight–6 am and 2 pm–4 pm)	occurred on roads with speed limits under 80 kilometres per hour
head-on collisions where neither vehicle was overtaking at the time	involved pedestrians
	involved unlicensed drivers
	involved drivers with high levels of alcohol (blood alcohol over 0.05 g/100 ml)

Source: Australian Transport Safety Bureau, *Fatigue-Regulated Crashes: An analysis of fatigue-regulated crashes on Australian roads using an operational definition of fatigue* (2002), p 3

An operational definition of relative fatigue improves reporting of fatigue-related crashes and enables agencies to gauge trends over time or between regions.

However, since 2002 most agencies have not adopted the operational definition, or adopted a modified version. The parameters set by the ATSB definition are considered by some to be arbitrary and misinterpreted as measures of fatigue crashes (Haworth 2015, p. 10). VicRoads, for example, has not adopted any measure based on time of occurrence or type of crash to supplement crash investigation and witness reports, on the grounds that a proxy definition is always going to be inconclusive, being either too narrow or too broad in its application.

There are concerns that the ATSB definition carves out too many fatigue-related crashes. For example, condition 1 fails to acknowledge that people can be tired at any time of the day (Dawson 2015, p. 7). There is also no evidence that younger drivers are any less likely to not drive while fatigued. There is no clear rationale for excluding speeds lower than 80 km/h, pedestrians or high levels of alcohol (Howard 2015, p. 10).

4.3 Assessment of current data

Comparability of data

The definition of fatigue and impairment of fatigue in the HVNL is broad and captures key concepts of feeling sleepy, weary and drowsy, and behaviours that are consistent with these feelings. However, the HVNL definitions of fatigue and fatigue impairment are only of value if driver behaviour is observed, or the courts are satisfied that – on the basis of driver activities prior to an incident – the driver did not have sufficient sleep in the previous 24 or 48 hours and it is reasonable to infer that the driver was fatigued.

Furthermore, the HVNL definition does not provide guidance or direction as to when fatigue has contributed to a vehicle crash. This means there is significant variation between jurisdictions – because investigators, including police, are attributing crash causation within different parameters and definitions.

There is no consistent and comparable definition of fatigue or data collection across operators and others in the industry, including insurers.

When fatigue is identified as a possible contributory factor, crash investigation reports and forms indicate that fatigue is only stated as a yes/no cause. When fatigue is identified, the reasons for this categorisation are not known and comparability is significantly impacted.

Driver-sourced data is notable for its inconsistency, both within and between organisations. Yet it is driver-sourced data that tells researchers the most about the impact of regulations on fatigue. In particular, a significant gap is data relating to driver schedules, given that agencies are not systemically collect work diary records for research purposes (especially unrelated to breaches); nor are agencies collecting the hours' option of drivers involved in fatigue-related crashes, or whether the driver is regulated under the HVNL.

Near misses rely on self-reporting by drivers to their operators or employers, and agencies do not report or collect data in relation to near misses.

Finally, because agency systems are jurisdiction-based and primarily closed and proprietary, de-identified data is not easily shared. This is especially problematic for heavy vehicle traffic which can be principally involved in interstate travel. There is even greater diversity of data systems amongst operators, which further reduces data comparability.

Current availability of data

High-level crash data is generally made available through departmental or agency websites, except for those jurisdictions (such as Victoria) where no version of the ATSB operational definition is used, in which case there is limited information available. More detailed data relating to driver fatigue is primarily only available for specific research projects and is provided in controlled conditions – analysis of this data is published in reports from time to time.

Policy-makers rely on published or internal surveys to understand the impact of regulations on driver fatigue. Information that could be ascertained from de-identified work diary records—such as the frequency and context of nose-to-tail schedules—are not publicly available. They are rarely maintained on police or road agency databases except for prosecution purposes.

There are no open data sources with heavy vehicle driver fatigue data in Australia.

Fatigue data opportunities

There are a number of powerful systems and analytical tools which may be adapted in a national environment, such as Cognos and the analytical tools used by the Data Intelligence Unit in TMR and database and data modelling functionality being developed as part of the Alertness CRC. However, obtaining data to perform any detailed analysis has not been feasible to date. Information collected is bounded by privacy laws and as previously noted, agencies have had difficulties collecting accurate fatigue data.

Given the current limitation of comparable and accessible data, there are a number of fatigue data opportunities. These data opportunities relate to governments and industry. Based on the analysis of current data collection and current data systems, and taking into consideration the aims of the fatigue data framework, these could include:

- agreeing and implementing a common definition *and interpretation* of driver fatigue
- uniform guidance as to what is fatigue and fatigue impairment
- introducing comparable indicators of fatigue: replace yes/no binary choice of fatigue as a contributing factor with a standardised *fatigue likelihood scale* and *fatigue impact scale*
- improving recording crash investigation data
- agreeing and implementing standardised fatigue coding
- implementing open data for research, or improving data sharing
- reviewing and adopting nationally the ATSB operational definition of relative fatigue.

These are explored in more detail in the next chapter. Efforts to improve data comparability and accessibility are consistent with Records of Government Services principles and support research and data collection activities canvassed in **chapter 5**.

Working with industry

The NTC survey suggested that operators collect a rich data set. This is likely to be because operators are managing driver fatigue on a daily basis and seek to use data to look forward to ensure that a driver is not impaired by fatigue – whereas enforcement agencies are focused on identifying fatigue and breaches of the law retrospectively. Industry data therefore provides a valuable source of data to inform fatigue policy, notwithstanding the comparability and accessibility challenges associated with a complex and large number of heavy vehicle operators.

Further, there are opportunities for industry-based research, including insurance and trade association data collection, to leverage comparable and accessible data in the framework. As discussed in **section 3.2**, the AMR Research paper provided a clear and comprehensive definition

of fatigue and one which was broadly consistent with the legislative definition contained in the HVNL. While the NTARC research did not provided a clear definition of fatigue it did provide high-level assessment criteria for how fatigue causation is determined following a crash. *The Value of Rest* research paper did not provide a definition of fatigue as its focus was on the restorative impacts of rest in different places typical for a long-haul driver (that is, at home or on the road).

Comparable units of injury

Comparable units of injury, such as *fatality*, *serious injury*, and *admitted to hospital* are important to meet broader statistical comparability aims. However, the focus of the data framework is identification of fatigue as a contributor to crashes and near misses, whereas units of injury record the outcome of a crash and reflect the speed the vehicles were travelling at the time of a crash. Comparable units of injury will not improve our understanding of the impact of regulations on driver fatigue, and therefore is not proposed as a targeted improvement in the framework.

5 Developing a data framework

Key points

- The proposed framework would consist of connected research projects, data collection activities and new in-field processes.
- These would be supported by agreed preconditions, such as terminology, to support data consistency and analysis.
- The framework should be underpinned by agreed principles to ensure ethical research, to protect personal information and to clarify the use of data for enforcement purposes.

5.1 Need for a data framework

The previous chapter provided an initial assessment of current data collection activities and concluded there are significant inconsistencies relating to definitions of driver fatigue and levels of fatigue impairment, and comparability and availability of data sources.

More available and more comparable data is therefore required to support further reforms to the fatigue laws. National agreement on the counting time provisions is illustrative of why a data framework is necessary: the case was made by two jurisdictions that the counting time rule that allowed for nose-to-tail schedules results in an unacceptable fatigue risk, but without evidence to support the reform, the Transport and Infrastructure Council did not agree to further amendments until better data was collected.

If the data gaps are not addressed, there is a risk that any future review of the fatigue laws will be impeded by lack of data and insufficient evidence to substantiate reforms. It may also be challenging to be able to identify and measure the regulatory impact on drivers and operators of potential reforms without better understanding how fatigue is currently managed.

Fatigue is a complex policy area. **Chapter 3** captured a range of stakeholder issues with fatigue regulations. There are eight priority issues, ranging from nose-to-tail schedules through to driver wellbeing and fitness. Further understanding fatigue and measuring and detecting alertness are also at the forefront of scientific endeavours. This needs to be reflected in the data framework, which should seek to balance fatigue management in the workplace with harnessing technologies to detect and predict impaired alertness. The data framework aims to achieve this by undertaking data collection activities such as industry surveys, balanced with scientific research, such as activities to measure sleep quality and quantity during major rest breaks.

5.2 Why data comparability and accessibility matters

Data comparability

Data comparability sits at the core of John Stuart Mills' development of logical methods for making comparisons. His *method of agreement* and *method of difference* form the basis of analytic comparison in qualitative data analysis (Neuman & Lawrence 2000, pp. 427-428). When making comparisons in experimental research, the researcher should focus on identifying regularities or patterned relations, not from seeking universal laws without a social context – fundamental to this approach is data comparability with defined taxonomy, parameters and controls.

An example of comparable data collection in a government context is the Productivity Commission's annual *Report on Government Services*. A key function of the Report is to collect objective and consistent data on the performance of a number government services including education, justice, emergency management, health, community services and housing. The primary aim is to use this information to help compare the equity, efficiency and effectiveness of service delivery, both across and within different jurisdictions to inform future policy decisions. In 2012, a high-level review of the Reports on Government Services re-emphasised that data can be considered directly comparable when definitions, counting rules and the scope of measure are

consistent (Productivity Commission 2012). Based on the review recommendations, considerable effort has been made to develop clear and robust national definitions and standard data collection methodology to allow greatly improve the comparability of data between and within jurisdictions.

The importance of comparability can also be seen in the development of interoperable systems that rely on a common data set or data dictionary. For systems to work together there must be a common understanding in each system of what the data signifies. To facilitate the effective exchange of information, this requires a common language and common definitions, so it is not just the nomenclature that is the same, but the meaning behind it.[25]

It logically follows that the viability of the data framework will be undermined by a lack of a common understanding and measures of fatigue-related crashes, which are themselves the consequence of inconsistent or individual concepts and definitions.

Accessibility – the opportunity for open data

Data will need to be accessible to be of value to the data framework. The optimal form of accessibility is an open data source where data is made freely available to everyone to use, modify and share for any purpose and without restrictions or gatekeeping.

All Australian governments currently engage in a wide range of open data initiatives, including health, crime and transport statistics.[26] Open data is publicly-funded data which can be 'opened up', thereby providing transparency and improved accountability of the impact of government services or regulations on societal indicators.

The collection and publication of open data allows for organisations to act as repositories for a wide range of government data (excluding private and security data) across multiple government agencies. Open data also enables third parties to leverage the potential of government data through the development of applications and services that address public and private demands.

There are multiple sources of open data In Australia and they are provided at national and state and territory levels. Each jurisdiction has different open data policies and frameworks, with different online data repositories. However, each of these data repositories comply with the *Australian Governments Open Access and Licensing Framework* (AusGoal) which provides support and guidance to government and related sectors to facilitate open access to publicly funded information.

In a similar way to principles of comparability and the data dictionary concept, open data should be provided in an open format. Open formats are specifications for storing and manipulating content, usually maintained by a standards organisation. Data published using an open format ensures that users, regardless of their operating system or platform, will be able to access and use data (Qld TMR 2015).

5.3 What is the data framework?

The data framework would be a collection of agreed preconditions, systems and process changes implemented by organisations. These changes would underpin delivery of comparable and accessible fatigue data and are summarised below (**Table 3**).

[25] The *Compliance and Enforcement Framework for Heavy Vehicle Telematics*, 2014, includes an example of a data dictionary.
[26] Open data for transport currently includes high-level crash and enforcement data in all Australian states except Qld and WA.

Table 3: proposed elements of the data framework

Comparable and accessible fatigue data requires:		Proposal
Preconditions	agreed terminology	agree working definition of fatigue
		agree 'fatigue likelihood scale'
		agree 'fatigue impact scale'
		review ATSB definition of fatigue
	agreed codes for statistical recording	nationally-adopted fatigue codes
System change	agreed data systems	agree sources of data
		agree ecosystem: who collects, holds and accesses data
		open data or data sharing arrangements
	agreed governance and oversight	agree organisations with responsibility and accountability – ensuring consistency with privacy principles, framework principles, periodic review
		data sharing agreements
Process change	agreed field processes	agree standard crash report questions
		implement agreed terminology
	agreed recording processes	agree process to collate, report and transmit data

Based on the delivery of comparable and accessible fatigue data, the data framework will create a platform to support data collection and research activities to address the fatigue issues identified through the discussion paper consultation process. The aim is to collect data and undertake research activities to have sufficient evidence to make the case for change.

The framework would require ongoing support and commitment from agencies, particularly police and the NHVR. Wherever possible, the process changes should be simple, easy to understand and execute, require minimal IT adjustments and have a clear value proposition for agencies. If agreed, specific ongoing funding will be required to resource and train agencies, and to manage the data framework. These costs should be identified as part of the framework action plan and implementation.

The next chapter identifies a number of proposed activities that could be undertaken as part of the data framework. The discussion paper considers which elements of the data framework (relating to preconditions, processes or systems) will underpin each of the proposed activities.

An optimal data framework

The optimal framework would support an open data approach. Under this approach, raw data would be made available on an open data system that can be accessed by researchers and policy makers to conduct independent research as required. Data platforms could operate in each jurisdiction, as is the case with data cubes made available in other policy areas, or fatigue data could be consolidated in a centrally-operated open data platform.

An optimal data framework would include data sources from government and industry, including insurers, operators and trade associations, and would include de-identified data related to both crashes and near misses.

The framework would be comprehensive include a wide range of data collection and research activities as set out in **chapter 5**, with comprehensive research projects undertaken by the Alertness CRC.

The ATSB definition would be updated as part of the framework.

A practical approach to a data framework

Alternatively, a road agency or third party could remain custodians of the data framework and provide data to policy analysts and researchers, such as Alertness CRC partners, on an as-needs basis.

Data collection and research activities could be focused on resolving the residual risk of nose-to-tail schedules in the first instance, and processes to attain written work diaries could be a simple scanning and emailing to a data custodian. It would not focus on proscribed activities – such as substance abuse.

The ATSB definition would be updated as a consequence of the framework at a later time.

A practical approach to a data framework could focus on government data in the first instance. This would put in place a step change that would enable industry, including insurers and researchers not related to the data framework, to adopt the same terminology.

A practical approach to a data framework could focus on enforcement activities and crash investigation and recording in the first instance – setting in place terminology, systems and processes that can support more sophisticated analysis of near misses and driver fatigue that is not linked to a crash or enforcement event.

5.4 Delivering comparable fatigue data

We can improve our understanding of the impact of HVNL regulations on driver fatigue by standardising how fatigue and alertness impairment are identified and reported in different jurisdictions.

Comparable fatigue data can be introduced in three areas:

1. **When investigating a heavy vehicle crash,** improve how crash investigators identify and categorise fatigue as a contributing factor, by replacing a binary yes/no choice with *fatigue likelihood* and *fatigue impact* scales.
2. **When recording a heavy vehicle crash,** introduce standard three questions that are always asked of the heavy vehicle driver, regardless of whether fatigue was identified as a contributing factor.
3. **When categorising a crash for statistical purposes**, review and nationally implement the operational definition of relative fatigue.

These three areas would form the core of the data framework, off which data collection and research activities can be undertaken.

Difference between investigating and recording a heavy vehicle crash

These proposals distinguish between investigating and recording a heavy vehicle crash. For the purpose of the framework, a crash investigation is undertaken by police or coroners when there has been a major incident, usually involving a fatality and/ or significant property damage. When a crash investigation takes place, significant resources are invested in the investigation and when fatigue is identified as a potential contributing factor, a comprehensive range of questions will be asked of the driver. These will include questions about when the driver last slept, how much sleep the driver had and details of the driver's schedule. When investigating a crash, the opportunities for improved comparable data relate to definition of fatigue – hence opportunities to introduce a fatigue likelihood scale and fatigue impact scale are discussed below in relation to crash investigations.

Crash recording, on the other hand, is undertaken by police when called to the scene of an incident that does not warrant a crash investigation. These events will not usually result in police interviewing the heavy vehicle driver to determine the likelihood of fatigue or the impact of the

driver's fatigue. These reports are generally short and concise because the incidents do not merit significantly more police resources. It is these reports where there is a significant opportunity to capture and record minimal data about the driver's sleep and hours option that should not significantly increase police reporting resources, but would provide an invaluable resource to understand driver fatigue in relation to how much sleep heavy vehicle drivers are getting, and whether they are working under standard hours, BFM or AFM.

Identifying and categorising fatigue crashes

The framework provides an opportunity to introduce a standardised method to identify and categorise fatigue as a contributing factor in crashes. The approach should be based on current knowledge of fatigue and be simple to implement without extensive officer re-training.

Professor Dawson advised the most important task is to standardise the criteria and methodology for determining the likelihood that an incident is fatigue-related. Without a legally and scientifically defensible set of criteria, and a valid and reliable investigative methodology, Professor Dawson advised the capability to measure the frequency of fatigue-related incidents, and the likelihood that any given incident is fatigue-related, will be limited.

To establish frequency and likelihood of fatigue, Professor Dawson advised that first principles must be met. Namely, it must be established that the:

- driver was fatigued
- nature of the errors that lead to the crash were consistent with the type of errors a fatigued person would make.

As it is not always possible to demonstrate fatigue unequivocally, Professor Dawson (2015, p. 5) advised these two principles should be expressed as a likelihood estimate rather than a categorical yes/no event. For example, a crash investigator will be able to use the information obtained from driver reports, witness reports, telematics and vehicle behaviour to estimate the likelihood the driver was fatigued at the time of the crash. Professor Dawson has proposed a fatigue likelihood scale (p. 7) that is included here for discussion (**Table 4**).

Table 4: example of a fatigue likelihood scale

Fatigue likelihood scale		Indicators
5	Highly likely to be fatigued	Complete loss of situational awareness or onset of sleep
4	Likely to be fatigued	Failure to avoid other road users, vehicles or road furniture
3	Possibly fatigued	Risky behaviour or incorrect prediction of other road user behaviour
2	Unlikely to be fatigued	Other factors are more likely to have caused the incident
1	Highly unlikely to be fatigued	Other causes are demonstrated and corroborated

Indicators could also be corroborated based on known inputs – for example, how much sleep the driver had in the last 48 hours.

Standard information recorded in every crash report

As discussed above, the circumstances and severity of a crash usually do not warrant comprehensive crash investigation. When heavy vehicle crash recording is undertaken – as opposed to a crash investigation – a standard set of three questions could be asked of the heavy vehicle driver, and recorded in a dataset. These questions should not take significant time to ask and record and would have the advantage of being standardised across every organisation and therefore able to generate sufficiently large data sets for research and policy-development purposes.

The standard information would be recorded in every report, regardless of whether fatigue was also recorded as a contributing factor. This will enable analysts to compare sleep data between drivers that are recorded as having being fatigued, and drivers who are not.

VicRoads has recommended an approach that has been proposed for further discussion – that measuring fatigue can be distilled into three key issues (outlined in **Table 5**): if every agency can consistently collect information in relation to these three questions, a foundation source of data can be provided for the framework.

Table 5: standard crash report questions

Proposed standard questions directed to a heavy vehicle driver when police report an incident involving a heavy vehicle	
Was the driver on Standard Hours, BFM or AFM?	___Standard/ BFM/ AFM
When did the driver wake up from last sleep?	___ time since wake up
How much sleep did the driver have in the last 24/ 48 hours?	___/___ hours

This information can be supplemented with comprehensive information as required, depending on the nature and scale of the incident.

For example, Professor Williamson advised that collecting the following information would significantly improve accuracy of coding fatigue crashes: time of day, time since last sleep and amount of sleep, duration of driving (with or without breaks), and recording driver symptoms prior to the crash (if available).

Professor Haworth took an alternative approach. She advised that standard and routine information should be related to injury severity, GPS coordinates, trip length, the driver's hours option and whether the crash meets the ATSB definition of fatigue. The following comprehensive information and data could then be sought:

- time since driver last took a short rest break
- time since driver commenced shift after a rest break of seven hours or more
- time since driver had a long rest break (24 hours or more)
- previous seven days of work diary records
- number of nose-to-tail shifts in previous seven and 28 days
- score on each component of the AFM risk classification matrix.

Victoria Police recommended that more in-depth information is required in relation to a driver's work, sleep and rest breaks. For example, collecting data about the factors leading up to the crash (such as time of day, location, work undertaken and work patterns), and the kind of work the driver is involved in, such as local work, long distance or sub-contracting.

Regardless of which approach is adopted, when this information is available, and the nature of the incident warrants police resources to investigate and record the findings, then this data can supplement the standard three questions undertaken as part of the data framework.

In the longer term, additional questions could be introduced, such as 'time since last rest break,' and additional procedures could be introduced, such as alertness and drug testing.

There will be challenges with implementing this proposed change. Victoria Police noted in its feedback that for operational reasons, including competing work demands, it may not be possible for many agencies to implement this approach, and that unless driver reports can be verified, the result may be skewed and provide an inaccurate picture of fatigue.

An alternative approach recommended by Victoria Police is that no changes are made to roadside processes to identify and investigate fatigue-related crashes, but that the NTC should consider undertaking a research project in collaboration with one or two enforcement agencies. Victoria Police suggested these agencies would commit to collecting specific detailed information over a fixed timeframe, thereby ensuring that the data is collected with integrity and purpose.

TfNSW has noted some concerns with this approach, notably difficulties in asking the questions in situations where the relevant driver is injured or killed; while fatal crashes also trigger a range of other reporting and investigation obligations for police (such as mandatory alcohol and drug testing) – additional fatigue questions will need to considered in this context. Taking these operational issues into consideration, TfNSW observed that it might be better to focus on objective data sources (such as industry or work diary records). This could reduce the data collection falling on police agencies and is discussed in more detail below at **section 6.1**.

Operational definition of relative fatigue

We saw in the previous chapter that the ATSB definition of operational fatigue was introduced in 2002 so that fatigue trends can be plotted over time. The ATSB report (2002, pp. 18-20) canvasses limitations with this approach, given the disparity between a previously-used operational definition of fatigue for statistical purposes, and fatigue identified through police and coronial investigations:

- Of the 1,511 fatal crashes in 1998, 46 crashes were identified as fatigue-related by both the operational definition and coroners or police. An additional 53 crashes were identified as fatigue-related only by coroners or police and an additional 205 crashes were identified as fatigue-related by only the operational definition.
- Of the 205 crashes identified as fatigue by the operational definition, the primary factor contributing to theses crashes according to coroners or police, included:
    - unintended driver errors (49 crashes), such as failing to see another road user
    - drugs and/or alcohol (37 crashes)
    - excessive speed (34 crashes)
    - unknown circumstances (29 crashes).
- Coroners or police identified fatigue as a factor in 53 crashes where the operational definition did not. These crashes were not included by the operational definition for a variety of reasons – the most common reason for exclusion was single vehicle crashes that occurred during non-critical time periods (34 crashes).

The problem with any definition is that general principles are applied to individual circumstances with generally no validation. A review of the definition may result in broader parameters but then fatigue may be *over-represented* in crash statistics, which would be of no benefit to the community.

It is also difficult to measure how much sleep a driver had if the ATSB definition is applied when the data is aggregated and decoupled from crash investigation reports. There would also be no reason to apply the ATSB definition if fatigue was already identified through the crash investigation.

Feedback from stakeholders was generally more supportive of improvements to crash investigation and crash recording than reviewing the ATSB definition. On face value, this view is reinforced by the high number of fatigue issues that could be supported by improvements to crash investigation recording, whereas the ATSB definition is only related to high-level statistical reporting of fatigue. For this reason, any review of the ATSB definition may be better placed in a separate project.

An alternative operational definition was recommended by Dr Howard which has been reproduced here for discussion purposes (**Table 6**):

Table 6: Alternative operational definition of relative fatigue

Includes	Excludes
single vehicle crashes occurring during ‘critical times’ – midnight–7 am and 2 pm–4 pm	crashes involving vehicle driven by unlicensed drivers
vehicle crashes that occurred during ‘critical times’ (midnight–7 am and 2 pm–4 pm) where another cause is not identified	
vehicle crashes between 2 am and 5 am, irrespective of other causes	

head-on collisions where neither vehicle was overtaking at the time	
crashes when the driver had less than five hours sleep in the previous 24 hours, or has been awake for more than 17 hours	

Source: Australian Transport Safety Bureau, *Fatigue-Regulated Crashes: An analysis of fatigue-regulated crashes on Australian roads using an operational definition of fatigue* (2002), pp 18-20.

Linked to fatigue recording and process change are crash severity codes, which also differ across jurisdictions. Professor Haworth (2015, p. 10) raised standardisation of crash severity codes as an enabler to compare crash data. Again, as discussed in the previous chapter, crash severity codes do not directly indicate fatigue impacts and could be undertaken as a separate project.

Comparable fatigue data will support analysis of the following fatigue issues:

- nose-to-tail schedules
- sleep quantity of heavy vehicle drivers
- impact of standard hours, BFM and AFM on fatigue crashes
- impact of night-time driving on fatigue crashes
- prevalence of local work
- prevalence of drivers involved in fatigue crashes that are operating below current HVNL thresholds (because of vehicle type or distance from base).

High-level roadmap to implement comparable fatigue data:

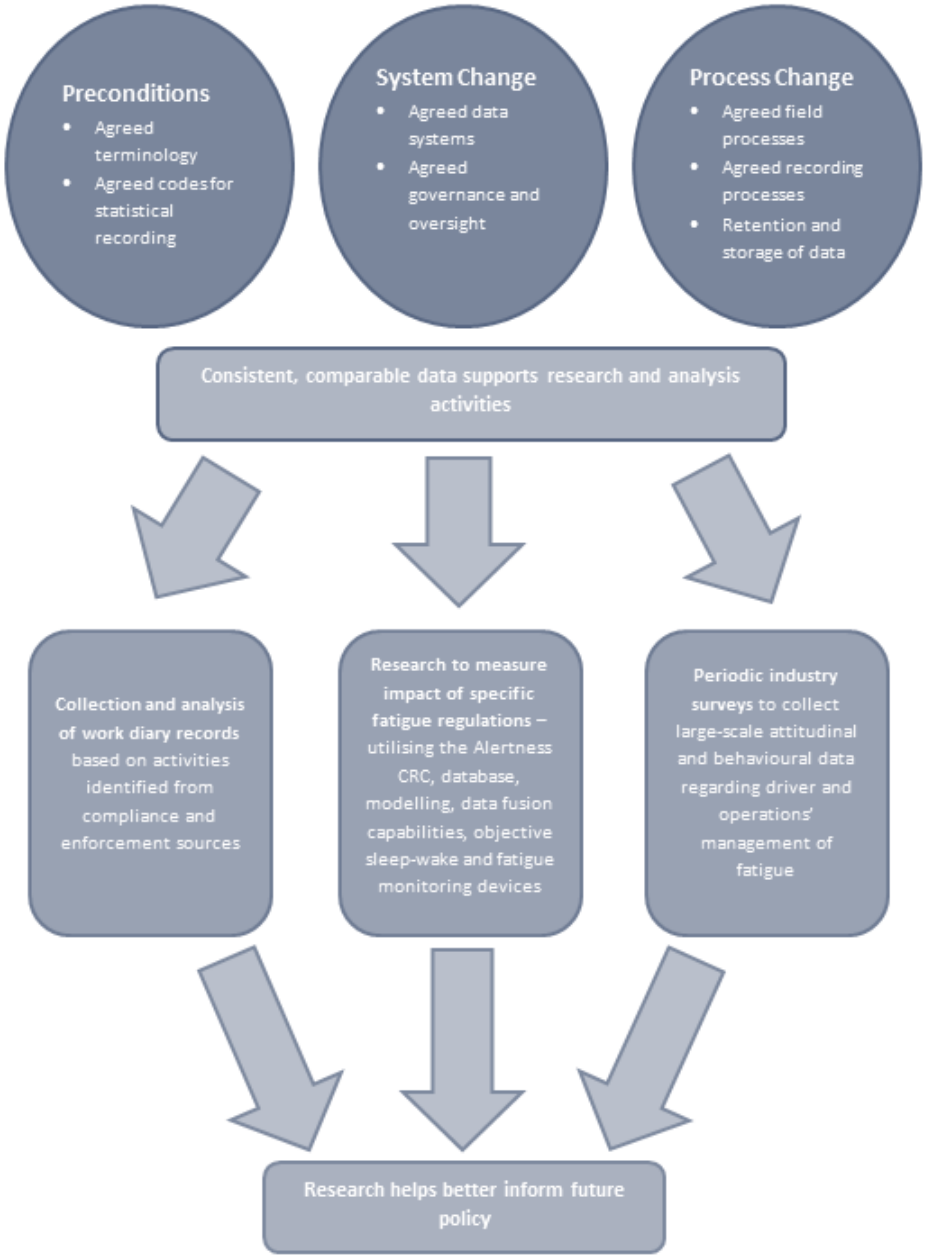
- convene an expert group to agree criteria to develop the fatigue likelihood scale, and a system to quantify the likelihood that a crash was fatigue-related
- embed fatigue likelihood and fatigue impact scales in coronial and police crash investigations
- embed standard three questions in police crash recording processes
- embed new processes to report new crash investigation information to a data custodian
- officer training and education to embed interview and recording processes and to improve identification of fatigue as a contributing factor in crashes
- convene an expert group to update the ATSB operational definition of relative fatigue
- develop and implement open-sourced data or a process to share data across jurisdictions.

Figure 1 illustrates how elements of the data framework (preconditions, system and process changes) come together to enable proposed activities to be undertaken.

An alternative approach is to trial process changes for an initial period

It is recognised that changing police processes could be a significant undertaking. The NTC seeks feedback on an alternative approach to trial the standard three questions, fatigue likelihood and fatigue impact scales in police crash recording processes for 24 months in nominated jurisdictions, with impacts of the trial reported to a data custodian.

Figure 1: key elements of the data framework that will enable proposed activities



5.5 Principles of data collection and research

The data framework must support data collection, research and evaluation, with articulated goals, objectives and strategies. The data framework will entail both collection and transfer of data between entities.

To ensure clarity of purpose, framework goals should set out why data is being collected. These should reflect project objectives. By example, Professor Haworth (2015, pp. 9-10) advised that activities undertaken as part of the data framework might stipulate that its data should:

- demonstrate that a given heavy vehicle driver was fatigued at the time of an incident
- establish a causal chain of errors that are consistent with fatigue

- express the involvement of fatigue in a heavy vehicle incident as a graded likelihood rather than a categorical certainty.

Support comparable and accessible data

The framework should support and facilitate comparable and accessible data. The framework should be consistent with the underlying principles of the Records of Government Services initiative and provide a solid evidence-base of real-life operational data to support research activities.

Ethical research guidelines

Just as it is necessary to establish the fundamental purposes and research methods of the data framework, it is also necessary to establish guidelines for the ethical creation, analysis and distribution of data and research findings.

The bedrock principle for ethical use of the data framework is that personal information held in and distributed through the framework is protected in accordance with the Australian Privacy Principles (APPs) and applicable standards for the ethical conduct of research in Australia.

These research standards are established in the Australian Code for the Responsible Conduct of Research[27] and the National Statement on Ethical Conduct in Human Research.[28] These codes:

- define *research* and *human research*
- explain when research should be authorised by a human research ethics committee or similar authority
- outline essential principles and practices for encouraging the responsible conduct of research
- provide a framework for resolving allegations of research misconduct.

In addition, they outline the responsibilities of research institutions to establish good governance and management practices. The National Statement is the most applicable for the data framework. It provides guidance on:

- values and principles of ethical conduct
- determining and balancing risk and benefit in research
- gaining the consent of participants
- waiving consent
- ethical considerations specific to research methods or fields.

The National Statement also provides comprehensive guidance on research governance and ethical review processes, including:

- institutional responsibilities
- avoiding and managing conflicts of interest
- monitoring approved research
- handling complaints
- ensuring accountability.

Research guidelines must stipulate that any given research has merit and integrity. This means that research is:

> *Justifiable by its potential benefit, which may include its contribution to knowledge and understanding, to improved social welfare and individual wellbeing, and to the skill and expertise of researchers. What constitutes potential benefit and whether it justifies research may sometimes require consultation with the relevant communities*.

Researchers are also responsible for designing the research to minimise the risks of harm or discomfort to participants, clarifying for participants the potential benefits and risks and to manage the welfare of the participants in the research context.

Consistent with the APPs, researchers should communicate with participants as to how their personal information will be protected, as well as their right to withdraw from further participation at any stage, along with any implications of withdrawal, and whether it will be possible to withdraw

[27] Issued by National Health and Medical Research Council, Australian Research Council and Universities Australia (2007).
[28] Issued by NHMRC, ARC, Australian Vice-Chancellors Committee (2007, revised 2014).

data. Participation in research must be voluntary, and based on sufficient information and adequate understanding of both the proposed research and the implications of participation in it.

The National Statement also provides a framework for users and custodians of a research databank. These rules require researchers and custodians observe confidentiality, and custodians should take every precaution to prevent data becoming available for uses to which participants did not consent (National Health and Medical Research Council et al 2014, pp iii-iv, 9-11, 16-17, 29).

The need for data collection and research principles in the framework

In the Australian context, most if not all contributors and users of the data framework will be employed or engaged by organisations that have comprehensive human research ethics guidelines. For example, Victoria Police has its own human research ethics committee and publicly-available terms of reference, while the Monash University Accident Research Centre is governed by human research and research data management strategies and processes.

However, given that data will be collected and transferred between organisations through a data custodian with umbrella data collection and research functions, data collection principles relating to ethics and privacy protection should capture the relationships between entities and overarching governance and data-handling responsibilities.

Framework principles may also support template agreements for data collection and transfer, and collaborative research. The Alertness CRC, for example, requires Essential Participants and CRC sub-contractors to ensure role clarity and compliance with ethics codes and guidelines adopted by the National Health and Medical Research Council.

The data framework participants' agreement could capture policies and standards relating to privacy, confidentiality and the appropriate sharing and publicising of data collection and research.

Other research considerations

The data framework will need to balance the objectives of providing authorities, researchers and industry with greater quantities and quality of information about managing fatigue risk in heavy vehicle operations, with protecting the privacy of individual drivers. In addition, transport operators will need to be reassured that commercial or otherwise sensitive information will not be given, even inadvertently, to their competitors.

Adopting a privacy-by-design approach, de-identification of data early in the collection process would be a first step in clearly distinguishing data uses. Participants should be made aware of any situations (such as a major crash investigation) where access to identified data could be made available.

6 Activities the framework could support

Key points

The framework would comprise of standardised recording processes, data collection and new research. These activities are connected and will require national coordination, taking into consideration project priorities and resourcing constraints.

By establishing comparable and available data sources, the framework can support the following activities:

Group 1 activities	**Collection and analysis of work diary records** based on activities identified from compliance and enforcement sources.
Group 2 activities	**Research to measure impact of specific fatigue regulations** – utilising the Alertness CRC, database, modelling, data fusion capabilities, objective sleep-wake and fatigue monitoring devices to compare different schedules and to determine if there are measurable differences in fatigue impairment.
Group 3 activities	**Periodic industry surveys** to collect large-scale attitudinal and behavioural data regarding driver and operations' management of fatigue.

For each activity undertaken as part of the framework, the following sections:

- provide a description of the activities that could be undertaken
- identify the priority fatigue issues that would be addressed by the activities
- data framework requirements (outlined in Table 3)
- high-level implementation requirements.

6.1 Group 1 activities: work diary and commercial data

Analysis of work diary records

Police and road agencies interact with heavy vehicle drivers through compliance and enforcement activities. While the priority is to undertake enforcement, investigation or audit activities in a regulatory and compliance context, these interactions provide an opportunity to collect improved fatigue data. Operators participating in research activities can also provide de-identified compliance data, such as work schedules.

The introduction of the EWD will further provide enhanced research capability to identify patterns of behaviour under the framework and to obtain and analyse work records more efficiently and effectively. The role of telematics more broadly can also provide highly valuable operational data. For example, vehicle diagnostic data can be used to monitor changes in driving style (such as variable speeds) to identify fatigue patterns. When matched with schedules, work diary records and/ or alertness monitoring devices, improved validation of linkages between fatigue and work patterns and regulations can be made.

Further, if infringements are linked to detailed work diary records, 'there could be considerable insight into the combinations of work and rest locations and routes that may create pressures on drivers that produce fatigue risk' (Williamson 2015, p. 4).

Consistent with proposed framework principles, fatigue data collected through compliance and enforcement activities should be de-coupled from any fatigue-related investigations. Opportunities could be explored to match de-identified data. For example, if an authorised officer identifies a pattern of behaviour, such as a nose-to-tail schedule, at the roadside based on both work diary records and telematics information, it is beneficial that both sets of data are matched for research purposes.

Under this proposed activity, when a pattern of behaviour is identified during routine compliance or enforcement activities, relevant copies of the work diary records are submitted to the data framework for research purposes:

> **Step 1** identification of a relevant pattern of behaviour during a compliance or enforcement activity.
>
> **Step 2** copies of the relevant 28 days of records are extracted from the work diary.
>
> **Step 3** records are de-identified.
>
> **Step 4** de-identified records are submitted to the open data source or data custodian with additional relevant data or information relating to the driver's state of alertness, or other relevant information.
>
> **Step 5** de-identified records are analysed by third parties or distributed by a data custodian to partner organisations for analysis (such as fatigue experts and the Alertness CRC).

Defining a pattern of behaviour

A pattern of behaviour is not a breach of the law. It refers to a legal pattern of behaviour that is of interest to policy-makers, operators or researchers due to being a potentially higher risk. To ensure the results can be standardised it is important that data is sourced from complaint drivers.

Work diary records provide a primary data source for two of the priority fatigue issues: the fatigue impact of nose-to-tail schedules and short rest break patterns of BFM two-up drivers (Williamson 2015, p. 6). These are examples of 'patterns of behaviour' that are legal but—if identified during routine compliance or enforcement activities—could be captured and submitted to the framework for in-depth analysis.

Research could also include a comparative analysis of work diary records cross-referenced with other sources (such as the periodic industry surveys, insurance data and crash data) to investigate the effects of night driving, major rest breaks and the impact of local work and long-distance driving on work schedule patterns (Williamson 2015, pp. 2-7).

In-field data collection would not require new or complex IT solutions. The relatively low prevalence of nose-to-tail schedules and BFM two-up suggests that simple processes based on scanning work diary records and emailing to a dedicated inbox may be sufficient under a practical framework model.

Officer training would be required to ensure that authorised officers are able to identify the relevant patterns of behaviour that sit outside enforcement matters.

28 days of records

Work diary records do not provide information about whether the driver was fatigued, or whether that fatigue was a result of the schedule. However, work diary records provide valuable information that can inform fatigue experts' understanding of the impact of specific regulations. The impact of nose-to-tail-schedules cannot be comprehensively evaluated because experts do not have access to the operational data that tells them 1) the prevalence of nose-to-tail schedules, 2) the frequency and position of nose-to-tail schedules within a driver's 28-day cycle of work and rest, and 3) other factors within the driver's 28-day cycle (such as longer rest breaks or reduced night driving) that mitigate the fatigue risk.

Professor Williamson (2015, pp. 4-5) advised that routinely collected work diary records provide evidence of the frequency of nose-to-tail scheduling by individual drivers and across drivers. Work diary records:

> *could also provide information on the circumstances in which these types of schedules are worked including the routes and distances drivers are working when they do these schedules, the timing of work and rest within the nose-tail arrangement and hours option drivers are using. This additional information will aid in understanding and estimating fatigue risk associated with nose-to-tail schedules*.

For these reasons, fatigue experts seek 28 days of work diary records, not limited to the two days of records across which the nose-to-tail schedule appears. A similar benefit of collecting 28 days of records exists in relation to BFM two-up driving.

It is acknowledged, however, that collecting 28 days of work diary pages would increase the time spent on some enforcement intercepts and therefore have resource implications for police, road agencies and the NHVR. The NHVR has a key role, with responsibility for standardising and co-ordinating on-road practices.

The removal of work diary pages must also be for a *lawful purpose* and whether or not a research undertaking is a lawful purpose in the circumstances will need to be addressed.

An alternative source of data could be filled-up work diaries that have been returned to road agencies. De-identified, this data would provide the same information, although identifying the patterns of behaviour in a manual process would be labour-intensive and compliance with privacy principles would have to be addressed.

Analysis of commercial fatigue management data

The provision of commercial fatigue management data by third party service providers to the framework for research analysis is another rich source of driver data, which – properly de-identified and provided with consent – can provide valuable information about driver patterns of behaviour. Commercial systems that capture driver logbook and scheduling data could have a higher value than written work diary records because they are likely to be highly accurate and not provided in an enforcement context.

Operators are increasingly using third party commercial services to conduct internal compliance and safety checks. These data sources could be used to identify average sleep opportunities of heavy vehicle drivers in different operational models and the frequency of nose-to-tail schedules within 28 day periods.

However, while there are significant benefits linked to analysis of commercial fatigue management data, it is clear that this approach would require strong partnerships between third party service providers, operators, the data custodian and research institutes. Governance arrangements would be required to ensure that drivers' privacy is protected and that the data is only used for research purposes.

The NTC invites submissions from commercial third party service providers and operators to comment on the feasibility and challenges associated with this potential approach.

Priority fatigue issues addressed by group 1 activities:

- nose-to-tail schedules
- impact of lack of rest break requirements for BFM two-up drivers
- impact of local work
- impact of thresholds
- capturing prevalence of drivers taking rest breaks within minimum periods.

High-level requirements to implement group 1 activities:

- officer training and education to identify a relevant pattern of behaviour
- agree and implement process to de-identify and submit work diary records to an open data source or data custodian
- agree and implement processes to access or share data for analysis.

6.2 Group 2 activities: research to measure impact of laws

The data framework can provide a platform to support a range of research activities. A platform approach enables a bank of data to be developed that can provide evidence for any number of policy issues, including nose-to-tail schedules, sleep quantity and quality on major rest breaks, impact of longer work hours under BFM or AFM, and measuring fitness to work at the start of the shift with monitoring of fatigue/alertness levels during the shift (Howard 2015, p. 89).

A platform approach also ensures that standard methodology, terminology and assumptions are adopted. Professor Dawson 2015, p. 2) described the optimum conditions to conduct data collection and research activity within a data framework:

> *It will … be important to develop "platform" data that will enable a much broader level of systematic data collection over time. [The development of a] tool-kit of accepted methodologies for answering specific questions in the field of fatigue research, enabling the comparative use of research over time, should be prioritised*.

Elements of a data platform approach

The value of the data platform approach lies within the standardisation of key elements that are common to data collection and research activities, thereby facilitating comparative analysis. Professor Dawson (2015, p. 3) advised that the following key elements should be **standardised**:

- subjective and objective measures of fatigue and alertness
- measures of sleep wake behaviour, including EEG, actigraphy and sleep diaries
- methods of recording work and rest data
- data format for entering, recording and displaying data
- guidelines for using and interpreting modelled data
- definition and methodology for determining fatigue likelihood
- in-vehicle monitoring system measures to identify fatigue-related changes in driving performance
- method to quantify the personal and corporate socio-economic effects of fatigue-related changes in alertness and/or driving performance (measured using in-vehicle monitoring systems.

The Alertness CRC may be able to provide this platform to support the research activities.

Within a data platform approach, new research can be undertaken to measure the impact of specific fatigue regulations. Capabilities of the Alertness CRC can be used to compare different schedules and to determine if there are measurable differences in fatigue impairment.

There are three research areas where the Alertness CRC can provide value to the framework:

- In-field research using alertness monitoring devices to scientifically compare fatigue and alertness impact of different schedules (such as a comparative analysis of nose-to-tail and conventional schedules).

- Objective monitoring of sleep and rest periods in conjunction with sleep/work diaries, to assess the level of sleep drivers are achieving on short and long rest breaks.

- Drawing on the modelling and data fusion capability of the Alertness CRC and other modelling programmes to use multiple sources of scheduling and crash data to improve understanding of linkages between different regulations and alertness levels.

The Alertness CRC is also contributing to the development of a practical and validated methods to screen and manage sleep disorders (such as sleep apnoea) in drivers. This work will be invaluable in the context of managing heavy vehicle driver health issues, but is not a separate project that is required as part of the data framework.

In-field research to measure impact of regulations on fatigue

Alertness monitoring devices can be installed in heavy vehicle driving operations to measure the alertness of drivers undertaking nose-to-tail schedules compared to conventional schedules, and evaluating sleep quantity and quality of drivers on different lengths of short and major rest breaks, including BFM two-up drivers. Alertness monitoring devices could be supported by self-reported sleepiness tests, in-vehicle monitoring (such as driving style diagnostics) and driver sleep diaries and questionnaires.

Typically any evaluation of work and rest, as well as sleep, should be conducted over a period of one month at a minimum (Williamson 2015, p. 7).

Assessment of driver sleep quantity and quality

Sleep actigraphy instruments can measure driver sleep quantity and quality. Research conducted under the framework could evaluate the sleep quantity and quality of selected heavy vehicle drivers, with the objective of assessing whether drivers taking minimum rest breaks allowed in the HVNL have sufficient sleep opportunity. This would include assessment of sleep quantity and quality of drivers on standard hours with a minimum seven hours of sleep opportunity, and drivers on BFM with a minimum six hours of sleep opportunity.

Dr Howard (2015, p. 8) advised that research should compare sleep during long rest breaks of 12 hours or more with sleep during seven-hour rest breaks (including naps) and the impact on objectively measured alertness during the related drives:

> *Results would need to be controlled for other factors, such as time of day (rest period/sleep during the day vs rest period/sleep at night). Ideally assessments would be made with the same driver under different conditions and across a sequence of days when there is more than one rest break of seven hours duration. This would enable determination of the amount of sleep obtained during seven hour breaks during both the day and night, the amount of supplementary sleep obtained from naps under these conditions and the relationship between these schedules and fatigue/alertness*.

Sleep actigraphy instruments could be supported by self-reported sleepiness tests, in-vehicle monitoring (such as driving style diagnostics) and driver sleep diaries and questionnaires.

To provide a comprehensive analysis, research could be extended to include sleep quantity and quality on reset rest breaks.

To overcome individual differences, the research should be undertaken on heavy vehicle drivers rather than the general population, be undertaken in in-field operational and on a significant scale to establish a robust evidence base. The sleep research should also be undertaken within vehicle sleeping berths, given that studies have suggested that in-cab sleeping facilities 'can increase the relative sleep fraction for a sleep opportunity when compared to estimates derived from people living in residential settings' (Dawson 2015, p. 3).

Modelling the fatigue effects of work schedules

The Alertness CRC is developing data fusion and shift modelling capabilities. Its objectives are to:

- develop a physiologically-based model of alertness, sleep and circadian dynamics
- develop a Data Fusion System for real-time individual predictions of these dynamics.

These will form the basis for multiple products and applications such as scheduling, lighting design, and alertness prediction software.

The modelling and data fusion streams are interdependent. The physiologically-based model will be developed to predict alertness, sleep and circadian phase dynamics based on light exposure, shift schedule, and a range of individual/group parameters in controlled and real-world conditions.

This model will be the core element for the development of a Data Fusion System, capable of real-time alertness prediction for individuals. The fusion software will then be integrated into personal individualised alertness prediction devices developed through the Alertness CRC project activities. This can include supporting predicative analysis of different heavy vehicle driver schedules.

Dr Howard noted that model inputs such as jurisdictional fatigue-related crash reports would also have to be standardised to be incorporated into data fusion and modelling.

Next generation of alertness monitoring devices

The Alertness CRC will develop the next generation of evidenced-based alertness management tools. Current laboratory-based studies are underway to identify novel biomarkers of alertness. Using state-of-the-art data fusion techniques, biological and neurophysiological data inputs will be combined for individualised alertness assessment.

Measuring alertness at the individual level is an essential component of measuring, monitoring and predicting alertness within transportation, and other safety-critical industry sectors. The Alertness CRC recognises the need for personalised approaches to alertness management and will improve on subjective self-reporting and the current inadequate 'one-size-fits-all' approach to managing alertness.

Current proof-of-concept studies to identify biomarkers of alertness will provide foundational data to develop prototype systems for individualised alertness testing, monitoring, prediction and management.

These 'next generation' tools could draw on the data collected under the framework. These tools could be implemented in a range of scenarios in a similar way in which alcohol is tested today – including roadside testing, workplace testing for fitness for duty, sleep disorder diagnostics and to support optimal shift work scheduling.

- Alertness CRC

Pre-existing modelling capability

A range of pre-exiting shift modelling programmes that are not part of the Alertness CRC can provide data analysis capability. For many years, sectors which rely on shift workers with a high level of responsibility, including mining, rail, healthcare and aviation, have managed safety in part by using bio-mathematical tools to model the effects of specific work and rest patterns on their workers' performance and safety.

For example, the *System for Aircraft Fatigue Evaluation* uses algorithms that enable aircraft operators to estimate the likely fatigue risk of different work shifts, taking into account factors such as trans-meridian travel, cumulative fatigue and on-board napping.

These risk factors are measured against data obtained from thousands of completed rosters to produce a fatigue score. The score is also calculated from data describing the fatigue effects of:

- time of day of work and rest breaks
- duration of work and rest breaks
- work patterns of previous seven days
- all of these factors in concert with circadian rhythm and other biological factors, particularly sleep.

Bio-mathematical models rely on data that is comprehensive enough to predict the relative fatigue of an average person experiencing a particular pattern of work and rest hours, so that likely higher risk patterns are identified and addressed. In this way, roster patterns can be adjusted to lower fatigue scores or ratings.

The road transport sector has not made extensive use of bio-mathematical models for estimating fatigue risk in specific work schedules. Professor Dawson advised that it would be useful to extend previous validation studies of the models from other industries to the road transport sector. [29]

Professor Dawson (2015, pp. 3-4) considered the value of modelling in the context of evaluating BFM. He advised that a research project surveying industry work patterns is undertaken, using bio-mathematical models that 'would enable the fatigue likelihood and sleep opportunity of BFM to be estimated against the fatigue likelihood and sleep opportunities under standard hours and relative to AFM'. This would be:

a critical step in assessing the validity of the BFM policy structure, as it would provide empirical data on the increased likelihood of fatigue/reduced sleep opportunity associated with different regulatory regimes. The specific BFM questions could be answered as a subset of the broader survey of working time arrangements.

Research activities should also make full use of existing evaluation of work-rest characteristics and schedules for heavy vehicle and other industries. These include studies conducted by Central Queensland University, Curtin University, Monash University, Queensland University of Technology and the University of New South Wales (Williamson 2015, p. 8).

Priority fatigue issues addressed by group 2 activities:

- nose-to-tail schedules
- insufficient sleep, including quantity and quality of sleep in major rest breaks
- impact of additional hours worked under BFM and AFM
- no short rest breaks required for two-up drivers working BFM
- impact of night time driving
- impact of local work
- driver wellbeing and fitness to work.

High-level requirements to implement group 2 activities:

- agree standardised definitions and terminology
- initiate research projects with the Alertness CRC
- industry partnerships to participate in the research activities.

6.3 Group 3 activities: periodic industry surveys

Periodic industry surveys are used by agencies to collect large-scale attitudinal and behavioural data. The NTC and TfNSW have commissioned periodic, or wave surveys, on a range of themes.[30] Industry has also undertaken its own field studies to better understand driver fatigue.[31]

The NHVR, TfNSW and a number of experts have recommended that periodic surveys are commissioned as part of the framework to measure over time how fatigue is managed by drivers, operators and others in the chain of responsibility. The aim would be to survey and quantify the range of operating schedules and practices across the industry so that a baseline of industry practice can be established. For example, periodic surveys could track the extent to which drivers and schedulers maximise work and rest periods permitted in the HVNL. Professor Dawson (2015, p. 2) advised that 'until we have a clearer understanding of actual operating practices as distinct to maximum allowable working practices, it will be difficult to characterise the risk landscape associated with road transport in Australia'. Professor Williamson drew a similar conclusion – that research:

should involve companies and/or drivers currently working variations of the work-rest option or characteristic of interest. The best approach to these evaluations would involve employing measures of a combination of details of work and rest opportunities, indicators of fatigue in driving performance, driver performance capacity and current state, and safety outcome measures including crashes and infringements.

The periodic surveys could be collected and analysed by a data custodian, or by agencies on behalf of a data custodian. Survey results could also form inputs into the Alertness CRC's data fusion capability.

The AMR surveys referenced in this discussion paper provide an example of a periodic survey that captures fatigue issues. A larger scale period survey is the *Queensland Road Safety Campaign Survey*, which was reporting wave 20 in 2011. This is a frequent survey of around 400 respondents. It captures, for example, motorist attitudes towards fatigue and its attribution to

[30] For example, the NTC has commissioned periodic attitudinal surveys regarding fatigue and compliance: AMR Interactive, 2013, *Reform Evaluation in the Road Transport Industry, 2012: Driver Fatigue*.
[31] For example, Integrated Safety Support, 2011, *The Value of Rest: investigating the impact of rest opportunity and sleep quantity and quality in Australian truck drivers* (prepared for NatRaod).

long-distance driving between 2009 and 2011 (Market and Communications Research 2011, pp. 106-11).

A periodic industry surveys conducted as part of the data framework could capture the following information over time. They relate directly to the priority fatigue issues canvassed in **chapter 6**:

- hours option – whether standard hours, BFM or AFM
- work patterns, including night driving
- sector the driver is operating within, such as line-haul or urban delivery
- region, such as metropolitan or remote
- demographic factors of drivers, including sex, age, weight and height
- medical conditions that may impact alertness, and how they are treated
- fatigue management systems used
- sleep quantity and quality over last seven days, including naps
- self-reported feelings of drowsiness or sleepiness.

Data could also be drawn from operator surveys or questionnaires undertaken to assess a driver's fitness to work prior to the commencement of a shift. Such data – which should be de-identified for the purposes of the framework – is likely to vary depending on each operator's focus and workplace culture, but could include questions relating to sleep quantity and quality the previous night; and family, health and lifestyle issues that affect the wellbeing of drivers.

Priority fatigue issues addressed by group 3 activities:

- insufficient sleep, including quantity and quality of sleep in major rest breaks
- impact of additional hours worked under BFM and AFM
- impact of night time driving
- impact of local work
- driver wellbeing and fitness to work
- prevalence of minimising rest periods within the law
- threshold parameters.

Industry surveys can also help governments better understand impediments to compliance with mandated work and rest hours. By including questions about availability and capacity of rest areas, and the level of facilities in place to support quality sleep, surveys provided an additional opportunity to identify rest area gaps and opportunities.

High-level requirements to implement group 4 activities:

- input from industry, drivers, fatigue experts, NHVR, agencies and the Alertness CRC in the development of the surveys
- commission and implement surveys
- analysis of results – including as an input into the Alertness CRC data modelling and data fusion system.

7 Project risks and final considerations

Early discussions with stakeholders indicate that a data collection and research undertaking of this scope and depth will have a range of risks that should be taken into account in the design and implementation of the data framework.

The industry survey, for example, found that operators and drivers highest concerns were in relation to the protection of driver privacy and the fear of prosecution arising from participation in the project. Respondents also raised commercial and intellect property sensitivities and reported concerns about the costs of data collection and analysis.

We have identified key risks for further discussion – it will be important that the overall design of the framework, in addition to whichever options are implemented, take into consideration these risks.

Below are four key risks identified to date, but there are broader risks around losing stakeholder momentum and resource costs to implement options that may want to be further explored in submissions to this discussion paper.

Risk that research results will not be representative of industry

One of the challenges facing fatigue management and fatigue research generally is that fatigue impairment is impacted by individual, biological differences. Data collection and research activities should be designed and implemented to reduce the impact of these individual differences as far as practicable, and the research offering of the Alertness CRC—with its focus on progressing biological markers for sleep disorders and objective alertness monitoring—will go a long way towards reducing this problem. Well-established fatigue impairment models built on objective measures that exist outside of individual differences (primarily time since last sleep and circadian rhythms) are also important contributions.

Building on these methods, research results will have greater levels of acceptance if participants are representative of industry, namely heavy vehicle drivers who operate in the key sectors regulated by the HVNL. This is primarily long-distance road transport (freight and coach drivers), but also drivers engaged in urban freight deliveries and local bus services.

Where possible, research activities should draw from a drivers' representative of the industry, except in the circumstances where a control group is introduced for comparison purposes.

Industry-specific factors that are relevant to the research results may manifest themselves in a number of ways that should be further explored, bearing in mind there are cost and complexity issues associated with any new controls introduced. These factors could include:

- the health profile of the driver demographic
- normalised shift work, particularly at night
- self-selected demographic with a predisposed ability to be less impacted by long hours of driving (reducing impact on fatigue, as opposed to sleepiness).

Risk that use of drugs by drivers will impact research outcomes

The 2012 AMR Interactive report asked 500 heavy vehicle drivers to rate the helpfulness of 12 identified (on-road) strategies in managing fatigue. When driver responses were positive toward taking stay-awake drugs, the interviewer asked them to clarify which 'stay-awake' drugs they would consider drivers find to be effective. The survey did not ask drivers about personal drug use, but whether they thought that drug use was an effective method for managing the effects of fatigue.

The survey results were compared to a similar survey conducted in 2006. It found that:

- There was some reduction from 2006 in drivers considering caffeine/energy drinks as helpful in preventing fatigue, although it was still nominated as helpful by half of drivers. Taking stay-awake drugs continued to be considered helpful by a minority of companies (5 per cent) and drivers (15 per cent).

- the most common stay-awake drugs mentioned were amphetamines (including speed and methamphetamines), followed by Duromine[32] and No-Doz.[33]

Drug use includes both central nervous system stimulants and depressants, such as cannabis. While it is not an objective of the framework to measure the prevalence and impact of drugs by heavy vehicle drivers, there is a risk that without considering the impact of stimulants and depressants on the heavy vehicle driver population, the validity of the research results could be questioned.

One approach to consider is the introduction of a comparison group with lower (or no) drug use, although this may rely on assumptions about relative levels of drug taking in both groups.

Alternatively, drug taking could remain an unknown without significantly impacting upon the research results. For example, if we are to compare nose-to-tail schedules with conventional schedules using the same group of drivers, this commonality reduces the issue of drug-taking, assuming that the same or similar level of drugs are taken by the same drivers under both schedules. This approach, however, does not factor in drug-taking at some times and not others.

Drug testing remains the most robust and validated mitigation to manage potential drug taking in participant sample. Drug testing, preferably based on hair samples, will increase research cost and complexity, and potentially impact participation rates, but is the most comprehensive means by which the impact of drugs on alertness measures can be reliably factored.

Risk that fatigue impairment parameters cannot be agreed

There is a risk that data collection and research findings will be undermined if the theoretical threshold at which a driver becomes too fatigued to drive cannot be agreed.

The NTC and NHVR could work with stakeholders in industry and the research community to agree a sleepiness scale to be adopted. Further consideration should be given to the adoption of both a 'likelihood of fatigue' scale and a *likelihood of fatigue error scale*, as recommended by Professor Dawson.

Unless near misses can be better measured through in-vehicle technology, crash and incident data remains the best indicator of unacceptable fatigue impairment. Therefore, data collection activities could achieve more robust outcomes if sleep quantity and quality of two groups of drivers are measured: those who have been involved in fatigue-related crashes, and those who have not. Professor Dawson advised that comparative results should demonstrate where possible that drivers *not* involved in fatigue-related crashes have more sleep and better quality sleep than drivers who are.

Industry wave surveys can significantly mitigate this problem if a correlation can be drawn between sleep quantity and quality and levels of fatigue impairment based on survey results.

Risk that personal information will be identifiable and used for enforcement

Candidate drivers and operators may not engage with data collection and research activities if they have a perception that data will be identifiable and used for enforcement purposes.

Embedding national framework principles (chapter 4) in design and implementation will be critical to mitigating this risk. It will also be important to clearly demarcate between information collected for enforcement and investigation purposes (such as roadside checks and crash investigation) which will not be subject to de-identification, but subsequently collected under the national framework and be de-identified.

Finally, it may be appropriate to consider which entities should undertake data collection and research activities. Perceptions that personal information will be identifiable and used for enforcement could be mitigated if the coordinator of the data was not also a regulator, but this needs to be balanced with other considerations, such as resources, skill sets and the national focus of the framework.

[32] A prescription stimulant drug, similar to amphetamines and used as an appetite suppressant.
[33] Over the counter caffeine tablets.

Appendix A: Glossary

Term	Definition
Actigraphy	A method to monitor human rest/activity cycles – usually involving a device worn like a wrist watch
AFM	Advanced Fatigue Management
Alertness CRC	Cooperative Research Centre for Alertness, Safety and Productivity (Alertness CRC)
BFM	Basic Fatigue Management
Circadian rhythm	Physical, mental and behavioural changes that approximately follow a 24-hour cycle, responding primarily to light and darkness
Data custodian	An entity that has overarching responsibility for the data framework and data sharing
EEG	Electroencephalogram – a test that uses electrodes attached to the scalp to detect electrical activity in the brain
Fatigue	Defined term in the HVNL: an inclusive term that includes feeling sleepy, drowsy, weary or tired
HVNL	Heavy Vehicle National law – regulates driver fatigue in all jurisdictions except Western Australia and the Northern Territory in vehicle over 12t (or buses over 4.5t and 12+ people carrying capacity)
Phenotyping	To measure the inherent characteristics of a thing
Sleepiness	The propensity to fall asleep

Appendix B: Government databases

Organisation	Database	Notes
QLD TMR	RoadCrash	Oracle database, sourced from QPRIME data – available for research purposes
QLD Police	QPRIME	Crash reporting system that includes duration of last rest break, time and duration of last sleep
VicRoads	Road Crash Information System (RCIS)	Crash database – does not include specific fatigue-related data
VicRoads	Regulatory Services database	Holds e-copies of work diary records collected by TSS at on-road intercepts. Lotus Notes
VicPol	Traffic Incident System (TIS)	Electronic crash reporting system
SA Police	Vehicle Collision System (VCS)	All-vehicle crash data: crash code can indicate fatigue as 'inattention'
SA Police	Offender Record Manage-ment System (ORMS)	Details any fatigue breaches via offence code/ section number
SA Police	Expiation Notice System (ENS)	Details any fatigue breaches via offence code/ section number
SA DPTI	TARS	Oracle database that uses MS Access to query data and generate web-based maps. Data derived from police VCS data
NSW Centre for Road Safety	CrashLink	Oracle Discover database, uses data from NSW Police. Collect data on time of day, day of week, number of vehicles involved, vehicle type (including HVs); outside of CrashLink, RMS collects work schedules and diary records
NSW Centre for Road Safety	Heavy Vehicle Rating System (HVRS)	Risk-based system that stores operator breaches of fatigue
NT Government	Vehicle Accident Database (VAD)	Crash data collected by NT Police in Crash Report Form and recorded on the VAD. Includes "Fatigue-Y/N" as a contributory factor

Appendix C: Examples of alertness monitoring devices

Seeing Machines and Optalert are two example of alertness monitoring devices that can be used for research and operational purposes to monitor and manage driver fatigue. They are both partner organisations in the Alertness CRC. The following descriptions of the technology have been provided by Seeing Machines and Optalert respectively. They are provided as illustrative examples only – there are a range of other alertness monitoring devices that could be used for research purposes in the framework.

The NTC is not advocating any of these particular devices or supporting claims made by Seeing Machines Fleet Solution or Optalert.

Seeing Machines Fleet Solution

Seeing Machines Fleet solution uses smart cameras and algorithms to track a driver's face, eyes and eyelids to monitor attention / inattention and driver fatigue. Using the information captured by these algorithms we are able to support drivers by measuring their alertness and attention levels in real time and provide feedback when needed. The technology works by tracking driver eye and facial movement to provide fleet operators an objective way of detecting and preventing driver fatigue and distraction events. The moment a threat is detected, the system alerts the driver and the monitoring staff through in-vehicle alarms and seat vibrations while sending an informative data package to the central monitoring team for further analysis and action.

The system also reports back real time to a web application, providing fleet company management heightened visibility of their operations and driver fatigue levels, and thus their overall risk exposure. Seeing Machines also provides a regular suite of trend reports and analytics to enable organisations to implement policies and programs to further mitigate risks associated with operator fatigue and distraction.

Factors being detected

The eye-tracking software detects drowsiness via micro sleeps, which are measured by monitoring the eyelid behaviour of the driver sixty times per second. Other factors that contribute to the determination of fatigue are also measured, including changes to facial features (drooping mouth edges) and head behaviours (such as head roll), which are synonymous with the onset of drowsiness.

Head position tracking identifies when the driver is facing away from the road for too long or if the head dips forward, both of which are signs of inattention. Distraction events are captured by the head position.

System reliability

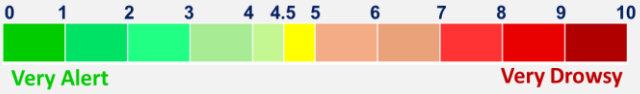
For more than eight years, Seeing Machines has conducted field studies, implemented the technology in over 4,000 trucks and vehicles worldwide, and analysed the data for continuous improvements and refinements for delivering the most effective safety monitoring system in the industry. Achieving a sustained 80 per cent reduction rate of fatigue and distraction events, operators are protected more than ever.

The technology is the subject of multiple patents. More information about Seeing Machines can be accessed at: www.seeingmachines.com.

Optalert

Optalert is an Australian-based company that has developed technology for continuous, real-time monitoring of alertness/drowsiness levels of operators whose job requires almost continuous vigilance, such as haul truck driving at mines and 24-hr road transport operations.

Optalert uses infrared reflectance oculography to measure the relative velocity and duration of eyelid movements during blinks that occur spontaneously during wakefulness. A small sensor array housed in a pair of glasses is used to illuminate the eye with infrared (IR) light to determine the eye and eyelid activity, then patented drowsiness detection algorithms calculate a drowsiness score on a proprietary measure of drowsiness, the Johns Drowsiness Scale (JDS™).



The JDS™ is calibrated against the relative risk of “performance failure” at the time, such as the risk of driving off the road and crashing.

Optalert’s latest drowsiness detection system consists of wireless glasses paired with either a ruggedised tablet or a small, light-weight device. Optalert devices are mounted in an operator’s vehicle cabin, with the JDS™ score visible on the device screen and updated every minute.

Optalert’s technology does not simply detect eye closure. It is designed to detect the early signs of drowsiness, thereby warning the user before they involuntarily close their eyes. A loud audible warning is issued when the operator’s drowsiness approaches a dangerous level.

For research users, eye movement data can also be retrieved from the device and analysed using Optalert’s research software to re-generate ocular variable data and JDS™ scores.

Optalert’s technology is patented and has been independently validated, as described in several peer-reviewed journals. More information about Optalert can be accessed at: http://www.optalert.com/.

Appendix D: Example of crash investigation guidelines relating to fatigue

Example of crash investigation guidelines when fatigue is identified (QLD TMR) [34]

Your observations of drivers involved in traffic crashes may indicate physical signs of fatigue. These observations may include:

- slurring words
- blood shot eyes
- unsteady gait
- dishevelled clothing
- lack of concentration.

In the investigation of all traffic crashes careful questioning of drivers together with other corroborative evidence will assist in finding the cause of the incident, and proving any criminal responsibility (for example dangerous operation of a vehicle). In particular, the following fatigue-related questions that investigators are required to ask about sleep include:

1. How much sleep did you have in the last 48 hours?
2. What time did you get up this morning?
3. When did you last sleep? Where?
4. How long did you sleep for?
5. Where had you driven from?
6. How long did it take you?
7. What breaks did you have in your driving?
8. Were you feeling tired or drowsy?
9. How tired were you?
10. When did you first start feeling tired?
11. What did you do?
12. How far from the incident scene was that?
13. Have you been taking anti-sleep pills (number and dosage)?
14. Why didn't you stop and have a sleep?
15. Are you a shift worker?
16. What shifts do you work?
17. What shifts did you work this week (days and hours worked)?
18. When did you finish work today?
19. Did you drive straight from work to (crash location)?
20. Can you explain what you do at work?

34 Information provided by ANZPAA, 12 August 2014.

21. Do you have rest breaks at work? How long?

22. Did you have a rest break on your last shift?

23. What did you do after finishing work on your last shift?

24. Do you suffer from sleep apnea?

25. (If yes) Can you explain your knowledge of this condition?

26. Are you under the treatment of a doctor? What is the name of your doctor?

27. When did you last see the doctor?

28. What advice does the doctor give you to manage the condition?

The above questions are a guide only and questioning should be adjusted to the occasion. One very important purpose of the questioning is to establish whether the driver was aware (or should have been aware) he/she was fatigued and, despite the warning signals, kept driving.

Other inquires to support fatigue as a cause may include:

(i) mobile phone records
(ii) traffic camera and service station footage
(iii) down-loading engine management systems and satellite tracking records (if available)
(iv) interviewing friends
(v) interviewing family members
(vi) interviewing work colleagues.

Appendix E: References

AMR Interactive, 2013, *Reform Evaluation in the Road Transport Industry, 2012: Driver Fatigue.*

Austroads, 2013, *Heavy Vehicle Safety Data*, prepared by Raftery et al., CASR, University of Adelaide.

Australian Transport Safety Bureau, 2002, *Fatigue-related crashes: an analysis of fatigue-related crashes on Australian roads using an operational definition of fatigue*, Canberra.

Bureau of Infrastructure, Transport and Regional Economics, 2015 *Road trauma involving heavy vehicles 2014 statistical summary*, Commonwealth of Australia, Canberra.

Dawson D, 2015, *Advice to the National Transport Commission in relation to the development of a Heavy Vehicle Fatigue Data Framework*, Appleton Institute, Central Queensland University, Adelaide.

Haworth N, 2015, *Advice to the National Transport Commission in relation to the development of a Heavy Vehicle Fatigue Data Framework*, Centre for Accident Research and Road Safety, Queensland University of Technology, Brisbane.

House of Representatives Standing Committee on Communications, Transport and the Arts, 2000, *Beyond the Midnight Oil: an inquiry into managing fatigue in transport*, Parliament of the Commonwealth of Australia, Canberra.

Howard M, 2015, *Advice to the National Transport Commission in relation to the development of a Heavy Vehicle Fatigue Data Framework*, Institute for Breathing and Sleep, Austin Hospital, Melbourne.

Integrated Safety Support, 2011, *The Value of Rest: investigating the impact of rest opportunity and sleep quantity and quality in Australian truck drivers*, Adelaide.

Main Roads Western Australia, 2012, *A review of road crash data definitions utilized in Australia and recommendations towards harmonization*, Perth.

Main Roads Western Australia website, accessed 17/06/2015: https://www.mainroads.wa.gov.au/UsingRoads/HeavyVehicles/Accreditation/Pages/Accreditation.aspx.

Market and Communications Research Pty Ltd, 2011, *Queensland Road Safety Campaign Survey Report,* Wave 20, Sydney.

National Health and Medical Research Council, Australian Research Council and Australian Vice-Chancellors' Committee, 2014, *National Statement on Ethical Conduct in Human Research*.

National Heavy Vehicle Regulator website, accessed 17/06/2015: https://www.nhvr.gov.au/node/872.

National Transport Commission, 2007, *Guidelines for Managing Heavy Vehicle Driver Fatigue*, National Transport Commission, Melbourne.

National Transport Commission, 2014, *Counting Time and Residual Risk Final Report*, National Transport Commission, Melbourne.

National Transport Commission website accessed 08/07/2015: http://www.ntc.gov.au/Media/Reports/(159F4D5E-FCF2-4C1E-8C9E-3318AEFF9116).pdf

National Truck Accident Research Centre, 2015, *Major Accident Investigation Report: covering major accidents in 2013*, National Truck Accident Research Centre, Brisbane.

Neuman, Lawrence W, 2000, *Social research methods: qualitative and quantitative approaches*, Allyn and Bacon, Boston.

Productivity Commission, 2012, *Report on Government Services*, Volume 1, Melbourne.

Queensland Department of Transport and Main Roads, 2015, *Open Data Strategy 2015-2018,* Brisbane.

Williamson A, 2015, *Advice to the National Transport Commission in relation to the development of a Heavy Vehicle Fatigue Data Framework*, Transport and Road Safety (TARS) Research, Sydney.

VicRoads, 2015, *2014 Analysis of the Victorian Road Toll: fatalities and serious injuries*, Melbourne.